Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Annual CNSC Staff Report for 2007 on the Safety Performance of the Canadian Nuclear Power Industry

Canada

Annual CNSC Staff Report for 2007 on the Safety Performance of the Canadian Nuclear Power Industry

Cat. No. CC171-1/2007E-PDF
ISBN 978-1-100-10418-8

Published by the Canadian Nuclear Safety Commission, August 2008
CNSC Catalogue number INFO-0770

Le présent document est disponible en français sous le titre « Rapport annuel 2007 du personnel de la CCSN sur le rendement en matière de sûreté des centrales nucléaires au Canada ».

Document availability
This document is available on the CNSC Web site at *nuclearsafety.gc.ca*. To order a print copy of the document in English or French, please contact:

Canadian Nuclear Safety Commission
280 Slater St.
P.O. Box 1046, Station B
Ottawa, Ontario K1P 5S9
CANADA
Telephone: (613) 995-5894 or 1-800-668-5284 (Canada only)
Facsimile: (613) 995-2915
E-mail: info@cnsc-ccsn.gc.ca

Cover Images: Canadian Nuclear Power Plants

Front cover from left to right:
Bruce A and Bruce B Nuclear Generating Stations (Tiverton, Ontario)
Point Lepreau Nuclear Generating Station (Point Lepreau, New Brunswick)
Pickering A and Pickering B Nuclear Generating Stations (Pickering, Ontario)

Back cover from left to right:
Darlington Nuclear Generating Station (Bowmanville, Ontario)
Gentilly-2 Nuclear Generating Station (Bécancour, Québec)

Annual CNSC Staff Report for 2007 on the Safety Performance of the Canadian Nuclear Power Industry

INFO-0770

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report summarizes the Canadian Nuclear Safety Commission (CNSC) staff's assessment of the Canadian nuclear power industry's safety performance in 2007, and describes licensee programs and implementation in nine safety areas.

Through inspections, reviews, and assessments, CNSC staff concluded that the nuclear power industry operated safely during 2007. The evaluation of the safety areas, as presented in this report, shows that overall, licensees made adequate provision for the protection of the environment, health and safety of persons, and measures required to implement Canada's international obligations. No worker at any nuclear power station or member of the public received a radiation dose in excess of the regulatory limits, and emissions from all plants were below regulatory limits. This finding is consistent with the overall findings from previous years.

Areas exceeding expectations:
An "A" grade indicates an effort on the part of licensees to go beyond existing CNSC requirements and performance expectations in these areas.

CNSC has ranked a number of safety areas and programs at the "A" level, including the implementation of Occupational Health and Safety programs at Bruce A and B and at Darlington, the Reliability program design at Point Lepreau, and the implementation of the Radiation Protection program at Darlington. All stations received an "A" for their Emergency Preparedness programs, and Bruce A and B, Darlington and Pickering A and B were further recognized for implementation.

Areas meeting expectations:
In 2007, the stations received a "B" grade for the majority of the programs and their implementation in the nine safety areas, indicating that licensees have fully met the objectives of CNSC requirements and performance expectations in these areas.

Areas of improvement:
Some improvement was noted in 2007 in the Performance Assurance safety area. Bruce Power continued to enhance its management system through its Process and Documents Enhancement Project (PDEP). Based on the achievements of the PDEP project, CNSC staff upgraded the documented Quality Management program to "B" for Bruce A and B for 2007. Implementation of the Quality Management program at Bruce A was also upgraded to a "B".

In addition, in the area of Human Factors, the program grade for Point Lepreau was upgraded to a "B" for 2007, although, due to concerns related to hours of work and incorporating human factors into design, the implementation of the program remained assessed at a "C" for 2007.

Areas below expectations:
CNSC assigns a "C" grade when a licensee's performance falls below expectations, or programs deviate from the intent or objectives of CNSC requirements. 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 and ensure compliance with regulatory requirements in the long term.

CNSC staff assigned a rating of "C" for implementation of both the Operating Performance and Performance Assurance safety areas at Pickering A in 2007. The ratings were based, in part, on management-related deficiencies identified as a result of an event involving the Inter-Station Transfer Bus. While there have been no *serious process failures* at Pickering A since the renewal of its licence in 2005, this incident in June 2007 resulted in the extended outages of both Units 1 and 4. There has also been a noted decline in the ratings for the implementation of the programs for Organization and Plant Management, Operations, Human Factors, Quality Management and Design.

Bruce A was rated "C" for implementation of the Training, Examination and Certification program. This was down from the 2006 report, and due to concerns regarding preparation of candidates for the simulator-based certification examination. Bruce A also received a "C" for the implementation of the Design program, because of legacy issues with design. Gentilly-2 was rated as "C" in the implementation of its Quality Management program. This was attributed to management's failure to fully implement corrective actions in a timely fashion.

In Equipment Fitness for Service, CNSC staff rated the implementation of the Maintenance program at Bruce A as "C" due to high maintenance backlog levels. Darlington was rated a "C" for implementation of the Equipment Qualification program again in 2007. While the implementation of the Equipment Qualification program at Darlington is evolving, it has yet to fully meet CNSC staff expectations.

CNSC staff continues to closely monitor facilities that receive a "C" grade to ensure that the licensee has taken, or is taking appropriate actions to fully meet the objectives of CNSC requirements and performance expectations in these areas.

INTRODUCTION

To meet the legal requirements of the *Nuclear Safety and Control Act* (NSCA) and its associated regulations, licensees must implement programs that provide adequate provisions for the protection of the environment, health and safety of persons, 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 and the Canadian nuclear power industry as a whole, in 2007. The assessment is based on legal requirements of the NSCA and its regulations, as well as conditions of operating licences and applicable standards.

Licensee programs are grouped into nine safety areas (see Figure 1). The programs and their implementation are evaluated using a rating system established by CNSC staff in CMD 02-M5.[1] Descriptions of the safety areas and their constituent programs are provided in Appendix A.

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

Section 1 of the report focuses on individual power reactor sites and provides detailed assessments of the safety areas and programs. Pickering A is currently in the middle of the five-year period covered by its operating licence. Since this report is intended to serve as a mid-term report for Pickering A, additional details and a brief conclusion specific to Pickering A are provided.

New to the 2007 report is the inclusion of dose tables showing the five-year (2003-2007) trend of annual doses to workers at each station. The dose tables are provided in the summary assessment of the radiation protection program at each station.

Also in 2007, the assessments of the Equipment Qualification programs at the stations are based solely on CNSC staff's assessment of licensees' *Environmental Qualification* (EQ) programs. EQ is an important sub-program of Equipment Qualification and deals with the identification and qualification of safety-related equipment that would be subjected to environmentally harsh conditions resulting from *design basis accidents*.

Section 2 highlights industry-wide trends and significant issues that pertain to the industry as a whole. CNSC performance indicators (PIs) illustrating various trends are

[1] CMD 02-M5 *Information from Canadian Nuclear Safety Commission staff regarding recommended approach and terminology to be used to rate CNSC licensee programs, performance and qualification in annual reports and licensing Commission Member Documents*, Canadian Nuclear Safety Commission, Ottawa, January 17, 2002.

also presented in Section 2 of the report, as are tables summarizing licensee grades for 2007.

Section 2.3.2, Safety Issues, provides greater context this year for the generic action items (GAIs) among a list of CANDU safety issues identified and agreed to by a joint CNSC-Industry group of experts in 2007. Consequently, Appendix F has been renamed "CANDU Safety Issues".

Appendix A contains definitions of the safety areas and programs. The grades assigned to each program and safety area are based on the rating system described in Appendix B.

Some specialized and technical terms are defined in Appendix C and are italicized throughout the report. The acronyms used in this report are listed in Appendix D.

Important events or developments at the stations were reported to the *Commission Tribunal* in Significant Development Reports (SDRs) via *Commission Member Documents* (CMDs). Appendix E contains the significant developments relevant to the stations in 2007, as well as the related follow-up activities.

Finally, Appendix F, "CANDU Safety Issues" (formerly "Generic Action Items"), contains descriptions of the safety-significant CANDU safety issues as well as a table of GAIs that were open in 2007.

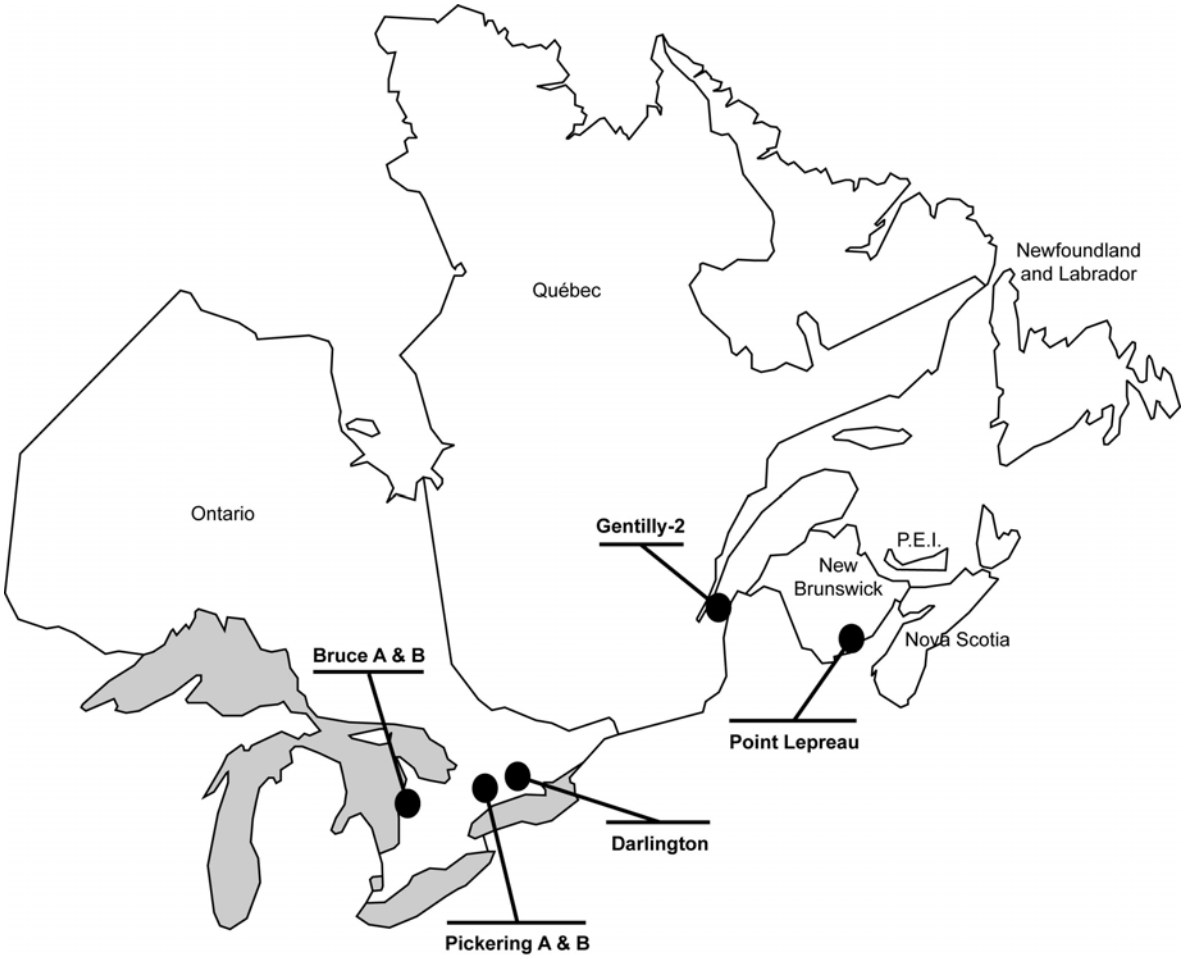
Figure 2 shows the locations of power reactor sites in Canada, the number and generating capacity of their reactors, their initial start-up dates, the names of the licence holders, and the expiry dates of current licences. Of the 22 CANDU reactors with operating licences issued by the *Commission Tribunal*, 18 provided power to the electrical grid in 2007. Bruce A Units 1 and 2 remained in shutdown state for the entire year due to refurbishment work. At Pickering A, Unit 2 was defuelled and Unit 3 is being defuelled, as part of the preliminary decommissioning plan for placing the units in long-term safe storage.

Figure 1: Safety Areas and Programs

SAFETY AREA Program
OPERATING PERFORMANCE
Organization and Plant Management
Operations
Occupational Health and Safety (Non-radiological)
PERFORMANCE ASSURANCE
Quality Management
Human Factors
Training, Examination, and Certification
DESIGN AND ANALYSIS
Safety Analysis
Safety Issues
Design
EQUIPMENT FITNESS FOR SERVICE
Maintenance
Structural Integrity
Reliability
Equipment Qualification
EMERGENCY PREPAREDNESS
ENVIRONMENTAL PROTECTION
RADIATION PROTECTION
SITE SECURITY
SAFEGUARDS

For a complete definition of each safety area and program, including the performance objective, please refer to Appendix A.

Figure 2: Locations and Data for Nuclear Power Plants in Canada



PLANT DATA							
Plant	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Licensee	Bruce Power	Bruce Power	Ontario Power Generation	Ontario Power Generation	Ontario Power Generation	Hydro-Québec	New Brunswick Power Nuclear
Reactor Units	4	4	4	4	4	1	1
Gross Electrical Capacity/Reactor (MW)	904	915	935	542	540	675	680
Start-Up	1977	1984	1989	1971	1982	1983	1982
Licence Expiry	2009/03/31	2009/03/31	2013/02/28	2010/06/30	2008/06/30	2010/12/31	2011//06/30

SECTION 1 – SAFETY PERFORMANCE AT THE POWER REACTOR SITES

This section is organized by power reactor site, with grades provided for the safety areas and programs at each site. The grades for all the sites are also summarized in the tables found at the end of Section 2. Appendix A defines the safety areas and programs, and provides overall performance objectives.

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

1.1 BRUCE A and BRUCE B

The two nuclear generating stations on the Bruce site are grouped together for this report since the operator, Bruce Power, uses common programs at both stations. Therefore, the program evaluations discussed below apply equally to Bruce A and Bruce B. However, the implementation of each program is assessed separately for Bruce A and Bruce B.

1.1.1 Operating Performance

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

Bruce A and Bruce B operated safely in 2007. The Operating Performance safety area at both stations met the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to safe operation in 2007.

Bruce A experienced three reactor trips in 2007; however, none of these were considered as challenges to safety. Bruce B maintained their performance in the area of reducing transients and shutdowns, and improved their performance in conventional safety, remaining current with the international safety developments in nuclear power plant operation.

1.1.1.1 Organization and Plant Management

Throughout 2007, the management of Bruce Power continued to provide leadership to its staff and to promote safety. Bruce Power continued to integrate the Bruce site and its processes. CNSC staff has observed continued improvement, with Bruce Power striving to achieve higher performance.

CNSC staff found no negative issues in this area in 2007. The inspections, surveillance and monitoring activities carried out by CNSC staff have found no significant changes to the program or its implementation over the past year. The grade of "B" from the previous year remains valid for both Bruce A and Bruce B.

During the year, CNSC staff carried out numerous inspections of various aspects of Bruce Power. CNSC staff noted the promotion of safety by the licensee's organization and good compliance with requirements. There were no *serious process failures* at Bruce A or B, and there were minimal operational transients.

In 2007, Bruce A had three reactor trips, no *stepbacks* and nine *setbacks*. The reactor trips did not challenge reactor safety; nevertheless, Bruce Power appropriately investigated the causes of the trips and put in place corrective measures to prevent reoccurrence, as appropriate. The *setbacks* were all minor in nature (less than 1% power change) and were managed by the reactor regulation system.

In 2007, Bruce B had no reactor trips, two *stepbacks* and one *setback*. One *stepback* had no impact, while the second one resulted in a manual shutdown of the reactor followed by corrective action by Bruce Power. The *setback* was minor in nature (less than 1% power change) and was managed by the reactor regulation system.

The implementation is ranked as "B", due to continuing low number of trips and *stepbacks*. The number of trips and *stepbacks* is consistent with the world average and has diminished over the last few years. This is considered an indicator of the overall state of the plant and represents a positive indication of continued good performance. A secondary indication, based on CNSC staff observations, is the fact that when there is a trip or transient there are no secondary events as a result of the initial transient.

1.1.1.2 Operations

CNSC staff conducted numerous field and control room inspections over the year to verify compliance. Most inspections did not reveal any non-compliances. In some inspections, minor non-compliances were discovered, and in almost all cases they were immediately corrected by licensee staff. For the other cases, Bruce Power provided corrective actions plans, which CNSC staff has followed up on.

Two planned outages took place at Bruce A in the spring. Bruce B also underwent two planned outages - one in the winter and one in the fall. Overall, outage execution and outage safety and work management met requirements.

1.1.1.3 Occupational Health and Safety (Non-radiological)

Overall, the Occupational Health and Safety program ratings remain at "B" for both Bruce A and Bruce B. There were no major changes to this program in 2007. The accident frequency and severity (see Section 2.1.3, Table 16) is very good in comparison with other industries, and has resulted in an "A" rating for implementation at both stations. This marks an improvement for Bruce B; Bruce A was already rated at "A" in 2006.

Furthermore, CNSC staff considers that Bruce Power has made a significant improvement to non-radiological safety by reducing the risk of a secondary side pipe failure through modifications to the piping and control of the high pressure feedwater heaters. This modification has been installed and placed in service on five of the six units.

1.1.2 Performance Assurance

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

At both Bruce A and B, the program and implementation of the Performance Assurance safety area met the objectives of CNSC requirements and performance expectations.

In 2007, Bruce Power continued to enhance its management system. Bruce A's implementation of the Quality Management program has been upgraded to a "B", reflecting that the operation of Units 3 and 4 met requirements, although improvements are still needed for the restart of Units 1 and 2. While these issues do not currently affect operational safety of the plant, it is important that Bruce Power continues to address these issues in a timely fashion. The results of two examinations undertaken in 2007 have led CNSC staff to conclude that there are implementation problems with the training of authorized Bruce Power staff. Consequently, the implementation of the Training, Examination, and Certification program at Bruce A has been downgraded to a "C".

1.1.2.1 Quality Management

In 2007, Bruce Power continued to work on the Process and Documents Enhancement Project (PDEP) and completed the program level documents. CNSC staff review of these program documents produced only minor comments. A continuous improvement

initiative has been undertaken by Bruce Power to support the move to the Governance, Oversight, Support and Perform accountability model.

In November 2007, CNSC staff inspected the implementation of the PDEP project, to determine if the project had met its objectives. The inspection reviewed the improvements made to the processes and documents supporting the Engineering Design Change process. The inspection identified minor inconsistencies and inadequacies pertaining to the referencing of related support documents. CNSC staff analysis determined that the inconsistencies and inadequacies were indicative of a learning curve for the processes established under PDEP. The inspection also identified evidence of management support and staff buy-in, at all levels.

In general, CNSC staff noted that the PDEP project is obtaining the desired results. Based on the achievements of the PDEP project, CNSC staff has upgraded the documented Quality Management (QM) program for Bruce A and Bruce B to a "B" for 2007.

The oversight of the Units 1 and 2 Restart Project included a number of inspection activities of both Bruce Power and its major contractor. The inspections identified that processes are insufficiently adhered to for full compliance with Bruce Power's documented QM program. Though issues are being addressed when identified by inspections, CNSC staff concluded that implementation of the QM program needs to be improved.

Bruce Power took corrective actions to address the non-compliances identified by a CNSC Contractor Management inspection in 2006. However, there are two outstanding actions which remain open. CNSC staff requested further clarification on these actions in late 2007.

The implementation of the Quality Management program for the operation of Bruce A Units 3 and 4 met CNSC expectations in 2007. However, CNSC staff considers the non-compliances identified in 2007, and the insufficient rigour regarding QM implementation from 2006 for the Bruce A Units 1 and 2 restart activities, as a moderate risk associated with their safe restart. The overall implementation of the QM program at Bruce A is assessed at a "B" for 2007, but the work on Unit 1 and 2 is considered to remain at a "C" level.

A defect traced back to the supplier caused a fuel failure event in Units 5 and 7 at Bruce B. Bruce B staff took immediate and adequate actions to minimize its impact. An inspection of Bruce B Unit 8 identified the use of operating memos for long periods of time as opposed to immediate corrective actions. CNSC staff analysis concluded that the event and the use of operating memos did not represent a risk to the safe operation of the facility. The implementation of the Quality Management program at Bruce B remains at "B" for 2007.

1.1.2.2 Human Factors

Bruce Power's Human Factors-related programs and their implementation have met requirements in 2007, and therefore all four grades remain as "B". However, there are several issues that CNSC staff will address through compliance activities planned for 2008.

The submissions regarding Human Factors work received by CNSC staff were not clear, leading to repeated requests for additional information to enable CNSC staff to review the submissions. To improve future submissions, Bruce Power will be following the relevant CNSC regulatory guidance concerning Human Factors Engineering Program Plans, validation, and demonstration of sufficient minimum complement (i.e., G-276 *Human Factors Engineering Program Plans*, G-278 *Human Factors Verification and Validation Plans* and G-323 *Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement*). This issue of submission quality for Human Factors reports will be monitored in 2008.

A *Type I Inspection* of Problem Identification and Resolution Practices has made sixteen recommendations, four of which included programmatic aspects of Human Performance. Bruce Power has indicated that the implementation is either "complete" or "in progress" for the majority of the recommendations, which is encouraging. The verification of the Human Performance aspects of the completed recommendations is planned for 2008.

There are indications that considerable work is being carried out to develop the Human Performance Program at Bruce Power. Therefore, CNSC staff plans to conduct a formal desktop review of the Human Performance Program in early 2008.

Bruce Power underwent an extensive organization change in 2007. CNSC staff review of the management role documents cited in the licences was difficult to carry out, because the submitted documents underwent frequent incremental changes during the reorganization. Bruce Power proposed an alternative approach, which CNSC staff concluded would provide regulatory oversight without the need for frequent minor licence amendments. In the future, Bruce Power will annually compile and report to the CNSC all organizational changes, and will notify the CNSC prior to making organizational changes.

CNSC staff noted a positive trend in the identification of Human Performance causes of events reportable to the CNSC. Specific review of Human Performance causes in events will continue to be monitored and reviewed by CNSC staff in 2008.

1.1.2.3 Training, Examination and Certification

Licensee staff in safety-critical positions must undergo CNSC knowledge-based and performance-based examinations in order to assess their competence prior to CNSC certification. After CNSC certification, licensees conduct knowledge-based and performance-based requalification examinations so as to ensure that certified staff retains the necessary knowledge and skills to safely perform their duties.

During the reporting period, the success rate on certification examinations at Bruce B was acceptable. However, the success rate for two simulator-based certification examinations at Bruce A was below expectations. This low success rate raises a serious concern regarding Bruce Power's implementation of their programs to prepare candidates for the simulator-based certification examination. CNSC staff requested Bruce Power to determine the root cause of the abnormally poor performance of their candidates in CNSC certification examinations, and to provide an action plan to prevent reoccurrence. CNSC staff is expecting the action plan from Bruce Power by April 2008.

Bruce Power submitted an update to the Bruce Power Certified Operator Staffing Plan. This update provided details of the Bruce Power plan which ensures that Bruce Power has a sufficient number of certified staff on all reactor units. CNSC staff believes that the abnormally poor performance of the candidates in CNSC certification examinations could have a negative impact on Bruce Power's implementation of the certified operator staffing plan, especially considering the staffing requirements to return Bruce A Units 1 and 2 to service. CNSC staff requested that Bruce Power review the Certified Operator Staffing Plan and report to the CNSC. CNSC staff is expecting the Bruce Power report by April 2008, and are continuing to assess the levels of certified staff at Bruce Power as part of the on-going compliance program.

As a prerequisite for the CNSC project to transfer certification examinations to licensees, licensees must have a sufficient number of examiners who meet the qualification requirements specified in the relevant CNSC regulatory documents. To verify that Bruce Power is meeting this requirement, CNSC staff requested that Bruce Power provide the processes which ensure that their examiners will be qualified to administer certification examinations. Bruce Power responded to this request, and CNSC staff will review the response by June 30, 2008.

Several training inspection reports on Bruce A certification training were issued in 2007. One of them documented important deficiencies in the initial station systems (specifics) training for certified nuclear operators. The deficiencies included missing lesson plans for Integrated Plant Operation, and uncertainty regarding whether Bruce A continues to provide training on important learning objectives from the previous "Reactor and Auxiliaries" and "Turbine and Auxiliaries" courses. Bruce Power has made good progress in resolving the identified deficiencies.

Inspection reports identified deficiencies in the initial simulator training for authorized nuclear operators and shift managers. Problems with the simulator exercise guides were found in both programs. In addition, the control room shift supervisor's training needs were not well documented in the training governing documents for initial certification training co-piloting. Bruce Power has made good progress in resolving these deficiencies. CNSC review has confirmed that all required actions for Bruce A Certification Training Program Evaluations have been completed.

In late 2007, Bruce Power submitted requests for closure on all training program evaluations to support transfer of certification examinations to the licensees. CNSC staff

has reviewed the evidence provided and found it to be acceptable. CNSC staff has issued evaluation close-out letters.

Although the evaluations identified potential deficiencies, based on the supporting data for the period, the Training, Examination and Certification program meets requirements and remains at a grade of "B" for both Bruce A and Bruce B.

Bruce B's overall implementation of the program also meets requirements and therefore remains assessed as a "B". However, Bruce A's implementation of the Training, Examination and Certification program has been downgraded to a "C" because of the serious concern regarding the preparation of candidates for the simulator-based certification examination and the adequacy of the Bruce Power Certified Operator Staffing Plan.

1.1.3 Design and Analysis

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

Both the program and implementation of the Design and Analysis safety area at Bruce A and B met the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to safe facility operations in 2007. CNSC staff reviews concluded that the licensee continued to provide acceptable safety analyses and responses to new design and safety issues.

1.1.3.1 Safety Analysis

Both the program and implementation of the Safety Analysis program area at Bruce A and B met CNSC staff's expectations. Therefore, all four grades remain as "B".

1.1.3.1.1 Safety Report Update

The Bruce A and B operating licences require an update to the respective *Safety Reports* every three years, in order to ensure that the documents continue to reflect current facility design, operation and modifications to safety analysis.

Bruce Power submitted an update of the Bruce A *Safety Report* in 2006, and an update of the Bruce B *Safety Report* in 2005. CNSC staff has completed a review of the updated

Safety Reports, Part 3. The reviewers assessed the document from the following points of view:

- verifications related to the use of validated tool sets;
- consistency and conservatism in the analysis methodologies and assumptions, especially with regard to the initial plant conditions;
- treatment of simulation and measurement uncertainties; and
- general compliance with quality assurance standards consistent with CSA N286.7-99.

CNSC staff identified a number of issues, which were communicated to Bruce Power, although the safety case for the reactors is not in question. Bruce Power replied with an action plan to address these concerns in subsequent routine updates of the *Safety Report,* which CNSC staff finds acceptable.

1.1.3.1.2 Methodology and Model Verification and Validation

Bruce Power has submitted new neutron overpower protection (NOP) trip set points design calculations. Bruce Power concluded that although its new design analysis methodology reduces conservatisms, the new NOP analysis provides results with a level of confidence and safety equal to those obtained under the previous methodology. CNSC staff is of the opinion that a more substantiated assessment is necessary to further confirm that compensatory measures similar to those applied to other CANDU stations are not necessary for current conditions. However, this issue does not pose an immediate concern, given the current limitations on reactor power at both Bruce A and Bruce B. CNSC staff is undertaking a technical evaluation and review of Bruce Power's related programs and will provide a progress update to the *Commission Tribunal* in November 2008.

1.1.3.1.3 Probabilistic Risk Assessment

The Bruce A Probabilistic Risk Assessment is continuously being updated to ensure that the model is representative of the current station configuration. In 2007, Bruce Power submitted three updated models, which are currently being reviewed by CNSC staff. The target date for the completion of the reviews is the end of May 2008.

Bruce Power submitted the Bruce B Risk Assessment (BBRA) to the CNSC in 1999, and the BBRA at-power model has been updated and enhanced since then, in accordance with CNSC requirements. Bruce Power is also developing a user-friendly model to support plant decision-making. In addition, Bruce Power is making further improvements on supporting analysis to the risk assessment. CNSC staff found that the update and enhancement meet staff expectations.

1.1.3.2 Safety Issues

CNSC staff reviewed the progress made by the CANDU industry and utilities to resolve generic action items (GAIs). Bruce Power continued its work, including participation in industry efforts, toward resolution of the GAIs. The overall progress was judged satisfactory, and Bruce Power requested closure of GAI 95G02, which CNSC staff will

accept in early 2008. A brief description and the expected completion date of each GAI are provided in Appendix F, Table F.1.

1.1.3.3 Design

The overall plant design programs at Bruce A and B are rated as meeting CNSC staff's expectations. However, CNSC staff identified weaknesses with respect to the implementation of the programs, particularly for Bruce A.

Bruce A has significant legacy issues related to the fact that all its units were not operating between 1997 and 2003. This has resulted in design drawings, system classification and registration documentation not being maintained to current plant status. Bruce Power had committed to address these issues in a timely fashion after the restart of Bruce A Units 3 and 4; however progress has been slower than initially anticipated. Bruce Power has been in discussions with CNSC staff to implement a system registration recovery program to the latest edition of the Canadian Standards Association (CSA) standard CSA N285.0, which is expected to be underway in 2008.

CNSC staff's review of the Bruce A Units 1 and 2 Integrated Safety Review (ISR) also found areas where the plant design program implementation is weak. Bruce Power will address these concerns prior to restart.

CNSC staff also identified weaknesses in the implementation of the fire protection design sub-program at Bruce A, and found that the licensee's corrective actions have not been effective in some cases. Bruce Power made a submission in December 2007 to address these fire protection issues, and has made commitments to follow-up on all legacy code non-compliances between then and the end of 2010. CNSC staff finds the current Bruce Power approach acceptable.

Given the slow implementation of follow-up in the past, CNSC staff will be monitoring Bruce Power progress on these issues as part of the ongoing compliance program for 2008. As a result of these three issues, the design program implementation at Bruce A has been downgraded to a "C".

The overall implementation of the Design program at Bruce B met CNSC expectations and therefore remains a "B". CNSC staff identified weaknesses in the implementation of the fire protection design sub-program at Bruce B, and that licensee corrective actions have not been effective in some cases. Bruce Power has recognized the need for continued focus on these issues and has strengthened the internal oversight of fire protection.

1.1.4 Equipment Fitness for Service

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

Overall, the Bruce A and B programs in the Equipment Fitness for Service safety area, along with their implementation, met the objectives of CNSC requirements and performance expectations and contributed to safe facility operation in 2007. The implementation of the Maintenance program at Bruce A continues to be a challenge, although some progress was observed in 2007.

1.1.4.1 Maintenance

Bruce Power has policies, processes and procedures in place providing direction and support for its maintenance program. The Bruce Power program, which applies to both Bruce A and Bruce B, meets CNSC expectations.

However, due to continued high maintenance backlog levels at Bruce A, the implementation of the Bruce A Maintenance program remains below performance expectations. Bruce Power has made efforts to address this situation. The measures include the tightening of their definition of Corrective Maintenance in late 2007, bringing it more in line with international standards. This improvement caused a one-time increase in the number of maintenance items, which had the consequence of more than doubling the backlog indicator numbers at both Bruce A and B. Bruce Power will submit an action plan showing how the maintenance backlog will be brought in line with the existing Bruce A and B targets by the end of May 2008. Bruce Power will also submit, by August 1, 2008, a report verifying that Bruce A and B are still in compliance with the license conditions on maintenance, given the high level of outstanding maintenance work.

1.1.4.2 Structural Integrity

The scope of and schedule for in-service inspections of fuel channels, *feeders* and *steam generators* at Bruce A were based on the most recent revision of Bruce Power's Periodic Inspection Program (PIP), as well as component aging and life cycle management plans. Chemistry control and material degradation management measures taken by the licensee have reduced the development of new flaws. However, improvements to the *steam*

generator life cycle management program can be made. CNSC staff is satisfied both with the basis for these plans and the adequacy of documentation, but expects further refinements as necessary. Bruce Power's Structural Integrity program is rated as a "B".

CNSC staff is satisfied both with the inspection work and the licensee's assessment of inspection findings at Bruce A and rate the implementation as a "B". However, for Bruce B, while Bruce Power did demonstrate conservatism in assessing the *steam generator* tube leak that caused a forced outage for Unit 8, the decision not to carry out secondary side visual inspection of the leak site during the outage to confirm the nature of the tube degradation and attempt to identify or retrieve the foreign material source, resulted in insufficient information to confirm the root cause of the leak. Thus, Bruce Power missed an opportunity to acquire additional information that may have been useful for updating their *steam generator* life cycle management plan. Nevertheless, the implementation of Bruce B's Structural Integrity program is rated as a "B".

1.1.4.3 Reliability

The 2006 industry report reported that CNSC staff remained concerned about the pace at which Bruce Power is producing the updated documentation associated with its reliability program. In 2007, Bruce Power informally submitted a partial set of documents to support the reliability program. Bruce Power has been requested to re-submit for review their complete reliability program by June 2008, as part of licence renewal. The program for Bruce A and Bruce B remains as a "B", based on previous reviews of the program.

All Systems Important to Safety at Bruce A Units 3 and 4 met the reliability targets, with the exception of SDS2, which did not meet the target due to an *Environmental Qualification* issue. The issue has been addressed, and will not have an impact on the future reliability of the systems. The overall implementation of the program at Bruce A is rated as "B".

All the Bruce B Systems Important to Safety met the actual and operational past reliability targets in 2007, although the Negative Pressure Containment System experienced many minor impairments, which reduced redundancy and defence in depth. The system has had a high Predicted Future Unavailability for a number of years, due to minor impairments of components with long outage times. In the fall of 2007, CNSC staff requested Bruce Power to further investigate this issue and is tracking this issue under an a*ction item.*

The review of the 2006 Bruce B annual reliability report found that the report was incomplete, and that not all the systems' faults were analyzed in detail. CNSC requested Bruce Power to provide a timeline to address this issue by January 2008. The overall assessment of the implementation of the Reliability program at Bruce B is still rated as a "B", but Bruce Power needs to address the outstanding issues in the coming year.

1.1.4.4 Equipment Qualification

An important component of the Equipment Qualification program is *Environmental Qualification* (EQ). Within this area, CNSC staff rated the licensee as being in compliance with the requirements of the licence condition 7.1, regarding EQ of equipment.

Continued implementation and preservation of the EQ program provides reasonable assurance that systems, equipment, components, protective barriers and structures within the scope of the EQ program will continue to perform their intended functions under the environmental conditions defined by the *design basis accidents*. In 2006 and 2007, there were several EQ-related reportable events at both Bruce A and Bruce B related to the steam protection barrier program, which constituted a degradation of the steam protection of the affected rooms. CNSC staff reviewed and assessed selected event reports, which indicate some weaknesses in the implementation of the steam protection barrier program at both Bruce A and Bruce B. Bruce Power's *root cause analysis* related to these events revealed a number of contributing factors for which Bruce Power has taken proper corrective actions. The identified issues were assessed by Bruce Power as having no impact on operability.

Based on the above, the overall Equipment Qualification program and its implementation met CNSC expectations in 2007.

1.1.5 Emergency Preparedness

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

Bruce Power's Emergency Preparedness program is the same for Bruce A and Bruce B. While the program was not re-assessed in detail in 2007, CNSC staff did not identify any changes suggesting any degradation in the program or weaknesses in its implementation.

Reportable events associated with the program were reviewed with no significant findings. Concurrently, no reportable events had any significant bearing on Bruce Power's Emergency Preparedness Program.

Bruce Power submitted a revised emergency plan at the end of 2006. The proposed changes to the Bruce Power Emergency Plan were found to be administrative in nature and were initiated to meet the requirements of their Process Document Enhancement Project. The changes do not fundamentally change the content of the previous plan.

The Emergency Preparedness program and its implementation at Bruce A and Bruce B have reached maturity and no degradation has been observed. Consequently, there is no

change in the grading for Bruce A or Bruce B. Both the program and implementation for the two stations remain at "A" ratings for 2007.

1.1.6 Environmental Protection

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

Bruce Power's Environmental Protection Policies, Procedures, Effluent Monitoring Program, and Environmental Monitoring Program meet CNSC regulatory requirements.

Bruce Power's Policies and Procedures for environmental protection are implemented effectively and meet CNSC requirements and performance expectations. The releases of nuclear substances from Bruce A and Bruce B, in 2007, were well below *derived release limits*. The estimated radiation dose to the public for the entire Bruce site (which includes Bruce A, Bruce B and Ontario Power Generation (OPG)'s Western Waste Management Facility) was 2.07 μSv for 2007, which is well below the regulatory limit of 1000 μSv per year. There were no unplanned emissions of nuclear or hazardous substances from either Bruce A or Bruce B that posed a threat to the environment.

1.1.7 Radiation Protection

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

Bruce Power has a mature radiation protection program that meets applicable regulatory requirements and CNSC performance expectations. During 2007, there were no radiation exposures that exceeded regulatory limits, and no action levels were exceeded at Bruce A or Bruce B.

Tables 1 and 2 provide a five-year trend (2003-2007) of annual doses to workers at Bruce A and Bruce B respectively.

Table 1: Annual Doses at Bruce A (not including restart)

Year	Collective Dose - Routine Operations (person-mSv)	Collective Dose - Outages (including forced outages) (person-mSv)	Total Collective Internal Dose (person-mSv)	Total Collective External Dose (person-mSv)	Total Collective Effective Dose (person-mSv)
2003	-	2,177	239	1,938	2,177
2004	749	730	333	1,146	1,479
2005	319	2,024	374	1,969	2,343
2006	514	1,508	491	1,531	2,022
2007	385	4,304	750	3,939	4,689

Note: 2005 and 2006 data does not include forced outage dose in the outage dose totals

Table 2: Annual Doses at Bruce B

Year	Collective Dose - Routine Operations (person-mSv)	Collective Dose - Outages (person-mSv)	Total Collective Internal Dose (person-mSv)	Total Collective External Dose (person-mSv)	Total Collective Effective Dose (person-mSv)
2003	652	3,624	390	3,886	4,276
2004	881	1,825	404	2,302	2,706
2005	370	5,972	347	5,995	6,342
2006	688	3,116	277	3,527	3,804
2007	471	3,748	383	3,836	4,219

In 2007, doses to workers at Bruce A and Bruce B were approximately 1.5 person-Sv per operating unit. Bruce Power staff has reported that the final collective dose for the year was higher than the projected dose targets and this was attributed to three factors: human performance, increase in outage scope, and equipment problems. A corrective action plan has been put in place for 2008, which includes the installation of dehumidifiers to reduce tritium levels in the reactor vaults, the use of new personal protective equipment, and a gamma dose rate reduction program. The issues related to outage management will require a longer time frame to address. CNSC staff will be monitoring Bruce Power's progress through the on-going compliance program.

1.1.8 Site Security

The assessment of the Site Security safety area for Bruce A and B is documented in a separate (secret) *Commission Member Document* (CMD 08-M37.A).

1.1.9 Safeguards

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

In 2007, the *safeguards* program at the Bruce A and Bruce B continued to meet all *safeguards* requirements and CNSC performance expectations.

No major *safeguards* events occurred in 2007, including events pursuant to the S-99[2] framework.

The licensee has developed and continues to maintain satisfactory documentation for the *safeguards* program. Bruce A and B staff was also actively involved throughout 2007 in a series of trilateral meetings with other power reactor licensees, the IAEA and the CNSC, to develop a new State-level integrated *safeguards* approach for all CANDU sites. Full implementation of this new approach is expected to be attained at Bruce A and B in 2008. The licensee has also provided, on a timely basis, all the reports and information necessary for *safeguards* implementation and has complied fully with IAEA and CNSC requirements.

No compliance issues were identified during a scheduled physical inventory verification, conducted by the IAEA in 2007 and attended by CNSC staff. Four scheduled *safeguards* inspections were also carried out at Bruce A to determine the status of Unit 2 and the booster rods. All quarterly IAEA interim inventory verifications at Bruce A and B were replaced in 2007 by short-notice randomized inspections under a new *safeguards* approach. IAEA inspectors also attended scheduled transfers of spent fuel to dry storage, initiated from Bruce A in July 2007, on an unannounced and randomized basis. In addition, the IAEA performed one unscheduled Complementary Access at Bruce A on June 13, 2007. No compliance issues arose from that visit.

1.1.10 Update on Other Major Projects and Initiatives

1.1.10.1 Bruce A Units 1&2 Life Extension

Refurbishment work progressed well during 2007. The *steam generators* have been replaced on Units 1 and 2. Turbine overhaul is nearing completion and should be completed in the 2nd quarter of 2008. Pressure tube removal on Unit 2 has been completed. Calandria tube removal is now in progress.

Bruce Power continued to make various submissions to the CNSC in conformity with CNSC Regulatory Document RD-360 *Life Extension of Nuclear Power Plants*, in

[2] CNSC Regulatory Standard S-99 *Reporting Requirements for Operating Nuclear Power Plants*, Canadian Nuclear Safety Commission, 2003.

response to the CNSC staff review of Bruce Power's integrated safety review. CNSC staff has continued to review these submissions, with the objective of reaching agreement on the extent of practicable improvements to be made to enhance safety.

During 2007, CNSC staff maintained regulatory oversight of the refurbishment project through meetings, desktop reviews, *Type I* and *Type II inspections* on various aspects of the refurbishment project. Satisfactory progress is being made on all issues.

1.1.10.2 Low Void Reactivity Fuel

The Low Void Reactivity Fuel (LVRF) is a new fuel design, intended to restore large LOCA safety margins. The new fuel uses slightly enriched uranium oxide and is characterized by a reduced void reactivity coefficient and improved heat transfer characteristics.

In February 2008, Bruce Power completed a demonstration irradiation of two channels worth of LVRF fuel in Unit 7. Preliminary indications are that the new fuel behaved as expected. The licensee is continuing to analyze the data from the demonstration. The final analysis is expected to be submitted as part of the safety case supporting a licence amendment for full core implementation in 2009.

The current proposed strategy is to implement full core LVRF fuel in the refurbished Units 1 & 2, after they have been returned to service and reached an equilibrium core (approximately 1 year after restart). Units 3 to 8 will then be fueled after that, as Bruce Power accumulates sufficient reserves of new fuel.

CNSC staff continues to closely monitor this licensee project and will brief the *Commission Tribunal* on any significant developments.

1.2 DARLINGTON

1.2.1 Operating Performance

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

Darlington operated safely in 2007. The Operating Performance safety area at Darlington met the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to safe facility operation in 2007.

1.2.1.1 Organization and Plant Management

There were no significant events related to process failures at Darlington in 2007.

CNSC staff observed no negative issues in this area. Initiatives aimed at improving the efficacy of the programs and processes are identified and tracked by the Darlington Navigator, which is OPG's business tool at Darlington, used to track performance in three key focus areas. These areas are leadership behaviours, human performance and station reliability. This business tool has been expanded in 2008 as an OPG fleet-wide program called Cornerstone.

The inspections, surveillance and monitoring carried out by CNSC staff have found no significant changes to the program or the implementation over the past year, so the "B" grades from the previous year remain valid.

1.2.1.2 Operations

CNSC staff conducted several field and control room inspections during 2007 and reported no major findings.

Based on CNSC *Type II inspections* and surveillance and monitoring by CNSC staff, there were no indications of degraded performance or changes to the program. The "B" program grade from the previous year remains valid.

In the areas of communications, configuration management and outage management, CNSC staff observed that safety performance met requirements.

1.2.1.2.1 Operations – Tritium Removal Facility

Tritium is a by-product that gradually builds up as a result of day-to-day operations of OPG's nuclear reactors. The Darlington site includes a Tritium Removal Facility (TRF) designed to minimize the amount of tritium going into the environment, as well as reducing the potential radiation exposure of workers. The TRF extracts tritium from the heavy water used in the reactors. The extracted tritium is then safely stored in stainless steel containers within a concrete vault.

In 2007, there were no environmental non-compliance events at the TRF. During this period, the TRF was shutdown twice for one forced outage and one scheduled maintenance outage. The forced outage occurred as a result of Loss of Station service power (Class IV). OPG has made the necessary engineering changes to ensure adequate redundancy through even/odd group separation so as to prevent any future occurrence of this event.

OPG has indicated to CNSC staff that a Life Cycle Management Plan and a Maintenance Improvement Initiative Plan are being developed to improve the overall health of TRF related systems. Overall, CNSC staff is satisfied with the operation of the TRF.

1.2.1.3 Occupational Health and Safety (Non-radiological)

In 2007, Darlington operated for close to 4 million person hours without a Lost Time Accident (LTA). The 2007 All Injuries Rate (AIR) was 1.10 as compared to 1.34 in 2006, while the 2007 Accident Severity Rate (ASR) was 0.08 as compared to 8.19 in 2006 (see Section 2.1.3). Darlington has met their year-end target for both indicators (1.30 and 4.75, respectively).

In 2007, Darlington staff sustained zero LTAs and 20 medically treated injuries as compared to 5 LTA and 15 medically treated injuries in 2006. Most of the 2007 injuries were musculoskeletal and extremities-related.

The improvement seen in the AIR and ASR can be attributed to the 2006 conventional safety initiatives for continual safety performance improvement through worker performance, management/supervisory oversight and effective planning, scheduling and execution of work. CNSC staff will continue to monitor the progress made in this area in the upcoming year.

Based on the fact that, in 2007, Darlington was significantly better than the average Canadian industry performance over the past 5 years for LTA (which registered 3.3 person days per 200,000 person-hours worked), along with the improvements in the AIR and ASR, the implementation of the Occupational Health and Safety program has been upgraded to an "A" for 2007.

1.2.2 Performance Assurance

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

Both the program and implementation of the Performance Assurance safety area at Darlington met the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to safe facility operation in 2007.

1.2.2.1 Quality Management

The governing document for the Darlington Quality Management Program is the Ontario Power Generation Nuclear (OPGN) Charter, N-CHAR-AS-0002. A revision (R10) to the Charter was submitted in 2007. CNSC staff concluded that the quality management program as described in the Charter complies with the requirements of CAN/CSA N286.0-92. The Charter was subsequently approved for use by the *Commission Tribunal* in PROL 13.00/2013.

A *Type I inspection* of the engineering change control process was conducted in 2006 and continued in 2007. Preliminary findings for the 2006 and 2007 inspections were provided to OPG Darlington staff. In general, the engineering change control documentation describes a design change process complying with the quality assurance standard CSA N286.5, although the documents lacked the clarity needed to ensure consistent implementation. The final inspection report documenting the analysis and conclusions regarding the findings will be issued in 2008.

In 2007, some events reported under the Regulatory Standard S-99 identified issues concerning the non-adherence to OPG documentation on work control, verification, change control, and communications. A CNSC staff analysis of the events concluded they did not represent an unreasonable risk to the safe operation of the facility. For 2007, Darlington's documented quality management program and its implementation met CNSC expectations, and were assessed as "B".

1.2.2.2 Human Factors

Based on compliance activities carried out in 2007, Darlington met CNSC expectations for its human factors program and its implementation. CNSC staff will continue to closely monitor the completion of outstanding enforcement actions in the different review areas, as well as the emerging trends in performance observed through S-99 event reports and information provided in the facility's quarterly operations reports.

CNSC staff conducted a *Type I inspection* to verify OPG's compliance with the station shift complement document and Limits of Hours of Work procedure, in 2005. The licensee continues to make progress in addressing the action notices and recommendations from the inspection report. An additional item was identified in 2007, relating to Hours of Work Limits for Casual Construction Trades Persons. CNSC staff has requested OPG to provide information regarding the potential impact of their work on nuclear safety, and defining the limits of hours of work for these workers.

As identified in the 2006 annual report, OPG continues to be committed in meeting the requirement to have an Authorized Nuclear Operator at the Darlington reactor panel at all times by July 31, 2009. CNSC staff notes that OPG has currently exceeded the minimum number of Authorized Nuclear Operators required in the station for almost half of the shifts worked over the past year and is on track to meet the commitment.

The methodology used by OPG in their Safety Culture Self-Assessment, conducted in September 2006, was assessed by CNSC staff. Staff has monitored the continual improvements made by OPG on the methodology. OPG is to be commended on the initiative to develop a safety culture self-assessment approach and is encouraged to continue the development work.

1.2.2.3 Training, Examination and Certification

In 2006, CNSC staff identified some deficiencies related to the re-qualification testing for certified shift personnel. Since then, OPG has proposed revisions to the requirements for re-qualification testing. CNSC staff is reviewing these proposals and plans to revise and reissue the document in early 2008. CNSC staff considers that the resulting changes will clarify the requirements, and should allow for the closure of all outstanding issues.

CNSC staff conducted an evaluation of Darlington's Non-Licensed Nuclear Operator (N/O) training programs, in July 2007. This evaluation covered all four streams of N/O training including: Generating Unit, Unit 0, Fuel Handling (F/H), and Tritium Removal Facility (TRF) training. Some positive aspects were identified, including the use of desktop simulators and comprehensive orientation of new staff. However, CNSC staff also identified some deficiencies such as inaccurate references to governing documents, inadequate documentation of required "co-piloting" by new panel operators, and a lack of continuing training for the fuel handling and tritium removal facility operator streams. In January 2008, Darlington submitted an action plan, which is currently under review by CNSC staff. CNSC staff will be completing the review of this action plan by June 15, 2008.

In addition to the above, the evaluation identified two deficiencies associated with the training program governing document OPG-N-PROG-TR-0005. A new revision has since been issued by OPG. CNSC staff is currently reviewing the new revision to determine the acceptability and potential impact on the training and qualification of staff arising from the changes. A report on this review will be issued in early 2008.

In August 2007, OPG completed the corrective actions needed to remedy deficiencies in the initial mechanical maintenance training program, which is identical for all the OPG reactor sites. All but two of the corrective actions for the initial control maintenance training program were also completed. OPG plans to complete the remaining corrective actions by July 2008.

As part of an ongoing project to transfer certification examinations for certified shift personnel from the CNSC to OPG, CNSC staff has requested OPG to provide the processes that have been put in place to ensure that their examiners will be qualified to administer certification examinations. In addition, Regulatory Document RD-204, *Certification of Persons Working at Nuclear Power Plants*, was issued in February 2008, to provide clarification and additional details to the requirements set out in the NSCA and the regulations made under the NSCA. CNSC staff will be meeting with the NPP licensees by May 2008, to provide further guidance on the preparation of supporting documents to be submitted to the Secretariat. Depending on the *Commission Tribunal's* decision, the implementation of RD-204 is set for September 2008.

The overall success rate of certification examinations at Darlington was acceptable during the year. CNSC staff concluded that the program and its implementation met CNSC expectations.

1.2.3 Design and Analysis

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

Both the program and implementation of the Design and Analysis safety area at Darlington met the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to safe facility operation in 2007. CNSC staff reviews, which included evaluation of the work performed towards a plant-specific probabilistic safety assessment, concluded that the licensee continued to provide acceptable safety analyses and responses to new design and safety issues.

1.2.3.1 Safety Analysis

CNSC staff rates the overall Safety Analysis programs and implementation by Darlington NGS as acceptable. However, several issues have been identified in this area in 2007, including the impact of plant aging on the safety analysis, the need for a *Safety Report* accident analysis update, and the restoration of large Loss of Coolant Accident (LLOCA) safety margins for which corrective measures to ensure the long term safe operation of Darlington are generally not fully developed. These issues are further discussed below.

1.2.3.1.1 Plant Aging on Safety Analysis

The aging of plant components can have a direct and immediate impact on plant safety. The impact manifests itself in terms of reduced effectiveness of the *special safety systems* to cope with certain *design basis accidents*. The two principal aging mechanisms affecting the Heat Transport System (HTS), identified by OPG, are pressure tube diametrical creep and magnetite transport and deposition behaviour in the HTS. To address the impact of aging on the NOP of its reactors, OPG and Bruce Power have developed a new NOP analysis, which demonstrates a larger safety margin, and hence continued plant safety, without the need to reduce current shutdown system trip set points. Additional information was provided to CNSC staff in November 2007, and will be used to determine if other safety measures are needed to ensure the effectiveness of trip coverages for other design basis events. CNSC staff is of the opinion that, although the new approach may be theoretically sound, it would require a detailed review to assess the appropriateness of its utilization for NOP determination, and for other safety analysis applications. CNSC staff is undertaking such a review and a progress update will be provided to the *Commission Tribunal* in November 2008. In the meantime, it is CNSC staff's opinion that, although safety margins have been reduced by the effects of aging, plant operation remains within the plant's design safety limits.

1.2.3.1.2 Safety Report Accident Analysis Update

In November 2006, OPG submitted an update of Part 3 (Accident Analysis) of the Darlington *Safety Report*, which was subsequently reviewed by CNSC staff. Staff concluded that there were several areas that did not meet the evaluation criteria. These were:

- Use of validated computational tools to perform safety analysis;
- Consistency and conservatism in analysis methodologies and assumptions;
- Consistent treatment and application of simulation and measurement uncertainties and;
- General compliance with Quality Assurance standards consistent with CSA N286.7-99.

OPG has since agreed to work towards resolving this issue. In particular, OPG has proposed to provide a Project Execution Plan by the first quarter of 2009, covering all the related activities and completion dates for performing a comprehensive review and update of the *Safety Report*. This effort will require the involvement of the Canadian nuclear industry as a whole insofar as agreeing to a standardized approach for *Safety Report* updates. CNSC staff is satisfied with OPG's proposal for addressing this issue.

1.2.3.1.3 Restoration of Large Loss of Coolant Accident Safety Margins

A Large Loss of Coolant Accident (LLOCA) is a postulated accident initiated by a failure in the Primary Heat Transport system, resulting in fast voiding of coolant and significant degradation of heat removal from the fuel. A LLOCA event is a relatively unlikely *serious process failure*, which sets the design requirements for the response speed of the shutdown systems.

Following a series of discoveries that have led to an erosion of safety margins against LLOCA events, OPG initiated the "Large Break LOCA (LBLOCA) Margin Restoration Program". This program includes performing analyses with a new methodology called Best Estimate and Uncertainty Analysis (BEAU), evaluating design changes, conducting supporting research, and proposing a new licensing framework for LLOCA.

In a recent submission, OPG has stated its position that existing LLOCA margins are adequate for continued safe operation, while recognizing that there is no significant room left to accommodate future adverse discovery issues (however unlikely). OPG is confident that these margins could be significantly increased through improvements to the safety analysis methodologies and code validations, as well as through the use of risk informed decision-making. In December 2007, OPG submitted an update on the issues and activities related to LBLOCA analysis, and highlighted the following two items for their strategy for LBLOCA margin restoration:

1. OPG will continue to develop and apply BEAU to demonstrate and substantiate the existence of greater LBLOCA safety margins and,
2. LBLOCA events will be redefined as *beyond design basis accidents*. This approach is similar to international developments in risk-informed decision making.

CNSC staff is reviewing this submission and plans to meet with OPG in June 2008 to discuss the above issues.

1.2.3.1.4 Probabilistic Safety Analysis

The first Darlington Probabilistic Safety Assessment (PSA) was completed in 1987, and was called the Darlington Probabilistic Safety Evaluation (DPSE). The DPSE served as a design verification tool in support of the safety analysis. In order to ensure the continued validity of the safety analysis, updates were made to the DPSE, which then became known as the Darlington A Risk Assessment (DARA). To meet internal and regulatory requirements, OPG is fully updating and finalizing the DARA. DARA level 1 should be finalize by the end of 2008. For the interim, OPG has confirmed that the previous PSA still adequately supports the current safety analysis.

1.2.3.2 Safety Issues

CNSC staff reviewed the progress of the CANDU industry and utilities in resolving issues related to GAIs. OPG continued its work, including participation in the industry efforts, toward resolution of the GAIs. The overall progress was judged to be satisfactory. A brief description and the expected completion date of each GAI are provided in Appendix F, Table F.1.

1.2.3.3 Design

CNSC staff concludes that OPG's design program documentation of equipment qualification and system classification met CNSC requirements in 2007. OPG has maintained an up-to-date System Classification List (SCL) to reflect the current status of

pressure-retaining systems and components in the nuclear facility. No significant deficiencies with respect to design changes were identified, and OPG continues to pursue safety enhancement programs.

A *Type I inspection* of the licensee's Emergency Power Supply (EPS) and Emergency Service Water (ESW) systems was conducted in 2006, to evaluate the capability of the EPS/ESW systems to perform their design functions under normal and accident conditions. No major issues were identified, but there were several areas where improvements could be made. OPG submitted a response with a corrective action plan to address these issues, and provided a further update in November 2007. The update is currently under review. Overall, CNSC staff is satisfied with the information provided so far.

In the area of fire protection, the CNSC staff review and assessment concluded that OPG is operating its Darlington facility in general compliance with licence requirements. There were several issues requiring corrective actions. However, these issues are not considered to present unreasonable risk to persons and the environment from fires at the facility.

In 2006, OPG was granted a temporary licence deviation for the use of CSA standard N285.0-06 *General Requirements for Pressure Retaining Systems and Components in CANDU Nuclear Power Plants*. This condition has since been made permanent by the *Commission Tribunal* in PROL 13.00/2013.

CNSC staff concluded that overall, the design program at Darlington and its implementation met CNSC expectations.

1.2.4 Equipment Fitness for Service

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

Both the program and implementation of the Equipment Fitness for Service safety area at Darlington met the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to safe facility operation in 2007. Progress in the implementation of the Equipment Qualification program continued towards meeting the December 31, 2010 completion date required by the licence.

1.2.4.1 Maintenance

OPG has in place policies, processes and procedures that provide direction and support for the Darlington maintenance program. The program is supported by a significant

organization with established goals. Continuous status reports track whether the goals are being met and look for areas of improvement.

CNSC staff concluded that the Darlington maintenance program implementation met expectations, and that there is evidence of continuous improvement.

1.2.4.2 Structural Integrity

In order to ensure pressure boundaries remain fit-for-service, OPG performed many periodic and in-service inspections (PIP) throughout 2007, to monitor degradation rates of pressure boundary components. Major pressure retaining components, which include *pressure tubes*, *steam generator* tubes and *feeder* piping, are also closely monitored under the fitness-for-service programs.

During the 2007 Unit 2 and 4 planned outages, Darlington performed in-service inspections, in accordance with the scope and schedule defined in the PIP as well as the aging and life cycle management strategy and plans. Key pressure retaining components, such as *pressure tubes*, *steam generator* tubes and *feeder* piping, were inspected with no significant findings. In 2007, two *feeders* were replaced in Unit 2 as part of OPG's *feeder* fitness-for-service and life cycle management strategy. The OPG strategy is to repair *feeders* as necessary to allow station operation to continue until the fuel channels need replacing. CNSC staff is satisfied with both the inspection work and the assessment provided upon the findings.

The structural integrity program and its implementation at Darlington continued to meet CNSC expectations in 2007.

1.2.4.3 Reliability

OPG submitted the Darlington Reliability Program to the CNSC in 2006, as required by S-98. This reliability program has been developed consistent with the industry approach. OPG continued to implement the S-98 requirements at Darlington, such as refining reliability models for all the systems important to safety and addressing CNSC comments. CNSC staff held workshops with the industry in 2007, to resolve the generic issues related to the implementation of S-98 reliability program. OPG has made progress, however, there are still ongoing discussions on a few issues.

CNSC staff is generally satisfied with the progress in implementing the reliability program at Darlington in 2007, and will continue to monitor it throughout 2008.

1.2.4.4 Equipment Qualification

In 2007, the Equipment Qualification program at Darlington was assessed solely through the *Environmental Qualification* (EQ) of equipment. OPG continued to optimize the EQ program scope. This will resolve inadequacies with the program as well as eliminating areas where there is no impact on operability of safety related equipment.

A CNSC *Type I inspection* of the Darlington EQ program was conducted in 2007, and no significant issues were identified. Following the inspection, OPG developed a plan to optimize the EQ scope in order to meet the December 31, 2010 completion date required by the licence.

The Steam Protection Program is an important aspect of the EQ program. OPG is undertaking considerable effort to ensure that the steam barriers continuously meet their leakage tightness requirements. CNSC staff has reviewed the recent room leakage test report for steam-protected rooms. Overall, CNSC staff accepts the method used to conduct the test. However, the frequency of routine testing to verify that the steam-protected rooms continue to meet their maximum allowable leakage requirements is still under discussion between OPG and CNSC staff. CNSC staff continues to evaluate this situation and the path forward.

While the implementation of the EQ program is evolving, it has yet to fully meet CNSC staff's expectations. CNSC staff will continue to closely monitor the Darlington EQ program implementation in the upcoming year.

1.2.5 Emergency Preparedness

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	EMERGENCY PREPAREDNESS	A	A

In 2007, the Emergency Preparedness program and its implementation at Darlington continued to exceed applicable CNSC requirements and performance expectations.

A *Type I inspection* was conducted at Darlington in 2007 to evaluate the OPG's Emergency Preparedness program. Darlington has consistently met the expectations set out in CNSC Regulatory Guide G-225 *Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills*, and in some cases exceeded expectations. CNSC staff will continue to monitor the licensees' Emergency Preparedness performance through regular compliance activities.

Revision 8 of the Consolidated Nuclear Emergency Plan (CNEP) was submitted for approval by OPG. A review of the plan was completed in December 2007 by CNSC staff and was approved by the *Commission Tribunal* in PROL 13.00/2013.

Darlington continued to meet regulatory requirements for emergency preparedness and response capability. Consistent with the previous industry report, the licensee continued to demonstrate effective emergency response capability.

1.2.6 Environmental Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	ENVIRONMENTAL PROTECTION	B	B

The Environmental Protection program and its implementation at Darlington met the objectives of CNSC requirements and performance expectations in 2007.

Both airborne emissions and liquid releases of nuclear substances to the environment were less than 1% of the *derived release limit* for Darlington, and there were no reports of environmental action levels being exceeded. In 2007, the reported dose to the public was 1.4 µSv for Darlington.

There were no reported unplanned releases of nuclear substances or hazardous substances from Darlington that posed a significant risk to the environment in 2007.

CNSC staff reported on a *Type I inspection* of the OPG nuclear environmental management system in 2007, and identified no significant issues.

1.2.7 Radiation Protection

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	RADIATION PROTECTION	B	A

In 2007, Darlington's Radiation Protection program continued to meet the objectives of CNSC requirements and performance expectations, and was assigned a "B" grade. The Darlington radiation protection program is part of OPG's overall radiation protection program, which met CNSC staff expectations. However, recommended improvements have been identified for the control of internal dose to workers. CNSC staff continues to work with OPG towards the closure of this recommendation.

Implementation of the radiation protection program at Darlington continued to exceed CNSC staff expectations in 2007, and was rated an "A".

There were no radiation exposures that exceeded regulatory limits at Darlington in 2007.

Table 3 provides a five-year trend (2003-2007) of annual doses to workers at the Darlington Nuclear Generating Station:

Table 3: Annual Dose at Darlington NGS

Year	Collective Dose – Routine Operations (person-mSv)	Collective Dose – Outages (person-mSv)	Total Collective Internal Dose (person-mSv)	Total Collective External Dose (person-mSv)	Total Collective Effective Dose (person-mSv)
2003	308	2,534	356	2,486	2,842
2004	460	2,170	270	2,360	2,630
2005	377	2,481	342	2,516	2,858
2006	353	2,848	383	2,818	3,201
2007	343	3,764	354	3,753	4,107

Collective dose during routine operations, although varying from year-to-year, remained relatively steady. A slightly elevated collective dose during outages was observed in 2007. However, this was primarily due to Darlington going to a schedule of longer periods between outages, which resulted in two longer outages in 2007.

No incidents resulting in a reportable dose in excess of OPG's action levels were observed in 2007. Radiation Protection related events were reported promptly to CNSC staff and were accompanied by adequate implementation of corrective actions.

Darlington was awarded with the 2007 ALARA World Class Performance Award at the North American ALARA Symposium, for exemplary performance in occupational dose reduction. The licensee continues to strive for improvements in radiation protection, through a strategic source term reduction plan scheduled to continue through 2011.

1.2.8 Site Security

The assessment of the Site Security safety area for Darlington is documented in a separate (secret) *Commission Member Document* (CMD 08-M37.A).

1.2.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Darlington	SAFEGUARDS	B	B

In 2007, the *safeguards* program at Darlington continued to meet all *safeguards* requirements and CNSC performance expectations.

No major *safeguards* events occurred in 2007, including events pursuant to the S-99 framework.

The licensee has developed and continues to maintain satisfactory documentation for its *safeguards* program. Darlington staff was also actively involved throughout 2007 in a series of trilateral meetings with other power reactor licensees, the IAEA and the CNSC,

to develop a new State-level integrated *safeguards* approach for all CANDU sites. Full implementation of this new approach is expected to be attained at Darlington in 2008. The licensee has also provided, on a timely basis, all the reports and information necessary for *safeguards* implementation and has complied fully with IAEA and CNSC requirements.

No compliance issues were identified during a scheduled physical inventory verification conducted by the IAEA in 2007, and attended by CNSC staff. All quarterly IAEA interim inventory verifications were replaced in 2007 by short-notice randomized inspections, under a new *safeguards* approach. In addition, the IAEA performed one unscheduled Complementary Access at Darlington on November 27, 2007. No compliance issues arose from that visit.

1.3 PICKERING A

1.3.1 Operating Performance

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

Implementation of the Organization and Plant Management program and Operations program were both assessed as "C –below requirements" at Pickering A in 2007. Consequently, implementation of the Operating Performance safety area was also rated as a "C".

The Occupational Health and Safety program and its implementation met the objectives of CNSC requirements and performance expectations in 2007.

1.3.1.1 Organization and Plant Management

In 2007, the two operating units at Pickering A were in operation about 40% of the time. A number of forced outages, unit trips and planned outage extensions contributed to the low operating period. One major event involved the shutdown of both units in order to restore functionality to the Inter-Station Transfer Bus (ISTB) electrical system (see Appendix E).

The ISTB event began with the discovery of non-qualified openings in steam protected rooms, which could cause impairment of the system. Similar problems had been detected in other nuclear stations, so this represented an inadequate response to industry Operating Experience. During repairs to the non-qualified openings, it was determined that the ISTB did not have adequate capacity. OPG made a conservative decision to shutdown the units until system functionality could be restored. The investigation of this event by the licensee and reviews by CNSC staff identified management deficiencies.

There were five forced unit outages due to equipment problems (one each on Units 1 and 4 were due to ISTB). There were also six reactor trips – Unit 1 had two manually initiated trips and Unit 4 had three automatic and one manual trip.

There was one planned outage on Unit 1, originally scheduled for a duration of 65 days, which was completed in 79 days, despite some work being pulled ahead into the ISTB forced outage. The Unit 4 60-day planned outage, which began in early October 2006, was completed in February 2007, with a total duration of 129 days. Both outages were affected by significant amounts of discovery work, indicative of equipment deficiencies.

Unscheduled reports required by Regulatory Standard S-99, continued to be a source of concern. In some instances, CNSC staff identified events that should have been detected by licensee staff. Delays in the issuing preliminary reports and the overuse of Additional Reports tend to complicate staff reviews; however, these issues show improvement from the previous year.

There were 19 reported instances of unavailability of safety or safety-related systems in 2007, which is considered a high number, and included events on Emergency Coolant Injection, Standby Generation (emergency Class III power), Auxiliary Boiler Feed and several on Powerhouse Environmental Protection systems (which impact on ISTB availability).

Given the limited operating time during the year and the management deficiencies identified during the ISTB investigation, there has been no noticeable improvement in this program area from 2006. Therefore, Organization and Plant Management implementation remains a "C" for 2007.

1.3.1.2 Operations

CNSC staff assessed Operations using information collected through inspections, reviews of operations and S-99 reports.

CNSC staff conducted a series of field compliance inspections at Pickering A during 2007. While many housekeeping or plant status deficiencies were noted, they were generally minor and easily corrected. The overall housekeeping performance in the operating units was improved, but areas in Units 2 and 3 were deficient and the licensee has been taking action to address this deficiency. Inspections and S-99 reports continue to identify deficiencies related to the control of equipment and tooling in seismically qualified areas.

A number of reactor trips were caused directly or indirectly by Operations staff. Unit 4 tripped three times during the year. One of these trips was the result of inappropriate adjustments made to heat transport pressure controller settings in a past outage. Another trip occurred when Operations field staff was attempting to reseat heat transport drain valves without adequate consideration for the impact on system pressure at the current conditions, no formal troubleshooting plan, and no comprehensive pre-job briefing. The third trip was due to Operations staff using an Abnormal Incident Manual procedure that had not been updated.

CNSC staff also observed a number of incidents caused by Operations staff not following procedures and not recognizing the significance of decisions.

These trips caused by operator actions, and the unsuitable decisions, appear to be excessive and will require enhanced oversight. Therefore, implementation of Operations is rated as "C".

1.3.1.3 Occupational Health and Safety (Non-radiological)

CNSC staff considers that the accident frequency and severity rates, as reported by OPG during 2007, demonstrated adequate occupational health and safety performance at Pickering A. The Pickering A and B combined value for the "Accident Severity Rate" PI (see Section 2.1.3, Table 16) compares favorably to the industry average. There was one Lost Time Accident at Pickering A, which occurred early in the year.

Overall, the Occupational Health and Safety program and implementation met CNSC performance expectations.

1.3.2 Performance Assurance

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

The implementation of the Quality Management and Human Factors programs at Pickering A were assessed as "C - Below Requirements" in 2007. Consequently, implementation of the Performance Assurance safety area at Pickering A was also given a "C" grade.

The Training, Examination and Certification program and its implementation met CNSC requirements and performance expectations in 2007.

1.3.2.1 Quality Management

The governing document for the Pickering Quality Management Program is the Ontario Power Generation Nuclear (OPGN) Charter, N-CHAR-AS-0002. A revision (R10) to the Charter was submitted in 2007. CNSC staff concluded that the quality management program, as described in the Charter, complies with the requirements of CAN/CSA N286.0-92.

An inspection of the engineering change control process was performed in February 2007, and a preliminary finding report was provided to Pickering A staff. In general, the engineering change control documentation describes a design change process complying with the quality assurance standard CSA N286.5, although the documents lacked the clarity needed to ensure consistent implementation. The inspection revealed inconsistencies regarding installation and commissioning for some modifications. In addition, the inspection identified inconsistencies regarding the technical evaluations of design inputs and outputs.

In 2007, events reported under Regulatory Standard S-99 identified issues regarding the non-adherence to OPG documentation regarding work control, verification, change control, maintenance, configuration management, communication, and corrective actions. However, CNSC staff analysis of these events concluded they did not represent an unreasonable risk to the safe operation of the facility.

As a result of the ISTB event at Pickering A, licensee staff performed an extensive investigation including *root cause analysis* and extent of condition assessments. The investigation determined that management deficiencies were the primary cause of the incident. These deficiencies indicated a break down in several management activities and practices over many years.

CNSC staff reviewed the OPG investigation report and concluded that some Pickering A processes were less than adequate, and that the root causes were not adequately explained or clearly supported in the investigation report.

In the review of the temporary modification of the ISTB, CNSC staff found deficiencies with respect to modifying the design requirements, documenting the rationale for the modifications of the design requirements, and disposing of the design review comments. In addition, CNSC staff concluded that OPG staff did not adhere consistently to the defined and accepted engineering change processes and practices, and no complete assurance was provided regarding the capability of the current engineering change processes to process complex design changes.

CNSC staff assessment of the ISTB event and its investigation, and the analysis of reported events and inconsistencies identified by the engineering change control process inspection, indicates problems with the implementation of the QM program. As a result, CNSC staff has assessed the implementation of the Pickering A QM program as a “C” for 2007.

1.3.2.2 Human Factors

In 2006, the implementation of the Human Factors program was rated “C”. CNSC staff requested OPG to provide an update to its Human Performance Program, including the program’s effectiveness. A complete response is expected later in 2008.

CNSC staff analyzed the S-99 reportable events and inspection findings for 2006. A number of deficiencies were identified, and CNSC staff requested OPG to provide resolutions. In the review of S-99 events reported in 2007, CNSC staff has found similar deficiencies. The CNSC is waiting for OPG’s final response.

Pickering A performed a Safety Culture Self-Assessment in August 2007, but the licensee report has not yet been received. CNSC staff observed the implementation of the Safety Culture method and the use of the supporting data input tool and communicated its observations in a letter to OPG, along with recommendations for future implementation of the Safety Culture Self-Assessment methodology at OPG facilities. The development

of a safety culture self-assessment is a dynamic, on-going process, for which OPG should be commended.

Given that the final response to the identified deficiencies remains outstanding and there has been no noticeable improvement in this program area since 2006, the implementation of the Human Factors program continues to be assessed as a "C" for 2007.

1.3.2.3 Training, Examination and Certification

The overall success rate in certification examinations at Pickering A was adequate during the year. This program and implementation met CNSC staff's expectations.

As a prerequisite for the CNSC project to transfer certification examinations to licensees, the licensees must have a sufficient number of examiners who meet the qualification requirements specified in the relevant CNSC regulatory documents. To verify that OPG is meeting this requirement, CNSC staff requested that OPG provide the processes that have been put in place to ensure that their examiners will be qualified to administer certification examinations. CNSC staff is currently reviewing OPG's response.

CNSC staff performed follow-up activities to review the results of licensee progress in resolving deficiencies identified in pre-2007 training program evaluations supporting Examination Transfer to the licensees. Pickering A has made good progress in resolving these deficiencies. Pickering A completed all actions by year-end 2007, and CNSC staff is reviewing these completed actions. In early 2008, Pickering A submitted requests for closure on all training program evaluations to support transfer of certification examinations to the licensees. CNSC staff has reviewed the evidence provided and found it to be acceptable. CNSC staff will be issuing evaluation close-out letters by May 31, 2008.

CNSC staff is reviewing the revised OPG Program Document "Training," N-PROG-TR-0005. A report on this review will be issued in early 2008. The document governs all of OPG's nuclear generating stations. CNSC staff is concerned about the implications of the concept of non-task limiting training qualifications introduced in the latest revision of this high-level program document. Despite this concern, the overall assessment of the program documentation meets CNSC requirements.

Although the evaluations identified some deficiencies, based on the supporting data for the entire period, CNSC staff rates the Training, Examination and Certification program and its implementation as "B" for 2007.

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	C

Both the program and implementation of the Design and Analysis safety area at Pickering A met the objectives of CNSC requirements and performance expectations. The programs under this safety area contributed adequately to safe facility operation in 2007. However, the implementation of the Design program was assessed as "C" due to ISTB design issues.

1.3.3.1 Safety Analysis

A number of concerns in the Safety Analysis program area at Pickering A have been raised over the past year or continue from previous years. These concerns are related to issues in the following areas:

- Shutdown Systems Effectiveness – Large Break Loss of Coolant Accident Safety Margins
- Impact of Plant Aging on Trip Coverage
- The discrepancy in the 28-Element Fuel String Core Heat Flux Experiments and its impact on safety.
- *Safety Report* Update

CNSC staff rates the Safety Analysis program and its implementation at Pickering A as "B – Meets Requirements". However, based on the issues mentioned above, staff considers the trend for implementation to be "deteriorating".

1.3.3.2 Safety Issues

CNSC staff reviewed the progress made by the CANDU industry and utilities to resolve the GAIs. OPG continued its work, including participation in the industry efforts toward resolution of the GAIs. The overall progress was judged satisfactory. A brief description and the expected completion date of each GAI are provided in Appendix F, Table F.1.

1.3.3.3 Design

The ISTB event at Pickering A indicated deficiencies in the design of the system that had existed since it had been installed in 1991. OPG has designed and installed a temporary modification to permit the ISTB to meet its design intent. However, there are deficiencies in the temporary modification involving lack of redundancy, reduced reliability and increased operator actions. A permanent modification is being developed by OPG and is expected to be installed early in 2010.

CNSC staff found weaknesses in the fire protection design program, as the development of some documents and program sub-elements is incomplete. These issues are not considered to present an unreasonable risk to persons and the environment, in the event of a fire at the facility. The licensee has provided an action plan to address these deficiencies in the program documentation, and the plan is considered to be acceptable by CNSC staff.

Implementation of the Design program for Pickering A has been rated as "C", due to the discovery of the ISTB design deficiencies and the installation of the temporary modification.

1.3.4 Equipment Fitness for Service

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

Both the program and implementation of the Equipment Fitness for Service safety area and related program areas at Pickering A met the objectives of CNSC requirements and performance expectations in 2007.

1.3.4.1 Maintenance

Pickering A has in place policies, processes and procedures that provide direction and support for its maintenance program. The program is supported by a significant organization with established goals. In 2007, continuous status reporting tracked whether or not the goals were being met, and looked for areas of improvement.

Pickering A has maintained its corrective maintenance backlog within industry norms and the level of elective maintenance backlog is trending down to target. CNSC staff assesses the Pickering A maintenance program and its implementation as a "B" for 2007.

1.3.4.2 Structural Integrity

The scope and scheduling for in-service inspections at Pickering A were based on the most recent revision of OPG's components aging and life-cycle management strategy and plans, which are up-to-date. With respect to the safety significant components (fuel channels, *feeders*, *steam generators*) structural integrity in Pickering A, CNSC staff is satisfied with the programs and considers that the rating for last year, "B", is still valid.

The "Certificate of Authorization" programs addressing repair, alteration and new fabrication are in place and working as anticipated. Implementation of these programs suggests an improving trend in pressure boundary integrity.

In accordance with the scope and schedule defined in Pickering A's PIP, as well as the aging and life cycle management strategy and plans, OPG performed in-service inspections during the 2007 planned outage. CNSC staff is satisfied with both the inspection work and the assessment of the inspection findings. Since the units in Pickering A are either in laid-up condition or just restarted recently, and the related programs are in place, staff consider that with respect to implementation of the structural integrity program, the rating remains a "B".

1.3.4.3 Reliability

OPG submitted the Pickering A Reliability Program to the CNSC in 2006, as required by S-98. This reliability program has been developed consistent with the industry approach. OPG continued to implement the S-98 requirements at Pickering A, such as refining reliability models for all the systems important to safety and addressing CNSC comments. CNSC staff held workshops with the industry in 2007 to resolve the generic issues related to the implementation of S-98 reliability program. OPG has made progress, however, there are still issues that OPG is required to address.

The Pickering A *special safety systems* - the two shutdown systems, the emergency core cooling (ECC) system, and the containment system - performed as required and met the availability targets in 2007. However, there was one event that resulted in ECC impairment for about 6.5 hours in 2007. At the time of the ECC impairment, the ECC was not required because all the Pickering A units were either in *guaranteed shutdown state* or approaching *guaranteed shutdown state*. There was no system impairment of the other *special safety systems* at Pickering A in 2007.

Other systems important to safety also performed well and met the availability targets in 2007. However, it was discovered during the year that the ISTB system had insufficient capacity to support the existing loads on all units. Therefore, the ISTB did not meet the design intent and was not available. OPG has taken actions to correct the problems and CNSC staff will continue to monitor the progress.

CNSC staff considers the overall reliability performance at Pickering A in 2007 acceptable, and will continue to monitor OPG's performance to ensure sustained improvement.

1.3.4.4 Equipment Qualification

In 2007, CNSC staff did not identify any significant changes suggesting degradation in the Pickering A Equipment Qualification program or weaknesses in its implementation.

In the area of *Environmental Qualification* (EQ), CNSC staff rated the licensee as being in general compliance with the requirements of the licence condition 7.1. In 2007, there

were several EQ-related reportable events related to deficiencies in the EQ Steam Barrier Program, which is an important aspect of the Pickering A EQ program. These were all corrected by the licensee.

Although there are some challenges with regard to Equipment Qualification sustaining activities, it is recognized that OPG has been addressing the issues with a corrective action plan. Consequently, in 2007, the overall Equipment Qualification program and its implementation met the objectives of CNSC requirements and performance expectations.

1.3.5 Emergency Preparedness

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

A *Type II inspection* was conducted at Pickering A and B during November 2007, concluding that "within the scope of the inspection, Pickering has demonstrated its ability to effectively respond to and manage an emergency". Pickering A and Pickering B share corporate resources for emergency response.

Pickering A continued to meet all regulatory requirements for emergency preparedness and response capability. Consistent with the previous industry report, no unreasonable risk to the effectiveness of the emergency response capability was determined. The Pickering A Emergency Preparedness program and its implementation continued to exceed expectations.

1.3.6 Environmental Protection

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

The Environmental Protection program and its implementation at Pickering A met the objectives of CNSC requirements and performance expectations in 2007. Both airborne emissions and liquid releases of nuclear substances to the environment were less than 1% of the *derived release limit* for Pickering A. There were no reports of environmental action levels being exceeded. In 2007, the reported dose to the public was 2.6 µSv for the Pickering site (A and B).

In 2007, there were no reported unplanned releases of nuclear substances or hazardous substances from Pickering A that posed a significant risk to the environment.

CNSC staff conducted a *Type I inspection* of the OPG nuclear environmental management system in 2006, and no major issues were identified. Nine action notices were issued and OPG has committed to resolve them by the end of September 2008.

1.3.7 Radiation Protection

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

In 2007, the Pickering A Radiation Protection program and its implementation continued to meet the objectives of CNSC requirements and performance expectations.

One incident in 2007 resulted in an individual receiving a tritium dose in excess of an action level. CNSC staff is satisfied with the licensee's investigation. This incident did not represent a loss of control of the licensee's radiation protection program.

Respiratory protection program-related deficiencies concerning medical surveillance and procedural adherence, identified following the *Type I Inspection* of the radiation protection program in March 2006, remain open. CNSC staff continues to oversee the licensee's efforts to work towards the closure of these items.

The licensee has developed a 2007 – 2011 ALARA strategy, which includes initiatives to identify and control source term, reduce worker tritium exposure through engineering methods, implement shielding barriers where appropriate, and modify human performance to prevent unplanned exposures.

CNSC staff will monitor the licensee's progress regarding the implementation of these improvement plans through regular compliance verification activities.

Table 4 provides a five-year trend (2003-2007) of annual doses to workers at Pickering A.

Table 4: Annual Dose at Pickering A

Year	Collective Dose - Routine Operations (person-mSv)	Collective Dose - Outages (including forced outages) (person-mSv)	Total Collective Internal Dose (person-mSv)	Total Collective External Dose (person-mSv)	Total Collective Effective Dose (person-mSv)
2003	256	1,323	608	971	1,579
2004	233	2,605	970	1,868	2,838
2005	730	4,148	1,620	3,254	4,878
2006	570	2,254	580	2,244	2,824
2007	330	1,816	466	1,680	2,146

In 2005, the increased number of outages necessary to return Until 1 to service contributed to the elevated collective dose in that year. Since 2005, the total collective effective dose has improved by a factor of more than 2.3.

1.3.8 Site Security

The assessment of the Site Security safety area for Pickering A and B is documented in a separate (secret) *Commission Member Document* (CMD 08-M37.A).

1.3.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering A	SAFEGUARDS	B	B

In 2007, the *safeguards* program at Pickering A continued to meet all *safeguards* requirements and CNSC performance expectations.

No major *safeguards* events occurred in 2007; however, a loss of power to installed *safeguards* equipment for Units 1 and 2, and to the overhead lights in Irradiated Fuel Bay-A, was reported under the S-99 framework.

The licensee has developed, and continues to maintain, satisfactory documentation for the *safeguards* program. Pickering A staff was also actively involved throughout 2007 in a series of trilateral meetings with other power reactor licensees, the IAEA and the CNSC, in order to develop a new State-level integrated *safeguards* approach for all CANDU sites. Full implementation of this new approach is expected to be attained at Pickering A in 2008. The licensee has also provided, on a timely basis, all the reports and information necessary for *safeguards* implementation, and has complied fully with IAEA and CNSC requirements.

No compliance issues were identified during a scheduled physical inventory verification conducted by the IAEA in 2007 and attended by CNSC staff. All quarterly IAEA interim inventory verifications were replaced in 2007 by short-notice randomized inspections, under a new *safeguards* approach. IAEA inspectors also attended scheduled transfers of spent fuel to dry storage, as well as discharges of spent fuel from the Unit 2 and 3 reactors during the defuelling campaigns, on an unannounced and randomized basis.

1.3.10 Update on Other Major Projects and Initiatives

1.3.10.1 Pickering A Units 2 and 3 Safe Storage Project

In November 2005, OPG advised the CNSC of its decision not to return Pickering A Units 2 and 3 to service as previously planned, after its Board of Directors accepted management's recommendation not to proceed with the restart of these units. The safe return to service of these units would have been technically feasible; the decision not to proceed with refurbishment was made for business reasons. Instead of returning to operation, Units 2 and 3 will be placed in long-term safe storage.

The units are currently in a *guaranteed shutdown state*. Unit 2 has been completely defuelled and Unit 3 defuelling is ongoing. Both Units 2 and 3 contain heavy water. Due to the many interconnections between the systems in the operating Units 1 and 4, some Unit 2 and 3 systems will be required to remain operational in order to support the operation of Units 1 and 4.

The preliminary decommissioning plan for Pickering A calls for units to be placed in a safe storage state, after being permanently shut down and before being dismantled. Accordingly, the goal of the safe storage project is to remove the fuel and heavy water from Units 2 and 3, and maintain them in safe storage until Units 1 and 4 are permanently shut down, and plant decommissioning activities have begun.

Initially, OPG and CNSC staff believed that all the activities required to place the units in safe storage (i.e., removal of fuel and heavy water) could be performed under the existing operating licence. As a result, OPG did not intend to apply for a different licence for Units 2 and 3 while they are being placed - or while they are - in the safe storage state. In mid-2006, new legal advice indicated that CNSC staff does not have the authority to approve licence amendments for documents referenced in the licence. At about the same time, OPG had informed the CNSC of a number of amendment requests required for the Safe Storage Project, including requesting approval in principal for amendments to the Operating Policies and Principles (OP&Ps).

As per the new legal advice, the CNSC conducted an Environmental Assessment (EA) Determination for the OP&Ps amendment request, in December 2006, and determined that a determination could not be made without a formal EA project description.

CNSC staff formally requested a project description in January 2007. OPG responded in March 2007, and explained why an EA was not required. The CNSC made another request in April 2007. OPG finally submitted the project description in June 2007, but later withdrew it after CNSC staff determined (in August 2007) that an EA was required, and that all work related to safe storage should stop. OPG suspended the safe storage work, but continued to remove fuel from Unit 3 for safety reasons, and was authorized to do so under the existing licence with CNSC approvals/amendments. A revised project description was submitted in December 2007.

1.3.11 Conclusion

During the two-day hearing for the renewal of the Pickering A operating licence, the *Commission Tribunal* requested that CNSC staff present to the *Commission Tribunal* at the approximate midpoint in the licence term, a report on the performance at Pickering A. The report will be presented at a public proceeding of the *Commission Tribunal* and could be part of the CNSC Staff Annual Report on the Canadian Nuclear Power Industry for the year 2006 or 2007.

This mid-term report will address those requests for update made by the *Commission Tribunal* during the hearing as identified in the Transcripts and the Record of Proceedings.

Since the renewal of the Pickering A operating licence in June of 2005, Unit 1 has been returned to service from its long-term lay-up and a decision was made to not restart Units 2 and 3 and place them into a safe storage state.

There has been no *serious process failures* at Pickering A since the renewal of the licence. The most significant incident was the discovery of the problems with the ISTB in June 2007, which resulted in the extended outages of both Units 1 and 4.

Since 2005, there has been a noted decline in the ratings for the implementation of the Program Areas for Organization and Plant Management, Operations, Human Factors, Quality Management and Design. Many of these problems became apparent as a result of the ISTB problems; however those of Organization and Plant Management and Human Factors had been identified before this event.

1.3.11.1 Emergency Preparedness

The *Commission Tribunal* requested to be kept informed of the progress of the installation of sirens in the City of Pickering.

The original design of the warning system had over 20 sirens installed within the City of Pickering. There were objections to the proposed number and locations of these sirens. The City of Pickering commissioned another study and it was determined that four sirens at key locations was adequate for the purposes intended. The four sirens have been installed and are presently being tested.

1.3.11.2 Pickering Airport

The *Commission Tribunal* requested that they be advised of new developments of the proposed Pickering Airport. The “Draft Plan” for the airport showed the airport to be operational by 2012. However, this plan indicated that the Environmental Assessment would be started in 2004 and this study has yet to be started.

The impacts of the proposed airport are addressed in the Environmental Assessment for the Pickering B refurbishment, which will be brought before the *Commission Tribunal* in the fall of 2008.

1.4 PICKERING B

1.4.1 Operating Performance

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

Both the program and implementation of the Operation Performance safety area at Pickering B met the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to safe facility operation in 2007.

1.4.1.1 Organization and Plant Management

There were nine forced outages across the four units in 2007: two due to water treatment plant ion exchange resin excursion, five due to excessive leakage from the heat transport system due to failed components, one due to an algae run and one other due to failure of equipment on the conventional side of the plant.

For some persistent issues, such as SDC pump seal and heat transport valve leakage, the licensee has taken corrective actions, but it may be some time before these corrective actions can be fully implemented and proven effective. Water supply system modifications and increased management oversight of the vendors' operation of the water treatment plant will prevent another resin excursion. Corrective actions have been taken for the electrical system failure and turbine protective system mis-operation, and repeat events are considered unlikely.

The incident involving algae clogging of the intake cooling water system necessitated unit de-ratings, one unit forced outage, and a delayed unit restart. The licensee has taken some corrective actions, including installation of a diversion net by the water intake, as well as improvements in mitigating operating procedures; but these are proving to be of limited effectiveness. Increased algae growth in the lake will continue to challenge plant operations.

There were two planned outages scheduled during the year, both of which were extended due to equipment failures late in the outage. A 40-day extension was added to the planned 132 days of outage time on the two units. In addition, the outage on Unit 7 extended 28 days into 2007, from its start in late 2006.

There were two reactor trips during the year, one manual and one automatic.

Although some deficiencies have been identified in the implementation of Organization and Plant Management, overall, the program and its implementation are rated a "B" for 2007.

1.4.1.2 Operations

CNSC staff assessed Operations from information collected through inspections, review of operations and S-99 reports. CNSC staff conducted a series of field compliance inspections at Pickering B during 2007, during which several minor issues were noted. CNSC staff considered overall housekeeping performance to be acceptable, but noted problems in temporary equipment tagging and non-compliance with seismic route requirements.

Unit 6 was manually tripped from low power due to incorrect shut-off rod indications, which resulted from an incorrect troubleshooting procedure while checking electrical connections.

The Operations program and its implementation have been rated a "B" for 2007.

1.4.1.3 Occupational Health and Safety (Non-radiological)

CNSC staff considers that the accident frequency and severity rates, as reported by OPG during 2007, demonstrated adequate occupational health and safety performance at Pickering B. The Pickering A and B combined value for the "Accident Severity Rate" PI (see Section 2.1.3, Table 16) compares favorably to the industry average. There were no Lost Time Accidents counted against Pickering B in 2007. Overall, the Occupational Health and Safety program and implementation met CNSC performance expectations.

1.4.2 Performance Assurance

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

The Performance Assurance safety area at Pickering B met the objectives of CNSC requirements and performance expectations. The programs under this safety area adequately contributed to safe facility operation in 2007.

Deficiencies were identified within the implementation of the quality management and the human factors programs; however, they were given a "B" rating, and will require additional oversight for the next year.

1.4.2.1 Quality Management

The governing document for the Pickering Quality Management Program is the Ontario Power Generation Nuclear (OPGN) Charter, N-CHAR-AS-0002. A revision (R10) to the Charter was submitted in 2007. CNSC staff concluded that the quality management program as described in the Charter complies with the requirements of CAN/CSA N286.0-92.

Activities related to the engineering change control inspection started in 2006 and continued in 2007. The design records inspected were for modifications that were not yet operational. CNSC staff plans to inspect the fully operational modification design records in 2008. A preliminary finding report for the 2006 inspection was provided to Pickering B staff.

In general, the engineering change control documentation describes a design change process that complies with the requirements of CSA N286.5. However, the documentation lacked the clarity needed to ensure the consistent control of modifications. The analysis of the engineering change control inspection findings from December 2006 is currently ongoing; the final inspection report is to be issued in 2008.

In 2007, events reported under Regulatory Standard S-99, identified issues regarding the non-adherence to OPG documentation regarding work control, verification, change control, maintenance, and configuration management. CNSC staff analysis of the events concluded they did not represent an unreasonable risk to the safe operation of the facility.

In general, the Quality Management program and its implementation at Pickering B are both assessed as “B” for 2007.

1.4.2.2 Human Factors

CNSC staff conducted an inspection and review of the engineering change control process. The review indicated that some design packages were incomplete or lacking in proper documentation and signatures.

A Human Reliability Analysis was conducted during 2007, as part of the Probabilistic Risk Analysis. The preliminary report indicated that there were a number of human reliability issues that required further resolution.

The reportable events at Pickering B were assessed for 2006 and the first 10 months of 2007, to determine whether there were any trends in event types, in the area of Human Factors, and specifically with respect to organizational behaviors. CNSC staff has found that event types were approximately the same for both years. Particular areas of concern include Attention to Safety, Formalization of Processes and Procedures, Performance Quality, Communication, and Training. The Roles and Responsibilities of staff as well as Organizational Learning raised some concerns with CNSC staff that the site is not learning from its past experience and the experience of other external sources.

Based on compliance activities carried out in 2007, Pickering B meets CNSC requirements for their Human Factors Program and its implementation.

1.4.2.3 Training, Examination and Certification

During this reporting period, the success rate on certification examinations at Pickering B was acceptable.

As a prerequisite for the CNSC project to transfer certification examinations to licensees, licensees must have a sufficient number of examiners who meet the qualification requirements specified in the relevant regulatory documents. CNSC staff requested OPG to provide the proposed process used to ensure the examiners' qualifications to administer certification examinations. CNSC staff is currently reviewing OPG's process.

CNSC staff performed follow-up activities to review the results of the licensee's progress in resolving the deficiencies identified in pre-2007 training program evaluations supporting Examination Transfer to the licensees. Pickering B has made good progress in resolving these deficiencies. All the actions were completed by the end of 2007, and CNSC staff is reviewing them. In early 2008, Pickering B submitted requests for closure on all training program evaluations to support transfer of certification examinations to the licensees. CNSC staff has reviewed the evidence provided and found it to be acceptable. CNSC staff will be issuing evaluation close-out letters by May 31, 2008.

CNSC staff is reviewing the revised OPG Program Document "Training," N-PROG-TR-0005. This document governs all of the OPG nuclear generating stations. A review report will be issued early in 2008. CNSC staff is concerned about the implications of the concept of non-task limiting training qualifications, introduced in the latest revision of this high-level program document.

CNSC staff judges that the implementation of the OPG training processes and procedures, as presented in the training governing documents, remains adequate.

Although the evaluations identified some deficiencies, based on the supporting data for the period, the Training, Examination and Certification program and its implementation continued to meet CNSC requirements and performance expectations in 2007.

1.4.3 Design and Analysis

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

Both the program and implementation of the Design and Analysis safety area at Pickering B met the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to safe facility operation in 2007. CNSC staff reviews, which included a review of the work performed towards a plant-specific probabilistic risk assessment, concluded that the licensee continued to provide acceptable safety analyses and responses to new design and safety issues.

1.4.3.1 Safety Analysis

In 2007, OPG submitted Pickering B Risk Assessment Revision 2 to the CNSC for a detailed review. This review is under way and its results will demonstrate whether Pickering B fully complies with requirements of Regulatory Standard S-294 *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*.

A number of concerns in the Safety Analysis program area at Pickering B have been raised over the past year or continue from previous years. These concerns are related to issues in the following areas:

- Shutdown Systems Effectiveness – Large Break Loss of Coolant Accident Safety Margins
- Impact of Plant Aging on Trip Coverage
- The discrepancy in the 28-Element Fuel String Core Heat Flux Experiments and its impact on safety.
- *Safety Report* Update

CNSC staff rates the Safety Analysis program and its implementation at Pickering B as "B – Meets Requirements". However, based on the issues mentioned above, staff considers the trend for the implementation to be "deteriorating".

1.4.3.2 Safety Issues

CNSC staff reviewed the progress made by the CANDU industry and utilities to resolve the GAIs. OPG continued its work, including participation in industry efforts, towards the resolution of the GAIs and overall progress was judged satisfactory. A brief description and the expected completion date of each GAI are provided in Appendix F, Table F.1.

1.4.3.3 Design

CNSC staff rates the Design program area as a "B" for both the program and implementation at Pickering B. The implementation of this program had previously been rated as a "C" since 2003.

During the past year, OPG has completed the installation of the Auxiliary Power Supply (APS) that can supply power to the units in the event of a loss of grid. This power supply will allow the Pickering B units to be cooled down upon loss of Class IV power. The inability to cool down was the primary reason for the previous "C" rating. CNSC staff reviewed the design of the APS and provided comments to OPG. OPG has resolved all comments except for the provision of fire water to the APS units during a Loss of Bulk

Electrical System (LOBES) event, and routine testing of APS units to demonstrate the load pick-up capability of APS units. CNSC staff and OPG are discussing a path forward to resolve these remaining points.

CNSC staff found a weakness in the fire protection design program, as the development of some documents and program sub-elements are incomplete. These issues are not considered to present an unreasonable risk to persons and the environment from fires at the facility. The licensee has provided an action plan to address the deficiencies in program documentation, and the plan is considered to be acceptable by CNSC staff.

The ISR for evaluating the feasibility and scope for the life extension of Pickering B includes a detailed Safety Factor Report on "Plant Design". This OPG report reviews the existing plant against modern codes and standards. OPG will disposition the gaps identified from the review, and will apply these findings to the operation of Pickering B where necessary.

1.4.4 Equipment Fitness for Service

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

Both the program and the implementation of the Equipment Fitness for Service safety area, at Pickering B, met the objectives of CNSC requirements and performance expectations in 2007.

The maintenance program, which received a "C" for implementation in 2006, has been upgraded to a "B" in 2007.

1.4.4.1 Maintenance

An excessive number of maintenance backlogs have posed a challenge for Pickering B for several years, and the implementation of this program was previously rated as "C" for this reason.

The corrective maintenance backlog met its target of 25 work orders per unit by the end of 2007. Corrective maintenance backlogs are the most important type. The elective maintenance backlog still remains above its target.

CNSC staff is satisfied with the reduction in the backlogs and therefore rates the Maintenance program and its implementation as "B" in 2007.

1.4.4.2 Structural Integrity

OPG obtained certificates of authorization for pressure boundary work several years ago, and has been working towards updating its procedures to the latest revision of CSA N285.0-06, before submitting a request for licence amendment.

Quarterly Reports on Degradation of Pickering B Plant Pressure Boundaries were submitted on a regular basis; therefore OPG has met the reporting requirements for 2007. OPG developed and implemented structural integrity programs for all safety significant SSCs, as well as improvements plans to keep OPG programs and practices up-to-date with best industry practices. CNSC staff rates the Structural Integrity program at Pickering B as "B- meets requirements". OPG has made some improvements in their plans and practices in comparison to previous licensing periods.

Cracking and leakage of the stainless steel intergasket leak-off lines for the upper manways of the Unit 5 *steam generators* were discovered during the Unit 5 restart following a planned outage. All of the leak-off lines on Unit 5 were replaced and inspection of the lines for the remaining Pickering B units is planned for the next outage for each unit. Pinhole leaks and cracks were discovered in Pickering B secondary side piping, but the consequences were minimal. Acceptable performance was demonstrated during the pressure relief device set point tests.

The programs called "Certificate of Authorization", addressing repair and alteration and new fabrication, are in place and working as anticipated. Implementation of these programs suggests an improving trend in pressure boundary integrate.

In 2007, OPG performed the in-service inspection of the CSA N285.5 containment components for Units 5-8. In general, the inspection reports submitted by OPG met the requirements of CSA N285.5. In addition, OPG submitted the updated Pickering B PIP to CNSC staff for review and staff found that update program acceptable. OPG has made some improvements in their plans and practices in comparison to the previous licensing period. Based on the information provided above, CNSC staff rates the implementation of the Structural Integrity program at Pickering B as "B".

1.4.4.3 Reliability

In 2006, Pickering B submitted its reliability program, developed in accordance with the industry approach, to the CNSC. CNSC staff considers the industry approach to be generally acceptable, although some generic issues still need to be resolved. CNSC staff continues to work with the industry to resolve these remaining generic issues. Overall, CNSC staff considers the reliability program at Pickering B to be acceptable.

During 2007, there were three impairments on the ECC, with Actual and Operational Past Unavailability assigned to them. Inspections held at Pickering B during the year did not identify any major issue that would adversely impact the long-term plant systems reliability. CNSC staff considers the Pickering B reliability program and its

implementation to be acceptable and will continue to monitor OPG's performance in this area so as to ensure sustained improvement.

1.4.4.4 Equipment Qualification

The Steam Reject Valves (SRVs) are not environmentally qualified to be operated from the Main Control Room during powerhouse harsh environment events. SRV operations from the Main Control Room require the availability of both unit instrument air supply to the SRVs, and class II power. As per the *Environmental Qualification* (EQ) Design Guide, instrument air compressors and associated class II power are not formally environmentally qualified. The SRVs have environmentally qualified backup air supply reservoirs. These air reservoirs are normally isolated from the normal instrument air supply but can support SRV operation from the Unit Emergency Control Centre only.

OPG is currently assessing the thermal hydraulic impact of delayed operation of SRVs from the Unit Emergency Control Centre. OPG is also performing analyses to evaluate the potential qualification of the SRV group I controls. CNSC staff is following up this issue.

A station condition record (SCR) was raised to account for Industry Operation Experience (OPEX) from Pickering A, with regard to potential harsh environment in the reactor auxiliary bay caused by a steam line break above the reactor auxiliary bay roof. The SCR impacts on the steam barrier program, but initial reviews indicated no impact to EQ program. Further analysis is underway to explicitly assess steam barrier and environmental conditions in the reactor auxiliary bay. CNSC staff is following up this issue.

Overall, the Equipment Qualification program and its implementation met CNSC requirements in 2007.

1.4.5 Emergency Preparedness

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

A *Type II inspection* was conducted at Pickering A and B during November 2007, concluding that "within the scope of the inspection, Pickering has demonstrated its ability to effectively respond to and manage an emergency". Pickering A and Pickering B share corporate resources for emergency response.

Pickering B continued to meet all regulatory requirements for emergency preparedness and response capability. Consistent with the previous industry report, no unreasonable risk to the effectiveness of the emergency response capability was determined. The Pickering B Emergency Preparedness program and its implementation continued to exceed expectations.

1.4.6 Environmental Protection

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

The Environmental Protection program at Pickering B and its implementation met the objectives of CNSC requirements and performance expectations in 2007.

Both airborne emissions and liquid releases of nuclear substances to the environment were less than 1% of the *derived release limit* for Pickering B. There were no reports of environmental action levels being exceeded. In 2007, the reported dose to the public was 2.6 µSv for the Pickering site (A and B).

There were no reported unplanned releases of nuclear substances or hazardous substances from Pickering B in 2007 that posed a significant risk to the environment.

CNSC staff conducted a *Type I inspection* of the OPG nuclear environmental management system in 2006, and no major issues were identified. Nine action notices were issued and OPG has committed to resolve them by the end of September 2008.

1.4.7 Radiation Protection

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

In 2007, the Radiation Protection program and its implementation at Pickering B continued to meet the objectives of CNSC requirements and performance expectations.

An action level was exceeded in 2007, when a person alarmed a portal monitor at the Main Security Building. Actions were taken by the licensee to increase the effectiveness of the detection of contamination and coaching was also provided to the person involved to prevent future reoccurrences.

A *Type 1 inspection* carried out in April/May 2005 resulted in twelve action notices, four of which remain open. The outstanding issues relate to procedural compliance, contamination surveying, neutron dosimetry reporting, respiratory protection and medical surveillance. CNSC staff continues to oversee the licensee's efforts to work towards the closure of these items.

The licensee has a number of future improvements to their radiation protection program, including an ALARA plan for long term dose reduction initiatives.

Table 5 provides a five-year trend (2003-2007) of annual doses to workers at Pickering B.

Table 5 Annual Dose at Pickering B

Year	Collective Dose - Routine Operations [1] (person-mSv)	Collective Dose - Outages (person-mSv)	Total Collective Internal Dose (person-mSv)	Total Collective External Dose (person-mSv)	Total Collective Effective Dose (person-mSv)
2003	1,041	2,469	1,096	2,414	3,510
2004	1,326	3,914	1,376	3,864	5,240
2005	830	5,610	1,176	5,264	6,440
2006	1,238	3,602	1,048	3,792	4,840
2007	929	2,795	752	2,972	3,724

Note 1: The collective dose due to forced outages was less than 10 mSv in total, and is included in the Routine Operations dose.

The collective internal dose has decreased since 2004. This reduction can be partially attributed to several airborne tritium exposure reduction initiatives. In 2007, there was a significant improvement in dose management at the station. The total collective effective dose has improved by a factor of more 2.3 since 2005.

1.4.8 Site Security

The assessment of the Site Security safety area for Pickering A and B is documented in a separate (secret) *Commission Member Document* (CMD 08-M37.A).

1.4.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Pickering B	SAFEGUARDS	B	B

In 2007, the *safeguards* program at Pickering B continued to meet all *safeguards* requirements and CNSC performance expectations.

No major *safeguards* events occurred in 2007; however, a loss of power to the overhead lights in Irradiated Fuel Bay-B and a loss of power to installed *safeguards* equipment for Unit 5 were reported under the S-99 framework.

The licensee has developed and continues to maintain satisfactory documentation for the *safeguards* program. Pickering B staff was also actively involved, throughout 2007, in a series of trilateral meetings with other power reactor licensees, the IAEA and the CNSC, in order to develop a new State-level integrated *safeguards* approach for all CANDU sites. The full implementation of this new approach is expected to be attained at Pickering B in 2008. The licensee has also provided, on a timely basis, all the reports and information necessary for *safeguards* implementation, and has complied fully with IAEA and CNSC requirements.

No compliance issues were identified during a scheduled physical inventory verification conducted by the IAEA in 2007. CNSC staff attended this inspection. All quarterly IAEA interim inventory verifications were replaced in 2007 by short-notice randomized inspections under a new *safeguards* approach. IAEA inspectors also attended scheduled transfers of spent fuel to dry storage on an unannounced and randomized basis.

1.4.10 Update on Other Major Projects and Initiatives

1.4.10.1 Refurbishment

Pickering B has operated continuously since 1983. Mid-life *pressure tube* refurbishment is an element of CANDU plant design, and assumed to be required at some point in the life of the plant, generally after 25 to 30 years of operation.

OPG initially informed the CNSC of its intent to refurbish Pickering B in 2005. Since then the OPG Board of Directors has approved a project to undertake a study for the life extension of the Pickering B reactors. This includes an EA and an ISR. The results of the EA studies and the ISR will make an important contribution to OPG's decision on whether to refurbish the Pickering B units. The results of the ISR and the EA study may be incorporated in future licences for the continued operation of Pickering B after refurbishment.

1.4.10.1.1 Environmental Assessment (EA)

In June 2006, OPG submitted a project description for the refurbishment of the units at Pickering B. CNSC staff reviewed this project description and determined that it was acceptable and that the content was sufficient to enable a determination on the application of the *Canadian Environmental Assessment Act*. At that time, it was decided that a screening-level EA was appropriate for this project. Consequently, CNSC staff has prepared draft EA guidelines that were issued for review by public and federal authorities. The draft guidelines and comments from these reviews were dispositioned in CMD 07-H2. The draft EA guidelines were approved by the *Commission Tribunal* on April 13, 2007.

In accordance with the draft EA Guidelines, OPG has submitted its proposed valued ecosystem components, criteria for evaluating significance of environmental effects, public involvement program, and bounding malfunctions and accidents, which must be accepted by the CNSC in accordance with the EA guidelines. All but the bounding malfunctions and accidents were accepted on May 16, 2007 by CNSC staff. OPG was requested to include an additional accident in the bounding malfunctions and accidents.

The final EA Study Report was submitted by OPG on December 17, 2007 for detailed review and comment by CNSC staff and Federal and Provincial Authorities. In 2008, OPG will receive CNSC staff comments on the final EA Study Report. These comments must be dispositioned by OPG to the satisfaction of CNSC staff. CNSC staff will then prepare the draft EA Screening Report, which is expected to include a 30-day review period in May/June 2008, coupled with a public EA Information Session. CNSC staff

tentatively plan to revise the EA Screening Report and submit it to the *Commission Tribunal* for a hearing date in late September 2008.

1.4.10.1.2 Integrated Safety Review (ISR)

OPG is conducting the ISR in accordance with CNSC Regulatory Document, RD-360 *Life Extension of Nuclear Power Plants*, which states that the objectives of an ISR are to determine:

- The extent to which the plant conforms to modern standards and practices;
- The extent to which the licensing basis will remain valid over the proposed operating life;
- The adequacy of the arrangements that are in place to maintain plant safety for long-term operation; and
- The improvements to be implemented to resolve safety issues that have been identified.

In accordance with RD-360, OPG is expected to prepare an ISR Basis Document, which sets out the scope and methodology for the conduct of the ISR. OPG submitted the ISR Basis as a procedure in July 2007. CNSC staff provided final comments on the procedure in September 2007, indicating that the ISR Basis will be acceptable for the Pickering B ISR following the incorporation of final comments. It is anticipated that OPG will submit revision 1 of the procedure early in 2008, for CNSC acceptance.

CNSC staff accepted the Benefit-Cost Analysis process submitted by OPG. This is an integral part of the Risk-informed Decision-making process used to determine the corrective actions and safety improvements to address the shortcomings identified in the ISR.

The Pickering B Risk Assessment (PBRA) is a tool to support Benefit-Cost Analysis, and is a key tool for identifying limiting accidents and malfunctions. The preliminary review of Revision 1 of the PBRA was completed in August 2007. The review identified a number of methodology issues that make it difficult to review and use for some applications. As a result, CNSC staff may require a longer period of time to review submissions that are based on information presented in the PBRA. OPG has subsequently submitted Revision 2 of the PBRA. CNSC staff expects to complete the final review report by January 31, 2009.

The ISR includes a review of 17 safety factors, which are documented in twelve reports. At the end of 2007 one report was not yet submitted. Two reports were being rewritten to address CNSC comments and three reports have been accepted and one report has been conditionally accepted. Two other reports are expected to be accepted in early 2008. The review of these reports is expected to continue well into to 2008. OPG plans to submit the final ISR Report and Global Assessment in early 2009. In addition, OPG is expected to get a decision on the life extension of the Pickering B units from their board in the same time frame. It is planned that all the discrepancies found during the ISR review will be resolved by March 2009. This will be followed by OPG's submission of the final Integrated Implementation Plan, which will include the results from the ISR and the EA.

A licence amendment will incorporate improvements required prior to the start of refurbishment work in 2014.

1.5 GENTILLY-2

1.5.1 Operating Performance

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

Both the program and the implementation of the Operating Performance safety area met the objectives of CNSC requirements and performance expectations in 2007. The programs under this safety area contributed adequately to safe facility operation.

An unplanned outage, between November 2, 2007 and January 30, 2008, was initiated when a fuelling machine became jammed on a fuel channel. During the outage, considerable work was completed on SDS 1, SDS 2, the containment system, the emergency core cooling system, the fuelling machines and heat exchanger 3211-HX11. Damage to this heat exchanger was discovered during the outage after pieces of foreign material were found flowing freely in the moderator system. The maintenance work lasted throughout the outage and was performed in a safe manner.

In 2007, Gentilly-2 underwent a change in the plant management organization, with the appointment of a new plant manager. Hydro-Québec also initiated a reorganization of one of its divisions to take over the responsibility of the fuelling machine systems engineering work.

1.5.1.1 Organization and Plant Management

There were no *serious process failures* at Gentilly-2 in 2007; therefore this area was not assessed. Also in 2007, there were no program evaluations in the areas of global program integration, plant status and material condition, and public information.

An evaluation of Hydro-Québec's financial guarantee was completed by comparing it against the expectations in CNSC regulatory guide G-206 *Financial Guarantees for the Decommissioning of Licensed Activities*. CNSC staff concluded that while the financial guarantee generally meets most expectations, some aspects need to be revised or clarified before it can be recommended for acceptance.

In 2006, an inspection of the emergency power supply revealed weaknesses with the seismic qualification of several components. Hydro-Québec submitted a corrective action plan, which has been reviewed and accepted by CNSC staff. This issue is on-going and follow-up actions are carried out on a regular basis.

The results of inspections and event reviews prompted follow-up on some aspects of implementation in the areas of global program integration and plant status and material condition. No major issues were identified. Twelve *Type II inspections* were completed by CNSC site staff at Gentilly-2 in 2007, and no major deficiencies were found.

CNSC staff considers the implementation of the Organization and Plant Management program to be acceptable.

1.5.1.2 Operations

CNSC staff concludes that Hydro-Québec's Operations program met requirements in 2007.

Overall, CNSC staff also concludes that Hydro-Québec's performance in implementing station operations was acceptable. Based on the references and documents gathered, staff found that Hydro-Québec met expectations in the areas of configuration management, outage management and internal operator certification process. However, some weaknesses were noted in the areas of procedural adherence and communications.

1.5.1.3 Occupational Health and Safety (Non-radiological)

In CMD 06-H15 of August 16, 2006, on the renewal of the operating licence for Gentilly-2, CNSC staff concluded that the Occupational Health and Safety program met regulatory expectations. Since then, no program evaluation has been conducted.

Overall, CNSC inspectors considered Hydro-Québec's performance to be acceptable in 2007. Hydro-Québec regards this program seriously; its committees routinely review relevant statistics as well as specific accidents. For example, based on statistics about hand wounds, wearing gloves is now mandatory for workers in the field.

During three quarters of 2007, the performance indicator "Accident Severity Rate" was higher than the historical average. From observations made in the field, conformity with the requirements on the wearing of personal protective equipment was satisfactory, but there were some exceptions. While most of these exceptions were relatively minor in nature, the cumulated effect of these exceptions and the high value of the performance indicator "Accident Severity Rate" are precursors of more serious accidents. Hydro-Québec is aware of the need for closer monitoring of the implementation of its Occupational Health and Safety program.

1.5.2 Performance Assurance

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

Both the program and implementation of the Performance Assurance safety area at Gentilly-2 met the objectives of CNSC requirements and performance expectations, and the programs under this safety area contributed adequately to safe facility operation. However, a lack of rigor in resolving corrective action matters related to the Quality Management program diminishes the positive results achieved in the other programs. The licensee needs to resolve the shortcomings of the Quality Management program implementation.

1.5.2.1 Quality Management

The Quality Management (QM) program documentation at Gentilly-2 is still in a transition phase, awaiting the integration of two levels from the old documentation structure. Gentilly-2 staff has developed some new documents. However, some documents referenced in the new documentation do not yet exist. CNSC staff will continue to review the QM documents and the links between them. Overall, the documentation related to this program met the requirements of the relevant standards.

During follow-up inspections conducted in 2007, CNSC staff found that corrective actions initiated following previous inspections had not been properly managed by Hydro-Québec. The corrective actions that were still open had been raised following evaluations of the management of self-assessments, the corrective action process, and the evaluation of the performance of suppliers, held in 2004, 2005, and 2006 respectively. CNSC staff concluded that not completing the corrective actions within the time allocated is an issue that presents a moderate risk to the adequate implementation of the QM program. CNSC staff also completed an evaluation of the change control management process which revealed some non-compliances as well as difficulties in controlling and managing the number of changes currently in progress.

CNSC staff considers that the corrective actions initiated in previous years and not yet fully implemented, as well as the non-compliances identified in 2007, are weaknesses of the QM program implementation. Therefore, CNSC staff concludes that the implementation of the QM program did not meet regulatory requirements in 2007.

1.5.2.2 Human factors

Both the Human Factors program at Gentilly-2 and its implementation continued to meet CNSC staff's expectations in 2007.

At Gentilly-2, the human factors procedures are sufficiently well documented to allow skilled personnel to implement them adequately.

In 2007, CNSC staff performed a focused review of the detailed event reports submitted in accordance with regulatory standard S-99. Weaknesses were identified in the application of the event analysis method used to identify human root causes. It is important to note that these weaknesses had already been identified through the compliance program, part of QM, and are being dealt with by the licensee as part of its corrective action plan.

A safety culture self-assessment was conducted at Gentilly-2 in 2007. This is a positive demonstration of the nuclear industry's growing interest in evaluating and maintaining a positive safety culture.

1.5.2.3 Training, Examination and Certification

Licensee staff in safety-critical positions must undergo CNSC knowledge-based and performance-based examinations to assess their competence prior to CNSC certification. After CNSC certification, licensees conduct knowledge-based and performance-based requalification examinations to ensure that certified staff retains the necessary knowledge and skills to safely perform their duties. During the reporting period, the success rate in certification examinations at Gentilly-2 was satisfactory.

Based on the success of the training program for non-certified staff and on the availability of an approved corrective action plan to correct the weaknesses of the training program for certified staff, the implementation of this program meets CNSC expectations. Some corrective actions have been modified to take into account the results of evaluations conducted previously by the CNSC. Other action notices were closed after CNSC staff determined that the implementation of the related corrective actions was satisfactory. Completion of the remaining corrective actions is a prerequisite for the transfer of the certification examinations to the licensee.

Based on the compliance data gathered during the reporting period, CNSC staff concludes that the Training, Examination and Certification program and its implementation met expectations.

1.5.3 Design and Analysis

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

Both the program and implementation of the Design and Analysis safety area at Gentilly-2 met the objectives of CNSC requirements and performance expectations. The programs under this safety area contributed to safe facility operation.

1.5.3.1 Safety Analysis

The CNSC is satisfied with the Safety Analysis program at Gentilly-2, because it is based on a requirement to comply with the most recent quality assurance standards in this area. Staff's evaluation confirmed that, in general, Hydro-Québec has an adequate safety analysis program in place to support ongoing safe operation at the station.

Overall, CNSC staff is also satisfied that the implementation of the Safety Analysis program at Gentilly-2, is able to confirm that appropriate safety margins are being maintained. CNSC staff will closely monitor how Hydro-Québec implements the required quality assurance standards in future safety analyses and their potential impact on the current safety margins.

1.5.3.2 Safety Issues

Hydro-Québec cooperated with other utilities and organizations of the nuclear industry on research programs specifically designed to resolve GAIs. Closure of GAI 99G01 for Gentilly-2 is expected in early 2008.

CNSC staff concludes that the Safety Issues program as a whole and its implementation meet expectations.

A brief description and the expected completion date of each GAI are provided in Appendix F, Table F.1.

1.5.3.3 Design

With the exception of some shortcomings in the area of fire protection, which is a sub-program of Design, CNSC staff considers that, overall, the Design program at Gentilly-2 met CNSC expectations in 2007.

Based on reviews and evaluations, CNSC staff has concluded that the fire protection program is still incomplete. For the time being, however, these issues are not considered to present an unreasonable risk to persons or the environment.

ECC design issues were identified in 2002. Contrary to other NPPs (e.g. Point Lepreau), Gentilly-2 does not have automatic transfer from the medium pressure phase to the low pressure phase. However, an agreement was reached that the automatic transfer function would be added during the refurbishment of the plant, originally planned for 2007. The CNSC granted an authorization to Hydro-Québec which allowed them to delay this modification until then. Plant refurbishment is now planned for 2011, and this modification of the ECC has not yet been completed. In December 2007, CNSC staff raised this issue during discussions with Hydro-Québec staff. In addition, in order to

prevent a failure of the low pressure ECC if either PV 10 or PV 11 fails; there is a need to add two valves to the ECC system, in series with PV10 and PV11. Hydro-Québec has committed to resolve these issues. The valves are due to be installed during the planned outage in 2009.

Notwithstanding the deficiencies in the area of fire protection, which represent only one area of the design program, CNSC staff considers the implementation of the Design program at Gentilly-2 to have met the expectations of the CNSC in 2007.

1.5.4 Equipment Fitness for Service

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

The program and the implementation of the Equipment Fitness for Service safety area at Gentilly-2 met the objectives of the CNSC requirements and performance expectations. The programs under the safety area contributed to safe facility operation in 2007.

1.5.4.1 Maintenance

The Maintenance program at Gentilly-2 is supported by a significant organization with well established goals. The policies, processes and procedures in place at Gentilly-2 provide direction and support for the Maintenance program. The program meets requirements.

In addition, although inspections have shown that priority setting and timely work completion continue to be a challenge at Gentilly-2, CNSC staff concludes that the implementation of the Maintenance program at Gentilly-2 meets CNSC expectations.

1.5.4.2 Structural Integrity

The quality assurance programs related to pressure limits and their implementation procedures are in place at Gentilly-2. The scope and the schedule of the in-service inspections are based on the most recent revision of Hydro-Québec's Periodic Inspection Program as well as the fuel channel aging and life cycle management plans. CNSC staff is satisfied with the principles followed in these plans and the documentation. Furthermore, Hydro-Québec made progress in documenting the *steam generators* program.

The fuel sheaths and the *steam generators* were not inspected at Gentilly-2 in 2007. However, CNSC staff is satisfied with the proactive approach followed so far by Hydro-

Québec in preparation for the planned outage of April 2008, and with its inspection activities.

CNSC staff concludes that the systems and equipment Structural Integrity program and its implementation meets CNSC expectations.

1.5.4.3 Reliability

Hydro-Québec submitted a Reliability Program for Gentilly-2 in 2006, as required by regulatory standard S-98. This program was developed in accordance with the industry approach. In 2007, Hydro-Québec continued to meet the requirements of the standard S-98 at Gentilly-2, such as developing reliability models for all systems important to safety.

A follow-up inspection of the process for collecting and processing reliability data was conducted and showed that significant progress had been made in procedure development and data collection.

In general, Hydro-Québec's Reliability Program is well planned and maintained. The performance of systems important to safety met the regulatory objectives in 2007. Appropriate reports on the state of plant reliability were prepared at Gentilly-2.

Overall, the Reliability program at Gentilly-2 and its implementation met CNSC expectations in 2007.

1.5.4.4 Equipment Qualification

A *Type I inspection* of the Equipment Qualification program was conducted at the end of 2006. The results of this inspection showed that this program is adequate and firmly in place at Gentilly-2 and that it meets the CNSC staff's expectations.

The implementation of the Equipment Qualification program is in progress and requires some minor corrections before fully achieving its objectives. The 2006 inspection revealed some weaknesses that were dealt with by Hydro-Québec in the action plan it submitted to the CNSC at the end of 2007. These weaknesses do not affect the integrity of the Equipment Qualification program at Gentilly-2 and, for this reason, the implementation of this program continued to meet regulatory requirements in 2007.

1.5.5 Emergency Preparedness

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

CNSC staff has reviewed the reports submitted in accordance with regulatory standard S-99, but there were no significant findings. In 2007, no reportable event had a significant impact on Hydro-Québec's emergency response program.

Hydro-Québec's Emergency Response Plan was initiated several times in 2007; however, none of the incidents had an impact on plant safety. All incidents were corrected within a suitable timeframe, with no significant impact on the emergency response program.

CNSC staff had planned to conduct a *Type I inspection* of the emergency exercise DERAD 2007. However, operational constraints and an unforeseen problem with a fuelling machine forced the exercise to be postponed until March 2008.

CNSC requirements and expectations with respect to emergency preparedness and response continued to be met at Gentilly-2. No unreasonable risks to the emergency response capability were noted or reported. As a result, there is no change in the overall grading for Gentilly-2. The program retains an "A" rating and implementation continues to receive a "B" rating for 2007.

1.5.6 Environmental Protection

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

The Environmental Protection program and its implementation at Gentilly-2 met the objectives of CNSC requirements and performance expectations in 2007. Both airborne and liquid releases were less than 1% of the *derived release limits* (DRLs) for Gentilly-2. The estimated dose to the critical group in 2007 was 0.89 µSv, which is well below the regulatory limit of 1000 µSv.

In addition, the physical and chemical parameters meet the provincial requirements. Changes to the enforcement measures have been defined and put in place.

With respect to unplanned released, there were a few minor releases reported, however these did not have any impact on the public or the environment.

1.5.7 Radiation Protection

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

In 2007, there were no radiation exposures that exceeded regulatory limits. Over the last five years, there has been a decrease in both the internal and external collective dose at Gentilly-2. This decrease can be attributed to radiation protection improvement initiatives.

The following table gives a summary of the annual doses to the workers at Gentilly-2 from 2003 to 2007.

Table 6: Annual Dose at Gentilly-2

Year	Collective dose during normal operations (person-mSv)*	Estimated collective dose during outages (person-mSv)	Total collective internal dose (person-mSv)	Total collective external dose (person-mSv)	Total collective effective dose (person-mSv)
2003	379	2,645	355	2,669	3,024
2004	190	58	81	167	248
2005	315	1,233	268	1,280	1,548
2006	322	904	198	1,028	1,226
2007	163	487	115	535	650

** Total collective effective dose minus the estimated collective dose*

No incidents resulting in a reportable dose in excess of the licensee's action levels were observed.

The licensee has planned to make further improvements to the radiation protection program, including initiatives to reduce doses. Through regular compliance inspections, CNSC staff will monitor Hydro-Québec's progress in implementing these improvements.

The Radiation Protection program and its implementation at Gentilly-2 continued to meet the objectives of CNSC requirements and performance expectations in 2007.

1.5.8 Site Security

The assessment of the Site Security safety area for Gentilly-2 is documented in a separate (secret) *Commission Member Document* (CMD 08-M37.A).

1.5.9 Safeguards

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

The Gentilly-2 Safeguards program and its implementation continued to meet all requirements and CNSC performance expectations in 2007.

No major *safeguards* events occurred in 2007, however, in accordance with regulatory standard S-99, an event report was submitted because a report on fissionable and fertile substances was not submitted on time.

The licensee has developed and continues to maintain adequate documentation for their *safeguards* program. Gentilly-2 and CNSC staff met in June 2007, to discuss the development of a new safeguards integrated approach at the national level. A partial implementation of this new approach is planned for 2008. In addition, the licensee has submitted on a regular basis, all reports and information required to fulfil *safeguard* obligations and has fully complied with all CNSC and IAEA requirements.

The IAEA conducted four scheduled *safeguards* inspections in 2007. CNSC staff monitored one of the inspections and no non-compliances were identified. The IAEA inspectors also witnessed all spent fuel transfers to the dry storage cask.

1.5.10 Update on Other Major Projects and Initiatives

1.5.10.1 Gentilly-2 Solid Radioactive Waste Management Facility

Hydro-Québec is currently working to complete phase I of the Solid Radioactive Waste Management Facility (SRWMF) project, which includes the construction of fifteen low and medium-level radioactive waste storage areas and two other areas to store used filters from plant systems, as well as the installation of a portal crane. Phase I construction work will be completed in August 2008.

The necessary approvals for the construction were granted by the CNSC in April 2007, and by the Québec government in August 2007. The commissioning of the SRWMF is planned for 2008.

1.6 POINT LEPREAU

1.6.1 Operating Performance

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

Both the program and implementation of the Operating Performance Safety area at the Point Lepreau Generating Station (PLGS) met the objectives of CNSC requirements and performance expectations and contributed to the achievement of safe facility operation in 2007.

1.6.1.1 Organization and Plant Management

There were no *serious process failures* at PLGS in 2007. The station experienced two reportable activation(s) of a shutdown system in 2007. The station was shutdown unexpectedly on September 24, 2007 when an erroneous Liquid Zone Control System level indication upset caused a bank of adjuster rods to drive out of the reactor core. A second unrelated station shutdown occurred on November 16, 2007 when a shutdown system channel spuriously actuated while another shutdown system channel was undergoing routine maintenance.

New Brunswick Power Nuclear (NBPN) implemented changes to the management organization in 2007. A new Site Director was assigned in 2007, to oversee the establishment of the required infrastructure for the refurbishment project. The position of Director of Engineering was eliminated and the incumbent was reassigned to the position of Deputy Chief Nuclear Officer, whose duties include long-term planning and strategy. The responsibilities of Design Authority, which were part of the Director of Engineering position, were reassigned to the Technical Manager.

The financial guarantees provided by NBPN were considered to be adequate. The various programs established by NBPN to manage its activities were adequately integrated.

1.6.1.2 Operations

CNSC site staff conducted 19 field and 10 main control room inspections during 2007. Other daily activities, which included the review of station logs and other station records, attendance at various planning, production, and technical meetings, as well as extensive walk-downs, were also completed during 2007. There were no major findings. All minor findings were reported to NBPN staff for correction.

CNSC site staff also conducted *Type II inspections* on specific topics during 2007. The planned maintenance outage, the forced outage, and the fuel management programs were subject to this type of inspection.

Based on the results of these compliance activities, CNSC staff concludes NBPN met CNSC requirements in 2007.

1.6.1.3 Occupational Health and Safety (Non-radiological)

A safety fair was held at the PLGS on March 27, 2007, just before the beginning of the planned maintenance outage. The NBPN President and CEO, the Vice-President Nuclear, and the Local Union Leader used this opportunity to encourage station staff to continue applying a questioning attitude during the outage in order to maintain workplace safety. The safety fair also included safety equipment demonstrations, a demonstration of a plant shutdown in the simulator, and several safety information booths.

In 2007, PLGS's accident severity rate was 0.56 days lost per 200,000 person hours. This value compared favourably to the industry average of 0.91 days lost per 200,000 person hours (see Section 2.1.3, Table 16). PLGS's accident frequency rate of 0.80 disabling injuries per 200,000 person-hours was above the industry average of 0.20 disabling injuries per 200,000 person-hours.

Overall, the Occupational Health and Safety program and its implementation met CNSC performance expectations.

1.6.2 Performance Assurance

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

Both the program and implementation of the Performance Assurance safety area at PLGS met the objectives of CNSC requirements and performance expectations, and contributed adequately to safe facility operation in 2007.

1.6.2.1 Quality Management

In January 2007, NBPN completed implementation of the corrective action plan required to address deficiencies identified during a 2005 *Type I inspection* of the station process change control program. CNSC staff reviewed the update report and confirmed the adequacy of the measures implemented by NBPN.

CNSC staff conducted a follow-up inspection to a 2006 *Type I inspection* of the NBPN supplier performance evaluations. The follow-up inspection, conducted in 2007, confirmed that NBPN is implementing the corrective actions required to address the deficiencies identified in the 2006 inspection.

CNSC staff evaluated the PLGS corrective action program during 2007 and concluded that the program met CNSC requirements. Some inspection findings related to the evaluation of causes, determination and implementation of corrective actions, and trending to evaluate the effectiveness of the corrective actions taken. These findings are being addressed by NBPN. CNSC staff concluded these findings were minor and did not represent an unreasonable risk to the safe operation of the facility.

NBPN continued to prepare for the refurbishment outage in 2007. Additional staff was assigned to the station internal audit group, along with the responsibility for carrying out surveillances and audits of the refurbishment contractors and suppliers. CNSC staff observed the conduct of two of these surveillances during 2007, and concluded that the NBPN contractor and supplier oversight and monitoring effort was adequate.

The PLGS quality management program and its implementation both remain at a "B" rating for 2007.

1.6.2.2 Human Factors

NBPN continued to make progress in developing and implementing processes to ensure the availability of staff with the necessary engineering and technically based skills required to support the safe operation of the station. NBPN succeeded in formalizing the station staff succession planning process in 2007. NBPN also implemented a policy that enables some existing and replacement employees to occupy the same position in the organization. The intent of this policy is to facilitate mentoring and knowledge transfer between existing and newly hired station staff. CNSC staff notes NBPN has made significant progress in this area.

Nuclear power plants limit the number of hours that can be worked by staff, in order to reduce the risk of performance impairments due to fatigue. During 2007, NBPN continued to improve the station process for monitoring compliance with annual hours of work limits. Quarterly reports are being produced to assist supervisory staff in identifying the station workers who are nearing these limits. NBPN is also considering the implementation of scheduling software, to assist its supervisors in managing the hours of work. NBPN expects to have this process formalized in 2008.

NBPN provided the results of an organizational culture survey, conducted by an external contracting firm, and has begun to address the deficiencies identified by the survey.

In 2007, NBPN continued to formalize the process for systematically incorporating human factors in the design change process. CNSC staff conducted an inspection in December 2007, to assess the status of the process implementation and noted an

improving trend. Some concerns remain with aspects of the implementation phase. The CNSC staff inspection report is expected in early 2008.

NBPN is conducting a Human Reliability Analysis, as part of the probabilistic risk assessment for the life extension project. The Human Reliability Analysis is a useful tool for identifying the most safety significant human actions. NBPN will be able to use the results of the Human Reliability Analysis to improve the programs that support reliable human performance, including design, procedures, and training.

CNSC staff recognizes the program improvements implemented by NBPN in 2007, and concludes the Human Factors program at the PLGS now meets CNSC requirements.

CNSC staff also acknowledges the progress made by NBPN in implementing the updated Human Factors program; however some concerns remain in the areas of hours of work and incorporating human factors into design. Consequently, the Human Factors program implementation is assessed as a "C" for 2007.

1.6.2.3 Training, Examination and Certification

NBPN submitted a response to a CNSC staff finding resulting from a 2006 inspection of the documentation for certification examinations; CNSC staff is currently reviewing this response.

CNSC staff conducted an inspection of the Supplementary Simulator-based Testing component of the certified staff requalification testing program. This inspection confirmed that NBPN met CNSC requirements for all of the topics reviewed.

NBPN continued with the development of a proposed new SAT-based training program in science fundamentals and equipment principles for certified staff. The proposed objectives for the new program were submitted in July of 2007 and the CNSC review is under way. Should this program be found acceptable, NBPN will have satisfied all of the pre-requisites for the transfer of the responsibility for certification examinations from CNSC staff to NBPN staff. CNSC staff notes the NBPN approach follows closely that of the science fundamentals and equipment principles programs, which were already accepted and adopted by other Canadian licensees.

As a pre-requisite for the CNSC project to transfer certification examinations to licensees, the licensees must have a sufficient number of examiners who meet the qualification requirements specified in the relevant regulatory documents. To determine whether NBPN meets this requirement, CNSC staff requested NBPN to provide the processes that have been put in place to ensure their examiners will be qualified to administer certification examinations. NBPN's response to this request is currently being reviewed by CNSC staff.

NBPN continued to make significant progress in implementing the corrective actions required to address previously identified deficiencies in the maintenance training program. The work on the remaining two deficiencies (related to program

documentation) continued in 2007, and NBPN provided regular updates to CNSC staff on this topic.

1.6.3 Design and Analysis

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

Both the program and implementation of the Design and Analysis safety area at PLGS met the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to safe facility operation in 2007.

The CNSC compliance activities conducted in 2007 included a *Type II inspection* of the proposed classification and registration procedures and pressure boundary program; Type II field inspections; and reviews of system health monitoring reports, detailed event reports, quarterly operations reports, pressure boundary reports, individual safety analysis reports, and the updated Point Lepreau *Safety Report*.

1.6.3.1 Safety Analysis

PLGS conducted a series of deterministic safety analyses in support of the upcoming refurbishment project. These analyses covered planned design changes aimed at improving reactor trip coverage and defence-in-depth for various categories of events, reactor trip coverage under pre-equilibrium (fresh) fuel conditions, and updates to previously conducted safety analyses. The CNSC staff reviews of these safety analyses generally confirmed the conclusions of these analyses; however some of the reviews were still in progress at the end of 2007.

NBPN also submitted the Level 1 Probabilistic Safety Assessments (PSA) in support of the refurbishment project. The CNSC staff review of this document entitled “Accident Sequence Quantification for Level 1 Internal Events”, was in progress at the conclusion of 2007.

NBNP continued to work on the Fire Probabilistic Safety Assessment during 2007. The “Cable/Conductor Routing Analysis of Fire PSA Devices”, and the “Reactor Building Fire Scenarios Analysis – Level 1 PSA” were submitted in 2007. The CNSC staff review of the “Cable/Conductor Routing Analysis of Fire PSA Devices” concluded it was generally acceptable. The CNSC staff review of the “Reactor Building Fire Scenarios Analysis – Level 1 PSA” will be completed in 2008.

The CNSC staff review of the updated Point Lepreau *Safety Report*, which focuses on the methodologies and on the qualification of the tools used to perform the analyses, and was still ongoing at the conclusion of 2007.

The PLGS safety analysis program complies with modern quality assurance standards and therefore meets CNSC requirements.

1.6.3.2 Safety Issues

CNSC staff requested NBPN to review the analysis relating to the potential safety impact of de-tensioning the shutoff rod guide tubes, as observed at Gentilly-2. NBPN confirmed the Gentilly-2 analysis results are applicable to PLGS, and concluded there is no significant safety impact associated with the de-tensioning of the shutoff rod guide tubes at PLGS.

CNSC staff also reviewed the progress made by the CANDU industry and utilities to resolve GAIs. NBPN continued its work, including participation in the industry efforts, toward finding resolution of the GAIs, and its overall progress was found satisfactory. A brief description and the expected completion date of each GAI are provided in Appendix F, Table F.1.

1.6.3.3 Design

NBPN is revising the PLGS pressure boundary design program, in order to meet the latest edition of the standard CSA N285.0. There are some minor legacy issues that require follow-up; however this area of the program still meets CNSC requirements.

Implementation of the corrective measures required to improve the fire protection program at PLGS continued during 2007. Further improvements in the compliance with code mandated testing and inspections are required to increase the reliability of the fire safety systems and to identify potential latent reliability issues. The PLGS fire protection program and its implementation remained below CNSC requirements in 2007.

NBPN continued implementing the corrective measures identified in an earlier electrical distribution system functional inspection. CNSC staff is generally satisfied with the progress achieved in 2007. A request for closure of the related *action item* was under review at the end of 2007.

Notwithstanding the deficiencies in the area of fire protection, which represent only one area of the design program, CNSC staff concludes that the overall PLGS design program and its implementation met CNSC expectations in 2007.

1.6.4 Equipment Fitness for Service

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

Both the program and implementation of the Equipment Fitness for Service safety area at PLGS met the objectives of CNSC requirements and performance expectations in 2007.

1.6.4.1 Maintenance

NBPN continues to have a well-documented basis for the maintenance program processes and procedures. The maintenance program continues to be supported by a significant organization with established goals. Status reports and internal audits are conducted on a regular basis to determine whether these goals are met and to identify potential improvement opportunities.

In February 2007, NBPN reported completion of the work required to address the recommendations identified in the reliability centered maintenance studies done on the four containment subsystems at the PLGS.

CNSC staff concludes the PLGS maintenance program and its implementation continued to meet CNSC expectations during 2007.

1.6.4.2 Structural Integrity

NBPN continued to update the PLGS PIP, in order to ensure compliance with the latest revision of CSA standard N285.4. The licensee's goal is to achieve full compliance with the 2005 version of the standard by the end of the refurbishment outage, which is currently planned for November 30, 2009. CNSC staff continues to monitor the NBPN progress in this area.

CNSC staff completed the review of the PLGS report on the 2007 periodic inspections for CSA N285.4 and found the report generally acceptable and in compliance with the S-99 reporting requirements.

NBPN submitted a report on the inspection of the secondary side pipe work for the protection of the main control room and secondary control area, conducted during the 2007 outage. The report concluded that all the sites inspected during the 2007 outage met the acceptance criteria.

NBPN has assessed the results of the 2007 outage *pressure tube* scrape campaign. The assessment confirmed the *pressure tubes* would remain fit for service until the 2008 refurbishment outage. NBPN also submitted a fuel channel management plan to minimize the risks associated with aging of the fuel channels.

The NBPN pressure retaining components program continued to meet CNSC requirements during 2007, based on the PIP and the aging life cycle management strategies and plans.

1.6.4.3 Reliability

CNSC staff completed the review of the Point Lepreau Generating Station 2006 annual reliability report in 2007, and confirmed that it met the requirements of S-99.

NBPN participated in an industry workshop hosted by CNSC staff. The purpose of the workshop was to clarify generic issues in order to facilitate industry compliance with S-98 *Reliability Programs for Nuclear Power Plants*.

NBPN provided the 2007 reliability program information required under S-98. CNSC staff notes the PLGS reliability models for systems important to safety include sources of failures such as human actions and common-cause failures, and are extracted from the probabilistic safety assessment models. This effectively positions the NBPN reliability program at the forefront of the Canadian nuclear industry.

CNSC staff concludes the PLGS reliability program exceeds CNSC expectations. The implementation of the program continued to meet CNSC requirements during 2007.

1.6.4.4 Equipment Qualification

In 2007, the Equipment Qualification program at PLGS was assessed solely on the *Environmental Qualification* (EQ) of equipment. EQ is an important sub-program of the Equipment Qualification program.

NBPN continued to provide update reports on the implementation of the required corrective actions identified during a previous CNSC *Type I inspection* conducted on this subject. CNSC reviewed these update reports to monitor the progress made in this area and concludes the PLGS EQ program and its implementation continue to achieve a “B” rating for 2007.

1.6.5 Emergency Preparedness

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

CNSC staff did not plan any *Type I inspection* of the PLGS emergency preparedness program during 2007, since one had been completed in 2006. CNSC site and specialist staff did conduct desktop reviews and observed emergency drills throughout 2007.

PLGS continued to maintain its emergency preparedness program at levels comparable to previous years, and this program continues to exceed applicable CNSC requirements and performance expectations.

Improvements to the self-assessment of the PLGS emergency exercise process were implemented in 2007, and emergency procedures were updated in preparation for the 2008 refurbishment outage. The implementation of the emergency preparedness program continues to meet CNSC requirements and performance expectations.

1.6.6 Environmental Protection

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

The environmental protection program and implementation at PLGS met the objectives of CNSC requirements and performance expectations in 2007. Both airborne emissions and liquid releases of nuclear substances to the environment were less than 1% of the *derived release limit*, and there was no report of any environment action level being exceeded. The estimated doses to the critical group in 2007, for airborne emissions and liquid effluents, were 0.52 μSv and 0.19 μSv respectively. These values are well below the regulatory limit of 1000 μSv.

There were no reported unplanned releases of nuclear substances or hazardous substances from PLGS in 2007 that posed a significant risk to the environment.

In May 2007, NBPN submitted a revision to the report on the Ecological Effects Review conducted at PLGS. The revised report reflects the CNSC staff comments on the original Ecological Effects Review report and addresses CNSC staff concerns.

1.6.7 Radiation Protection

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

The radiation protection program and its implementation at PLGS continued to meet the objectives of CNSC requirements and performance expectations during 2007.

There was no radiation exposure in excess of regulatory dose limits, and no action level was exceeded during 2007.

NBPN continued to implement the corrective actions required to address deficiencies identified during a joint 2006 *Type II inspection* of the radiation protection and occupational safety programs. CNSC staff continues to monitor the progress in this area.

Follow-up activities were conducted during the April 2007 planned outage, along with an ALARA-focused follow-up in August 2007. No major deficiency was noted. PLGS is successfully working towards the implementation of an effective ALARA program. CNSC staff reported the outcome of the August visit and other related ALARA assessments in CMD 07-M43, which was presented to the *Commission Tribunal* on December 6, 2007.

Table 7 provides a summary of annual doses to workers at the Point Lepreau Nuclear Generating Station from 2003-2007.

Table 7: Annual Dose at Point Lepreau

Year	Collective Dose - Routine Operations (person-mSv)	Collective Dose - Outages (person-mSv)	Total Collective Internal Dose (person-mSv)	Total Collective External Dose (person-mSv)	Total Collective Effective Dose (person-mSv)
2003	176	970	120	1,026	1,146
2004	149	770	122	797	919
2005	137	1,440	134	1,443	1,577
2006	156	745	131	770	901
2007	129	535	68	596	664

Station dose for 2007 was the lowest annual dose recorded since 1991. CNSC staff also notes the internal dose total for 2007 is approximately half of the annual internal dose received in recent years. CNSC staff attributes this improved result in part to the duration of the 2007 planned outage, 24 days, which was shorter than the planned outages of recent years. Other factors affecting the 2007 station dose were the need to replace a single *feeder* during the 2007 outage, as opposed to as many as 13 during the 2005 outage, and an increased focus on ALARA and dose reduction by station staff.

1.6.8 Site Security

The assessment of the Site Security safety area for PLGS is documented in a separate (secret) *Commission Member Document* (CMD 08-M37.A).

1.6.9 Safeguards

Site	SAFETY AREA	Grades	
		Program	Implementation
Point Lepreau	SAFEGUARDS	B	B

NBPN complied fully with both IAEA and CNSC requirements during 2007. The safeguards program and its implementation both continue to meet CNSC expectations.

No major *safeguards* events occurred in 2007, including events pursuant to the S-99 framework.

NBPN has developed and continues to maintain satisfactory documentation for the *safeguards* program. NBPN also continued to provide the IAEA inspectors with the access and assistance required for the conduct of the inspection activities. CNSC staff met with NBPN staff in June 2007, to discuss the development of a new state-level integrated *safeguards* approach. The implementation of this new approach is expected in 2008. In addition, NBPN provided all *safeguards* implementation reports and information in a timely manner.

Four scheduled *safeguards* inspections were conducted at the PLGS by the IAEA in 2007. CNSC staff participated in one of these. IAEA inspectors also attended all the scheduled transfers of spent fuel to the dry storage facility.

1.6.10 Update on Other Major Projects and Initiatives

1.6.10.1 Point Lepreau Refurbishment

Work in all aspects of the Point Lepreau refurbishment project continued to be on schedule during 2007.

The World Association for Nuclear Operators (WANO) performed a radiation protection assist visit at the Point Lepreau Generating Station in January 2007. The objective of the visit was to evaluate the station's radiation protection practices against the best-known international radiation protection practices for refurbishment projects. NBPN management staff confirmed the information obtained through the visit would be evaluated and applied where appropriate, in order to enhance the station radiation protection program in preparation for the refurbishment outage.

CNSC staff continued to monitor the progress of the NBPN refurbishment project activities through a series of monthly project planning meetings, quarterly human factors and radiation protection meetings, and other topical meetings.

NBPN staff provided the *Commission Tribunal* with a refurbishment project update report at the December 6, 2007, *Commission Tribunal* meeting. The report, presented under CMD 07-M12, covered several aspects of the refurbishment project including:

- a description of the planned activities;
- a description of the organizational structure that will be in place for the refurbishment project;
- the status of the ongoing preparation activities;
- the proposed safety improvements;
- the planned layup, commissioning, return to service, and restart activities; and
- the health, safety, and environment program.

CNSC staff also presented an information report to the *Commission Tribunal* at the December 6, 2007 meeting. This report, presented under CMD 07-M43, covered the radiation protection practices which are being planned for the refurbishment to keep worker radiation dose as low as reasonably achievable.

1.6.10.1.1 Planning Activities

The development of the refurbishment project master plan was completed in 2007. The plan details every construction work package to be completed by NBPN and contractor staff during the refurbishment project.

NBPN is also planning to provide additional refurbishment project update reports to the *Commission Tribunal* in June and October 2008.

1.6.10.1.2 Procurement and Design

The development of the specialized tooling that will be required for retube activities was completed in 2007. CNSC staff visited the Automated Tooling System manufacturing facility, to gain familiarity with the retube tooling. CNSC staff also visited a warehouse in Saint-John, where some of the retube equipment will be assembled before being sent to the station, and where most of the retube training will be conducted.

All major components were ordered and/or in delivery stream during 2007. The production schedule for the end fittings caused challenges during 2007. NBPN staff effectively managed any arising supplier issues through increased surveillance. NBPN staff conducted vendor quality assurance surveillance visits to supplier production facilities in 2007, with CNSC staff present as observers for one of the visits.

1.6.10.1.3 Solid Radioactive Waste Management Facility (SRWMF)

CNSC staff presented a mid-term report on the SRWMF to the *Commission Tribunal* on April 11, 2007. This report, presented under CMD 07-M12, included a brief description of the facility, an update on issues raised at the previous 2003 licence renewal, an update on construction activities at the SRWMF, and an overview of the licensee performance since 2003.

In December 2007, CNSC staff received a request to allow the use of additional Phase I SRWMF vaults to house the low and intermediate level waste expected from extended station operation.

The construction and commissioning activities for the Phase III containment structure to house high-level waste generated by the refurbishment project, were almost complete at the conclusion of 2007. Work required to address deficiencies identified during commissioning delayed the final sign-off, which was then expected to occur in early 2008.

SECTION 2 – SAFETY PERFORMANCE AND TRENDS ACROSS THE INDUSTRY

This section of the report discusses the overall safety performance of the stations and is organized according to the safety areas and programs defined in Appendix A of this report. Year-to-year trends are illustrated and significant issues that pertain to the industry at large are highlighted. CNSC Performance Indicators (PIs) illustrate various trends and issues. Their definitions are taken from Regulatory Standard S-99. PIs can be used to study an individual station's performance over time, or the industry's performance over time. Comparing station to station data in any particular year is difficult, since many factors - such as the number of operating units, design, unit capacity, station governing documents, etc. - contribute to differences in PI data.

2.1 OPERATING PERFORMANCE

There were 18 reactors operating in 2007. Bruce A Units 1 and 2 remained in shutdown state for the entire year due to refurbishment work. At Pickering A, Unit 2 was defuelled and Unit 3 is being defuelled, as part of the preliminary decommissioning plan for placing the units in long-term safe storage.

2.1.1 Organization and Plant Management

The licensees had appropriate organizations to manage and safely operate their stations in 2007.

No worker at any station or member of the public received a radiation dose in excess of the regulatory limits and 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 2007. These results are general reflections of adequate controls being employed by the organizations at their respective sites.

There were no *serious process failures* at any station in 2007.

CNSC staff uses *action items* to bring forth issues that require timely and corrective action to the attention of licensees. In 2007, CNSC staff was generally satisfied with licensees' *action item* management, event reporting, plant system performance analysis, and follow-up. There were 668 reportable events at the stations throughout 2007. The most important ones are described in Appendix E.

The "Number of Unplanned Transients" PI denotes the unplanned reactor power transients due to all sources, while the reactor was not in a *guaranteed shutdown state* (GSS). This PI, illustrated in Tables 8 through 10, shows the number of manual and automatic power reductions from actuation of the shutdown, *stepback* or *setback* system (note that Pickering A does not have a *stepback* system). Unexpected power reductions may indicate problems within the plant and place unnecessary strain on systems. Most of the unplanned transients in 2007 were *setbacks*, which typically pose little risk to plant

operations. The most significant transients are described in the CMDs known as Significant Development Reports (see Appendix E).

Table 8: Number of Unplanned Transients for 2007

Station	GSS Hours	Unplanned Transients at Sites in 2007			
		Trips	*Stepbacks*	*Setbacks*	Total
Bruce A	2,643	3	0	9	12
Bruce B	2,541	0	2	1	3
Darlington	2,764	0	1	1	2
Pickering A	3,067	6	n/a	4	10
Pickering B	4,327	2	0	2	4
Gentilly-2	1,391	1	1	3	5
Point Lepreau	761	2	0	0	2
Industry Total	17,494	14	4	20	38

Tables 9 and 10 show the trends of this PI for the industry since 2003. Industry-wide, the total number of transients in 2007 remains consistent with previous years. In 2007, there was an industry average of 7,788 hours of non-GSS time between reactor trips or *stepbacks*. The international performance target is one reactor trip per 7,000 hours of operation, which puts Canadian nuclear power plants slightly above international norms.

Table 9: Trend Details of Number of Unplanned Transients for Industry

Year	GSS Hours	Unplanned Transients in Industry			
		Trips	*Stepbacks*	*Setbacks*	Total
2003	47,922	19	13	11	43
2004	20,424 *	10	5	22	37
2005	25,533 *	13	5	35	53
2006	17,137 *	9	7	22	38
2007	17,494 *	14	4	20	38

*****For 2004 to 2007, GSS hours were only tabulated for reactors not in a *lay-up state*.

Table 10: Trends of Number of Unplanned Transients for Stations

Station	Unplanned Transients				
	2003	2004	2005	2006	2007
Bruce A	1	17	25	6	12
Bruce B	8	4	7	8	3
Darlington	10	6	4	8	2
Pickering A	7	4	3	9	10
Pickering B	14	3	9	5	4
Gentilly-2	2	1	3	2	5
Point Lepreau	1	2	2	0	2
Industry Total	43	37	53	38	38

2.1.2 Operations

Most of the CNSC staff inspections conducted in 2007 confirmed the stations' compliance with CNSC requirements and the licensees' governing procedures and documents. The majority of findings were minor in nature. In general, CSNC staff found that licensees satisfactorily addressed all identified remedial actions.

The purpose of the "Unplanned Capability Loss Factor" PI in Tables 11 and 12 is to indicate how a unit is managed, operated, and maintained in order to avoid unplanned outages. The indicator is the percentage of the reference electrical output for the station lost during the period due to unplanned circumstances. Some of the unplanned shutdowns for the stations are described in Appendix E.

Pickering A, Gentilly-2 and Point Lepreau all experienced large increases in the unplanned capability loss factors reported for 2007. The increase at Pickering A is primarily attributed to the forced outage caused by the ISTB event, described in Section 1.3.1.1.

Point Lepreau's increase in the unplanned capability loss factor was mainly due to three events. In September 2007, a controller failure caused a liquid zone control system disturbance, which in turn resulted in a forced station outage. The duration of this forced outage was extended to allow for the completion of repairs to a turbine-generator emergency stop valve. In November 2007, a spurious shutdown system actuation also resulted in a forced station outage, which lasted approximately five days. Finally, during December 2007, NBPN staff shut down the station for approximately a week, for repairs to a fuelling machine.

At Gentilly-2, the unit was shutdown when a fuelling machine became stuck on the reactor face while defuelling a channel. During the outage, foreign materials were discovered in the moderator system. The metallic pieces that were retrieved were found to have caused damage to the tube support plate of a heat exchanger, which in turn required repairs. The repairs were performed during the outage, thereby extending the outage into the new year. The unit restarted on January 30, 2008.

Bruce A values for the Unplanned Capability Loss Factor PI were relatively consistent over the last 5 years, while Bruce B, Pickering B, and Darlington all reported values lower than the 5-year average for each of their stations.

Table 11: Unplanned Capability Loss Factor for 2007

Station	Unplanned Capability Loss Factor (%)				
	Quarter				For Year
	Q1	Q2	Q3	Q4	
Bruce A	0.5	5.1	19.4	5.0	7.5
Bruce B	1.6	6.0	3.5	1.6	3.2
Pickering A	34.7	38.4	100.0	23.6	49.2
Pickering B	2.9	8.6	12.6	12.2	9.1
Darlington	0.0	1.1	3.2	3.1	1.9
Gentilly-2	2.5	0.0	2.5	72.3	19.3
Point Lepreau	0.0	3.1	6.4	23.5	8.3

Table 12: Trend Details of Unplanned Capability Loss Factor for Industry

Station	Unplanned Capability Loss Factor (%)				
	Year				
	2003	2004	2005	2006	2007
Bruce A		11.4	5.7	7.4	7.5
Bruce B	3.8	4.9	8.5	3.4	3.2
Pickering A	10.2	18.5	30.1	17.9	49.2
Pickering B	19.1	12.2	5.1	14.0	9.1
Darlington	4.3	6.7	3.4	5.4	1.9
Gentilly-2	0.2	10.2	1.3	0.9	19.3
Point Lepreau	3.9	6.9	6.6	1.6	8.3

The "Non-Compliance Index" PI indicates the number of occurrences where the operation of the station failed to comply with licence conditions, or with the *Nuclear Safety and Control Act* (NSCA) and regulations. CNSC staff evaluates all non-compliances, which are categorized as follows:

a = number of non-compliances with the operating policies and principles referred to in the licence
b = number of non-compliances with the radiation protection requirements referred to in the licence
c = number of non-compliances with the minimum shift complement referred to in the licence
d = number of other non-compliances with the licence
e = number of non-compliances with the NSCA and regulations

Tables 13, 14 and 15 illustrate the Non-Compliance Index for the industry. All stations, with the exception of Pickering, reported more non-compliances in 2007 than in previous

years. The CNSC promotes self-reporting by licensees. The majority of the reported non-compliances were related to category “d”.

The variation in non-compliance rates is relative to different site requirements, including operating policies and principles, radiation protection requirements, design, licence conditions, and practices. Individual non-compliances are dealt with on their merit and appropriate regulatory action is taken when an issue occurs.

Table 13: Non-Compliance Index for 2007

Station	Non-Compliances by Type					
	a	b	c	d	e	Total
Bruce A	12	28	1	56	1	98
Bruce B	1	33	3	52	1	90
Pickering A	28	5	0	19	1	53
Pickering B	15	19	1	19	2	56
Darlington	24	27	0	41	1	93
Gentilly-2	11	1	0	24	4	40
Point Lepreau	13	4	1	12	6	36

Table 14: Trend Details of Non-Compliance Index for Industry

Year	Non-Compliances by Type					
	a	b	c	d	e	Total
2003	142	186	10	203	50	591
2004	108	167	20	142	36	473
2005	95	144	24	156	19	438
2006	95	96	15	164	13	383
2007	104	117	6	223	16	466

Table 15: Trends of Non-Compliance Index for Stations

Station	Total Non-Compliances				
	2003	2004	2005	2006	2007
Bruce A	120	81	69	71	98
Bruce B	79	72	86	77	90
Pickering	282	202	173	136	109
Darlington	70	71	82	54	93
Gentilly-2	13	23	6	24	40
Point Lepreau	27	24	22	21	36
Industry Total	591	473	438	383	466

2.1.3 Occupational Health and Safety (Non-radiological)

The licensees met or exceeded the expectations for Occupational Health and Safety at all sites in 2007. The "Accident Severity Rate" (ASR) performance indicator is used to monitor licensee performance in meeting nuclear industry standards in the area of worker safety (see Tables 16, 17 and 18). The indicator 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 with respect to definitions of industrial accidents, jurisdiction of worker safety, and the interpretation of lost time associated with chronic health problems.)

With the exception of Gentilly-2, the licensee accident severity rates decreased in 2007. The industry average is below the 5-year average for this PI. CNSC staff is following up with Hydro-Québec regarding the high ASR value for Gentilly-2.

Table 16: Accident Severity Rate for 2007

Site	Days Lost	Person Hours	Accident Severity Rate
Bruce A and B	10	6,498,720	0.31
Pickering A and B	54	7,888,485	1.37
Darlington	2	4,948,711	0.08
Gentilly-2	126	1,321,630	19.07
Point Lepreau	7	2,513,638	0.56
Industry Average	199	23,171,184	1.72

Table 17: Trend Details of Accident Severity Rate for Industry

Year	Days Lost	Person Hours	Accident Severity Rate
2003	372	16,612,884	4.48
2004	145	16,447,399	1.76
2005	170	22,698,360	1.50
2006	384	22,926,178	3.35
2007	199	23,171,184	1.72

Table 18: Trends of Accident Severity Rate for Stations

Site	Accident Severity Rate				
	2003	2004	2005	2006	2007
Bruce A and B	4.2	0.0	0.9	1.6	0.3
Pickering A and B	3.7	0.0	2.0	4.8	1.4
Darlington	0.6	0.0	1.0	8.19	0.1
Gentilly-2	20.4	1.2	3.6	1.3	19.1
Point Lepreau	0.1	14.2	0.7	0.0	0.6

2.2 PERFORMANCE ASSURANCE

In 2007, all nuclear generating stations met CNSC expectations for their documented programs in the Performance Assurance safety area. With the exception of Pickering A and Gentilly-2, CNSC expectations were also met for the implementation of the programs. Though weakness within the individual programs of the Performance Assurance safety area have been identified by CNSC staff, these weaknesses did not represent an immediate risk to the safe operation of the stations.

2.2.1 Quality Management

The OPG stations (Darlington and Pickering A and B) revised their documented Quality Management (QM) program. CNSC staff reviewed the revised document and determined that it continued to meet requirements in 2007. The CNSC staff oversight activities also determined that the implementation of the QM program at Darlington and Pickering B continued to meet CNSC expectations. The QM program implementation at Pickering A was assessed to be below CNSC expectations, as a break down in several management activities and practices were identified as causes of the ISTB failure event.

Bruce A and B have made progress in documenting their QM program. In 2007, the documented QM program and its implementation were assessed at both stations as meeting CNSC expectations. Non-conformances have been identified with the restart project of Units 1 and 2 at Bruce A, but they do not impact the risk to the safe operation of Units 3 and 4.

Gentilly-2 has a documented QM program that is being updated, however it continued to meet CNSC expectations. The implementation of the QM program was assessed as being below expectations, given that actions from CNSC inspections 2004 through 2006 are still outstanding.

Point Lepreau's documented QM program and its implementation continued to meet CNSC expectations in 2007. The Point Lepreau station was in preparation for refurbishment activities due to start in 2008. CNSC staff will monitor the activities.

Overall, CNSC staff expectations for the documentation and implementation of the QM programs at the nuclear generating stations were met in 2007. The indications of negative trends concerning implementation at some stations will require continued oversight by

CNSC staff. However, these trends have been assessed as having minimal or no immediate impact on the risk for safe operation of the stations.

2.2.2 Human Factors

The programs related to Human Factors (HF) met CNSC staff's expectations and were acceptable at all sites. All the facilities remained unchanged in meeting program expectations, with the exception of Point Lepreau, which improved to an acceptable level in 2007. The implementation of HF-related programs remains unchanged from 2006, with progress still required for Pickering A and Point Lepreau.

In 1997, Ontario Hydro's integrated improvement program recommended eliminating the use of non-certified staff to monitor the control panels of the reactor units. Pickering A, Pickering B and Bruce B have addressed this recommendation and currently have an authorized nuclear operator (ANO) at the control panels of each reactor unit at all times. Darlington and Bruce A have committed to meeting the ANO requirement in 2009, and Darlington is on track to meeting this commitment. Bruce A has been asked to review its Certified Operator Staffing Plan implementation to consider the requirements for ANOs with the planned return to service of Units 1 and 2. This issue will continue to be monitored in 2008.

Several work organization and job design issues were assessed in 2007. The submissions regarding proposed changes to Bruce A and B minimum complement were reviewed. Although some issues were raised with respect to the submission quality for HF validation activities, the proposed minimum complement changes were approved. The limits of hours of work for casual construction trades at OPG have been identified as an issue. OPG has been requested to provide information regarding the potential impact of casual construction trade work on nuclear safety and to define the limits of hours of work for these workers. NBPN continued to improve their station process for monitoring compliance with hours of work limits during 2007, and succeeded in formalizing a station staff succession planning process to address its aging workforce.

There are indications that Bruce Power is carrying out considerable work to develop its Human Performance Program, and a desktop review is to be conducted in 2008. Pickering A has been requested to provide an update to its Human Performance Program, including the program's effectiveness. A response is expected later in 2008. Pickering B conducted a Human Reliability Analyses during 2007, as part of the Probabilistic Risk Analysis. The preliminary report indicated that a number of human reliability issues required further resolution. NBPN is conducting a Human Reliability Analysis for its life-extension project. NBPN will be able to use the results to improve the programs that support reliable human performance, including design, procedures, and training.

CNSC staff reviewed the human performance aspects of all S-99 reportable events across all sites in 2007. Pickering A and B reportable events in 2007 were assessed and compared against those of 2006, and it was found that event types were similar for both years. Particular areas of concern that were identified will continue to be monitored in 2008. CNSC staff will continue to monitor the completion of outstanding enforcement

actions in different review areas, as well as any emerging trends in performance observed through S-99 reportable event reports.

2.2.3 Safety Culture and Safety Management

During 2007, CNSC staff categorized, trended and analysed some of the 2006 and all the 2007 events that occurred at the nuclear power plants. The framework used for this purpose was the CNSC Safety Culture Organizational Behaviors Model. The main objective of the analysis was to validate the results with respect to the reports received by the licensee and the CNSC inspection reports.

As part of the nuclear industry's growing interest in evaluating and maintaining a positive safety culture, three Safety Culture Self-Assessments were conducted during the year, namely at Gentilly-2, Point Lepreau and Pickering A. One of those evaluation methods was developed and carried out by the facility staff themselves. CNSC staff reviewed, observed and commented on that method.

CNSC staff understands that the development of a Safety Culture Self-Assessment Method is a continuous improvement process. CNSC also encourages licensees Senior Management to support such a self-assessment process with the purpose of achieving a reliable method that could be used for future safety culture self-assessments.

2.2.4 Training, Examination and Certification

Licensee staff in safety-critical positions undergo CNSC knowledge-based and performance-based examinations, in order to assess their competence prior to CNSC certification. Following CNSC certification, licensees conduct knowledge-based and performance-based requalification examinations, to ensure that certified staff retains the necessary knowledge and skills to perform their duties safely.

A number of licensee facilities are in various stages of unit refurbishment. In all of these cases, CNSC staff is monitoring the programs for certified staff continuing training and requalification testing during the refurbishment outages, as well as reviewing and monitoring the training on modified systems and for unit restart.

Significant progress is being made on the project to establish and implement training and examination programs for certified shift personnel in support of examination transfer to licensees. This project is being managed by the CNSC, in consultation with industry members. In April 2007, CNSC staff met with licensees to discuss the progress being made on the project. CNSC staff requested detailed scheduling information for future training programs and certification examinations, to facilitate CNSC staff planning of regulatory oversight activities for 2008 and beyond.

In 2007, evaluations of certification training programs across the industry continued as scheduled. In parallel, follow-up work to correct previously identified deficiencies continued at all licensee facilities. CNSC staff continues to monitor and review individual licensee progress.

Most licensees are facing an industry-wide challenge to maintain the required number of qualified staff. This area is continuing to receive special review by CNSC staff, by such means as a semi-annual licensee report of the status in key areas.

2.3 DESIGN AND ANALYSIS

Overall, licensees continued to meet the requirements and performance expectations for programs in this safety area in 2007. However, legacy issues at Bruce A and the design issues associated with the ISTB event at Pickering A resulted in downgraded implementation grades for the Design programs at both stations.

2.3.1 Safety Analysis

Safety Analysis relates to the confirmation that the probability and consequences of a range of events are acceptable. A summary of those safety analyses is documented in the *Safety Reports* of the operating plants.

In general, the tool used to perform the task is a set of computer codes, which model the physical plant. The tool needs to be qualified; that is, validated to give confidence that it can adequately predict real events as well as obtain from the validation activity a quantitative measure of the ability of the tool to predict certain parameters that will be used to assess the safety margins on critical parameters. Performing a Safety Analysis with validated tools is a requirement in the NPP operating licences granted by the CNSC.

Updates to the S*afety Report* for each site are required every three years, in accordance with the operating licenses. During 2007, CNSC staff performed a detailed review of the licensees' *Safety Reports*, trying to establish the general compliance with quality assurance standards consistent with CSA N286.7-99. After the review, CNSC staff expressed concerns about the current status of the licensees' *Safety Reports* because, although the safety margins appear acceptable, most of the analyses documented in the *Safety Report*s do not fully comply with the standards.

The requirement to comply with Standard S-294 *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, is being added to each nuclear operating licence at the time of renewal. All the licensees have either already submitted their PSAs for review by the CNSC, or produced some plans to delineate the amplitude and timeframe for the project. In particular, during 2007, CNSC staff continued the review of the Pickering B and Point Lepreau PSAs. Darlington has submitted the methodology and Quality Assurance program for developing their PSA. Recognizing that production of a PSA is normally a multi-year project, the CNSC is discussing with all its NPP licensees the specific requirements and schedules needed to bring all the PSAs in line with the CNSC standard.

2.3.2 Safety Issues

Safety issues relate to the identification and resolution of safety-related concerns arising from operational experience, analysis, research and incorporation of new knowledge or

requirements. A safety-related concern that cannot be resolved based on current knowledge is referred to as an outstanding safety issue. Those outstanding safety issues that are common to more than one station and complex in nature have been designated as generic action items (GAIs). Eleven GAIs were active in 2007. A brief description and the expected completion date of each GAI are provided in Appendix F, Table F.1.

In early 2007, the CNSC initiated a project to systematically re-assess the current status of outstanding design and analysis safety issues for Canadian CANDU reactors, and to address potential residual concerns on nuclear safety in a risk-informed manner. An initial list of issues was developed using the IAEA TECDOC-1554 *Generic Safety Issues for Nuclear Power Plants with Pressurized Heavy Water Reactors and Measures for their Resolution*. Additional issues were identified through regulatory oversight of currently operating reactors, results of life extension assessments, and pre-licensing reviews of new CANDU designs. The GAIs were also included. The safety issues were identified, and their relative risk importance assessed, leading to classification into the following three broad categories:

Category 1: Not an issue in Canada.

Category 2: The issue is a concern in Canada. However, the licensees have appropriate control measures in place to address the issue and to maintain safety margins.

Category 3: The issue is a concern in Canada. Measures are in place to maintain safety margins, but further experiments and/or analyses are required to improve knowledge and understanding of the issue, and to confirm the adequacy of the measures.

It is important to note that the issues identified should not be viewed as questioning the safety of operating reactors, which have attained a very high operational safety record. Rather, they represent areas where uncertainty in knowledge exists, or the current approaches need to be confirmed. Consequently, further work, including experimental research, may be required to more accurately determine the overall effect of an issue on the safe operation of the facility, and to confirm that station operation is acceptable as there remain adequate safety margins.

In a manner consistent with the CNSC regulatory approach, the risk-informed decision making process was applied to the potentially risk-significant issues, including GAIs, to identify, estimate and evaluate the risks associated with each safety issues, and to recommend measures to control these risks. As a result of this work, the path forward for the resolution of the safety issues in relation to operating reactors, life extension of operating reactors and new reactors was developed and, in the case of the GAIs, was re-assessed. Work is now in progress to determine detailed technical closure criteria for the Category 3 issues. The CNSC and industry will reach an agreement for resolving these issues, including closure of some of the GAIs, by the first quarter of 2009. Descriptions of these issues are provided in Appendix F.

2.3.3 Design

In 2007, OPG obtained amendments to the operating licences for Pickering A, Pickering B and Darlington, to update the pressure boundary design program requirements to the latest edition of CSA standard N285.0-06 *General Requirements for Pressure Retaining Systems and Components in CANDU Nuclear Power Plants*. Hydro-Quebec and NBPN are currently revising their pressure boundary design programs to meet this most recent edition of the CSA standard. The Bruce A and B pressure boundary programs are based on the 1995 edition of CSA N285.0; however Bruce Power has proposed updating their procedures to facilitate implementation of certain improvements to the pressure boundary regulatory process work associated with the units 1 and 2 restart.

CNSC staff reviews and assessments indicate that the fire protection programs at many stations continued to have weaknesses in 2007. CNSC staff will continue to monitor the licensees' progress as they address non-compliances and other issues in this area.

Overall, in other areas of the Design program, the licensees' programs were found to be acceptable. However, legacy issues at Bruce A and the design issues associated with the ISTB event at Pickering A resulted in downgraded implementation grades for both those stations.

2.4 EQUIPMENT FITNESS FOR SERVICE

In 2007, CNSC staff assessments showed that the licensees met requirements for programs in the area of Equipment Fitness for Service. However, in some cases, the implementation of those programs did not meet requirements.

2.4.1 Maintenance

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

Maintenance backlogs continued to be a challenge for some licensees in 2007, however, there is indication that overall trends are improving.

2.4.2 Structural Integrity

Both OPG and Bruce Power maintain Certificates of Authorization issued by the Technical Standards and Safety Authority (TSSA) for pressure boundary activities, in accordance with CSA Standard N285.0. CNSC staff is satisfied that the implementation of these programs is working as anticipated, and has noted improving trends in pressure boundary work at Darlington, Pickering A and B, and Bruce A and B. Hydro-Québec and NBPN continue to employ contract service providers with the appropriate certificates of authorization for nuclear pressure boundary work at Gentilly-2 and Point Lepreau. However, both of these licensees have been working towards upgrading their pressure boundary programs in accordance with CSA N285.0.

Fitness-for-service, as commonly applied in the nuclear power industry, focuses on the integrity of the base material itself and its welds. Fitness-for-service is comprised of a set of quantitative engineering methods and programs used by licensees to determine the integrity and remaining life of nuclear pressure-retaining systems and components and their supports, and to make “operate-or-repair” decisions. Periodic inspections and fitness-for-service assessments of safety significant structures, systems and components (SSC) are mandatory through the power reactor operating licence. Implementation is through the CSA N285.4 and N285.5 standards on Periodic Inspections of CANDU Nuclear Power Plant Components and additional standards specified as conditions of the operating licence. The CNSC requires licensees to establish programs to manage structural integrity of SSCs, including monitoring, fitness-for-service assessment, mitigation, and, if appropriate, the replacement of degraded components. Licensees carry out periodic inspections to confirm that major primary heat transport systems and components remain fit for service. These inspections emphasize *pressure tubes*, *feeder* piping and *steam generator* tubes among others.

Licensees have developed and implemented fitness-for-service programs for all safety significant SSCs, as well as improvements plans to keep those programs and practices up-

to-date with best industry practices. Through the CANDU Owner's Group, the licensees have developed *feeder* fitness-for-service guidelines, which provide methodologies and acceptance criteria for the structural integrity assessment of *feeders* experiencing flow accelerated corrosion wall thinning. In 2007, the CNSC approved the *feeder* fitness-for-service guidelines as a trial for three years.

Overall, CNSC staff rates the Structural Integrity programs and implementation at all stations as "B - Meets Requirements". CNSC staff notes that licensees made some improvements in their plans and practices, in comparison to previous years.

The "Number of Pressure Boundary Degradations" PI demonstrates the number of pressure boundary degradations that occurred at the stations, and monitors the performance in meeting nuclear industry codes and standards. Degradations are defined as instances where limits in relevant design or inspection criteria are exceeded. The "class" that is referred to is the code classification of nuclear systems. The industry data for this indicator is shown in Tables 19, 20, and 21. In previous years, the number of pressure boundary degradations in the stations' non-nuclear systems was also presented in the PI Tables. Typically, the numbers were much higher on the non-nuclear side, compared to the nuclear side. These values are not presented in the Tables this year so as not to confound the nuclear system data.

In 2007, the reported number of pressure boundary degradations in the stations' nuclear systems was consistent with, or less than, previous years. The exception is Bruce A, which appears to be experiencing an upward trend in pressure boundary degradations. Most of the reported degradations at Bruce were found to be due to either normal wear and aging, or inadequate installation practices.

Table 19: Pressure Boundary Degradations for 2007

Station	Number of Pressure Boundary Degradations by Type				
	Class 1	Class 2	Class 3	Class 4	Total
Bruce A	10	6	13	0	29
Bruce B	2	0	13	0	15
Darlington	7	5	8	0	20
Pickering A *	1	0	3	1	5
Pickering B	1	0	6	0	7
Gentilly-2	0	0	0	0	0
Point Lepreau	2	0	1	1	4

* Due to legacy issues with the system pressure boundary registration at Pickering A, certain features are not required to be reported.

Table 20: Trend Details of Pressure Boundary Degradations for Industry

Year	Number of Pressure Boundary Degradations by Type				
	Class 1	Class 2	Class 3	Class 4	Total
2003	37	10	28	1	76
2004	21	4	23	0	48
2005	47	13	27	1	88
2006	35	7	46	1	89
2007	23	11	44	2	80

Table 21: Trends of Pressure Boundary Degradations for Stations

Station	Total Number of Pressure Boundary Degradations				
	2003	2004	2005	2006	2007
Bruce A	44	11	12	23	29
Bruce B	17	13	31	20	15
Darlington	0	11	33	29	20
Pickering A and B	11	9	16	15	12
Gentilly-2	0	0	0	0	0
Point Lepreau	4	2	2	2	4

2.4.3 Reliability

Each licensee has developed a reliability program consistent with the industry approach, in order to meet the requirement of S-98. CNSC staff considers the industry approach as generally acceptable although some generic issues still need to be resolved. In 2007, CSNC staff continued discussions with the industry on the reliability program implementation. Progress has been made in some areas and the discussions will continue in 2008, to resolve the remaining issues.

Overall, the systems important to safety performed well in terms of reliability, although there were events in 2007 that challenged the reliability of some of the *special safety systems*.

The purpose of the "Number of Missed Mandatory Safety System Tests" PI is to indicate the successful completion of the tests required by licence conditions, including those referenced in documents submitted in support of a licence application. This PI represents the ability of licensees to successfully complete routine tests on systems related to safety. Data for this PI is shown in Tables 22, 23 and 24. Approximately 91,000 of these tests were performed throughout the industry in 2007. The total number of missed tests was similar to that of previous years. The total number of missed tests for the *special safety systems* represented only an insignificant percentage of the tens of thousands of tests performed in 2007. This indicated a consistent industry commitment to test its safety systems on a regular basis.

Table 22: Missed Mandatory Safety System Tests for 2007

Station	Total # Tests	Missed Mandatory Safety System Tests			
		Special	Standby	Safety Related	Total
Bruce A	20,424	3	0	2	5
Bruce B	29,937	0	0	0	0
Darlington	10,799	1	0	4	5
Pickering A	10,329	0	0	0	0
Pickering B	10,982	3	0	0	3
Gentilly-2	4,733	1	0	0	1
Point Lepreau	4,250	1	0	0	1
Industry Total	91,454	9	0	6	15

Table 23: Trend Details of Missed Mandatory Safety System Tests for Industry

Year	Total # Tests	Total Number of Missed Mandatory Safety System Tests			
		Special	Standby	Safety Related	Total
2003	64,303	2	2	3	7
2004	84,471	18	3	6	27
2005	84,099	11	2	4	17
2006	85,702	4	2	7	13
2007	91,454	9	0	6	15

Table 24: Trend of Missed Mandatory Safety System Tests for Stations

Station	Total Number of Missed Mandatory Safety System Tests				
	2003	2004	2005	2006	2007
Bruce A		2	4	6	5
Bruce B	0	1	7	0	0
Darlington	0	1	3	1	5
Pickering A	0	0	0	0	0
Pickering B	5	19	2	1	3
Gentilly-2	2	2	1	5	1
Point Lepreau	0	2	0	0	1
Industry Total	7	27	17	12	15

2.4.4 Equipment Qualification

In 2007, CNSC staff's assessment of the Equipment Qualification programs at licensees' facilities was based on the assessment of *Environmental Qualification* of equipment. *Environmental Qualification* (EQ) is a sub-set of Equipment Qualification and deals with the identification and qualification of safety-related equipment that would be subjected to environmentally harsh conditions resulting from *design basis accidents*.

Some stations continue to have EQ issues related to steam-protected rooms. However, overall CNSC staff found that licensee EQ programs met CNSC requirements and performance expectations in 2007.

2.5 EMERGENCY PREPAREDNESS

The industry continued to meet, and in many cases, exceed CNSC expectations for emergency preparedness programs. No reportable events had any significant bearing on any of the industry's emergency preparedness programs or their implementation in 2007.

2.6 ENVIRONMENTAL PROTECTION

In 2007, the monitoring data on airborne emissions and liquid releases of radioactive substances for all stations showed that the releases to the environment were less than 1% of the *derived release limit*, and there were no reports of environmental action levels being exceeded.

The reported doses (μSv/year), to the public from the operations of Bruce, Darlington, Pickering, Gentilly-2 and Point Lepreau, were 2.07, 1.4, 2.6, 0.89 and 0.71, respectively in 2007. These numbers are a small fraction of the 1000 μSv/year regulatory dose limit for a member of the public.

Licensees are required to report to the CNSC any unplanned releases of radioactive material, or other hazardous substances to the environment. There were no reported unplanned releases of nuclear substances or hazardous substances from any power reactor sites, in 2007 that posed a significant risk to the environment.

2.7 RADIATION PROTECTION

Radiation Protection programs at all the stations continued to meet CNSC staff expectations in 2007.

For each of the stations, annual dose information from 2003-2007 was provided in Section 1 of this report. In general, collective doses from routine operations have remained relatively stable over the last five years, while outage doses tend to be more variable. This is primarily a result of the aging fleet of reactors in Canada requiring increased maintenance work. The nature of this maintenance work varies, but often involves workers performing tasks in areas with higher dose rates, or for extended periods of time, in comparison to routine operations. This results in increased radiation doses to the workers. Each licensee is required to provide evidence that this work is being performed in a manner that ensures doses to workers remain ALARA.

The "Radiation Occurrence Index" PI represents the number and weighted severity of radiation occurrences at a station, thereby providing a tool for monitoring the performance in meeting the CNSC's expectations in the area of worker radiation protection. The index and its components are defined and calculated as follows:

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

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

The weight of each component in the formula indicates the relative safety significance of various types of occurrences. Tables 25, 26 and 27 show the industry's Radiation Occurrence Index. In 2007, there were no doses in excess of specified limits (see the value of "d" in Table 25). Bruce A and B, Darlington, Pickering B, Gentilly-2 and Point Lepreau had no occurrences of any type. For Pickering A the index for 2007 can be attributed entirely to a type "c" occurrence.

Table 25: Radiation Occurrence Index for 2007

Station	Radiation Occurrence				
	a	b	c	d	Index
Bruce A	0	0	0	0	0
Bruce B	0	0	0	0	0
Darlington	0	0	0	0	0
Pickering A	0	0	2	0	10
Pickering B	0	0	0	0	0
Gentilly-2	0	0	0	0	0
Point Lepreau	0	0	0	0	0

Table 26: Trend Details of Radiation Occurrence Index for Industry

Year	Radiation Occurrence				
	a	b	c	d	Index
2003	2	0	6.7	0	35.5
2004	0	0	2.1	0	10.4
2005	0	0	11.4	0	56.8
2006	0	0	5.5	0	27.6
2007	0	0	2	0	10

Table 27: Trends of Radiation Occurrence Index for Stations

Station	Radiation Occurrence Index				
	2003	2004	2005	2006	2007
Bruce A	0	0	0	0	0
Bruce B	0	5	0	0	0
Darlington	0	0	0	0	0
Pickering A	0	5.4	0	12.6	10
Pickering B	0	0	18.0	15.0	0
Gentilly-2	35	0	17.1	0	0
Point Lepreau	0	0	21.8	0	0

2.8 SITE SECURITY

The assessment of the Site Security safety area for the industry is documented in a separate (secret) *Commission Member Document* (CMD 08-M37.A).

2.9 SAFEGUARDS

In 2007, pursuant to the *safeguards* agreements between the Government of Canada and the *International Atomic Energy Agency* (IAEA), IAEA staff performed *safeguards* inspections and other verification activities at all power reactor sites in Canada. In a timely manner, all licensees provided the information necessary for the CNSC to meet its reporting commitments to the IAEA. All the licensees cooperated with the CNSC and the IAEA to successfully accomplish routine inspection activities, including design information verification, the annual simultaneous physical inventory verification, complementary accesses, and equipment installations. All licensees promptly addressed any problems or issues that arose. The IAEA has yet to report its final conclusion on the *safeguards* results in Canada for 2007; however, the CNSC expects a positive result.

Throughout 2007, the CNSC worked in close collaboration with licensees and the IAEA to develop and implement a new State-level integrated *safeguards* approach at the power reactor sites in Canada. At the multi-unit reactor sites, scheduled quarterly IAEA inspections were replaced by short-notice randomized inspections and IAEA attendance at all transfers of spent fuel to dry storage was reduced to an unannounced randomized sampling of selected transfer activities. The major part of this ongoing transition to integrated *safeguards* is expected to be in place at all power reactor sites in Canada by the end of 2008.

2.10 CONCLUSION

CNSC staff concludes that the Canadian nuclear power industry operated safely in 2007. The review of the programs in the nine safety areas, as covered by this report, confirms that the licensees had adequate programs and implementation to support the safe performance of their stations in 2007. There were no *serious process failures* at the stations in 2007. No worker at any nuclear power station, or member of the public,

received a radiation dose in excess of the regulatory limits, and emissions from all plants were below regulatory limits.

The grades assigned to the licensees for the various safety areas and programs are summarized in Tables 28 through 30. Table 28 shows the program portion of the safety area grades, and Table 29 shows the implementation portion of the safety area grades. In both tables, the grades from the three previous annual reports are shown for comparison. Table 30 repeats all the grades for all safety areas in 2007, as well as the grades for all the programs under each safety area.

Table 28 shows that the licensees' programs for the various safety areas met or exceeded CNSC requirements. However, as indicated in Table 29, in some cases, these programs were not well implemented. In every case, the risk of not meeting regulatory requirements remains low in the short term.

The industry continues to have well-developed and well-implemented programs in the Emergency Preparedness, Environmental Protection, Radiation Protection and *Safeguards* safety areas.

The CNSC has ranked a number of safety areas and programs at the "A" level, including implementation of Occupational Health and Safety (Bruce A&B, Darlington), Reliability program design (Point Lepreau), Emergency Preparedness (all stations for program and Bruce A&B, Darlington and Pickering A&B for implementation) and Radiation Protection implementation (Darlington). An "A" grade indicates an effort on the part of licensees to go beyond existing CNSC requirements and performance expectations in these areas.

The implementation of Organization and Plant Management, as well as implementation of Operations at Pickering A were both rated as "C" in 2007. As a result, the Operating Performance safety area was also given a "C" for implementation. The ratings were based on the management-related deficiencies identified as a result of the ISTB event, as well as issues related to actions and decisions taken by operators.

Pickering A was also given a "C" for the implementation of both its Quality Management and Human Factors programs. The deficiencies identified as a result of the ISTB event and the lack of noticeable improvement in the Human Factors program area since 2006, contributed to the low ratings in these areas.

Some improvement was made in 2007 in the Performance Assurance safety area. Bruce Power continued to enhance its management system, through its Process and Documents Enhancement Project (PDEP). Based on the achievements of the PDEP project, CNSC staff upgraded the documented QM program to "B" for Bruce A and B in 2007. Implementation of the QM program at Bruce A was also upgraded to a "B".

In the area of Human Factors, the program grade for Point Lepreau was upgraded to a "B" for 2007, although, due to concerns related to hours of work and incorporating

human factors into design, the implementation of the program remained assessed at a "C".

Bruce A was rated "C" for its implementation of the Training, Examination and Certification program. This was down from the 2006 report, due to serious concerns regarding preparation of candidates for the simulator-based certification examination. Gentilly-2 was rated a "C" for the implementation of its Quality Management program. This was attributed to a number of deficiencies, including Hydro-Quebec's failure to fully implement corrective actions initiated in previous years.

In the Design and Analysis safety area, the implementation of the Design program at both Bruce A and Pickering A was rated as "C". The Bruce A assessment is the result of legacy issues with design, while the Pickering A grade is attributed to design issues associated with the ISTB event.

In Equipment Fitness for Service, CNSC staff rated the implementation of the Maintenance program at Bruce A as "below requirements" due to high maintenance backlog levels. Darlington was again rated a "C" for the implementation of its Equipment Qualification program in 2007. While the implementation of the Equipment Qualification program at Darlington is evolving, it has yet to fully meet CNSC staff expectations.

Table 28: Trends of Program Grades from Annual Reports for the Nine Safety Areas at all Sites

Safety Area	Year of Report	Bruce		Darlington	Pickering		Gentilly-2	Point Lepreau
		A	B		A	B		
Operating Performance	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Performance Assurance	2004	B	B	B	B	B	C	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Design and Analysis	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Equipment Fitness for Service	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Emergency Preparedness	2004	A	A	A	A	A	A	A
	2005	A	A	A	A	A	A	A
	2006	A	A	A	A	A	A	A
	2007	**A**	**A**	**A**	**A**	**A**	**A**	**A**
Environmental Protection	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Radiation Protection	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Site Security	2004	Protected						
	2005							
	2006							
	2007							
Safeguards	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**

Legend:

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

Table 29: Trends of Implementation Grades from Annual Reports for the Nine Safety Areas at All Sites

Safety Area	Year of Report	Bruce		Darlington	Pickering		Gentilly-2	Point Lepreau
		A	B		A	B		
Operating Performance	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**C**	**B**	**B**	**B**
Performance Assurance	2004	B	B	B	B	B	C	B
	2005	C	B	B	B	B	C	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**C**	**B**	**B**	**B**
Design and Analysis	2004	B	B	B	B	C	B	B
	2005	B	B	B	B	C	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Equipment Fitness for Service	2004	B	B	B.	B	B	B	C
	2005	B	B	B	B	C	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Emergency Preparedness	2004	A	A	A	A	A	B	C
	2005	A	A	A	A	A	B	B
	2006	A	A	A	A	A	B	B
	2007	**A**	**A**	**A**	**A**	**A**	**B**	**B**
Environmental Protection	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Radiation Protection	2004	B	B	B	B	B	C	B
	2005	B	B	B	B	B	B	B
	2006	B	B	A	B	B	B	B
	2007	**B**	**B**	**A**	**B**	**B**	**B**	**B**
Site Security	2004	Protected						
	2005							
	2006							
	2007							
Safeguards	2004	B	B	B	B	B	B	B
	2005	B	B	B	B	B	B	B
	2006	B	B	B	B	B	B	B
	2007	**B**	**B**	**B**	**B**	**B**	**B**	**B**

Legend:

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

Table 30: Summary Table of Program and Implementation Grades for all Safety Areas and Programs at all Sites

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**	**C**	**B**	**B**	**B**
Organization and Plant Management	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**C**	**B**	**B**	**B**
Operations	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**C**	**B**	**B**	**B**
Occupational Health and Safety (non-radiological)	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**A**	**A**	**A**	**B**	**B**	**B**	**B**
Performance Assurance	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**C**	**B**	**B**	**B**
Quality Management	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**C**	**B**	**C**	**B**
Human Factors	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**C**	**B**	**B**	**C**
Training, Examination, and Certification	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**C**	**B**	**B**	**B**	**B**	**B**	**B**
Design and Analysis	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Safety Analysis	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Safety Issues	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Design	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**C**	**B**	**B**	**C**	**B**	**B**	**B**
Equipment Fitness for Service	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Maintenance	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**C**	**B**	**B**	**B**	**B**	**B**	**B**
Structural Integrity	P	**B**	**B**	**B**	**B**	**B**	**B**	**B**
	I	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Reliability	P	**B**	**B**	**B**	**B**	**B**	**B**	**A**
	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**	**B**
Emergency Preparedness	P	**A**	**A**	**A**	**A**	**A**	**A**	**A**
	I	A	**A**	**A**	**A**	**A**	**B**	**B**

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

Legend:

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

APPENDIX A – DEFINITIONS OF SAFETY AREAS AND PROGRAMS

OPERATING PERFORMANCE

Operating Performance relates to organization and plant management as well as overall station operation.

Operating Performance is a cross-cutting safety area that takes into account findings from all safety areas applicable to overall plant performance.

Performance Objective
Safe and secure operation of the facility solely for peaceful purposes and public confidence in the operator's ability to achieve this outcome

Organization and Plant Management

Organization and Plant Management relates to the overall review of plant management.

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. Indicators include, *inter alia*, evidence of configuration management, management self-assessment, prompt reporting to the CNSC, corrective action program, and defence-in-depth risk approaches as well as minimization of process failures and unplanned transients.

Performance Objective
Capable organization and management of safety programs that provide adequate attention to health, safety, security, environmental protection and international obligations

Operations

The Operations program relates to the performance of a plant's 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.

This area 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. CNSC staff also monitors maintenance outages to ensure reactor safety principles are maintained and that licensee programs such as maintenance, radiation protection and dose control are effectively managed.

Performance Objective
Safe and secure plant operation with adequate regard for health, safety, security, environmental protection and international obligations

Occupational Health and Safety (Non-radiological)

The Occupational Health and Safety program is mandated of all employers and employees by federal and, in most cases, provincial statutes, to minimize risk to the health and safety of workers posed by conventional (non-radiological) hazards in the workplace.

Performance indicators include lost time injuries and accident severity rate

Performance Objective
Occupational health and safety work practices and conditions achieve a high degree of personnel safety

PERFORMANCE ASSURANCE

Performance Assurance assures the safe performance of the facility through the continuous improvement and implementation of policies, programs, standards, and procedures required to manage a nuclear facility.

Quality management, Human Factors and Training, Examination, and Certification are cross-cutting programs; that is, their performance affects that of other programs and the effectiveness of overall plant management.

Performance Objective
Continued and consistent safe performance of a nuclear facility through a system of programs, policies, standards and procedures

Quality Management

Quality Management is the program of coordinated activities to direct and control an organization with regard to the safe performance of a nuclear facility.

Quality Management focuses on the achievement of results in satisfying the CNSC defined quality objectives. An operational quality management program requires the series of processes necessary for the safe performance of a nuclear power plant to be integrated and documented in manuals, policies, standards, and procedures and implemented.

Performance Objective
Adequate management oversight of the control and implementation of activities defined by the documented series of processes

Human Factors

Human Factors programs are intended to reduce the likelihood of human error by addressing factors that may affect human performance.

CNSC staff currently reviews the following human factors areas to ensure licensee compliance with regulatory expectations:

- human factors in design
- human reliability analysis
- work organization and job design (for example, staffing levels, hours of work)
- procedures
- human performance
- performance measurement
- performance improvement
- organization and management

Performance Objective
Reduced likelihood of human error by effectively addressing factors that may affect human performance

Training, Examination and Certification

Training, Examination and Certification programs ensure a sufficient number of qualified workers to carry out the licensed activities.

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 based on the review of training programs and use criteria based on the methodology called a *systematic approach to training*, not the performance of licensee candidates in certification exams. However, ongoing satisfactory certification of workers is a requirement for all stations.

Performance Objective
Sufficient numbers of qualified workers to carry out the licensed activities

DESIGN AND ANALYSIS

The Design and Analysis safety area relates to the organization's activities to confirm that systems in a nuclear power plant continually meet design requirements, given new information resulting from operating experience, safety analysis or the resolution of safety issues. Accordingly, this safety area includes the Safety Analysis, Safety Issues and Design programs.

CNSC staff evaluates the documentation of plant systems and assessment of system performance under normal and upset conditions. CNSC staff will raise an *action item* with the licensee if system performance does not meet specifications or if a new failure or degradation mechanism is discovered. The licensee must then take interim compensatory measures to maintain safe reactor operation. The issue will be monitored until it has been satisfactorily and permanently resolved.

Performance Objective
Continued safe operation of the nuclear facility through the identification and resolution of safety-related issues of design and analysis

Safety Analysis

Safety Analysis relates to the confirmation that the probability and consequences of a range of events are acceptable. It also includes an integrated review of the adequacy of the plant design with respect to safety. Analysis results are used to define safe operational limits.

Power reactor licensees routinely carry out safety analyses to confirm that plant design changes would allow potential consequences of *design basis accidents* to meet CNSC requirements. In addition, probabilistic safety assessments are performed to identify and better manage all important contributors to public risk. CNSC staff review safety analyses primarily to verify that licensees employ adequate assumptions; use validated models and analytical tools, as required by plant operating licences; have appropriate scope and demonstrate acceptable results.

Performance Objective
Demonstrated acceptability of the consequences of design basis accidents, the capability of protective systems to adequately control power, cool the fuel and contain any radioactivity that is released from the plant and the capability to adequately manage the risk contributors identified by the probabilistic safety assessment.

Safety Issues

The Safety Issue program relates to the identification and resolution of safety-related concerns arising from operational experience, analysis, research and incorporation of new knowledge or requirements. A safety-related concern that cannot be resolved based on current knowledge is referred to as an outstanding safety issue.

Those outstanding safety issues that are common to more than one station and complex in nature have been designated as generic action items (GAIs). GAIs identify areas where there is uncertainty in the knowledge basis of the safety assessment or where regulatory decisions need to be confirmed. Further work or experimental research is required to more accurately determine the overall safety impact on the facility. CNSC staff allows station operation because GAIs deal with situations where safety margins still exist. Issues with confirmed, immediate safety significance are addressed by other means on a priority basis.

Performance Objective
Timely identification and resolution of safety issues arising from operational experience, analysis, research and incorporation of new knowledge or requirements

Design

Design relates to the licensee's activities to confirm that the design of systems and equipment continually meet regulatory requirements, given changes resulting from new information, operating experience, safety analysis, the resolution of safety issues or correction of deficiencies.

CNSC staff reviews plant design to ensure licensees maintain an accurate documented description of systems and equipment, and that technical changes proposed or implemented by licensees respect regulatory requirements. CNSC staff reviews licensees' design changes and safety enhancement programs.

Performance Objective
Up-to-date plant specifications aligned to applicable regulatory requirements

EQUIPMENT FITNESS FOR SERVICE

Equipment Fitness for Service includes those programs that have an impact on the physical condition of structures, systems and components (SSC) in the plant.

This safety area covers Maintenance, Structural Integrity, Reliability, and Equipment Qualification programs. To ensure that safety-significant SSCs are effective and remain so as the plant ages, licensees must establish adequate *Environmental Qualification* (EQ) programs and integrate the results of inspection and reliability programs into their plant maintenance activities.

Performance Objective
Continued safe operation of the nuclear facility through the identification and resolution of safety-related issues involving structures, systems and components

Maintenance

Licensees are required to maintain their SSCs in a state that conforms to current design requirements and analysis results.

Licensees 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.

Performance Objective
Structures, systems, and components whose performance may affect safe operations or security remain available, reliable and effective, consistent with the design and analysis documents

Structural Integrity

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

CNSC staff requires licensees to establish strategies to manage structural integrity problems, including monitoring, assessing, mitigating, and, if appropriate, replacing degraded components. Licensees carry out periodic inspections to confirm that major primary heat transport systems and safety system components — important to worker and

public health and safety and the protection of the environment — remain fit for service. These inspections emphasize *pressure tubes*, *feeder* piping and *steam generator* tubes.

Performance Objective
Safety-significant structural components remain fit for service

Reliability

Licensees must establish a program that includes setting reliability targets, performing reliability assessments, testing and monitoring, and reporting for plant systems whose failure affect the risk of a release of radioactive material.

CNSC staff reviews of licensees' reliability programs include the following:

- reliability models and data verification
- reliability of systems important to safety
- surveillance program
- reporting

Performance Objective
Systems important to safety can and will meet their defined design and performance specifications at acceptable levels of reliability throughout the lifetime of the facility

Equipment Qualification

Equipment Qualification relates to plant-specific functional and performance requirements that ensure that SSCs are suitable for operation.

An important component of the Equipment Qualification program is *Environmental Qualification* (EQ) to ensure that equipment can perform its intended safety function in an aged condition and under extreme environmental conditions resulting from *design basis accidents*. To be deemed effective, EQ programs must meet a number of acceptance criteria developed by CNSC staff. The licensee must:

- have a documented EQ program and associated processes in place for establishing and maintaining *environmental qualification* and have all EQ-related documentation available at the station;
- ensure that EQ processes and procedures meet recognized industry standards;
- have a condition monitoring program in place to assess degradation and failures of qualified equipment during normal operation;
- have an environmental monitoring program in place to assess changes in environmental conditions in rooms that contain qualified components;
- have procedural controls in place to preserve *environmental qualification* of equipment for the life of the plant;
- ensure that the EQ program complies with the station quality assurance program; and
- train both in-house and contract personnel dealing with qualified equipment on EQ principles and related procedures

Other review topics under Equipment Qualification include seismic qualification, fire protection and electromagnetic interference/radio frequency interference (EMI/RFI).

Performance Objective
Safety and safety related systems, equipment, components, protective barriers and structures are qualified to perform their safety functions during normal operation and when exposed to harsh environmental conditions resulting from design basis accidents

EMERGENCY PREPAREDNESS

Emergency Preparedness relates to the consolidated emergency plan, the emergency preparedness program, and licensee staff performance during emergency exercises and response to real emergencies.

Licensees must establish a consolidated emergency plan with an associated emergency preparedness program and must verify the performance of their response capability by conducting evaluated exercises of simulated emergencies. To confirm the effectiveness of the emergency preparedness program of a licensee, CNSC staff assesses the licensee's emergency plan and preparedness program as well as the licensee's performance during emergency exercises. These assessments provide evidence of the effectiveness of the licensee's emergency response strategy and a level of assurance of the licensee's state of readiness.

Performance Objective
Adequate provisions for preparedness and response capability that would mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security

ENVIRONMENTAL PROTECTION

Environmental Protection relates to the programs that prevent, identify, control and monitor all releases of radioactive and hazardous substances from facilities.

CNSC regulations require that each licensee take all reasonable precautions to protect the environment and the health and safety of persons, including controlling the release of radioactive and hazardous substances to the environment. CNSC staff verifies that licensees have the appropriate policies, programs and procedures in place to prevent, identify, control and monitor releases of radioactive and hazardous substances to the environment. CNSC staff reviews of environmental performance include:

- public radiation doses
- effluent monitoring results
- environmental monitoring results
- unplanned releases

Performance Objective
Protection of the environment and the health and safety of persons by taking all reasonable precautions, including identifying, controlling, and monitoring the release of radioactive substances and hazardous substances to the environment

RADIATION PROTECTION

Radiation Protection relates to the program in place to protect 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, the regulations require licensees to establish a radiation protection program to keep exposures to radiation as low as reasonably achievable (ALARA) through the implementation of a number of control programs, including:

- management control over work practices
- personnel qualification and training
- control of occupational and public exposure to radiation
- planning for unusual situations
- verifying the quantity and concentration of any nuclear substance released as a result of the licensed activity

Performance Objective
Adequate protection of the health and safety of persons inside the facility with respect to ionizing radiation

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
- 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.

Performance Objective
Provision of a physical protection program to provide the required security for a facility and its operations

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 and a protocol additional to the agreement with the *International Atomic Energy Agency* (IAEA). These agreements provide the IAEA with the right and the responsibility to verify that Canada is fulfilling its international commitment on the peaceful use of nuclear energy.

The CNSC provides the mechanism, through the *Nuclear Safety and Control Act*, *Nuclear Safety and Control Regulations* and facility licences, for the IAEA to implement the *safeguards* agreements. Essential requirements for the application of IAEA *safeguards* are stated as specific licence conditions.

Performance Objective
Conformity with measures required by the facility to meet Canada's international safeguards obligations, through:

- *timely and accurate provision of reports on nuclear materials;*
- *provision of access and assistance to IAEA inspectors for verification activities;*
- *submission of annual operational information and accurate design information of plant structures, processes and procedures; and*
- *development and satisfactory implementation of appropriate facility safeguards procedures.*

APPENDIX B – RATING SYSTEM

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

A - Exceeds requirements

Assessment topics or programs meet and consistently exceed applicable CNSC requirements and performance expectations. Performance is stable or improving. Any problems or issues that arise are promptly addressed, such that they do not pose an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed.

B - Meets requirements

Assessment topics or programs meet the intent or objectives of CNSC requirements and performance expectations. There is only minor deviation from requirements or the expectations for the design and/or execution of the programs, but these deviations do not represent an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. That is, there is some slippage with respect to the requirements and expectations for program design and execution. However those issues are considered to pose a low risk to the achievement of regulatory performance requirements and expectations of the CNSC.

C – Below requirements

Performance deteriorates and falls below expectations, or assessment topics or programs deviate from the intent or objectives of CNSC requirements, to the extent that there is a moderate risk that the programs will ultimately fail to achieve expectations for the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. Although the risk of 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 C – 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.

beyond design basis accident (BDBA)
Accident conditions less frequent and more severe than a *design basis accident.* A BDBA may or may not involve core degradation.

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

Commission Tribunal
A corporate body of not more than seven members, established under the *Nuclear Safety and Control Act* and appointed by the Governor in Council, to perform the following functions:

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

Commission Member Documents (CMD)
Documents prepared for *Commission Tribunal* 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.

design basis accident
Accident conditions against which an NPP is designed according to established design criteria, and for which the damage to the fuel and the release of radioactive material are kept within authorized limits.

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

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

guaranteed shutdown state (GSS)
A method for ensuring that a 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)
The International Atomic Energy Agency (IAEA) is an independent international organization related to the United Nations system. The IAEA, located in Vienna, works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies. The IAEA reports annually to the UN General Assembly and, when appropriate, to the Security Council regarding non-compliance by States with their *safeguards* obligations as well as on matters relating to international peace and security.

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
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 designed to determine the underlying reason(s) for a situation or event, which is conducted with a level of effort consistent with the safety significance of the event.

safeguards
A system of international inspection and other verification activities undertaken by staff of the *International Atomic Energy Agency* (IAEA) in order to evaluate, on an annual basis, Canada's compliance with its obligations pursuant to the *safeguards* agreements

between the Government of Canada and the IAEA. In the case of Canada, the objective is for the IAEA to provide credible assurance to Canada and to the international community that all declared nuclear material is in peaceful, non-explosive uses and that there are no undeclared nuclear material or activities in this country.

Safety Reports
The *Safety Reports*, described in Regulatory Standard S-99 *Reporting Requirements for Operating Nuclear Power Plants* provides descriptions of the systems, structures, and equipment of a facility including their design and operating conditions. It includes a final safety analysis report demonstrating the adequacy of the design of the nuclear facility.

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

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

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

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

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

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

Type I inspection
An audit or evaluation carried out by CNSC staff of a licensee's programs, processes and practices.

Type II inspection
An equipment or system inspection or operating practice assessment carried out by CNSC staff, which includes item-by-item checks and rounds that focus on outputs or performance of licensee programs, processes and practices. Findings play a key role in identifying where a *Type I inspection* may be required to determine systemic problems in programs, processes or practices.

APPENDIX D – ACRONYMS

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

AECL	Atomic Energy of Canada Limited
AIR	all injuries rate
ALARA	as low as reasonably achievable
ANO	authorized nuclear operator
APS	Auxiliary Power Supply
ASR	accident severity rate
BBRA	Bruce B Risk Assessment
BDBA	beyond design basis accident
BEAU	Best Estimate Analysis and Uncertainty
CMD	*Commission Member Document*
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CSA	Canadian Standards Association
DARA	Darlington A Risk Assessment
DPSE	Darlington Probabilistic Safety Evaluation
EA	environmental assessment
ECC	emergency core cooling
EPS	Emergency Power Supply
EQ	environmental qualification
ESW	Emergency Service Water
GAI	generic action item
GSS	guaranteed shutdown state
HPECI	high pressure emergency coolant injection
HTS	heat transport system
IAEA	International Atomic Energy Agency
ISR	Integrated Safety Review
ISTB	Inter-Station Transfer Bus
LBLOCA	large break loss of coolant accident
LLOCA	large loss of coolant accident
LOCA	loss of coolant accident
LOECC	loss of emergency core cooling
LOR	loss of regulation
LTA	lost time accident
LVRF	low void reactivity fuel
LZCS	liquid zone control system
NBPN	New Brunswick Power Nuclear
NGS	nuclear generating station
NOP	neutron overpower protection
NPP	nuclear power plant
NSCA	*Nuclear Safety and Control Act*
OP&P	operating policies and principles
OPG	Ontario Power Generation

PDEP	Process and Documents Enhancement Project (Bruce Power)
PI	performance indicator
PIP	periodic inspection program
PROL	power reactor operating licence
PSA	probabilistic safety assessment
QA	quality assurance
QM	quality management
ROP	regional overpower protection
SAT	systematic approach to training
SDR	Significant Development Report
SDS	shutdown system
SRV	Steam Reject Valve
SSC	structures, systems and components
TRF	Tritium Removal Facility

APPENDIX E – SIGNIFICANT DEVELOPMENTS AND FOLLOW-UP FOR POWER REACTORS

The descriptions of significant developments are organized by site and date. Most of the information is summarized from CMDs, known as significant development reports (SDR). In the case of late-breaking developments, which were reported verbally to the *Commission Tribunal*, the information is from the Minutes of the *Commission Tribunal* meetings.

E.1 Significant Development Reports for Bruce A

E.1.1 Forced Outage at Bruce A, Unit 3

E.1.1.1 Original Description (CMD 07-M30)

On July 25, 2007, Unit 3 of Bruce A was operating at 92.5% full power, and the operators started a routine re-fuelling on a fully instrumented channel (FINCH). During the refueling process, a trip signal from the detectors adjacent to the channel being refueled caused the reactor to trip on SDS1. All systems performed as expected after the trip and the reactor remained in shutdown for two days.

Bruce Power immediately conducted an event investigation. It was determined that the wrong FINCH channel had been rejected on one of the two digital control computers. Operating procedures required the channel to be rejected on both digital control computers prior to moving fuel bundles in a fully instrumented channel, to avoid causing trip signals. The direct apparent cause was human performance, but there was also a weakness in the operating instructions, which at the time did not require independent verification. The documentation was revised immediately after the event.

There was no adverse impact to Bruce Power staff, to public safety or the environment from the event.

E.1.1.2 Follow-up

Bruce Power submitted the detailed event reports within the timeframes required by its licence. Bruce Power has completed all corrective actions related to this event. CNSC staff was satisfied with Bruce Power initial actions. Further analysis of the human performance aspects of this event is currently being conducted as part of a wider review of human performance events at Bruce Power. The review is expected to be completed by the end of June 2008.

E.2 Significant Development Reports for Bruce B

E.2.1 Containment Isolation on High Activity at Bruce B, Unit 7

E.2.1.1 Original Description (CMD 07-M30)

During the removal of a suspect defective fuel element from a channel in Unit 7, a containment radiation detector initiated containment isolation on high activity. No stack radiation alarms were received. The fuelling machine with the defective fuel was moved to the Central Service Area. Containment isolation was then reset, and no stack alarms were received in any unit. During the subsequent transfer of the fuel into the Primary Irradiated Fuel Bay, intermittent Central Service Area stack alarms came in and cleared on high iodine levels. Iodine and particulate samples were taken for the Central Service Area stack and analyzed. No exceedence of the weekly 1% of the *derived release limit* occurred. Laboratory samples of Unit 7 iodine showed that the levels had returned to those prior to the re-fuelling of the channel.

E.2.1.2 Follow-up (CMD 07-M38)

The initial SDR (CMD 07-M30) reported that the removal of a defective fuel bundle at Bruce B Unit 7 resulted in containment isolation on high radiation. Subsequent examination of the bundle revealed multiple weld failures between the fuel sheath and the endcaps. While weld failures have been observed in the past, multiple failures on a single bundle are unprecedented in recent Canadian power reactor history.

Based on the normal continuous monitoring of the iodine level in the heat transport system, both before and after removal of the defective bundle, the weld failures opened up significantly during the de-fueling operation, while the bundle was pushed into the fueling machine. However, while the bundle was in the reactor, the shut-down limit for total iodine in the heat transport system was never approached.

Since August 9, 2007, Bruce Power has removed one other defective bundle from Bruce B Unit 5, in mid-October. The second defective bundle showed evidence of a couple of weld defects, but not to the extent observed in the first bundle. The iodine levels in all operating Bruce Power reactors remain well below the shut-down limit.

E.2.1.3 Additional Information (from Minutes of Dec. 5, 2007 Commission Tribunal Meeting)

CNSC staff provided the *Commission Tribunal* with an update on the actions taken by the licensee and the CNSC since the submission of the SDR. CNSC staff stated that it was determined that the two bundles were manufactured on the same day at Zircatec Precision Industries Inc. (Zircatec), and as a result, Bruce Power is monitoring all bundles produced since November 2005.

CNSC staff reported that the *root cause analysis* is in a preliminary stage, since no definitive conclusion on the cause of the defects can be drawn until post-irradiation

examinations are completed. CNSC staff does not expect any results until the end of August 2008.

CNSC staff stated that its special inspection of Bruce Power's fuel management program has shown no further corrective action from Bruce Power is necessary, and that the measures taken by Bruce Power were acceptable.

Bruce Power reported that it has approximately 15,000 fuel bundles in quarantine, 103 of which are higher risk. Bruce Power noted that a *root cause analysis* is being conducted at Bruce Power and Zircatec.

Bruce Power stated that there has been no increased risk to the public or workers from this event, and that the situation is being managed.

E.2.1.4 Follow-up

Bruce Power removed the last of the "higher risk" bundles in March 2008. There have not been any further fuel problems since the removal of the second defective bundle in October 2007. The post-irradiation examinations are continuing and have not yet determined a definitive root cause.

E.3 Significant Development Reports for Darlington

E.3.1 Darlington NGS – Contamination of Virgin Heavy Water

E.3.1.1 Original Description (CMD 07-M30)

In March 2007, Ontario Power Generation (OPG) shipped 12 drums of Virgin Heavy Water (VHW) to a customer in the United States (USA), under valid export licenses. This customer is in the stable isotope production and sales business, and has resold 7 kilograms of VHW from the OPG shipment to three other organizations. One of the organizations, upon receiving and testing the VHW, found it to be contaminated with 20 millicuries of tritium per kilogram of heavy water.

On June 28, 2007, after confirming the result through independent analysis, the customer notified OPG of the finding, adding that only one of the twelve drums was contaminated. OPG reported the event to the CNSC the same day. The total weight of the heavy water in the drum was 149 kilograms, with a total tritium content of 110.37 GBq (2980 millicuries).

The shipment resulted in the following violations:
a) Nuclear Substances and Radiation Devices Regulations (NSRD)
- Exemption quantity for export of nuclear substance was exceeded (1 GBq)

b) PROL 13.15/2008 LC 8.1 - Radiation Protection Requirements
- Tritium content above fixed beta-gamma activity limit for such a transfer

These two violations were reported to the CNSC as per S-99 Reporting Requirements.

OPG immediately put all the movements of VHW on hold, and initiated an investigation into the potential origin of the tritium contamination and the root causes of the event. The contaminated heavy water in the USA was quarantined and controlled. OPG determined that there was no dose to the public, OPG staff, or their customers from this event. OPG also reviewed its shipments to other customers, made since January 2006, and verified that no contamination existed in any other shipments.

In order for the contaminated heavy water to be returned to OPG for processing, an import licence was requested and subsequently issued by a CNSC Designated Officer. With the exception of one kilogram of heavy water that was absorbed in a container, which will be incinerated along with other tritiated waste (as per a Nuclear Regulatory Commission licence), the rest will be consolidated by the customer in the USA and shipped back to OPG.

CNSC staff notified OPG that no further transfer of heavy water should take place outside of OPG and its associated facilities at the Bruce site, until adequate assurance has been provided that such an event is not likely to recur. CNSC staff also initiated a focused inspection of this event. As part of the inspection, the staff monitored the internal OPG root cause investigation. CNSC staff met with OPG's investigators and managers, to ascertain that the scope of the OPG investigation was consistent with what the CNSC staff believes was adequate, and to discuss the progress to that date.

OPG has completed a preliminary root cause report, and has advised CNSC staff of the findings. Based on this information, CNSC staff indicates the recommended corrective actions should adequately address the findings. However, until the final OPG investigation and root cause reports are submitted, and CNSC staff is satisfied that the corrective actions are adequate, all the shipment restrictions that are currently imposed on OPG will continue to apply.

E.3.1.2 Follow-up

OPG has provided the following information to support their resumption of VHW shipments:

a) The results of OPG's investigation, including *root cause analysis* of the event.
b) The actions taken to minimize the possibility of recurrence for such an event.

CNSC staff believes that the incident investigation report has adequately identified the root causes of the event. CNSC staff agrees with OPG that the corrective actions for the root causes should be sufficient to prevent further recurrence. CNSC staff has subsequently approved OPG to resume shipments of heavy water outside of OPG and Bruce Power Facilities.

E.4 Significant Development Reports for Pickering A

E.4.1 Reactor Trip at Pickering A Unit 4

E.4.1.1 Original Description (CMD 07-M10.A)

On February 9, 2007, while operating at low power, the Unit 4 reactor tripped on low heat transport system pressure, during cooldown. The slow response of the pressure control circuit caused a drop in heat transport pressure. The problems were corrected and the unit returned to power.

E.4.1.2 Additional Information (from Minutes of April 11, 2007 Commission Tribunal Meeting)

CNSC staff indicated that it has followed up on the event and that it was satisfied with OPG's response. CNSC staff added that it will be reviewing the detailed root cause assessment and follow-up actions to the event.

OPG explained that the trip occurred due to deficiencies with the control of the heat transport system pressure. The parameters have since been corrected on Unit 4 and confirmed to be correct on the other operating reactor (Unit 1). OPG stated that there was no impact on the public or on employee safety from the event.

E.4.2 Pickering A - Unit 4 Reactor Trip on Shutdown System Enhancement Heat Transport Low Pressure

E.4.2.1 Original Description (CMD 07-M17)

On April 17, 2007, at 22:22 hrs, during unit restart, with the reactor at less than 1% full power, a Shutdown System Enhancement (SDSE) Heat Transport Low Pressure (HTLP) trip occurred. The operators were performing troubleshooting activities, trying to correct a heat transport heavy water leakage to collection.

The CNSC staff is satisfied with the immediate actions taken by the licensee following the event. There was no release to the environment, no immediate risk to the public or the workers related to this event, and the safety margins were not reduced, since the reactor tripped as per design.

E.4.3 Pickering A - Units 1 and 4 Shut Down Because of Potential Loss of Electrical Power

E.4.3.1 Original Description (CMD 07-M17.A)

On May 2, 2007, it was discovered that a cable entry at the bottom of an electrical panel on Unit 2 was not appropriately sealed, as required, to prevent steam ingress. Various electrical rooms on Pickering A are designated as "steam-proof". They house essential electrical equipment, which can be powered via the Inter-Station Transfer Bus (ISTB) from Pickering B. The equipment is required to operate after a main steam line break.

Actions were initiated to seal the non-qualified opening area, which was less than the allowable opening size for system impairment. Additional checks were initiated, to determine the extent of condition.

On May 6, 2007, during additional checks, a number of holes exceeding the allowable size were found in a room on Unit 4. This represented a reduction in margin of safety, and a shutdown clock of 30 days was initiated (i.e. shut down Units 1 & 4 by June 6, 2007, if availability of the system could not be confirmed).

During the inspection and repair of the steam protected rooms, another problem was discovered. It was related to modifications made in 2005, which had removed the power supply to the ventilation of the Unit 3 steam protected rooms. Without this ventilation, the availability of the ISTB could not be guaranteed in the event of a main steam line break. Without the ISTB, all power to the station could be lost in the event of a main steam line break. As a result, on Monday, June 4, a decision was made to shut down Units 1 and 4.

CNSC staff initiated a focused inspection, involving specialists and site personnel on June 8, 2007, and will remain informed of this issue until it is resolved.

E.4.3.2 Follow-up (CMD 07-M30.A)

OPG recognized an under-capacity problem associated with the ISTB, when calculations determined (and were confirmed by testing) that the voltage drop in the cables would be excessive, resulting in insufficient power to the Pickering A units. Although operational changes were made at that time, with the intent of correcting this problem, it is evident that they were not adequate.

OPG proposed a temporary solution, involving the installation of additional cables from Pickering B to Pickering A, and removing some non-essential loads from the ISTB, to reduce the demand for power. CNSC staff has reviewed the proposed solution and agrees with the concept.

In the longer term, OPG will implement permanent changes to the ISTB design, which could include dedicated ISTB supply transformers, voltage regulators and capacitor banks, to increase ISTB voltage. CNSC staff is actively monitoring the resolution of this issue, in both the short and long term.

E.4.3.3 Additional Information (from Minutes of September 13, 2007 Commission Tribunal Meeting)

CNSC staff reported that, since the preparation of the SDR report, OPG successfully completed its testing of the modified ISTB. OPG also requested CNSC approval for the temporary operational changes required to resolve the loading problems of this bus. CNSC staff further noted that it intends to approve this request, and that the return to service of Units 1 and 4 is imminent. CNSC staff indicated that it will review the *root cause analysis* recently submitted by OPG.

E.4.3.4 Additional Follow-up (CMD 08-M4)

Since the events of May and June 2007, OPG designed and installed temporary modifications to restore functionality to the ISTB. The new configuration was tested, and load capacity and voltage drops met OPG's specifications. OPG requested CNSC approval to make operational changes for these temporary modifications, before the units were restarted. CNSC approval was given, and the first unit was restarted in October 2007.

CNSC staff formed an inspection team, and conducted a review of OPG's response to the impairment of the ISTB. The CNSC team reviewed in detail the engineering design and operational changes implemented to restore the ISTB function, along with OPG's Root Cause Investigation Report and Extent of Condition reports.

To date, CNSC staff has closely followed the design and installation of the temporary modifications, performed the review of OPG's response to this issue, and is tracking the progress of the permanent ISTB installation.

E.4.4 Pickering A & B – Findings from 28-Element Dryout Power Tests

E.4.4.1 Original Description (CMD 07-M30.A)

At the annual joint CANDU Owners Group (COG)-CNSC R&D Seminar in May 2007, research findings, from tests done in the spring of 2006, reported that the dryout power of the 28 element fuel bundles was lower than previously believed. These findings call into question the ability of the shutdown systems to prevent fuel damage at the stations that use this design of fuel, namely Pickering A and B.

The dryout power refers to the point at which the rate of energy deposition into the fuel sheath exceeds the ability of the coolant flow to remove it. As a result, the sheath becomes blanketed locally with steam, which further reduces the ability of the coolant to remove the generated heat (since steam functions as an insulator) causing the fuel to heat up. The design intent of the shutdown systems is to reduce reactor power before any bundle reaches the dryout threshold.

On June 21, 2007, OPG made a presentation to CNSC staff, indicating that the impact of the lower dryout power was insignificant, except for the effectiveness of the neutron overpower protection (NOP) trip, which is designed to protect the reactor in the event of a power transient such as a loss of reactivity control. Following a review of the S-99 reports and of the information provided, CNSC staff concluded that interim mitigating measures had to be put in place, to restore safety margins.

CNSC staff requested OPG, in a letter dated August 13, 2007, to take compensatory actions prior to the restart of Pickering A Units 1 and 4, in order to restore the safety margins and performance of the shutdown systems. This was to be done by implementing a 5% FP penalty on NOP trip setpoints. OPG has confirmed that it will take the

appropriate actions, and will also implement a 1% penalty on NOP trip setpoints for the Pickering B units (on which a 4% penalty already exists, for other reasons.)

CNSC staff has investigated the applicability of the research findings to the 37-elements bundles that are used at Bruce, Darlington and the CANDU-6 units, and has concluded that no mitigating action is necessary, since their experimental evidence continues to be reliable.

E.4.5 Public Report of Water in the Pressure Relief Duct at Pickering NGS

E.4.5.1 Original Description (CMD 07-M30.A)

On July 19, 2007, the Toronto Star reported that a *"hole in a radiation containment system at Pickering Generating Station has not been fixed more than a month after detection, sparking concern that Ontario Power Generation is dragging its feet on safety and keeping important information hidden from the public."* The Toronto Star became aware of the matter after an individual claiming to be a concerned employee of OPG mailed an anonymous letter.

The author of the article had called the CNSC, and been told that CNSC staff was aware of the situation, which had no safety significance. Rainwater can collect on top of the duct and seep into it at a hinged joint through capillary action (because the duct is at slightly negative pressure) causing an occasional puddle on the floor of the duct. This does not impair the ability of the duct to function as part of the negative pressure containment system. An inspection conducted after the puddle had been found determined that the hinged joint was in good condition. Because this was below the threshold of the regulatory reporting criteria in S-99, it was not reported formally to the CNSC.

The subject was reported to the *Commission Tribunal*, in view of the level of public interest, pursuant to the criteria of CMD 03-M68.

E.4.6 Pickering A – Unit 4 Reactor Trip on Heat Transport System Overpressure

E.4.6.1 Original Description (CMD 07-M38)

On October 8, 2007, during a reactor *setback*, the turbine was tripped and caused a reactor trip on Heat Transport System (HTS) over-pressure. Due to known problems with the turbine controls (i.e., speeder gear), a prolonged reactor *setback* will result in HTS under-pressure, and will require a turbine trip to prevent a HTS low pressure trip. To compensate for the HTS low pressure condition, the operators had both heat transport pressurizing pumps in service. When the turbine was manually tripped, the heat transport pressure control response was too slow to prevent a heat transport high pressure trip.

The licensee filed a Technical Procedure Action Request (TPAR) to update the *Setback* portion of the Overall Unit Manual (OUM), discussing the preferred method of turbine

runback to lead a reactor *setback*. The CNSC staff has reviewed the relevant operating logs and records, to confirm appropriate station response.

E.4.6.2 Additional Information (from Minutes of December 5, 2007 Commission Tribunal Meeting)

CNSC staff stated that it is satisfied with OPG's handling of the incident, and that there was no increase in risk during that time. CNSC staff also stated that it is satisfied that the proposed changes to the procedures will reduce the likelihood of similar events.

E.5 Significant Development Reports for Pickering B

E.5.1 Multi-Unit Forced Outage at Pickering B

E.5.1.1 Original Description (CMD 07-M4.A)

On December 21, 2006, Unit 6 of Pickering B was shut down after OPG discovered impurities in the boiler feedwater system. The boiler feedwater must be pure de-mineralized water to prevent long-term degradation of the boiler tubes.
On January 6, 2007, Unit 8 was shut down due to the same boiler chemistry issue.
In addition to the forced shutdown of Units 6 and 8, the station-wide impact of this issue delayed the restart of Unit 7 (which had just completed a planned outage) so that from January 6 until January 16 only Unit 5 was operating at Pickering B.

A condition of the Pickering operating licences requires CNSC approval for continued operation beyond four days if only one unit of the station is operating. In this configuration (single unit operation) a high pressure emergency coolant injection (HPECI) pump must be kept running with its electrical supply from a dedicated standby generator. CNSC staff approved the continued operation of Pickering A and B stations with a standby generator supplying the running HPECI pump until a second unit could be restarted.

OPG's investigations determined that the cause of the boiler chemistry problems was resin in the de-mineralized water supply. The release of resin was caused by an equipment failure in the station water treatment plant that supplies the de-mineralized water system. Resin breakdown at high temperatures, such as those in the boilers, contributes to high sulphates that can be damage tubes over the long term. For these reasons, OPG undertook a thorough clean up of the boiler water supply system, including the de-mineralized water header, tank and feedwater supply in those units affected by the resin contamination. OPG is also conducting an investigation to ensure that the causes of this event are understood so that a repeat does not occur.

While the event resulted in the release of some resin to the lake, the impact on the environment was below the levels requiring CNSC notification (OPG notified the Ontario Ministry of the Environment, however.) CNSC staff is satisfied that OPG took adequate corrective actions to ensure safe continued operation of the stations during this event, and that there was no adverse impact to OPG staff or public safety or the environment.

E.5.2 Reactor Trip at Pickering B Unit 5

E.5.2.1 Original Description (CMD 07-M10.A)

On January 28, 2007, Unit 5 underwent a process transient causing the reactor to trip. One bus of the Uninterruptible Power Supply failed, which caused the new digital process controllers in the Heat Transfer System to lose power for long enough to cause a pressure transient, which led to a reactor trip of both Shutdown Systems.

E.5.2.2 Additional Information (from Minutes of April 11, 2007 Commission Tribunal Meeting)

CNSC staff indicated that it was satisfied with OPG's response to the incident, and agreed that returning the reactor to power was safe. CNSC staff indicated there was minimal risk to the public as a result of this event, and that it will be reviewing detailed reports concerning the apparent root causes of the process failures and the proposed follow-ups for correction.

E.6 Significant Development Reports for Gentilly-2

E.6.1 Manual Tripping of Shutdown System at Gentilly-2

E.6.1.1 Original Description (CMD 07-M10)

CNSC staff was notified at about 08:00 hrs, on January 25, 2007, of the shutdown of the reactor, following the manual tripping of shutdown system No. 1.

On the morning of January 25, at approximately 05:30 hrs, computer X showed an illogical reactor power reading and erratic behaviour of the control programs. When the automatic transfer of control programs to computer Y failed, the shift supervisor decided to manually trip shutdown system No. 1. When computer X failed to reboot, all the station's control programs were manually routed to computer Y.

Investigation by the licensee showed that a defective analogue board was the reason for the malfunction of computer X. The board was replaced, and the control programs were restarted. Computer X returned to normal operation, and was once again available for all control and alarm functions. After everything had been verified, the reactor returned to full power on January 27, 2007.

The CNSC was satisfied that the incident had no negative effects on the station, the employees, the public or the environment. CNSC staff is satisfied with the steps taken by the licensee as well as the licensees' review of the event and implementation of corrective measures.

E.7 Significant Development Reports for Point Lepreau

E.7.1 Actuation of Both Shutdown Systems at Point Lepreau

E.7.1.1 Original Description (CMD 07-M38)

At approximately 22:00 hrs, on September 24, 2007, the station was shut down unexpectedly from high power (90% FP) operation when both Shutdown System One (SDS1) and Shutdown System Two (SDS2) actuated following the detection of Regional overpower protection (ROP) conditions in the reactor core.

The event occurred when a Liquid Zone Control System (LZCS) level indication upset (erroneous indication) caused a bank of adjuster rods to drive out of the reactor core. The maneuver was initiated under the control of the Reactor Regulating System, when the indicated average zone level (erroneous indication) dropped to below 20%. The change of reactivity mechanism configuration resulted in localized reactor power increases, which were detected and terminated by both SDS1 and SDS2.

NBPN staff attributed the cause of the LZCS indication upset to instability in the LZCS balance header pressure, which resulted in false low-level indications from the LZCS instrumentation.

E.7.1.2 Follow-up (CMD 08-M21.D)

NBPN staff concluded this event was not a *serious process failure*, on the basis that the bulk control of reactor power was being maintained by the regulating system via the liquid zone controllers and adjuster rod movement. Other reactivity mechanisms, such as the Mechanical Control Absorbers, were also available to limit reactor power. CNSC staff concurs with this assessment. CNSC staff is satisfied with the steps taken by the licensee to address any necessary corrective measures.

APPENDIX F – CANDU SAFETY ISSUES

As described in Section 2.3.2, the CNSC initiated a project in 2007 to identify safety issues associated with the design and analysis of Canadian CANDU reactors. The identified issues were grouped into 3 categories based on risk considerations. This included the GAIs (see Table F.1), which were re-assessed in the context of all outstanding safety issues. Category 3 issues are potentially risk-significant. They represent areas where uncertainty in knowledge exists or the current approaches need to be confirmed. Through the application of the risk-informed decision making process, the Category 3 issues can be broadly grouped as follows:

Positive Void Reactivity and Large LOCA

Many CANDU safety issues are related to the positive void reactivity coefficient of the reactor, which leads to challenges in Anticipated Operational Occurrences and *design basis accidents* where core void increases as a result of the initiating event. In particular, a Loss of Regulation (LOR), a Loss of Flow and a Loss of Coolant Accident (LOCA) are all made more severe by positive feedback. Among these accident scenarios, a Large LOCA is the most difficult accident to analyze for a CANDU reactor, because many aspects of the reactor behavior under accident conditions, and its computer modeling, are subject to considerable uncertainties.

GAIs 95G05, 95G04, 99G02, and 00G01 are included under this safety issue.

Safety Analysis Methodology

The neutron overpower protection/regional overpower protection (NOP/ROP) trip setpoint function is to provide the reactor trip for the analyzed core states prior to fuel dryout. The trip setpoint is designed to prevent any potential fuel damage, primarily for slow loss of regulation events. An inadequate NOP/ROP trip may lead to fuel failures, affecting a significant portion of the fuel channels prior to reactor shutdown on other trips.

Issues have been raised by CNSC staff in association with the NOP/ROP analysis methodology and its assumptions. These are being currently addressed by the industry in the context of the development of the new (improved) NOP/ROP analysis method. The industry states that new methodology also addresses aging issues. The new method is under review by the CNSC. Continued effort is needed to agree on an acceptable NOP trip setpoint methodology such that the risk from fuel dryout and possible consequential fuel channel failure is negligible.

ECC Sump Screen Adequacy

The issue as described in the IAEA TECDOC has been closed. However, a related issue has been identified in US research into chemical effects in sump water. The CNSC raised GAI 06G01 “ECC Strainer Deposits” to address the concern.

Hydrogen Control Measures during Accidents

Although this has been a long-standing issue, the industry has developed a sufficient understanding of hydrogen behavior during accidents, and has developed technology to effectively manage both short- and long-term hydrogen production during accidents. As part of closure of GAI 88G02, licensees have committed to installing passive autocatalytic recombiners to improve hydrogen control during accidents.

Aging of Equipment and Structures and its Impact on Safe Plant Operation

Safety-related functions in nuclear power plants must remain effective throughout the life of the plant. Licensees are expected to have a program in place to prevent, detect and correct significant degradation in the effectiveness of important safety-related functions.

Licensees have Aging Management programs as well as Fitness-For-Service Guidelines for life limiting components (i.e., *feeders, pressure tubes, steam generator* tubes). However, licensee programs for management of aging of other systems and components, have not been implemented systematically as yet, and there are concerns that aging degradation in components other than *feeders, pressure tubes* and *steam generators* is not adequately managed. In addition, licenses need to make sure that aging effects are taken into account when establishing appropriate operating limits and conditions.

Open Design of the Balance of Plant – Steam Protection

In some stations, the steam line break and feedwater line breaks are the largest contributors to the Core Damage Frequency and the Large Release Frequency, accounting for about 70% to 80%. This is due to the fact that a steam line break impacts on the entire turbine and many electrical cabinets, and instrument air would fail. The turbine hall is an open design with very little steam protection.

Bruce Power has installed baffle walls in several parts of the turbine hall to protect electrical rooms, and other multi-unit stations may need to address the status of steam protection. Licensees need to consider practicable measures to reduce the probability of consequential failures of support systems to control, cool, and contain (e.g., instrument air, electrical, heating ventilation air conditioning, emergency forced air discharge system, and air cooling units).

Systematic Assessment of High Energy Line Break Effects

On the secondary side, all CANDU NPPs have constructed isolation barriers/engineered restraints and are establishing a second control room to reduce impact from high energy line breaks. For the primary side, Darlington was the first station that explicitly and fully addressed the requirement for protecting the structures, systems and components (SSCs) from effects of postulated Primary Heat Transport pipe rupture. By constructing isolation barriers/engineered restraints against jet impingement/pipe whip, or being satisfied with the leak-before-break criteria, Darlington has adequately protected the SSCs from the consequences associated with a postulated rupture of high-energy piping. However, the

issue of high energy line break on the primary side was not fully addressed in the design stage for other stations. It is important to note that a probabilistic justification was used to minimize the number of locations of high concern.

Licensees need to do an assessment to identify vulnerabilities and implement corrective measures where practicable. In addition, licensees should carry out appropriate inspection and maintenance activities to support fitness-for-service of high energy pipe.

Analysis for Pressure Tube Failure with Consequential Loss of Moderator

Tests have shown that in circumstances where the *calandria tube* fails after a *pressure tube* break, there is a possibility of ejecting the end fitting and draining of the moderator. The current *Safety Reports* do not include scenarios involving a LOCA and a loss of moderator. The issue is relevant only to the dual failure in-core LOCA and loss of emergency core cooling (LOECC) since the moderator is credited as the ultimate heat sink for the reactor.

The unavailability of the moderator as a backup heat sink, during an in-core LOCA and LOECC could lead to a severe core damage accident. Furthermore, the results of fuel channel burst tests conducted by the industry suggest that pressure tube rupture events leading to a large loss of moderator are more probable than previously assumed.

GAI 95G02 is included under this safety issue. The industry has submitted the plans of actions to reduce the potential risk associated with this postulated event. CNSC staff has, in principle, agreed with the proposed administrative measures taken to mitigate the potential consequences of this event, and also agreed that implementation of any substantial design changes to reduce the likelihood of the event could be done during plant refurbishment and replacement of fuel channels.

Molten Fuel/Moderator Interaction

This safety issue is captured under GAI 95G01. High pressure injection of molten fuel in the cold moderator may occur during an in-core LOCA, that follows a stagnation *feeder* break or flow blockage, possibly leading to a steam explosion. The additional loads due to molten fuel/metal interaction may cause impairment of the shut-down function (failure of SDS1 rods guide tubes). In addition, the fuel cooling function may be impaired if several channels consequentially fail due loads generated during the molten fuel/metal interaction. If neither the shut-down function nor cooling function fails, there is still a significant likelihood that *design basis accidents* may propagate to severe core damage. As the containment integrity is not expected to be challenged, the public doses are not expected to be significant.

Early experimental results indicate that the magnitude of the damage and its likelihood are low. Nevertheless, completion of the planned sets of experiments is recommended to improve the confidence in the adequacy of the design and the understanding of molten fuel/metal interaction phenomena.

Adequacy of Reliability Data

A well-organized component reliability database is a prerequisite to enable the quantitative evaluation (e.g. PSA) of a nuclear power plant.

Recording reliability data is a requirement for *special safety systems*. Reliability data must be reported as a part of the Annual Reliability Report required by Regulatory Standard S 99.

PSA work in Canada utilizes CANDU component failure databases, which have been developed by the utilities, based typically on their plant-specific operating experiences. A need for a generic CANDU component database has been realized and AECL is in the process of starting a pilot project to develop such a generic database. Various CANDU utilities are being invited to participate in this pilot project by providing their plant-specific database to AECL for a selected set of components.

Table F.1 provides brief descriptions of the GAIs that were open in 2007. Several of these GAIs are on track for closure in 2008.

Table F.1: Generic Action Items Open in 2007

GAI	Title	Brief Description	Expected Closure Date
88G02	Hydrogen behaviour in CANDU nuclear generating stations	Loss of coolant accidents can lead to substantial hydrogen releases into containment. Containment integrity must be assured.	2008
94G02	Impact of fuel bundle condition on reactor safety	The effects of bundle degradation on reactor safety are not fully known, partially because of limitations of safety analysis methods. It is necessary to conduct an integrated evaluation of information obtained from inspections and examinations, research and safety analyses.	2008
95G01	Molten fuel-moderator interaction	Severe flow blockage in a fuel channel, or flow stagnation, could potentially lead to fuel melting and ejection of molten fuel into the moderator. This scenario and its potential consequences need to be well understood.	2009
95G02	Pressure tube failure with consequential loss of moderator	For dual failures involving pressure tube rupture plus loss of ECC the moderator may not be available to provide cooling for the fuel channels, due to the possibility of end fitting ejection leading to moderator drainage. Severe accident frequency following this scenario needs to be determined.	2008

95G04	Positive void reactivity uncertainty - treatment in large LOCA analysis	Accuracy of void reactivity calculations is a significant safety issue in the analysis of *design basis accidents* involving channel voiding especially for large LOCAs. Uncertainties and safety margin adequacy are the main questions.	TBD
95G05	Moderator temperature predictions	In some large LOCA scenarios, channels may fail if the moderator temperature is too high to prevent calandria tube external dryout. Computer codes predicting moderator temperatures need to be adequately validated.	2008
99G01	Quality assurance of safety analyses	Inadequate QA has resulted in the past in poor safety analyses. The CNSC expects licensees to conduct operations in accordance with an adequate QA program.	2008
99G02	Replacement of reactor physics computer codes used in safety analyses of CANDU reactors	Shortcomings need to be rectified, with respect to inaccurate computer code predictions of key parameters for accident conditions, lack of proper validation and a lag of licensees' methods and codes behind the state of knowledge in this area.	2008
00G01	Channel voiding during a LOCA	At issue is the adequate validation of computer codes used for prediction of overpower transients for CANDU reactors with a positive coolant void reactivity coefficient.	2009
01G01	Fuel management and surveillance software upgrade	Compliance with reactor physics safety limits defining the safe operating envelope, such as channel and bundle power limits, has enhanced the need for an improved analytical model, validated over a broader range of applications and conditions plus better-defined compliance allowances and more consistent procedures.	2008
06G01	Emergency core coolant (ECC) strainer deposits	A postulated LOCA would dislodge significant quantities of insulation material which could potentially lead to partial blockage of the strainers, thereby impairing ECC recirculation. Station-specific studies need to be undertaken and appropriate compensatory measures taken.	2008

INFO - 0770