Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Annual CNSC Staff Report for 2004 on the Safety Performance of the Canadian Nuclear Power Industry

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ANNUAL CNSC STAFF REPORT FOR 2004
ON THE SAFETY PERFORMANCE OF THE CANADIAN NUCLEAR POWER INDUSTRY

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SUMMARY

This report summarizes the Canadian Nuclear Safety Commission (CNSC) staff's assessment of the Canadian nuclear power industry's safety performance in 2004. The report describes the licensees' programs and implementation in nine safety areas. The stations at Darlington and Gentilly-2 are currently in the middle of the period covered by their operating licences. This report is intended to serve as a "mid-term report" for those two stations.

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 2004. 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 2004 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 2004. There were a few significant changes in the assessment of the programs within the safety areas, but more changes in the assessment of the implementation of the programs. On average, program implementation among the licensees improved during 2004, based on the grades assigned by CNSC staff.

As in previous years, the industry continued to deliver good programs for Environmental Performance and Safeguards. With the exception of one station in each case, Emergency Preparedness and Radiation Protection were also noteworthy strengths for the industry.

However, the Performance Assurance safety area remained, in general, a weakness for the licensees. At least one program within that safety area was a problem area for each of the sites. In general, Quality Management remained a weakness at the multi-unit stations, whereas Human Factors remained a weakness at the single-unit stations.

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 2004. 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 or 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 inspections by CNSC staff, document and event reviews, and CNSC performance indicators (PIs).

Section 1 of the report focuses on individual power reactor sites and provides detailed assessments of the safety areas and programs, especially where programs or performance fell below CNSC staff expectations. The stations at Darlington and Gentilly-2 are currently in the middle of the period covered by their operating licences. This report is intended to serve as a "mid-term report" for those two stations. Additional details and a brief conclusion are provided for both of them.

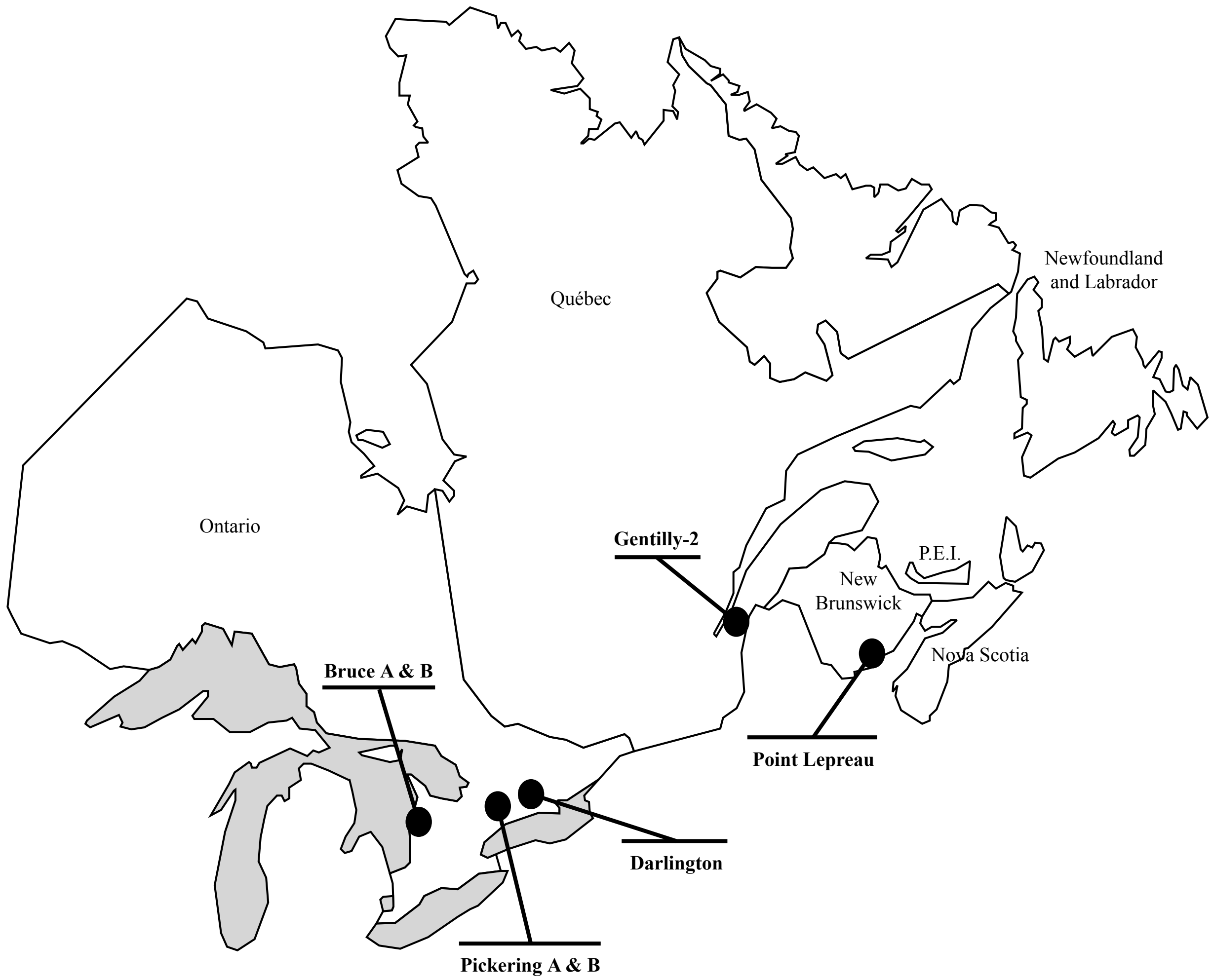
Section 2 makes comparisons between stations, shows year-to-year trends, and highlights significant issues that pertain to the industry at large. It also contains tables of PI data and tables that summarize the grades for the licensees in 2004.

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 2004 were reported to the *Commission* via *Commission Member Documents* (CMDs) called Significant Development Reports (SDRs). Appendix D, which is based on the SDRs, describes the significant developments relevant to power reactors in 2004 and follow-up activities.

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

Figure 1 (on the following page) shows the location of all power reactor sites in Canada, the number and generating capacity of the reactors, the year of the initial start-up, 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*, 17 provided power to the electrical grid in 2004. Rehabilitation was conducted on three other reactors (Pickering A Units 1 to 3), while two reactors remained defuelled and in a *lay-up state* (Bruce A Units 1 and 2).



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 Bunswick Power
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	2005/06/30	2008/06/30	2006/12/31	2005/12/31

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

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 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 the employer 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 performance and training 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. Performance Assurance groups three programs together: Quality Management, Human Factors, and Training, Examination and Certification.

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

The Human Factors program is 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), 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

The Safety Issues program 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 the currently available 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 GAIs. 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 SSC 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

Maintenance relates to the requirements and activities to maintain the plant SSC in a state that conforms to the current design requirements and analysis results.

Licensees are required to maintain their SSC 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 system (HTS) 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

Reliability relates to assessing, testing, monitoring, reporting, and setting targets for plant systems whose failure impacts on the risk of a release of radioactive or hazardous material. Licensees are required to ensure that systems whose failure impacts on the risk of a release of radioactive material be part of a reliability program. Licensees must establish a program that includes setting reliability targets, performing reliability assessments, testing and monitoring, and reporting. 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 which ensure that SSC 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's quality assurance (QA) 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 Performance

Environmental Performance relates to the programs that identify, control and monitor all releases of radioactive and hazardous substances from the 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 NSCA 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, and compliance includes the timely provision of reports on the movement and location of all nuclear materials and 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 and document and event reviews.

The sub-sections for Darlington and Gentilly-2 also serve as "mid-term reports" for the current terms of the operating licences for those two sites. As such, those sub-sections contain detailed discussions of programs and safety areas requiring attention from the licensees. Also, those sub-sections briefly address relevant conditions in the operating licences and present brief conclusions for Darlington and Gentilly-2.

1.1 BRUCE A AND 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

Early in 2004, Bruce A Unit 3 was restarted and synchronized to the power grid. During 2004, Bruce Power determined the feasibility of restarting Bruce A Units 1 and 2 and is currently in an environmental assessment process for their potential restart. No decision has yet been announced on whether a project to restart these units will be undertaken.

Bruce Power also underwent an environmental assessment process in 2004 for the new fuel project, which would entail using a low-void-reactivity fuel in the Bruce B reactors.

Bruce Power improved its performance in 2004 based upon CNSC inspection findings. Bruce Power continued to work on uniting the Bruce A and Bruce B sites with a common set of procedures, processes, and approaches to issues.

1.1.1.1 Organization and Plant Management

Bruce Power continued to integrate the organization of the Bruce A and B sites. Management provided leadership to staff and promoted safety. The licensee has moved to a more global approach with the integration of the Bruce A and B sites and by aligning Bruce Power processes with international standards. This integration will be tested in 2005 when the first audit of Bruce Power is completed by the World Association of Nuclear Operators.

CNSC staff observed promotion of safety and good compliance with requirements during inspections at Bruce A and B. There were no *serious process failures* at Bruce A and B in 2004. The operating transients were few and of minimal consequence. Some of the transients are described in Section D.1.

Bruce Power has an effective communications program with the public that meets CNSC requirements.

1.1.1.2 Operations

Bruce Power's integration of procedures and processes for Bruce A and B meant that the two sites operated in a similar manner in 2004.

Outage management met CNSC requirements. Work completion rates were high and maintenance backlogs remained at acceptable levels. CNSC staff inspected the installation of start-up instrumentation and found that work control required improvement. Despite this specific shortcoming, overall, the Operations program and implementation continue to meet CNSC requirements.

Bruce Power demonstrated a commitment to "safety-first" by extending the Unit 5 outage for approximately 15 days to replace a heat transport system (HTS) pump containment seal component, even though the component had not failed to the point that replacement was required.

There was one directive issued in 2004 concerning reactor thermal power at Bruce B that was above the limit in the operating licence. The issue was resolved on schedule to the satisfaction of CNSC staff. There were no safety-significant findings found by CNSC staff at Bruce A or B during inspections or reviews of requests for approval.

1.1.1.3 Occupational Health and Safety (Non-radiological)

In 2004, Bruce Power operated for more than 6 million person-hours without a lost time accident. This is reflected in Table 9, which shows that the "Accident Severity Rate" performance indicator (PI) for the Bruce site in 2004 was zero.

Bruce Power implemented a plan to deal with a possible flu pandemic and about two-thirds of its staff has been voluntarily inoculated.

1.1.2 Performance Assurance

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

Bruce B	PERFORMANCE ASSURANCE	B	B
	Quality Management	C	B
	Human Factors	B	B
	Training, Examination, and Certification	B	B

Overall, based upon the information collected from CNSC activities during 2004, the Performance Assurance safety area meets CNSC requirements. However, Bruce Power has not met its deadlines for the development and submission of its Quality Management program documents, and the documents submitted so far are not easy to understand. In addition, there were a number of minimum-shift-complement violations discovered during a Human Factors inspection in 2004.

1.1.2.1 Quality Management

For information on Bruce Power's application for accreditation to perform pressure boundary work, see Section 2.2.1.

In February 2004, CNSC staff performed an initial review of the management policies and programs being prepared for formal submittal to the CNSC in March 2005. It was found that Bruce Power was behind schedule and that the document quality and completeness would not satisfy the requirements of the relevant Canadian Standards Association (CSA) standard. In addition, the documents were not well integrated and did not meet the CNSC staff expectation of providing continuity with Bruce Power's management system manual. This led CNSC staff to conduct a pre-inspection of the ongoing implementation of management policies and programs in April 2004.

The April 2004 pre-inspection concluded that Bruce Power would still not be in a position to submit the required documents by the deadline they requested (September 2004). Many of the program documents were in draft form, some documents were lacking in quality and completeness, and a systematic approach was not evident in all cases. The documents were still not well integrated and did not interface easily under Bruce Power's management system manual. Many documents had been drafted in isolation and did not fully consider the implementation of programs that they supported.

Based on the above, the grade for Bruce Power's overall program is 'C'.

The evaluation of implementation for Bruce Power in 2004 was based primarily on the performance results from *Type II inspections* (conducted during the vacuum building outage and the Unit 6 outage). Overall, implementation of the Quality Management program met CNSC requirements in 2004.

1.1.2.2 Human Factors

During 2004, CNSC staff focused on compliance with minimum-shift-complement requirements and procedures related to hours of work at Bruce Power. In response to an increasing trend in minimum complement violations at Bruce Power, CNSC staff carried out an inspection to examine Bruce Power's mechanisms to ensure compliance. CNSC staff found that Bruce Power had investigated causal factors leading to minimum complement violations and was implementing corrective actions.

CNSC staff continued to monitor the implementation of Bruce Power's human factors engineering program plan for the reactor core conversion project and will be monitoring implementation of the same plan for the new fuel project.

In 2003, the operating licences for Bruce A and B were amended to state that there shall be an authorized nuclear operator (ANO) in direct attendance at the reactor unit's main control room control panels at all times, beginning in 2005. Bruce Power requested a licence amendment to delay this requirement until 2007 at Bruce B and 2009 at Bruce A. In considering this delay, CNSC staff continues to discuss appropriate interim measures with Bruce Power.

Human error contributed to several of the significant developments at Bruce A and B in 2004 (see Sections D.1.4, D.1.5, D.1.9, and D.1.12). CNSC staff is following up on Bruce Power's root cause investigations and corrective actions in response to these events.

1.1.2.3 Training, Examination, and Certification

Two evaluations were conducted at Bruce A during the reporting period: 1) the Unit 0 control room operator initial simulator training program; and 2) the implementation of the Bruce A shift manager/control room shift supervisor initial incremental training program. No evaluations were conducted at Bruce B in 2004. Bruce Power requested a postponement of a training program evaluation from June 2004 to December 2005 to allow program development to continue.

In general, progress is being made toward Bruce Power's fulfillment of its corrective action commitments associated with certified staff training programs. Progress is also being made in the development of training programs for ANOs based on a *systematic approach to training*. Reviews of these programs are tentatively set for May and December of 2005 for Bruce B and A, respectively.

Revision of Bruce Power's certified Unit 0 initial training program is required to incorporate the newly-revised template of "lesson plan objectives."

Although evaluations identified some deficiencies, generally Bruce A's training and testing documentation and processes met the intent or objectives of CNSC requirements and performance expectations. Although no evaluations were conducted for Bruce B, their training and testing documentation and processes were still considered to have met the intent or objectives of CNSC requirements and performance expectations. The success rate in certification examinations at Bruce Power was also found to be adequate.

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	B
Bruce B	DESIGN AND ANALYSIS	B	B
	Safety Analysis	B	B
	Safety Issues	B	B
	Design	B	B

In 2004, CNSC staff reviews of Design and Analysis showed that Bruce Power continued to provide acceptable safety analysis and responses to new design and safety issues.

1.1.3.1 Safety Analysis

In 2004, CNSC staff reviews confirmed that Bruce Power performed acceptable safety analysis. The licensee submitted adequate updates to the safety report, as required. Also, Bruce Power submitted the CANDU Owner's Group (COG) report on safety research and development and participated in a COG information meeting with CNSC staff. In addition, Bruce Power submitted information on the following safety analysis projects and topics:

- the "best estimate analysis with uncertainty" (BEAU) methodology (in collaboration with Ontario Power Generation [OPG]),
- the low-void reactivity fuel project,
- operation at 93% full power at Bruce B (see Section D.1.8),
- steam generator and pre-heater tube consequential leak assessment,
- the 2004 vacuum building outage at Bruce B, and
- operation of Bruce A with de-fuelled fuel channels.

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 2004.

1.1.3.3 Design

Bruce Power made significant progress in addressing fire protection issues. Upgrades to various fire protection systems continued at Bruce A and B, initiated under various legacy programs. Upgrades of some fire protection systems at Bruce A were completed as part of the Unit 3 and 4 restart projects. CNSC staff's reviews showed that the fitness-for-service of fire protection systems at Bruce A and B was acceptable.

1.1.4 Equipment Fitness for Service

Site	SAFETY AREA Program	Grades	
		Program	Implementation
Bruce A	EQUIPMENT FITNESS FOR SERVICE	B	B
	Maintenance	B	B
	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

Bruce Power made significant progress in the Structural Integrity program at Bruce A such that systems and equipment met their functional and performance requirements. Therefore, the implementation grade was raised from ‘C’ to ‘B’ in 2004. CNSC staff also rated the other programs for Bruce A under this safety area as ‘B’. Therefore, both the program and implementation grades for the Equipment Fitness For Service safety area at Bruce A are ‘B’.

CNSC staff did not perform any *Type I inspections* to evaluate the Maintenance program at Bruce B in 2004. The other three programs in this safety area—Structural Integrity, Reliability and Equipment Qualification—met CNSC expectations. Therefore, both the program and implementation grades for the Equipment Fitness For Service safety area at Bruce B are ‘B’.

1.1.4.1 Maintenance

Bruce A established and documented its maintenance program as a part of the return-to-service program. As part of this program, corrective maintenance backlog targets were provided to CNSC. The Bruce A corrective maintenance backlog has increased since 2003. Bruce Power is managing the backlog and CNSC staff will continue to monitor the situation.

Bruce B established and documented its maintenance program. The Bruce B corrective maintenance backlog targets were met. The preventive maintenance backlog at Bruce B remains high but it is being satisfactorily managed.

1.1.4.2 Structural Integrity

The Bruce A Unit 3 and 4 periodic inspection programs for HTS and safety system pressure boundaries were reviewed and approved to the latest standard requirements before the units were re-licensed for operation. The Bruce B periodic inspection programs for HTS and safety system pressure boundaries are outdated and reporting during 2004 did not meet requirements. The periodic inspection programs for containment appurtenances at Bruce A and B were updated to the latest standard revision. CNSC staff is actively monitoring implementation of the programs and still awaits acceptable follow-up responses related to implementation.

Since Units 3 and 4 returned to service, Bruce Power implemented a fuel channel fitness-for-service program at Bruce A that is equal in scope and comparable in schedule to the program at Bruce B. Bruce Power has made significant progress in addressing concerns with respect to structural integrity that pre-date the return to service. It is also taking a proactive approach to mitigating the impact of fuel channel degradation (e.g. selective de-fuelling of fuel channels in Bruce A Unit 3).

During the planned outage in spring 2004, all eight *steam generators* at Unit 4 were partially inspected to provide confirmation of the assessment to warrant continued operation. Greater focus was given to zones that are more susceptible to degradation, including areas in which degraded tubes were discovered in prior outages. Stress corrosion cracking was discovered at Unit 4 and addressed by plugging the affected tubes. All other *steam generator* inspections at Bruce A and B resulted in no significant findings.

Bruce Power continued to ensure the integrity of the fuel channels at Bruce B through a comprehensive program of inspection and maintenance. It continued to base the scope and schedule of its inspections on routine re-assessments of fuel channel inspection data and evidence from research and development. The assessments were comprehensive and clearly presented.

Each fuel channel at Bruce B has either "loose-fitting" or tight-fitting" spacers to center the *pressure tube* (PT) within the *calandria tube* (CT). The methods used by Bruce Power for disposition of possible PT-CT contact depend on the type of spacers employed. For both types, CNSC staff remains satisfied that Bruce Power's inspections and assessments continue to be appropriate and conservative.

1.1.4.3 Reliability

Bruce Power is currently developing the Bruce A reliability program to meet the requirements of CNSC regulatory standard S-98 ("Reliability Programs for Nuclear Power Plants"). CNSC staff verified that Bruce Power identified the documentation required for the program. Bruce Power is also writing procedures and updating the probabilistic risk assessment for Bruce A to derive appropriate models of unavailability for the special safety systems.

The development and implementation of the reliability program at Bruce B has, for the most part, met CNSC requirements. Bruce B's *special safety systems* met their unavailability targets. However, for two safety-important systems (power house venting and auxiliary condensate extraction), the unavailability targets were exceeded.

1.1.4.4 Equipment Qualification

Bruce Power continued to work on its *environmental qualification* (EQ) programs to comply with the licence condition on EQ (see Section D.6.1). The development of the EQ program at Bruce A was completed. CNSC reviewed Bruce Power's submissions and found that the program met CNSC requirements. Program implementation will be assessed following a *Type I inspection*.

The implementation of the EQ program at Bruce B was completed. CNSC staff inspected the program and determined that it meets requirements. The single action notice that was raised (regarding signage on steam-protected doors) was promptly and satisfactorily addressed by Bruce Power.

1.1.5 Emergency Preparedness

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

CNSC staff evaluated the emergency exercises at Bruce Power in 2002 and 2003 and found that both the program and implementation exceeded CNSC expectations at both stations. CNSC staff judged that it is not necessary to evaluate emergency exercises more often than once every three years for facilities with ‘A’ grades for implementation of the Emergency Preparedness program.

Hence, CNSC staff did not evaluate a major emergency preparedness exercise staged by Bruce Power at Bruce B in 2004. Nonetheless, CNSC staff reviewed the report produced by Bruce Power for the exercise. The findings in the report did not indicate any evidence of degradation in the Emergency Preparedness program or weakness in its implementation. Hence, both the program and implementation retained ‘A’ ratings in 2004.

1.1.6 Environmental Performance

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

Releases of radioactive substances from Bruce A and B in 2004 were well below derived emission limits and, therefore, estimated radiation doses to the public were well below the regulatory limits. There were no unplanned releases of radioactive substances or hazardous substances from Bruce A and B that posed an unreasonable risk to the environment. A release of non-radioactive, chemically-treated water from Bruce B occurred in 2004, but it was appropriately handled by the licensee (see Section D.1.10).

Environmental Performance at Bruce A and B meets CNSC requirements and thus, both program and implementation are rated ‘B’.

1.1.7 Radiation Protection

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

In 2004, Bruce Power modified its respiratory protection program to include protection against radiological hazards and documented the modifications to ensure conformance with the relevant CSA standard. The revised documents will be reviewed by CNSC staff in 2005. Bruce Power continued to meet the implementation requirements for all relevant elements of its Radiation Protection program.

1.1.8 Site Security

The assessment of the Site Security safety area for Bruce A and B is documented in a separate (protected) *Commission Member Document* (CMD 05-M31.A).

1.1.9 Safeguards

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

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.

In 2004, there was a reportable event at Bruce B due to the interruption in operation of the spent fuel bundle counter system used by the *International Atomic Energy Agency* (IAEA). The interruption was not caused by the operator and, in fact, the operator had no way of knowing about the failure until it was discovered by the IAEA. Although the event was reportable under regulatory standard S-99 ("Reporting Requirements for Operating Nuclear Power Plants"), it is not considered to be reflective of a shortcoming of the licensee. For more details, see Section D.1.1.

CNSC staff changed its approach to grading Safeguards in 2004, so the grades for program and implementation at Bruce A and B have been reduced from 'A' last year to 'B'. This is a standardization change only and does not reflect any deficiency on the part of the station. For more details, refer to Section 2.9.

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

Darlington's performance met CNSC requirements in 2004 for all three programs under the Operating Performance safety area. Darlington satisfactorily addressed some weaknesses observed in the 2003 station containment outage, particularly with respect to work protection practices. Darlington encountered problems with steam protection barriers in 2004 that resulted in the shutdown of units before all problems were rectified. Remediation activities were undertaken with high priority. By mid-November, the repairs of all significant deficiencies were completed.

1.2.1.1 Organization and Plant Management

In 2004, Darlington had a spring outage at Unit 1 and a fall outage at Unit 3. Significant improvements in performance of work protection and employee safety were observed, compared with the station containment outage in 2003.

In November 2004, Units 1 and 4 were shut down (in addition to Unit 3 remaining in its planned outage) to complete the inspection and repair of steam-protected room barriers. By mid-November, repair of high priority deficiencies were completed and all units returned to power. For more details, see Section D.2.3.

There were no *serious process failures* at Darlington in 2004.

Darlington had six transients during the year. There were two *stepbacks*, two emergency power reductions initiated by the Independent Market Operator, two manual shutdowns, and one manual power reduction.

Darlington's compliance with the reporting requirements of regulatory standard S-99 was good in 2004. There were 99 events at Darlington for which OPG had to submit preliminary and detailed reports. CNSC staff judged the follow-up actions identified by Darlington to be appropriate in most cases.

In 2004, CNSC staff raised one new *action item* and closed 12 at Darlington. CNSC staff was satisfied with Darlington's *action item* management, event reporting, plant system performance analysis, and follow-up.

Based on the results of CNSC verification activities in 2004, Darlington's Organization and Plant Management in 2004 continued to meet CNSC requirements.

1.2.1.2 Operations

Any problems that were identified during *Type II inspections* at Darlington in 2004 were promptly resolved by station management.

CNSC staff reviewed 37 licensee requests for approval for Darlington in 2004. In general, the submissions contained the necessary information for CNSC staff to conduct the review and grant approval.

The program and implementation related to Operations continued to meet CNSC requirements in 2004.

1.2.1.3 Occupational Health and Safety (Non-radiological)

Darlington continued to improve in the area of conventional safety. The "Accident Severity Rate" PI for 2004 was zero (see Table 9). The PI data for 2004 revealed no significant findings.

In March 2004, CNSC staff conducted a *Type II inspection* to evaluate the implementation of the work protection code at Darlington. CNSC staff issued three action notices and 13 recommendations as a result of the assessment. Darlington developed a corrective action plan to address the issues and it was accepted by CNSC staff.

The number of reportable events during the Unit 1 outage was significantly less than those during the station containment outage in 2003. In 2004, there were seven reportable, unsafe work protection code violations at Darlington. This was below the target of 10, and only one of them was caused by operations.

This program and its implementation at Darlington continue to meet CNSC requirements.

1.2.2 Performance Assurance

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

Based upon the information collected from CNSC activities in 2004, overall, the Performance Assurance safety area for Darlington meets CNSC requirements for both program and implementation. This is an improvement over 2003 when implementation was rated ‘C’ due to weaknesses in the implementation of the Quality Management, Human Factors and Training, Examination and Certification programs. For 2004, the only major weakness remains with the implementation of the Quality Management program.

1.2.2.1 Quality Management

In 2004, Darlington was successful in obtaining accreditation to perform pressure boundary work. See Section 2.2.1 for more details.

The OPG stations have an adequately documented quality assurance (QA) program. The implementation problems that were identified in the 2003 industry report (CMD 04-M30) were addressed in 2004. Darlington modified its program for controlling and calibrating measuring and test equipment. CNSC staff participated in follow-up meetings with OPG, reviewed the revisions to procedure documentation, and concluded that the corrections were adequate. The 2003 industry report also described the cancellation of the *Type I inspection* of the engineering change control process at Darlington in November 2003. Darlington continued to modify the overall engineering change control process in 2004. An extended *Type I inspection* was started by CNSC staff in October 2004, for which a report is scheduled for issue in May 2005.

In 2004, Quality Management inspections at Darlington examined the identification and resolution of problems with documents, services, and activities that do not meet prescribed requirements. The CNSC requires prompt identification and effective resolution so that station operations remain reliable and safe and the risk to workers and the public remains reasonable. For the most part, OPG satisfied the objectives of the inspections. However, several areas of weakness in implementation were identified, especially with respect to the categorization of problems and trending of causal factors. Based on those observations, implementation of the Quality Management program at Darlington continues to be assessed as below requirements. CNSC staff continues to monitor this area closely.

1.2.2.2 Human Factors

As reported in the 2003 industry report (CMD 04-M30), the *Type I inspection* of the engineering change control process at Darlington was cancelled. OPG conducted a self-assessment of human factors within the process and prepared an action plan for improvements. CNSC staff reviewed and agreed to the plan. However, improvements to the human factors process will be delayed until 2005 due to modifications to the overall engineering change control process.

Darlington provided information regarding its adherence to procedures related to hours of work. During 2002 and 2003, there were no violations of the annual hours of work limits by certified staff. CNSC staff continues to monitor hours of work as part of ongoing compliance activities.

CNSC staff conducted a review of a submission by OPG to reduce the minimum emergency response team complement. CNSC staff did not concur with this request on the basis that the submission failed to demonstrate that Darlington could safely and efficiently respond to any incident with the proposed number of personnel on the team.

CNSC staff conducted a *Type I Inspection* to assess the adequacy of the process related to the station condition record at Darlington. No action notices were issued by CNSC as a result of this inspection.

CNSC staff accepted Darlington's corrective action plan to address human factors issues raised during the *Type II inspection* of work protection code implementation.

The OPG sites, including Darlington, also developed a human performance plan for 2004 and are tracking the number of event-free day "resets" and other indicators as a means of measuring the success of their efforts. They have implemented a number of human performance initiatives to support their plans.

Based on the above information, Darlington's Human Factors program and implementation meets requirements.

1.2.2.3 Training, Examination, and Certification

No evaluations of certified or non-certified staff training programs were conducted during 2004. However, in general, good progress was made by Darlington to fulfill its commitments associated with certified staff training programs. Darlington has an approved action plan to incorporate the newly-revised template of "lesson plan objectives" into its ANO initial training program. This initiative is resource-intensive and is currently on schedule to meet its target completion date in 2006.

Re-qualification training at Darlington using diagnostic, simulator-based tests was found to be acceptable in 2004.

Despite some deficiencies, Darlington's training and testing documentation and processes meet CNSC requirements and performance expectations. Overall, the improvements in implementation of the Training, Examination, and Certification programs that were witnessed in 2003 continued into 2004. The success rate in certification examinations has also been 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

In 2004, CNSC staff reviews of Design and Analysis showed that the licensee continued to provide acceptable safety analyses and responses to new design and safety issues.

1.2.3.1 Safety Analysis

In 2004, CNSC staff reviews confirmed that Darlington performed acceptable safety analysis. OPG submitted adequate updates to the safety report, as required. In addition, OPG submitted the industry COG report on safety research and development and participated in a COG information meeting with CNSC staff. Also, Darlington submitted information on the following safety analysis projects or topics:

- the BEAU methodology (in collaboration with Bruce Power), and
- neutron-over-power detector failure.

CNSC staff also inspected the "smart buyer function" for safety analysis at OPG to confirm that procurement of safety analysis services meets CNSC expectations for safety analysis.

1.2.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the GAIs. Darlington 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 2004.

1.2.3.3 Design

OPG has continued to implement fire protection upgrades originally initiated under various legacy programs. Upgrades to fire barriers, fire suppression systems, fire detection systems and additional analyses are substantially complete. The remaining major projects are scheduled for completion by the end of 2005. CNSC staff's reviews of fire protection fitness-for-service indicate that the systems at Darlington are acceptable.

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

CNSC staff did not perform any *Type I inspections* to evaluate the Maintenance and Reliability programs at Darlington in 2004. Structural Integrity and Equipment Qualification did meet CNSC expectations with respect to programmatic issues in 2004.

Implementation of the Equipment Qualification program was significantly below expectations and has become an area of major concern for CNSC staff. Also, there was some concern regarding the implementation of the Maintenance program in 2004, although the grade remains 'B'.

Overall, the Equipment Fitness for Service safety area met CNSC staff expectations with respect to both program and implementation in 2004.

1.2.4.1 Maintenance

In 2004, OPG took appropriate action to address deficiencies originating in 2003 related to the instrument calibration program at Darlington.

However, CNSC staff is concerned by the maintenance backlog at Darlington in 2004. OPG needs to focus on maintaining and improving its maintenance practices to ensure that program implementation does not slip, but rather improves to best-industry practices. CNSC staff will continue to closely monitor maintenance practices at Darlington, including management of the backlog, in 2005.

1.2.4.2 Structural Integrity

Darlington successfully completed the vacuum building pressurization test in 2004. The periodic inspection programs for HTS and safety system pressure boundaries and containment appurtenances were assessed to be in compliance with the applicable standards.

OPG continued to ensure the integrity of fuel channels at Darlington through a comprehensive program of inspections and maintenance. The scope and schedule of inspections is based on routine re-assessments of inspection data and evidence from research and development. OPG updated its fuel channel aging and life cycle management strategy and plans. In order to increase inspection and measurement efficiency and reduce irradiation exposures, OPG started to use new tools for inspecting fuel channels and measuring hydrogen concentration. Some shortcomings and improvements were identified and will be addressed by task groups comprised of staff from the licensee, tool developer, and CNSC.

OPG continued to inspect *feeder* piping for thinning and cracking associated with flow-accelerated corrosion (FAC). For more details on *feeder* inspections, see Section D.2.2. Darlington will begin a titanium injection program in 2005 to determine if this method will arrest, or at least reduce the rate of, FAC. (Further discussion of FAC, in the context of Point Lepreau, is given in Section D.5.5.)

CNSC staff performed a *Type I inspection* of Darlington's program used to monitor the health of *steam generators*. The inspection determined that the program complies with CNSC requirements and exceeds CSA requirements for inspections of *steam generator* tubes. However, the inspection team discovered two problem areas. One was the use of uncontrolled documentation, although the problem was previously identified and none of the uncontrolled documents was likely to impact safety. The other problem area concerned Darlington's execution of its review of the steam generator program. OPG subsequently responded to the action notice and addressed the problem.

CNSC staff will continue to monitor the Structural Integrity program at Darlington for assurance that adequate margins are maintained for important pressure-retaining components (especially *feeders*).

1.2.4.3 Reliability

OPG is currently developing the Darlington reliability program to meet the requirements of regulatory standard S-98. CNSC staff is satisfied with OPG's progress.

1.2.4.4 Equipment Qualification

OPG completed the development of Darlington's EQ program to address licence condition 7.1 on EQ (see Section D.6.1). CNSC staff reviewed the submissions and found that, in principle, Darlington's EQ program meets the CNSC's requirements. Program implementation will be assessed following a *Type I inspection*.

Early in 2004, CNSC staff found that some safety-significant equipment could not meet the EQ standards. This finding was after OPG had given assurance that the work to be done, after the deadline of June 30, 2004, consisted essentially of resolving "gap analysis" issues related to age-sensitive components. CNSC staff also questioned the ability of OPG to meet its commitment of having a sustainable EQ program for Darlington.

In 2004, Darlington staff found gaps in walls of steam-protected rooms. OPG found that the aggregate area of the gaps was approximately one square meter (i.e. significantly greater than the 75 square centimetre limit established in station procedural controls and supporting analysis). The gaps resulted from incomplete (initial) construction activities and their presence could have impaired the performance of mitigating and safety support systems during some postulated accidents. OPG addressed the problem by implementing a rigorous inspection and repair program and by taking mitigating actions to reduce the likelihood and severity of a potential event. Some repairs could not be completed within defined deadlines. The affected units were shut down by OPG until all repairs and subsequent tests and inspections were completed. CNSC staff continues to monitor the situation. For more details, see Section D.2.3.

Based on these problems with qualification of equipment, implementation has been downgraded to 'C' in 2004.

1.2.5 Emergency Preparedness

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	EMERGENCY PREPAREDNESS	A	A

OPG took prompt action to amend its consolidated nuclear emergency plan to reflect changes to the notification process in Ontario related to liquid emissions. OPG also made other changes considered necessary to make the plan easier to understand. CNSC staff reviewed and approved the plan. The Emergency Preparedness program is assessed to exceed CNSC requirements.

In 2004, there was no *Type I inspection* to evaluate performance during a nuclear emergency exercise at Darlington. However, there has been no evidence suggesting any degradation in Darlington's ability to implement the emergency preparedness response program during an emergency. Hence, the grade for the implementation of the program remains 'A' in 2004. A comprehensive evaluation of an emergency exercise at Darlington is planned for 2005.

1.2.6 Environmental Performance

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	ENVIRONMENTAL PERFORMANCE	B	B

In 2004, data on airborne emissions and liquid releases of radioactive substances from Darlington showed that releases to the environment were well below derived emission limits. Therefore, estimated radiation doses to the public were well below the regulatory limits. There were no unplanned releases of radioactive or hazardous substances that posed an unreasonable risk to the environment.

Environmental Performance at Darlington met CNSC requirements in 2004 and, thus, both program and implementation are rated 'B'.

1.2.7 Radiation Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	RADIATION PROTECTION	B	B

In 2004, CNSC staff imposed a new requirement for the respiratory protection program at Darlington to meet the relevant CSA standard to include protection against radiological hazards. This new requirement had already been put in place in 2003 for all sites except Darlington and Gentilly-2. In response to the new requirement, Darlington modified its respiratory protection program to include protection against radiological hazards and documented these modifications.

The revised documents will be reviewed by CNSC staff in 2005. Although the program is no longer considered to exceed requirements, it is still considered, overall, to meet CNSC requirements because the new respiratory requirement is one of many Radiation Protection requirements. Thus, the program grade has been reduced from 'A' to 'B'.

Darlington continued to meet the implementation requirements for all relevant elements of its Radiation Protection program.

1.2.8 Site Security

The assessment of the Site Security safety area for Darlington is documented in a separate (protected) report (CMD 05-M31.A).

1.2.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	SAFEGUARDS	B	B

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

CNSC staff changed its approach to grading Safeguards in 2004, so the grades for program and implementation at Darlington have been reduced from 'A' last year to 'B'. This is a standardization change only and does not reflect any deficiency on the part of the station. For more details, refer to Section 2.9.

1.2.10 Financial Guarantees for Decommissioning

OPG satisfied the requirement in licence condition 11.2 to have a financial guarantee in place for decommissioning of Darlington by July 2003. In 2005, OPG also satisfied the requirement in licence condition 11.3 to provide confirmation to the CNSC of the ongoing validity and adequacy of the financial guarantees for decommissioning (reference CMD 05-M20).

1.2.11 Conclusion for Darlington

The Darlington site continued to operate safely in 2004. Programs and implementation for the nine safety areas were generally acceptable, although some programs require improvement to meet CNSC requirements and expectations. Notable improvements were observed in implementation of the Performance Assurance safety area, particularly with respect to implementation of the Human Factors and Training programs. However, implementation of the Quality Management program remained below requirements in 2004. Difficulties were also observed in the implementation of the Equipment Qualification program in the Equipment Fitness for Service safety area.

In 2004, Darlington modified its Radiation Protection program to address a new requirement introduced by CNSC staff. The assessment of the program has been changed from "exceeds requirements" to "meets requirement" while CNSC staff reviews the modifications.

1.3 PICKERING A AND B

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
Pickering B	OPERATING PERFORMANCE	B	B
	Organization & Plant Management	B	C
	Operations	B	B
	Occupational Health & Safety (Non-radiological)	B	B

Performance at Pickering A met the CNSC requirements in 2004 for all three programs under the Operating Performance safety area. For Pickering B, however, some of the difficulties noted under implementation of the Organization and Plant Management program in 2003 (refer to CMD 04-M30) continued in 2004. There was some improvement, though, in implementation of Organization and Plant Management during 2004 at Pickering B. Based on that improvement, overall implementation of the Operating Performance safety area has been upgraded to 'B'.

1.3.1.1 Organization and Plant Management

CNSC staff reviewed OPG's request to amend the Senior Vice-President/Site Vice-President role documents. The role documents described the responsibilities and accountabilities of the position in sufficient detail and clarity, so CNSC staff approved the amendment. OPG also requested an amendment to the operating licence that constituted significant changes regarding approval of certain role documents. This request is currently under review by CNSC staff.

Following extensive discussions between OPG and CNSC staff, OPG revised the control room shift operating supervisor role document that is referenced in the Pickering operating licenses. CNSC staff considers that the revision has significantly improved the description of the qualification requirements and accountabilities for the role.

In 2004, CNSC staff was satisfied with OPG's *action item* management for Pickering A and B. It also considers that OPG met the event reporting requirements of regulatory standard S-99 for Pickering A and B.

Late in 2004, there was a *serious process failure* at Unit 4 due to a loss of Class IV power caused by a switchyard equipment failure (see Section D.3.4). The response of the electrical systems to the loss of power is still under review by both OPG and CNSC staff to determine the causes of equipment failures, which complicated the event. CNSC staff is currently reviewing a reactor trip, caused by a fuse failure, which occurred at the end of 2004 (see Section D.3.5). In both of these events, CNSC staff considers that licensee staff responded correctly to safely shut down the unit.

Despite some improvement at Pickering B in the implementation of the Organization and Plant Management program, the grade remains ‘C’. The number of forced outages in 2004 (some of which are described in Section D.3) declined from the excessive number in 2003, but the decrease was not large enough to warrant a grade change. In addition, work management continued to be a challenge at Pickering B, as evidenced in problems with implementation of the maintenance program (see Section 1.3.4.1).

1.3.1.2 Operations

The majority of compliance inspections at Pickering A and B in 2004 did not find any deficiencies that required correction by OPG. During the inspections, CNSC staff found that operations were well conducted.

In 2004, CNSC staff inspected procedural compliance in Operations (as well as Maintenance) at Pickering A and B. The evidence suggested that there was commitment to compliance with technical procedures by both management and workers.

CNSC staff assessed the planned outage of Unit 4 in 2004. The planning and completion of the outage met CNSC requirements.

1.3.1.3 Occupational Health and Safety (Non-radiological)

CNSC staff considers that the accident frequency and severity rates, reported during 2004, demonstrated good occupational health and safety performance. The “Accident Severity Rate” PI for Pickering B for 2004 was 0. At Pickering A, there was one lost-time accident in 2004 that resulted in 63 days of lost time (see Table 9).

1.3.2 Performance Assurance

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

Pickering B	PERFORMANCE ASSURANCE	B	B
	Quality Management	B	C
	Human Factors	B	B
	Training, Examination, and Certification	B	B

Based upon the information collected from CNSC activities in 2004, the Performance Assurance safety area for Pickering A and B meets overall CNSC requirements. However, weakness remains with respect to implementation of the Quality Management program.

1.3.2.1 Quality Management

In 2004, Pickering was successful in obtaining accreditation to perform pressure boundary work. See Section 2.2.1 for more details.

The OPG stations have an adequately documented QA program. In 2004, Quality Management inspections at Pickering A and B examined the identification and resolution of problems with documents, services, and activities that do not meet prescribed requirements. CNSC requires prompt identification and effective resolution so that station operations remain reliable and safe, and the risk to workers and the public remains reasonable. For the most part, OPG satisfied the objectives of the inspections. However, several areas of weakness in implementation were identified (categorization of problems and trending of causal factors) that warrant the continuation of the ‘C’ grade.

1.3.2.2 Human Factors

The incorporation of human factors in design (as part of the engineering change control process) at Pickering A was assessed with respect to restart activities for Unit 1. CNSC staff required OPG to take corrective and preventive measures after it failed to perform a human factor assessment on a modification to ventilating equipment that affects main control room habitability. OPG discovered that these issues were applicable to the engineering change control process as a whole (not just for the restart project). OPG developed an action plan to address these issues at all OPG stations. In general, CNSC staff found that the action plan was adequate to address the human factors issues. However, the improvements to the human factors process for restart will be delayed due to the schedule for modifications to the OPG engineering change control process.

Pickering provided information regarding its adherence to procedures related to hours of work. During 2002 and 2003, there were no violations of the annual hours of work limits by certified staff. CNSC staff continues to monitor hours of work as part of ongoing compliance activities.

In response to a request from CNSC staff, OPG committed to validate the minimum-shift-complement required at Pickering A and B for common mode accidents.

CNSC staff conducted a *Type I inspection* to assess the adequacy of the station condition record process at Pickering A and B. The aim of the investigation, from a Human Factors viewpoint, was to assess the extent to which the OPG process adequately identifies, investigates, addresses, and tracks human performance issues. The inspection identified issues relating to the quality and use of quarterly trend reports. There is no link between the trend information and the resulting action plans. Causes of problems are insufficiently detailed, leading to an inability to effectively analyze the data. CNSC staff is currently reviewing OPG's corrective action plan.

CNSC staff reviewed a reportable event related to the inappropriate disposal of active liquid waste. It was satisfied with the OPG investigation and actions for resolution. CNSC staff also reviewed the findings of OPG's investigation (including *root cause analysis* and corrective actions) of the appropriateness of the action taken by operating staff during a reactor *setback*.

In 2004, CNSC staff inspected procedural compliance in operations and maintenance at Pickering A and B and found that there is a commitment to comply with technical procedures by both management and workers.

The OPG sites, including Pickering, developed a human performance plan for 2004 and are tracking the number of event-free day "resets" and other indicators as a means of measuring the success of their efforts. They have implemented a number of human performance initiatives to support their plans.

1.3.2.3 Training, Examination, and Certification

Two certified staff training program evaluations were performed at Pickering A in 2004: the ANO initial simulator training program and the implementation of the shift manager/control room shift supervisor incremental initial training program.

For Pickering B, two training programs were evaluated for certified staff: the shift manager/ control room shift supervisor initial simulator training program and the ANO initial simulator training program. The first program was found to be deficient in the areas of training material, completion of prerequisite training and mentor support to the program. The second program was found to have only a minor deficiency.

The re-qualification written testing program was evaluated and found to be acceptable.

In general, good progress is being made at Pickering A and B to fulfill the commitments associated with certified staff training programs. Revision of the ANO training program is currently underway to incorporate the newly revised template of "lesson plan objectives." This initiative is resource-intensive and is currently on schedule to meet its target completion date in 2006.

Although the evaluations identified some deficiencies, the training and testing processes at Pickering A and B generally meet CNSC requirements and expectations. The success rate in certification examinations has also been 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
Pickering B	DESIGN AND ANALYSIS	B	C
	Safety Analysis	B	B
	Safety Issues	B	B
	Design	B	C

In 2004, CNSC staff reviews of Design and Analysis showed that OPG continued to provide acceptable safety analysis and responses to new safety issues at Pickering. Its actions to resolve design and equipment issues that resulted from the August 2003 electrical blackout were generally acceptable, but several issues remain open for Pickering B. A plan to resolve the issues is in place. Issues related to the fire protection program and its implementation also remain a concern. These design deficiencies remain significant enough to warrant the rating of implementation for the entire Design and Analysis safety area at Pickering B as below requirements.

1.3.3.1 Safety Analysis

In 2004, CNSC staff reviews confirmed that OPG performed acceptable safety analysis for Pickering A and B. OPG submitted adequate updates to the safety report, as required. In addition, OPG submitted the industry COG report on safety research and development and participated in a COG information meeting with CNSC staff. Other assessments by CNSC staff included the following:

- review of OPG's collaborative analysis with Bruce Power on the BEAU project, and

- inspection of the "smart buyer function" for safety analysis at OPG to confirm that procurement of safety analysis services meets CNSC expectations for safety analysis.

1.3.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the GAIs. Pickering 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 2004.

1.3.3.3 Design

OPG made progress in addressing legacy fire protection issues and completed upgrades of some fire protection systems as part of the Pickering A restart project.

As reported in 2003, CNSC staff raised design and equipment issues as a result of investigations into the performance of systems and equipment at Pickering B during the August 2003 electrical blackout. At the time, the nature of the issues was not fully known and the focussed inspection report had not been issued. Hence, the Design program for Pickering B was graded 'C' in 2003. Since then, however, most of the problems have been attributed to poor maintenance, the unexpected nature of the loss of the power grid, incomplete operational safety requirements for the service water system, and the fact that Pickering is an old design with some "legacy" problems. In general, these issues cannot be directly attributed to a deficiency in the Design program itself. Therefore, the program is now assessed to meet requirements.

Several of the design issues stemming from the August 2003 blackout remained open in 2004 and are currently being tracked by CNSC staff (see Section D.3.10 for more details). With the exception of fire protection, CNSC staff is satisfied with the actions OPG is taking to close out these issues.

OPG continued to implement fire protection upgrades at Pickering B that were initiated under various legacy programs. OPG completed a significant upgrade of the turbine generator fire sprinkler system. The service water (source of fire water) design issues related to the August 2003 blackout are not completely resolved and CNSC staff is waiting for additional analysis and a committed path forward from the licensee.

Based on the above, Pickering B continues to be graded 'C' for Design implementation.

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
Pickering B	EQUIPMENT FITNESS FOR SERVICE	B	B
	Maintenance	B	C
	Structural Integrity	B	B
	Reliability	B	B
	Equipment Qualification	B	B

CNSC staff did not perform any *Type I inspections* to evaluate the Maintenance programs for Pickering A and B in 2004. Implementation of the Maintenance program at Pickering B was assessed to be below requirements. However, the other programs in this safety area met CNSC expectations in 2004. Therefore, both program and implementation grades for the Equipment Fitness for Service safety area are 'B' for Pickering A and B.

1.3.4.1 Maintenance

CNSC staff did not perform any *Type I inspections* to evaluate the Maintenance programs for Pickering A and B in 2004. However, as part of the return-to-service of Unit 1, Pickering A addressed various Maintenance program issues. CNSC staff is currently reviewing this work.

In 2003, Maintenance program and implementation for Pickering B were both graded 'C' due, largely, to problems during the August 2003 electrical blackout that were caused by poor maintenance. The review of the incident indicated that the problems were due to poor implementation of the Maintenance program, rather than the program itself, which is common to all OPG plants. Thus, the Maintenance program at Pickering B is now assessed to meet requirements.

CNSC staff completed a *Type II inspection* of the Pickering B service water system. The inspection raised some concerns regarding preventative and corrective maintenance, especially a high level of work order backlogs. CNSC staff asked OPG to submit an action plan in 2005 to address the concerns.

In 2004, CNSC staff inspected procedural compliance in Maintenance (as well as Operations) at Pickering A and B. The evidence suggested that there was a commitment to comply with technical procedures by both management and workers.

However, difficulties with respect to work management at Pickering B are judged by CNSC staff to contribute to ongoing weakness in implementation of the Maintenance program (e.g. large maintenance backlogs). Therefore, implementation of the Maintenance program at Pickering B continues to be graded ‘C’.

1.3.4.2 Structural Integrity

OPG continued to ensure the integrity of fuel channels at Pickering through a comprehensive program of inspections and maintenance. The scope and schedule of inspections is based on routine re-assessments of inspection data and evidence from research and development. OPG updated its fuel channel aging and life cycle management strategy and plans. In order to increase inspection and measurement efficiency and reduce irradiation exposures, OPG started to use new tools for inspecting fuel channels and measuring hydrogen concentration. Some shortcomings and improvements were identified and will be addressed by task groups comprised of staff from the licensee, tool developer, and CNSC.

OPG continued to inspect *feeder* piping for thinning and cracking associated with FAC. No *feeder* cracking was identified in 2004. One *feeder* at Pickering B Unit 7 and one *feeder* at Unit 8 were observed to have wall thinning. Those pipes were dispositioned in accordance with the CSA standards. For more details on OPG’s *feeder* inspections, see Section D.2.2.

1.3.4.3 Reliability

All Pickering A *special safety systems* met their availability targets in 2004. Emergency core coolant (ECC) was unavailable for about 2 hours and 10 minutes due to a seismic breaker failure (see Section D.3.2). OPG is currently developing the Pickering A reliability program to meet the requirements of regulatory standard S-98. CNSC staff is satisfied with OPG’s progress in this area.

All Pickering B *special safety systems* met their availability targets in 2004. The performance of *special safety systems* and other safety-significant systems at Pickering B were comparable to those from previous years, although the number of missed mandatory safety system tests was significantly greater (see Table 15). The cases of missed mandatory tests or system unavailability were either corrected or are under investigation.

Several reliability issues were identified for Pickering B following the August 2003 electrical blackout. In 2004, OPG undertook reasonable measures to improve the situation, as discussed in Section D.3.10.

The Reliability program for Pickering A and B continued to meet CNSC requirements in 2004.

1.3.4.4 Equipment Qualification

OPG completed the development of Pickering's general EQ program to address the licence condition on EQ (see Section D.6.1). Implementation of the detailed EQ program at Pickering A was completed. CNSC staff performed a *Type I inspection* of the program in 2004 and determined that it meets CNSC requirements. CNSC staff raised four action notices that OPG is currently addressing. The development of the detailed EQ program at Pickering B was completed. CNSC staff reviewed the submissions and found that, in principle, Pickering B's EQ program meets requirements.

OPG repaired some impairments to steam barriers at Pickering A following the discovery of openings in steam-protected rooms at Darlington. See Section D.3.3 for more details.

1.3.5 Emergency Preparedness

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

OPG took prompt action to amend its consolidated, nuclear emergency plan to reflect changes to the notification process in Ontario related to liquid emissions. OPG also made other changes considered necessary to make the plan easier to understand. CNSC staff reviewed and approved the plan. The Emergency Preparedness program is assessed to meet and exceed CNSC requirements.

CNSC staff was satisfied with OPG's response to the loss of Class IV power at Pickering A Unit 4 (see Section D.3.4) and the station emergency at Pickering B (see Section D.3.8). A comprehensive evaluation of an emergency exercise at Pickering is planned for 2005.

1.3.6 Environmental Performance

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

In 2004, data on airborne emissions and liquid releases of radioactive substances from Pickering showed that releases to the environment were consistently below *derived release limits*. Therefore, estimated radiation doses to the public were well below the regulatory limits. There were no unplanned releases of radioactive or hazardous substances from Pickering that posed an unreasonable risk to the environment.

Environmental performance at Pickering A and B meet CNSC requirements and, thus, both program and implementation are rated “B”.

1.3.7 Radiation Protection

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

In 2004, Pickering modified its respiratory protection programs to include protection against radiological hazards and documented the modifications to ensure conformance with the relevant CSA standard. The revised documents will be reviewed by CNSC staff in 2005.

In 2004, Pickering continued to meet the implementation requirements for all relevant elements of its radiation protection programs.

1.3.8 Site Security

The assessment of the Site Security safety area for Pickering A and B is documented in a separate (protected) report (CMD 05-M31.A).

1.3.9 Safeguards

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

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

CNSC staff changed its approach to grading Safeguards in 2004, so the grades for program and implementation at Pickering A and B have been reduced from 'A' last year to 'B'. This is a standardization change only and does not reflect any deficiency on the part of the station. For more details, refer to Section 2.9.

1.4 GENTILLY-2

1.4.1 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

Hydro-Québec's performance met CNSC requirements in 2004 for all three program areas under the Operating Performance safety area. As such, the overall assessments for both Operating Performance program and implementation continue to be 'B'. Hydro-Québec satisfactorily addressed some weaknesses observed in 2003, particularly with respect to management processes and the wearing of conventional safety equipment. However, adherence to radiation protection procedures continued to be problematic. This weakness, together with inadequate work protection practices observed during the last planned outage in 2003, continues to be an area of focus for CNSC staff. Other subjects of focused surveillance include: 1) the effectiveness of actions to address the observed non-conservative attitude towards safety in at least one event (CNSC staff review of a second event is ongoing); and 2) configuration management weaknesses identified through CNSC staff inspections.

1.4.1.1 Organization and Plant Management

Hydro-Québec's efforts over the last few years have brought its management processes into compliance with applicable standards. CNSC staff conducted two inspections on topics directly indicative of Hydro-Québec's ability to assess its own management processes—self-evaluations and independent evaluations. Both inspections concluded that Hydro-Québec's performance met CNSC requirements.

Although there were no planned shutdowns in 2004, the station did experience two unplanned outages—in May and December. The first was due to a leak in the electrical generator cooling system that required immediate repair (see Section D.4.2). The second was prompted by new computer modeling results that predicted a significant probability of PT-CT contact in one fuel channel (see Section D.4.4). Hydro-Québec shut down the reactor as a precautionary measure one week before actual fuel channel inspections could be done. The inspections revealed no evidence of contact.

There were no *serious process failures* at Gentilly-2 in 2004. One reactor *stepback* occurred during start-up following the May 2004 outage because of low water level in the *steam generators*.

Hydro-Québec's compliance with S-99 reporting deadlines was good in 2004. There were 29 events at Gentilly-2 for which Hydro-Québec had to submit preliminary and detailed reports. Nineteen of those involved non-compliances. CNSC staff judged the follow-up actions identified by Hydro-Québec to be appropriate in most cases. CNSC staff closed 14 event follow-ups after completion of the related actions.

CNSC staff raised 33 new *action items* and closed 25, giving a year-end balance of 49. Some of these *action items* were related to inspection follow-ups that CNSC staff judged to be untimely. The situation improved in the latter half of the year following discussions with Hydro-Québec personnel.

Based on the above results, Hydro-Québec's performance is judged to meet CNSC requirements, and both program and implementation continue to be rated 'B'.

1.4.1.2 Operations

CNSC staff conducted 23 *Type II inspections* of station operations in 2004. Reports for 18 of those inspections were issued by the end of the year and three reports for inspections done late in 2003 were also issued in 2004. Of the 21 reports issued, 19 assessed performance to be at 'B' level and two were at the 'C' level. Hydro-Québec's response to actions emerging from these inspections improved over an unacceptable situation that existed in the first half of 2004.

Weakness in configuration management and operational practices, first observed during the fall 2003 outage, were the two most significant observations during the inspections. Adherence to radiation protection procedures was a particularly weak practice during that outage. Some improvement by the end of 2004 was observed with respect to configuration management, but CNSC staff continued to monitor sustainability. The effectiveness of improvements undertaken for outage practices will be assessed in spring 2005, particularly with respect to procedural adherence.

About half of the 29 events reported in 2004 related to operations, with equal proportions assessed as medium- or low-safety significance. However, there was clear evidence of a non-conservative attitude towards safety in at least one event. CNSC staff is following up with focused surveillance on the effectiveness of actions to address the problem. CNSC staff is also currently reviewing a second similar event at Gentilly-2.

The grades for the Operations program and its implementation remain 'B' in 2004, with CNSC staff continuing to follow-up on various events.

1.4.1.3 Occupational Health and Safety (Non-radiological)

CNSC inspections found improvement in the wearing of safety hats and glasses, revealing that Hydro-Québec's actions to enforce better adherence to procedures have been effective. Work protection practices related to equipment isolation (observed to be inadequate during the fall 2003 outage) will be closely scrutinized during the spring 2005 outage.

Data for the "Accident Severity Rate" PI for 2004 revealed no significant findings (see Table 9). Except for a chlorine leak in the station pump house (see Section D.4.3), there were no reportable events in 2004 related to conventional safety. Corrective actions for a scaffolding-related event, which occurred during the 2003 outage, should be completed early in 2005 when training will be delivered to workers who are preparing for the spring outage. Another event that same year, involving a worker who fell from a ladder, was closed in 2004 following completion of follow-up actions.

CNSC staff assesses this program and Hydro-Québec's implementation of it to meet requirements.

1.4.2 Performance Assurance

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

Information collected from CNSC activities in 2004 resulted in significant changes to the assessments of the programs under the Performance Assurance safety area. Although the program and implementation grades for Quality Management increased to 'B' in 2004, the program and implementation grades for Training, Examination, and Certification decreased to 'C'. The grades for Human Factors remained at 'C'. As a result, the overall program and implementation grades for the Performance Assurance safety area remain 'C' for Gentilly-2. In general, improvements are still required in three areas.

1) Gentilly-2 did not complete a formal "job and task analysis" to support training for the position of control room operator.
2) There was a lack of adherence to procedures related to hours of work.

3) There were inadequacies in the procedure (and its implementation) to include human factors in the engineering change control process.

1.4.2.1 Quality Management

Hydro-Québec completed the documentation and implementation of its QA program in April 2004. The quality management manual was issued and all processes were implemented. This satisfied the deadline for the establishment of Hydro-Québec's QA program, as prescribed by licence condition 3.4 of the Gentilly-2 operating licence.

The process of merging tiers of documents, thereby correcting duplication of information, is progressing. In 2004, CNSC staff conducted inspections of both management self-assessment and independent assessment, resulting in corrective actions and recommendations. Even though some improvement is required on the program documentation and implementation to comply with the applicable quality standards, overall, Hydro-Québec meets the requirements for both the QA program and its implementation. Other CNSC inspections are planned in 2005 to confirm the compliance of other processes.

For information on the requirements for accreditation to perform pressure boundary work at Gentilly-2, see Section 2.2.1.

1.4.2.2 Human Factors

During 2004, the following human factors areas were reviewed: 1) hours of work; and 2) incorporation of human factors into the engineering change control process.

A CNSC inspection confirmed that the software tool being used allowed the licensee to effectively track hours of work. The use of, and training for, the software tool were judged to meet requirements. However, the inspection also revealed that improvements were required regarding adherence to the hours of work procedure.

CNSC staff also observed improvement in the incorporation of human factors in the engineering change control process. However, this improvement was limited in scope (restricted to minor changes). CNSC staff required further improvements to the documented process for incorporating human factors into minor design changes before it could be considered satisfactory.

CNSC staff reviewed human factors aspects in the documents supporting the refurbishment project at Gentilly-2. Given the scope and degree of completion of the project at the time of the review, CNSC staff was generally in agreement with the approach proposed by the licensee to handle human factors.

Based upon the information available from activities completed by CNSC staff in 2004, the Human Factors program and its implementation are rated ‘C’. Although CNSC staff judges that the program and its implementation are improving, further improvements are still required to the procedure developed to include human factors in the engineering change control process and in adherence to Gentilly-2’s hours of work procedure.

1.4.2.3 Training, Examination, and Certification

Two certified staff training programs were evaluated at Gentilly-2 in 2004: the shift supervisor incremental training program and the control room operator and shift supervisor simulator training program. Gentilly-2 has not conducted a formal job and task analysis for the position of control room operator. This was identified as a major weakness in the training program and led to the issue of action notices to Hydro-Québec.

Some positive aspects were found in the shift supervisor incremental training program. The *systematic approach to training* has been implemented, the administration and delivery personnel are well-qualified, and there is good management support for the program. However, the program also had several deficiencies.

- There is no description of the overall training program leading to the accreditation of operating personnel.
- All supplementary training for shift supervisors is not completed before the end of the co-piloting phase.
- The knowledge and skills related to the administrative duties of the shift supervisor are not sufficiently integrated into the program and are not properly evaluated.
- The systems engineers who teach the program do not receive ongoing training.

Some positive aspects were found in the control room operator and shift supervisor simulator training program. The program documentation, resources, and materials are adequate, the work procedures are very good, and the training personnel is well-qualified. However, the program also had several deficiencies.

- The program description and the task analysis used to establish the program content are not satisfactory.
- The shift supervisor candidates do not have all of the qualifications for the program.
- The shift supervisor candidates have not acquired enough experience on the control room panel.

The success rate in certification examinations was adequate in 2004 and the testing documentation and processes met CNSC requirements and performance expectations. However, the deficiencies identified by the CNSC program evaluations indicate that Gentilly-2's training documentation and processes fall below the CNSC requirements and performance expectations. Therefore, both Training program and implementation grades are 'C'.

1.4.3 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

In 2004, CNSC staff reviews of Design and Analysis showed that the licensee continued to provide acceptable safety analysis and responses to new design and safety issues.

1.4.3.1 Safety Analysis

In 2004, CNSC staff reviews confirmed that Hydro-Québec performed acceptable safety analysis. The licensee submitted adequate updates to the safety report, as required. In addition, Hydro-Québec submitted the industry COG report on safety research and development and participated in a COG information meeting with CNSC staff.

1.4.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the GAIs. Gentilly-2 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 2004.

1.4.3.3 Design

Hydro-Québec initiated and completed upgrades to selected fire suppression systems and fire alarm systems at Gentilly-2. The CNSC's reviews showed that these upgrades were acceptable. Emergency response team performance was assessed to be acceptable following a *Type I inspection*.

1.4.4 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

CNSC staff did not perform any *Type I inspections* to evaluate the Maintenance and Reliability programs at Gentilly-2 in 2004. The other two programs in this safety area met CNSC expectations. Overall, the program and implementation of the Equipment Fitness For Service safety area at Gentilly-2 met CNSC requirements in 2004.

1.4.4.1 Maintenance

Although there were no *Type I inspections* to evaluate the Maintenance program at Gentilly-2 in 2004, maintenance was routinely evaluated during *Type II inspections* of systems. The preventative and corrective maintenance programs at Gentilly-2 met their targets. However, in the area of documentation of the former, the necessary paperwork was not efficiently closed out. CNSC staff is conducting inspections to determine the effectiveness of actions taken by Hydro-Québec to address this concern.

1.4.4.2 Structural Integrity

Gentilly-2 staff submitted their updated periodic inspection program for approval in 2004 and CNSC staff is currently reviewing it.

In 2003, Hydro-Québec performed a test to measure the leak rate from the reactor building, as required by licence condition 3.6 in the Gentilly-2 operating licence. The measured leak rate was below the required value.

Hydro-Québec continues to ensure the integrity of fuel channels through a comprehensive program of inspections and maintenance. Hydro-Québec has taken a proactive approach to improving the tooling used to inspect its fuel channels. As a precautionary measure, Hydro-Québec shut down Gentilly-2 following new calculations that showed an increased possibility of the formation of blisters in some fuel channels (see Section D.4.4).

A feeder inspection campaign was conducted at Gentilly-2 during the outage in fall 2003. In 2004, Gentilly-2 was considering replacement of one feeder during the spring 2005 outage, due to excessive wall thinning.

1.4.4.3 Reliability

Gentilly-2 has maintained a good reliability program and good surveillance activities, including test scheduling and periodic maintenance. The quarterly and annual reporting were adequate and provided sufficient information to demonstrate compliance with regulatory standard S-99. Gentilly-2 also demonstrated compliance with regulatory standard S-98.

1.4.4.4 Equipment Qualification

In 2004, Hydro-Québec completed the development of the EQ program for Gentilly-2 to comply with licence condition 7.1 on EQ (see Section D.6.1). CNSC reviewed Hydro-Québec's submissions and found that, in principle, the EQ program met CNSC requirements. CNSC staff's final position on program implementation will be established following a *Type I inspection*.

CNSC staff's reviews showed that the fitness-for-service of the fire protection systems was acceptable.

1.4.5 Emergency Preparedness

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

CNSC staff evaluated a full-scale emergency exercise at Gentilly-2 in 2004 and emergency response team performance was assessed to be acceptable. The evaluation team concluded that Gentilly-2 demonstrated that it had the capability to effectively manage the responses to an emergency. However, there were some minor weaknesses that required improvement (availability of alternative measuring equipment and systematic distribution of iodine pills). Hence, the implementation rating for the Emergency Preparedness program was downgraded from 'A' to 'B'.

The evaluation team also concluded that during the evaluation of the emergency exercise, there was no evidence suggesting any degradation in the program. Hence the rating of the program remained 'A'.

CNSC staff observed no difficulties with the response of Hydro-Québec staff to the chlorine alert described in Section D.4.3.

1.4.6 Environmental Performance

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

The Environmental Performance safety area had a program grade of ‘C’ at the time of the licence renewal for Gentilly-2 in 2002 (reference CMD 02-H18). However, Hydro-Québec has since responded to the action notices that were outstanding from an evaluation of the program in 2000.

In 2004, releases of radioactive substances from Gentilly-2 were well below the derived emission limits and, therefore, estimated radiation doses to the public were well below the regulatory limits. There were no unplanned releases of either radioactive substances or hazardous substances from Gentilly-2 that posed an unreasonable risk to the environment. CNSC staff conducted a *Type I inspection* of the Gentilly-2 effluent monitoring program in June 2004. Although CNSC staff issued four action notices and two recommendations, the radiological effluent monitoring program was rated ‘B’.

Environmental Performance at Gentilly-2 meets the CNSC requirements and thus, both the program and implementation are graded ‘B’.

1.4.7 Radiation Protection

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

Adherence to radiation safety procedures has been a problem at Gentilly-2 in recent years, and it was a particularly weak practice in the fall 2003 outage. In 2004, Hydro-Québec continued to have difficulty ensuring its employees adhere to radiation safety procedures. Numerous instances of non-adherence to radiation protection procedures or poor radiation protection practices were noted by CNSC staff. In addition, Hydro-Québec has been slow to address action notices arising from previous radiation protection inspections. Because of these ongoing problems, implementation of the Radiation Protection program at Gentilly-2 continues to be graded ‘C’. The effectiveness of improvements undertaken for radiation protection practices during outages will be assessed in spring 2005, particularly with respect to procedural adherence. In addition, two other Radiation Protection inspections are planned for 2005.

In 2004, CNSC staff imposed a new requirement for the respiratory protection program at Gentilly-2 to meet the relevant CSA standard to include protection against radiological hazards. This new requirement had already been put in place in 2003 for all sites except Darlington and Gentilly-2. In response to the new requirement, Gentilly-2 established a program and informally submitted a draft document in November 2004. CNSC staff reviewed the document and communicated its comments to Hydro-Québec. CNSC staff is following up with Gentilly-2 to ensure that its respiratory protection program is documented and designed to meet the CSA standard.

Although the Radiation Protection program is no longer considered to exceed requirements, it is still considered, overall, to meet CNSC requirements because the new respiratory requirement is one of many Radiation Protection requirements. Thus, the program grade has been reduced from 'A' to 'B'.

1.4.8 Site Security

The assessment of the Site Security safety area for Gentilly-2 is documented in a separate (protected) report (CMD 05-M31.A).

1.4.9 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.

CNSC staff changed its approach to grading Safeguards in 2004, so the grades for program and implementation at Gentilly-2 have been reduced from 'A' to 'B'. This is a standardization change only and does not reflect any deficiency on the part of the station. For more details, refer to Section 2.9.

1.4.10 Financial Guarantees for Decommissioning

In November 2003, an unconditional guarantee from the province of Québec came into effect to provide a financial guarantee for decommissioning at Gentilly-2. As such, Gentilly-2's operating licence conditions have no further reporting requirements for Hydro-Québec with respect to the decommissioning guarantee until June 2006 (six months prior to the licence expiration).

1.4.11 Conclusion for Gentilly-2

The station operated safely in 2004. Programs and their implementation for most of the safety areas were generally acceptable.

There were noteworthy improvements in 2004 at Gentilly-2 with respect to the Quality Management program and its implementation. However, the other two programs under the Performance Assurance safety area (Human Factors and Training, Examination, and Certification) require improvement with respect to both the program and implementation in order to meet CNSC requirements. Overall, the Performance Assurance safety area and its implementation continue to be below CNSC requirements. Evaluations of various programs and processes for this safety area will continue in 2005.

In 2004, Gentilly-2 modified its Radiation Protection program to address a new requirement introduced by CNSC staff. The assessment of the program has been changed from “exceeds requirements” to “meets requirements” while CNSC staff reviews the modifications.

Significant improvement is required with respect to implementation of Radiation Protection at Gentilly-2, as well as work protection practices. Several inspections related to Radiation Protection are planned for 2005. The effectiveness of improvements undertaken for outage practices will also be assessed in spring 2005, particularly with respect to procedural adherence.

1.5 POINT LEPREAU

1.5.1 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

CNSC staff considers that Point Lepreau operated safely in 2004. Overall, the Operating Performance safety area is considered to meet requirements. However, CNSC staff is concerned about an apparent decrease in the effectiveness of the Health and Safety (Non-Radiological) program and will continue to monitor performance in this area.

1.5.1.1 Organization and Plant Management

There were no *serious process failures* at Point Lepreau in 2004.

CNSC staff approved a significant organizational change at New Brunswick Power (NB Power) in 2004 when roles and responsibilities were transferred from the nuclear safety department to the technical unit. The change was made to advance organizational effectiveness, improve the alignment of group responsibilities with station processes, and clarify roles and responsibilities with respect to reactor system health.

The *New Brunswick Electricity Act* came into force on October 1, 2004. This resulted in the restructuring of NB Power and the incorporation of New Brunswick Power Nuclear Corporation (NB Power Nuclear). The new corporation became the sole licensee for the Point Lepreau site. This change did not have a significant impact on the licensee's management, organization, or organizational programs.

1.5.1.2 Operations

CNSC staff conducted an operating practice assessment during the 2004 maintenance outage. CNSC staff concluded that Point Lepreau staff followed procedures, performed the necessary testing and verifications, and complied with the requirements of the operating policies and principles during the shutdown.

However, during normal operation, there was an incident related to maintenance of shutdown system (SDS) #1 that was conducted contrary to the requirements of the operating policies and principles (see Section D.5.4).

1.5.1.3 Occupational Health and Safety (Non-radiological)

CNSC staff had conducted an evaluation of the Point Lepreau respiratory protection program in 2003. CNSC staff found the NB Power respiratory protection program was generally satisfactory with the exception that it was not formally documented and did not meet the relevant CSA standard. NB Power responded in 2004 with the implementation of program improvements required to correct the deficiencies.

The "Accident Severity Rate" PI for Point Lepreau in 2003 compared favourably with the 2003 industry average of 4.5 lost days per 200,000 person-hours worked (see Tables 10 and 11). However, for 2004 the rate at Point Lepreau increased to 14.2 lost days per 200,000 person-hours worked (see Table 9). This data does not compare favourably with the industry average of 2.1 for 2004.

CNSC staff rates the program and implementation of the non-radiological health and safety program at Point Lepreau as meeting requirements. However, CNSC staff is concerned about an apparent decrease in the effectiveness of the program based on the significant increase in the "Accident Severity Rate" PI. CNSC staff will continue to monitor performance in this area.

1.5.2 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

Based upon the information collected from CNSC activities in 2004, overall, the Performance Assurance safety area for Point Lepreau meets CNSC requirements. The Quality Management program was observed to improve in 2004. However, weakness remains in the Human Factors program relating to hours of work, human factors within design, and minimum complement staffing.

1.5.2.1 Quality Management

Quality Management at Point Lepreau was rated ‘C’ in 2003, while NB Power continued to document and implement its QA program. During late 2003 and 2004, three *Type I inspections* were conducted at Point Lepreau to assess the degree of implementation of three significant components of the Quality Management system:

- problem identification, corrective action, and operating experience,
- design configuration control, and
- management self-assessment.

In the first inspection, it was noted that problem identification and corrective action had greatly improved since the previous inspection. For the other two inspections, only one directive was issued (for the inspection of management self-assessment). During the three inspections, it was possible to close all outstanding directives arising from previous QA inspections.

The inspections confirmed that the Point Lepreau Quality Management system has been effectively documented and implemented. Consequently, the grades for Quality Management program and implementation were raised from ‘C’ to ‘B’.

1.5.2.2 Human Factors

CNSC staff raised a concern about the amount of overtime worked at Point Lepreau in 2004. NB Power Nuclear has since reduced the amount of overtime, but further reductions may be required.

During an inspection of the modification process in 2001, CNSC staff recommended that NB Power systematically incorporate human factors into the design change process. Since that time, NB Power developed four design guides that meet the expectations of CNSC staff. NB Power Nuclear intends to do a gap analysis between its modification process and the CNSC regulatory guides on human factors.

NB Power had been asked to provide an assessment to justify staffing for its minimum complement. In 2004, NB Power supplied an assessment that led to the addition of a power plant operator to its minimum complement. CNSC staff is working with NB Power Nuclear to ensure concerns arising from the minimum complement are addressed.

Between 2003 and 2004, NB Power reduced its workforce by 99 positions and developed mechanisms to monitor the impact of downsizing. CNSC staff carried out an inspection to ensure that NB Power defined the engineering and technical skills necessary to safely operate the station and that NB Power Nuclear had a succession planning process to ensure adequate staffing in the future. CNSC staff found that NB Power Nuclear has developed processes for succession planning, but these processes are not yet fully implemented.

CNSC staff met with NB Power in 2004 to promote its expectations for the Human Factors program. Although CNSC staff recognizes improvements made at Point Lepreau in the area of human performance, concerns exist regarding hours of work, human factors in design, and minimum complement staffing.

1.5.2.3 Training, Examination, and Certification

Two certified staff training programs were evaluated at Point Lepreau in 2004: the implementation of the shift supervisor initial training program and the control room operator initial simulator training program.

Re-qualification testing using comprehensive simulator-based tests and written tests was evaluated and found to be acceptable.

In general, good progress is being made at Point Lepreau to fulfill the corrective action commitments associated with certified staff training programs.

Although evaluations identified some deficiencies, the training and testing documentation and processes at Point Lepreau generally met the CNSC requirements and performance expectations. The success rate in certification examinations was also adequate.

1.5.3 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	C	C

In 2004, CNSC staff reviews of Design and Analysis showed that the licensee continued to provide acceptable safety analysis and responses to new safety issues. However, CNSC staff is currently monitoring some deficiencies in the fire protection program and implementation.

1.5.3.1 Safety Analysis

In 2004, CNSC staff reviews confirmed that Point Lepreau performed acceptable safety analysis. NB Power Nuclear submitted adequate updates to the safety report, as required, as well as adequate safety analysis in support of the potential refurbishment. In addition, NB Power

Nuclear submitted the industry COG report on safety research and development and participated in a COG information meeting with CNSC staff.

1.5.3.2 Safety Issues

CNSC staff reviewed the progress made by the various industry teams to resolve the GAIs. Point Lepreau 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 2004.

1.5.3.3 Design

A design flaw in the logic modules of shutoff rods (SORs) was discovered and addressed at Point Lepreau in 2004. See Section D.5.3 for details.

Point Lepreau has not completed a deterministic fire hazard analysis. This analysis is required by the operating licence, and Point Lepreau had committed to complete it by mid-2003. Point Lepreau is pursuing a different analysis methodology (fire probabilistic safety analysis) to assess outstanding issues; it is currently scheduled for completion in 2006.

Fire protection system inspection, testing, and maintenance activities at the station are currently not being carried out in accordance with the National Fire Code. Point Lepreau has implemented an aggressive plan to address gaps in inspection, testing, and maintenance and CNSC staff is monitoring the progress. Emergency response team performance was rated as below requirements during two *Type I inspections* in 2004 and Point Lepreau is reviewing its training program.

Point Lepreau did not meet the performance expectations for the fire protection program and implementation in 2004. Therefore, the program and implementation grades for Design were reduced to ‘C’.

1.5.4 Equipment Fitness for Service

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

The Maintenance, Reliability and Equipment Qualification programs at Point Lepreau met CNSC expectations in 2004. Concerns about seismic qualification of safety support systems for containment resulted in a 'C' grade for implementation of the Equipment Qualification program. The Structural Integrity program and its implementation for Point Lepreau did not meet CNSC expectations and are rated 'C'. Events in 2004 related to Structural Integrity, and deficiencies in the program (particularly regarding periodic inspections), contributed to the lower grades.

1.5.4.1 Maintenance

In general, Point Lepreau continued to improve its maintenance program in 2004. However, as part of an event related to SDS maintenance (see Section D.5.4), problems were noted with Point Lepreau's *special safety system* recalibration procedures. Point Lepreau staff is currently investigating the problems.

In 2004, there was an event where an SDS #1 SOR fell into the core (for more details, see Section D.5.3). The failure was partly attributed to poor maintenance practices.

1.5.4.2 Structural Integrity

In 2004, CNSC staff reviews raised some concerns regarding the updating of periodic inspection programs at Point Lepreau. The program for HTS and safety system pressure boundaries is out-dated. Point Lepreau has made a commitment to update the program by December 2005. The periodic inspection programs for containment appurtenances are up to date with the latest standard revision.

Point Lepreau has developed and implemented periodic inspection programs for fuel channels and performed the required inspections and analysis. Point Lepreau also started to use new tools for fuel channel inspections to increase inspection and measurement efficiency and reduce radiation exposures.

Cracks extending partially through the wall thickness have been discovered at the bends of Point Lepreau *feeder* pipes. At those locations, the *feeder* wall thickness is reduced because of FAC. Furthermore, fracture toughness of the material at the bend of a spare pipe was measured to be significantly below that of the straight part of the same pipe. This means it may not be precluded that a crack propagating at the bend can grow in an unstable manner. Detection technology for *feeder* cracks may be insufficient to detect cracks at an early stage. If such a crack at a bend is not detected, a *feeder* failure induced by a seismic event may not be precluded. Consequently, CNSC staff raised an *action item* requesting Point Lepreau to demonstrate that *feeder* cracking does not significantly increase the likelihood of *feeder* failure during a seismic event. If that cannot be demonstrated, Point Lepreau was requested to confirm the seismic capability of the ECC. More details regarding this development are provided in Section D.5.5.

In October 2004, a leak was discovered in a steam dump line used during reactor start-up. The leak was attributed to circumferential fatigue cracking, and the cracks were repaired prior to re-starting the reactor. For more details, see Section D.5.3.

1.5.4.3 Reliability

Point Lepreau's reliability data collection, analysis, and reporting were satisfactory in 2004. Although the Reliability Program appeared to be well implemented, CNSC staff was concerned about repeated unavailability of the emergency power system. There was also an occurrence of long unavailability of the diesel portion of the system. See Section D.5.2 for more details. CNSC staff will continue to monitor licensee performance in this area.

CNSC staff also expressed concern regarding Point Lepreau's evaluation of the frequency of containment failure and the need to implement short-term compensatory measures to reduce the predicted future unavailability. CNSC staff is currently reviewing the response of NB Power Nuclear to this problem.

1.5.4.4 Equipment Qualification

NB Power Nuclear completed the development of the EQ program to comply with the licence condition pertaining to EQ (see Section D.6.1). CNSC staff found that, in principle, the Point Lepreau EQ program meets CNSC requirements. CNSC staff intends to confirm the acceptability of program implementation during a future *Type I inspection*. In the absence of confirmatory evidence, the implementation grade for the Equipment Qualification program remains 'C'.

The review of Point Lepreau's evaluation of containment performance raised issues regarding seismic qualification of safety support systems for containment. CNSC staff is satisfied with Point Lepreau's actions to resolve these issues.

In 2004, NB Power Nuclear completed the investigation of polyvinyl chloride cables inside containment. NP Power Nuclear resolved issues related to traceability of the cables and determined that some previously non-identified cables did not negatively impact plant safety. Nevertheless, NB Power Nuclear intends to replace the non-identified cables during a future outage.

1.5.5 Emergency Preparedness

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

In 2004, CNSC staff evaluated the emergency preparedness program at Point Lepreau. At that time, several initiatives related to Emergency Preparedness were scheduled by NB Power to address issues previously raised by the CNSC. However, the CNSC evaluation team concluded that Point Lepreau has yet to demonstrate that it is capable of meeting its self-imposed goals related to implementation of its Emergency Preparedness program. Consequently, although the program is judged to exceed expectations, implementation is considered to be below requirements. A follow-up evaluation of the status of the implementation of the program is planned for 2005.

1.5.6 Environmental Performance

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

In 2004, data on airborne emissions and liquid releases of radioactive substances from Point Lepreau showed that these releases to the environment were well below derived emission limits. Therefore, estimated radiation doses to the public were well below the regulatory limits. There were no unplanned releases of radioactive or hazardous substances that posed an unreasonable risk to the environment. CNSC staff reviewed an ecological risk assessment submitted by Point Lepreau and sought clarification on technical issues.

There has been no significant change from the previous assessment of Environmental Performance at Point Lepreau.

1.5.7 Radiation Protection

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

In 2004, Point Lepreau modified its personnel respiratory protection program to include protection from radiological hazards to ensure conformance with the relevant CSA standard. The revised documents will be reviewed by CNSC staff in 2005. Point Lepreau continued to meet the implementation requirements of all relevant elements of the Radiation Protection program.

1.5.8 Site Security

The assessment of the Site Security safety area for Point Lepreau is documented in a separate (protected) report (CMD 05-M31.A).

1.5.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Point Lepreau	SAFEGUARDS	B	B

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.

CNSC staff changed its approach to grading Safeguards in 2004, so the grades for program and implementation at Point Lepreau have been reduced from 'A' last year to 'B'. This is a standardization change only and does not reflect any deficiency on the part of the station. For more details, refer to Section 2.9.

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 are provided following 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 17 reactors that were operational in 2004 were in a *guaranteed shutdown state* (GSS) approximately 14% of the time. At Pickering A, only Unit 4 operated in 2004, while the other three units were in a *lay-up state*. Commissioning continued to prepare Unit 1 for restart in 2005. In early 2004, Bruce A Unit 3 was restarted and synchronized to the power grid. Bruce A Units 1 and 2 are currently undergoing an environmental assessment for their potential restart.

2.1.1 Organization and Plant Management

An important development with respect to Organization and Plant Management at Point Lepreau occurred when the *New Brunswick Electricity Act* came into force on October 1, 2004, resulting in the restructuring of New Brunswick Power and the incorporation of New Brunswick Power Nuclear Corporation (NB Power Nuclear). This new corporation is now the sole licensee for Point Lepreau.

No worker at any station or member of the public received a radiation dose in excess of the regulatory limits in 2004. 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 2004. These results are general reflections of adequate controls employed by the organizations at the sites.

There was only one *serious process failure* at any station in 2004; see Section D.3.4 for details.

CNSC staff uses *action items* to bring issues that require timely, corrective action to the attention of licensees. In 2004, CNSC staff opened a total of 105 *action items* and closed 80. A total of 272 *action items* were open at the end of 2004. CNSC staff was satisfied with licensees' *action item* management, event reporting, plant system performance analysis, and follow-up. There were 457 reportable events at the stations in 2004 and 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.

Licensees generally had appropriate organizations in place to manage and safely operate their stations. However, Pickering B was rated below requirements for implementation of its Organization and Plant Management program due to organizational difficulties that contributed to the forced outages in 2004.

2.1.2 Operations

In 2004, CNSC staff conducted 30 *Type I inspections* and more than 200 *Type II inspections* to verify various programs relevant to station operations. Most inspections 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 found that the licensees implemented appropriate measures to correct the deficiencies.

In 2004, CNSC staff reviewed 391 requests from the licensees for various approvals. The majority of the requests were timely and adequately documented.

The purpose of the "Number of Unplanned Transients" PI is to indicate the number of reactor power transients due to equipment failures or operator errors while the reactor is not in 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. Many of the unplanned transients in 2004 were *setbacks*, which typically pose little risk to plant operations. The significant transients are described in the *Commission Member Documents* (CMDs) known as Significant Development Reports (SDRs; see Appendix D). Note that a larger number of transients would be expected for the units at Bruce A and Pickering A that returned from long lay-ups.

The PI also includes the number of hours in GSS for the reactors. Note that GSS hours are only reported in Tables 1 and 2 in 2004 for reactors that were not in the *lay-up state*. For the years 2000 to 2003, GSS hours are summed for all reactors, including those in the *lay-up state*.

Table 1: Number of Unplanned Transients for 2004

Station	GSS Hrs	Unplanned Transients at Sites in 2004			
		Trips	*Stepback*s	*Setbacks*	Total
Bruce A	1956	4	2	11	17
Bruce B	4511	2	0	2	4
Darlington	3135	0	2	4	6
Pickering A	1411	2	NA	2	4
Pickering B	8107	1	0	2	3
Gentilly-2	210	0	1	0	1
Point Lepreau	1095	2	0	0	2
Total for Industry	20424	11	5	21	37

Tables 2 and 3 show the trends of this PI for the industry since 2000. For the entire industry in 2004, the number of transients was similar to 2003, but the number of reactor trips was much less. In 2004, there was an industry average of 8590 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
2000	57788	5	4	2	11
2001	41341	6	5	10	21
2002	51503	3	1	13	17
2003	47922	19	13	11	43
2004	20424*	11	5	21	37

* For 2004, GSS was only tabulated for reactors not in a *lay-up state*.

Table 3: Trends of Number of Unplanned Transients for Stations

Station	Unplanned Transients				
	2000	2001	2002	2003	2004
Bruce A	NA	NA	NA	1	17
Bruce B	5	3	6	8	4
Darlington	1	5	1	10	6
Pickering A	NA	NA	NA	7	4
Pickering B	3	12	6	14	3
Gentilly-2	1	0	2	2	1
Point Lepreau	1	1	3	1	2
Total for Industry	11	21	18	43	37

The purpose of the "Unplanned Capability Loss Factor" PI is to indicate how a unit is managed, operated, and maintained in order to avoid unplanned outages.

Tables 4 and 5 show the "Unplanned Capability Loss Factor" PI which is the percentage of the reference electrical output for the station that was lost during the period due to unplanned circumstances. In addition to being an economic indicator, it is a reflection of overall management of the plant. Although this factor has generally been high for Pickering B in the past, in 2004 it was comparable to the rest of the industry (see Table 5). The loss factor was also relatively high for Bruce A, Pickering A, and Gentilly-2 in 2004. Some of the unplanned shutdowns for those stations are described in Sections D.1, D.3, and D.4, respectively. A relatively high loss factor is typical of units at stations that return from long lay-ups, such as Bruce A and Pickering A. Bruce B, Darlington, and Point Lepreau continued to have relatively small unplanned capability losses in 2004.

Table 4: Unplanned Capability Loss Factor for 2004

Station	Unplanned Capability Loss Factor (%)				
	Quarter				For Year
	Q1	Q2	Q3	Q4	
Bruce A	31.0	3.5	0.0	11.0	11.4
Bruce B	9.3	0.7	3.1	6.7	4.9
Pickering A	6.3	22.4	22.5	22.7	18.5
Pickering B	12.3	13.5	16.4	6.7	12.2
Darlington	13.0	0.6	4.5	8.8	6.7
Gentilly-2	0.0	26.0	0.0	14.6	10.2
Point Lepreau	0.0	4.2	2.8	21.3	6.9

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

Station	Unplanned Capability Loss Factor (%)				
	Year				
	2000	2001	2002	2003	2004
Bruce A					11.4
Bruce B	3.8	1.3	6.4	3.8	4.9
Pickering A					18.5
Pickering B	15.4	9.6	7.2	19.1	12.2
Darlington	7.8	5.6	4.9	4.3	6.7
Gentilly-2	0.0	0.0	0.0	0.2	10.2
Point Lepreau	0.0	14.3	9.2	3.9	6.9

In 2004, there were 13 planned shutdowns for routine outages of the operating reactors, lasting a total of 610 days. The longest outage was 140 days, which was for a planned outage that was extended at Pickering B Unit 8. In general, CNSC staff found that the planning and performance of outages in 2004 was acceptable.

Darlington encountered problems with steam protection barriers in 2004. Two units were shut down and the start-up of Unit 3 was delayed until the problems were rectified. See Section D.2.3 for more details.

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.

Tables 6, 7 and 8 illustrate the "Non-Compliance Index" PI for the industry. 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.

All non-compliances are evaluated by CNSC staff. Table 6 shows that Pickering had the most non-compliances in 2004, as well as in previous years (Table 8). This is partly explained by the size of the operation (three reactors in rehabilitation and five operating at the Pickering site). Table 8 also illustrates the positive trend, especially for Pickering, of declining non-compliances in 2004. It should be noted that the non-compliances are relative to the different requirements at each site, including different operating policies and principles, radiation requirements, designs, licence conditions, practices, etc. Also note that 2004 was the first full year for which this PI was reported separately for Pickering A and B.

Table 6: Non-Compliance Index for 2004

Station	Non-Compliances by Type					
	a	b	c	d	e	Total
Bruce A	6	40	1	34	0	81
Bruce B	1	34	18	17	2	72
Pickering A	36	12	0	18	6	72
Pickering B	31	48	1	36	14	130
Darlington	18	32	0	19	2	71
Gentilly-2	14	1	0	6	2	23
Point Lepreau	2	0	0	12	10	24

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

Year	Non-Compliances by Type					
	a	b	c	d	e	Total
2000	307	109	31	115	50	612
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

Table 8: Trends of Non-Compliance Index for Stations

Station	Total Non-Compliances				
	2000	2001	2002	2003	2004
Bruce A	42	9	24	120	81
Bruce B	219	123	124	79	72
Pickering A and B	238	295	337	282	202
Darlington	63	110	58	70	71
Gentilly-2	22	18	20	13	23
Point Lepreau	28	34	55	27	24
Total for Industry	612	589	618	591	473

2.1.3 Occupational Health and Safety (Non-radiological)

All licensees met the requirements and expectations for Occupational Health and Safety at all sites in 2004. 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 in the definitions of industrial accidents, jurisdiction of worker safety, interpretation of lost time associated with chronic health problems, etc.)

The Accident Severity Rates for most licensees in 2004 were lower than previous years (Table 11). The Accident Severity Rate was significantly lower for Gentilly-2 in 2004. However, it was significantly greater for Point Lepreau, and CNSC staff is monitoring this area at that station.

Table 9: Accident Severity Rate for 2004

Site	Days Lost	Person Hours	Accident Severity
Bruce A and B	0	6364851	0.0
Pickering A and B	63	4913994	2.6
Darlington	0	2597923	0.0
Gentilly-2	7	1185949	1.2
Point Lepreau	99	1384979	14.2

Table 10: Trend Details of Accident Severity Rate for Industry

Year	Days Lost	Person Hours	Accident Severity
2000	462	19186826	4.82
2001	468	19514814	4.80
2002	350	17579865	3.98
2003	372	16612884	4.48
2004	169	16447696	2.05

Table 11: Trends of Accident Severity Rate for Stations

Site	Accident Severity Rate				
	2000	2001	2002	2003	2004
Bruce A and B	3.8	9.7	4.8	4.2	0.0
Pickering A and B	3.9	0.7	1.4	3.7	2.6
Darlington	8.0	0.7	0.0	0.6	0.0
Gentilly-2	6.5	18.0	25.2	20.4	1.2
Point Lepreau	1.3	8.5	0.0	0.1	14.2

2.2 PERFORMANCE ASSURANCE

Weakness in the programs under the Performance Assurance safety area was noted for all of the sites in 2004, although there was significant improvement in some of the programs at the sites.

Bruce Power does not yet have an adequately documented quality assurance (QA) program. Implementation of Quality Management at Darlington, Pickering A, and Pickering B was assessed to be below requirements because of deficiencies within their station condition record process to identify and resolve problems. The Human Factors programs at Point Lepreau and Gentilly-2 had inadequacies relating to the design process and hours of work. In addition, Gentilly-2 demonstrated inadequacies relating to the job and task analysis to support training for the position of control room operator.

2.2.1 Quality Management

The single unit stations (Gentilly-2 and Point Lepreau) made progress in implementing their QA programs in 2004. Both the programs and their implementation, which were considered to be below requirements in 2003, are now assessed to meet requirements.

The Ontario Power Generation (OPG) stations (Darlington and Pickering) have an adequately documented QA program. However, the stations also share a critical implementation problem—the inability to promptly identify and effectively resolve problems related to documents, services, and activities that do not meet prescribed requirements.

The Quality Management programs for Bruce A and B were assessed to be below requirements because Bruce Power did not meet the deadlines for the development and submission of its Quality Management documents. However, implementation was assessed to meet requirements in 2004, based on observations of the adequate implementation of secondary program documentation for outage activities.

In 2004, the Technical Standards and Safety Authority (TSSA) assessed OPG's application for Certificates of Authorization for pressure boundary work (repairs, replacements, modifications and fabrications to its non-nuclear and nuclear pressure-retaining boundaries). CNSC staff observed the TSSA's pressure-boundary implementation survey of the Darlington and Pickering sites. It was found that OPG had successfully addressed new requirements for its QA programs. The TSSA subsequently awarded nine Certificates of Authorization to each site to cover the various scopes of work. The certificates expire in three years.

In 2004, Bruce Power failed to satisfy new requirements for alignment of maintenance procedures with its QA program. Bruce Power did not receive accreditation as a holder of a Certificate of Authorization. It is upgrading its maintenance procedures and plans to reapply for certification in mid-2005.

In 2004, CNSC staff continued to review documentation in support of accreditation for pressure boundary work at Gentilly-2. Hydro-Québec re-drafted the document for pressure boundary work that falls within the third level of tiered documents in its quality management system. Following the CNSC's review of that document in 2005, Hydro-Québec will be in a position to apply for Certificates of Authorization for pressure boundary work.

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

2.2.2 Human Factors

In 2004, CNSC staff focussed on hours of work and staffing issues. Bruce Power and OPG moved towards achieving the objective of one authorized nuclear operator (ANO) in attendance at the main control room for each operating unit. Currently, the licences of multi-unit stations require an ANO or a supervised control panel operator (SCPO) to be in direct attendance at the main control room control panels at all times. The qualifications of SCPOs allow them to monitor reactor unit panels, but they must be under the supervision of an ANO. The Integrated Improvement Plan (1997) recommended eliminating the practice of monitoring control panels by non-authorized staff (SCPOs). Both OPG and Bruce Power committed to CNSC staff that they will ensure there are enough ANOs to monitor and operate the panels for each reactor unit not in the *lay-up state*. A date for when this will be achieved at Bruce A and B will be established in 2005. Darlington is committed to achieving the target by July 2009. Pickering A Unit 4 has had an ANO in attendance at all times since the unit was taken out of GSS in 2003, and is committed to maintaining this practice. Pickering B is committed to achieving the ANO target by July 2007.

The Human Factors grades for Point Lepreau remain 'C' due to deficiencies in the area of human factors in design. The grades for Gentilly-2 also remain 'C' due to deficiencies in both the procedure and implementation to include human factors in the engineering change control process.

In March, 2004, CNSC staff evaluated the implementation of the work protection code at Darlington. Implementation was assessed to meet requirements, thus justifying the increase in the grade for Human Factors implementation at Darlington from 'C' to 'B'.

CNSC staff conducted a *Type I inspection* of procedural compliance in operations and maintenance at Pickering A and B. The results were positive at both sites. It is intended that this inspection will be carried out at other stations in 2005.

2.2.3 Safety Culture and Safety Management

The CNSC conducted a symposium on safety culture in March 2004 and followed up with industry workshops in June 2004 and January 2005. The participants reported on the significant progress made by the industry in 2004. The following are two examples of relevant progress.

- Some facilities have developed their own safety culture frameworks.
- Some facilities have developed and piloted their own evaluation methods to perform safety culture self-assessments.

The CNSC and the industry were able to effectively collaborate during the recent workshop and achieve the common goal of resolving outstanding issues from the previous workshop. The participants also identified the need for the CNSC to formalize its expectations with respect to industry self-assessments. CNSC staff plan to meet with individual facilities or sectors to further advance progress in this area and to collaborate with them on their respective safety management programs.

2.2.4 Training, Examination, and Certification

The focus of program evaluations in 2004 was on those certification training programs that were required to meet an acceptable standard prior to the transfer of the regulatory certification examinations to the licensees. These evaluations identified deficiencies in most of the programs, and the licensees are currently addressing them through their corrective action plans. CNSC staff will conduct follow-up activities to verify the completion of the proposed corrective actions, and will continue with scheduled evaluations of the training programs.

CNSC staff conducts knowledge-based and performance-based examinations in order to assess the competence of licensee staff in safety-critical positions. During 2004, Phase I of the transfer of certification examinations from the CNSC to the licensees continued. In Phase I, overseen by CNSC staff, the licensees prepared, conducted and graded all written and simulator-based certification examinations for reactor operators and shift supervisor candidates in accordance with CNSC procedures. CNSC staff continued to approve and issue the certification examinations and the examination results.

The success rate on examinations for shift supervisors and control room operator candidates was 99% (well above the average historical success rate of 87%).

In 2004, licensees conducted written and simulator re-qualification examinations. Licensees encountered significant problems adhering to the procedure for written testing prescribed by the CNSC. The licensees proposed license amendments that allow them to conduct written re-qualification testing with a reduced number of multiple-choice questions and to choose potential questions in an alternate manner other than that described in the re-qualification requirements.

Three evaluations of the re-qualification process were conducted in 2004. Although deficiencies were identified, the re-qualification processes in place at Darlington, Pickering, and Point Lepreau met CNSC expectations.

2.3 DESIGN AND ANALYSIS

2.3.1 Safety Analysis

For the year 2004, CNSC staff reviews confirmed that all licensees performed acceptable safety analyses.

2.3.2 Safety Issues

There has been progress on some issues in 2004 while progress on others proved to be slower than anticipated. Fourteen generic action items (GAIs) were active in 2004; one GAI was closed 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

CNSC staff was satisfied with licensees' progress in 2004 in implementing physical upgrades for fire protection, initiated as a result of GAIs and hazard analyses. The majority of the fire suppression and detection upgrade projects are now completed.

However, the service water (source of fire water) design issues related to the electrical blackout in 2003 at Pickering B are not completely resolved. Other design issues at Pickering B that were identified following the blackout remained open in 2004 and are being tracked by CNSC staff.

2.4 EQUIPMENT FITNESS FOR SERVICE

In 2004, CNSC staff reviews found that licensees implemented adequate measures and appropriately adjusted their inspection programs to manage identified degradation. CNSC staff judged that, in 2004, licensees' equipment at all sites continued to be fit for service. However, some programs did not meet requirements at some sites.

2.4.1 Maintenance

All licensees have established maintenance programs to meet the licence conditions related to maintenance. Efficient completion of preventative and corrective maintenance work is a continuous challenge for all licensees and has, in some cases, led to chronic backlogs.

2.4.2 Structural Integrity

In 2004, CNSC staff directed Bruce B and Point Lepreau to update their periodic inspection programs to meet current standards. Ongoing implementation of the update at Bruce A has not yet fully met the expectations of CNSC staff. Point Lepreau responded to CNSC staff's concerns in December 2004 but is not expected to be compliant until 2005.

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. This approach will apply requirements that are commensurate with the safety significance of the system.

The purpose of the "Number of Pressure Boundary Degradations" PI is to indicate the number of pressure boundary degradations that have occurred at the station and to monitor the performance in meeting nuclear industry codes and standards.

Tables 12, 13 and 14 illustrate the "Number of Pressure Boundary Degradations" PI for the industry. 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 number of degradations in 2004 was consistent with previous years (Table 13). The decrease in the number of degradations at Bruce A and Pickering A and B from 2003 to 2004 is noteworthy (Table 14). (Note that 2004 was the first full year for which this PI was reported separately for Pickering A and B.) For all stations, the vast majority of the degradations occurred in the conventional systems.

Table 12: Pressure Boundary Degradations for 2004

Station	# Pressure Boundary Degradations by Type					
	Class 1	class 2	class 3	class 4	conv	Total
Bruce A	3	0	8	0	57	68
Bruce B	8	0	5	0	121	134
Darlington	6	1	4	0	55	66
Pickering A	1	1	2	0	13	17
Pickering B	2	0	3	0	42	47
Gentilly-2	0	0	0	0	0	0
Point Lepreau	1	2	1	0	4	8

Table 13: Trend Details of Pressure Boundary Degradations for Industry

Year	# Pressure Boundary Degradations by Type					
	class 1	class 2	class 3	class 4	conv	Total
2000	54	8	51	2	379	494
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

Table 14: Trends of Pressure Boundary Degradations for Stations

Station	Total # Pressure Boundary Degradations				
	2000	2001	2002	2003	2004
Bruce A	51	21	18	131	68
Bruce B	197	47	71	109	134
Darlington	65	80	91	59	66
Pickering A and B	125	155	109	100	64
Gentilly-2	11	3	3	0	0
Point Lepreau	45	39	35	10	8

2.4.3 Reliability

CNSC regulatory standard S-98 ("Reliability Programs for Nuclear Power Plants") will soon be incorporated in all operating licences. The licensees were required to develop their programs and report on progress in their annual reliability reports.

CNSC staff is satisfied that all licensees are making good progress towards meeting the requirements of regulatory standard S-98.

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 (i.e. to monitor performance in meeting regulatory and licensee availability requirements).

Tables 15, 16 and 17 show the "Number of Missed Mandatory Safety System Tests" PI for the industry. This PI represents the ability of licensees to successfully complete routine tests on systems related to safety. Approximately 90,000 of these tests were performed throughout the industry in 2004. The total number of missed tests was higher in 2004 than in the previous three years—the increase can be attributed almost entirely to an increase at Pickering B. However, the numbers of missed tests remain small, indicating a consistent industry commitment to test its safety systems on a regular basis. Based on the information reported in the licensees' annual reliability reports, CNSC staff did not observe any significant impact on safety due to the missed tests.

Table 15: Missed Mandatory Safety System Tests for 2004

Station	Total # Tests	Missed Mandatory Safety System Tests			
		Special	Standby	Safety Related	Total
Bruce A	17666	2	0	0	2
Bruce B	29992	1	0	0	1
Darlington	10799	1	0	0	1
Pickering A	9283	0	0	0	0
Pickering B	10984	11	3	5	19
Gentilly-2	2855	1	0	0	1
Point Lepreau	5747	2	0	0	2
Total for Industry	87326	18	3	5	26

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

Year	Total # Tests	Total # Missed Mandatory Safety System Tests			
		Special	Standby	Safety Related	Total
2000	no data	11	6	25	42
2001	52841	2	0	4	6
2002	63864	3	1	0	4
2003	64303	2	2	3	7
2004	87326	18	3	5	26

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

Station	Missed Mandatory Safety System Tests				
	2000	2001	2002	2003	2004
Bruce A	-	-	-	-	2
Bruce B	1	0	0	0	1
Darlington	32	4	0	0	1
Pickering A	0	0	0	0	0
Pickering B	6	2	1	5	19
Gentilly-2	0	0	1	2	1
Point Lepreau	3	0	2	0	2
Total for Industry	42	6	4	7	26

2.4.4 Equipment Qualification

In 2004, CNSC staff reviewed submissions from all licensees and found that, in principle, their Equipment Qualification programs met requirements. CNSC staff's final position on program implementation will be established following completion of *Type I inspections* at each site. For more details, see Section D.6.1.

2.5 EMERGENCY PREPAREDNESS

Ongoing compliance activities for Bruce Power and OPG confirmed that their Emergency Preparedness programs and implementation exceeded CNSC requirements. The programs at Gentilly-2 and Point Lepreau also exceeded requirements. However, implementation was considered to meet requirements at Gentilly-2 and was assessed to still be below requirements at Point Lepreau.

2.6 ENVIRONMENTAL PERFORMANCE

In 2004, 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. As in previous years, these results demonstrate the continuation of a strong 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 either radioactive substances or hazardous substances, from any power reactor site in 2004 that posed an unreasonable risk to the environment.

2.7 RADIATION PROTECTION

CNSC staff carried out regular reviews of all aspects of Radiation Protection programs at all facilities and found that, in general, licensees continued to adequately manage radiation doses. No worker received a radiation dose in excess of the regulatory limits.

In 2004, licensees worked toward modifying their respiratory protection programs and documented the modifications to ensure conformance with the relevant CSA standard. Some of the licensees did not complete the implementation of the requirements of the CSA standard by the end of the year. Others did, but their revised documents did not reach the CNSC for review and acceptance until late in the year. Hence, for 2004, the program grades were ‘B’ for all stations.

In 2004, most of the stations met the regulatory requirements for implementation of their Radiation Protection programs. Hydro-Québec continued to have difficulty ensuring its employees adhere to radiation safety procedures, although the radiation doses to workers at Gentilly-2 remained low 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.

Tables 18, 19 and 20 show the “Radiation Occurrence Index” PI. The index and its components are defined and calculated as follows:

a = number of occurrences, after decontamination attempts, of fixed body contamination > 50 kBq/m2

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 occurrence. In 2004, there were no doses in excess of specified limits (value of "d" in Table 18). For some licensees, no occurrences of any type occurred. Of particular note was the significant decrease in the index for Gentilly-2 in 2004 (Table 20).

Table 18: Radiation Occurrence Index for 2004

Station	Radiation Occurrence				
	a	b	c	d	Index
Bruce A	0	0	0	0	0
Bruce B	0	0	1	0	5
Darlington	0	0	0	0	0
Pickering A	0	0	1.08	0	5.4
Pickering B	0	0	0	0	0
Gentilly-2	0	0	0	0	0
Point Lepreau	0	0	0	0	0

Table 19: Trend Details of Radiation Occurrence Index for Industry

Year	Radiation Occurrence				
	a	b	c	d	Index
2000	0	0	9.5	0	47.4
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

Table 20: Trend of Radiation Occurrence Index for Stations

Station	Radiation Occurrence Index				
	2000	2001	2002	2003	2004
Bruce A	0	0	0	0	0
Bruce B	0	17.2	13.2	0	5
Darlington	0	0	0	0	0
Pickering A and B	12.4	0	8.8	0	5.4
Gentilly-2	22.2	27.0	0	35.5	0
Point Lepreau	12.8	1.0	0	0	0

2.8 SITE SECURITY

The assessment of the Site Security safety area for the industry is documented in a separate (protected) report (CMD 05-M31.A).

2.9 SAFEGUARDS

In 2004, CNSC staff assessed all licensees as meeting Safeguards requirements. All reports required by the *International Atomic Energy Agency* (IAEA) were provided in a timely manner. All licensees cooperated with 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.

Upon review of the rating system for Safeguards programs and implementation at all stations, most of the grades have been changed from ‘A’ to ‘B’. CNSC staff has acquired more experience with the rating system and has had the opportunity to compare the rating approach across all the safety areas. Upon reconsideration, Safeguards programs and their implementation were assessed to meet, rather than exceed, the relevant requirements and expectations. Hence, ‘B’ grades are now considered to be appropriate for both program and implementation at all the stations. This is a standardization change only and does not reflect any deficiency or decline in performance at the stations.

2.10 CONCLUSION

The review of the Operating Performance safety area supported the conclusion that the Canadian power reactor industry operated safely in 2004. 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 sufficiently adequate programs in place to support the safe performance of the industry in 2004.

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 2004, as well as the grades for all the programs under each safety area.

The relatively small number of ‘C’ grades in Table 21, compared with Table 22, suggests that the licensees generally have good programs for the various safety areas but that they are not always well-implemented. As indicated by the smaller number of highlighted grades in Table 21 compared with Table 22, it is also true that the program grades for the licensees change far less frequently than the implementation grades. If one discounts the grade changes for Safeguards (they were a result of rating standardization rather than changes in licensee performance), Table 22 shows that there was more improvement in 2004, rather than decline, in the implementation of the safety areas across the industry.

As in previous years, the industry continued to have good programs for Environmental Performance and Safeguards. With the exception of one station in each case, Emergency Preparedness and Radiation Protection were also noteworthy strengths for the industry.

There were significant developments in 2004 in the Performance Assurance safety area, which continued to be the area of greatest weakness for the industry. All licensees continued to work toward developing, maintaining, and implementing adequate programs for Quality Management, Human Factors, and Training, Examination, and Certification. Although progress was made at some stations for some programs, more work remains before these programs will meet all requirements and be adequately implemented at all stations. In general, Quality Management remained a weakness at the multi-unit stations in 2004, whereas Human Factors remained a weakness at the single-unit stations.

Table 21: Trends of "Program" Grades from Annual Reports for the Nine Safety Areas

Safety Area	Year of Report	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Operating Performance	2002	B	B	B	B	B	B	B
	2003	B	B	B	B	B	B	B
	2004	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Performance Assurance	2002	B	B	B	B	B	C	C
	2003	B	B	B	B	B	C	C
	2004	**B**	**B**	**B**	**B**	**B**	**C**	**B**
Design & Analysis	2002	B	B	B	B	B	B	B
	2003	B	B	B	B	C	B	B
	2004	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Equipment Fitness for Service	2002	B	B	B	B	B	B	B
	2003	B	B	B	B	B	B	B
	2004	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Emergency Preparedness	2002	A	A	A	A	A	A	A
	2003	A	A	A	A	A	A	A
	2004	**A**	**A**	**A**	**A**	**A**	**A**	**A**
Environmental Performance	2002	B	B	B	B	B	B	B
	2003	B	B	B	B	B	B	B
	2004	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Radiation Protection	2002	A	A	A	A	A	A	A
	2003	B	B	A	B	B	A	B
	2004	B	B	B	B	B	B	B
Site Security	2002	Protected						
	2003							
	2004							
Safeguards	2002	A	A	A	A	A	A	A
	2003	A	A	A	A	A	A	A
	2004	**B**	**B**	**B**	**B**	**B**	**B**	**B**

Program grades for 2004 that changed since the 2003 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

Safety Area	Year of Report	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Operating Performance	2002	B	B	B	B	B	B	B
	2003	B	B	B	B	C	B	B
	2004	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Performance Assurance	2002	C	C	C	B	C	C	C
	2003	B	B	C	C	B	C	C
	2004	**B**	**B**	**B**	**B**	**B**	**C**	**B**
Design & Analysis	2002	B	B	B	B	B	B	B
	2003	B	B	B	B	C	B	B
	2004	**B**	**B**	**B**	**B**	**C**	**B**	**B**
Equipment Fitness for Service	2002	C	B	B	B	B	B	B
	2003	B	B	B	B	B	B	B
	2004	**B**	**B**	**B**	**B**	**B**	**B**	**C**
Emergency Preparedness	2002	A	A	A	A	A	A	C
	2003	A	A	A	A	A	A	C
	2004	**A**	**A**	**A**	**A**	**A**	**B**	**C**
Environmental Performance	2002	B	B	B	B	B	B	B
	2003	B	B	B	B	B	B	B
	2004	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Radiation Protection	2002	B	B	B	B	B	C	B
	2003	B	B	B	B	B	C	B
	2004	**B**	**B**	**B**	**B**	**B**	**C**	**B**
Site Security	2002	Protected						
	2003							
	2004							
Safeguards	2002	A	A	A	A	A	A	A
	2003	A	A	A	A	A	A	B
	2004	**B**	**B**	**B**	**B**	**B**	**B**	**B**

Implementation grades for 2004 that changed since the 2003 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

Safety Area / Program	P or I	Bruce		Darlington	Pickering		Gentilly-2	Point Lepreau
		A	B		A	B		
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**	**C**	**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**	**C**	**B**
	I	**B**	**B**	**B**	**B**	**B**	**C**	**B**
Quality Management	P	**C**	**C**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**C**	**C**	**C**	**B**	**B**
Human Factors	P	**B**	**B**	**B**	**B**	**B**	**C**	**C**
	I	**B**	**B**	**B**	**B**	**B**	**C**	**C**
Training, Examination, and Certification	P	**B**	**B**	**B**	**B**	**B**	**C**	**B**
	I	**B**	**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**	**C**
	I	**B**	**B**	**B**	**B**	**C**	**B**	**C**
Equipment Fitness for Service	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**B**	**B**	**B**	**C**
Maintenance	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**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**	**B**	**B**	**B**
Equipment Qualification	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**C**	**B**	**B**	**B**	**C**

Safety Area / Program	P or I	Bruce		Darlington	Pickering		Gentilly-2	Point Lepreau
		A	B		A	B		
Emergency Preparedness	P	**A**	**A**	**A**	**A**	**A**	**A**	**A**
	I	**A**	**A**	**A**	**A**	**A**	**B**	**C**
Environmental Performance	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**	**C**	**B**
Site Security	P	**Protected**						
	I	**Protected**						
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 (CTs)
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 NSCA and appointed by Governor in Council, to:

- regulate the development, production and use of nuclear energy, 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 (CMDs)
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 life 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 (PTs)
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
An international program of monitoring and inspection carried out by staff of the International Atomic Energy Agency. Safeguards ensure that nuclear materials at the plant are not diverted to non-peaceful uses.

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 no.1, the shutdown system no. 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
BEAU	best estimate analysis with uncertainty
CT	calandria tube
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owner's Group
CSA	Canadian Standards Association
DBA	design basis accident
ECC	emergency core coolant
EFADS	emergency filtered air discharge system
EQ	environmental qualification
FAC	flow-accelerated corrosion
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
LOECC	loss of emergency core coolant
LLOCA	large loss of coolant accident
LZCS	liquid zone control system
NB Power	New Brunswick Power
NSCA	*Nuclear Safety and Control Act*
OPG	Ontario Power Generation
PI	performance indicator
PT	pressure tube
QA	quality assurance
SCPO	supervised control panel operator
SDR	Significant Development Report
SDS	shutdown system
SSC	structures, systems and components
SOR	shutoff rod
TSSA	Technical Standards and Safety Authority

APPENDIX C
RATING SYSTEM

Grades are assigned for both design of the program and its implementation/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 failing to meet regulatory 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. All dates are for 2004 unless otherwise noted. Most of the information was compiled from *Commission Member Documents* (CMDs) called Significant Development Reports (SDRs).

D.1 BRUCE A AND B

D.1.1 Bruce Failed Bundle Counter

D.1.1.1 Description of Development (Reference SDR CMD 04-M43)

During a routine *International Atomic Energy Agency* (IAEA) inspection of IAEA-controlled *safeguards* equipment in July, IAEA staff discovered that the spent fuel bundle counter was not functioning, having failed at some point since the previous inspection in April. IAEA staff repaired the bundle counter and requested Bruce Power to perform a physical inventory verification of bundles discharged during that period. After the inventory verification, the IAEA confirmed that the requirements of the Safeguards Agreement were met.

D.1.2 Bruce A Unit 3 Shutdown System One Trip

D.1.2.1 Description of Development (Reference SDR CMD 04-M4)

On January 12, Unit 3 experienced a shutdown system 1 (SDS #1) trip from 50% full power. Unit 3 was limited to 55% full power for "Phase C" reactor physics testing at the time of the trip. The trip was initiated by an electrical fault on heat transport system (HTS) pump #4. An electrical connection to the pump motor failed on one of the three phases causing the pump to shutdown. This initiated a SDS #1 trip on low flow of the HTS.

The unit reacted as designed during the transient. The unit was returned to service on January 14 after repairs to the pump motor electrical connection were completed.

D.1.2.2 Follow-up (Reference Status Report CMD 04-M5)

At the time of the trip, all units were shut down except Units 3 and 4. Unit 3 was shut down later the same day to repair a damaged bearing on the turbine generator.

D.1.3 Bruce A Unit 3 Heat Transport Leak and Shutdown

D.1.3.1 Description of Development (Reference Supplemental Information to the Status Report CMD 04-M5)

On February 3, Bruce A Unit 3 developed a HTS leak and was shut down to determine the source of the leak.

D.1.3.2 Follow-up

The leakage was confirmed to be coming from Graylock fittings. The repairs were made and the unit was brought back into service.

D.1.4 Work on Wrong Unit During Bruce A Unit 4 Shutdown

D.1.4.1 Description of Development (Reference SDR CMD 04-M14 and Transcript to March 24 *Commission* Meeting)

On March 13, Unit 4 was being shut down to repair a leak in the HTS pump secondary seal. During the shutdown procedure, an operator went to Unit 3 to perform a standard shut-down manoeuvre. This error caused the Unit 3 turbine to trip. As per design, the unit set back and subsequently poisoned out. Both units have since been returned to power and CNSC staff is investigating the cause of this human error.

D.1.5 Bruce A Unit 4 Shutdown System One Trip

D.1.5.1 Description of Development (Reference Supplemental Information to SDR CMD 04-M43)

On November 6, Bruce A Unit 4 experienced a SDS #1 trip when an operator accidentally left a valve open following a routine safety system test on SDS #2. This caused gadolinium to leak from the poison injection tanks into the moderator, which led to a trip of SDS #1 on neutron overpower protection. Unit 4 was later returned to full power.

D.1.6 Degradation of Bruce B Unit 8 Steam Generator Tube Support Plates (Originally reported in 2003 industry report CMD 04-M30)

D.1.6.1 Follow-up (Reference: Status Report CMD 04-M5)

Units 5, 6 and 7 returned to high power in November. During the Unit 8 planned outage, the secondary side boiler inspections of the seventh support plate in Boiler B04 indicated unexpected plate erosion. As a result, Bruce Power expanded the boiler inspection program. The projected date for synchronization to the grid was January 22.

D.1.6.2 Additional Follow-up

Bruce Power completed its disposition of the degradation and all necessary repairs. Bruce Power also submitted preliminary plans for confirmatory inspections in the future. Unit 8 was returned to service.

D.1.7 Bruce B Unit 5 Shutdown to Repair Leak

D.1.7.1 Description of Development (Reference Supplemental Information to the Status Report CMD 04-M5)

On January 31, Bruce B Unit 5 was shut down to repair a leak in the HTS, a passing valve in SDS #2, and a corroded SDS #2 horizontal flux detector. The unit was synchronized to the grid in February.

D.1.8 Maximum Allowable Power for Bruce B Unit 6

D.1.8.1 Description of Development (Reference: SDR CMD 04-M20)

Since the early 1990's, the Bruce B reactors have been limited to a maximum power of 90% to provide adequate operational safety margins under certain low probability accident scenarios (large loss of coolant accidents, or LLOCA). Bruce Power has modified the fuelling process from fuelling "against the flow" of the reactor coolant to fuelling "with the flow". This change has been analysed to provide adequate safety margins to allow an increase in reactor power from 90% to 93%. On April 20, the CNSC designated officer gave Bruce Power approval to raise reactor power to 93% for Unit 6. Bruce Power raised reactor power to 93% on April 23.

D.1.9 Bruce B Planned Maintenance on Unit 6 Flow Transmitter

D.1.9.1 Description of Development (Reference: SDR CMD 04-M35)

On August 18 and 19, Bruce Power was performing planned maintenance on a Unit 6 flow transmitter on channel F. About 20 minutes after the flow transmitter was “failed safe” in the control room, the flow transmitter for channel E was mistakenly disconnected in the field. SDS #1 then tripped on low *feeder* flow. The unit poisoned out and was stabilized at -4.5 decades in the zero-power hot state. SDS #1 was subsequently re-poised. The unit was re-synchronized to the grid on August 22.

D.1.10 Leakage of Non-Radioactive Chemically-Treated Water at Bruce B

D.1.10.1 Description of Development (Reference CMD SDR 04-M43)

During the startup of Bruce B Unit 7 licensee staff discovered that non-radioactive, chemically-treated water from the emergency water system storage tank had leaked into the lake due to a passing valve. The leak was stopped and assessed. The event was reported to the Ontario Ministry of the Environment and also to the CNSC under regulatory standard S-99 (release of a hazardous substance that has the potential to adversely affect the environment). The Ontario Ministry of the Environment dealt with the issue.

D.1.11 Internal Dose to Bruce B Operator

D.1.11.1 Description of Development

On October 27, an operator received an internal dose of approximately 4.8 millisieverts (480 mrem) due to a tritium uptake. The operator was wearing inadequate radiation protection clothing while cleaning up some spilled moderator. The Bruce B action level for reporting to the CNSC, per regulatory standard S-99, is 200 mrem. The CNSC regulatory annual limit is 5000 mrem. This event was reported to the *Commission* for information.

D.1.12 Bruce B Unit 8 Shutdown Due to Valving Error

D.1.12.1 Description of Development (Reference Supplemental Information to SDR CMD 04-M43)

On November 10, Bruce B Unit 8 was shut down by automatic and manual actions due to a valving error in the screenhouse which caused the turbine to lose vacuum. Unit 8 was later returned to service at full power. This and other events at Bruce A and B involved human performance errors. CNSC staff is monitoring the licensee’s follow-up to these events (see Sections D.1.4, D.1.5 and D.1.9).

D.2 DARLINGTON

D.2.1 Darlington Unit 2 Return to Service—Trip and Annulus Gas System Incident (Originally reported in 2003 industry report CMD 04-M30)

D.2.1.1 Additional Follow-up

CNSC staff followed up this issue during the Unit 2 outage in March and was satisfied with procedural changes to address the issues. In addition, Darlington improved instrumentation and completed training in 2004.

D.2.2 Investigation of Feeder Weld Repairs at Darlington and Pickering (Originally reported in 2003 industry report CMD 04-M30)

D.2.2.1 Additional Follow-up

Ontario Power Generation (OPG) added inspections of repaired *feeder* welds to its revised *feeder* pipe aging management plan. Accessible *feeder* weld repairs were inspected in 2004; OPG plans to inspect 50 repaired welds during each outage. The techniques for inspecting welds for cracking are still in the process of development. The software to analyse *feeder* cabinet leakage was improved and preparations were made to install improved leak detection equipment.

D.2.3 Openings in Steam-Protected Rooms at Darlington

D.2.3.1 Description of Development (Reference: SDR CMD 04-M43)

A number of steam-protected rooms were found to have openings greater than the allowable size assumed in the safety analysis. Steam-protected rooms are designed to ensure equipment that is important to safety will operate during postulated events such as a steam line break or feed water pipe rupture.

In February, OPG staff discovered several gaps greater than the assumed safety limit in three steam-protected rooms that house safety-significant equipment. In the following months, OPG staff continued to find more gaps in other rooms. In September, in response to the increasing discoveries of gaps, OPG implemented a more rigorous inspection and repair program and took some mitigating actions to reduce the likelihood and severity of a potential event.

By November 1, out of 283 steam-protected rooms, 85 were identified as needing repairs, 25 rooms were repaired, and six inspections were outstanding. OPG had 140 workers involved in the inspections and repairs.

These events were reported to CNSC staff according to the reporting requirements of their nuclear power reactor operating licence.

At the oral request of CNSC staff, OPG provided the CNSC with written assurance that the steam-protected rooms of greatest safety significance in operating units would be inspected and repaired by November 9. Unit 3, then in a planned outage, would not be restarted until all its steam-protected rooms were inspected and repaired.

CNSC staff had a series of meetings with OPG and monitored the progress of the work.

D.2.3.2 Initial Follow-up (Reference: SDR CMD 04-M43.A)

OPG made good progress in the inspection of steam-protected rooms and the repair of any significant gaps that were discovered. However, it was determined by November 7 that repairs to rooms of Units 1 and 4 could not be completed by November 9. Therefore, OPG shut down Units 1 and 4.

By November 9, all steam-protected rooms in the station were inspected and all significant gaps were repaired in Units 0, 2 and 3. Unit 1 and 4 repairs were expected to be completed in a few days. All shut-down units were expected to be restarted when repairs and subsequent tests and inspections were completed.

Independent verification of 40 rooms was carried out by OPG engineering to confirm the effectiveness of the gap identification. OPG investigated options for leakage testing of the steam-protected rooms to provide a more definitive confirmation that all significant gaps were found and repaired. OPG also conducted about 150 non-destructive and 10 destructive tests of repairs to give added assurance of the integrity of the repairs.

CNSC staff actively monitored OPG’s progress on this issue. Oversight activities included the witnessing of initial inspections, inspection of repairs, witnessing of non-destructive and destructive testing of repairs, and the witnessing of independent verification inspections. In addition, CNSC staff attended OPG daily meetings on this subject.

D.2.3.3 Follow-up (Reference Supplemental Information to SDR CMD 04-M43)

At Darlington, all inspections and repairs have been completed to steam-protected rooms. Units 1, 2 and 4 are now operating at high power. Unit 3 is in the process of returning to service.

D.2.3.4 Additional Follow-up

On December 16, a pilot steam room leakage test was successful in demonstrating the leak rate measurement method proposed by OPG. A larger room of more complicated configuration is scheduled to be tested in the spring of 2005. A quality assurance (QA) inspection related to this work is also planned for 2005.

D.2.4 Reduction of Output for Darlington Unit 2

D.2.4.1 Description of Development (Reference: supplemental information to Status Report CMD 04-M5)

Power output at Darlington Unit 2 was reduced to 59% because of a no fuelling restriction due to a fuelling machine trolley problem. OPG staff was investigating how to repair the trolley.

D.2.4.2 Initial Follow-up (Reference: Transcript to March 24 *Commission* Meeting)

Unit 2 had been reduced to 59% power due to a trolley problem in the transfer bay of the fuelling machine. As a result, fuelling was not available to maintain core reactivity to support full power operation. The trolley was repaired, the fuelling machine returned to service, and the unit returned to full power.

D.2.4.3 Additional Follow-up

All trolleys are now inspected during unit outages.

D.3 PICKERING A AND B

D.3.1 Pickering A Unit 4 Liquid Zone Control System Failure

D.3.1.1 Description of Development (Reference SDR CMD 04-M35A)

On July 20, an equipment failure in the liquid zone control system (LZCS), coupled with an earlier intermittent problem in the same system, led OPG to declare the LZCS unreliable. Unit 4 was shut down and, in accordance with operating manual instructions, the SDS was manually actuated. The failed equipment was replaced and the unit was returned to service on August 5. Efforts to determine the cause of the intermittent problem are continuing and mitigating measures are in place to minimize the risk of a unit upset.

D.3.1.2 Additional Follow-up

OPG is continuing to address the equipment problems by replacing and inspecting valve diaphragms and installing additional monitoring. The investigation is also continuing to determine the root cause of the intermittent problem (inaccurate zone level indications) in the LZCS and identify appropriate long-term corrective actions to prevent a recurrence.

D.3.2 Pickering A Unavailability of Emergency Core Coolant

D.3.2 Description of Development (Reference SDR CMD 05-M4)

On November 24, while performing routine checks, OPG discovered that a seismically-qualified circuit breaker was in the open position. This resulted in an emergency core coolant (ECC) valve being unable to operate and, hence, this *special safety system* was unavailable for a few hours. The initial assessment indicated that a switch on the breaker had been bumped inadvertently causing it to open the breaker. A protective barrier was installed around the switch. CNSC staff considers that OPG has taken adequate corrective actions to prevent a repetition of this failure.

D.3.3 Pickering A Environmental Qualification

D.3.3.1 Description of Development (Reference SDR CMD 05-M4)

On November 24, following a review of Darlington's steam barrier operating experience (see Section D.2.3), OPG completed a thorough assessment and found some impairments to the Pickering A steam barrier in a wall around Units 3 and 4. The stairwells on Unit 3 and 4 were found to require reinforcement and the repairs were completed.

D.3.4 Pickering A Unit 4 Loss of Class IV Power

D.3.4.1 Description of Development (Reference SDR CMD 05-M4)

On December 9, Unit 4 was at 87% and being returned 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, Class IV power was restored in approximately 22 minutes, and the unit was placed in the *guaranteed shutdown state* (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 did respond to the alarm. CNSC staff was satisfied with the response of the unit and OPG staff during the incident.

D.3.4.2 Follow-up

The response of the electrical systems to the loss of power is still under review by both OPG and CNSC staff to determine the causes of equipment failures that complicated the event.

D.3.5 Pickering A Unit 4 Trip

D.3.5.1 Description of Development (Reference: Transcript to January 12, 2005 *Commission* Meeting)

On December 24, Unit 4 tripped on the SDS enhancement neutronic parameters log rate. The unit upset began when a 120 volt power fuse failed. This resulted in the loss of a calandria spray control which caused the calandria inlet valves to close. This, in turn, caused the calandria level to drop. A low calandria level *setback* was initiated by the regulating system. The unit subsequently tripped on the SDS enhancement neutronic log rate parameter. The fuse was replaced and the unit was returned to high power operation.

D.3.6 Pickering B Unit 8 Shutdown after Problem with Uninterruptible Power Supply

D.3.6.1 Description of Development (Reference: supplemental information to Status Report CMD 04-M5)

On January 26, Pickering B Unit 8 was shut down to repair a problem with its uninterruptible power supply. The unit returned to power over the February 1st weekend. However, the unit experienced subsequent boiler level control problems and set back to low power and poisoned out. Also, see Section D.3.7.

D.3.7 Pickering B Unit 8 Boiler Level Control Valve Failed Fully Open

D.3.7.1 Description of Development (Reference SDR CMD 04-M14)

On February 3, while performing a routine duty change of a boiler level control valve on Unit 8, the valve failed fully open. The turbine tripped on high boiler level, the reactor power was lowered automatically and the reactor was shut down to repair the valve.

D.3.7.2 Follow-up

The repairs were made and the unit was re-synchronized to the grid in February.

D.3.8 Pickering B Station Emergency

D.3.8.1 Description of Development (Reference SDR CMD 04-M14)

On March 1, a station emergency was declared following a hydrogen leak from the Unit 6 generator. Unit 6 was in the process of being shut down to repair cooling fans in the reactor building when the turbine was manually tripped when problems were noticed with the generator. The hydrogen leak from the generator was then discovered. OPG activated the site management center to support the station response to the event and all appropriate precautions were taken to eliminate hazards to personnel and the plant, including the use of contingency plans to deal with the possibility of fire. No fire or personnel injuries occurred. The causes of the problems with the turbine-generator were investigated.

D.3.8.2 Initial Follow-up (Reference: SDR CMD 04-M20)

During the Unit 6 shutdown, vibration was noted in the generator and a pressure drop in the hydrogen system indicated a leak. The follow-up investigation revealed that a flashover between conductor bars, caused by foreign material, had damaged a generator stator cooling water box.

The hydrogen leak was internal to the stator cooling system. It is a closed system, other than a tank at a higher elevation, which was found to have overflowed. As a precaution during the event, the hydrogen system was vented to atmosphere. A small amount of hydrogen was released through the vent of the head tank to the upper level of the turbine hall and dissipated.

D.3.9 Degradation of the Bleed Condenser at Pickering B

D.3.9.1 Description of Development (Reference: oral update of SDR CMD 04-M20)

On April 21, CNSC staff became aware of degradation in the bleed condenser of the HTS. OPG did not proceed with the start-up until CNSC staff was satisfied that the cause of the problem was understood and that adequate measures were in place to assure a safe return to operation.

D.3.10 Pickering B Response to 2003 Blackout (Originally reported in 2003 industry report CMD 04-M30)

D.3.10.1 Follow-up (Reference: SDR CMD 04-M20 and supplemental information)

In April, CNSC staff gave its report to OPG on the independent inspection of the response of Pickering B to the electrical blackout in August 2003. The review also assessed OPG’s investigation of the event and the corrective actions already undertaken.

The inspection report acknowledged that the event had no direct nuclear safety consequences for the public or workers during the loss of the bulk electrical system. Nevertheless, CNSC staff identified 19 findings related to the design, maintenance, and operation of the plant. The report also identified deficiencies in certain aspects of OPG's investigation and corrective actions. In the opinion of CNSC staff, the findings represented significant weaknesses in the station's defence-in-depth against this type of event.

On March 22, pursuant to Section 12 (2) of the General Nuclear Safety and Control Regulations, CNSC staff instructed OPG to review each finding in the report, assess its impact on nuclear safety, and propose a plan and schedule of action for resolution. OPG recognized the weaknesses highlighted by the report and had plans to address the issues. OPG submitted a response and CNSC staff is reviewing it. In the interim, OPG has taken measures to improve the station response to a similar event.

D.3.10.2 Additional Follow-up (Reference: SDR CMD 05-M18)

Since November, OPG continued to improve 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 overhauls at the other units were planned for upcoming outages.

OPG submitted documentation to demonstrate that the service water systems are able to meet all their capability requirements. OPG also submitted action plans, including activities and schedules, related to service water design, operation, surveillance, maintenance, and safety analysis. CNSC staff is reviewing the plans to confirm that they resolve the remaining issues related to service and fire water, while continuing to monitor the relevant improvement activities.

D.3.11 Pickering B Loss of Bleed during Restart

D.3.11.1 Description of Development (Reference: Transcript to January 12, 2005 *Commission* Meeting)

On December 31, during the restart of Unit 7 after a planned maintenance outage, the unit experienced a 20 second loss-of-bleed while placing the HTS belled condenser into service. This caused a HTS pressure transient and a SDS #1 trip on high HTS pressure. The loss-of-bleed was caused by a valve failing to open as per design. The valve control logic was repaired and the unit returned to high power operation.

D.4 GENTILLY-2

D.4.1 Blockage of Gentilly-2 Condenser Intake Filters (Originally reported in 2003 industry report CMD 04-M30)

D.4.1.1 Additional Follow-up

Hydro-Québec responded to CNSC staff's comments on its significant event report. CNSC staff reviewed these responses and found them to be generally acceptable.

D.4.2 Gentilly-2 Shutdown following Hydrogen Leak

D.4.2.1 Description of Development (Reference SDR CMD 04-M26)

The power plant was shut down in early May following the discovery of a leakage of hydrogen (cooling gas for the rotor) into the de-mineralized water system that cools the alternator stator. The leak was caused by a tiny hole in one of the welds in a de-mineralized water system pipe. The weld was repaired and the plant started up again on May 30.

D.4.3 Chlorine Leak at Gentilly-2

D.4.3.1 Description of Development (Reference SDR CMD 04-M35)

On August 10, an alarm went off in the control room indicating chlorine in the circulating water chlorination room. A sectoral alarm was issued according to the "chlorine alert" emergency procedure. Personnel accounting was carried out with no difficulty. The leak, which came from the circulating water chlorinator, was isolated and the sectoral alarm was lifted. The purpose of the circulating water system is to cool the condenser. When the incident occurred, Gentilly-2 was operating at full power. Hydro-Québec prepared a detailed report of the incident for submission to the CNSC, pursuant to regulatory standard S-99.

D.4.4 Unplanned Shutdown of Gentilly-2

D.4.4.1 Description of Development (Reference SDR CMD 05-M4)

In the light of the new technical calculations for *pressure tubes* (PTs), Hydro-Québec took the precaution of shutting down Gentilly-2 on December 4. 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. Gentilly-2 reached full power two days later.

D.5 POINT LEPREAU

D.5.1 Point Lepreau Shutdown Following Lightning Strikes

D.5.1.1 Description of Development (Reference SDR CMD 04-M35)

Point Lepreau was shut down on July 9 following a series of lightning strikes. The reactor was returned to the critical state on July 11 and the generator was synchronized to the grid on July 12.

D.5.2 Point Lepreau Emergency Power System Control Problems

D.5.2.1 Description of Development (Reference SDR CMD 04-M43)

Diesel generator #2 in the emergency power system experienced frequency control problems during two recent routine test runs. Diesel generator #1 was sent off-site for overhaul and was unavailable. Diesel generator #2 cannot be unavailable for more than 48 hours before the reactor is put in GSS in accordance with the requirements of the power reactor operating licence.

D.5.2.2 Follow-up (Reference SDR CMD 05-M4)

Diesel generator #1 was returned to site, re-installed, and declared available for service on December 11.

D.5.3 Point Lepreau Forced Outage due to Shutoff Rod Failure and Steam Leak

D.5.3.1 Description of Development (Reference SDR CMD 04-M43)

A forced outage occurred on October 2 when a SDS #1 shutoff rod (SOR) module failed, causing the SOR to drop into the core. The affected SOR control module was replaced and SDS #1 was declared available.

On October 4, during the return to service with reactor power at 35%, an operator discovered a steam leak near the main steam balance header. Station power was immediately reduced to 0.1% and further inspections revealed three significant cracks on the west condenser steam discharge valve dump header. The reactor was returned to GSS to allow additional inspections, engineering assessments, and repairs. The repair and inspection work included additional pipe inspections requested by CNSC staff. The steam line work was completed and accepted by CNSC staff on October 16.

While the reactor was in GSS, Point Lepreau staff removed SDS #1 from service to perform maintenance on the logic modules for all of the SORs. Licensee staff discovered an unsafe failure mode linked to a transistor of the SOR modules. This failure mode could prevent the SORs from dropping into the core.

New transistors were installed in all SOR modules and the SOR testing program was expanded to improve failure detection. This was a design flaw related to other CANDU 6 stations, but it was already resolved for Gentilly-2.

D.5.3.2 Follow-up

The steam header leak was attributed to circumferential fatigue cracking on the top side of a weld. The cracks had grown over a long time, and the header had not been inspected under the station in-service inspection program. Subsequent inspections identified similar cracking on two other lines. All cracks were repaired prior to restarting the reactor.

D.5.4 Point Lepreau Maintenance on Three Channels of Shutdown System #1

D.5.4.1 Description of Development (Reference SDR CMD 04-M43.A)

On October 26, Point Lepreau staff performed maintenance on all three channels of SDS #1 without first rejecting the affected channels. This intervention to the function of SDS #1 lasted approximately 11 minutes. Following the maintenance, the operators also failed to test the function of the SDS #1 log rate trip that could have been affected by their intervention. The action of the operators was contrary to the requirements of the operating policies and principles that define the licensing requirements for the operation of the station. Specifically, the operating policies and principles require, prior to maintenance on channelized systems, that the operator must place them in a safe state and must also test each channel prior to returning it to service. A subsequent Point Lepreau staff review determined that the above maintenance caused impairment of SDS #1 by decreasing the HTS low pressure trip setpoint below its acceptable level.

On November 8, CNSC staff met with Point Lepreau management to communicate concern about the apparently non-conservative decision making that characterized the operator's actions during this event. CNSC staff plans to conduct a detailed review of the root cause evaluation that NB Power Nuclear is required to submit.

D.5.5 Cracking of Outlet Feeder Pipes at Point Lepreau (Originally reported in 2003 industry report CMD 04-M30)

D.5.5.1 Additional Follow-up

To improve its understanding of the causes of cracking in outlet *feeder* pipes, NB Power contracted destructive examinations of tight-radius bends from eight outlet *feeders* removed from the reactor. At a meeting with NB Power Nuclear in January 2005, CNSC staff was informed about the discovery of evidence of active cracks on the outside surface of the bend extrados on two *feeders*. CNSC staff believes that cracking at such a location is quite serious because it corresponds to the point where: 1) the initial wall thickness is a minimum (due to the bending process used during *feeder* installation); and 2) additional in-service wall thinning has been observed due to flow-accelerated corrosion (FAC).

To assess this finding, CNCS staff considered information from two recent reports from NB Power Nuclear.

- Based on measurements of one spare Point Lepreau *feeder* bend, NB Power Nuclear established that the extrados material has approximately one quarter of the fracture toughness of the straight portion of the same pipe. (Fracture toughness is a parameter reflecting a crack's resistance to propagation.)
- NB Power Nuclear re-evaluated its capability to detect *feeder* cracks during in-service inspections. Until recently, NB Power Nuclear had asserted a detection limit (on depth) of 1mm; it now admits that the detection limit is probably deeper than 2mm for detection of cracks on the inside surface of the pipe. To put this in context, the wall thickness at the extrados bend of a number of Point Lepreau *feeders* is known to be approaching the minimum allowable value of 2.7 mm.

CNSC staff believes that these findings raise very serious questions concerning the structural integrity of outlet *feeder* pipes at Point Lepreau. Specifically:

- the observation of active cracks in a portion of the *feeder* known to suffer wall-thinning by FAC, where resistance to crack-propagation is relatively low, implies a non-negligible risk of unstable through-wall cracking during reactor operation; and
- the minimum detectable depth for cracks on the inside surface of in-service *feeders* (approximately 2mm) is close to the minimum allowable wall thickness at the extrados of *feeders* experiencing FAC (2.7 mm).

Based on the few extrados cracks observed to date, the expected low growth rate for any cracks that do occur, and its extensive inspection program, NB Power Nuclear asserts that the presence of extrados cracking does not represent an unreasonable risk to the safe operation of

Point Lepreau. However, it plans to remove six outlet *feeders* (where FAC-induced wall-loss is expected to exceed 40%) during the May 2005 outage and perform destructive analysis for evidence of cracking on the outside surface of the bend extrados. NB Power Nuclear has also evaluated ultrasonic detection for outside surface cracks and found it to be more sensitive than detection of inside cracks. In addition, NB Power Nuclear plans to perform supplementary eddy current inspections of the thinnest *feeders* during the 2005 outage to improve the probability of crack detection on the outside surface.

D.6 ALL STATIONS

D.6.1 Environmental Qualification of Equipment

D.6.1.1 Description of Development (Reference SDR CMD 04-M35)

On June 30, licence condition 7.1 on *environmental qualification* (EQ) came into effect for all power reactor sites: "the licensee shall establish that all required systems, including equipment, components, protective barriers and structures in the nuclear facility are qualified to perform their safety functions under the environmental conditions defined by the nuclear facility's design-basis accidents."

Each licensee has developed and implemented an EQ program and committed to sustain it in the long term. They also have committed to a schedule to resolve the few remaining EQ anomalies. CNSC staff concluded that the licensees have met CNSC expectations regarding this licence condition and will confirm this through planned compliance program inspections at each site. Through ongoing discussions and other promotion activities with licensees, CNSC staff found that the awareness of, knowledge of, and commitment to resolve EQ issues at all sites has improved substantially in the past four years.

D.6.2 Kansai Electric's Mihama Event

D.6.2.1 Description of Development (Reference Oral Update to SDR CMD 04-M35)

On August 9, a fatal accident occurred on the secondary side at Kansai Electric's Mihama plant in Japan. The unit is a pressurized water reactor. Although preliminary reports from the company indicate there were no nuclear consequences, the rupture of a high-pressure pipe killed four workers and injured seven others.

The Mihama accident was somewhat similar to another fatal accident at the Surry plant in Virginia in the 1980s. That accident led to extensive inspection, discovery, and remedial work, and operators worldwide have recognized the need for ongoing inspection and monitoring of feedwater piping.

In Canada, there have been no events of similar severity. Actions were placed on licensees following the Surry incident requiring the implementation of monitoring and inspection programs. Following Mihama, CNSC staff asked the licensees to confirm that their inspection programs will address any new information that comes out of the investigation. Staff will follow up this verbal request with a written communication when more information is available from the *root-cause analysis* of this incident.

D.6.3 Report in the *Toronto Sun* on Reliability of Radiation Emission Figures

D.6.3.1 Description of Development (Reference supplemental information to SDR CMD 04-M35)

On September 14, the *Toronto Sun* reported that internal reports at OPG are casting doubt on the reliability of radiation emission figures from the Darlington and Pickering nuclear power plants. At the present time, staff believes that reports received from OPG accurately represent emissions from the plants, which historically have been below 1% of the regulatory *derived release limits*. However, CNSC staff is following up on this issue.

APPENDIX E
GENERIC ACTION ITEMS

E.1 GAI 88G02 — Hydrogen Behaviour in CANDU Nuclear Generating Stations

Loss of coolant accidents (LOCAs) 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 of hydrogen generation. Radiolysis of the water collected in containment by radio-nuclides from failed fuel bundles can also lead to the release of an appreciable amount of hydrogen in the long term. In addition, for LOCA scenarios where emergency core coolant (ECC) is impaired or lost (LOECC), oxidation of over-heated fuel sheaths is expected to result in short-term releases of hydrogen into 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* (EQ) 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 concern as to whether the licensee's adopted course of action would be sufficient to resolve this containment issue. Hydro-Québec is adopting the deterministic, dual-failure approach, whereas the other utilities are adopting an essentially probabilistic approach. Factors requiring additional consideration include: (1) the need to adopt a separate approach for refurbished units and for units approaching their end of life; (2) consistent treatment of severe accidents; and (3) consistency of proposed modifications with the licensing basis of existing reactors. CNSC staff is currently finalizing its position with regard to the path to be taken to achieve an optimum level of containment protection. Since CNSC staff decided to revise its approach to closure, licensee performance was not rated for this generic action item (GAI) in 2004.

E.2 GAI 90G02 — Core Cooling in the Absence of Forced Flow

Failure of the primary heat transport pumps to provide forced circulation of water for fuel cooling is a possibility in some accident sequences. The reactors then rely on natural circulation of the coolant to remove residual heat from the fuel to the *steam generators*. Natural circulation experiments done at Atomic Energy of Canada Limited's (AECL) Whiteshell Laboratories showed degraded cooling in some channels if coolant inventory is low. The experimental results cast doubt on the safety analysis predictions regarding the effectiveness of natural circulation under partial inventory conditions. Licensees were requested to identify the causes leading to the observed degraded cooling conditions and, if needed, to revise their safety analyses or implement design changes.

Prior to 2004, GAI 90G02 was closed for all licensees except NB Power. In 2004, CNSC staff completed the evaluation of the analysis submitted by NB Power and concluded that the closure criteria were met, therefore closing the GAI for NB Power as well.

The analysis identified that certain low-probability, small-break cases (those with additional ECC failures) may need changes to the loop isolation setpoint. This is outside the scope of the GAI and is being followed up as a station-specific *action item*.

The performance of NB Power on this GAI was satisfactory.

E.3 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 (EFADS) filters and other non-EFADS filters that are credited in safety analyses.

The GAI is already closed for Hydro-Québec. CNSC staff is waiting for NB Power to present a similar argument to Hydro-Québec and to provide details on how conditions in containment would be stabilized in the long term following such accidents.

By the beginning of 2004, Ontario Power Generation (OPG) and Bruce Power had provided additional information to meet the closure criteria for non-EFADS filters at Pickering A and B, Darlington, and Bruce B (having already addressed EFADS). The remaining issues were discussed and clarified in 2004. In July 2004, Bruce Power submitted the analyses regarding EFADS and non-EFADS filters for Bruce A.

The review of this information concluded that the closure criteria for GAI 91G01 for all OPG and Bruce Power stations are met. Also, the review resulted in a number of actions that OPG and Bruce Power have committed to complete. It was considered that successful completion of these actions will not raise special difficulties and that their progress can be adequately monitored in line with other current activities. Also, in a meeting on April 30, 2004, issues related to potential life extension of charcoal filters were discussed. It was agreed that charcoal life extension shall be carried out in such a way to ensure that post-accident filter effectiveness is not impaired, and that the safety margins demonstrated in GAI 91G01 are not eroded. Charcoal filter life extension is being monitored by a separate project.

On the above basis, GAI 91G01 was closed for Pickering A and B, Darlington, and Bruce A and B. Overall, CNSC staff was satisfied with the work performed by OPG and Bruce Power to close this GAI.

E.4 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 parameters to measure are not known. Although some fuel inspections have been conducted and the results have been submitted to the CNSC, it is important for licensees to have a formal process to ensure that the fuel and fuel channel conditions are identified and accounted for.

Consequently, the licensees were 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 OPG and Bruce Power in 2001 and 2002, respectively. Hydro-Québec has submitted information describing their process and requesting closure of this GAI. Closure for Hydro-Québec is pending their response to questions raised by CNSC staff. NB Power has been developing an updated set of station processes during the last several years; the closure of this GAI is expected once all processes are in place.

E.5 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 shutoff rod guide tubes and prevent shutdown system 1 (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 also accepted the licensees' proposed experimental program schedule, which plans 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 classification approval for the test facility, the first of the planned four tests was performed successfully in December, 2004. CNSC staff expects an update from the licensees on the schedule of the remaining tests in the first quarter of 2005.

E.6 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 LOECC, 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* (CTs) 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 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. Assessment of this submission was on hold, but now that the guidelines for the use of cost-benefit analysis are sufficiently finalized, staff is about to review the measures proposed by the licensees to reduce the potential risk associated with this postulated event.

NB Power is considering the replacement of existing seam-welded CTs by seamless (stronger) CTs as part of its refurbishment plan. NB Power has submitted documents describing the CT qualification and verification programs in 2004. CNSC staff’s review of these documents led to a request to address water-hammer loading associated with the postulated PT rupture. NB Power committed to submit a report of the results of the water-hammer analysis to the CNSC by October 2004, but this has been delayed.

E.7 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 (DBAs) involving channel voiding, especially for large LOCAs (LLOCAs). 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 addressed the recommendations that were made and proposed relevant research and development activities. The bulk of the proposed activities were completed in 2004 and all licensees requested the closure of this GAI in December 2004. CNSC staff is currently reviewing the submitted information.

E.8 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 balloon radially and make 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 (3-D) integral moderator tests.

An industry team representing all Canadian utilities completed the 3-D test 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 tests and the 3-D integral test.

In December 2004, the industry team requested the closure of this GAI, and submitted a summary report describing all work completed. CNSC staff is currently reviewing this submission to confirm that the computer code is capable of predicting moderator temperature distribution with acceptable accuracy.

E.9 GAI 98G01 — Primary Heat Transport 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 was closed for Bruce B, Pickering, Darlington, and Gentilly-2 prior to 2003. It was closed for Point Lepreau in 2003 following review of their analysis of pipe fatigue in the HTS when subjected to pump-generated pressure pulsations caused by two-phase flow conditions.

The results of a re-assessment of the integrity of Bruce A piping when HTS pumps operate under two-phase conditions were reviewed by CNSC staff in 2003. Additional confirmatory piping stress analyses were requested from Bruce Power and the results, including possible design and operating changes, were discussed informally during a meeting in July 2004. Bruce Power's request for closure of this GAI for Bruce A will be considered following submission of a summary of the results of the confirmatory analyses, outline of recommended actions, and implementation schedule.

E.10 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 analysis results.

The industry has responded to this GAI favorably 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, are considered to be sufficient to warrant the closure of this GAI, and it has been closed for Bruce Power and OPG. An audit of NB Power was carried out in 2003 and the results were satisfactory. Closure of this GAI is contingent on compatibility with the overall quality assurance (QA) program being developed at Point Lepreau, evidence of which was submitted by NB Power in late 2004. A similar audit will be carried out for Hydro-Québec in the first quarter of 2005.

E.11 GAI 99G01 — Quality Assurance of Safety Analysis

The CNSC expects power reactor licensees to conduct operations in accordance with a QA program. This program includes requirements for various safety-related activities, including safety analyses. The acceptability of the safety-related information established by the 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. In 1999, staff's conclusion that inadequate QA of safety analyses was resulting in a reduction in the overall confidence in the safety analysis results led to the initiation of this GAI.

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 was closed for Bruce Power, and is under review for other licensees. The results of an audit at NB Power were satisfactory, but closure of this GAI is contingent on compatibility with the overall QA program being developed at NB Power. The results of an audit at OPG were also satisfactory, but CNSC staff must assess its compatibility with the new QA program following the re-organization of OPG. An audit planned for Gentilly-2 in the first quarter of 2005 will be considered prior to considering closure of this GAI for Hydro-Québec.

E.12 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 done by 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 a set of agreed activities and declared the new reactor physics toolset in service for future accident analysis. The new reactor physics toolset was applied in licensing and commissioning safety analyses for restart of Bruce A Units 3 and 4. Work on a second set of code validation activities was completed in 2004 and Bruce Power and OPG requested the closure of this GAI.

The work of NB Power and Hydro-Québec is behind schedule.

E.13 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 AECL's 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 address the outstanding issues—namely, to:

- perform scaling analysis and document the scaling rationale for the LLOCA simulated in RD-14M and demonstrate the relevance of the channel void measurements in the reactor situation;
- estimate the uncertainty of the thermalhydraulic code's prediction of the channel void fraction during the rapid voiding phase following a LLOCA (using the simulation and experimental results);
- confirm that the thermalhydraulic code, when simulating channel voiding in a 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 uncertainty in the channel void predictions of the thermalhydraulic code on key safety parameters (e.g., peak fuel centreline and sheath temperatures) during the early blow-down phase of a LLOCA.

Each licensee has responded to the CNSC staff's request and provided a plan to address the above issues. Ongoing discussions between CNSC and industry staff are continuing to resolve the outstanding issues.

E.14 GAI 01G01 — Fuel Management and Surveillance Software Upgrade

This 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 DBAs 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 modelling 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. CNSC staff is closely monitoring the progress of this GAI.