Canada's Nuclear Regulator

CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2008

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Canadian Nuclear Safety Commission
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Canada

CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2008

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Cover Images: Canadian Nuclear Power Plants
From left to right:
Bruce A and Bruce B Nuclear Generating Stations (Tiverton, Ontario)
Darlington Nuclear Generating Station (Bowmanville, Ontario)
Gentilly-2 Nuclear Generating Station (Bécancour, Québec)
Pickering A and Pickering B Nuclear Generating Stations (Pickering, Ontario)
Point Lepreau Nuclear Generating Station (Point Lepreau, New Brunswick)

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EXECUTIVE SUMMARY

Every year, the Canadian Nuclear Safety Commission (CNSC) publishes a report on the safety performance of Canada's operating nuclear power plants (NPPs). The *CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants*—formerly titled the *Annual CNSC Staff Report on the Safety Performance of the Canadian Nuclear Power Industry* and currently abbreviated as the 'NPP Report'—evaluates how well licensees are meeting regulatory requirements and CNSC expectations for the ongoing implementation of their programs.

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

The 2008 NPP Report has undergone some changes aimed at making the report clearer and the underlying assessment more process-based. This year and going forward, the CNSC is adopting a risk-informed decision-making approach in determining the safety ratings. This new approach helps to incorporate all the findings over the year and introduces an integrated plant rating, which will allow the CNSC to better identify and monitor performance trends over time.

Rating categories in this year's report have been renamed. Previously, the NPP Report used a five-level letter grading system: A, B, C, D, and E. Starting with this report, there are four levels and ratings, expressed as "Fully Satisfactory (FS)", "Satisfactory (SA)", "Below Expectations (BE)" and "Unacceptable (UA)."

As a result of their assessments, CNSC staff concluded that nuclear power plants in Canada operated safely during 2008:

- There were no serious process failures at the NPPs.
- No workers at any NPP, or a member of the public, received a radiation dose above the regulatory limits.
- None of the environmental releases from the plants were above regulatory limits.
- Canada was able to meet its international obligations regarding the peaceful use of nuclear energy.

No Canadian nuclear power plant received a safety area or program rating lower than "Below Expectations." CNSC staff continues to closely monitor those plants that received a "Below Expectations" rating, in any safety area or program, to ensure that the licensee has taken—or is taking—appropriate action to fully meet the objectives of CNSC requirements and performance expectations.

The following chart summarizes the results for Canada's NPPs, as evaluated across the safety areas and programs:

Safety Area / Program	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Operating Performance	**SA**	**SA**	**FS**	**SA**	**SA**	**SA**	**FS**
Organization and Plant Management	SA	SA	FS	BE	BE	SA	SA
Operations	SA	SA	FS	SA	SA	SA	FS
Occupational Health and Safety (non-radiological)	FS	FS	FS	SA	SA	SA	FS
Performance Assurance	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**
Quality Management	SA	SA	SA	SA	SA	BE	SA
Human Factors	SA	SA	FS	BE	BE	SA	SA
Training, Examination, and Certification	SA	SA	SA	SA	SA	SA	SA
Design and Analysis	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**
Safety Analysis	SA	SA	SA	SA	SA	SA	SA
Safety Issues	SA	SA	SA	SA	SA	SA	SA
Design	BE	SA	SA	BE	SA	SA	SA
Equipment Fitness for Service	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**
Maintenance	BE	BE	FS	SA	SA	BE	SA
Structural Integrity	SA	SA	FS	SA	SA	SA	SA
Reliability	SA	SA	SA	SA	SA	SA	SA
Equipment Qualification	SA	SA	BE	SA	SA	SA	SA
Emergency Preparedness	**FS**	**FS**	**FS**	**SA**	**SA**	**FS**	**FS**
Environmental Protection	**SA**	**SA**	**SA**	**BE**	**BE**	**SA**	**SA**
Radiation Protection	**SA**	**SA**	**FS**	**SA**	**SA**	**SA**	**SA**
Security	**Prescribed**						
Safeguards	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**
Integrated plant rating	FS	FS	FS	SA	SA	SA	SA

INTRODUCTION

This report summarizes the Canadian Nuclear Safety Commission (CNSC) staff's assessment of the safety performance of operating nuclear power plant (NPP) licensees in 2008.

To meet the legal requirements of the *Nuclear Safety and Control Act* (NSCA) and its associated regulations, all licensees must implement programs that "provide adequate provisions for the protection of health and safety of persons, and the environment, and for maintenance of national security, and the measures required to implement Canada's international obligations with respect to the peaceful use of nuclear energy." In other words, licensees are responsible for ensuring that their plants are operating safely.

The safety performance assessment is based on the legal requirements of the NSCA and its regulations, as well as operating licence conditions and applicable standards. The evaluations in this report are based on information gathered through CNSC staff monitoring, inspections, general surveillance, document assessments, event reviews, and performance indicators.

Performance is reported in nine safety areas, eight of which are reported publicly:

- Operating performance
- Performance assurance
- Design and analysis
- Equipment fitness for service
- Emergency preparedness
- Environmental protection
- Radiation protection
- Safeguards

The ninth safety area is "Site security", which is addressed in a separate and confidential report. Detailed descriptions of the safety areas and their associated programs are given in Appendix A.

NEW FOR 2008

The 2008 NPP Report has undergone some changes, aimed at making the report clearer and the underlying assessment more process-based. The new assessment approach improves on the previous CNSC approach and builds on best practices used by peer organizations globally—including, for example, the nuclear regulators of the United States, United Kingdom, and Finland.

For this year's report and going forward, the CNSC is adopting a risk-informed decision-making approach. The term "risk-informed" means that the risk to safety is considered together with other inputs—such as regulations, licence conditions, and professional judgment—to confirm the safety of the operation. This approach provides the regulator with a better integration of all the findings over the year, when determining the safety ratings. It also facilitates an overall—or "integrated"—plant rating. To establish that integrated plant rating, the CNSC ranked the safety significance of each of the eight safety areas (excluding security), so as to determine their relative "weight" on overall plant safety. Over time, having an integrated plant rating will allow the CNSC to better identify and monitor performance trends.

Also new this year is a shift away from publishing separate ratings for Program and Implementation. Programs are evaluated and rated as part of the licence application and approved by the CNSC at that time, or again when they undergo a change required by new information, evolving standards, regulatory requirements or operating experience. For this reason, they do not need to be evaluated every year. Instead, they have been replaced in this report by a single rating for safety performance.

Rating categories in this year's report have been renamed. Previously, the NPP Report used a five-level letter grading system: A, B, C, D, and E. Starting with this report, there are four levels and ratings, expressed as "Fully Satisfactory (FS)", Satisfactory (SA)", "Below Expectations (BE)" and "Unacceptable (UA)."

Previous rating	New rating
A Exceeds Requirements	**FS** Fully Satisfactory
B Meets Requirements	**SA** Satisfactory
C Below Requirements	**BE** Below Expectations
D Significantly Below Requirements	**UA** Unacceptable
E Unacceptable	

Full descriptions of the ratings can be found in Appendix B, but for ease of reference, here is a brief summary:

Fully Satisfactory (FS): Performance meets or exceeds CNSC requirements and expectations. Striving for excellence should continue to be the goal.

Satisfactory (SA): Performance meets CNSC requirements and expectations. Some improvements could be undertaken.

Below Expectations (BE): Performance has deteriorated and fallen below expectations, or programs deviate from the intent or objectives of CNSC requirements. Improvements are required.

Unacceptable (UA): Performance is unacceptable, to the extent that overall plant performance is undermined. Immediate corrective actions are required.

Overall, the improved NPP Report approach allows the CNSC to:

- take full consideration of all data pertaining to plant and plant organization performance during the entire year.
- integrate findings in a more reproducible, systematic manner.
- produce risk-informed ratings for programs and safety areas.
- clarify the relative impact of safety areas through risk-ranking.
- produce an integrated rating for a given plant.
- more easily identify trends.

NAVIGATING THE REPORT

SECTION 1
Compliance and Safety Performance at the Nuclear Power Plant Sites

This section focuses on individual NPP sites and provides detailed assessments of the program and safety area safety performance. It also contains the "report cards" for each NPP.

SECTION 2
Generic Observations

This section highlights significant issues and generic observations across the NPP sites as a whole. They include such topics as industry-wide safety issues, new licensing requirements, or a particular event or experience that affected a number of NPP licensees. Also in this section are graphs on environmental emissions and public dose from each NPP.

SECTION 3
Performance Indicator Trends

This section, new to the report for 2008, presents CNSC performance indicators (PIs). A performance indicator defines the measurement of a piece of important and useful information concerning the performance of a program. PIs can be used to study an individual station's performance, or the NPP industry's performance over time.

SECTION 4
Conclusions

This section contains a summary of the overall conclusions on safety performance for 2008.

APPENDIX A provides definitions of the safety areas and programs.

APPENDIX B provides full definitions for the new ratings.

APPENDIX C is a glossary of specialized and technical terms italicized throughout the report.

APPENDIX D explains the acronyms used in this report.

APPENDIX E describes the significant developments pertaining to the stations in 2008, as well as the related follow-up activities. Important events or developments at the stations were reported to the Commission in Significant Development Reports, via Commission Member Documents.

APPENDIX F, "CANDU Safety Issues" (formerly Generic Action Items or "GAIs"), contains descriptions of the safety-significant CANDU safety issues, as well as a table of GAIs that were open in 2008.

APPENDIX G is new in 2008, and provides worker doses at all Canadian NPPs in 2008. The tables provide a five-year trend (2004-2008) of annual collective doses to workers at each station. This information has been broken down to show collective doses received during routine operations versus doses received during outages, as well as total collective internal doses, total collective external doses, and total collective effective doses.

FIGURE 1: LOCATIONS AND PLANT DATA OF POWER REACTOR SITES IN CANADA

Plant Data							
Plant	**Bruce**		**Darlington**	**Pickering**		**Gentilly-2**	**Point Lepreau**
	A	**B**		**A**	**B**		
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	2*	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	2009/10/31	2009/10/31	2013/02/28	2010/06/30	2013/06/30	2010/12/31	2011/06/30

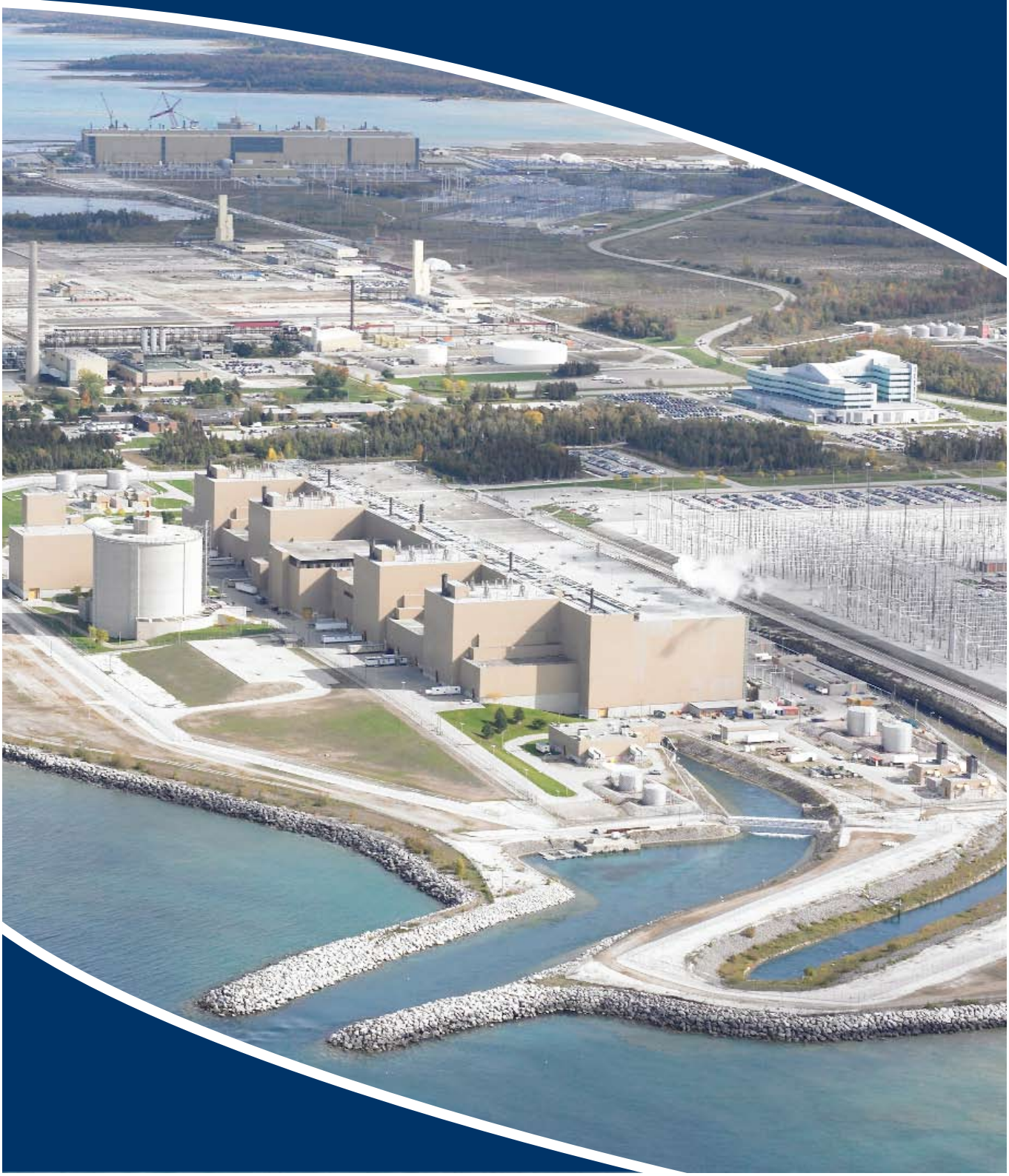
* plus 2 units in safe storage

SECTION 1

COMPLIANCE AND SAFETY PERFORMANCE AT THE NUCLEAR POWER PLANT SITES

This section is organized by station, with performance ratings provided for the safety areas and programs (with the exception of security, as previously indicated).

1.1 BRUCE A AND BRUCE B



1.1 Bruce A and Bruce B

Table 1 presents the safety performance ratings for Bruce A and B for 2008. These ratings were determined using a risk-informed approach, integrating findings from three (3) *Type I* and 102 *Type II inspections*, surveillance and monitoring activities, desktop reviews and assessments, and the professional judgement of CNSC staff. The integrated plant rating for both Bruce A and B is "Fully Satisfactory" for 2008. Rating definitions, and a table of comparison with the old rating system, are provided in Appendix B.

TABLE 1: SAFETY PERFORMANCE RATINGS FOR BRUCE A AND B FOR 2008

Safety Area	**Performance Rating**	
Program	Bruce A	Bruce B
Operating Performance	**SA**	**SA**
Organization and Plant Management	SA	SA
Operations	SA	SA
Occupational Health and Safety (non-radiological)	FS	FS
Performance Assurance	**SA**	**SA**
Quality Management	SA	SA
Human Factors	SA	SA
Training, Examination, and Certification	SA	SA
Design and Analysis	**SA**	**SA**
Safety Analysis	SA	SA
Safety Issues	SA	SA
Design	BE	SA
Equipment Fitness for Service	**SA**	**SA**
Maintenance	BE	BE
Structural Integrity	SA	SA
Reliability	SA	SA
Equipment Qualification	SA	SA
Emergency Preparedness	**FS**	**FS**
Environmental Protection	**SA**	**SA**
Radiation Protection	**SA**	**SA**
Security	**Prescribed**	**Prescribed**
Safeguards	**FS**	**FS**
Integrated plant rating	FS	FS

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. However, the implementation of each program may vary between Bruce A and Bruce B, therefore performance is assessed separately.

1.1.1 Operating Performance

Bruce A and Bruce B operated safely in 2008. The Operating Performance safety area at both stations met the objectives of CNSC requirements and performance expectations, and the programs under the safety area contributed adequately to the safe operation of the facilities. This safety area is rated as "Satisfactory" for Bruce A and B in 2008.

1.1.1.1 Organization and Plant Management

Licensees must report any significant change in organizational structure to the CNSC, under section 15 of the *General Nuclear Safety and Control Regulations*. Of the submissions reviewed, CNSC staff did not find any issues with the organizational changes at Bruce Power during 2008.

Throughout 2008, the performance of Bruce Power management conformed to the requirements listed in the Canadian Standards Association (CSA) N286.0-N286.7 series of standards. These include, among other things, the aspects of adequate leadership, and continued improvements to achieve and maintain higher performance. Since 2006, Bruce Power has undertaken a program of benchmarking performance in all key disciplines against industry best performance. This has resulted in the implementation of improvement plans in a number of areas. Bruce Power has kept CNSC staff informed of the benchmarking results. The Bruce A and B licence renewal applications, received in July 2008, also included transition plans to the most modern management standards.

Performance in this program area is rated "Satisfactory" for both Bruce A and B.

1.1.1.2 Operations

In 2008, Bruce A experienced three forced outages, two trips, two *stepbacks* and four *setbacks*. Bruce B experienced six forced outages, three *stepbacks* and two *setbacks*. *Stepbacks* and *setbacks* are controlled power reductions, initiated automatically by the reactor regulating system. There were no serious process failures at either station.

A brief description of the events of interest is provided below.

Bruce A Unit 3

- March 3, 2008 – (*setback*) A *setback* occurred due to the removal of a panel to replace a failed fuse.
- March 24, 2008 – (*setback*) During a routine test, a shut-off rod dropped approximately 1/4 of the way into the core. The operator then initiated a sequence to withdraw the rod, resulting in a *setback*.
- November 19, 2008 – (trip) Human error caused shutdown system 1 (SDS1) Heat Transport System Flow to alarm low, causing the spurious trip and all shut-off rods to drop into the core.
- December 9, 2008 – (*stepback*) A seal oil leak on the shell side of a heat exchanger caused a low oil pressure, and the operator manually tripped the turbine. As a result, oil leaked onto the turbine building floor, which was promptly cleaned up. A small amount leaked to the environment, through a drain. Bruce Power placed booms in the outfall to retain any lost oil, and found no evidence of oil on the shoreline or in the lake.
- December 23, 2008 – (*setback*) During routine fuelling, a *setback* occurred and reactor power dropped by 0.7%.

Bruce A Unit 4

- February 1, 2008 – (trip) With one channel rejected for testing, a SDS2 Neutron Log Rate spuriously alarmed high on a second channel, and caused a trip and poison out of the unit.
- September 7, 2008 – (forced outage) Forced outage, due to a leak in the thrust bearing oil cooler.

Bruce B Unit 5

- February 23, 2008 – (forced outage) The fuelling machine was stuck on the face of the reactor, so the unit was shut down in order to safely remove the fuelling machine from the channel.
- April 28, 2008 – (*setback*) A fault occurred in the digital control computer, which resulted in reactor power decreasing; the operator manually shut down the reactor, causing a forced outage.

Bruce B Unit 6

- October 6, 2008 – (*stepback*) A problem with the generator caused a turbine trip, which led to an automatic reactor stepback and a reactor *setback* on flux tilt.

Bruce B Unit 7

- May 23, 2008 – (forced outage) A transient occurred due to the digital control computer stalling; the reactor power was manually reduced and a forced outage occurred.
- June 6, 2008 – (*setback*) Due to faulty liquid zone indications, there was a low margin to trip, and operators manually set back the reactor by 3%.
- July 8, 2008 – (*stepback*) A small fire on the transformer for heat transport pump 4 shut down the transformer and the pump. The reactor automatically completed a *stepback*. Operators manually shut down the reactor.

Bruce B Unit 8

- January 26, 2008 – (forced outage) Digital control computer stalled and reactor power dropped by 15%. Unit was shut down for investigations.
- August 14, 2008 – (*stepback*) During routine maintenance, a coincident failure of a level controller occurred. This led the moisture separator tank levels to rise and resulted in an automatic turbine trip. The turbine trip caused an automatic stepback.

For all these events, Bruce Power performed either a root cause investigation or an apparent cause evaluation, and implemented appropriate corrective actions.

CNSC staff conducted an inspection concerning the Bruce A Unit 3 SDS1 trip. An action item was raised to track the action notice resulting from this inspection. Additional details regarding this event are provided in Appendix E. There were no regulatory actions enforced upon Bruce Power as a result of any of the other events.

There were two planned outages at Bruce A: one in the spring and one in the fall; and two planned outages at Bruce B: one in the winter and one in the spring. Overall outage execution and outage safety and work management met regulatory requirements.

CNSC staff carried out 102 *Type II inspections* at Bruce A and B in 2008, in addition to surveillance and monitoring activities, desktop reviews and assessments, and meetings with the licensee. Based on these activities, the Operations program area at both Bruce A and B has been rated as "Satisfactory" in 2008.

1.1.1.3 Occupational Health and Safety (non-radiological)

Number of lost time injuries reported by the licensee:	0
Accident frequency (AF):	0
Accident severity rate (ASR):	0

AF and ASR are performance indicators reported by the licensee as per S-99[1] requirements. The AF and ASR at Bruce A and B in 2008 remain very good in comparison with other industries.

In 2008, Bruce Power began transitioning from the International Safety Rating System to the OHSAS 18001 Industrial Safety Occupational, Health and Safety Management System. Bruce Power exceeded 10 million hours without an acute lost time injury.

CNSC staff is satisfied that occupational health and safety work practices and conditions achieve a high degree of personnel safety at Bruce A and B, and have rated the program as "Fully Satisfactory" for both stations.

1.1.2 Performance Assurance

The Performance Assurance safety area at Bruce A and B met the objectives of CNSC requirements and performance expectations in 2008. Both stations have been rated as "Satisfactory" in this safety area.

[1] CNSC Regulatory Standard S-99 "Reporting Requirements for Operating Nuclear Power Plants"

1.1.2.1 Quality Management

Bruce Power completed the implementation of their management system (Management System Manual) in December 2007. In 2008, Bruce Power continued with extensive internal reviews and external benchmarking of the programs and processes that make up the managed system, as part of their continuous improvement philosophy.

In 2008, CNSC staff assessment of Quality Management at Bruce A focused on Bruce Power's work on the restart of Units 1 and 2. During the year, a number of inspections examined several aspects of the CSA N286 standards, relating to the process to be used for return to service. The inspections revealed that, throughout the year, Bruce Power showed a pattern of continual improvement, refinement, and strengthening of the process. Issues uncovered early in the year were found to have been corrected during subsequent follow-up inspections, as the process was better defined. As a result, Quality Management at Bruce A was rated as "Satisfactory" in 2008.

For Bruce B, CSNC staff assessed general compliance. Inspections focused on supply chain and procedural adherence. Some areas of low safety significance were identified as needing improvements. Bruce Power continued to make progress with their process and document enhancement activities, and closed out actions resulting from an inspection in the previous year. Quality Management at Bruce B is also rated as "Satisfactory" in 2008.

1.1.2.2 Human Factors

The CNSC has found an improving trend with respect to station minimum shift complement violations over the last four years at the Bruce stations.

CNSC staff also reviewed the root cause investigation regarding the Level 1 Impairment of Emergency Coolant Injection (ECI) (see Appendix E) and found it acceptable.

Based on the findings of the assessments conducted in this program area, the Human Factors program at both Bruce A and B is rated as "Satisfactory" for 2008.

1.1.2.3 Training, Examination and Certification

Overall, the CNSC is satisfied that there are sufficient numbers of qualified workers at Bruce A and B to carry out the licensed activities. The Training, Examination and Certification program area is rated "Satisfactory" for both Bruce A and Bruce B in 2008.

Training

In November 2008, CNSC staff conducted a *Type II inspection* on the performance of duties under supervision (co-piloting) for Control Room Shift Supervisors at Bruce A and concluded that Bruce Power met CNSC expectations.

A report on the *Type I inspection* of the Bruce B Non-Licensed Operator Training Program was also issued in 2008. While the report acknowledged the high quality of lesson plans and course materials, it also identified a number of deficiencies, which resulted in six action notices. In December 2008, Bruce Power submitted an Action Plan to address these deficiencies. CNSC staff is reviewing the plan.

Five training program inspections (conducted between 2005 and 2006) were closed out in June 2008, after verification that Bruce Power had completed all corrective actions to the satisfaction of CNSC staff.

Examination and Certification

Bruce Power's overall pass rate in 2008 for certification examinations was 91.8%. The Bruce A certification examination success rate was 94%, while the Bruce B certification examination success rate was 90.6%. The industry average was 94.3%. Overall, CNSC staff finds the results acceptable, even though Bruce B was slightly lower than average.

Bruce Power submits updates of the Bruce Power Certified Operator Staffing Plan every six months. This plan ensures that Bruce Power has a sufficient number of certified staff on all reactor units. The most recent staffing plans indicate slow but constant improvement in the numbers of available certified staff.

In 2007, the success rate for two similar-based certification examinations at Bruce A was below expectations. CNSC staff was concerned that this could have a negative effect on the number of available Authorized Nuclear Operators (ANOs) required to adequately staff the restart of Units 1 and 2. Consequently, in December 2007, the CNSC requested that Bruce Power determine the causes of the abnormally poor candidate performance and provide the analysis results, including an action plan to prevent reoccurrence.

In March 2008, Bruce Power submitted the requested supporting information in a document titled "Status Table for Station Condition Record B-2007-15058 and the Associated Apparent Cause Report". This report identified 3 apparent causes and 4 contributing factors of the poor examination results. The apparent causes were:

1. Certification training staffing issues (shortage of qualified instructors to support simulator training).
2. Simulator training instructional delivery deficiencies (deficiency in simulator skills instructional plans, large class sizes).
3. Candidate issues (experienced candidates present challenges in terms of their acceptance of coaching and lessons learned, and the use of the new *Systematic Approach to Training* (SAT) based training material for station systems and integrated plant operations).

Bruce Power provided a table of 24 activities which will address the apparent causes and contributing factors. Seventeen of these activities were considered complete as of March 31, 2008. CNSC staff is satisfied with the progress on this issue.

As described in Section 2.2.3, the independent initial certification examination process was the subject of significant activity in 2008, as NPP licensees and the CNSC worked to transfer the responsibility of administering initial certification examinations to the licensee. This project requires the licensee to establish and document new processes, and CNSC staff to develop and implement the necessary compliance and inspection activities designed to confirm the effectiveness of the new process. The *Commission* approved the transfer of initial examination certification to Bruce Power in January 2009.

1.1.3 Design and Analysis

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 2008. CNSC staff reviews concluded that the licensee continued to provide satisfactory responses to new design and safety issues. This safety area is rated as "Satisfactory" for both Bruce A and B.

1.1.3.1 Safety Analysis

Overall, the Safety Analysis program area at Bruce A and B met CNSC expectations and received a "Satisfactory" rating for 2008. Updates on the issues carried over from previous years are provided below.

Safety Report Update
The Bruce A and B power reactor operating licences (PROL) require an update to the respective *Safety Reports* every 3 years, in order to ensure that the documents continue to reflect current facility design, operation and modifications to safety analysis. Bruce Power has submitted updates to Part 3 (Accident Analysis) of the Bruce A and B *Safety Reports*. These updates are currently under review by CNSC staff.

CHECKING THE CONFINEMENT DOOR TO ENSURE THE SEALS ARE INFLATED AND WITHOUT LEAKS.

Impact of Plant Aging on Safety Analysis

This issue, common to Bruce Power and OPG licensees, is described in detail in Section 2.3.1 "Neutron Overpower Protection (NOP) Improved Methodology". CNSC staff is reviewing the new NOP methodology, to confirm the adequacy and robustness of NOP trip set points for certain events, and the supporting compliance and monitoring program. In addition, an Independent Technical Panel (ITP) was formed in 2008 to review probabilistic aspects of the new methodology. The final report of the ITP is expected in May 2009 and the CNSC final review is targeted for the end of 2009.

Probabilistic Risk Assessment

The Bruce A Probabilistic Risk Assessment (BAPRA) models for the plant operating states have not reached a level of realism to fully satisfy CNSC expectations. However, no major concern was identified during the high-level review. CNSC staff expects Bruce Power to implement their recommendations in future updates of BAPRA models.

The Bruce B Risk Assessment (BBRA) at-power model has been updated and enhanced, to ensure that the model is consistent with the existing plant configuration. Bruce Power is also developing user-friendly models to facilitate PSA applications for supporting plant decision-making. In addition, Bruce Power is making further improvements on supporting analysis to the risk assessment. Bruce power submitted a status report of the update undertaken in 2007, along with an electronic model in 2008. CNSC staff is currently reviewing these updates.

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.

GAIs 88G02, 95G02, and 06G01 were closed for Bruce Power in 2008. A brief description and the expected completion date of each of the outstanding GAIs are provided in Appendix F.

This program area is rated as "Satisfactory" for Bruce A and B in 2008.

1.1.3.3 Design

Bruce A has legacy issues related to configuration management, due to the fact that the units were shut down and defuelled between 1997 and 1998. The result is that design drawings, system classifications and registration documentation were not maintained to reflect the current operating plant status.

Bruce Power has provided a corrective action plan to bring Units 3 and 4 back into compliance with the licence conditions regarding registration of pressure-retaining systems. The field operating documentation has been updated, but progress has been slower than initially anticipated for registration information. The implementation of the corrective action plan is being tracked by CNSC staff. Bruce Power's intention to use a transition plan following the provisions from the new standard CSA N285.0-06 will help to complete registration of some legacy unregistered systems for Units 1-4.

Approximately 40 legacy systems must be registered under the existing licence conditions for Units 1 and 2. CNSC staff has advised Bruce Power that the pressure-boundary system classification list must be updated prior to the restart of Units 1 and 2. Bruce Power is implementing a registration corrective action plan for Unit 1 and 2, to address the above issues, with a forecast completion date of mid-2009.

In 2008, CNSC staff performed a comprehensive review of Bruce Power's fire protection program. Some minor negative findings were identified; however, the program is considered to be adequate.

Due to the slow progress on the legacy issues related to configuration management, Design at Bruce A is rated "Below Expectations" for 2008. Bruce B is rated as "Satisfactory" for performance in this area.

1.1.4 Equipment Fitness for Service

The Equipment Fitness for Service safety area has been given a "Satisfactory" rating for both Bruce A and B in 2008. Overall, this safety area meets CNSC requirements and performance expectations; the Maintenance program at Bruce A continues, however, to be a challenge, and has also become an issue at Bruce B.

1.1.4.1 Maintenance

Bruce Power completed a review of its equipment reliability practices against best industry practice and performance in 2006 and 2007. The review indicated significant opportunity for improvement; as a result, Bruce Power management made the decision to implement the strong equipment reliability processes, programs and metrics utilized by industry leaders. Bruce Power discussed the implementation plans with CNSC staff in December 2007, including a prediction that the corrective and elective maintenance backlogs would grow as Bruce Power focused on improving preventative maintenance results. This prediction was based on industry experience that showed that although a fully effective preventative maintenance program would reduce corrective maintenance requirements, there would be a time lag between these results. Implementation of industry standard definitions for corrective and elective maintenance resulted in a step increase in these backlog numbers in early 2008. Inspections confirmed that corrective and elective maintenance backlogs at Bruce A and B had not recovered by the end of 2008. In fact, a *Type II inspection* of the Bruce A and B maintenance backlog found that the number of maintenance items in most of the backlog indicators at Bruce A had more than doubled by the beginning of 2008.

There have been many performance monitors in place, and the tracking system appears to be sound; however, the information reviewed shows that there is an adverse trend. The corrective and elective backlog levels are also trending upwards at Bruce B. Based on the number of items impacting on the system health, there is an increasing potential for negative impacts on the overall station performance.

As a result of the backlog inspection, Bruce Power was assigned an action item to submit an action plan for backlog reduction, along with the assurance that they are still in compliance with the applicable maintenance licence condition.

In a preliminary response, Bruce Power described some of the improvements being implemented, such as a resource focus on preventive maintenance completion. Bruce Power has indicated that these initiatives have resulted in improvements to the overall preventive maintenance completion rate (50% to 82%) and a consistent licensing and mandatory preventive maintenance completion rate above 99%. Assurance that Bruce Power remained in compliance with the licence was also provided. CNSC staff has requested further details on the impact of the backlog on safety, a formal submission of Bruce Power's reduction plan and quarterly updates on progress.

CNSC site staff at Bruce A also conducted a number of maintenance cross-cutting *Type II* field inspections, including routine field walk-downs with the Bruce Power Maintenance Manager. Throughout various inspections, it was noted that timely completion of maintenance tasks was an issue.

As a result of these findings, this program area is rated as "Below Expectations" for both Bruce A and Bruce B.

1.1.4.2 Structural Integrity

Bruce Power conducts periodic inspections at Bruce A and B, according to station Periodic Inspection Programs (PIPs) and CSA standards N285.4 "Periodic Inspection of CANDU Nuclear Power Plant Components" and N285.5 "Periodic Inspection of CANDU Nuclear Power Plant Containment Components". The inspection reports are submitted to CNSC staff on an ongoing basis, for review and acceptance.

INSPECTORS MONITOR THE STRUCTURAL INTEGRITY OF A VACUUM BUILDING.

At Bruce A in 2008, Bruce Power performed N285.4 and N285.5 inspections in Units 3 and 4. The N285.4 inspection reports submitted by Bruce Power met the requirements of the CSA standards. There were some negative findings for the N285.5 containment components in both Units 3 and 4. An *action item* was raised for Bruce Power to provide the technical basis demonstrating that the inspection findings are acceptable in accordance with the requirements of N285.5.

At Bruce B, Bruce Power performed N285.5 inspections for Units 0 and 7 containment components. CNSC staff found that the inspection reports submitted by Bruce Power were acceptable and met the requirements of N285.5

With respect to fitness-for-service assessments of Bruce A and B fuel channels, CNSC staff concurred that Bruce Power had performed all inspections in accordance with applicable requirements and as proposed in Bruce Power's Fuel Channel Life Cycle Management Plan. In addition, staff was satisfied that Bruce Power had dispositioned the inspection findings in accordance with the CNSC-approved Fitness for Service Guidelines.

During the 2008 outages at Bruce A and B, *feeder* inspections were carried out as planned in the feeder life cycle management plans. Engineering evaluation based on the inspection results confirmed that the feeders at the Bruce stations are fit for service.

In July 2008, CNSC staff conducted a *Type II inspection* of Bruce B PIPs. Staff found that the licensee's implementation of the PIPs meets the requirements; however, some negative findings were identified. CNSC staff is tracking these issues via two *action items*.

In 2008, CNSC staff conducted reviews of outage inspection reports for Units 3, 4, 5, 7 and 8 for the Steam Generator Life Cycle Management Program. There appear to be some degradation issues with s*team generator* tubes in Units 3 and 4. However, the growth rates are conservatively predicted by models employed by Bruce Power, and the degradation mechanism remains manageable. Bruce Power has changed its outage boiler lay-up procedure, and early results indicate this has been successful in arresting the degradation. In addition, Bruce Power has undertaken a significant research effort to better characterize the degradation mechanism, since this represents a plant operation life-limiting factor for Unit 4.

CNSC staff also reviewed the quarterly operations and pressure boundary reports required under S-99. For the most part, the pinhole leaks, cracks, corrosion and support failures identified during 2008 were of minimal consequence, and Bruce Power took adequate steps to address this identified degradation. There were several findings concerning pressure boundary degradation. Bruce Power has committed to three actions regarding the two main findings at Bruce A and the one main finding at Bruce B.

Based on these results, the Structural Integrity program at both Bruce A and B is rated as "Satisfactory" for 2008.

1.1.4.3 Reliability

Bruce Power is required to establish and implement a reliability program in accordance with the requirements of CNSC regulatory document S-98 "Reliability Programs for Nuclear Power Plants". Bruce Power submitted their formal Reliability Program for CNSC review in June 2008. Overall, CNSC staff found that the Bruce Power reliability program, which consists of various programs and procedures, was well-prepared.

Follow-up to a *Type I inspection* at Bruce A and B on reliability data collection and treatment showed that Bruce Power was not making sufficient progress in responding to the identified deficiencies. Bruce Power delayed this project to complete a transition to the latest revision of their integrated information management system (Passport v10). CNSC staff found this delay acceptable, but will conduct a follow-up visit to the Bruce site to verify the progress in implementing the required actions.

Based on S-99 quarterly reports, the unavailabilities of two systems important to safety were above the target limits for 2008:

- Emergency Coolant Injection System
  Unavailability: 1.317E-3 yrs/yr (target 1.0E-3 yrs/yr)
- Emergency Power System
  Unavailability: 8.55E-2 yrs/yr (target 1.0E-2 yrs/yr)

In March 2008, a level 1 impairment of the Emergency Coolant Injection System occurred in Bruce B Unit 6. Details of this event are provided in Appendix E. The impairment remained undetected for about seven hours. As a result of this event, the system is likely to exceed its unavailability target for the whole calendar year. CNSC staff has reviewed Bruce Power's *root cause analysis* and had some minor concerns, which are being resolved through ongoing discussions with Bruce Power.

On September 29, 2008, an emergency exit to the Secondary Control Areas (SCAs) was found inoperable. This is the protected pathway from the main control room to the SCAs in the event of a main steam line break or a seismic event. However, the SCAs remained accessible from outside the plant. Delays in repairing this access way resulted in a significant increase of Emergency Power System actual and operational unavailability, which is 8.55E-2 years/yr, eight times over the licensing target. CNSC reviewed Bruce Power's corrective actions and found them acceptable.

Except for these two systems, all other systems important to safety at Bruce A and B met their targets.

Based on the findings of the assessments conducted in 2008, both Bruce A and Bruce B receive a "Satisfactory" rating in this area.

1.1.4.4 Equipment Qualification

Type I inspections (conducted in 2005) of the Bruce A and B *Environmental Qualification* (EQ) programs determined that the programs and their implementation meet the intent of the CNSC acceptance criteria. CNSC staff raised four action notices as a result of the Bruce A inspection, and one action notice as a result of the Bruce B inspection. With one exception, all the inspection findings have since been addressed to the CNSC's satisfaction.

This program area is rated as "Satisfactory" for Bruce A and B.

1.1.5 Emergency Preparedness

In 2008, Emergency Preparedness at Bruce A and B met and, in some cases, exceeded the objectives of CNSC requirements and performance expectations. Based on staff assessments in this safety area, both stations have been rated as "Fully Satisfactory".

In April 2008, CNSC staff performed a *Type II inspection* of the Bruce B full station emergency response drill. There were no action items resulting from this inspection.

In September 2008, CNSC staff conducted a *Type I inspection* of the Bruce A and B Nuclear Emergency Preparedness program. From the inspection, staff concluded that the program and its implementation meet the expectations of CNSC Regulatory Guide G-225 "Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills", and exceed the requirements for emergency preparedness and response capability.

Staff also reviewed reportable events associated with emergency preparedness at Bruce A and B, and did not observe any significant issues.

1.1.6 Environmental Protection

In 2008, the reported dose to the public due to both Bruce A and B was 2.70 µSv, which is well below the public dose limit of 1000 µSv. Gaseous and aqueous releases of nuclear substances were always below Environmental Action Levels for both stations.

CNSC staff review of Bruce Power Quarterly Operations Reports submitted under S-99 did not identify any significant issues related to radiation dose to the public or environmental protection. There were no reported unplanned releases of nuclear substances or hazardous substances from Bruce A or B that posed an unreasonable risk to the environment.

In 2008, the Environmental Protection safety area met CNSC requirements and performance expectations. Both Bruce A and B received a "Satisfactory" rating for this safety area.

INSPECTORS ARE TRAINED IN RADIATION PROTECTION. REMOVING PERSONAL PROTECTIVE EQUIPMENT CORRECTLY IS AN IMPORTANT STEP IN AVOIDING CONTAMINATION.

1.1.7 Radiation Protection

In 2008, there were no radiation exposures at Bruce A or B that exceeded regulatory dose limits. No action levels were exceeded at Bruce A, but there was one action level exceeded at Bruce B. Bruce Power provided the CNSC with formal notification on October 22, 2008, that an individual had received an uptake of tritium with an estimated dose commitment of 2.81 mSv. Bruce Power submitted the relevant event reports, which included a root cause investigation. The actions identified and taken to restore the effectiveness of the Radiation Protection Program are appropriate for this event; however, Bruce Power will be conducting an additional root-cause investigation, focusing on work assessment. CNSC staff has requested a summary of the findings and corrective actions resulting from this investigation.

In February 2008, CNSC staff conducted a *Type II inspection* at Bruce B, to assess Bruce Power's performance in contamination control and radiation exposure and dose control. Although the inspection was conducted at Bruce B, some findings were pertinent to both stations. As an "as low as reasonably achievable" (ALARA) initiative, staff observed that teledosimetry is being implemented for dose control in the Units 1 and 2 restart project, as well as regular Bruce Power maintenance outages.

Some negative findings from the inspection included the following:

- Collective doses are higher than projected targets. This is attributed to several factors – such as human performance, outage scope increases, and issues related to equipment and tooling.
- There is an ongoing issue with unposted hazards at Bruce A and B. Unposted hazards were identified over the course of the inspection by CNSC inspectors. Also, since January 2008, numerous S-99 reports have been raised by Bruce Power personnel for unposted hazards, some of which have been identified by CNSC inspectors.

As a result of this inspection, the CNSC issued one directive and three action notices, to which Bruce Power has adequately responded.

During a radiation survey performed by Bruce Power on June 22, 2008, an elevated radiation field was discovered in a localized area of the Unit 2 reactor vault. Details of this event are provided in Appendix E. CNSC staff is satisfied that Bruce Power's response was appropriate and the root cause was well understood. Staff will follow-up on Bruce Power's corrective actions.

Bruce Power has been providing various levels of dose information related to the Unit 1 and 2 restart project on a monthly basis. This information includes dose projections for the overall project, as well as for specific tasks. Worker-specific dose information is also provided. Through the end of 2008, work progressed below projected dose targets.

The Bruce A and B Radiation Protection safety area meets the objectives of CNSC requirements and performance expectations, and contributed to safe facility operation in 2008. This safety area is rated as "Satisfactory" for Bruce A and B.

1.1.8 Site Security

This safety area is presented to the *Commission* in a separate *Commission Member Document* (CMD 09-M28.A).

1.1.9 Safeguards

CNSC staff rates the implementation of the Safeguards safety area by Bruce Power at Bruce A and B as "Fully Satisfactory" in 2008, since it meets or exceeds applicable CNSC requirements and performance expectations. Bruce Power has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

In 2008, Safeguards staff from Bruce Power participated in a series of trilateral meetings with the *International Atomic Energy Agency* (IAEA), the CNSC and the other facility operators, to develop an Integrated Safeguards Procedure for the CANDU stations. In developing the procedures, Bruce B par-

ticipated in a field trial for Short-Notice Random Inspections (SNRIs) at the facility, in June 2008. This inspection was carried out in order for the IAEA to detect and deter the diversion of nuclear material, tampering with IAEA surveillance equipment and undeclared activities. As of July 2008, these SNRIs replace traditional IAEA inspections that were carried out on an announced quarterly basis.

The inspection was attended by CNSC staff who undertook to review: the facility's support for IAEA inspectors, including escorts and equipment; the provision of accountancy information and supporting documents; the facility compliance with safeguards licence conditions relevant to the inspection activity; and the IAEA's adherence to its rights and obligations relevant to the inspection. This was the first IAEA field trial inspection of this type at the Bruce site under the new Integrated Safeguards regime for CANDU stations. No significant compliance issues were identified by CNSC staff during the inspection.

There were no Complementary Access visits by the IAEA at the Bruce site in 2008. A Design Information Verification was performed by the IAEA at Bruce A on June 12, 2008, and at Bruce B on June 13, 2008. CNSC members did not attend these verifications. The IAEA has yet to report its results, although no issues are anticipated.

1.1.10 Update on Major Projects and Initiatives

1.1.10.1 Bruce A Units 1 and 2 Life Extension

Refurbishment work progressed well during 2008. The fuel channels have been removed in Unit 2; significant progress has been made on the electrical distribution systems and the valve program; and the Low Pressure Service Water system in Unit 2 has been filled and flushed. Due to a re-baselining in the refurbishment activities, the overall project schedule has been delayed by about a year.

Bruce Power continued to make submissions in accordance with RD-360 "Life Extension of Nuclear Power Plants", in response to the various comments made by CNSC staff on Bruce Power's Integrated Safety Review. CNSC staff has continued to review these submissions and has reached an agreement with Bruce Power on the path forward for many of the technical issues. This has led to commitments from Bruce Power, through the Integrated Implementation Plan, for the implementation of various safety improvements in the units. CNSC staff does not expect any issues with the resolution of the remaining technical issues.

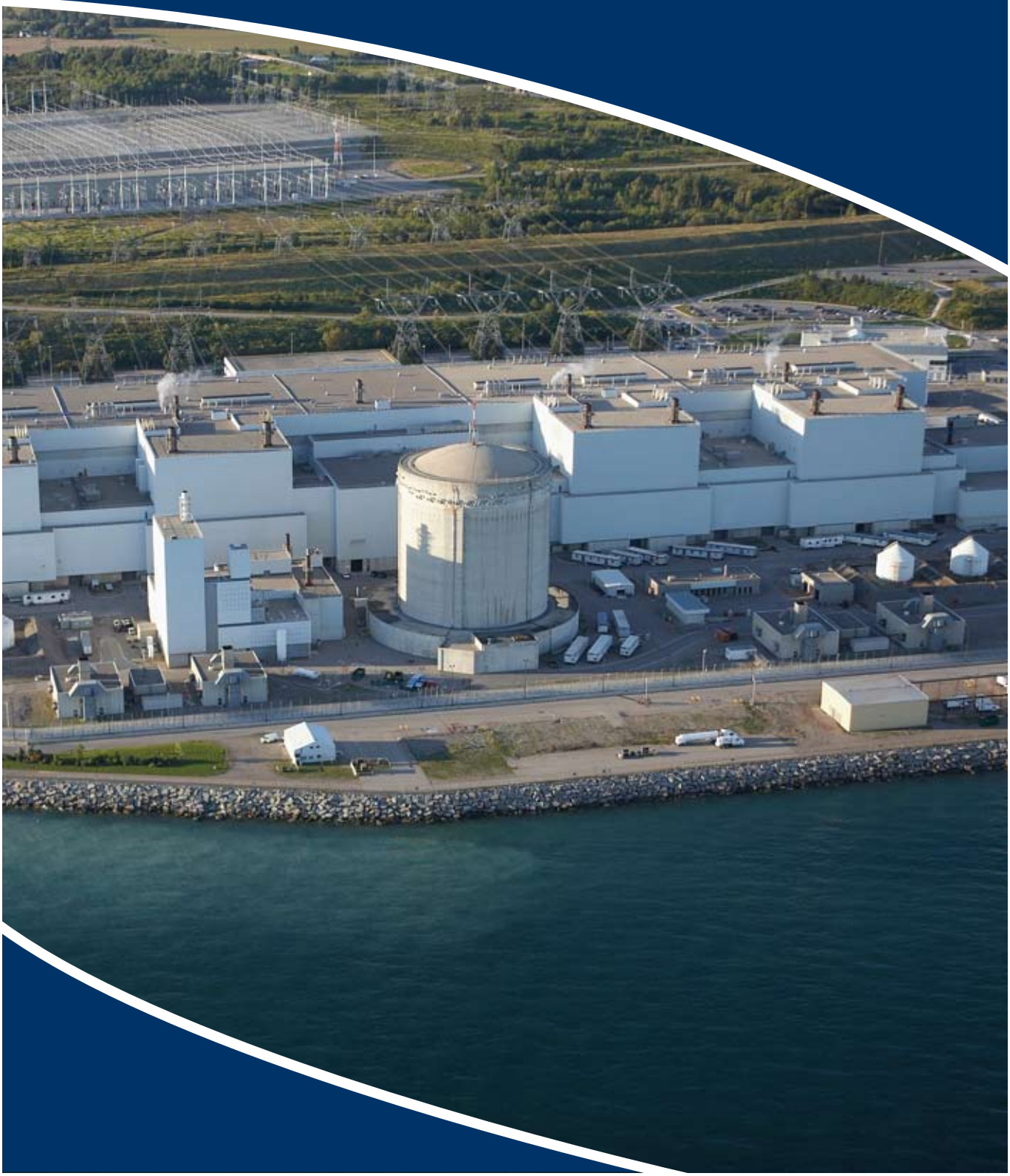
A series of inspections was conducted on Bruce Power's Return to Service process for the project. As a result of these inspections, CNSC staff concluded that there is a robust and comprehensive process in place.

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. The data from the demonstration was utilized as part of the safety case supporting full core implementation in Units 1 and 2 (currently undergoing refurbishment.) The LVRF fuel would be implemented after reactor re-start, once the reactor has obtained an equilibrium core.

1.2 DARLINGTON



1.2 Darlington

Table 2 presents the safety performance ratings for Darlington for 2008. These ratings were determined using a risk-informed approach integrating findings from one (1) Type I and 67 Type II inspections, surveillance and monitoring activities, desktop reviews and assessments, and the professional judgement of CNSC staff. The integrated plant rating for Darlington is "Fully Satisfactory" for 2008. Rating definitions and a table of comparison with the old rating system are provided in Appendix B.

TABLE 2: SAFETY PERFORMANCE RATINGS FOR DARLINGTON FOR 2008

Safety Area Program	**Performance Rating**
Operating Performance	**FS**
Organization and Plant Management	FS
Operations	FS
Occupational Health and Safety (non-radiological)	FS
Performance Assurance	**SA**
Quality Management	SA
Human Factors	FS
Training, Examination, and Certification	SA
Design and Analysis	**SA**
Safety Analysis	SA
Safety Issues	SA
Design	SA
Equipment Fitness for Service	**SA**
Maintenance	FS
Structural Integrity	FS
Reliability	SA
Equipment Qualification	BE
Emergency Preparedness	**FS**
Environmental Protection	**SA**
Radiation Protection	**FS**
Security	**Prescribed**
Safeguards	**FS**
Integrated plant rating	FS

1.2.1 Operating Performance

Darlington operated safely in 2008. The Operating Performance safety area at Darlington met the objectives of CNSC requirements and performance expectations, and the programs under this safety area contributed adequately to the safe operation of the facility. This safety area is rated as "Fully Satisfactory" for Darlington for 2008.

1.2.1.1 Organization and Plant Management

Throughout 2008, performance of Darlington management conformed to the Ontario Power Generation (OPG) document "Chief Nuclear Officer Expectations" N-CHAR-AS-0002-R12. This includes, amongst other things, the aspects of adequate leadership and continued improvements to achieve and maintain higher performance.

CNSC staff did not identify any significant findings in the inspections, surveillance and monitoring activities within this program area. Consequently, the performance of this program is rated as "Fully Satisfactory" for 2008.

1.2.1.2 Operations

In 2008, Darlington experienced two forced outages, one stepback and one setback. There were no *serious process failures*. A brief description of these events is provided below.

Unit 2

- April 18, 2008 – (*setback*) A *setback* occurred in Unit 2 due to a faulty temperature transmitter in the Main Moderator System, which resulted in a false temperature reading.

Unit 4

- July 22, 2008 – (forced outage) Unit tripped when the even bank of SDS1 dropped into the core and resulted in a poison outage. The cause was attributed to a faulty fuse holder. The fuse holders were replaced, and the unit was returned to power with no additional issues. Additional details regarding this event are provided in Appendix E.
- October 2008 – (forced outage) Unit tripped due to an electronic turbine controller card experiencing intermittent fault. As a result of the failure, two control absorbers (out of 4) dropped into the core. OPG has replaced the turbine controller card and determined the cause of the control absorber power supply failure. The unit was returned to power with no additional issues.
- October 2008 – (*stepback*) *Stepback* due to a ground fault at the Hydro One switchyard.

In response to these events, OPG took immediate action and investigated the causes of the transients.

Unit 1 had a planned outage during March and April 2008. Overall, outage safety and work management met requirements.

CNSC staff carried out 67 *Type II inspections* at Darlington in 2008. These included several field and control room inspections. CNSC staff also carried out surveillance and monitoring activities, desktop reviews and assessments, and held several meetings with the licensee to discuss enforcement actions, licensing requirements, inspection findings, and results of reviews and assessments. Based on the results of these activities, the Operations program area is rated as "Fully Satisfactory" for 2008.

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 released into the environment, as well as reducing the potential radiation exposure of the 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 2008, there were no environmental non-compliance events at the TRF. A dedicated TRF outage manager was added, to improve leadership and oversight at that facility. Overall, CNSC staff is satisfied with the operation of the facility. The TRF has been scheduled for an outage in 2009, from February to July. CNSC staff will be assessing the effectiveness of the outage campaign, and will provide the Commission with an update, in the 2009 NPP report.

1.2.1.3 Occupational Health and Safety (non-radiological)

Number of lost time accidents reported by licensee:	1
Accident Frequency (AF):	0.04
Accident Severity Rate (ASR):	2.09

AF and ASR are performance indicators reported by the licensee, as per S-99 requirements. CNSC staff considers that the AF and ASR, as reported by OPG during 2008, demonstrated adequate occupational health and safety performance at Darlington. The AF and ASR reported for Darlington in 2008 were very low in comparison with other industries.

In 2008, Darlington staff sustained one lost time accident and sixteen medically treated injuries. As with previous years, most of the injuries were musculoskeletal and extremities-related. To reduce these types of injuries, OPG will be initiating an Injury Prevention Plan.

CSNC staff is satisfied that Occupational Health and Safety work practices and conditions achieve a high degree of personnel safety at Darlington, and has rated the program as "Fully Satisfactory" for 2008.

WHILE WORKING IN CONFINED SPACES OR AT HEIGHTS, INSPECTORS WEAR HARNESSES TO ENSURE SAFETY.

1.2.2 Performance Assurance

The Performance Assurance safety area at Darlington met the objectives of CNSC requirements and performance expectations, and is rated as "Satisfactory" for 2008.

1.2.2.1 Quality Management

The governing document for the Darlington Quality Management Program is the OPG Charter N-CHAR-AS-0002. CNSC staff concluded that the quality management program, as described in the Charter, complies with the requirements of the applicable CSA standards.

A report on the *Type I inspection* of the Engineering Change Control (ECC) process at Darlington was issued in July 2008. Six action notices and two recommendations were raised, to improve the ECC process documentation and implementation. OPG provided a response to the CNSC in October 2008, with plans to resolve the issues by August 2009.

CNSC staff also analyzed the quality management-related events reported under S-99 in 2008, and concluded that they did not represent an unreasonable risk to the safe operation of the facility.

Based on the assessments carried out, Quality Management at Darlington is rated as "Satisfactory" for 2008.

1.2.2.2 Human Factors

In 2008, OPG carried out several improvements initiatives in the Human Factors area, such as a Procedure Ambiguity Awareness campaign and making rapid responses to human performance events, to prevent recurrence.

In 2008, OPG completed their work to address the action notices and recommendation issued as a result of a *Type I inspection* in 2005 on station minimum shift complement and limits of hours of work. Based on the information provided, CNSC staff is confident that OPG has proper processes in place to demonstrate compliance with the Station Shift Complement document D-PROC-OP-0009, and concluded that outstanding issues related to the minimum shift complement have been addressed in a satisfactory manner.

In 2005, CNSC staff requested OPG to submit contingency plans for maintaining staff in key positions on-site and strategies if unable to meet all staff requirements. This was requested to assess the vulnerability of Canadian power reactor sites to off-site events (whether man-made or natural, such as severe weather). Later, this also included discussion on Pandemic Planning. OPG has submitted these plans and has addressed issues raised by CNSC staff.

Based on the findings of the assessments carried out in this program area, the Human Factors program is rated as "Fully Satisfactory" for 2008.

1.2.2.3 Training, Examination and Certification

The Training, Examination and Certification program area at Darlington met CNSC performance expectations and is rated as "Satisfactory" for 2008. OPG has demonstrated that there are sufficient numbers of qualified workers at Darlington to carry out the licensed activities.

Training

In 2008, CNSC staff completed a desktop review of OPG's training program document N-PROG-TR-0005 (R08) and identified five deficiencies. These deficiencies were associated with new terminology being introduced in training qualifications and the categorization of programs which are required to be based upon *Systematic Approach to Training* (SAT) principles. OPG has provided a plan to address the deficiencies, along with a timeframe for its completion. Most of the corrective actions are expected to be completed in 2009. Since this new version of the Training Program has been issued very recently, CNSC staff is confident that it did not adversely impact on worker qualification, and that OPG currently has enough qualified staff to perform their work.

In 2008, two earlier training program inspections were closed out, after verifying that OPG had completed all corrective actions to the satisfaction of CNSC staff. One deficiency was still carried over from a 2004 *Type I inspection*, relating to the initial training program for mechanical and control maintainers.

Examination and Certification

In 2008, Darlington's overall pass rate for certification examinations was 100%. The industry average was 94.3%.

As a prerequisite for the transfer of certification examinations to licensees, licensees must have a sufficient number of examiners who meet the qualification requirements specified in the relevant regulatory documents. In February 2008, the CNSC issued the Regulatory Document RD-204 "Certification of persons Working at Nuclear Power Plants", which provides the expectations for the training, certification and continuing training of certified staff. CNSC staff assessed OPG's examination programs against this document and found them to be satisfactory.

Following the publication of RD-204, OPG applied to amend the Darlington PROL to incorporate RD-204 and conduct their own initial certification examinations for certified shift personnel. The Commission approved the transfer of initial examination certification to OPG in January 2009.

1.2.3 Design and Analysis

The Design and Analysis safety area at Darlington met CNSC requirements and performance expectations, and is rated as "Satisfactory" for 2008. The programs under this safety area contributed adequately to safe facility operation, and were each also rated as "Satisfactory".

CNSC STAFF PASS THROUGH A HAND AND FOOT MONITOR TO ENSURE THEY HAVE NOT PICKED UP ANY RADIOACTIVE PARTICLES. THIS PREVENTS THE SPREAD OF CONTAMINATION BETWEEN ZONES.

1.2.3.1 Safety Analysis

Overall, the implementation of the Safety Analysis program area at Darlington met CNSC expectations, and is rated as "Satisfactory" for 2008. Updates on issues carrying over from previous years are provided below.

Plant Aging on Safety Analysis

This issue, common to Bruce Power and OPG licensees, is described in detail in Section 2.3.1 "Neutron Overpower Protection (NOP) Improved Methodology". CNSC staff is reviewing the new NOP methodology, to confirm the adequacy and robustness of NOP trip set points for certain events, along with the supporting compliance and monitoring program. An Independent Technical Panel (ITP) was formed in 2008, to review probabilistic aspects of the new methodology. The final report of the ITP is expected in May 2009, and the CNSC final review is targeted for the end of 2009.

Safety Report Update

In November 2006, OPG submitted an update of Part 3 (Accident Analysis) of the Darlington *Safety Report*. The CNSC's review of the report identified several areas that did not meet CNSC evaluation criteria. OPG agreed to work with the CNSC towards resolving this issue; this represents an effort that would require the involvement of the Canadian nuclear industry insofar as agreeing to a standardized approach for *Safety Report* updates.

A meeting was held in June 2008, between the CNSC and the nuclear industry, to develop a strategy to improve the *Safety Report*. In January 2009, a progress report provided by OPG included a COG-wide Terms of Reference on Safety Analysis Improvement and Safety Analysis Principles and Guidelines. OPG will submit the final Safety Analysis Improvement Plan by December 2009.

Probabilistic Safety Analysis

The Darlington Probabilistic Safety Evaluation (DPSE) was completed in 1987, and served as a design verification tool in support of safety analysis. In order to ensure the continued validity of safety analysis, updates were made to the DPSE, which then became known as the Darlington A Risk Assessment (DARA).

Darlington continues its work in the PSA area, to meet the licence condition which requires OPG to perform a Level 2 PSA by December 31, 2010.

In 2008, OPG submitted their PSA methodology (which includes human reliability issues) as well as their Quality Assurance (QA) program used to update DARA. CNSC staff notes that the PSA methodology used by OPG generally complies with S-294 "Probabilistic Safety Assessment (PSA) for Nuclear Power Plants". However, staff has identified several issues which need to be addressed. OPG has since submitted a response to CNSC comments.

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 the resolution of the GAIs.

GAIs 88G02 and 95G02 were closed for Darlington in 2008. A brief description and the expected completion date of each remaining GAI are provided in Appendix F.

This program area is rated "Satisfactory" for Darlington in 2008.

1.2.3.3 Design

In 2006, CNSC staff conducted a *Type I inspection* of Darlington's emergency power supply and emergency service water systems, which identified several areas where improvements could be made. OPG has provided updates in 2007 and 2008, to show their continued progress in addressing these issues. Overall, the CNSC staff is satisfied with the information provided.

In the area of fire protection, CNSC staff review and assessment concluded that OPG is operating its Darlington facility in general compliance with licence requirements.

Based on the review of this program area, Darlington met CNSC expectations and received a "Satisfactory" rating.

ONCE EVERY SIX YEARS, NUCLEAR GENERATING STATIONS ARE SHUT DOWN TO TEST THE CONTAINMENT IS LEAK TIGHT. THIS INSPECTOR IS ON THE ROOF OF THE VACUUM BUILDING AT DARLINGTON.

1.2.4 Equipment Fitness for Service

The Equipment Fitness for Service safety area is rated as "Satisfactory" for Darlington in 2008. Overall, this safety area meets the objectives of CNSC requirements and performance expectations. However, continued deficiencies with the Equipment Qualification program has resulted in a "Below Expectations" rating for that program area.

1.2.4.1 Maintenance

CNSC staff inspections, surveillance monitoring and review of S-99 reportable events for 2008 did not identify any significant maintenance-related issues.

In 2008, Darlington reduced their online elective and corrective maintenance backlogs. They have also exceeded their preventative maintenance completion rate target (~90% completion rate versus 80% target).

Based on these improvements, and the results of CNSC staff compliance assessments, the Darlington maintenance program is rated as "Fully Satisfactory" for 2008.

CNSC INSPECTORS CHECKING THE VENTED CLOSURE PLUG THAT WILL BE PUT INTO THE REACTOR DURING AN OUTAGE. THIS COMPONENT ALLOWS WORK DURING THE OUTAGE TO BE DONE FASTER.

1.2.4.2 Structural Integrity

In 2008, Darlington met the pressure boundary requirements referenced in the PROL. Inspections were carried out as per applicable CSA Standards. OPG has adequate fitness-for-service programs in place, to ensure the integrity of *pressure tubes*, *feeders*, and *steam generators* is well maintained.

Fifteen *pressure tubes* were inspected during the Unit 1 outage in 2008, and were found to be fit for service until at least 2011. OPG has made good progress in meeting CNSC staff's expectations in the application of a new methodology used to assess *pressure tube* integrity.

The Darlington *feeder* inspection program was expanded in 2008 to include baseline inspections for all *feeders* on all units. Three *feeders* were replaced in Unit 1, while two more will be required at the next outage in 2011.

All four *steam generators* on Unit 1 were inspected during the 2008 outage, to determine the extent of tube fretting. Inspections were performed on the *steam generator* tubes, as well as specific components such as divider plates. No major issues were identified.

CNSC staff conducted a *Type II inspection* on Darlington's Periodic Inspection Program (PIP) in March 2008. Overall, the inspection found OPG to be generally in compliance in the implementation of the approved station PIP. Staff identified six positive observations and one negative observation, which dealt with record keeping.

A *Type II inspection* report was issued in July 2008 which identified items of non-compliance with regulatory requirements set out in the pressure boundary related licence condition. OPG has provided their path forward to correct these deficiencies, and CNSC staff is satisfied with the actions taken by OPG on this issue.

Based on the results of the compliance activities carried out and the review of Darlington's performance, CNSC staff rates the Structural Integrity program area as "Fully Satisfactory" for 2008.

1.2.4.3 Reliability

In 2008, all the special safety systems met their unavailability targets. CNSC staff is generally satisfied with OPG's progress with implementing the Reliability program at Darlington, and rates the program as "Satisfactory" for 2008.

1.2.4.4 Equipment Qualification

In 2008, OPG completed corrective actions to address the eight action notices and seven recommendations issued as a result of a *Type I inspection* in 2007 of the Darlington *Environmental Qualification* (EQ) program.

Darlington PROL Condition 7.1, requires that by December 31, 2010, the nuclear facility's EQ program meet the requirements of CSA standard N290.13-05 "Environmental Qualification of Equipment for CANDU Nuclear Power Plants." To meet this commitment, an EQ project is in progress to resolve numerous inadequacies. While substantial EQ upgrades have been completed, there is a significant amount of work to be done to ensure that the Darlington NPP is qualified, as required by the operating licence.

As a result of these deficiencies, the current EQ program at Darlington has been rated "Below Expectations" for 2008.

1.2.5 Emergency Preparedness

In June 2008, CNSC staff conducted a *Type II inspection* of OPG response during the Nuclear Emergency Worker Drill. The drill was organized and run by the Durham Region Emergency Management Organization. Overall, CNSC staff concluded that Darlington is in compliance with its regulatory requirements.

Staff also reviewed S-99 reportable events associated with emergency preparedness at Darlington in 2008, but did not observe any significant issues.

Based on staff assessments, the performance of the Darlington Emergency Preparedness program is rated as "Fully Satisfactory" for 2008.

1.2.6 Environmental Protection

In 2008, the reported dose to the public from Darlington was 1.3 µSv, which is well below the public dose limit of 1000 µSv. Gaseous and aqueous releases of nuclear substances were always below Environmental Action Levels.

CNSC staff review of Darlington Quarterly Operations Reports submitted under S-99 did not identify any significant issues related to radiation dose to the public or environmental protection. There were no reported unplanned releases of nuclear substances or hazardous substances from Darlington that posed an unreasonable risk to the environment.

A *Type I inspection* of Darlington's environmental protection polices and procedures was performed in July 2006. OPG provided updates in 2008 regarding the completion of outstanding action notices from the inspection, and CNSC staff is satisfied with the actions that OPG has taken to date.

In 2008, Darlington's Environmental Management System was recertified for 3 years under the ISO 14001 standard. Overall, the Environmental Protection safety area at Darlington met CNSC requirements and performance expectations and has been rated as "Satisfactory" for 2008.

1.2.7 Radiation Protection

In 2008, there were no radiation exposures at Darlington that exceeded regulatory limits, and no incidents resulting in reportable dose in excess of OPG's action levels. Radiation Protection-related events were reported promptly to CNSC staff and were accompanied by adequate implementation of corrective actions.

In 2008, CNSC staff conducted a *Type II inspection* on the implementation of the Radiation Protection Program at Darlington. The three program elements evaluated include contamination control, instrumentation and equipment, and radiation exposure and dose control. Two issues were identified concerning the control of airborne contamination between zonal boundaries and deficiencies at rubber areas. OPG has provided a corrective action plan to address these two items.

In 2008, Darlington was in the top quartile for performance in collective dose in the CANDU industry, due to a number of ALARA initiatives. For the first time in the last six years, there were no internal or external unplanned exposures.

The Radiation Protection program at Darlington is rated as "Fully Satisfactory" for 2008.

1.2.8 Site Security

This safety area is presented to the Commission in a separate *Commission Member Document* (CMD 09-M28.A).

1.2.9 Safeguards

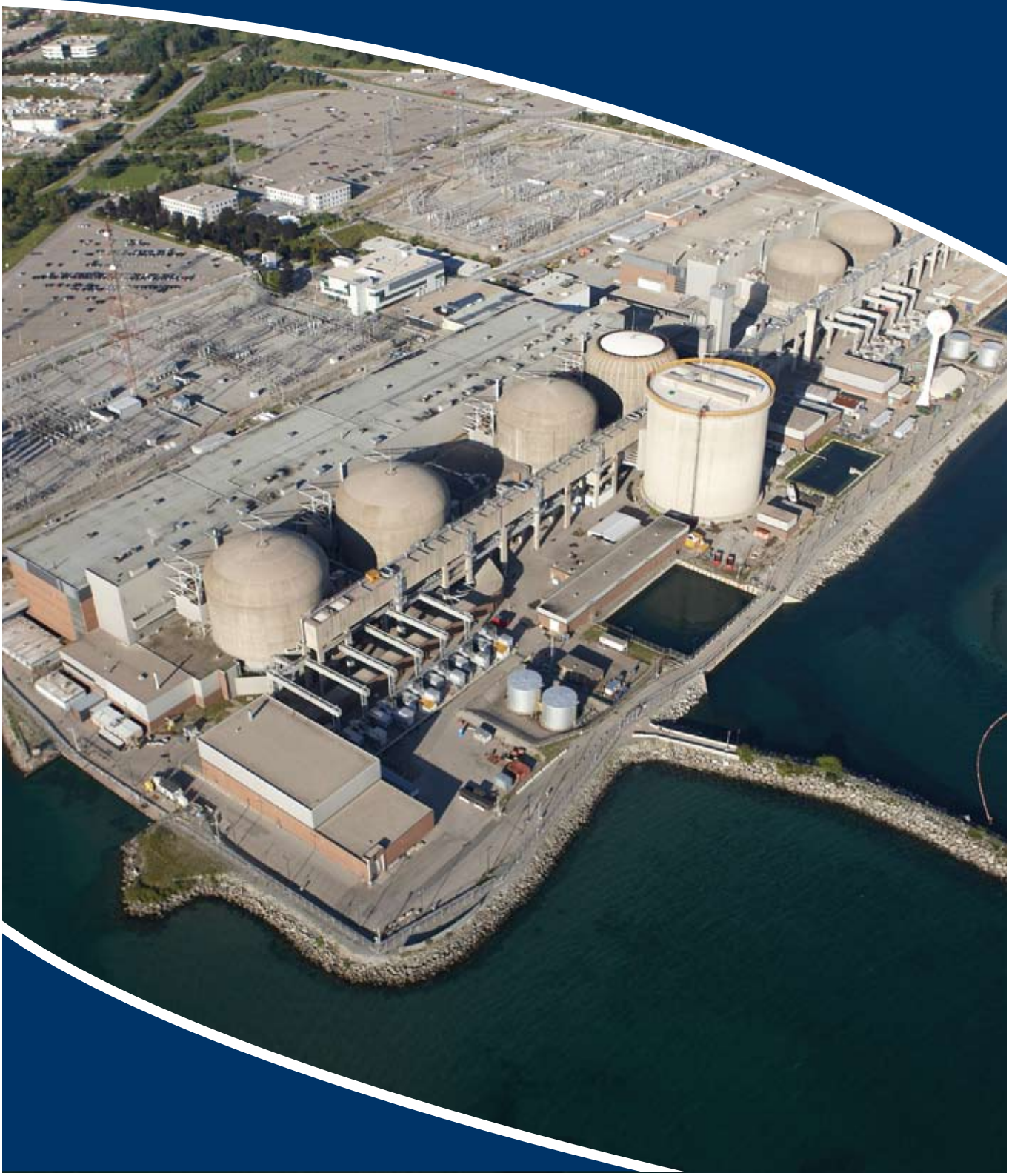
CNSC staff rates the implementation of the Safeguards safety area by OPG at Darlington as "Fully Satisfactory" in 2008, since it meets or exceeds applicable CNSC requirements and performance expectations. OPG has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

The IAEA conducted a Physical Inventory Verification at Darlington in July 2008. The inspection was undertaken to: verify that no diversion of nuclear material had taken place; detect any tampering with the IAEA's containment/surveillance system; and confirm the declarations provided by the State authorities and facility operators. The inspection was attended by CNSC staff, who undertook to review: the facility's support for IAEA inspectors, including escorts and equipment; the provision of accountancy information and supporting documents; the facility compliance with safeguards licence conditions relevant to the inspection activity; and the IAEA's adherence to its rights and obligations relevant to the inspection. This was the first IAEA inspection of this type at Darlington under the new Integrated Safeguards approach for CANDU stations. No significant compliance issues were identified.

In addition, a Design Information Verification was performed by the IAEA at Darlington in 2008. The IAEA has not yet issued reports of the results, but no issues are anticipated.

In 2008, Safeguards staff from Darlington participated in a series of trilateral meetings with the IAEA, the CNSC and the other facility operators, to develop an Integrated Safeguards Procedure for the CANDU stations. In developing the procedures, Darlington participated in a field trial for Short-Notice Random Inspections (SNRIs) at the facility, in order for the IAEA to detect and deter the diversion of nuclear material, tampering with IAEA surveillance equipment and undeclared activities. As of July 2008, these SNRIs formally replaced traditional IAEA inspections that were carried out on an announced quarterly basis.

1.3 PICKERING A



1.3 Pickering A

Table 3 presents the safety performance ratings for Pickering A for 2008. These ratings were determined using a risk-informed approach integrating findings from three (3) *Type I* and 26 *Type II inspections*, surveillance and monitoring activities, desktop reviews and assessments, and the professional judgement of CNSC staff. The integrated plant rating for Pickering A is "Satisfactory" for 2008. Rating definitions and a table of comparison with the old rating system are provided in Appendix B.

TABLE 3: SAFETY PERFORMANCE RATINGS FOR PICKERING A FOR 2008

Safety Area Program	**Performance Rating**
Operating Performance	**SA**
Organization and Plant Management	BE
Operations	SA
Occupational Health and Safety (non-radiological)	SA
Performance Assurance	**SA**
Quality Management	SA
Human Factors	BE
Training, Examination, and Certification	SA
Design and Analysis	**SA**
Safety Analysis	SA
Safety Issues	SA
Design	BE
Equipment Fitness for Service	**SA**
Maintenance	SA
Structural Integrity	SA
Reliability	SA
Equipment Qualification	SA
Emergency Preparedness	**SA**
Environmental Protection	**BE**
Radiation Protection	**SA**
Security	**Prescribed**
Safeguards	**FS**
Integrated plant rating	SA

1.3.1 Operating Performance

The Operating Performance safety area at Pickering A is rated as "Satisfactory" in 2008, since it meets the objectives of CNSC requirements and performance expectations. Overall, the programs under this safety area contributed adequately to the safe operation of the facility.

1.3.1.1 Organization and Plant Management

There were no significant organizational or management changes at Pickering A in 2008.

Three main issues affected the rating of implementation of the Organization and Plant Management program in 2008. These are:

- Inter Station Transfer Bus (ISTB) event, which occurred in 2007 and identified management deficiencies as root causes.
- number of plant transients.
- S-99 events contributing to organizational behaviours.

CNSC staff recognizes that Pickering A has made several improvements to address the root causes of the ISTB event (described in more detail in section 1.3.10.2.). These improvements include the installation of a temporary modification, which resolves the capacity issues of the ISTB. Culture-changing activities, focused on reinforcing correct behaviours, were introduced. It was noted that two independent culture-change assessments were completed, which indicate that good progress has been made in establishing new behaviours. The effectiveness of these new behaviours is being assessed by CNSC staff.

In 2008, Pickering A has shown improvement in operation from previous years; however, the capacity factors at both Units 1 and 4 were still relatively low. There were ten forced outages in 2008—as described in 1.3.1.2—for the two operational Pickering A units. This is consistent with previous years, although still considered a high number for two units. There were two transients that resulted in reactor trips in 2008, compared to six in 2007. OPG attributes the reduction in unplanned transients to procedural changes.

CNSC staff conducted a *Type I inspection* early in 2008, due to concerns over the licensee's compliance with the S 99 reporting requirements. The inspection determined the licensee was in compliance, but found problems with timeliness of reporting, initial recognition of events by licensee staff, and the overuse of Additional Reports—which cause unnecessarily delays in the provision of full information to CNSC staff. OPG has responded to the two action notices made in the inspection report and has implemented procedural changes. An end-of-year review of licensee's reporting performance noted improvements in the timeliness of reporting, reduction in the Additional Report backlogs and in the use of Additional Reports.

CNSC staff recognizes OPG's efforts and commitment to improve the safety culture framework and self-assessment methodology. CNSC staff encourages OPG senior management to continue to support the safety culture improvement initiatives toward the achievement of a heightened awareness by all staff of safety culture at the facility and its role in maintaining and further improving safe and reliable operation.

The analysis of S-99 reported events for the two first quarters of 2008 indicate a pattern of organizational behaviours similar to that found and reported during 2006 and 2007. CNSC staff has requested OPG to submit the results of its review of the 2008 assessment. OPG has submitted its plans to address the performance, and has committed to providing regular updates to CNSC.

In 2008, the CNSC review of events that initiated root cause investigations did not identify any management-related issues.

Based primarily on the management deficiencies which led to the ISTB event and on the compliance activities carried out and the review of the Pickering A's performance, the Organization and Plant Management program area at Pickering A is rated as "Below Expectations" for 2008.

1.3.1.2 Operations

CNSC staff assessed Operations from information collected through inspections, and review of operations.

During 2008, Pickering A experienced ten forced outages, two *setbacks*, and no *serious process failures*. There were no planned maintenance outages in 2008.

Unit 1 (5 forced outages)

- January 3, 2008 – Forced shutdown related to continuing problems with turbine governor valve control (1 day).
- February 28, 2008 – Forced shutdown to repair a failed shutdown cooling pump motor (6 days). Extended on March 6, 2008, to repair turbine governor valve control, reactor tripped (19 days).
- May 6, 2008 – Forced shutdown to remove a stuck fuelling machine from the reactor (59 days).
- October 25, 2008 – Forced shutdown related to auxiliary boiler feed system issues (16 days).
- November 20, 2008 – Forced shutdown related to auxiliary boiler feed system issues (5days).

Unit 4 (5 forced outages)

- June 20, 2008 – (*setback*) Setback due to an inadequate procedure and failure to use operating experience during maintenance on the bleed condenser level instrumentation. Reactor tripped at low power (3 days).
- September 6, 2008 – Forced shutdown to repair defective shutoff rod #8 mechanism (7.5 days).
- November 8, 2008 – Forced shutdown to repair leakage from the heat transport system (23.5 days) extended on December 1, 2008, by a *setback* caused by defective steam release valve limit switch (1 day).
- December 6, 2008 – Forced shutdown to repair steam leak from flow element in feedwater heater line (2 days).
- December 9, 2008 – Forced shutdown due to alarms received on two of three protective system channels for boiler room high pressure signals (6 days).

INSPECTOR CHECKING THE STATE OF COMPONENTS INSIDE THE VACUUM BUILDING.

A trend of housekeeping deficiencies was noted in the field inspections. These deficiencies included water on the floor, clutter and out-of-service scaffolding, and equipment in need of removal.

CNSC staff conducted 26 *Type II inspections* in 2008, in addition to surveillance and monitoring activities, desktop reviews and assessments, and meetings with the licensee to discuss enforcement actions, licensing requirements, inspection findings and results of reviews and assessments. Based on the results of these activities, the Operations program area at Pickering A is rated as "Satisfactory" for 2008.

1.3.1.3 Occupational Health and Safety (non-radiological)

Number of lost time injuries reported by the licensee:	2
Accident frequency (AF) (Pickering A and B):	0.10
Accident severity rate (ASR) (Pickering A and B):	1.49

AF and ASR are performance indicators, reported by the licensee as per S-99 requirements. CNSC staff considers that the AF and ASR, as reported by OPG during 2008, demonstrated adequate occupational health and safety performance at Pickering A. The Pickering A and B combined value for the ASR is 1.49, which is better than the industry average of 2.39. There were two lost time accidents at Pickering A in 2008.

Based on the review of the performance of Pickering A, CNSC staff rates the Occupational Health and Safety program area at Pickering A as "Satisfactory" in 2008.

1.3.2 Performance Assurance

The Performance Assurance safety area at Pickering A is rated as "Satisfactory" in 2008, since it meets the objectives of CNSC requirements and performance expectations. Overall the program areas contributed adequately to the safe operation of the facility.

1.3.2.1 Quality Management

The desktop reviews of the OPG governing documents determined that the revised documents continue to address the applicable requirements of CSA standard N286.0. Inconsistencies were identified, but these do not impact the safety risk for operation.

CNSC staff conducted an analysis of the Pickering A S-99 reportable events, and linked them to the basic N286.5 quality program requirement. A weakness was identified in the QM requirement for the Control of Items, Processes and Practices.

The Quality Management program continues to be adequately documented, and no systematic non-adherence to those documented processes has been identified. Therefore, CNSC rates the Quality Management program as "Satisfactory".

1.3.2.2 Human Factors

The requirement to maintain and have assurance that an adequate minimum complement is available is a fundamental part of the Human Factors program. There have been several concerns related to the Minimum Complement issue at Pickering NGS in the past years. Common mode events occurred at Pickering NGS in 2003 and 2004 (the Algae Run and the Loss of Bulk Electrical System events), which demonstrated the challenges faced by the station during scenarios affecting more than one unit. The current Shift Station Complement document at Pickering lists the minimum complement requirements for an event on a single unit, at either Pickering A or B. CNSC staff expressed concerns that staffing levels for an event on a single unit might not be adequate, should a common mode event occur. In 2004, CNSC staff formally requested OPG to analyze the minimum staffing requirements for common mode accidents such as fire, seismic events, *design basis accidents*, etc.

CNSC staff review in 2008 indicates that OPG did not satisfactorily address this issue at Pickering A and B. Several meetings occurred between CNSC staff and OPG, during which the requirement for OPG to analyze the minimum staffing requirements for common mode events was reiterated.

The work presented by OPG in 2008 did not demonstrate compliance with regulatory guidance documents G-323 "Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities Minimum Staff Complement", and G-278 "Human Factors Verification and Validation Plans". In 2008, OPG submitted an action plan and schedule to demonstrate full compliance with these CNSC regulatory documents. CNSC staff will be closely monitoring OPG's progress on this issue, to ensure that all concerns regarding the minimum complement requirements are addressed.

In 2006, CNSC staff conducted an inspection at Pickering to verify compliance with the minimum shift requirements. As a result of the inspection, CNSC staff found that Pickering A and B did not control or monitor the status of minimum shift complement, to ensure that qualified personnel are available for all of the work group and emergency roles. In 2008, OPG implemented the Minimum Complement Coordination Program as the permanent method for the monitoring and control of minimum shift complement. Pickering A and B are making progress towards addressing the directive and action notices issued in the original inspection report.

In 2005, CNSC staff requested OPG to submit contingency plans for maintaining staff in key on-site positions, and strategies if unable to meet all staff requirements. This was requested in order to assess the vulnerability of Canadian power reactor sites to off-site events, whether man-made or natural. Later, this also included a discussion on Pandemic Planning. OPG has submitted these plans and has addressed issues raised by CNSC staff.

In 2008, OPG carried out several improvements initiatives in the Human Factors area, such as having a procedure ambiguity awareness campaign, and making rapid responses to human performance events, so as to prevent recurrence.

OPG performed a Safety Culture Self-Assessment in August 2007 at Pickering A. CNSC staff observed the implementation of the Safety Culture method and the use of the supporting data input tool, and communicated its observations early in 2008 to OPG, along with recommendations for further improvement. The development of a safety culture self-assessment is a dynamic, ongoing process, for which OPG should be commended. CNSC staff will continue to monitor OPG's improvements to this methodology.

Based on compliance activities carried out and the review of the performance of Pickering A, CNSC staff rates the implementation of the Human Factors program area by OPG at Pickering A as "Below Expectations" in 2008.

1.3.2.3 Training, Examination and Certification

CNSC staff is satisfied that there are sufficient number of qualified workers at Pickering A to carry out the licensed activities. The Training, Examination and Certification program area is rated as "Satisfactory" for Pickering A in 2008.

Training

In 2008, CNSC staff completed a desktop review of OPG's training program document N-PROG-TR-0005 (R08) and identified five deficiencies. These deficiencies were associated with new terminology being introduced in training qualifications, and the categorization of programs which are required to be based upon *Systematic Approach to Training* (SAT) principles. OPG has provided to CNSC staff a plan to address the deficiencies, along with a timeframe for its completion. Most of the corrective actions are expected to be completed in 2009. Since this new version of the Training Program has been issued very recently, CNSC staff is confident that it did not adversely impact on qualification of the workers, and that OPG currently has enough qualified staff to perform their work.

A *Type I inspection* of the Nuclear Operator Training Program was conducted in January 2008. The inspection found some positive aspects of this training program, along with some deficiencies. OPG was requested to produce an action plan to address the deficiencies by April 1, 2009.

In 2008, the CNSC concerns raised in a number of earlier inspections were considered resolved, following the verification of corrective actions. One deficiency still remains from a 2004 *Type I inspection*, relating to the initial training program for mechanical and control maintainers.

Examination and Certification
The overall success rate in certification examinations at Pickering A in 2008 was 100 %.

In 2007, OPG proposed revisions to the requirements for re-qualification testing for certified shift personnel. CNSC staff has reviewed the proposal and, during the consultation between CNSC and all NPPs in 2008, has determined that all the process-related issues relating to re-qualification testing have been resolved.

INSPECTORS PERFORM A ROUTINE WALKDOWN WITH STATION MANAGEMENT BEFORE A REACTOR RESTART.

As a prerequisite for the transfer of certification examinations to licensees, licensees must have a sufficient number of examiners who meet the qualification requirements specified in the relevant regulatory documents. In February 2008, the CNSC issued the Regulatory Document RD-204 "Certification of Persons Working at Nuclear Power Plants", which provides the expectations for the training, certification and continuing training of certified staff. CNSC staff assessed OPG's examination programs against this document, and found them to be satisfactory.

Following the publication of RD-204, OPG applied to amend the Pickering A PROL to incorporate RD-204 and conduct their own initial certification examinations for certified shift personnel. The *Commission* approved the transfer of initial examination certification to OPG in January 2009.

1.3.3 Design and Analysis

The Design and Analysis safety area at Pickering A is rated as "Satisfactory" in 2008, since it meets the objectives of CNSC requirements and performance expectations. Overall, the programs under this safety area contributed adequately to continued safe operation of the facility, through the identification and resolution of safety related issues of design and analysis. However, the Design program area is rated as "Below Expectations".

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:

- Impact of Plant Aging on Trip Coverage.
- The discrepancy in the 28-Element Fuel String Critical Heat Flux (CHF) Experiments and its impact on safety.
- *Safety Report* Update.

Updates were given in *Commission* Public Meetings in June 2008 (CMD 08-M37) and February 2009 (CMD 09-M5). Only the progress updates are discussed in the sub-sections below.

Impact of Plant Aging on Trip Coverage
Aging occurs in all CANDU reactor heat transport system (HTS) components (*pressure tubes*, *steam generators*, and *feeders*), which affects operating conditions (coolant flows, temperatures, and pressures) and can impact on safety margins.

Aging of HTS components may affect the adequacy of the currently installed NOP trip setpoints. The negative impact of aging on trip set points may be compensated by additional margins—through the use of the new NOP Methodology, as described in Section 2.3.1.

In 2008, OPG reported that aging of the HTS may also affect the adequacy of shutdown system trip coverage for loss of flow events and small LOCAs. The industry, together with the CNSC, is working to resolve this issue.

28-Element Fuel Bundle
In June 2007, OPG reported, that the results from 28 element fuel Critical Heat Flux (CHF) experiments indicated that the dryout powers of the 28 element fuel string currently being used at Pickering A were significantly lower than previously thought.

OPG has developed new CHF correlations, which are used inside the safety analyses currently under CNSC staff review. A formal OPG submission, proposing a path towards the resolution of these issues is expected in June/July 2009.

Safety Report Update
In 2007, CNSC staff informed OPG—and all licensees—that the Accident Analysis, as documented in Part 3 of the *Safety Report*, does not meet licensing criteria with respect to validated tools, consistency and conservatism in analysis methodologies and assumptions, treatment and application of simulation and measurement uncertainties. Although the Pickering A safety case is not in question, the safety margins and analysis need to be confirmed. OPG has prepared a proposed resolution strategy to resolve all the issues, with a planned completion date of 2010, and has been submitting regular updates on this matter.

Based on compliance activities carried out and the review of Pickering A's performance in 2008, the existing margins are adequate and major issues are similar to all CANDUs. Therefore, CNSC staff rates the Safety Analysis program area at Pickering A as "Satisfactory" in 2008.

1.3.3.2 Safety Issues

CNSC staff reviewed the progress of the CANDU industry and utilities in resolving issues related to GAIs. OPG continued work, including participation in the industry efforts, toward resolution of the GAIs.

GAIs 88G02 and 95G02 were closed for Pickering A in 2008. A brief description and the expected completion date of each remaining GAI are provided in Appendix F.

This program area is rated as "Satisfactory" for Pickering A in 2008.

1.3.3.3 Design

In 2007, the design of the Inter-station Transfer Bus (ISTB) was found to have deficiencies which had existed since it had been installed, in 1991. OPG has installed a temporary modification to permit the ISTB to meet its design intent. However, this temporary modification has a lack of redundancy, reduced reliability and relies more on operator action. A permanent modification has been developed by OPG, and its installation is expected during the Vacuum Building outage in 2010. A more detailed summary of the ISTB is provided in Section 1.3.10.2.

Several individual unit conditions currently existing at Pickering A create challenges for Operators during transient situations, including:

- Ability to maintain Heat Transport storage tank pressure.
- Slow speeder gear response to *setback*.
- Reactor Regulating System Lin/Log transition.
- Adjuster rod restrictions.
- Boiler level control challenges.
- De-aerator level control challenges.

OPG are well aware of these issues, and have committed to addressing all of them.

Based primarily on the deficiencies of the temporary ISTB modification, CNSC staff rates the performance of the Design program area at Pickering A as "Below Expectations" for 2008.

1.3.4 Equipment Fitness for Service

The Equipment Fitness for Service safety area at Pickering A is rated as "Satisfactory" in 2008, since it meets the objectives of CNSC requirements and performance expectations. The programs under this safety area contributed adequately to the continued safe operation of the facility, through the identification and resolution of safety related issues involving structures, systems and components.

1.3.4.1 Maintenance

A *Type II* Maintenance Condition Monitoring inspection was conducted in October 2008. The inspection was conducted to verify that Pickering A has processes and procedures in place for monitoring the condition of structures, systems and components (SSCs) in order to determine that they continue to be capable of performing their design intent. The inspection confirmed that major equipment was identified and functional failure analysis was done, to determine degradation mechanisms and monitoring parameters.

CNSC staff routinely reviews S-99 reportable events related to the maintenance program area. In 2008, 33 events related to maintenance were reported. Only one of these was important enough to warrant a Significant Development Report (SDR). It involved a shutdown cooling valve failing a routine scheduled test, due to a loose wire within the valve control circuit. A Level 1 impairment of the ECI System was declared (see Appendix E for further details).

Staff review of S-99 performance indicators concluded that the Preventive Maintenance Completion Ratio—the number of preventive maintenance work orders on safety-related systems, divided by the number of preventive, plus corrective work orders on safety related systems—has been improving at Pickering A over the past year.

Four indirect performance indicators of maintenance performance: the Number of Pressure Boundary Failures, Number of Missed Mandatory Safety System Tests, Number of Unplanned Transients and Unplanned Capability Loss Factor, were generally stable.

Based on compliance activities carried out, and the review of the performance of Pickering A, the Maintenance program at Pickering A has been rated as "Satisfactory" in 2008.

VERIFYING THE STATUS OF THE PRESSURE RELIEF DUCT AT PICKERING.

1.3.4.2 Structural Integrity

In 2008, Pickering A met the pressure boundary requirements referenced in the PROL. Inspections were carried out as per applicable CSA standards. OPG has adequate fitness-for-service programs in place, in order to ensure that the integrity of *pressure tubes*, *feeders*, *steam generators* is well maintained.

In 2008, there were no planned outages for the Pickering A units. However, in accordance with the fitness-for-service program, previous inspections of the *pressure tubes* and *feeders* confirmed that they are fit for service until the next planned outages—in 2010 for Unit 1, and 2009 for Unit 4. In addition, OPG reported the results of STEM elongation measurements performed on the east (fixed) and west (free) end of all 390 channels of Unit 1, during the 2007 outage. The report concluded that the results were satisfactory until the next planned inspection.

Eight of twelve Unit 1 *steam generators* were inspected during the fall 2007 outage. CNSC review of the inspection results, condition monitoring and operational assessments were conducted in 2008. Data from the inspection results show that *steam generators* can be safely operated until the next planned outage in 2010. Engineering evaluations based on the inspection results from the previous outages confirmed that *steam generators* at Pickering A Unit 4 are fit for service until the next planned outages in 2009.

OPG reported slightly elevated levels of main steam tritium for Pickering Unit 1, which would correlate with a *steam generator* tube leak to the order of 0.1 to 0.3 kg/h in July 2008. This leak rate was well below the allowable operational leakage rate of 15 kg/h, and is also below the threshold level of 5 kg/h—which OPG stated would improve their ability to confirm a tube leak. OPG has several measures in place to evaluate the possible consequences of a suspected tube leak. CNSC inspectors are satisfied that the information provided by OPG regarding this leak, pursuant to CAN/CSA N285.4-94, supports the continued operation of Pickering a Unit 1 *steam generators* until the next planned inspection in 2010.

OPG performs periodic inspections for CSA N285.5-M90 containment components, and submits the inspection reports to CNSC staff for review and acceptance, on an ongoing basis, as per the station Periodic Inspection Program (PIP). In late 2007, OPG performed inspections for Unit 0, Unit 1 and Unit 4 containment components, and the inspection reports were submitted to the CNSC. OPG addresses CNSC comments on the PIP reports satisfactorily.

OPG performs CSA N285.4 periodic inspections for Pickering A nuclear power plant components, and submits inspection reports to the CNSC on an ongoing basis as per the requirements of CSA N285.4 *Periodic Inspection Program* (PIP). In 2008, OPG submitted the CSA N285.4 PIP report for Unit 1 to CNSC staff for review and acceptance. The report was found to be generally satisfactory.

There were no CSA N287.7 inspections of containment structures in 2008.

In 2008, OPG met S-99 reporting requirements for reporting pressure boundary degradations. For the most part, the pinhole leaks, cracks, aging, and corrosion identified during 2008 were of minimal consequence, and OPG took adequate steps to address this identified degradation. Two incidents of class 6 pipes shearing off subsequent to pressure gauges installation were reported. These incidents prompted root cause analysis by OPG. Vibration induced metal fatigue was identified as the reason that led to pipes shear off. OPG has taken adequate steps to address the issue.

A CNSC review of the quarterly reports resulted in several findings of concern to pressure boundary issues. However, in all the cases, OPG took the necessary measures to assure the adequacy of the pressure boundary. There was one significant finding related to a severe wall thinning of the helium storage tank of the moderator system of Unit 1. Elaborate ultrasonic testing measurements, using phased array technique, concluded that the unexpected wall thinning is attributed to the lamination in the steel pipe.

Based on compliance activities carried out and the review of the performance of Pickering A, the Structural Integrity program at Pickering A is rated as "Satisfactory" in 2008.

1.3.4.3 Reliability

The current probabilistic risk assessment for Pickering A (PARA), submitted in 1995, served as a design verification tool in support of safety analysis. OPG has recently revised PARA and will submit it to CNSC. OPG has been requested to submit an implementation strategy for the implementation of CNSC standard S-294 "Probablistic Safey Assessment". It is expected that an up-to-date Pickering A Probabilistic Risk Assessment, as required by S-294, will be submitted in the coming years.

Pickering A experienced 14 impairments of a *special safety system* or standby safety-related system—reported in accordance with S-99—in 2008. This number is similar to those reported in previous years. The impairments in 2008 included events on Emergency Coolant Injection, Containment System, Auxiliary Boiler Feed, Emergency High and Low Pressure Service Water, Heat Transport System, and several related to the Inter-Station Transfer Bus.

The ECI System exceeded its Actual Past Unavailability target in 2008, due to failure of a shutdown cooling isolating valve to open. This incident resulted in 3.5 days of assigned unavailability of ECI.

CNSC staff raised a concern with OPG's criteria for identifying systems important to safety. A preliminary review of the OPG response indicates that the licensee has not fundamentally changed its position on these criteria. This represents an industry-wide issue, and the CNSC will further discuss this issue with OPG, in 2009.

Of the more than 12,000 safety system tests scheduled during 2008, only one test was missed on Unit 2. The missed test was completed successfully by the end of November 2008.

As discussed in 2007, OPG continued to implement S-98 requirements at Pickering A, such as refining reliability models for all the systems important to safety and addressing CNSC comments. Progress is being made in responding to CNSC comments.

Based on compliance activities carried out and the review of the performance of Pickering A, CNSC staff rates the Structural Integrity program area at Pickering A, as "Satisfactory" in 2008.

1.3.4.4 Equipment Qualification

In 2008, CNSC staff identified several deficiencies with seismic qualification during field inspections. These deficiencies included unrestrained equipment and materials, scaffolding not seismically-qualified, and improperly labelled or unlabelled scaffolding and emergency lighting. In addition to correcting these individual deficiencies, OPG has taken actions to reduce the number of future deficiencies. Continued implementation and preservation of the station's qualification program provides reasonable assurance that SSCs, within the scope of the EQ program, will continue to perform their intended functions consistent with Pickering A design and current licensing basis.

A specific action was placed on Pickering A with respect to cabling issues that were identified during the CNSC investigation of the Inter-Station Transfer Bus (ISTB) event. This event is discussed in more detail in 1.3.10.2. OPG was requested to provide demonstration of the qualification of cables, in accordance with its EQ program. Specifically, OPG was requested to provide the EQ List Development Packages, EQ Assessments, and any test reports and similarity analyses, along with eleven PVC insulation formulations. OPG has not yet responded to this request.

A Type II inspection was conducted in 2008 on the performance of the licensee's Chemistry Program. A few areas for improvement were brought to the attention of the licensees, with respect to Pickering A's participation in an Inter-laboratory Comparison Program (COGIS) for analytical quality control proposes.

Based on compliance activities carried out and the review of the performance of Pickering A in 2008, CNSC staff has given a "Satisfactory" rating to the Equipment Qualification program area at Pickering A.

1.3.5 Emergency Preparedness

CNSC staff has reviewed the S-99 Quarterly Performance Indicators and Quarterly Operations Reports submitted in 2008. Performance indicator data was consistent with the performance from the previous 5 years. Four reportable events occurred during 2008, and they were all reported correctly under the Provincial Nuclear Emergency Plan.

A *Type I inspection* of a station emergency response drill at Pickering A and B was performed in February 2008. The drill scenario consisted of a large LOCA on a Unit, with a number of complicating factors added, to challenge the duty crew and responders. Recommendations were included in the report, specifically regarding the drill performance. The inspection resulted in two action notices, which have been satisfactorily closed.

The implementation of the Emergency Preparedness safety area at Pickering A is rated as "Satisfactory" in 2008, since it meets applicable CNSC requirements and performance expectations. OPG has demonstrated adequate provisions for preparedness and response capability levels that would sustain an appropriate protection of the environment and the health and safety of Canadians during an emergency.

1.3.6 Environmental Protection

In 2008, the reported dose to the public due to both Pickering A and B was 4.1 µSv, which is well below the public dose limit of 1000 µSv. Gaseous and aqueous releases of nuclear substances were always below Environmental Action Levels.

CNSC staff review of Pickering A Quarterly Operations Reports, submitted under S-99, did not identify any significant issues related to radiation dose to the public or environmental protection. There were no reported unplanned releases of nuclear substances or hazardous substances from Pickering A, which posed an unreasonable risk to the environment.

A *Type I inspection* of the Pickering site environmental protection polices and procedures was performed in July 2006. In 2008, OPG provided updates regarding the completion of outstanding action notices resulting from the inspection, and CNSC staff is satisfied with the actions that OPG has taken to date.

In late 2007, OPG requested "approval in principle" for removal of the "Pickering A Return to Service Environmental Assessment (EA) Follow Up Monitoring Program" as a license condition, due to completion of the project. CNSC staff agreed with the revised scope change, and the PROL was subsequently amended. However, CNSC staff found that Pickering A had not been in compliance with the licence condition 12.4. Specifically, the environmental effects of the condenser cooling water system (i.e., impingement and entrainment [IE] and thermal releases) were not monitored and reported in accordance with the EA Follow Up Monitoring Program.

CNSC staff also reviewed data provided by OPG for the EA for the Pickering B refurbishment feasibility study, with regard to rates of fish mortality due to IE in the cooling water intake of both Pickering A and B. CNSC staff concluded that the ongoing fish mortality constitutes an unreasonable risk to the environment. CNSC staff also concluded that OPG did not implement the available mitigation measures identified in March 2003, during the course of its Fish IE Management Program. It was also noted that Fisheries and Oceans Canada has expressed its own concerns with the scale of IE losses of fish at the Pickering A and B sites. Therefore, OPG was requested, in accordance with 12(2) of the *General Nuclear Safety and Control Regulations*, to implement IE mitigation measures following a strict timetable. Interim IE mitigation measures will be installed in 2009, with the implementation of permanent IE mitigation measures by 2012. OPG is complying with the CNSC's request.

CHECKING THE RELAY PANEL.

In addition, CNSC staff is concerned with the environmental effects from temperatures at the existing Pickering site cooling water discharges. OPG has committed to conduct additional studies to confirm the extent of the thermal plume and the presence of fish species and life stages that may be adversely affected by increased cooling water. As a result, CNSC staff requested OPG to submit a plan that describes the nature and timing of the studies. OPG has provided a plan, which is currently under review.

CNSC staff also found incomplete evidence that environmental effects of the Pickering A Return to Service project regarding hazardous substances in groundwater were monitored, evaluated, and reported for the post-restart phase. This issue was subsequently addressed by OPG to the satisfaction of CNSC staff.

CNSC staff performed a *Type II inspection* of Pickering's Environmental Internal Investigation Level exceedances in 2007. The report was issued in 2008 and included several low-risk findings concerning the manner in which OPG was following up on Internal Investigation Levels exceedances. OPG has addressed all the findings in the report, and it was closed in early 2009.

The performance of the Environmental Protection safety area at Pickering A is rated "Below Expectations" for 2008, because the fish impingement and entrainment represents an unreasonable risk to the environment—deviating from the applicable CNSC requirements and reducing performance below expectations. OPG has committed to taking measures to reduce fish mortality.

1.3.7 Radiation Protection

In 2008, there were no radiation exposures at Pickering A that exceeded regulatory dose limits, and no incidents resulting in reportable doses in excess of OPG's action levels.

In early 2008, CNSC staff conducted a *Type II inspection* of the Radiation Protection Program at Pickering A and B. Several positive aspects were noted during the inspection, but some deficiencies were also identified, related to rubber area tags and access control to rubber areas, the decontamination of contaminated areas, and the calibration of radiological instruments. OPG has taken actions to correct the deficiencies.

Based on compliance activities carried out and the review of Pickering A's performance CNSC staff rates the Radiation Protection safety area at Pickering A as "Satisfactory" in 2008.

1.3.8 Site Security

This safety area is presented to the *Commission* in a separate *Commission Member Document* (CMD 09-M28.A).

1.3.9 Safeguards

CNSC staff rates the implementation of the Safeguards safety area by OPG at Pickering A as "Fully Satisfactory" in 2008, since it meets or exceeds applicable CNSC requirements and performance expectations. OPG has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

The IAEA conducted a Physical Inventory Verification at Pickering in September 2008. The inspection was undertaken to: verify that no diversion of nuclear material had taken place; detect any tampering with the IAEA's containment/surveillance system; and confirm the declarations provided by the State authorities and facility operators. The inspection was attended by CNSC staff, who undertook to review: the facility's support for IAEA inspectors including escorts and equipment; the provision of accountancy information and supporting documents; the facility compliance with safeguards licence conditions relevant to the inspection activity; and the IAEA's adherence to its rights and obligations relevant to the inspection. This was the first IAEA inspection of this type at Pickering under the new Integrated Safeguards approach for CANDU stations. No significant compliance issues were identified.

In addition, two Design Information Verifications and one Complementary Access visit were performed by the IAEA at Pickering in 2008. CNSC staff did not attend these activities. The IAEA has not yet issued reports of the results, but no issues are anticipated.

In 2008, Safeguards staff from Pickering participated in a series of trilateral meetings with the IAEA, the CNSC and the other facility operators, to develop an Integrated Safeguards Procedure for the CANDU stations. In developing the procedures, Pickering participated in a field trial for Short-Notice Random Inspections (SNRIs) at the facility, in order for the IAEA to detect and deter the diversion of nuclear material, tampering with IAEA surveillance equipment and undeclared activities. As of July 2008, these SNRIs formally replaced traditional IAEA inspections that were carried out on an announced quarterly basis.

1.3.10 Update on Major Projects and Initiatives

1.3.10.1 Units 2 and 3 Safe Storage – Guaranteed Drained State

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 the management recommendation not to proceed with the restart of these units. This decision was made for business reasons. Instead of returning to operation, Units 2 and 3 will be placed in long-term safe storage until Units 1 and 4 are ready to be decommissioned.

An Environmental Assessment was performed in 2008. The screening began in February, with the guidelines approved by the Commission in June, and approval to proceed was granted by the *Commission* in November.

The safe storage system end-states are chosen to meet safety, regulatory, environmental and design requirements for Pickering A and Pickering B, such that they no longer require operation, maintenance or surveillance.

Both units are currently defuelled. Draining and drying of the moderator and primary heat transport systems, along with the helium tank modifications for long term moderator water storage, are underway.

The next steps will involve isolating the reactor building bulkheads from the pressure relief duct and moving the containment boundary to the bulkheads, separating the emergency coolant injection and common containment systems from the operating units, electrically de-energizing the systems, cutting and capping support systems, closing and tagging system valves to form a contamination boundary, and modifying the reactor building ventilation system and stack monitoring systems such that they remain available on demand.

1.3.10.2 Inter-Station Transfer Bus (ISTB)

In early June 2007, OPG shut down the Pickering A station when it determined that the ISTB electrical system did not meet its design intent. The ISTB provides power from Pickering B to essential equipment after Main Steam Line Break (MSLB) in the Pickering A powerhouse. Under worst-case accident conditions, the ISTB did not have the load carrying capacity required, and had an unacceptably large voltage drop at the load end. In May 2007, OPG discovered openings in the steam barriers to the Steam Protected Rooms (SPRs) which contain equipment intended to be supplied by the ISTB post accident. OPG's investigation into the situation revealed several past design and commissioning problems with the ISTB, going back to its installation in 1991, and they decided to shutdown the station. The ISTB event affected many CNSC Safety Areas and Programs.

Over the next several months, Pickering A designed and installed temporary modifications to restore the functionality to the ISTB. The modifications removed loads from the ISTB, and added additional cabling to re-configure the ISTB buses to reduce voltage drops. The new configuration was tested, and the resulting load capacity and voltage drops met OPG's specifications. Pickering A requested CNSC approval to make temporary operational changes, required by the temporary modifications, before the units were restarted.

In its 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 did not provide complete assurance regarding the capability of the current engineering change processes to address complex design changes.

CNSC approval was given, and the first unit was restarted in October 2007. 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 2010.

CNSC staff formed the ISTB Review Team and conducted a review of OPG's response to the impairment of the ISTB. The ISTB Review Team reviewed in detail the engineering design and operational changes aiming to restore ISTB function, OPG's root cause investigation report, and OPG's extent of condition reports (used to determine how widespread the concerns might be). The main findings of the ISTB Review Team were:

- The design and operational changes to restore the ISTB are acceptable in the short term only, as the current arrangement has a weakened defence-in-depth, lowered safety margins and a higher risk.
- The root cause investigation report conclusions were not well supported by the analysis in the report; therefore, the root causes and corrective actions identified are questionable. OPG did not fully and satisfactorily explain why the ISTB concerns had not been previously corrected.
- Four extent of condition assessments were completed by OPG; however, the dispositions of some problems found were considered inadequate or incomplete by the ISTB Review Team.

The ISTB Review Team recommended that:

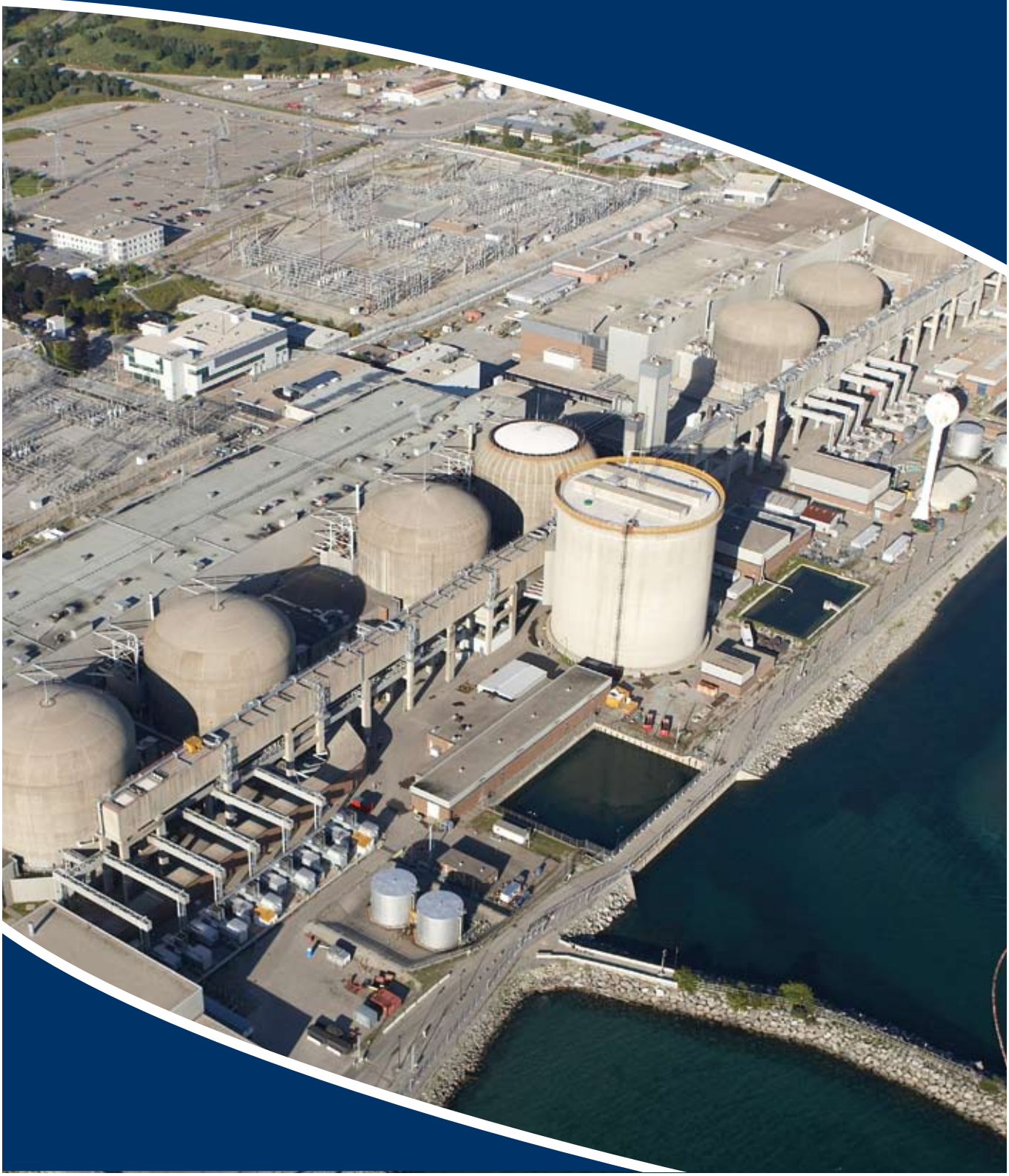
- OPG pursue a permanent solution to meet original ISTB design requirements with expediency, and provide a firm installation date for the permanent modifications.
- CNSC conduct a complete, thorough and unbiased independent organizational and management evaluation of the Pickering A station.
- OPG submit further information on the numerous corrective actions, detailed in this report and that CNSC review these submissions for adequacy.

The ISTB event also determined that management deficiencies were the primary cause of the incident. These deficiencies indicated a breakdown in several management activities and practices over many years.

Since 2007, Pickering A has made number of improvements to address the root causes of the ISTB event. These improvements included temporary and eventual permanent modifications, and culture-changing activities focused on reinforcing correct behaviours. It was noted that two independent culture change assessments were completed, indicating that good progress has been made in establishing new behaviours. The effectiveness of these new behaviours will be evaluated when the CNSC carries out a Safety Culture evaluation in early 2009, to determine effectiveness of the improvements related to the ISTB initiatives.

In 2008, CNSC staff assessed OPG's revised *root cause analysis* and plans, to discuss concerns with regard to the adequacy of the *root cause analysis* processes in 2009, including conducting verification activities.

1.4 PICKERING B



1.4 Pickering B

Table 4 presents the safety performance ratings for Pickering B for 2008. These ratings were determined using a risk-informed approach integrating findings from four (4) *Type I* and 55 *Type II inspections*, surveillance and monitoring activities, desktop reviews and assessments, and the professional judgement of CNSC staff. The integrated plant rating for Pickering B is "Satisfactory" for 2008. Rating definitions and a table of comparison with the old rating system are provided in Appendix B.

TABLE 4: SAFETY PERFORMANCE RATINGS FOR PICKERING B FOR 2008

Safety Area Program	Performance Rating
Operating Performance	**SA**
Organization and Plant Management	BE
Operations	SA
Occupational Health and Safety (non-radiological)	SA
Performance Assurance	**SA**
Quality Management	SA
Human Factors	BE
Training, Examination, and Certification	SA
Design and Analysis	**SA**
Safety Analysis	SA
Safety Issues	SA
Design	SA
Equipment Fitness for Service	**SA**
Maintenance	SA
Structural Integrity	SA
Reliability	SA
Equipment Qualification	SA
Emergency Preparedness	**SA**
Environmental Protection	**BE**
Radiation Protection	**SA**
Security	**Prescribed**
Safeguards	**FS**
Integrated plant rating	SA

1.4.1 Operating Performance

Operating Performance at Pickering B is rated as "Satisfactory" for 2008, since it meets the objectives of CNSC requirements and performance expectations. Overall, the programs under this safety area contributed adequately to the safe operation of the facility.

1.4.1.1 Organization and Plant Management

There were no significant organizational or management changes at Pickering B in 2008, except for the Senior Vice President position, which was reported to the *Commission* in accordance with section 15 of the *General Nuclear Safety and Control Regulations*.

Throughout 2008, based on findings collected during the various compliance activities, CNSC staff concludes that performance of Pickering B management conformed to the OPG document entitled "Chief Nuclear Officer Expectations" (N CHAR AS 0002), which was referenced as a new licence condition during the Pickering B licence renewal.

Two main issues affecting the implementation of the Organization and Plant Management program in 2008 are:

- management decisions which led to the Gadolinium reduction incident on Unit 7.
- S-99 events contributing to organizational behaviours.

In April, while Unit 7 was in the overpoisoned *guaranteed shutdown state* (GSS), a drop in gadolinium concentration was noticed. The reactor was placed in a drained GSS. Investigation revealed that because of specific conditions at the time, carbon dioxide—which was leaking through a known leak in a *calandria tube* from the annulus gas system to the moderator system—had caused the formation of a gadolinium oxalate on the surfaces within the calandria and the moderator system. In order to remove the gadolinium oxalate, OPG requested a deviation from the licence to allow the use of rod-based GSS. The systems were successfully cleaned and the unit returned to power. It was later found that the *calandria tube* had a crack and was not leaking from a rolled joint, as previously assumed. The management's decisions—based on this incorrect information— to allow the unit to continue to operate for over two years, had put the plant at increased risk. This incident was the subject on an SDR, as described in Appendix E.

CNSC staff conducted a *Type I inspection* early in 2008, due to concerns over the licensee's compliance with the S 99 reporting requirements. The inspection determined the licensee was in compliance, but found problems with timeliness of reporting, initial recognition of events by licensee staff, and overuse of Additional Reports—which unnecessarily delays the provision of full information to CNSC staff. OPG has responded to the two action notices made in the inspection report, and has implemented procedural changes. An end-of-year review of the licensee's reporting performance noted improvements in the timeliness of reporting, along with a reduction in the Additional Report backlogs and the use of Additional Reports.

CNSC staff recognizes OPG's commitment and efforts to improve the safety culture framework and self-assessment methodology. CNSC staff encourages OPG senior management to continue to support the safety culture improvement initiatives and achieve high levels of staff awareness concerning the safety culture at the facility and its role in maintaining and further improving safe and reliable operation.

Issues of concerns related to staffing levels were discussed during the licence renewal Day 2 – Public Hearing. As committed, CNSC staff has monitored OPG's staffing level during planned outages. While the same issues were observed, CNSC staff is satisfied that staffing levels have not adversely affected the safe operation of the facility. Monitoring in this area will continue.

Analysis of S-99 reported events, for the two first quarters of 2008, indicate a pattern of organizational behaviours similar to what was found and reported during 2006 and 2007. CNSC staff has requested OPG to submit the results of its review of the 2008 assessment. OPG has submitted its plans to address the performance, and has committed to providing regular updates to CNSC.

CNSC staff has also reviewed several *root cause analysis* reports submitted by OPG as per S-99 Reporting Requirements, in which inadequate management oversight has been identified.

Based primarily on management involvement in the Unit 7 incident, the compliance activities carried out, and the review of Pickering B's performance, the Organization and Plant Management program area at Pickering B is rated as "Below Expectations" in 2008.

1.4.1.2 Operations

During 2008, Pickering B experienced eight forced outages, two *setbacks*, no *stepbacks*, and no *serious process failures*. There were also two maintenance planned outages.

Unit 5 (2 forced outages)

- May 23, 2008 – Forced shutdown to repair the turbine overspeed bolt test circuit. The duration of this outage was expected to be two days but had to be extended for five additional days, due to moderator cover gas chemistry issues.
- December 4, 2008 – Forced shutdown to repair leaking shutdown cooling pump seals (11 days).

Unit 6 (2 forced outages)

- January 9, 2008 – Manual *setback* and forced shutdown to repair a feedwater deaerator rupture disk failure (3 days).
- June 19, 2008 – Forced shutdown to replace components in the turbine overspeed bolt test circuit (9 days).

Unit 7 (1 forced outage, 1 planned outage)

- April 6, 2008 – (*setback*) Setback in response to the turbine/generator trip, due to a voltage transient caused by electrical system grounds not removed in the 230kV switchyard. The Gadolinium reduction event occurred during this forced shutdown, and the planned outage (P871) was incorporated (238 days).

Unit 8 (3 forced outages and 1 planned outage)

- May 12, 2008 – Forced shutdown to repair a high pressure turbine casing steam leak (8 days).
- July 15, 2008 – Forced shutdown to repair leakage from heat transport D2O transfer valve. Reactor trip while sub-critical (26 days).
- August 16, 2008 – Forced shutdown to repair feedwater de-aerator rupture disk failure (4 days).
- The 60 days maintenance planned outage (P881) started on February 18, 2008 as scheduled, but was extended for a total duration of 73 days due to a 4 kV auto transfer switchyard investigation, following the 230 kV ground fault event.

CNSC staff conducted 55 *Type II inspections* at Pickering B in 2008. In addition, staff performed surveillance and monitoring activities, desktop reviews and assessments, and attended meetings with the licensee to discuss enforcement actions, licensing requirements, inspection findings and results of reviews and assessments. Based on the results of these activities, the Operations program area at Pickering B is rated as "Satisfactory" for 2008.

1.4.1.3 Occupational Health and Safety (non-radiological)

Number of lost time injuries reported by the licensee:	1
Accident frequency (AF) (Pickering A and B):	0.10
Accident severity rate (ASR) (Pickering A and B):	1.49

AF and ASR are performance indicators, reported by the licensee as per S-99 requirements. CNSC staff considers that the AF and ASR, as reported by OPG during 2008, demonstrated adequate occupational health and safety performance at Pickering B. The Pickering A and B combined value for the ASR is 1.49, which is better than the industry average of 2.39. There was one lost time accident at Pickering B in 2008.

In 2008, five High Maximum Reasonable Potential for Harm (MRPH) incidents have occurred at Pickering B, which were considered "near-miss" and will continue to be monitored by CNSC staff. Two events are worth mentioning: a ground fault occurred in the Pickering B switchyard, when 230 kV equipment was energized with grounding still in place; in the second event, a worker was pinned against a wall by moving equipment and briefly lost consciousness. While these events did not result in a Loss Time Accident, they represent a serious risk of injury.

Based on CNSC staff's assessment of this program area, Occupational Health and Safety at Pickering B is rated as "Satisfactory" for 2008.

1.4.2 Performance Assurance

The Performance Assurance safety area at Pickering B met the objectives of CNSC requirements and performance expectations in 2008. Overall, this safety area received a "Satisfactory" rating.

1.4.2.1 Quality Management

The governing document for the Pickering B Quality Management Program is the OPG document entitled "Chief Nuclear Officer Expectations" (N-CHAR-AS-0002). A new revision (R12) to the document was submitted in 2008, and was subsequently approved for use by the *Commission*. CNSC staff concluded that the Quality Management program, as described in the CNO Expectations document, complies with the requirements of the applicable CSA standard.

A *Type I inspection* report on Engineering Change Control (ECC) was sent to OPG in May 2008. As a result of the inspection, CNSC staff issued four action notices and two recommendations. OPG has submitted their corrective action plan to address the deficiencies, and their target date to complete them is the end of August 2009.

A *Type II inspection* to review adequacy of the engineering change records was conducted at the end of October 2008. The final report included four deficiencies to be addressed and one recommendation. The inspection did not identify any findings that could be linked to an increased risk to safe operation.

In 2008, CNSC staff carried out an analysis of the Pickering B S-99 reportable events against the requirements of the applicable CSA standard N286.5 "Operations Quality Assurance for Nuclear Power Plants". CNSC staff analysis did not identify any issues regarding an impact on safe operation of Pickering B; however, it found weaknesses dealing with the control of items, processes and practices, and verification, as well as personnel capability

Based on these compliance activities, CNSC staff rates the Quality Management program area at Pickering B as "Satisfactory" in 2008.

1.4.2.2 Human Factors

The requirement to maintain and have assurance that an adequate minimum complement is available is a fundamental part of the Human Factors program. There have been a number of concerns related to the Minimum Complement issue at Pickering NGS for several years. Common mode events occurred at Pickering NGS in 2003 and 2004 (the Algae Run and the Loss of Bulk Electrical System events), which demonstrated the challenges faced by the station during scenarios affecting more than one unit. The current Shift Station Complement document at Pickering lists the minimum complement requirements for an event on a single unit at either Pickering A or B. CNSC staff expressed concerns that staffing levels for an event on a single unit might not be adequate, should a common mode event occur. In 2004, CNSC staff formally requested OPG to analyze the minimum staffing requirements for common mode accidents such as fire, seismic events, *design basis accidents*, etc.

CNSC staff reviews in 2008 indicate that OPG did not address this issue to the satisfaction of CNSC staff at Pickering A and B. Several meetings occurred between CNSC staff and OPG, during which the requirement for OPG to analyze the minimum staffing requirements for common mode events was reiterated. The work presented by OPG in 2008 did not demonstrate compliance with regulatory guidance documents G-323 "Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities Minimum Staff Complement", and G-278 "Human Factors Verification and Validation Plans". In 2008, OPG was requested to submit an action plan and schedule to demonstrate full compliance with these CNSC regulatory documents. CNSC staff will be closely monitoring OPG's progress on this issue, to ensure that all concerns regarding the minimum complement requirements are addressed.

In 2006, CNSC staff conducted an inspection at Pickering NGS to verify compliance with the minimum shift requirements. As a result of the inspection, CNSC staff found that Pickering A and B did not control or monitor the status of minimum shift complement to ensure that qualified personnel are available for all of the work group and emergency roles. In 2008, OPG implemented the Minimum Complement Coordination Program (MCCP) as the permanent method for the monitoring and control of minimum shift complement. Pickering A and B are making progress towards addressing the directive and action notices issued in the original inspection report.

In January 2008, CNSC staff conducted a *Type II inspection* as a follow-up to the December 2006 Engineering Change Control *Type I inspection* at Pickering B and the ongoing review. CNSC staff found that the modifications installed were satisfactory, as were the responses from OPG staff interviewed. However, the absence of validation for some of the modifications does not ensure that they achieve their intended purpose.

During the Pickering B PROL renewal, CNSC staff raised their concern related to the fact that management was not exercising sufficient oversight to ensure compliance with the Limits of Hours of Work, as defined in OPG document entitled "Limits of Hours of Work". CNSC staff proposed to the *Commission* the inclusion of a new licence condition (2.4), by which the Limits of Hours of Work would become a regulatory requirement. This licence condition came into effect in the second half of 2008 and, for that short period of time, CNSC staff has not identified any major non-compliance.

In 2005, CNSC staff requested that OPG submit contingency plans for maintaining staff in key positions on-site and strategies if unable to meet all staff requirements. The purpose of this request was to assess the vulnerability of Canadian power reactor sites to off-site events, whether man-made or natural. Later, this also included discussions on Pandemic Planning. OPG has submitted these plans and has addressed the issues raised by CNSC staff.

In 2008, OPG carried out several improvements initiatives in the Human Factors area, such as having a procedure ambiguity awareness campaign and making rapid responses to human performance events, so as to prevent recurrence.

Based on the compliance activities carried out, and the review of Pickering B's performance, the Human Factors program area at Pickering B is rated as "Below Expectations" for 2008.

1.4.2.3 Training, Examination and Certification

CNSC staff is satisfied that there are sufficient numbers of qualified workers at Pickering B to carry out the licensed activities. The Training, Examination and Certification program area is rated as "Satisfactory" for Pickering B in 2008.

Training

As reported during the Day 2 – Public Hearing for the Pickering B PROL renewal, CNSC staff reviewed the OPG Program Document "Training" (N-PROG-TR-0005 (R08)), which governs all of the OPG nuclear generating stations. CNSC staff identified five deficiencies, associated with new terminology being introduced in training qualifications, and the categorization of programs which are required to be based upon *Systematic Approach to Training* (SAT) principles. OPG has provided to CNSC staff a plan to address the deficiencies, along with a timeframe for its completion. Most of the corrective actions are expected to be completed in 2009. Since this new version of the Training Program has been issued very recently, CNSC staff is confident that it did not adversely impact on qualification of the workers and that OPG currently has enough qualified personnel to perform their work.

In October 2008, CNSC staff observed a training session on Unit 7 return to service from the gadolinium oxalate event. The training was found to be acceptable, and the follow-up review indicated that the unit's approach to critical and subsequent increase to high power was performed without incident.

As reported during the Day 2 – Public Hearing for Pickering B licence renewal, CNSC staff has considered the corrective actions taken to address deficiencies in the Shift Manager/Control Room Shift Supervisor Initial Simulator Training Program and in the Authorized Nuclear Operator Initial Specifics Training Program to be satisfactory. This fulfills the prerequisite condition for these training programs to be based on a SAT, in order to allow the transfer of these certification examinations to the licensee.

A *Type I inspection* related to the Nuclear Operator Training Program was conducted in 2008. Some deficiencies were identified, for which CNSC staff expects OPG to submit a corrective action plan by the end of March 2009.

Two earlier inspections were closed out in 2008, after verification that OPG had completed all corrective actions to the satisfaction of CNSC staff. One deficiency still remains open from a 2004 inspection, related to the initial training program for mechanical and control maintainers.

Examination and Certification
In 2008, the pass rate for Pickering B initial certification examination was 98.1%. The industry average was 94.3%.

As a prerequisite for the transfer of certification examinations to licensees, licensees must have a sufficient number of examiners who meet the qualification requirements specified in the relevant regulatory documents. In February 2008, the CNSC issued the Regulatory Document RD-204 "Certification of persons Working at Nuclear Power Plants", which provides the expectations for the training, certification and continuing training of certified staff. CNSC staff assessed OPG's examination programs against this document and found them to be satisfactory.

Following the publication of RD-204, OPG applied to amend the Pickering B PROL to incorporate RD-204 and conduct their own initial certification examinations for certified shift personnel. The *Commission* approved the transfer of initial examination certification to OPG in January 2009.

The staffing plans being submitted every six months indicate constant improvement in the numbers of certified staff that are available. CNSC staff continues to monitor progress.

In 2007, OPG proposed revisions to the requirements for re-qualification testing for certified shift personnel. CNSC staff has reviewed the proposal and, along with ongoing consultation between CNSC and all NPPs in 2008, has determined that all the process-related issues concerning requalification testing have been resolved.

1.4.3 Design and Analysis

The Design and Analysis safety area at Pickering B is rated as "Satisfactory" in 2008, since it meets the objectives of CNSC requirements and performance expectations. The programs under this safety area contributed adequately to continued safe operation of the facility through the identification and resolution of safety-related issues of design and analysis.

1.4.3.1 Safety Analysis

A number of concerns in the Safety Analysis program 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:

- Impact of Plant Aging on Trip Coverage.
- The discrepancy in the 28-Element Fuel String Critical Heat Flux (CHF) Experiments and its impact on safety.
- *Safety Report* Update.

These issues were discussed in February and May 2008, during the Public Hearings (Day 1 and Day 2) for the Pickering B licence renewal. Updates were given in *Commission* Public Meetings in June 2008 (CMD 08-M37) and February 2009 (CMD 09-M5). Only updates on the progress made are discussed in sub-sections below.

Impact of Plant Aging on Trip Coverage
Aging occurs in all CANDU reactor heat transport system (HTS) components (*pressure tubes*, *steam generators*, and *feeders*). It affects operating conditions (coolant flows, temperatures, and pressures) and can impact on safety margins.

Aging of HTS components may affect the adequacy of the currently installed NOP trip setpoints. The negative impact of aging on trip set points may be compensated by additional margins, through use of the new NOP Methodology as described in Section 2.3.1.

In 2008, OPG reported that the aging of the HTS may also affect the adequacy of shutdown system trip coverage for loss of flow events and small LOCAs. The industry, together with the CNSC, is working to resolve this issue.

28-Element Fuel Bundle

In June 2007, OPG reported that the results from 28 element fuel Critical Heat Flux (CHF) experiments indicated that the dryout powers of the 28 element fuel string currently being used at Pickering B were significantly lower than previously thought. This was discussed during the Pickering B licence renewal, and an update was provided to the Commission in February 2009, under CMD 09-M5

OPG has developed new CHF correlations, used inside the safety analyses which are currently under CNSC staff review. A formal OPG submission, proposing a path towards the resolution of these issues is expected in June/July 2009.

Safety Report Update

CNSC staff informed OPG, and all licensees, that the Accident Analysis, as documented in Part 3 of the *Safety Report*, does not meet licensing criteria with respect to validated tools, consistency and conservatism in analysis methodologies and assumptions, treatment and application of simulation and measurement uncertainties. Although the Pickering B safety case is not in question, the safety margins and analysis need to be confirmed. OPG has prepared a proposed resolution strategy, with a planned completion date of 2010, to resolve all the issues and has also been submitting regular updates on this matter.

Based on compliance activities carried out, and the review of Pickering B's performance in 2008, the existing margins are adequate and major issues are similar to all CANDUs. Therefore, CNSC staff rates the Safety Analysis program area at Pickering B as "Satisfactory" in 2008.

1.4.3.2 Safety Issues

CNSC staff reviewed the progress made by the CANDU industry and utilities in resolving the Generic Action Items (GAIs). OPG continued its work—including participation in industry efforts—towards the resolution of the GAIs, and overall progress was judged satisfactory.

GAIs 88G02 and 95G02 were closed for Pickering B in 2008. A brief description and the expected completion date of each remaining GAI are provided in Appendix F.

This program area is rated as "Satisfactory" for Pickering B in 2008.

1.4.3.3 Design

CNSC staff has reviewed OPG's submission and supporting documentation regarding the alternative dispositions and resolutions to the Pickering B Fire Protection Code Compliance Review. CNSC staff concludes that the OPG's submission and supporting documentation provide acceptable code equivalencies. However, OPG is requested to develop the means to ensure that the commitments made will be documented and implemented, and that the code equivalent design and operating basis are maintained.

As committed in August 2008, during the Day 2 – Public Hearing for the Pickering B licence renewal, OPG has provided the CNSC with a status update concerning the full-load Emergency Power Generator testing for mission time. Further updates related to the "EPG Full Load Capacity Test Project" are expected in the last quarter of 2009. CNSC staff is satisfied with the progress made by OPG, and will continue to monitor the issue.

As reported in 2007, OPG has completed the installation of the Auxiliary Power Supply (APS), which can power 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. The APS has been commissioned for the manual initiation, and the commissioning of automatic start capability is continuing.

A *Type I inspection* of the Engineering Change Control process (also discussed under section 1.4.2.1 "Quality Management") did not identify any findings that could be linked to an increased risk to safe operation. In general, design modifications are done in accordance with the applicable CSA standard, as per Pickering B licence requirements.

Based on the compliance activities carried out, CNSC staff rates the implementation of the Design program area as "Satisfactory" in 2008.

1.4.4 Equipment Fitness for Service

The Equipment Fitness for Service safety area at Pickering B is rated as "Satisfactory" in 2008, since it meets the objectives of CNSC requirements and performance expectations. The programs under this safety area contributed adequately to continued safe operation of the facility, through the identification and resolution of safety related issues involving structures, systems and components.

1.4.4.1 Maintenance

As discussed during the Day 2 – Public Hearing for the Pickering B licence renewal, OPG committed to a long-term effort to reduce the corrective maintenance backlogs and gave short term targets for this reduction. OPG has provided quarterly status updates, and CNSC staff is satisfied with the progress of the reduction of backlogs.

In 2008, OPG has met its short-term backlogs targets:

- "Corrective Maintenance" was 24, versus a target of 25 work orders per unit.
- "Elective Maintenance" was 683, versus a target of 700 work orders per unit.

However, the elective maintenance backlog is considered high with respect to best industry practices. CNSC staff expects OPG to provide quarterly status update until the elective maintenance backlog at Pickering B is reduced to their committed long-term target, which is 300-400 work orders per unit. CNSC staff will continue to monitor this progress through normal follow-up activities.

Based on compliance activities conducted in 2008, CNSC staff rates the Maintenance program area at Pickering B as "Satisfactory".

MONITORING LEVELS OF CONTAMINATION ON CNSC INSPECTION EQUIPMENT.

1.4.4.2 Structural Integrity

CNSC staff reviewed S-99 reportable events related to compliance with OPG's Pressure Boundary Program, as well as the Pressure Boundary Degradation Quarterly reports, and did not identify any significant findings. For the most part, the pinhole leaks, cracks, and corrosion identified in 2008 were of minimal consequence, and OPG took adequate actions to address identified degradation.

OPG performed CSA N285.4 periodic inspections for Pickering B nuclear power plant components, and submits inspection reports to the CNSC on an ongoing basis, according to the terms of the Pickering B Periodic Inspection Program (PIP). In 2008, OPG submitted the PIP reports for Units 6 and 8 to CNSC staff, for review and acceptance. In general, CNSC staff found the periodic inspection reports acceptable; however, OPG is required to do some additional work in accordance with the CSA applicable standard.

OPG also performs Periodic Inspections for containment components, as per CSA standard, and submits the inspection reports to CNSC staff for review and acceptance on an ongoing basis, as required by the station's PIP. In late 2007, OPG performed inspections for Unit 6 containment components, and the inspection report was submitted to the CNSC. OPG also submitted the inspection report for on-power inspections performed on Units 5 to 8 containment components throughout 2007. Following its review, CNSC staff raised an *action item* regarding the current configuration of the anchor support for transfer pump P1 and some of the inspection results. OPG provided an action plan to address these issues; CNSC staff found the information and action plan provided by OPG to be acceptable.

OPG has adequate fitness-for-service programs in place, to ensure the integrity of *pressure tubes*, *feeder pipes*, and *steam generator* tubes is well maintained, and inspections were carried out as per applicable CSA standards.

In all instances, CNSC staff concurred that OPG had performed inspections in accordance with the scope and schedule prescribed by applicable CSA standards and proposed in its fuel channel life cycle management plan, and dispositioned the inspection findings in accordance with the CNSC-approved fitness-for-service guidelines—including the material surveillance examination on a *pressure tube* removed from Pickering Unit 6. OPG has restarted to use a wet scrape tool, rather than the terminal solid solubility tool, for monitoring the deuterium uptake behaviour of *pressure tubes*. The licensee has updated its leak-before-break assessment, to demonstrate the validity up to 185,000 EFPH; accordingly, re-assessments and re-dispositions of *pressure tube* flaws have been performed and submitted. OPG has entered a new phase of the trial use of the new *pressure tube* fitness-for-service guidelines, with some previous restrictions being removed.

A through-wall flaw was discovered in the *calandria tube* removed from Pickering B Unit 7. While root cause investigation for this flaw is ongoing, OPG has completed an assessment confirming that the Safety Analysis remains valid. Risks to the integrity of the pressure tubes from postulated *calandria tube* leaks and from worn garter springs were also assessed and they were found to be acceptable.

In 2008, feeder inspections for Unit 7 and Unit 8 at Pickering B were carried out as planned in the feeder life cycle management plan. Engineering evaluation based on the inspection results confirmed that feeders at Pickering B are fit for service.

The CNSC places a high priority on ensuring that *steam generator* tube degradation is carefully monitored through inspections, strict fitness-for-service criteria and the monitoring of water chemistry to detect leakage from the primary to the secondary side of the plant. During 2008, an inspection of Unit 7 and Unit 8 *steam generators* determined that the condition of steam generator tubes and internals has remained good. There were no leaking tubes at the Pickering B *steam generators* in 2008. Nine tubes were preventively plugged in Unit 8 and seven tubes in Unit 7, out of 31,200 in each unit. CNSC staff concludes that OPG has demonstrated that the steam generator life cycle management program will effectively manage the aging of the Pickering B *steam generators*.

Based on compliance activities carried out, CNSC staff rates the performance of the Structural Integrity program area at Pickering B as "Satisfactory" in 2008.

1.4.4.3 Reliability

The current probabilistic risk assessment for Pickering B (PBRA) was submitted to the CNSC in 2006, and a Revision 2 was provided in 2007. Preliminary comments on PBRA were submitted to OPG in late 2007; and CNSC staff reviewed the revised version of PBRA in 2008. CNSC staff has significant concerns with the report and will forward these concerns to OPG in 2009. OPG will be expected to comply with CNSC standard S-294 "Probabilistic Safety Assessment for Nuclear Power Plants", by December 31, 2010.

Pickering B experienced six occasions of impairments of safety-related systems during 2008. None of the safety-related systems exceeded their unavailability targets for the year.

Based on compliance activities carried out, CNSC staff rates the Reliability program area as "Satisfactory" in 2008

1.4.4.4 Equipment Qualification

In 2008, several minor events were reported under the S-99, because the emergency lighting on the seismic route was not working properly when tested. OPG has filed a work request to correct this issue. A few *Type II inspection* reports show that Pickering B is lacking attention to the seismic implications of equipment not being secured inside the Control Equipment Room.

In November 2008, CNSC staff conducted a *Type II inspection* of the Pickering Chemistry Program. The overall performance met CNSC expectations, although some areas of improvement were identified.

Based on the compliance activities carried out, CNSC staff rates the Equipment Qualification program area at Pickering B as "Satisfactory" in 2008.

1.4.5 Emergency Preparedness

CNSC staff has reviewed the S-99 Quarterly Performance Indicators and Quarterly Operations Reports submitted in 2008. Performance indicator data was consistent with the performance from the previous 5 years. Four (4) reportable events occurred during 2008, which were all reported correctly under the Provincial Nuclear Emergency Plan.

A *Type I inspection* of a station emergency response drill at Pickering A and B was performed in February 2008. The drill scenario consisted of a large LOCA on a unit, with a number of complicating factors added, to challenge the duty crew and responders. The inspection resulted in two action notices, which have been satisfactorily closed.

The implementation of the Emergency Preparedness safety area at Pickering B is rated as "Satisfactory" in 2008, since it meets applicable CNSC requirements and performance expectations. OPG has demonstrated adequate provisions for preparedness, and a response capability that would sustain the appropriate protection of the environment and the health and safety of Canadians during an emergency.

1.4.6 Environmental Protection

In 2008, the reported dose to the public due to both Pickering A and B was 4.1 µSv, which is well below the public dose limit of 1000 µSv. Gaseous and aqueous releases of nuclear substances were always below Environmental Action Levels.

CNSC staff review of Pickering B Quarterly Operations Reports, submitted under S-99, did not identify any significant issues related to radiation dose to the public or environmental protection. There were no reported unplanned releases of nuclear substances or hazardous substances from Pickering B that posed an unreasonable risk to the environment.

A *Type I inspection* of the Pickering site environmental protection polices and procedures was performed in July 2006. In 2008, OPG provided updates on the completion of outstanding action notices from the inspection; CNSC staff is satisfied with the actions that OPG has taken to date.

As detailed under the Pickering A section 1.3.6, OPG was requested, in accordance with 12(2) of the *General Nuclear Safety and Control Regulations*, to implement mitigation measures following a strict timetable. Interim Impingment and Entrainment (IE) mitigation measures will be installed in 2009, with the implementation of permanent IE mitigation measures by 2012. OPG is complying with the CNSC's request.

In addition, CNSC staff is concerned with the environmental effects from temperatures at the existing Pickering site cooling water discharges. OPG has committed to conduct additional studies, to confirm the extent of the thermal plume and the presence of fish species and life stages that may be adversely affected by increased cooling water. As a result, CNSC staff requested OPG to submit a plan that describes the nature and timing of these studies. OPG has provided a plan, which is currently under review.

CNSC staff performed a *Type II inspection* of Pickering's Environmental Internal Investigation Level exceedances in 2007. The report was issued in 2008, and included several low-risk findings regarding the manner in which OPG was following up on Internal Investigation Levels exceedances. OPG has addressed all the findings in the report, which was closed in early 2009.

The performance of the Environmental Protection safety area at Pickering B is rated as "Below Expectations" for 2008, because the fish impingement and entrainment represent an unreasonable risk to the environment, deviating from the applicable CNSC requirements, and the performance falls below expectations. OPG has committed to taking measures to reduce fish mortality.

1.4.7 Radiation Protection

In 2008, there were no radiation exposures at Pickering B that exceeded regulatory dose limits. There were three S-99 reportable events related to an Action Level being reached. However, CNSC staff reviewed the actions taken by the licensee and found them to be acceptable.

In early 2008, CNSC staff conducted a *Type II inspection* of the Radiation Protection Program at Pickering A and B. Several positive aspects were noted during the inspection; some deficiencies were also identified, related to rubber area tags and access control to rubber areas, the decontamination of contaminated areas, and the calibration of radiological instruments. OPG has taken actions to correct the deficiencies.

CNSC staff performed a follow-up on the *Type I inspection* of the Radiation Protection Programs conducted at Pickering B in 2005, and found that OPG has adequately addressed all of the action notices raised in the inspection.

OPG has developed a business plan that documents the major Radiation Protection strategies for the period 2009-13. The 2009-13 ALARA strategy includes external and internal dose reduction, improved contamination control, improved human performance, integrated operational planning and outage work management improvements, leverage technology, and providing staff with necessary skills and knowledge.

Based on compliance activities carried out, and the review of Pickering B's performance, CNSC staff rates the Radiation Protection safety area at Pickering B as "Satisfactory" in 2008.

1.4.8 Site Security

This safety area is presented to the *Commission* in a separate *Commission Member Document* (CMD 09-M28.A).

1.4.9 Safeguards

CNSC staff rates the implementation of the Safeguards safety area by OPG at Pickering B as "Fully Satisfactory" in 2008, since it meets or exceeds applicable CNSC requirements and performance expectations. OPG has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

The IAEA conducted a Physical Inventory Verification at Pickering in September 2008. The inspection was undertaken to: verify that no diversion of nuclear material had taken place; detect any tampering with the IAEA's containment/surveillance system; and confirm the declarations provided by the State authorities and facility operators. The inspection was attended by CNSC staff, who undertook to review: the facility's support for IAEA inspectors, including escorts and equipment; the provision of accountancy information and supporting documents; the facility compliance with safeguards licence conditions relevant to the inspection activity; and the IAEA's adherence to its rights and obligations relevant to the inspection. This was the first IAEA inspection of this type at Pickering under the new Integrated Safeguards approach for CANDU stations. No significant compliance issues were identified.

Two Design Information Verifications and one Complementary Access visit were also performed by the IAEA at Pickering, in 2008. CNSC staff did not attend these activities. The IAEA has not yet reported the results, but no issues are anticipated.

In 2008, Safeguards staff from Pickering NGS participated in a series of trilateral meetings with the IAEA, the CNSC and other facility operators, to develop an Integrated Safeguards Procedure for the CANDU stations. In developing these procedures, Pickering participated in a field trial for Short-Notice Random Inspections (SNRIs) at the facility, in order for the IAEA to detect and deter the diversion of nuclear material, tampering with IAEA surveillance equipment, and undeclared activities. As of July 2008, these SNRIs formally replaced the traditional IAEA inspections that were carried out on an announced quarterly basis.

As reported during the Day 2 – Public Hearing for the Pickering B licence renewal, a new Integrated Safeguards approach was fully implemented in July 2008. The IAEA is now conducting SNRIs at the facility, which replaces traditional regularly scheduled IAEA inspections. This approach also includes a secure mailbox system, which is important for the provision of information to support SNRIs.

AT THE END OF AN OUTAGE, CNSC INSPECTORS PARTICIPATE IN A "MANAGER'S WALKDOWN" WITH THE LICENSEE TO ENSURE ALL MATERIALS ARE PROPERLY REMOVED OR SECURED.

1.4.10 Update on Major Projects and Initiatives

1.4.10.1 Refurbishment Project

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 the undertaking of a study for the life extension of the Pickering B units. This includes an Environmental Assessment (EA) and an Integrated Safety Review (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.

This project has been discussed in last year's report (INFO-0770). Only the progress made and the current status of the project will be discussed hereafter.

1.4.10.2 Environmental Assessment

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, CNSC staff requested OPG to provide additional clarifications. The draft CNSC EA Screening Report was prepared in the spring of 2008. Public consultation of the CNSC's draft Screening Report occurred over the summer of 2008, which included two CNSC EA Open Houses on July 29 and August 12 in the Pickering area. All public comments were then addressed, and the final draft EA Screening Report was submitted to the *Commission* on October 10, 2008. The final draft EA Screening Report was presented to the *Commission* at a Public Hearing on December 10, 2008, in Ajax, Ontario. The EA concluded that the Refurbishment of Pickering B—taking into account the mitigation measures—is not likely to cause significant adverse environmental effects. The *Commission* approved the EA Screening Report on January 26, 2009.

1.4.10.3 Integrated Safety Review (ISR)

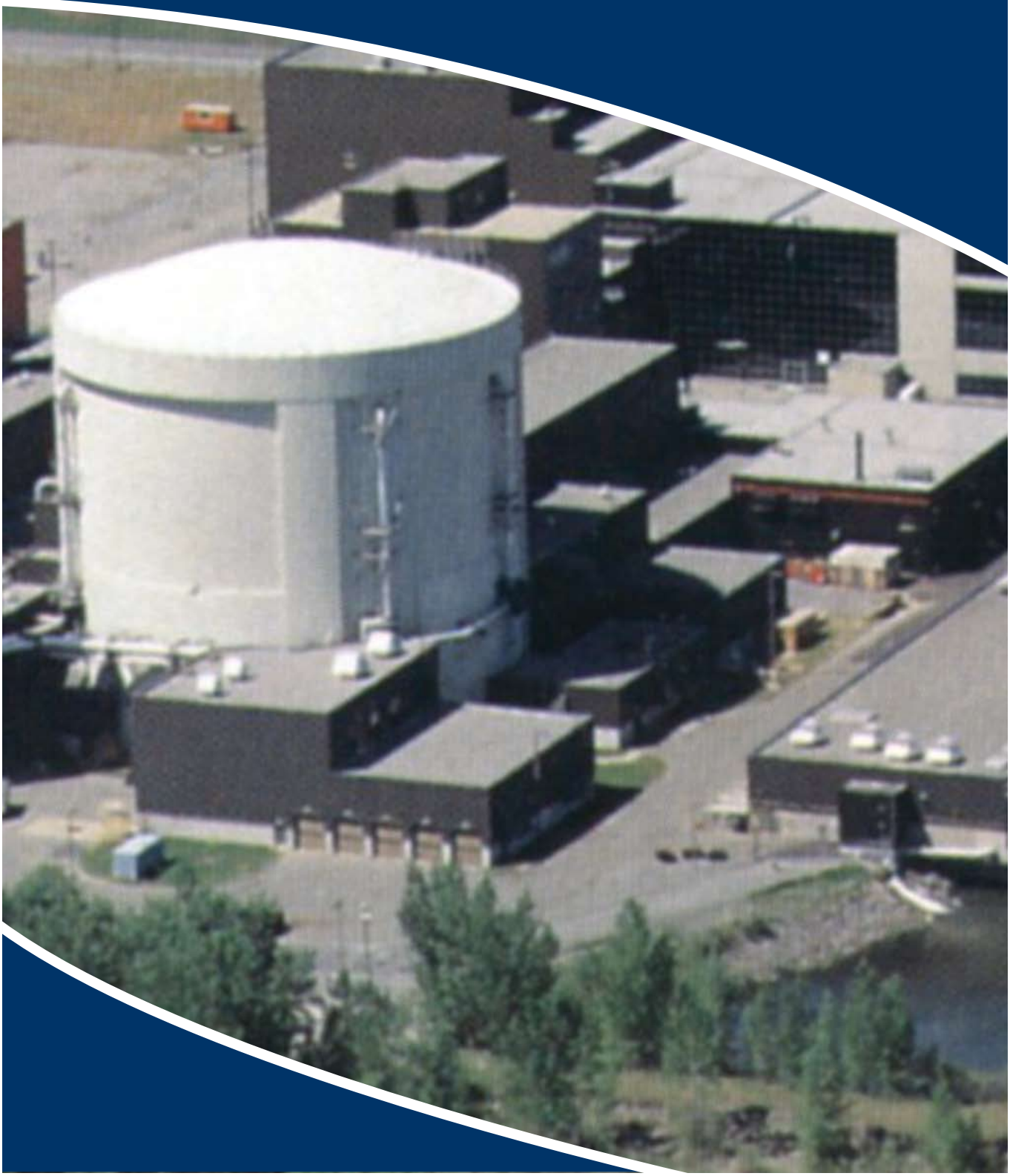
OPG is conducting the ISR in accordance with CNSC regulatory document RD-360 "Life Extension of Nuclear Power Plants".

As per RD-360, OPG prepared an ISR basis document, which sets out the scope and methodology for the conduct of the ISR. The document was initially submitted in mid 2006, and it was finally accepted in March 2008, after it was revised by OPG so as to address CNSC comments.

The ISR includes a review of 17 safety factors, which are documented in twelve reports. By the end of 2008, all twelve reports had been submitted. Five reports have been accepted (Uses of Experiences from other Plants and Research Findings, Security, Safeguards, Emergency Planning and Environment). One report was conditionally accepted (Equipment Qualification). The CNSC review of the remaining reports is expected to be completed by the end of February 2009, and CNSC staff will request OPG to address any outstanding comments in its submission of the Final ISR Report and Global Assessment, which is planned for September 25, 2009. CNSC staff plans to review this report over a period of 4 to 6 months.

OPG is expected to get a decision on the life extension of the Pickering B units from their Board; however, it is unclear when this decision will be made. OPG will propose a date for the submittal of the Integrated Implementation Plan (IIP) only if a positive decision is made to refurbish. Should there be a negative decision for refurbishment, it is expected that the ISR results will be used in the formulation of the Pickering B End-of-Life Plan. The IIP includes the results from the ISR and the EA; it describes the scope and the schedule for the life extension project, and includes the shortcomings identified during reviews against standards and practices. The IIP identifies corrective actions and safety improvements for each shortcoming, based on its significance, and proposes safety improvements, to the extent practicable. The IIP, once approved by CNSC staff, forms the basis for the licence amendment, which will be approved by the Commission in a Commission Hearing, prior to the beginning of the refurbishment work, in 2014.

1.5 GENTILLY-2



1.5 Gentilly-2

Table 5 shows the 2008 safety performance ratings for Gentilly-2. These ratings were determined using a risk-informed approach, integrating findings from two (2) *Type I* and 18 *Type II inspections*, surveillance and monitoring activities, desktop reviews and assessments, and the professional judgment of CNSC staff. The integrated plant rating for Gentilly-2 in 2008 is "Satisfactory".

TABLE 5: GENTILLY-2 SAFETY PERFORMANCE RATINGS FOR 2008

Safety Area Program	**Performance Rating**
Operating Performance	**SA**
Organization and Plant Management	SA
Operations	SA
Occupational Health and Safety (non-radiological)	SA
Performance Assurance	**SA**
Quality Management	BE
Human Factors	SA
Training, Examination, and Certification	SA
Design and Analysis	**SA**
Safety Analysis	SA
Safety Issues	SA
Design	SA
Equipment Fitness for Service	**SA**
Maintenance	BE
Structural Integrity	SA
Reliability	SA
Equipment Qualification	SA
Emergency Preparedness	**FS**
Environmental Protection	**SA**
Radiation Protection	**SA**
Security	**Prescribed**
Safeguards	**FS**
Integrated plant rating	SA

1.5.1 Operating Performance

Gentilly-2 operated safely in 2008. The Operating Performance safety area met CNSC requirements and performance expectations, and has been given a "Satisfactory" rating.

1.5.1.1 Organization and Plant Management

CNSC staff performed inspections of station systems and found shortcomings with some system follow-up reviews, which did not meet the requirements of CSA standard N286.5. Some positive aspects of the Gentilly-2 NPP organization were also noted, more specifically during the planned outage in Spring 2008. The planning and conduct of the outage were satisfactory, despite occasional difficulties that led to delays in completing some important work. Good cooperation on the part of Hydro-Québec was observed during the inspections conducted in 2008.

CNSC staff concludes that Organization and Plant Management at Gentilly-2 is "Satisfactory" for 2008.

INSPECTORS ARE CHALLENGED TO REPOSITION THEMSELVES WITHIN THE VAULT GIVEN THEIR BULKY PLASTIC SUITS.

1.5.1.2 Operations

In 2008, one forced outage, three *stepbacks* and three *setbacks* occurred at the Gentilly-2 NPP. There were no serious process failures.

Reactor outages

- An unplanned outage that started on November 2, 2007, ended on January 31, 2008.
- The station planned outage started on April 5, 2008 and ended on June 15, 2008.
- An unplanned outage, due to a *setback*, started on August 24, 2008. The reactor became critical again on August 25, 2008.

Restrictions:

- February 13, 2008 – Reactor power was lowered to 45% full power (FP) to allow replacement of the rotor ground relay.
- February 14, 2008 – (*stepback*) A stepback to 35% FP occurred, following a trip of the turbine generator, due to a ground fault on the rotor.
- June 12, 2008 – (*trip*) A reactor trip occurred, due to a low pressure of the heat transport system. This trip had no impact on the safety of the plant or its operation as it occurred during the time of the planned outage of the plant.
- July 31, 2008 – Operation at a reduced power of 83.5% FP, due to the unavailability of the fuelling machine.
- August 2, 2008 – (*stepback*) A *stepback* to 35% FP occurred due to a turbine trip.
- August 21, 2008 – The reactor power was lowered to 83.5% FP, due to a lack of reactivity caused by the unavailability of the fuelling machine.
- October 9, 2008 – The reactor power was lowered to 92% FP, due to a lack of reactivity caused by the unavailability of the fuelling machine.
- October 20, 2008 – (*stepback*) A stepback to 35% FP occurred, following a turbine trip.
- October 21, 2008 – Power was limited to 85% FP, due to the unavailability of condenser steam discharge valve #3.

18 *Type II inspections* were completed in 2008 by the Gentilly-2 CNSC site staff, and no major deficiencies were found. Based on the inspections conducted during 2008, CNSC staff concludes that Hydro-Québec meets the expectations in the areas of equipment configuration management and outage management. With respect to the management of temporary activities, Hydro-Québec generally complied with its guidelines on the matter. However, improvements are required in managing the control room documents. Progress has been observed in the area of procedural compliance.

CNSC staff concludes that Hydro-Québec performance in Operations is "Satisfactory".

1.5.1.3 Occupational Health and Safety (Non-radiological)

Number of lost time injuries reported by the licensee:	
Accident Frequency (AF):	1.75
Accident Severity Rate (ASR):	5.68

As defined in S-99, the Accident Frequency is the number of disabling injuries per 200,000 person hours worked at a NPP. The Accident Severity rate is the total number of days lost or charged for all disabling injuries per 200,000 person hours. Details about the accidents at Gentilly-2 were not reported in 2008. Consequently, Hydro-Québec was in non-compliance with the reporting requirements of S-99.

Most of the accidents did not have a major impact on the health and safety of the plant workers. With the exception of two fractures, the remainder of the incidents caused pain, bruises, and scratches to different parts of the body but did not lead to a large number of days lost.

CNSC staff concludes that Hydro-Québec performance in Occupational Health and Safety is "Satisfactory".

1.5.2 Performance Assurance

A "Satisfactory" rating is assigned to the Performance Assurance safety area in 2008.

1.5.2.1 Quality Management

In 2008, Hydro-Québec provided updates to CNSC staff on the progress made in implementing the

actions initiated to eliminate the non-compliances found during previous inspections. The *action items* still outstanding are related to a 2004 management self-assessment inspection, a 2005 corrective action processes inspection and a 2006 inspection pertaining to supplier performance assessments. The work completed by Hydro-Québec in 2008 was not enough to allow closure of these *action items*.

A review by CNSC staff of the event root-cause analyses revealed a significant delay in Hydro-Québec completing the implementation of its action plans. The delays in implementing these plans had also been identified during a 2005 inspection, pertaining to the Quality Management program at Gentilly-2.

The inspections conducted in 2008 at the Gentilly-2 NPP also revealed weaknesses in the subject areas of operating experience (OPEX), independent assessment and documentation control.

Based on these findings, CNSC staff concludes that, in 2008, the Quality Management program at Gentilly-2 was "Below Expectations".

1.5.2.2 Human Factors

An OPEX inspection was performed in 2008. Some of the weaknesses identified during the inspection were Human Factors-related, and concerned a lack of user knowledge of the actions found in the procedures and of the related responsibilities. An action notice was issued to Hydro-Québec, and is already taken into account in the Quality Management program.

CNSC staff concludes that the Human Factors program was "Satisfactory" in 2008.

1.5.2.3 Training, Examination and Certification

Training

With respect to staff training, CNSC staff has concluded that Hydro-Québec has answered in large part to the requests made by the CNSC following the inspections of previous years. The outstanding actions consist in correcting a deficiency of the operator task analysis; this analysis is part of the requirements of the systematic approach to training. Hydro-Québec will complete all outstanding actions by December 31, 2009.

Examination and Certification

Hydro-Québec staff in safety-critical positions must undergo knowledge-based and performance-based examinations, in order to gain assurance of their competence prior to CNSC certification. After CNSC certification, licensees conduct knowledge-based and performance-based requalification examinations, to ensure that certified staff retain the necessary knowledge and skills to perform their duties safely.

During the reporting period, the Gentilly-2 success rate in certification examinations was very low (57 %). Consequently, CNSC staff requested Hydro-Québec to conduct a root-cause analysis before the end of 2008, in order to determine why the exam results were so poor. An update on the progress made in this analysis is to be submitted. The candidates who were granted a conditional pass on the examination will have to complete appropriate training, so as to remedy the weaknesses revealed by the exam, and will need to be successful on another test specifically designed to target their weaknesses. The candidates who were not successful on the examination will have to undergo training to correct their shortcomings, after which they will undergo another regular examination.

In February 2008, the CNSC published regulatory document RD-204 "Certification of Persons Working at Nuclear Power Plants". This document lists the regulatory requirements regarding the initial training, certification and continuing training of certified staff.

Following the publication of the document RD-204, Hydro-Québec requested an amendment to the Gentilly-2 station operating licence, to incorporate RD-204 and to conduct their own initial certification examinations. The *Commission* is expected to approve the new licence during 2009.

Based on the successes of the staff training program and on the availability of an approved action plan to eliminate the deficiencies of the certified staff training program, it is concluded that the

Training, Examination and Certification program at Gentilly-2 meets the CNSC requirements. CNSC staff concludes that this program was "Satisfactory" in 2008.

1.5.3 Design and Analysis

The Design and Analysis safety area met CNSC's performance requirements and expectations. The programs under this safety area contributed to safe facility operation, earning a "Satisfactory" rating for 2008.

1.5.3.1 Safety Analysis

CNSC staff pays special attention to safety analyses. The next update to the *Safety Report* will include all the solutions to the issues raised by the CNSC. Most of these issues require long-lasting research work to identify the appropriate solutions. As part of the Gentilly-2 refurbishment project, Hydro-Québec has identified and committed to completing some other analyses needing to be updated by the end of the refurbishment.

Hydro-Québec follows an action plan to update the safety analyses. In accordance with regulatory document RD-310, this plan covers relevant subjects and supports the refurbishment project. Hydro-Québec also intends to participate, in collaboration with the industry, in the development of a common long-term strategy to improve the safety report. The action plan includes a list of new or revised analyses that will be integrated and updated in the next revision of the safety report. Some of the analyses on the list are already available, and ready to be added to the safety report.

CNSC staff will closely monitor the recording and updating of the analyses, as well as the implementation of Hydro-Québec's action plan, including a detailed timeline for major activities—such as ensuring compliance with regulatory document RD-310 and the station refurbishment project.

As required by regulatory standard S-294, Hydro-Québec must conduct a probabilistic risk assessment (PSA). At a meeting held in July 2007, Hydro-Québec presented its plan to conduct the PSA in support of the Gentilly-2 NPP refurbishment project. In June 2008, the CNSC received for review the document describing the PSA methodology.

CNSC staff concludes that the Safety Analysis program was "Satisfactory" in 2008.

1.5.3.2 Safety Issues

Hydro-Québec cooperates with other utilities and organizations of the nuclear industry on research programs specifically designed to acquire the knowledge required to close the generic action items still being processed.

CNSC staff concludes that the Safety Issues program was "Satisfactory" in 2008.

For additional information on specific safety issues, refer to Appendix F, which provides the significant developments of 2008 relevant to each of the generic action items.

1.5.3.3 Design

In 2008, CNSC staff made some positive observations about the Gentilly-2 NPP Design program, notably in the implementation of the fire protection program. Housekeeping was generally good, and storage of the fuel bundles was satisfactory.

However, there are deficiencies in the fire protection program itself and it does not fully meet conditions 3.4 and 6.1 of the PROL. Some aspects of the program are weak, while others are incomplete. However, for the time being, these issues do not present an unreasonable risk to persons or the environment.

Changes to the design standards—referred to in the Gentilly-2 licence—are currently under discussion. These changes could impact Hydro-Québec processes and, in particular, its relationship with the organization licensed to inspect pressure boundaries. A workshop was held on December 2, 2008, to inform Hydro-Québec, as well as the other NPP licensees, on the revisions to be made to the licence conditions.

CNSC concludes that the Design program was "Satisfactory" in 2008.

INSPECTING PANELS TO VERIFY SAFETY IMPORTANT COMPONENTS ARE READING CORRECTLY.

1.5.4 Equipment Fitness for Service

The Equipment Fitness for Service safety area at Gentilly-2 met CNSC staff expectations. The programs under this safety area contributed adequately to safe plant operation. A "Satisfactory" rating is assigned to this safety area for 2008.

1.5.4.1 Maintenance

The Maintenance program was assessed during 2008 through system inspections and reviews of event analyses. The data gathered from these activities revealed that, for corrective and elective maintenance, the response time was sometimes too long but had no significant impact on the performance of the Maintenance program.

However, a review of performance indicator no. 10 ("Preventive maintenance implementation coefficient") revealed an important degradation in the implementation of preventative maintenance work in 2008, with values below those of the historical performance at Hydro-Québec.

CNSC staff concludes that the Maintenance program was "Below Expectations" at Gentilly-2 in 2008.

1.5.4.2 Structural Integrity

Because of problems with the fuelling machine, Hydro-Québec requested to postpone several stages of the work planned for the 2008 outage. CNSC staff subsequently met with Hydro-Québec staff to assess the status of issues such as the reactor building pressurisation test, the SLAR pressure tube maintenance program, the steam generator tube inspection, as well as the removal of a steam generator tube. During the discussions, Hydro-Québec demonstrated the feasibility of postponing these tests and work until the next planned outage, and that showed this delay did not pose a risk to the Gentilly-2 plant safety. These activities are planned for the outage in 2009.

Fuel sheath and steam generator inspections were carried out at Gentilly-2 in 2008. CNSC staff is satisfied with its inspection activities, as well as the proactive approach followed by Hydro-Québec in preparation for the planned outage of April 2009.

CNSC staff concludes that the system and equipment Structural Integrity program at Gentilly-2 was "Satisfactory" in 2008.

1.5.4.3 Reliability

In 2008, CNSC staff met with Gentilly-2 NPP staff to follow-up on the inspection of reliability data collection and processing. The progress made by Hydro-Québec in the areas of planning and data recording was satisfactory. Additional efforts are however required in order to complete the data collection and the writing of all required procedures.

An additional meeting is planned in 2009, with the purpose of closing all outstanding actions before the end of the year.

Generally, the Hydro-Québec Reliability Program is adequately planned and appropriately maintained. The performance of the safety significant systems met the regulatory objectives in 2008. Appropriate reports on the state of plant reliability were submitted by Gentilly-2.

There was one Level 1 impairment of the emergency core cooling system in 2008. This event was caused by the simultaneous opening of two valves during a test on the shutdown cooling system. This event did not impact on plant safety, as the duration of the impairment was very short. The corrective actions taken by Hydro-Québec to address this situation were considered to be adequate.

CNSC staff concludes that the Gentilly-2 Reliability Program was "Satisfactory" in 2008.

CHECKING GAUGES TO ENSURE ADEQUATE PRESSURE OF THE BOILER FEED PUMP.

1.5.4.4 Equipment Qualification

An inspection of the Equipment Qualification program, conducted at the end of 2006, revealed some weaknesses, which were subsequently addressed by Hydro-Québec in an action plan submitted to the CNSC at the end of 2007.

Meetings with Hydro-Québec have been planned on a six-month basis, in order to keep track of the progress being made regarding Equipment Qualification.

Hydro-Québec has completed three action notices. Several other actions are still open, because the corrective measures chosen are not fully implemented. Gentilly-2 will soon enter a refurbishment phase and Hydro-Québec has requested to postpone the deadline for completion of the equipment qualification activities to the end of 2012. Some improvements have been observed, but additional progress is needed to complete the activities on time.

CNSC staff concludes that the Gentilly-2 Equipment Qualification program was "Satisfactory" in 2008.

1.5.5 Emergency Preparedness

During 2008, CNSC staff conducted an inspection of an emergency response exercise at the Gentilly-2 NPP.

Based on the observations made during this exercise, the CNSC inspection team concludes that, by and large, Hydro-Québec was able to demonstrate that it is capable of managing effectively a radiological emergency at Gentilly-2.

The CNSC team believes that the scenario used for the DERAD 2007 exercise (held in March 2008) was sufficiently challenging to evaluate the emergency response procedures and equipment, as well as the objectives set for the exercise.

DERAD 2007 also showed that some aspects of radiological emergency response could be improved. Based on the activities that were evaluated, the CNSC issued three action notices and two recommendations, in order to promote and improve the effectiveness of Hydro-Québec's response at its Gentilly-2 facilities.

Correctives measures were drafted mainly in reference to a more structured operations management, regarding emergency procedure compliance, information management and minimization of risk to site staff and—finally—the importance of compliance with plant radiation protection and industrial safety requirements, even during exercises.

CNSC staff concludes that, generally, Hydro-Québec complies with the regulatory requirements.

The safety area Emergency Preparedness met CNSC performance requirements and expectations in 2008. CNSC staff concludes that this safety area was "Fully Satisfactory" in 2008.

1.5.6 Environmental Protection

In 2008, the reported dose to the public was 0.64 µSv, which is well below the public dose limit of 1000 µSv. The airborne and liquid releases of radionuclides remained well below the action levels used for the control of releases. The physical and chemical parameters also met the provincial requirements. With respect to unplanned events, the few minor releases reported did not have any impact on the public or the environment.

An inspection of the environment radiological monitoring and release control was conducted at the station. Generally, Hydro-Québec meets the regulatory requirements, although CNSC staff noted that improvements are needed with regards to meeting deadlines and to document updating and consistency.

This safety area met CNSC performance requirements and expectations. CNSC staff concludes that this safety area was "Satisfactory" at Gentilly-2 in 2008.

1.5.7 Radiation Protection

There were no radiation exposures to staff that exceeded regulatory limits.

In 2008, the Gentilly-2 Radiation Protection program continued to meet regulatory requirements. It is worth mentioning that some improvements were made to the Radiation Protection program,

including several ALARA initiatives. Radiation protection-related events were analyzed appropriately and are linked to suitable action plans.

The total collective dose during normal operations at Gentilly-2 continues to decrease, and 2008 marked the lowest recorded collective dose over the past five years. The doses received during outages vary from year to year, and depend mainly on the scope and nature of the work carried out during each outage.

CNSC staff conducted an inspection of radiation protection instrumentation as well as of contamination and exposure control at Gentilly-2. Some deficiencies were noted regarding the frequency of calibration of radiation instrumentation and its inclusion in the appropriate radiation protection guidelines. Hydro-Québec has initiated an action plan to address these deficiencies.

CNSC staff also followed-up on outstanding radiation protection issues and concluded that Hydro-Québec had made significant progress. It is expected that these actions will be closed in the near future.

The Radiation Protection safety area met CNSC requirements and performance expectations in 2008. CNSC staff concludes that this safety area was "Satisfactory" at Gentilly-2 in 2008.

1.5.8 Site Security

This safety area is presented to the Commission in a separate document (CMD 09-M28.A).

1.5.9 Safeguards

CNSC staff rates the implementation of the Safeguards safety area by Hydro-Quebec at Gentilly-2 as "Fully Satisfactory" in 2008, since it meets or exceeds applicable CNSC requirements and performance expectations. Hydro-Quebec has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

The IAEA conducted a Physical Inventory Verification at Gentilly-2 in July 2008. The inspection was undertaken to: verify that no diversion of nuclear material had taken place; detect any tampering with the IAEA's containment/surveillance system; and to confirm the declarations provided by the State authorities and facility operators. The inspection was attended by CNSC staff, who undertook to review: the facility's support for IAEA inspectors—including escorts and equipment; the provision of accountancy information and supporting documents; the facility compliance with safeguards licence conditions relevant to the inspection activity; and the IAEA's adherence to its rights and obligations relevant to the inspection. No significant compliance issues were identified.

In addition, a Design Information Verification was performed by the IAEA at Gentilly-2 in 2008. CNSC staff did not attend this activity. The IAEA has not yet issued reports of the results, but no issues are anticipated.

In 2008, Safeguards staff from Gentilly-2 participated in a series of trilateral meetings with the IAEA, the CNSC and the other facility operators, aiming to develop an Integrated Safeguards Procedure for the CANDU stations. In developing the procedures, the station participated in a field trial for Short-Notice Random Inspections (SNRIs), in order for the IAEA to detect and deter the diversion of nuclear material, tampering with IAEA surveillance equipment and undeclared activities. As of the end of 2008, these SNRIs formally replaced traditional IAEA inspections, which were carried out on an announced quarterly basis.

1.5.10 Update on Other Major Projects and Initiatives

The Gentilly-2 NPP refurbishment project, which was under consideration since 2001 as part of the preliminary design phase, was officially approved by Hydro-Québec senior management in August 2008. This decision will have an impact on the various programs described in this report.

Meanwhile, Hydro-Québec has made a formal commitment to abide by the intent of regulatory guide RD-360 "Life Extension of Nuclear Power Plants". Therefore, CNSC staff expects that the documents to be revised as part of the Gentilly-2 refurbishment project will be submitted accordingly. Hydro-Québec has expressed its intention to submit an integrated safety review document and a global assessment report, including an integrated implementation plan, as described in RD-360. It is expected that the integrated safety review will be submitted before the end of 2009.

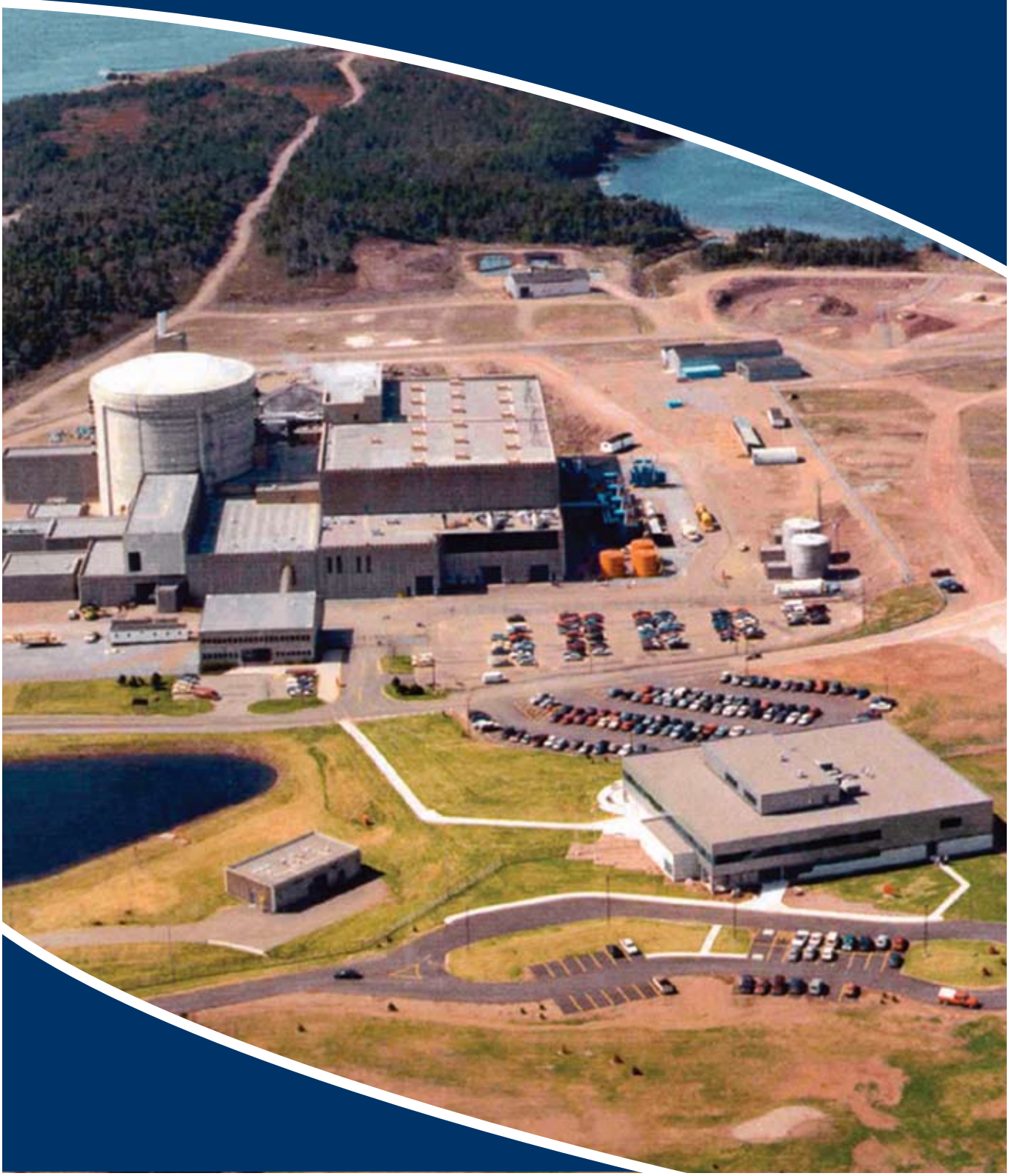
CSNC staff has set up an internal structure to review the various aspects of Hydro-Québec refurbishment project which have a direct impact on the relevant programs and safety areas. This evaluation will be conducted as part of the review of the documents submitted by Hydro-Québec in relation to the station refurbishment project.

1.5.11 Conclusion

There have been no *serious process failures* at Gentilly-2 since the renewal of its licence in 2006. The most significant incident at the station involved a collision in the reactor building between the fuelling machine and a trolley, which lead to significant delays in completing work during the 2008 outage.

Since 2006, the Quality Management and Maintenance programs performance ratings have declined. These changes in performance at the station in these areas have been documented, and are the subject of special attention on the part of the CNSC staff. Since the renewal of its operating licence, Gentilly-2 NPP was able to maintain its safety performance at a satisfactory level, while protecting the health and safety of persons and the environment, maintaining national security and complying with Canada's international obligations.

1.6 POINT LEPREAU



1.6 Point Lepreau

Table 6 presents the safety performance ratings for Point Lepreau for 2008. These ratings were determined using a risk-informed approach, integrating findings from 29 *Type II inspections*, surveillance and monitoring activities, desktop reviews and assessments, and the professional judgement of CNSC staff. The integrated plant rating for Point Lepreau is "Satisfactory" for 2008. Rating definitions and a table of comparison with the old rating system are provided in Appendix B.

TABLE 6: SAFETY PERFORMANCE RATINGS FOR POINT LEPREAU FOR 2008

Safety Area Program	**Performance Rating**
Operating Performance	**FS**
Organization and Plant Management	SA
Operations	FS
Occupational Health and Safety (non-radiological)	FS
Performance Assurance	**SA**
Quality Management	SA
Human Factors	SA
Training, Examination, and Certification	SA
Design and Analysis	**SA**
Safety Analysis	SA
Safety Issues	SA
Design	SA
Equipment Fitness for Service	**SA**
Maintenance	SA
Structural Integrity	SA
Reliability	SA
Equipment Qualification	SA
Emergency Preparedness	**FS**
Environmental Protection	**SA**
Radiation Protection	**SA**
Security	**Prescribed**
Safeguards	**FS**
Integrated plant rating	SA

1.6.1 Operating Performance

Point Lepreau Generating Station (PLGS) operated safely in 2008. The Operating Performance safety area at Point Lepreau met, and in some cases, exceeded the objectives of CNSC requirements and performance expectations. The programs under the safety area contributed adequately to the safe operation of the facility. This safety area is rated "Fully Satisfactory" for Point Lepreau in 2008.

1.6.1.1 Organization and Plant Management

As per section 15 of the *General Nuclear Safety and Control Regulations*, the licensee must report any significant change in its organizational structure to the CNSC. When the PLGS refurbishment outage began in March 2008, all activities were brought under the control of the Station Manager. Prior to the outage, refurbishment activities had been managed by a separate line organization. There were also sev-

eral temporary changes in the licensee's organization, as staff was redeployed to support various work activities. Nonetheless, CNSC staff did not observe any significant issues requiring follow-up.

Throughout 2008, performance of Point Lepreau management conformed to their internal guidance document, entitled "The Nuclear Management Manual". This manual includes the aspects of adequate leadership and continued improvements to achieve and maintain higher performance.

CNSC staff did not identify any significant findings in the inspections, surveillance and monitoring of the station in this program for 2008. Based on the compliance activities carried out, Organization and Plant Management at Point Lepreau receives a "Satisfactory" rating.

1.6.1.2 Operations

In 2008, Point Lepreau experienced no forced outages, *stepbacks*, or *serious process failures*.

On March 30, 2008 PLGS began its planned refurbishment outage. Operations performed well in the areas of defuelling, establishing a *guaranteed shutdown state* for the reactor, and management of the heat sinks.

CNSC site staff conducted 29 *Type II inspections* in 2008. CNSC staff also carried out surveillance and monitoring activities, desktop reviews and assessments, and held several meetings with the licensee to discuss enforcement actions, licensing requirements, inspection findings, and results of reviews and assessments. Based on CNSC staff observations, Point Lepreau meets expectations and is rated as "Fully Satisfactory" for 2008.

1.6.1.3 Occupational Health and Safety (non-radiological)

Number of lost time injuries reported by the licensee:	2
Accident frequency (AF):	0.72
Accident severity rate (ASR):	8.01

AF and ASR are performance indicators, reported by the licensee as per S-99 requirements. There were two lost time injuries reported in 2008, both as a result of trips and falls, with a significant recovery time. This resulted in a high ASR at Point Lepreau, in comparison to previous years.

In April 2008, the responsibility for the regulation of occupational health and safety was transferred to the province of New Brunswick (Canada Gazette Part II, vol. 142, No. 7). The refurbishment outage saw a large increase in the number of workers on site. WorkSafeNB[2] increased their oversight of the work activities on site, to meet the increased construction activity.

CNSC staff is satisfied that occupational health and safety work practices and conditions achieve a high degree of personnel safety at PLGS, and have rated the program "Fully Satisfactory" for 2008.

1.6.2 Performance Assurance

The Performance Assurance safety area at Point Lepreau met the objectives of CNSC requirements and performance expectations in 2008. Overall, the safety area receives a "Satisfactory" rating.

1.6.2.1 Quality Management

In 2008, CNSC staff conducted detailed assessments of the New Brunswick Power Nuclear (NBPN) quality management program, with emphasis on the ongoing refurbishment activities. In comparison to normal operation, refurbishment is associated more with construction projects, where routine operational activities are replaced with design and construction activities. The safety-related refurbishment activities include: the adequacy and completion of design and design verification; the competency and capability of suppliers of components, services and qualified staff; work control activities; material management; and documentation and records management.

[2] WorkSafeNB oversees the implementation and application of the New Brunswick Occupational Health and Safety Act, the Workers' Compensation Act of New Brunswick, and the Workplace Health, Safety and Compensation Commission Act of New Brunswick

AS PART OF A ROUTINE OUTAGE INSPECTION, CNSC INSPECTORS OBSERVE THE AREA AROUND THE FUELLING MACHINE TO MAKE SURE HOUSEKEEPING MEETS STATION STANDARDS.

To address these safety-related refurbishment activities, CNSC staff conducted a *Type II inspection* of the material management and handling at two stores in Point Lepreau and the Atomic Energy of Canada Limited (AECL) warehouse in Saint John. Overall, the material handling processes at the Saint John warehouse were found to be adequate. Four action notices were raised for NBPN to address: deficiencies with the identification and tagging of incoming material; the traceability and tracking of records; and the operation of a small parts quarantine area. NBPN has been addressing these deficiencies.

CNSC staff also conducted a *Type II inspection* of NBPN's change control process. From the inspection, staff concluded that the overall change control process meets the applicable requirements. However, two action notices were issued to address deficiencies with the design verification process (undocumented criteria of knowledge and experience) and with the issuance of contracts to design services suppliers. Despite these deficiencies, the change control process was determined to be robust and well implemented.

In addition, CNSC staff participated as an observer in several inspection activities completed by NBPN staff—for example, inspections of suppliers and design activities.

Prior to the return to service of the station, CNSC staff plans to undertake reviews and inspections to verify completion of commissioning activities and the station's safe operational configuration. These activities are discussed in more detail as part of the Fuel Reload CMD – see Section 1.6.10 on special projects.

Based on these assessments, Quality Management at Point Lepreau is rated as "Satisfactory" in 2008.

1.6.2.2 Human Factors

In 2008, NBPN provided updates on the outstanding issues identified during a CNSC inspection completed in 2004, regarding the establishment and the implementation of a plan that documents

all the engineering and technically-based skills necessary to support safe operation of the station. This plan would define the number of qualified staff required with these skills. Based on the information provided, CNSC staff concluded that NBPN has made significant progress towards establishing the infrastructure required to anticipate and manage staffing level changes, and to ensure that appropriate learning opportunities are provided to staff in a timely manner.

NBPN also provided updates on the outstanding *action item* from a *Type II inspection* completed in 2006, regarding the implementation of a process for monitoring compliance with hours of work limits. NBPN has introduced a process for producing quarterly and bi-weekly reports, which records occasions where hours of work limits have been exceeded. In addition, NBPN is testing a software solution for internal staff working a twelve hour shift schedule.

Based on the update, CNSC staff noted that these measures do not provide information that would allow supervisors to monitor all of the different hours of work limits, and are only reactive in nature. CNSC staff also expressed concern over the hours worked by contractors, the monitoring of compliance of these limits and the monitoring of violations. NBPN informed CNSC staff that contracting organizations had been requested to provide monthly reports on hours of work limits, and were required to adhere to the limits of hours of work as documented in station's procedures.

Human factors aspects of modifications made during refurbishment project are being guided by a Human Factors Engineering Program Plan (HFEPP). This HFEPP outlines the human factors activities identified as part of refurbishment, the re-tube tooling work to be completed at the reactor, and the modifications to the Solid Radioactive Waste Management Facility. CNSC staff has reviewed the HFEPP and agrees with the approach suggested in the plan. Moreover, CNSC staff has confidence that a systematic process for inclusion of human factors considerations into the design activities for refurbishment is being followed.

Based on compliance activities carried out in 2008, Point Lepreau has met CNSC expectations for the performance of the human factors program, and receives a "Satisfactory" rating. NBPN will be carrying out several other initiatives in 2009, such as a review of risk-significant human error events against modern human factors engineering standards.

1.6.2.3 Training, Examination and Certification

The Training, Examination and Certification program area at Point Lepreau met CNSC performance expectations in 2008, and has been given a "Satisfactory" rating. NBPN has demonstrated that there are sufficient numbers of qualified workers at Point Lepreau to carry out the licensed activities.

Training

In 2008, CNSC staff conducted *Type II inspections* on a quarterly basis, to monitor the implementation of the training plans for certified operators and non-licensed staff, to observe and inspect continuing training for certified operators, and to receive updates on training during the outage.

In general, CNSC staff found the continuing training for certified operators very well presented and well received by participants. Staff concluded that this training was very effective and met CNSC selected inspection objectives and supporting criteria.

These quarterly *Type II inspections* will continue according to the established agreement between CNSC and NBPN, leading up to fuel reload and return to service.

Examination and Certification

Certified staff continued to participate in regularly scheduled continuing training and requalification testing, as per the PROL conditions. In addition, certified staffing is being maintained at the levels specified by the PROL throughout the refurbishment outage for shift operation positions, in order to support refurbishment activities.

As with the other NPP licensees, following the publication of RD-204 "Certification of Persons Working in Nuclear Power Plants", NBPN applied to amend the Point Lepreau PROL to incorporate RD-204 and to conduct their own initial certification examinations for certified shift personnel. The Commission approved the transfer of initial examination certification to NBPN in January 2009.

1.6.3 Design and Analysis

The Design and Analysis safety area at Point Lepreau met the objectives of CNSC requirements and performance expectations and has been given a "Satisfactory" rating. CNSC staff reviews concluded that NBPN continued to provide satisfactory responses to new design and safety issues in 2008.

1.6.3.1 Safety Analysis

Overall, the CNSC is satisfied with the Safety Analysis program and its performance for Point Lepreau, since it is based on compliance with modern QA standards. The staff assessments confirmed that, in general, the station has an adequate safety analysis program in place, supporting the ongoing safe operation at Point Lepreau.

Probabilistic Safety Analysis
NBPN completed a Level 1 and a Level 2 PSA, as per CNSC regulatory standard S-294 "Probabilistic Safety Assessment (PSA) for Nuclear Power Plants". CNSC staff found the Level 1 PSA satisfactory as it adopts recognized methods and is well documented. However, CNSC staff noted that the Level 1 methodology used by NBPN resulted in a large number of fault trees, making the model more cumbersome than necessary. Nonetheless, the results of the PSA continue to demonstrate that the plant meets the CNSC safety goals.

In 2008, CNSC staff received the Level 2 PSA for Internal Events, Level 2 Flood PSA, Level 2 Fire PSA and a PSA-Based Seismic margin assessment. These submissions are currently under review.

CNSC staff will continue to monitor progress towards the implementation of the activities identified as part of the PSA outcome.

1.6.3.2 Safety Issues

CNSC staff reviewed the progress of the CANDU industry and utilities in resolving issues related to GAIs. NBPN continued its participation in the industry efforts toward resolution of the outstanding GAIs.

GAIs 88G02, 95G02, 99G01 and 06G01 were closed for Point Lepreau in 2008. A brief description and the expected completion date of each remaining GAI are provided in Appendix F.

This program area is rated as "Satisfactory" for Point Lepreau in 2008.

1.6.3.3 Design

NBPN has revised the Point Lepreau pressure boundary program, in accordance with CSA standard N285.0-06. In 2008, NBPN submitted and obtained CNSC approval of their Pressure Boundary Classification, Registration and Reconciliation processes.

In May 2008, the Point Lepreau PROL was amended and made effective for the establishment of a formal agreement between NBPN and NB Department of Public Safety—as the accredited Authorized Inspection Agency (AIA)[3]. In December, 2008, NBPN provided to CNSC staff, to other power reactor licensees and to inspection agencies, an update on their experience with the established AIA approach.

CNSC fire specialists reviewed the NBPN submission on Level 1 Fire PSA. In their reviews, CNSC staff requested NBPN to demonstrate that the industrial fire brigade can consistently meet the performance criteria assumed in the analysis. In addition, CNSC staff conducted a *Type II inspection* on Point Lepreau Industrial Fire Brigade Drill, in November 2008. This inspection was performed with the assistance of a contractor, and there were significant delays in receiving the contractor's final report. Therefore, the results of this inspection are not reported in this document, and will be made available in the subsequent Annual Report. The discussion on the status and resolution of outstanding fire issues is ongoing.

[3] NBPN has a formal agreement with the New Brunswick Department of Public Safety to provide services, as the AIA, for the pressure boundaries of the nuclear facility, as defined by Licence Condition 5.3 of the PROL.

NBPN staff has been working, in collaboration with CNSC staff, to prepare a gap assessment against current drafts of RD-334 "Aging Management for Nuclear Power Plants", and benchmark findings, and also to plan the schedule for completion of the Point Lepreau plant-level Aging Management Plan (AMP). In December 2008, NBPN provided an update on the development of the Point Lepreau AMP vis-à-vis RD-334 (draft). In their update, NBPN staff outlined the next planned steps as the following:

- Continue regular meetings with CNSC staff in 2009, to discuss the current version of RD-334 until completion of the Point Lepreau AMP.
- Provide a draft of the AMP for CNSC review by the end of February 2009.

Based on staff's review of this program area, Point Lepreau met CNSC performance expectations and received a "Satisfactory" rating.

CHECKING TURBINE SUMP PUMP LEVELS TO ENSURE THEY ARE WORKING EFFECTIVELY.

1.6.4 Equipment Fitness for Service

The Equipment Fitness for Service safety area at Point Lepreau met the objectives of CNSC requirements and performance expectations. Overall, the safety area received a "Satisfactory" rating.

1.6.4.1 Maintenance

CNSC site staff conducted a *Type II* maintenance inspection at Point Lepreau in 2008. The inspection included review of work order documentation and observation of the actual work in the field. This was the first maintenance work execution inspection completed at Point Lepreau as part of a set of baseline type II maintenance compliance inspections. No major findings were identified, and CNSC staff determined that the Point Lepreau work execution met regulatory requirements.

NBPN has also shown, for 2008, an improving trend in the completion of their Preventive Maintenance work.

CNSC staff routinely reviews events that are maintenance-related. In 2008, there were 30 reportable events that were related to maintenance; however, none of these events was considered significant.

Based on these findings, the performance of the maintenance program at Point Lepreau in 2008 is rated as "Satisfactory".

1.6.4.2 Structural Integrity

In 2008, NBPN met the Pressure Boundary requirements referenced in the PROL. Inspections were carried out as per applicable CSA Standards. NBPN has put in place adequate fitness-for-service programs, to ensure that the integrity of p*ressure tube*s, *feeders*, and *steam generators* is well maintained. No significant degradation effect with regards to Pressure Boundaries was reported in 2008.

Since the station is undergoing refurbishment, NBPN did not submit assessments for the *pressure tube* and the containment system components.

Through plant walkdowns and *Type II inspections*, CNSC staff found that most components were in their expected state and in good working order. Only a few components inspected at the Spent Fuel Bay were found in a different state than expected.

As part of the refurbishment of the reactor components, the entire inlet and outlet feeders are being replaced with new *feeders*. The material of the new *feeders* is more resistant to Flow Accelerated Corrosion. Another design improvement for the new *feeders* is the increase of the nominal wall thickness for the two-inch *feeder* pipes.

Based on these results, CNSC staff rate the performance of the Structural Integrity program area at Point Lepreau as "Satisfactory" in 2008.

1.6.4.3 Reliability

Due to the station being in refurbishment and defuelled since May 2008, the monitoring period for the 2008 Annual Reliability Report covers the period from January 1, 2008 to May 11, 2008.

In 2008, all the *special safety systems* and the systems important to past unavailabilities met their actual and predicted future unavailability targets.

NBPN uses the PSA models, including the support systems to calculate the systems unavailabilities, which is an improvement over past practice and in accordance with past CNSC staff requests.

CNSC staff concludes the PLGS reliability program meets CNSC expectations. This program area has been rated as "Satisfactory" for 2008.

1.6.4.4 Equipment Qualification

Equipment Qualification involves design and maintenance activities that keep the station's equipment capable of withstanding environmentally challenging environments— such as high temperatures and high humidity—encountered after large accidents.

NBPN provided update reports on the implementation of the required corrective actions identified during a previous CNSC *Type I inspection*, conducted in 2006. CNSC staff reviewed these update reports and concluded that all corrective actions have been implemented. The action item related to this inspection was closed in 2008.

This program area has been rated as "Satisfactory" for 2008.

1.6.5 Emergency Preparedness

The emergency planning basis at PLGS has been limited to an "on-site emergency" classification, due to the reduced risk presented by the facility while it is shut down for refurbishment. As a result of this risk reduction, CNSC staff did not conduct any specific inspections at the facility in 2008. Emergency management performance was monitored through regular reviews of S-99 reports, PLGS quarterly compliance reports and CNSC site staff weekly reports.

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. Prior to the fuel reloading, CNSC staff plans to conduct a *Type II inspection* of the emergency

program, in order to verify that adequate staffing and training are maintained, allowing for the Emergency Response Organization to be fully compliant with the license and emergency program requirements for normal operations.

NBPN has maintained an adequate Emergency Preparedness (EP) program, commensurate with the reduced emergency risk present during the outage. This program continues to exceed applicable CNSC requirements and performance expectations. As a result of these findings, Emergency Preparedness at Point Lepreau has been given a "Fully Satisfactory" rating for 2008.

1.6.6 Environmental Protection

In 2008, the reported dose to the public due to Point Lepreau was 1.8 µSv, which is well below the public dose limit of 1000 µSv. Gaseous and aqueous releases of nuclear substances were always below Action Levels.

CNSC staff review of Point Lepreau Quarterly Operations Reports, submitted under S-99, did not identify any significant issues related to radiation dose to the public or environmental protection. There were no reports of any unplanned releases of nuclear substances or hazardous substances from Point Lepreau, which could have posed an unreasonable risk to the environment.

In July 2008, CNSC staff performed a *Type II inspection* of Point Lepreau's liquid effluent monitoring. The objective of this inspection was to confirm that liquid effluent monitoring is executed according to approved procedures. Overall, staff determined that the liquid effluent monitoring process at Point Lepreau meets requirements.

The Environmental Protection safety area at Point Lepreau met CNSC requirements and performance expectations in 2008, and has been given a "Satisfactory" rating.

MONITORING UPON EXIT IS MANDATORY UNDER RADIATION PROTECTION POLICIES AND PROCEDURES.

1.6.7 Radiation Protection

In 2008, no radiation exposures at PLGS exceeded regulatory limits. There were two incidents resulting in reportable dose in excess of PLGS's action levels. Both cases involved individuals exceeding Administrative Dose Limits, through different means of barrier failure. Investigations were conducted, and appropriate corrective actions were taken.

CNSC staff conducted a *Type II inspection* on Contamination Control, Instrumentation and Equipment, and Radiation Exposure and Dose Control, as well as an update on Refurbishment activities. Five actions notices were raised as a result of this inspection; the licensee has requested closure for four of these, and CNSC staff is reviewing the request. The outstanding action notice concerns the management of radiation survey records.

An *action item* remains outstanding from a 2006 inspection. It requires the licensee to track necessary improvements to the radiation protection procedures. Procedure upgrades are planned to be completed for the end of refurbishment, to provide a sound basis for operation.

A possible trend was identified in 2008 in the area of waste handling. This program area will be closely monitored by CNSC staff, through various compliance and verification activities.

Finally, throughout 2008, monitoring by site inspectors indicated that Point Lepreau was having trouble meeting station standards—possibly due to considerable changes in the nature of work, and a significant increase in the number of workers on site without radiation protection experience.

Overall, the Radiation Protection safety area at Point Lepreau met the objectives of CNSC requirements and performance expectations in 2008, and has been given a "Satisfactory" rating. However, the problems identified in the monitoring reports, if not corrected, may result in declining performance in 2009. CNSC staff has and will continue to monitor NBPN to ensure that doses to workers are maintained below regulatory limits and are ALARA, and that precautions are taken for radiation safety throughout the execution of the refurbishment work and upon return to service.

1.6.8 Site Security

This safety area is presented to the *Commission* in a separate *Commission Member Document* (CMD 09-M28.A).

1.6.9 Safeguards

CNSC staff rates the implementation of the Safeguards safety area at Point Lepreau as "Fully Satisfactory" in 2008, since it meets or exceeds applicable CNSC requirements and performance expectations. NBPN has taken appropriate measures with respect to its licence conditions concerning Canada's international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

The IAEA conducted a Physical Inventory Verification at PLGS in July 2008. The inspection was undertaken to: verify that no diversion of nuclear material had taken place; detect any tampering with the IAEA's containment/surveillance system; and to confirm the declarations provided by the State authorities and facility operators. The inspection was attended by CNSC staff who undertook to review: the facility's support for IAEA inspectors—including escorts and equipment; the provision of accountancy information and supporting documents; the facility compliance with safeguards licence conditions relevant to the inspection activity; and the IAEA's adherence to its rights and obligations relevant to the inspection. No significant compliance issues were identified.

In addition, a Complementary Access visit was performed by the IAEA at Point Lepreau in 2008. CNSC staff did not attend this activity. The IAEA has not yet issued reports of the results, but no issues are anticipated.

In 2008, Safeguards staff from PLGS participated in a series of trilateral meetings with the IAEA, the CNSC and the other facility operators, to develop an Integrated Safeguards Procedure for the CANDU stations. In developing the procedures, Point Lepreau participated in a field trial for Short-Notice Random Inspection (SNRIs) at the facility, in order for the IAEA to detect and deter the diversion of nuclear material, tampering with IAEA surveillance equipment and undeclared activities. As of the end of 2008, these SNRIs formally replaced traditional IAEA inspections that were carried out on an announced quarterly basis.

1.6.10 Update on Major Projects and Initiatives

1.6.10.1 Point Lepreau Refurbishment Project

The Point Lepreau Refurbisment (PLR) project activities continued in 2008, with an overall progress approximately two months behind schedule. NBPN is making efforts to recover lost time and to identify opportunities or recommendations to optimize task sequences.

NBPN staff members presented two updates on the PLGS refurbishment outage to *Commission* members, at the CNSC public meetings held in June and December 2008 (CMD 08-M38 and CMD 08-M85). During the presentations, NBPN staff reported to Commission members on project status and challenges ahead, leading up to the One Day Public Hearing for fuel reload.

In 2008, completions or progress were achieved on the following PLR project major milestones:

- Completion of core defuelling (defuelled core state declared in May 2008).
- Turnover of reactor vault to AECL (as per contractual agreements, June 2008)
- Completion of Primary Heat Transport/Moderator Systems drainage
- Completion of feeder removal (September 2008)
- End fitting removal (completed in February 2009)

The Commission Hearing for Fuel Reload is planned for November 2009, with the objective to request approval of the *Commission* to reload fuel in the reactor and proceed with restart of the reactor, pursuant to Licence Condition 12.1 of the NBPN PROL.

1.7 Summary of NPP Safety Performance

Safety area and program performance ratings are summarized in Tables 7 and 8. Table 7 presents safety performance ratings for all the stations, in every program and safety area in 2008, while Table 8 compares safety area ratings for all stations over the last 3 years.

TABLE 7: SUMMARY TABLE OF SAFETY AREA AND PROGRAM RATINGS FOR ALL NPP IN 2008

Safety Area / Program	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Operating Performance	**SA**	**SA**	**FS**	**SA**	**SA**	**SA**	**FS**
Organization and Plant Management	SA	SA	FS	BE	BE	SA	SA
Operations	SA	SA	FS	SA	SA	SA	FS
Occupational Health and Safety (non-radiological)	FS	FS	FS	SA	SA	SA	FS
Performance Assurance	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**
Quality Management	SA	SA	SA	SA	SA	BE	SA
Human Factors	SA	SA	FS	BE	BE	SA	SA
Training, Examination, and Certification	SA	SA	SA	SA	SA	SA	SA
Design and Analysis	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**
Safety Analysis	SA	SA	SA	SA	SA	SA	SA
Safety Issues	SA	SA	SA	SA	SA	SA	SA
Design	BE	SA	SA	BE	SA	SA	SA
Equipment Fitness for Service	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**
Maintenance	BE	BE	FS	SA	SA	BE	SA
Structural Integrity	SA	SA	FS	SA	SA	SA	SA
Reliability	SA	SA	SA	SA	SA	SA	SA
Equipment Qualification	SA	SA	BE	SA	SA	SA	SA
Emergency Preparedness	**FS**	**FS**	**FS**	**SA**	**SA**	**FS**	**FS**
Environmental Protection	**SA**	**SA**	**SA**	**BE**	**BE**	**SA**	**SA**
Radiation Protection	**SA**	**SA**	**FS**	**SA**	**SA**	**SA**	**SA**
Safeguards	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**	**FS**
Integrated plant rating	FS	FS	FS	SA	SA	SA	SA

TABLE 8: THREE YEAR TREND OF SAFETY AREA PERFORMANCE AT ALL NPP

Safety Area / Program	Year	Bruce		Darlington	Pickering		Gentilly-2	Point Lepreau
		A	B		A	B		
Operating Performance	2006	B	B	B	B	B	B	B
	2007	B	B	B	C	B	B	B
	2008	SA	SA	FS	SA	SA	SA	FS
Performance Assurance	2006	B	B	B	B	B	B	B
	2007	B	B	B	C	B	B	B
	2008	SA	SA	SA	SA	SA	SA	SA
Design and Analysis	2006	B	B	B	B	B	B	B
	2007	B	B	B	B	B	B	B
	2008	SA	SA	SA	SA	SA	SA	SA
Equipment Fitness for Service	2006	B	B	B	B	B	B	B
	2007	B	B	B	B	B	B	B
	2008	SA	SA	SA	SA	SA	SA	SA
Emergency Preparedness	2006	A	A	A	A	A	B	B
	2007	A	A	A	A	A	B	B
	2008	FS	FS	FS	SA	SA	FS	FS
Environmental Protection	2006	B	B	B	B	B	B	B
	2007	B	B	B	B	B	B	B
	2008	SA	SA	SA	BE	BE	SA	SA
Radiation Protection	2006	B	B	A	B	B	B	B
	2007	B	B	A	B	B	B	B
	2008	SA	SA	FS	SA	SA	SA	SA
Safeguards	2006	B	B	B	B	B	B	B
	2007	B	B	B	B	B	B	B
	2008	FS	FS	FS	FS	FS	FS	FS

The new ratings correspond to the previous ratings as follows:

Previous rating	New rating
A Exceeds Requirements	**FS** Fully Satisfactory
B Meets Requirements	**SA** Satisfactory
C Below Requirements	**BE** Below Expectations
D Significantly Below Requirements	**UA** Unacceptable
E Unacceptable	

SECTION 2

GENERIC OBSERVATIONS

This section highlights significant issues and generic observations across the NPP sites as a whole. They include such topics as industry-wide safety issues, new licensing requirements, or a particular event or experience that affected a number of NPP licensees.

2.1 Operating Performance

There were no generic observations for this safety area in 2008. See Section 1 for issues affecting individual stations. Performance indicator trends for programs in this safety area are presented in Section 3.

2.2 Performance Assurance

2.2.1 Quality Management

There were no generic observations for Quality Management in 2008. See Section 1 for issues affecting individual stations.

2.2.2 Human Factors

Human Factors in Design
Over the past three years, several inspections and reviews have indicated that, in spite of documented processes and procedures, the effectiveness of incorporating human factors in engineering design must be improved for most of the industry. Areas for improvement include requirements definition, as well as verification and validation of designs. CNSC staff has worked on promoting the benefits of Human Factors in engineering design to licensees, and will continue to focus on this area through promotional activities, inspections and reviews, in 2009.

Fitness for Duty
Following the publication of Regulatory Document RD-204 "Certification of Persons Working at Nuclear Power Plants", in early 2008, CNSC staff initiated a project to further define requirements and applicability of fitness for duty programs. Through this project, the CNSC will acquire information from comparable high-risk Canadian regulatory agencies, non-Canadian nuclear regulators and current power reactor licensee programs related to fitness for duty. In 2009, the CNSC will continue to gather information, consult with stakeholders, and develop a proposal.

Safety Culture and Safety Management
Throughout 2008, CNSC staff reviewed and analyzed events reported by the stations during the year. The objective of the analysis was to validate the results with respect to the reports received by the licensee and CNSC inspection reports. The results obtained from the analysis were compared against results from previous years, and the conclusions were sent to the respective licensees. The framework used to perform the analyses was based on the CNSC's Safety Culture Organizational Behaviors Model.

CNSC staff also analyzed the methodologies developed and used by licensees to self-assess safety culture. The criterion used for the review was the CNSC guidance document entitled "Guidance for Licensee to Self-Assessment of Safety Culture". This document was distributed in 2004, at a Symposium on Safety Culture organized by the CNSC. It must be noted that some licensees benchmarked their self-assessment results against the world's top nuclear and non-nuclear performers, and CNSC staff considers this feature to be a strength.

The CNSC acknowledges that the achievement of a healthier safety culture cannot be accomplished in a short term period. However, CNSC staff encourages licensee Senior Management to actively participate at any activity related to this challenge.

2.2.3 Training, Examination and Certification

Since 2000, the CNSC has been moving towards a model for personnel certification which is based on the assurance of competence from a system of enhanced regulatory oversight of the licensees' training and examination programs, rather than a CNSC-led examination of certification candidates. This transition is consistent with CNSC policy[4], which states that licensees should be directly responsible for managing their regulated activities.

[4] CNSC Regulatory Fundamentals Policy (P-299)

In 2008—following industry and stakeholder consultations and the publishing of Regulatory Document RD-204 "Certification of Persons Working at Nuclear Power Plants"—all nuclear power reactor licensees applied to amend their operating licences to incorporate RD-204 and to independently administer initial certification examinations of their shift personnel seeking CNSC certification.

At the CNSC Commission Hearing of December 11, 2008, the Commission considered submissions from the licensees, CNSC staff, and interveners. The Commission concluded that the licensees are qualified to carry on the activity authorized by the amended licences, and that they will make adequate provisions for the protection of the environment, the health and safety of persons, and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

2.3 Design and Analysis

2.3.1 Safety Analysis

Neutron Overpower Protection (NOP) Improved Methodology

Shutdown is one of the most important safety functions in a nuclear reactor. Consequently, the analysis methodology used to determine the shutdown system trip setpoints (TSPs) is a key component of any nuclear reactor safety case. For a given set of trip parameters and TSPs, the effectiveness of the shutdown system is demonstrated through accident analysis, where the analysis must cover a wide range of scenarios—known as *design basis accidents*—and demonstrate compliance with a set of acceptance criteria. For the purpose of this report, the scenario of interest is the loss of regulation.

The intent of the Neutron Overpower Protection in-core detectors system is to initiate a reactor shutdown whenever the neutron flux reaches an unacceptably high level anywhere in the reactor core. Such a condition can occur, for instance, in a relatively high probability loss of regulation event, involving a loss of control of the bulk power and/or the spatial power distribution in the reactor. For such events, the acceptance criteria for determining the effectiveness of the shutdown system is the prevention of the onset of intermittent fuel sheath dryout.

Bruce Power (in 2005) and OPG (in 2006) submitted new NOP TSP design calculations using a new methodology. This new methodology includes the effects of Heat Transport System (HTS) aging.

CNSC staff carried out a screening review of the OPG/BP new NOP methodology. The review was completed in August 2007, and the results were communicated to OPG and BP. Based on the screening review findings and new information provided by OPG and BP, CNSC staff concluded that an independent review of certain aspects of the new methodology was required.

To facilitate the CNSC staff review, OPG and Bruce Power agreed to cosponsor an independent third-party review, through an Independent Technical Panel (ITP). The primary deliverable of the expert review will be a report addressing the merits and adequacy of the proposed improved methodology, either confirming the appropriateness of the approach for the safety application, or recommending an alternative position.

The start-up meeting of ITP work was held in September 2008. The ITP's final seminar was held on April 20 and 21, 2009, in Toronto, and was attended by CNSC staff and representatives of the industry. The expert panel will address comments received from the CNSC, OPG and BP staff; the final ITP report is expected by the end of May 2009.

The target date for the completion of CNSC staff review of the new NOP methodology is the last quarter of 2009. Depending on the outcome of the Independent Technical Panel's review, an interim CNSC staff review report may be required to address the findings of this expert panel.

It is to be noted that a Progress Report on the CNSC staff review of the OPG/BP new NOP Methodology was presented to the *Commission* during the February 19, 2009, Commission Meeting.

Safety Report Updates

Updates to the *Safety Report* for each site are required every three years, in accordance with the operating licence. In 2007, the CNSC informed all NPP licensees that Part 3 (Accident Analysis)

of the *Safety Report* does not meet CNSC criteria with respect to the following: validated tools; consistency and conservatism in analysis methodologies and assumptions; treatment and application of simulation and measurement uncertainties; and compliance with CSA standard N286.7-99. Although the safety cases are not in question, the existing safety margins and analyses need to be confirmed. In June 2008, the CNSC and nuclear industry representatives met to develop a strategy to address this issue.

Computer Code Validation

Computer code validation is one of the most important parts of the licensing review, since it is the only measure of the computer code's capability to predict plant behaviour. To provide the necessary confidence in the safety analysis being performed, Canadian NPP licensees have established specific validation programs for Industry Standard Tool codes, as per CNSC requirements in Generic Action Item GAI 98G02.

In 2008, CNSC staff reviewed the existing validation work for some of the more important computer codes, to monitor the implementation of the validation process established by the industry. CNSC staff concluded that good effort and progress were being made. However, the existing code validation work does not, in general, comply with some requirements that would allow full qualification of these codes to perform tasks in accordance with current standards.

2.3.2 Safety Issues

A Generic Action Item (GAI) is an outstanding safety issue that is complex in nature and common to more than one station. Eleven GAIs were active in 2008. Of those, one was closed in 2008 and another was closed in early 2009. A brief description, along with the expected completion date of each GAI, is provided in Appendix F, Table F.1.

In 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. These safety issues have been previously addressed.

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, in order to improve knowledge and understanding of the issue, and to confirm the adequacy of the measures.

The CNSC applied a risk-informed decision making (RIDM) approach to assessing and defining the resolution paths for the outstanding Category 3 CANDU safety issues. The CNSC communicated the results of this work to the nuclear industry, and invited the industry to form a joint technical group to review this work and to agree on a final list of safety issues and alternatives for developing acceptable resolution paths.

A joint CNSC/Industry Working Group was formed in early January 2008. In March 2008, the Working Group held a workshop to review the application of the CNSC RIDM process to two of the Category 3 issues, and to develop proposals for reaching an agreement on the risk control measures on outstanding CANDU safety issues, as well as RIDM process issues.

As a result of the workshop, two teams were created in order to develop a revised RIDM process, to apply the revised RIDM process to the Category 3 safety issues, and develop risk control measures for them.

In parallel with this initiative, a Joint CNSC/Industry team was established, to address safety issues related to Large Break LOCA (LBLOCA), and to identify the path forward for resolution of these Large LOCA-related safety issues.

An important component of the Terms of Reference for all teams is to ensure that the Joint CNSC/Industry LBLOCA Team has provided all inputs required to update Issue Descriptions, and identify and evaluate acceptable risk-control measures for LBLOCA Category 3 issues.

Progress in 2008 includes:

- revision of the CNSC RIDM process by the process team.
- revision of the Issue Descriptions for all Category 3 CANDU Safety Issues, using an updated Issue Description template.
- application of the CNSC RIDM process (Revision 6) to determine the Risk Significance Levels of the Category 3 CANDU Safety Issues (Note: this work is in progress and undergoing review by the CNSC and Industry, and is expected to be completed by mid-2009).
- the Joint CNSC/Industry LBLOCA Team has provided the RIDM issues team with several candidate resolution strategies for the Large LOCA-related safety issues. The RIDM issues team will assess the relative merits of the various candidate resolution strategies within a risk informed framework, identify and evaluate acceptable risk-control measures for LBLOCA Category 3 issues, and provide an assessment and recommendation to the Industry and CNSC executives.

2.3.3 Design

Within the area of Design, two issues are currently affecting the NPP industry as a whole.

Flow accelerated corrosion is affecting both primary and secondary pressure boundary components in all operating Canadian NPPs. Wall thinning is resolved by replacing the affected section of the pipe. In order to take into account active or progressive degradation mechanisms—such as wall thinning or cracking—faced by the entire Canadian NPP industry during plant operating periods, the CANDU Operators Group (COG) has developed Fitness for Service Guidelines for Feeders, so as to monitor flow accelerated corrosion and pressure boundary wall thinning. These guidelines are being reviewed by CNSC staff.

The purpose of the Feeder Fitness for Service Guidelines (FFSG) is to provide the criteria and procedures required to evaluate the fitness-for-service of *feeders* experiencing wall thinning. When the degradations detected during in-service inspections do not satisfy the criteria of acceptance by examination, CAN/CSA-N285.4 permits a fitness-for-service assessment to determine acceptability.

To refine the methodologies used in the locally thinned *feeders*, the industry has been revising the FFSG. The licensees have been performing verification testing and developing technical bases document. It is expected that the first revision of the FFSG will be submitted to the CNSC for approval in 2009, together with the supporting test results and technical bases.

A Safety Bulletin from the CSA B51 Technical Committee on Boiler, Pressure Vessel and Pressure Piping Code, clarified the use of air receivers and propane cylinders in air service. CNSC staff has begun the task of ensuring that all small propane tanks in air service are phased out at nuclear facilities. Darlington is in the process of replacing their tanks to ensure compliance with their operating licence.

2.4 Equipment Fitness for Service

2.4.1 Maintenance

Licensee Maintenance Programs

Regulatory Document S-210 "Maintenance Programs for Nuclear Power Plants", published in July 2007, sets out expectations for maintenance programs, with a focus on managed processes. The document is being introduced as a licence condition as each nuclear power plant's licence comes due for renewal. To date, it has been incorporated into the Darlington and Pickering B licences.

Maintenance Performance Indicators

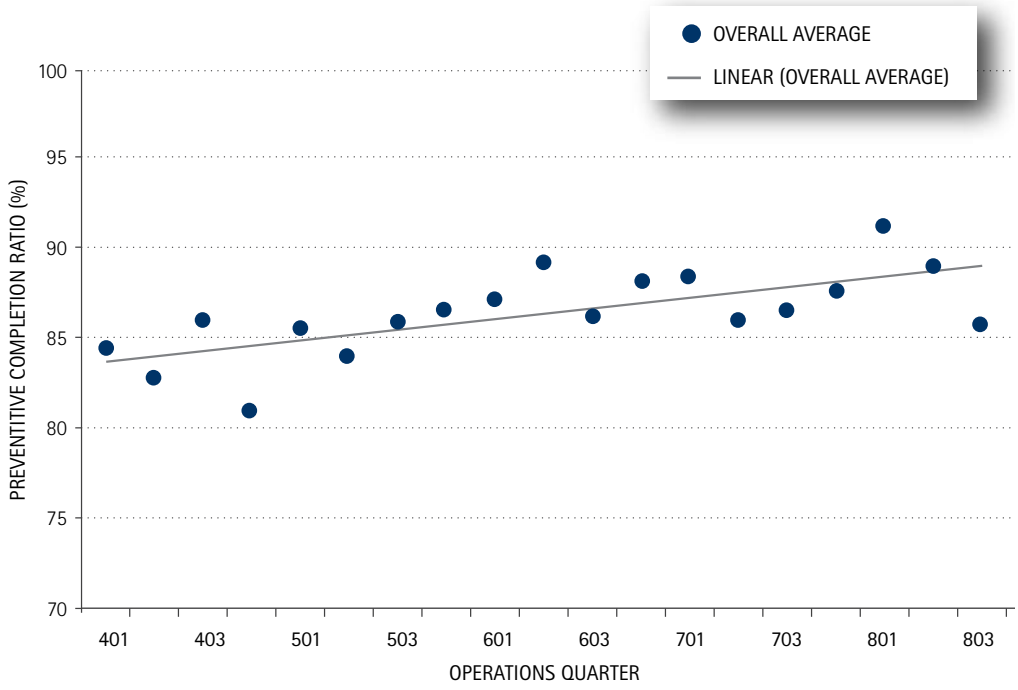
The Preventive Maintenance Completion Ratio (PMCR) is a performance indicator submitted by licensees to the CNSC on a quarterly basis. Defined in S-99, the PMCR consists of the ratio of Preventive Maintenance (PM) work orders completed on safety-related equipment, divided by the PM plus corrective maintenance (CM) work orders completed on safety-related equipment, as expressed in the following formula:

PMCR = PM/(PM+CM)

The ratio shows how much of the work is preventive in nature, as compared to the amount that is corrective. Corrective is defined as "work performed as a result of a failure of safety-related equipment".

The PMCR is a lagging indicator of PM program effectiveness. An optimal PM program will minimize—but not eliminate—corrective work, thus increasing the ratio. The historical data for PMCR is given in Figure 2 below. Since the first quarter of 2004 (set as 401 in this graph), the overall PMCR average data shows a general upward trend. Best industry practice sets a target of 90% or better for this indicator.

FIGURE 2: AVERAGE PMCR FOR ALL NPPS



Maintenance Backlog

Although it is not required to be reported under S-99 as an indicator, CNSC staff has been monitoring licensee maintenance backlogs, as an indicator of maintenance effectiveness. In particular, online corrective and elective maintenance backlogs are reviewed. The CM backlog consists of all corrective work generated through work order requests, and appears in the work management system as uncompleted work. It is a lagging indicator of PM effectiveness. The elective maintenance backlog is similar, except that it concerns equipment that is degrading but can still perform its design function. The combination of corrective and elective backlogs gives a good indication of the plant's material condition. There will always be a certain level of backlog, due to normal operation and equipment aging.

CNSC staff has noted that backlog levels at most sites have been higher than good industry practice. This issue has been discussed with the licensees. In general, licensees have taken steps to improve

the situation: more stations are adopting WANO/EPRI process guidance, benchmarking for good work practices, and developing and tracking more detailed performance indicators.

Due to the amount of work required to turn the situation around, the improvement process is slow. However, positive results are being seen in the reduction of CM backlogs and increase of PMCR.

2.4.2 Structural Integrity

Fuel Channels

In January 2008, CNSC staff met with industry representatives to clarify staff expectations with respect to *pressure tube* material surveillance. Presentations made at the meeting confirmed that a number of licensee-specific issues had contributed to a growing communication gap between industry and CNSC staff. However, a common concern was voiced by all licensees. In cases where the PROL required compliance with a specific edition of a CSA standard, licensees were uncertain about the appropriate mechanism to transition from one edition of the Standard to the next.

Based on this feedback, CNSC staff recommended that, in the future, the publication of a new version of a CSA Standard should automatically trigger a meeting of licensees, CNSC and CSA staff, with the purpose to begin development of transition plans. Since the January meeting, all licensees have confirmed their intention to adopt the newest (2005) edition of CSA N285.4 in their PROLS. In addition, each licensee has engaged CNSC staff in a managed process, to ensure they are capable of addressing the requirements of CSA N285.4-05 at the point they approach the *Commission* for PROL amendment.

To demonstrate that *pressure tubes* remain fit-for-service, licensees apply industry guidelines. CSA Standard N285.8-05 contains the latest set of fitness-for-service guidelines. A key requirement of this Standard is that licensees should periodically compare new surveillance results (from *pressure tubes* removed from service) with values used in fitness-for-service assessments of in-service tubes.

In 2008, Bruce Power removed a *pressure tube* for material surveillance. Detailed analysis of tube B6G18 revealed that all measurements met agreed-upon acceptance criteria, except one. In keeping with the process defined in CSA N285.8-05, Bruce Power convened a meeting of industry experts to review this new finding and assess its impact on existing and future *pressure tube* fitness-for-service assessments.

While CNSC staff has yet to complete their review, the preliminary conclusion is that the industry's approach to addressing the B6G18 finding (the first instance where the N285.8-05 process was invoked) has been an unqualified success.

Vacuum Building Positive Pressure Leakage Rate Test

In 2008, both OPG and Bruce Power submitted requests for approval to defer the positive design pressure test of the Vacuum Buildings (VBs) at Darlington and Bruce A, respectively. In their requests, the licensees cited that the previous results for the positive leakage rate tests of the VBs are within the allowable leakage rate limit, and that the on-power in-leakage rate tests also provide ongoing monitoring of the leak-tightness characteristic of the VBs. In addition, the Licensees asserted that the in-leakage rate tests results can be used to extrapolate the results for a positive design pressure leakage rate test.

CNSC staff has performed assessments of both requests for approval from OPG and Bruce Power. Staff concluded that, in both cases, there was not sufficient technical basis to justify the deferral of the vacuum building positive design pressure leakage rate tests as proposed by the licensees.

Staff recognized that, in OPG's request for approval and the additional information submitted, the licensee attempted to make reference to the performance-based option available in the newly revised CSA standard N287.7-08, to justify the deferral request. However, CNSC staff did not find in their submission sufficient technical basis and a common industry-wide approach to support the use of the performance-based option to increase the test interval of the VB positive design pressure leakage rate test.

Subsequently, CNSC staff issued a letter to OPG outlining the CNSC's expectation regarding the use of the performance-based option available in CSA N287.7-08, in determining the test interval for

the positive design pressure test for VBs. A similar letter will be sent to Bruce Power. CNSC staff will be meeting with the licensees, if requested, to provide feedback for a common industry-wide approach to utilize the performance-based option, in order to determine the positive design pressure leakage rate test interval for the VB of existing nuclear power plants, in accordance with the requirements of CSA N287.7-08.

2.4.3 Reliability

There were no generic observations in the area of Reliability for 2008. See Section 1 for issues affecting individual stations. Performance indicator trends for this program are presented in Section 3.

2.4.4 Equipment Qualification

Environmental qualification (EQ) is an important sub-program of Equipment Qualification. NPP licensees must ensure that all required equipment important to safety will withstand exposure to environmentally harsh conditions resulting from *design basis accidents* and perform their designated safety function.

The EQ programs at all sites, except Darlington and Gentilly-2, were implemented in 2004. Since then, CNSC staff has identified several weaknesses in EQ sustaining activities: ongoing processes (such as engineering change control), performance monitoring, maintenance, aging management and corrective action program. However, no significant issues have been identified.

While some weaknesses have been identified in the integration of EQ into licensees' performance monitoring programs, the overall condition monitoring of EQ equipment is continually improving, thanks to the experience gained and recent COG initiatives.

In May 2008, a CNSC/COG EQ meeting was held on issues of common interest, specifically condition monitoring, environmental monitoring and cable condition monitoring. CNSC staff was particularly interested in the licensees' current cable condition monitoring, as it is staff's position that they are weak in this area.

In June 2008, the COG EQ group issued a "Guideline for Environmental Qualification Condition Monitoring", to identify how Canadian NPP licensees meet the licence criterion for condition monitoring, which requires the licensee to have a monitoring program to assist in measuring degradation and failures of qualified equipment.

Although there are some challenges with regard to EQ sustaining activities, the CNSC believes that continued preservation of the stations' EQ program provides reasonable assurance that SSCs—within the scope of the EQ program—will continue to perform their intended functions under the environmental conditions defined by the *design basis accidents*.

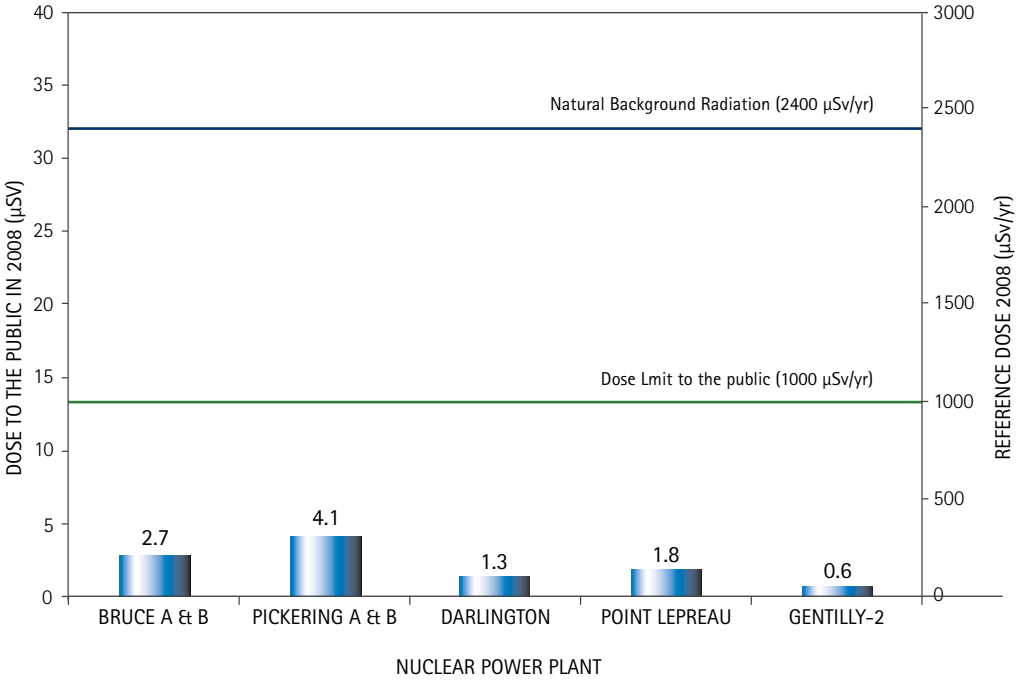
2.4 Emergency Preparedness

There were no generic observations for Emergency Preparedness in 2008. See Section 1 for issues affecting individual stations.

2.5 Environmental Protection

The dose to the public from each Canadian NPP in 2008 is provided in Figure 3. The figure shows that the doses to the public are well below the regulatory limit of 1000 µSv/year.

FIGURE 3: DOSE TO THE PUBLIC FROM CANADIAN NUCLEAR POWER PLANTS IN 2008



To ensure that the public dose limit and release limits are not exceeded, the PROL restricts the amounts of radioactive material that may be released from the NPP. These effluent limits are derived from the public dose limit (1000 µSv/year) and are referred to as *Derived Release Limits* (DRLs).

The licensees establish "action levels" (ALs) which are set at 10% of the DRLs. These levels, if reached, may indicate a loss of control of part of a licensee's environmental protection program, and triggers a requirement for specific action to be taken and reported to CNSC.

Airborne emissions and liquid releases are shown in Figures 4 and 5, respectively. Both airborne emission and liquid releases were lower than the DRLs in 2008, and always well below the Action Levels.

FIGURE 4: RADIONUCLIDES EMITTED TO AIR BY CANADIAN NPPS IN 2008

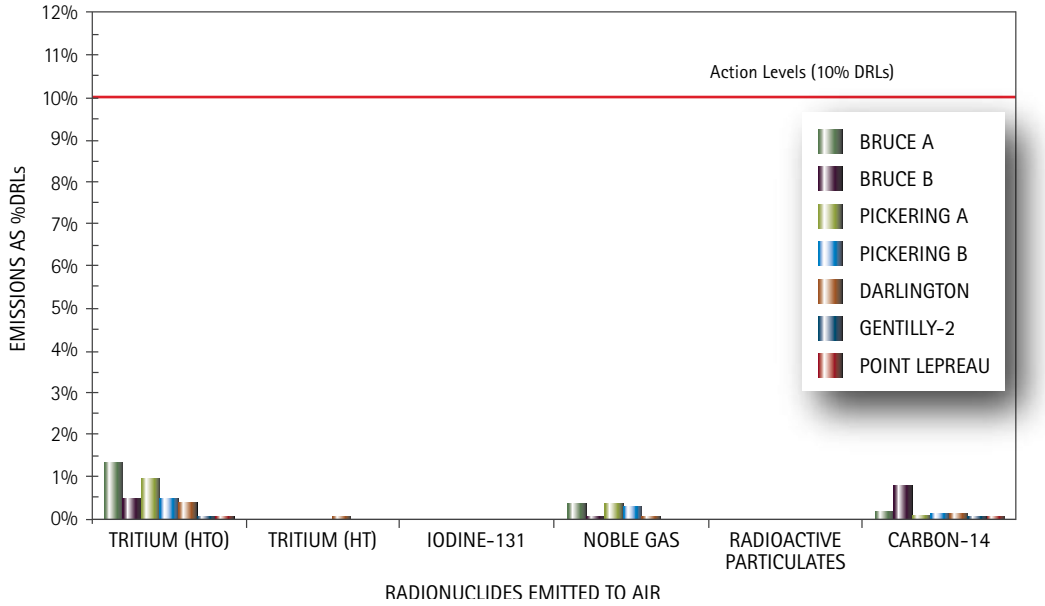
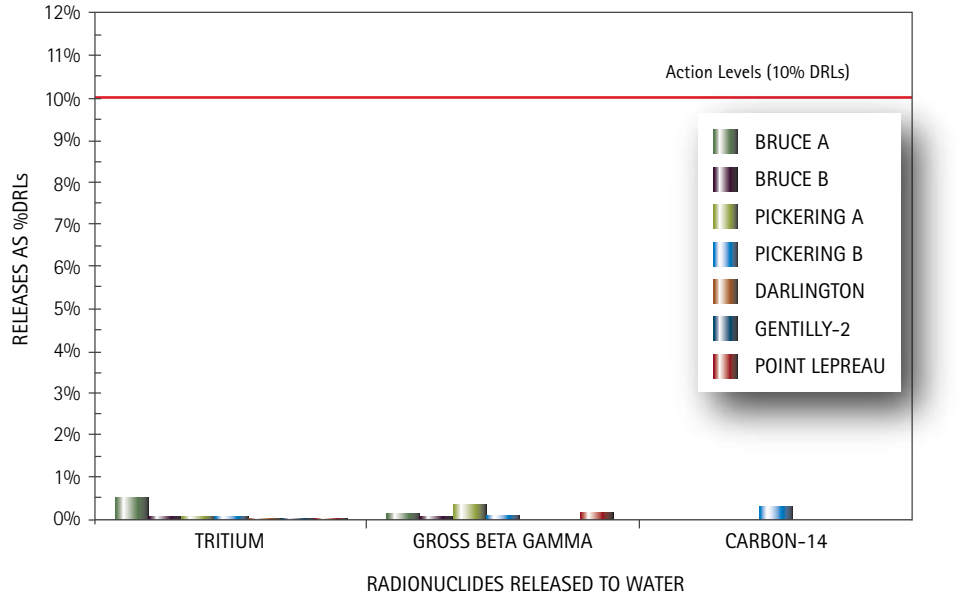


FIGURE 5: RADIONUCLIDES RELEASED TO WATER BY CANADIAN NPPS IN 2008



2.7 Radiation Protection

There were no generic observations for Radiation Protection in 2008. See Section 1 for issues affecting individual stations. Performance indicator trends and collective dose data are presented in Section 3 and Appendix G, respectively.

2.8 Safeguards

As a component of the CNSC's mandate to implement Canada's international commitments on the peaceful use of nuclear energy, the Safeguards program is evaluated on an annual basis by the IAEA. CNSC staff evaluates every licensee's compliance with its safeguards licence conditions and the associated procedures established, to ensure that the obligations arising from the Canada-IAEA Safeguards Agreement and Additional Protocol, as they pertain to each facility, can be met. The licensee's compliance with safeguards as a Safety Area—to ensure plant and public safety—is only a small component of safeguards compliance with Canada's international commitments.

Safeguards is a system of inspection and other verification activities undertaken by the IAEA in order to evaluate, on an annual basis, a State's compliance with its obligations pursuant to its safeguards agreement with the IAEA. Canada has entered into a safeguards agreement with the IAEA pursuant to its obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

The objective of the Canada-IAEA Safeguards Agreement is for the IAEA to provide assurance on an annual basis, to Canada and to the international community, that all declared nuclear material is in peaceful, non-explosive uses and that there is no indication of undeclared nuclear material or activities. This conclusion confirms that Canada is in compliance with its obligations under the Canada-IAEA Safeguards Agreement.

In Canada, the licensees must put in place a program and appropriate procedures to ensure that safeguards can be implemented effectively and in a manner consistent with the Canada-IAEA safeguards agreement, as it applies to the licensed facilities. These conditions are described in the facility's licence conditions and the *Nuclear Safety and Control Act*.

Canada's compliance with its international obligations arising from the Canada-IAEA Safeguards Agreement is evaluated by the IAEA on an annual basis, taking into consideration inspection results and evaluations. The findings and conclusions for Canada are presented to the IAEA Board of Governors each June, in the "Safeguards Implementation Report" (SIR). The SIR for 2008 states that Canada has maintained the most comprehensive positive conclusion provided by the IAEA.

In 2008, CNSC safeguards staff continued to participate in a series of trilateral meetings with the IAEA and licensees, in order to assist in the development of new IAEA safeguards implementation procedures. In developing these procedures, the stations participated in field trials for IAEA Short-Notice Random Inspections (SNRIs), which replace regularly scheduled announced inspections. The field trials were successfully completed and, as of the end of 2008, SNRIs were formally being implemented at all stations.

Under the new safeguards approach, the IAEA will carry out fewer inspections at the power reactors. However, these inspections will be carried out with less notice, and will be supported by the provision of additional advance information and declarations from the facilities. The new approach grants the facility operators greater flexibility to perform activities without coordination with the IAEA, the ability to select their own dates for physical inventory taking, and reduced resource allocation during activities that no longer require inspector presence.

In October 2008, CNSC Safeguards staff met with licensees to provide an update on the State-Level Integrated Safeguards Approach for Canada. This forum provided a unique opportunity for discussing recent achievements and the future direction for safeguards in Canada. CNSC staff made presentations on recent safeguards developments, on nuclear material reporting requirements and on the future direction of safeguards in Canada. Senior representatives from the IAEA Department of Safeguards also participated in this meeting.

SECTION 3

PERFORMANCE INDICATOR TRENDS

Performance indicators (PIs), used by the CNSC to monitor the licensee's safety performance, are defined in Regulatory Standard S-99 "Reporting Requirements for Operating Nuclear Power Plants". PIs can be used to study an individual station's performance or the NPP 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.

3.1 Number of Unplanned Transients

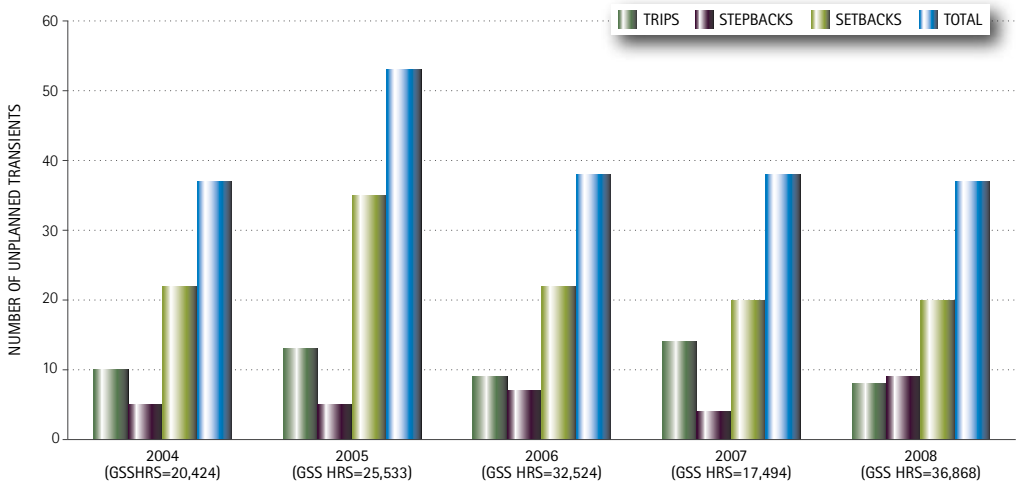
The "Number of Unplanned Transients" PI denotes the unplanned reactor power transients due to all sources, while the reactor was not in a *guaranteed shutdown state* (GSS). This PI, illustrated in Table 9 and Figures 6 and 7, shows the number of manual and automatic power reductions from actuation of 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 2008 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 9: NUMBER OF UNPLANNED TRANSIENTS FOR 2008

Station	GSS	Unplanned Transients at Sites in 2008			
	Hours	Trips	Stepbacks	Setbacks	Total
Bruce A	2,234	2	2	3	7
Bruce B	3,097	0	3	9	12
Darlington	1,546	2	1	1	4
Pickering A	19,347	2	n/a	2	4
Pickering B	8,100	1	0	2	3
Gentilly-2	1,500	1	3	2	6
Point Lepreau	1,045	0	0	1	1
Industry Total	36,868	8	9	20	37

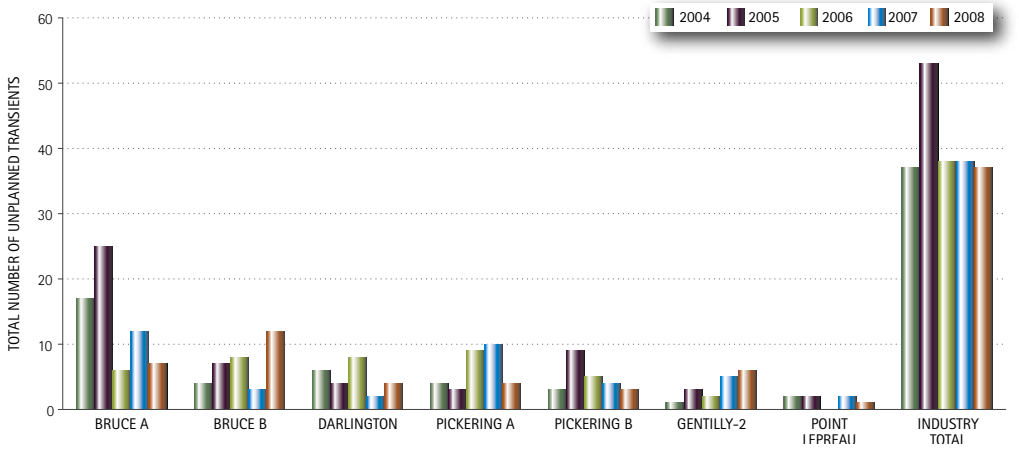
Figures 6 and 7 show the trends of this PI for the NPP industry since 2004. Industry-wide, the total number of transients in 2008 remains consistent with previous years. In 2008, there was an industry average of 7,100 hours of non-GSS time between reactor trips or *stepbacks*. The international performance target is one reactor trip per 7,000 hours of operation, which puts Canadian NPP slightly above international norms.

FIGURE 6: TREND DETAILS OF NUMBER OF UNPLANNED TRANSIENTS FOR INDUSTRY



Trips	10	13	9	14	8
Stepbacks	5	5	7	4	9
Setbacks	22	35	22	20	20
Total	37	53	38	38	37

FIGURE 7: TRENDS OF NUMBER OF UNPLANNED TRANSIENTS FOR STATIONS



2004	17	4	6	4	3	1	2	37
2005	25	7	4	3	9	3	2	53
2006	6	8	8	9	5	2	2	38
2007	12	3	2	10	4	5	2	38
2008	7	12	4	4	3	6	1	37

3.2 Unplanned Capability Loss Factor

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

Pickering B and Gentilly-2 experienced increases in the unplanned capability loss factors, compared to previous years.

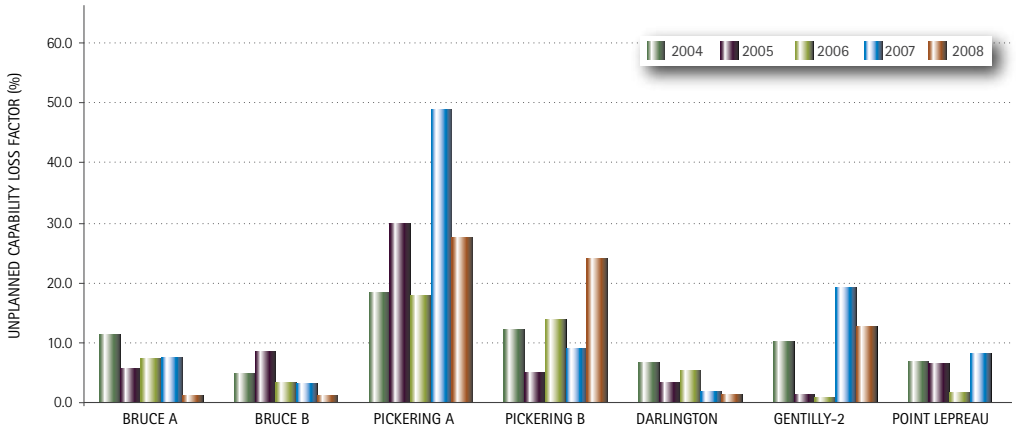
At Pickering B, this increase is primarily due to the gadolinium event in Unit 7 (see Appendix E for details). The reactor was in *guaranteed shutdown state* for 238 days, while OPG investigated the event and conducted recovery activities.

At Gentilly-2, an unplanned outage in late 2007—caused by a fuelling machine being stuck on a fuel channel—was extended until the end of January 2008, after a damaged heat exchanger was discovered. The outage lasted 91 days in total.

TABLE 10: UNPLANNED CAPABILITY LOSS FACTOR FOR 2008

Station	Unplanned Capability Loss Factor (%)				
	Quarter				For Year
	Q1	Q2	Q3	Q4	
Bruce A	1.4	1.0	0.3	2.2	1.2
Bruce B	2.9	1.2	0.5	0.5	1.2
Pickering A	22.0	36.7	15.0	37.3	27.7
Pickering B	1.8	36.1	36.3	22.4	24.1
Darlington	0.0	1.2	3.2	0.8	1.3
Gentilly-2	39.0	1.7	8.3	1.7	12.7
Point Lepreau	0.0	0.0	0.0	0.0	0.0

FIGURE 8: TREND DETAILS OF UNPLANNED CAPABILITY LOSS FACTOR FOR INDUSTRY



2004	11.4	4.9	18.5	12.2	6.7	10.2	6.9
2005	5.7	8.5	30.1	5.1	3.4	1.3	6.6
2006	7.4	3.4	17.9	14.0	5.4	0.9	1.6
2007	7.5	3.2	49.2	9.1	1.9	19.3	8.3
2008	1.2	1.2	27.7	24.1	1.3	12.7	0.0

3.3 Non-Compliance Index

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 its associated 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.

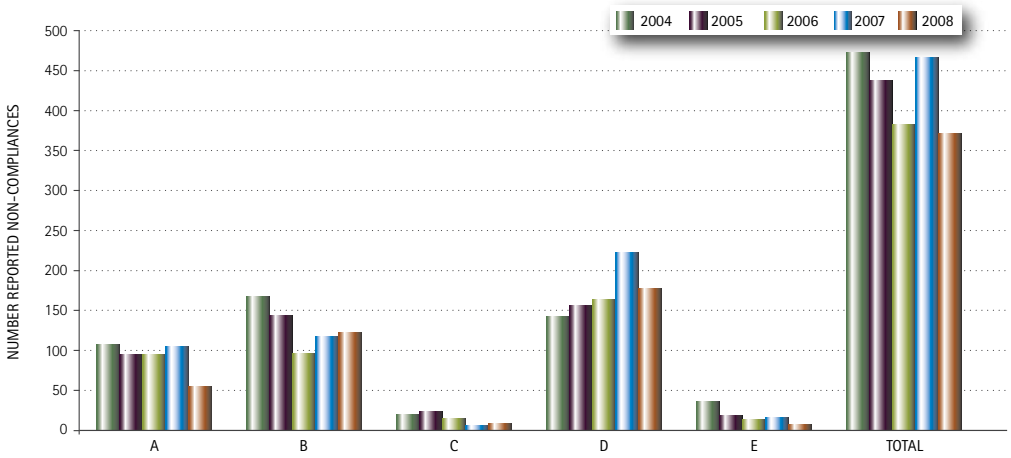
Table 11 and Figures 9 and 10 illustrate the Non-Compliance Index for the industry. The majority of reported non-compliances in 2008 were related to category "d".

The CSNC promotes self-reporting by licensees. 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 11: NON-COMPLIANCE INDEX FOR 2008

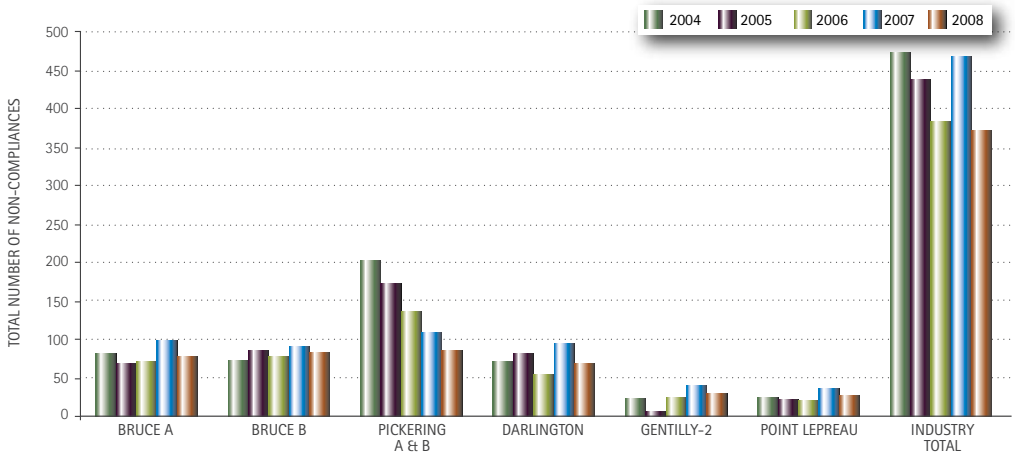
Station	Non-Compliances by Type					
	a	b	c	d	d	Total
Bruce A	2	30	0	45	0	77
Bruce B	0	30	5	46	2	83
Pickering A	9	20	1	15	0	45
Pickering B	10	13	2	15	1	41
Darlington	17	27	0	24	1	69
Gentilly-2	9	2	0	17	1	29
Point Lepreau	8	0	1	16	2	27

FIGURE 9: TREND DETAILS OF NON-COMPLIANCE INDEX FOR INDUSTRY



2004	108	167	20	142	36	473
2005	95	144	24	156	19	438
2006	95	96	15	164	13	383
2007	105	117	6	223	16	467
2008	55	122	9	178	7	371

FIGURE 10: TREND OF NON-COMPLIANCE INDEX FOR STATIONS



2004	81	72	202	71	23	24	473
2005	69	86	173	82	6	22	438
2006	71	77	136	54	24	21	383
2007	98	90	109	94	40	36	467
2008	77	83	86	69	29	27	371

3.4 Accident Severity Rate

The "Accident Severity Rate" PI measures the total number of days lost to injury for every 200,000 person-hours worked at the site. The indicator is used to monitor licensee performance in meeting nuclear industry standards in the area of worker safety. 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 Point Lepreau, the licensee accident severity rates for 2008 were low, compared to previous years. As reported in Section 1.6.1.3, there were two lost time injuries reported at Point Lepreau. Both injuries were the result of trips and falls, and required significant recovery time.

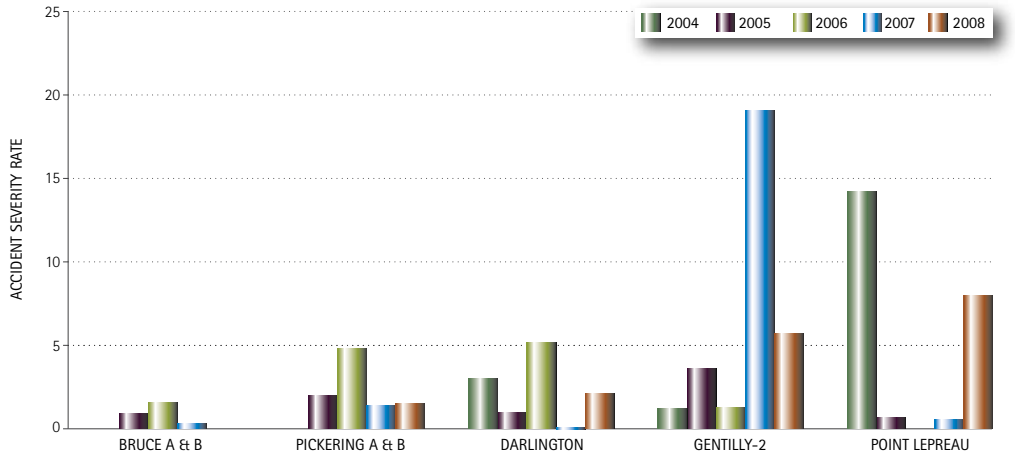
TABLE 12: ACCIDENT SEVERITY RATE FOR 2008

Site	Days Lost	Person Hours	Accident Severity Rate
Bruce A and B	0	7,246,402	0.00
Pickering A and B	58	7,808,986	1.49
Darlington	54	5,162,981	2.09
Gentilly-2	39	1,372,035	5.68
Point Lepreau	153	3,818,213	8.01
Industry Average	304	25,408,617	2.39

TABLE 13: TREND DETAILS OF ACCIDENT SEVERITY RATE FOR INDUSTRY

Year	Days Lost	Person Hours	Accident Severity Rate
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
2008	304	25,408,617	2.39

FIGURE 11: TRENDS OF ACCIDENT SEVERITY RATE FOR STATIONS



2004	0	0	3	1.2	14.2
2005	0.9	2	1	3.6	0.7
2006	1.6	4.8	5.2	1.3	0
2007	0.3	1.4	0.1	19.1	0.6
2008	0	1.5	2.1	5.7	8.0

3.5 Number of Pressure Boundary Degradations

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 Table 14 and Figures 12 and 13.

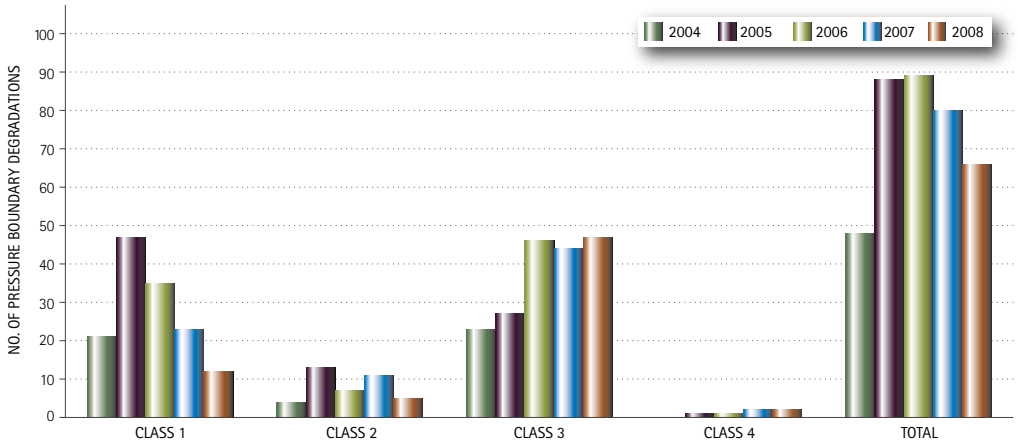
In 2008, the reported number of pressure boundary degradations in the stations' nuclear systems was consistent with, or less than, previous years.

TABLE 14: PRESSURE BOUNDARY DEGRADATIONS FOR 2008

Station	Number of Pressure Boundary Degradations by Type				
	Class 1	Class 2	Class 3	Class 4	Total
Bruce A	5	0	7	0	12
Bruce B	1	2	18	0	21
Darlington	0	1	13	0	14
Pickering A*	1	1	4	2	8
Pickering B	1	0	5	0	6
Gentilly-2	0	0	0	0	0
Point Lepreau	4	1	0	0	5

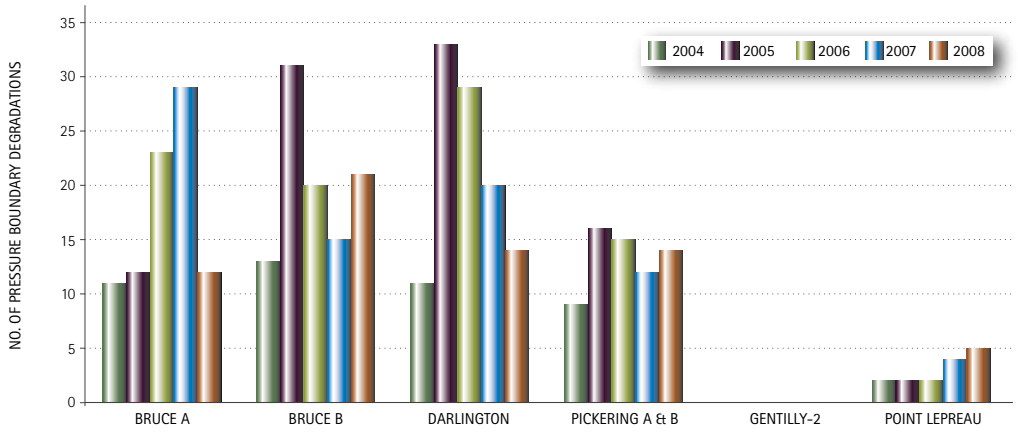
** Due to legacy issues with the system pressure boundary registration at Pickering A, certain features are not required to be reported*

FIGURE 12: TREND DETAILS OF PRESSURE BOUNDARY DEGRADATIONS FOR INDUSTRY



2004	21	4	23	0	48
2005	47	13	27	1	88
2006	35	7	46	1	89
2007	23	11	44	2	80
2008	12	5	47	2	66

FIGURE 13: TRENDS OF PRESSURE BOUNDARY DEGRADATIONS FOR STATIONS



2004	11	13	11	9	0	2
2005	12	31	33	16	0	2
2006	23	20	29	15	0	2
2007	29	15	20	12	0	4
2008	12	21	14	14	0	5

3.6 Missed Mandatory Safety System Tests

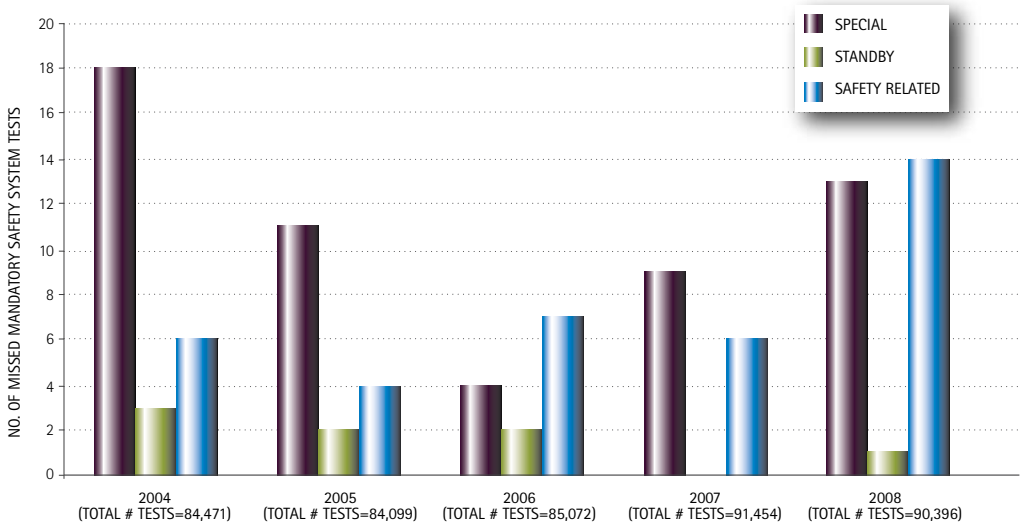
The purpose of the "Number of Missed Mandatory Safety System Tests" PI is to indicate the successful completion of the tests required by licence conditions, including those referenced in documents submitted in support of a licence application. This PI represents the ability of licensees to successfully complete routine tests on systems related to safety. Data for this PI is shown in Table 15 and Figures 14 and 15.

Approximately 90,000 routine tests were performed throughout the industry in 2008. The total number of missed safety system tests was slightly higher in 2008 than during previous years. However, the number of missed tests for the *special safety systems* remains very small compared to the tens of thousands of tests performed annually, and generally indicates an industry commitment to test its safety systems on a regular basis.

TABLE 15: MISSED MANDATORY SAFETY SYSTEM TESTS FOR 2008

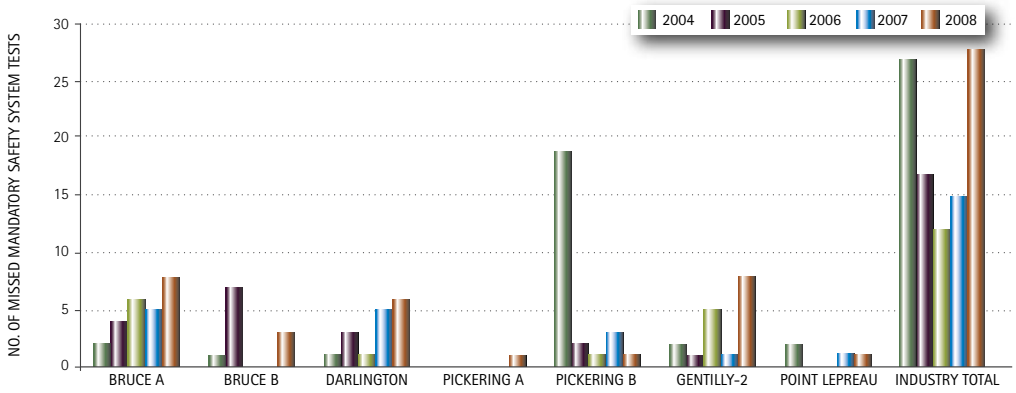
Station	Total # Tests	Missed mandatory Safety System Tests			
		Special	Standby	Safety Related	Total
Bruce A	20,154	7	0	1	8
Bruce B	30,384	2	0	1	3
Darlington	10,800	1	0	5	6
Pickering A	12,158	1	0	0	1
Pickering B	10,986	1	0	0	1
Gentilly-2	4,537	0	1	7	8
Point Lepreau	1,377	1	0	0	1
Industry Total	90,396	13	1	14	28

FIGURE 14: TREND DETAILS OF MISSED MANDATORY SAFETY SYSTEM TESTS FOR INDUSTRY



Special	18	11	4	9	13
Standby	3	2	2	0	1
Safety Related	6	4	7	6	14

FIGURE 15: TREND OF MISSED MANDATORY SAFETY SYSTEM TESTS FOR STATIONS



2004	2	1	1	0	19	2	2	27
2005	4	7	3	0	2	1	0	17
2006	6	0	1	0	1	5	0	12
2007	5	0	5	0	3	1	1	15
2008	8	3	6	0	1	8	1	28

3.7 Radiation Occurrence Index

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:

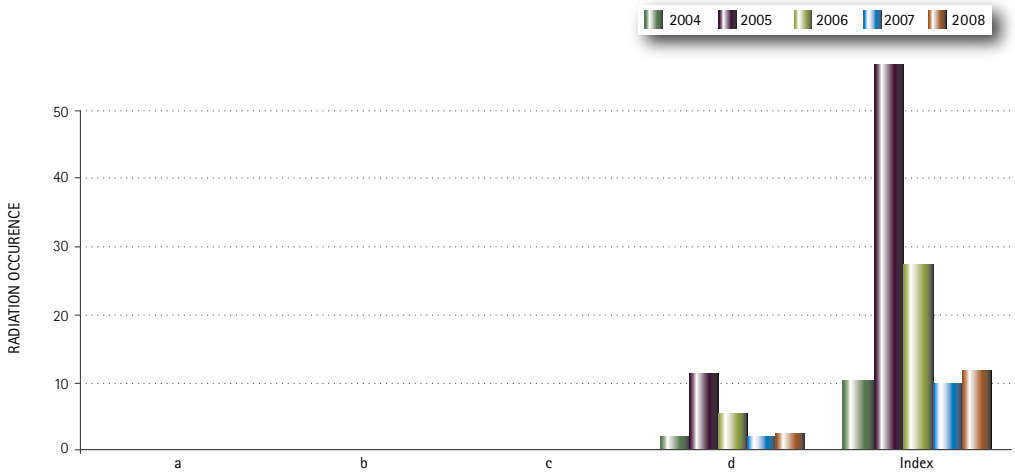
a	=	number of occurrences, after decontamination attempts, of fixed body contamination > 50 kBq/m^2
b	=	number of occurrences of unplanned acute whole body doses from external exposure > 5 mSv
c	=	number of occurrences of intake of radioactive material with effective dose > 2 mSv (normalized to 2 mSv)
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. Table 16 and Figures 16 and 17 show the industry's Radiation Occurrence Index. In 2008, there were no doses in excess of specified limits (see the value of "d" in Table 16). Bruce A, Darlington, Pickering A, Gentilly-2 and Point Lepreau had no occurrences of any type. Bruce B and Pickering B each had a type "c" occurrence. Overall, the industry average for the index remained low, when compared with previous years.

TABLE 16: RADIATION OCCURRENCE INDEX FOR 2008

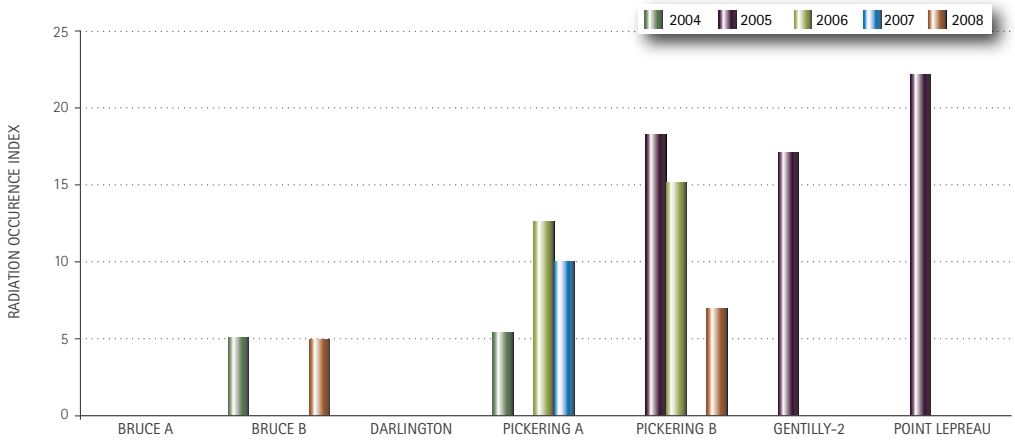
Station	Radiation Occurrence				
	a	b	c	d	Index
Bruce A	0	0	0	0	0
Bruce B	0	0	1	0	5.0
Darlington	0	0	0	0	0
Pickering A	0	0	0	0	0
Pickering B	0	0	1	0	7.0
Gentilly-2	0	0	0	0	0
Point Lepreau	0	0	0	0	0

FIGURE 16: TREND DETAILS OF RADIATION OCCURENCE INDEX FOR INDUSTRY



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
2008	0	0	2	0	12.0

FIGURE 17: TRENDS OF RADIATION OCCURENCE INDEX FOR STATIONS



2004	0	5	0	5.4	0	0	0
2005	0	0	0	0	18	17.1	21.8
2006	0	0	0	12.6	15	0	0
2007	0	0	0	10	0	0	0
2008	0	5	0	0	7	0	0

SECTION 4

SUMMARY AND CONCLUSIONS

CNSC staff concludes that nuclear power plants (NPPs) operated safely in Canada during 2008. There were no *serious process failures* at any station; no workers at any station or member of the public received a radiation dose in excess of the regulatory limits; all environmental emissions from the stations were below regulatory limits; and licensees complied with their licence conditions concerning Canada's international obligations.

In 2008, staff conducted a total of 16 *Type I* and 312 *Type II inspections* across all sites, in addition to surveillance and monitoring activities, reviews and assessments. Using a risk-informed approach, the relative safety importance of the findings from these activities was assessed and integrated into ratings for the safety areas and programs, as well as plant ratings. In 2008, no station received a safety area or program rating lower than "Below Expectations", and no station received an integrated plant rating below "Satisfactory".

As a result, CNSC staff concludes that licensees, through the implementation of their programs, made adequate provisions to protect the health and safety of Canadians and the environment, as well as to ensure that Canada continued to meet its international obligations on the peaceful use of nuclear energy.

APPENDIX A

DEFINITIONS OF SAFETY AREAS AND PROGRAMS

1. OPERATING PERFORMANCE

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

1.1 Organization and Plant Management

Organization and Plant Management relates to the overall review of plant management. It 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 provide adequate attention to health, safety, security, environmental protection and international obligations.

1.2 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 that 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.

1.3 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, in order 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.

2. 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; their performance affects 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.

2.1 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, implemented and documented in manuals, policies, standards and procedures.

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

2.2 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.

2.3 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 known as *systematic approach to training*, not the performance of licensee candidates in certification exams. However, the ongoing satisfactory certification of workers is a requirement for all stations.

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

3. 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.

3.1 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, so as 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.

3.2 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 complex in nature and common to more than one station 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 and 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.

3.3 Design

Design relates to the licensee's activities to confirm that the design of systems and equipment continually meets 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 that licensees maintain an accurate documented description of systems and equipment, and that any technical changes proposed or implemented by the licensees will 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.

4. 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.

4.1 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.

4.2 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.

4.3 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.

4.4 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), which ensures that the 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.
- 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.

5. 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 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.

6. 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 each licensee to 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.

7. RADIATION PROTECTION

Radiation Protection relates to the program established 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. The regulations also 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 person inside the facility with respect to ionizing radiation.

8. SITE SECURITY

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

To obtain assurance of compliance with these requirements, CNSC staff assesses its licensees' site security program, including:

- facilities and equipment including the associated security monitoring, assessment, detection, and communication systems/devices.
- access control including the effective screening of persons and vehicles entering the protected area.
- site security drills and exercises that test the effectiveness of security response plans/procedures, the physical protection system, training programs and the readiness of nuclear security personnel.
- nuclear response force including training and deployment.

Licensees are required to have a sufficient number of trained and properly-equipped nuclear security staff available on-site at all times. Their sites must be continuously monitored and licensees must take appropriate action in the event of a security breach. In addition, as specified by the regulations, CNSC staff expects all licensees to conduct joint security exercises with their respective off site response forces, on a regular basis.

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

9. 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

B.1 RATING DEFINITIONS

The performance ratings used in this report are defined as follows:

FS	Fully Satisfactory
Safety Area/ Program	Performance is fully satisfactory. Assessment topics meet and could exceed applicable CNSC requirements and performance expectations. Performance is stable or improving. Striving for excellence should, nevertheless, continue to be the goal. Any problems or issues that arise are promptly addressed, such that they do not pose an unreasonable risk to health, safety, security, or the environment, or conformance with international obligations to which Canada has agreed.
Plant	Plant performance does not represent an unreasonable risk to health, safety, security, or the environment, or conformance with international obligations to which Canada has agreed.
SA	**Satisfactory**
Safety Area/ Program	Performance is satisfactory. Assessment topics meet the intent or objectives of CNSC requirements and performance expectations. There is only minor deviation from requirements or the expectations for the execution of the programs, but these deviations do not represent an unreasonable risk to health, safety, security, or the environment, or conformance with international obligations to which Canada has agreed. There is some slippage with respect to CNSC requirements and expectations. However those issues are considered to pose a low risk to the achievement of regulatory performance requirements and expectations of the CNSC. Practical and/or cost-effective improvements would normally be undertaken.
Plant	There are minor deviations from CNSC requirements or performance expectations, but these deviations do not represent an unreasonable risk to health, safety, security, or the environment, or conformance with international obligations to which Canada has agreed.
BE	**Below Expectations**
Safety Area/ Program	Performance deteriorates and falls below expectations, or assessment topics deviate from the intent or objectives of CNSC requirements, to the extent that there is a moderate risk that the performance will ultimately fail to achieve expectations for health, safety, security, or the environment, or conformance with international obligations to which Canada has agreed. Improvements in performance are required to address identified weaknesses. The licensee or applicant has taken, or is taking, appropriate corrective action.
Plant	There is deviation from the CNSC requirements or performance expectations, to the extent that there is a moderate risk that plant performance will ultimately fail to prevent unreasonable risk to health, safety, security, or the environment, or conformance with international obligations to which Canada has agreed.
UA	**Unacceptable**
Safety Area/ Program	Performance is unacceptable. Assessment topics are significantly below requirements, or there is evidence of continued poor performance, to the extent that overall performance is undermined. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk to health, safety, security, or the environment, 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. Immediate corrective actions are required.
Plant	There is significant deviation from CNSC requirements and performance expectations, to the extent that there is a high probability that deficiencies in plant performance will lead to an unreasonable risk to health, safety, security, or the environment, or conformance with international obligations to which Canada has agreed.

Previously, the NPP Report used a letter grading system which corresponds to the new rating system as follows:

Previous rating	New rating
A Exceeds Requirements	FS Fully Satisfactory
B Meets Requirements	SA Satisfactory
C Below Requirements	BE Below Expectations
D Significantly Below Requirements	UA Unacceptable
E Unacceptable	

B.2 DETERMINING THE INTEGRATED PLANT RATING

The CNSC risk-informed decision-making process was used to rank the relative safety significance of each of the eight safety areas (security excluded). In other words, the risk perspective was factored in to determine the relative "weight" of each safety area to plant safety, and in establishing the integrated plant rating.

It is important to note that, as a result of risk ranking, the contribution of a given safety area to the integrated plant rating is distinct from the contribution of another safety area. Therefore, as an example, a plant could end up with an integrated rating of "Satisfactory," despite the fact that its ratings in several safety areas or programs are "Fully Satisfactory or "Below Expectations". The reason, in this case, would be due to the lower safety significance of those safety areas or programs.

APPENDIX C

GLOSSARY OF TERMS

These terms are italicized when used in the text:

accident frequency (AF)
The number of disabling injuries per 200,000 person-hours worked at a NPP.

accident Severity Rate (ASR)
The total number of days lost or charged for all disabling injuries per 200,000 person-hours worked at a NPP.

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
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 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 providing assurance that the 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.

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.

Safety Reports
The *Safety Reports*, described in Regulatory Standard S-99 *Reporting Requirements for Operating Nuclear Power Plants*, provide 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 syste*matic 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
ALARA	as low as reasonably achievable
ANO	authorized nuclear operator
ASR	accident severity rate
BBRA	Bruce B Risk Assessment
BDBA	beyond design basis accident
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CSA	Canadian Standards Association
EA	environmental assessment
ECC	engineering change control
ECI	emergency coolant injection
EFPH	equivalent full power hours
EPRI	Electric Power Research Institute
EQ	environmental qualification
GAI	generic action item
GSS	guaranteed shutdown state
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
LOCA	loss of coolant accident
LVRF	low void reactivity fuel
NBPN	New Brunswick Power Nuclear
NGS	nuclear generating station
NOP	neutron overpower protection
NPP	nuclear power plant
NSCA	*Nuclear Safety and Control Act*
OPG	Ontario Power Generation
PI	performance indicator
PIP	periodic inspection program
PROL	power reactor operating licence
QA	quality assurance
PSA	probabilistic safety assessment
ROP	regional overpower protection
SAT	systematic approach to training
SDR	Significant Development Report
SDS	shutdown system
SSC	structures, systems and components
STEM	scanning tool for elongation measurement
WANO	World Association of Nuclear Operators

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, the information is from the Minutes of the Commission meetings.

E.1 Significant Development Reports for Bruce A

E.1.1 Undetected Radiation Hazard (CMD 08-M46.A)

As part of refurbishment activities at Bruce A, Unit 2 was undergoing reactor channel replacement by the contractor, AECL. During a radiation survey performed by Bruce Power staff on June 22, 2008, an elevated radiation field was discovered in a localized area of the reactor vault. The elevated field was determined to be due to a *calandria tube* insert (CTI) which had fallen into the reactor vault area during reactor channel replacement work. CTIs emit significant radiation fields, due to their normal position in the reactor core. The CTI was removed shortly after discovery.

Further investigation determined that the CTI had been in the reactor vault area undetected since April 23, 2008. The CTI was discovered to be missing on April 23, 2008, but was assumed to be still inside the reactor. Contrary to procedures, AECL did not report this to Bruce Power. On May 3, 2008, AECL management acknowledged a discrepancy in expected CTI removal versus recorded/documented CTI removal, which was also not reported to Bruce Power.

Since the CTI in the reactor vault area was undetected, it was not posted as a radiation hazard, nor was it considered in radiation work protection activities. As refurbishment work was not being performed in close proximity to the area where the CTI was discovered, individuals performing that work were not exposed to high radiation fields. The most exposed worker was the individual performing the radiation survey when the CTI was discovered. This worker was exposed to elevated radiation fields for a short duration and received a total dose of 24 mrem.

Refurbishment work was stopped upon discovery of the CTI, and a preliminary investigation was performed to determine direct causes and to implement immediate corrective actions. A *root cause analysis* of event was also completed.

CNSC staff was informed of the event on June 23, 2008, and is satisfied that the response was appropriate and the cause understood.

E.1.2 Unit 3 Shutdown System 1 (SDS1) Reactor Trip (CMD 08-M81)

On November 19, 2008, two shift control technicians were requested to assist with the normalizing of the primary heat transport low flow transmitters for Channels D, E and F. The two control technicians proceeded to the control room to get authorization and to determine which channel to work on first. Initially, it was decided that Channel E should be normalize first. However, after further discussion, it was decided that Channel D should be normalized first.

The control technicians fail-safed Channel D in the Control Equipment Room, and proceeded to transmitter room R3-210. The heat transport low flow trip parameter uses "2 of 3 logic" to activate. Therefore, when the control technicians proceeded to normalize Channel E by mistake, they completed the 2 of 3 channel logic and caused an SDS1 trip on the heat transport low flow trip parameter.

The immediate cause of the event was determined to be human error. A *root cause analysis* is in progress.

E.1.2.1 Follow-up (CMD 09-M5)

CNSC staff reviewed the Preliminary and Detailed S-99 reports submitted by Bruce Power. However, there was insufficient information for CNSC staff to reach a conclusion on the corrective actions taken by Bruce Power, since the root-cause analysis normally required in the detailed report was not provided. Bruce Power committed to complete a Root Cause Investigation and report it to the CNSC in an S-99 Additional Information Report, as allowed by S-99.

CNSC site inspectors conducted a reactive Type II compliance inspection on November 26, 2008, to determine the physical state of the components and the adequacy of their identification. They also reviewed a report on a previous transient to confirm if operating experience and corrective actions from that event had been implemented. The inspection resulted in a recommendation and an action notice to Bruce Power.

E.2 Significant Development Reports for Bruce B

E.2.1 Bruce B NGS, Unit 6 - Level 1 Impairment (CMD 08-M21.A)

At approximately 02:00 hours on March 5, 2008, maintenance staff were performing motor starter overload setting checks on the emergency coolant injection (ECI) motorized valves. The work was evaluated as non-intrusive, and no post-maintenance testing was specified after the checks. However, the maintenance activities caused the loss of the automatic function of the two ECI valves, and the control room operators did not immediately notice the impairment. The impairment was found during the next routine scheduled check at 11:00 hours. Upon discovery, licensee staff immediately began corrective actions. These were completed and tested, and the system was confirmed to be available by 14:30 hours on March 5, 2008 (3.5 hours from time of discovery).

E.2.1.1 Additional Information (from Minutes of August 21, 2008 Commission Meeting)

CNSC staff reported that it had reviewed Bruce Power's report and was satisfied with the identified corrective actions. However, some points in the report still required clarification, and a follow-up meeting was to be arranged with Bruce Power in September 2008.

Bruce Power reported that the root cause for this event was identified, and three areas were identified for improvement: engineering, maintenance and operations. Corrective actions have been implemented as a result.

E.3 Significant Development Reports for Darlington

E.3.1 Darlington NGS Unit 4 Transient – Even Shutoff Rods Dropped in Core (CMD 08-M46)

On July 22, 2008, routine maintenance work was being performed on the primary power supply (PS2) for the "even" bank of shutoff rod clutches. Power to the clutches (which keep the rods suspended and poised) was transferred to the backup power supply (PS4), which was confirmed to be operational. However PS4 failed shortly thereafter, causing the "even" bank of SDS1 shutoff rods to drop into core.

In response to alarms received at the panel, the Main Control Room Operator quickly and appropriately tripped SDS1 as per the Operating Manual, causing the remainder of the shutoff rods (odd bank) to drop into core, shutting down the reactor. Unit 4 tripped from 100% full power and disconnected from the grid.

The likely cause of the event was identified as the fuse holder cap for the backup power supply (PS4). A clip inside the fuse holder cap was found to be degraded, and no longer provided good contact between the fuse and the fuse holder cap.

CNSC staff was informed of the event on July 22, 2008, and is satisfied that response was appropriate and cause is understood.

E.4 Significant Development Reports for Pickering A

E.4.1 Level 1 Emergency Coolant Injection (ECI) System Impairment due to Failed Shutdown Cooling (SDC) Valve (CMD 08-M8.A)

Each Pickering A Unit has eight shutdown cooling isolation valves, which open to allow ECI water to be injected into each of the eight Heat Transport System (HTS) headers in the event of a Loss of Coolant Accident (LOCA). These electrically operated motorized valves are tested every week, to verify that they will open on demand when required by the ECI system.

Pickering A's operating procedures specify that if any 1 of 8 valves fail to open, the ECI system is to be declared impaired. The requirement for all 8 valves to open is in place to cover all potential HTS piping break sizes and locations.

On February 9, 2008, during routine testing, a shutdown cooling isolation valve (1-33410-MV10) failed to drive open from the fully closed position. The ECI Impairments Abnormal Incident Manual (AIM) was referenced and a Level 1 impairment of the Unit 1 ECI system was declared, due to SDC MV10 failure in the fully closed position. As per the impairment AIM actions for an ECI Level 1 impairment, a four-hour shutdown clock was initiated on Unit 1, starting at 22:45 hours.

Investigation into the cause of MV10 failure to drive open revealed a loose 48Vdc connection. The connection was repaired and MV10 was driven open via ECI logic, as per the test procedure. The test was repeated successfully and MV10 operated correctly. MV10 was declared available, and the Level 1 ECI impairment on Unit 1 was lifted at 00:39 hours.

The unavailability assigned to the ECI system as a result of this event was approximately 3.5 days. This represents half the duration since the last time MV10 was successfully tested plus the two hours of repair time.

CNSC staff reviewed the Preliminary Event Report and relevant operating documentation. CNSC staff agrees that OPG responded correctly in establishing a four-hour shutdown clock and took timely and appropriate actions to discover, correct, and successfully retest the shutdown cooling isolation valve prior to shutdown clock expiry.

E.4.1.1 Follow-Up (CMD 08-M21.C)

An "apparent cause" analysis was conducted in lieu of a "root cause" analysis, due to the recommended resolution category and significance level assigned to this event.

After reviewing all completed Work Orders pertaining to this equipment, the licensee concluded that the loose wire originates back to Unit 1 return to service in October 2004. At that time, the breaker in 1-54130-MCC18 was upgraded to a seismic type and proper work practice was not followed, thus the terminal screw was not tightened to the specified torque value. This is a weakness in human performance; in order to address it, a reinforcement of "performed by and verified by" accountability is to be captured.

CNSC staff reviewed the S-99 Detailed Event Report, which includes the apparent cause as well as the corrective actions taken to correct and prevent recurrence of the event. CNSC staff agrees with OPG's apparent cause assessment, and is satisfied with the corrective action plan.

E.4.2 Unit 1 Reactor Trip on SDSE Heat Transport Low Pressure due to Governor Valve Response (CMD 08-M21.B)

On March 6, 2008, during the start-up sequence following the outage, Turbine Governor Valves (TGV) oscillations were observed at approximately 40% to 50% full power. While troubleshooting, a reactor trip occurred on Shutdown System E Heat Transport System low pressure.

Analysis of *steam generator* pressure and governor data during the investigation concluded that the governor did not respond to signals for several minutes. When the governor did respond, the response translated into a large TGV response which, in turn, caused the reactor trip on low Heat Transport System pressure.

The unit was restarted and synchronized to the grid on March 24, 2008. As of March 28, 2008, with the unit power ascension progress holding at ~77% full power, no governor valve oscillations had been observed.

Background
Each Pickering A Unit has a mechanical governor which uses a hydraulically balanced oil control system to control *steam generator* pressure by the TGV controlling steam flow into the turbine. To adjust TGV position when synchronized, the controlling pilot oil pressure is changed by the mechanical movement of a bushing via a "speeder gear". Proper operation of governor valve control is dependent on proper initial setup of pilot oil pressures and flows, as well as other factors. Setup and adjustment of the pilot oil pressure/flow by field operators is performed during the turbine run-up after each outage.

History
Since the restart after its planned outage, in January 2008, Unit 1 TGVs experienced periodic oscillations which translated into *steam generator* and primary Heat Transport System pressure oscillations. Initial troubleshooting identified some potential causes for these oscillations, with the two most likely causes believed to be improper set-up of the pilot oil regulating valve 1-41170-V25, or internal mechanical problems with the governor. OPG reviewed the investigation results and recommended continued unit operation, while further troubleshooting activities took place. Physical measurements inside the governor mechanism were taken and used to adjust the pilot oil regulating valve V25 with the turbine on-line. This action appeared to decrease the frequency of oscillations, but did not eliminate them. The other potential cause—mechanical problems inside the governor itself—was not considered likely.

At the end of February 2008, Unit 1 was shutdown to repair a cooling pump motor, during which time the opportunity was taken to investigate the TGV oscillations. During this short five-day outage, adjustments were made to V25.

The investigation team concluded that the initial governor valve oscillations in January and February were caused by excessive play in the governor mechanical linkages, compounded by the incorrect set-up of V25. The cause of the TGV anomalous response on March 6, 2008 (different from the oscillation problem) which led to the reactor trip has not been definitively determined. Although no foreign material was found, a theory for the delayed governor response is that foreign material may have been the cause.

CNSC staff will continue to monitor the status of this issue and review the S-99 Detailed Event Report, when it is received.

E.5 Significant Development Reports for Pickering B

E.5.1 Unit 7 Decrease in Gadolinium Concentration while in Overpoisoned Guaranteed Shutdown State (CMD 08-M29)

On April 6, 2008, the Unit 7 turbine tripped due to a voltage transient caused by a 230 KV ground fault. Problems with a Liquid Zone Controller necessitated the unit going into a forced outage for troubleshooting and repair.

On April 9, 2008, with Unit 7 in a forced outage and in a *guaranteed shutdown state* (GSS) (over-poisoned moderator), operating staff observed an unexplained decrease in Gadolinium nitrate (moderator poison) concentration from approximately 17.1 ppm to 14.9 ppm over a 30-hour time period. A corresponding increase in neutronic count-rate was also observed.

The Gadolinium concentration was increased to approximately 18 ppm, after which a concentration decrease was observed—at a rate of 1 ppm per 12 hours—, requiring operating staff to add Gadolinium to the moderator on an as-needed basis in order to maintain the concentration above the administrative limit of 14 ppm. The Gadolinium safety limit for the over-poisoned GSS is 12 ppm.

For additional margin of safety, the Shutoff Rods and Control Absorbers were driven and locked in-core.

In accordance with procedures, the operating crew declared the over-poisoned GSS unreliable and transitioned to a moderator drained GSS. Investigations into the cause were ongoing at the time this SDR was prepared.

E.5.1.1 Additional Information (from Minutes of October 9, 2008 Commission Meeting)

OPG reported that it has submitted a report of its investigation into the cause of the event to CNSC staff. OPG's conclusion is that gadolinium oxalate, which is non-soluble, was formed in the moderator system, due to elevated carbon dioxide (CO_2) levels, and it had deposited on the internal surfaces of the calandria in the moderator system piping. OPG added that an elevated CO2 level had been observed in Unit 7 in 2005, and that it had not interfered with the safe operation of unit.

OPG reported that it was still monitoring the CO_2 level, and that it was planning to replace that *calandria tube* during the 2010 planned outage activities.

OPG added that it was completing recovery activities and assessing the amount of remaining gadolinium deposited in the calandria, to decide if it would proceed with start-up of the unit or with the chemical clean-up of the moderator system to remove any gadolinium-related deposits. OPG noted that CNSC approval would be required for the start-up of Unit 7.

OPG informed the *Commission* that the removed *calandria tube* had been sent to AECL for a detailed inspection. OPG confirmed that the preliminary results of the inspection in regards of the failure mechanism would be shared with CNSC and other CANDU operators.

OPG concluded that the complete report, including the exact cause of failure, would be available by the end of 2008.

CNSC staff reported it had monitored the progress of the recovery of Unit 7 very closely. CNSC staff added that two formal submissions describing the initial results on the *root cause analysis* and the planning for the recovery of the unit had been received from OPG. CNSC staff also confirmed that the approval to restart Unit 7 would require that OPG demonstrates that the plant is safe to operate.

The *Commission* asked OPG why the event was reported only in 2008, taking into account that an elevated CO_2 level was first observed in 2005.

OPG reported that CNSC staff had been notified of an elevated CO_2 problem and that an investigation had confirmed it had a very low impact on the moderator system. OPG added that the SDR report, in Spring 2008, had been triggered by the appearance of oxalate, a very insoluble salt. OPG noted that, since 2005, a lot of discussion with experts and industry had taken place on the issue and that it had increased the surveillance of the Unit.

CNSC staff confirmed that, despite the issue, the gadolinium concentration in the moderator of Unit 7 always remained above the regulatory limit of 12 parts per million.

The Commission sought information on the criteria to be used to decide to start up the reactor. OPG answered that, in the presence of residual gadolinium, constraints and limits would be used to start the reactor at lower power to burn off the gadolinium and that the unit would be brought to full power as per regular procedures agreed on with CNSC for a safe return of the unit to service.

CNSC staff insisted that although the gadolinium concentration problem was not a safety issue, the root cause analysis on the calandria tubes degradation presently underway at AECL would be completed soon.

E.5.2 Unit 8 Shutdown System 1 (SDS1) Reactor Trip (CMD 08-M46)

On July 16, 2008, with Unit 8 recently shutdown and Heat Transport (HT) cooldown in progress, a completed SDS1 reactor trip on HT high pressure occurred.

The trip occurred approximately 5 hours after the reactor had been shutdown to allow repair to a cracked weld on a D2O transfer valve (used to transfer water into the unit's HT storage tank from other units or from a central storage facility). During the cool-down, the operators began a shutdown of the HT main circulating pumps, as per procedure. With some of the pumps shut down, a

pressure gradient was established in the HT system between different reactor outlet piping headers. The singleton loop pressure controller (P18A) sensed a decreasing system pressure and responded by opening the feed valve, leading to excessive D2O feed to the system and causing the trip condition.

Coincident with the SDS1 trip, the HT liquid relief valves (LRVs) for overpressure protection opened and directed excess inventory to the bleed condenser (as designed). Due to the normal system configuration at that point in the shutdown sequence, the bleed condenser was isolated, and over-pressurized due to the inflow from the LRV discharge causing its mechanical relief valve(s) to operate. These RVs discharge into an open-ended tank in the boiler room. HT pressure continued to oscillate about the LRV setpoint, causing the LRVs and bleed condenser RVs to cycle repeatedly. Approximately 7 Mg of D2O was lost from HT inventory to the open-ended tank, which eventually overflowed onto the boiler room floor. The spill of HT D2O was confined to the reactor building, and no direct environmental release resulted.

Operations staff responded to the SDS1 trip as per their transient response procedures, then entered a procedure which caters to an LRV stuck open. That procedure directs operators to lower the HT pressure setpoint to 7 MPa(g). This action was effective in stopping LRV/RV cycling, which allowed HT pressure to stabilize after about 10 minutes. The bleed condenser relief valves are reseated below ~8 MPa(g). The remaining operating HT pumps were shut down, to eliminate the pressure gradient condition. D2O was transferred into the HT storage tank, and the unit cool-down was successfully completed.

E.6 Significant Development Reports for Gentilly-2

E.6.1 Discovery of a Prolonged Licence Non-Compliance at the Gentilly-2 Nuclear Power Plant (CMD 08-M46)

CNSC staff has recently discovered a non-compliance with the Gentilly-2 NPP licence.

The Gentilly-2 NPP design includes a leak-before-break detection (LBBD) system on the steam lines inside the reactor building. Over the years, modifications made to conditions in the *Safety Report* have meant that some equipment can no longer be environmentally qualified. Rather than requalify all the equipment, it was decided to demonstrate that steam line break ruptures are not credible accident scenarios. Hydro-Québec completed an analysis of the qualification of the LBBD system and concluded that a break could not occur without a leak beforehand. Following this analysis, the decision was made to install a LBBD system on the steam lines inside the reactor building. A LBBD system can detect and localize small steam leaks on the boiler lines in the reactor building.

Paragraph 3.11.2.1 of the plant *Safety Report* states that the *design basis accidents* with an impact on the EQ envelope do not take into account a steam line break in the reactor building because a LBBD system is installed on these lines. Furthermore, section 1.3 of the Gentilly-2 PROL states that plant operation must be in accordance with the *Safety Report*, which is referred to in Part III of Appendix A of the licence.

The LBBD qualification of the steam lines inside the reactor building had been approved by the CNSC in a letter dated December 3, 2002. At that time, the detection system had not yet been selected. On March 16, 2004, Hydro-Québec sent a letter to CNSC staff informing them that the modification to the main steam line system and the installation of the LBBD system had been approved. Hydro-Quebec also indicated its intention to keep the CNSC informed of developments in this project. In a follow up letter dated January 14, 2005, the CNSC was informed that the LBBD system commissioning would take place during the planned outage in 2005. This commissioning activity was never completed and the LBBD system has remained unavailable since 2005.

Hydro-Québec forwarded on update on September 18, 2008, confirming that a LBBD was now fully available.

E.7 Significant Development Reports for Point Lepreau

There were no significant development reports for Point Lepreau in 2008.

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 RIDM 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. The Large LOCA *design basis accident* is the most impacted by the positive void reactivity, and one of the most difficult accident to analyze for a CANDU reactor, because many aspects of the reactor behavior under accident conditions, including its computer modeling, are subject to considerable uncertainties.

GAIs 95G05, 95G04, 99G02, and 00G01 are included under this safety issue.

Analysis Methodology for NOP/ROP
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.

Emergency Core Coolant Sump Screen Adequacy
The issue as described in the IAEA TECDOC has been closed. However, a related issue has been identified in recent United States-led research into chemical effects in sump water. The CNSC raised GAI 06G01 "ECC Strainer Deposits" to address the concern. The results of tests performed under CANDU-specific conditions indicate that the chemical effects are minor.

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 (PARs) to improve hydrogen control during *design basis accidents*.

Licensees are expected to determine the effects of *Beyond Design Basis Accidents* (BDBA) and Severe Accidents (SA) and assess mitigation measures, taking into account existing design provisions such as the PARS that will be installed to mitigate hydrogen production during design basis 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 the aging-related 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 (CDF) and the Large Release Frequency (LRF), accounting for about 70% to 80% of related incidents. 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 (HVAC), Emergency Forced Air Discharge System (EFADS), Air Cooling Units (ACUs)).

Systematic Assessment of High Energy Line Break Effects
On the secondary side, all CANDU NPPs have constructed isolation barriers/engineered restraints and established 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 (PHT) pipe rupture. By constructing isolation barriers/engineered restraints against jet impingement/pipe whip, or being satisfied with the Leak-Before-Break (LBB) 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 back-up 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 p*ressure 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 shutdown 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 shutdown function nor cooling function fails, there is 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 2008. Several of these GAIs are on track for closure in 2009.

TABLE F.1: GENERIC ACTION ITEMS OPEN IN 2008

GAI	Title	Brief Description	Notes	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.	· Closed for all stations except G-2 in 2008. · Closed for G-2 in February 2009	Closed in Feb 2009
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.	· Closed for all stations except G-2 prior to 2008. · Letter to close GAI for G-2 will be sent in 2009.	2009
95G01	Molten fuel-moderator interaction	Severe flow blockage in a fuel channel, or flow stagnation, could potentially lead to fuel and ejection of molten fuel into the moderator. This scenario and its potential consequences need to be well understood.	· Tests completed in August 2008. · Closure expected in 2009	2009
95G02	Pressure tube failure with consequential loss of moderator	For dual failures involving pressure tube rupture plus loss of emergency core coolant, 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.	· Closed for all sites except G-2 in 2008.	2009
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.	· Closure will depend on final recommendations by a joint industry/CNSC RIDM team	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.	· Submissions from the industry currently under review by CNSC staff.	2009
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.	· Closed for all sites except G-2 & PL prior to 2008. · Closed for G-2 in January 2008 and PL in June 2008.	Closed in 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 the licensees' methods and codes lagging behind the state of knowledge in this area.	· Linked to GAI 95G04 · Closure will depend on final recommendations, to be made by the joint industry/CNSC RIDM team	2009
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.	Closure will depend on final recommendations by a joint industry/CNSC RIDM team	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.	Under CNSC review	2009
06G01	Emergency core coolant strainer deposits	A postulated LOCA would dislodge significant quantities of insulation material, which could potentially lead to partial blockage of the strainers, thereby impairing emergency core coolant recirculation. Station-specific studies need to be undertaken and appropriate compensatory measures taken.	· Closed for all sites except OPG sites in 2008. · Waiting for more info from OPG.	2009

APPENDIX G

2008 NPP DOSE INFORMATION

The following tables provide a five-year trend (2004-08) of annual collective doses to workers at each station. This information has been broken down to show collective doses received during routine operations versus doses received during outages, as well as total collective internal dose, total collective external dose, and total collective effective dose.

It should be noted that Routine and Outage dose information is based on estimated doses from electronic dosimetry. The data provided for Total Internal, External, and Collective Effective Dose is official dose information.

Column 1 indicates a calendar year of operation.

Column 2 provides the collective dose for routine operations. Variations between years are attributed, in part, to how long the plant operated during each year, as well as typical dose rates associated with the operation of the station.

Column 3 presents the collective dose associated with outages (planned and forced), which includes the dose to all personnel, including contractors. Parameters that affect the dose include: the number of outages for the year, the scope of the work, the duration, the number of people involved, and the dose rates associated with the outage work.

Columns 4 and 5 provide the total collective dose as a function of internal and external exposure.

Column 6 is the total collective dose, which is the sum of the routine and outage doses.

The dose data has been broken into routine vs. outage, and internal vs. external, as a means of performance measurement. This data may indicate strengths or weaknesses in a plant's radiation protection program.

It is not appropriate to compare data between the tables due to differences associated with the individual stations, such as design, age, operation and maintenance.

No radiation exposures exceeded any regulatory dose limits, at any of the stations, for any individual worker.

G.1 ANNUAL DOSE AT BRUCE A

Bruce A Units 3 and 4					
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)
2004	749	730	333	1,146	1,479
2005	327	2,016	374	1,969	2,343
2006	439	1,583	491	1,531	2,022
2007	336	4,353	750	3,939	4,689
2008	387	3,853	578	3,662	4,240

Bruce A has two operating units. Unit 4 was brought back on-line in 2003, and Unit 3 was brought back on-line in 2004.

In 2007 and 2008 there were several major planned outages. Total collective effective dose has been increasing due to increased outage work associated with aging reactors.

Bruce A Units 1 and 2 Restart Project			
Year	Total Collective Internal Dose (person-mSv)	Total Collective External Dose (person-mSv)	Total Collective Effective Dose (person-mSv)
2004	-	-	-
2005	16	62	78
2006	214	1,291	1,505
2007	403	3,928	4,331
2008	88	3,116	3,204

Units 1 and 2 are shutdown, but have been under refurbishment since 2005. A significant portion of dose intensive work was carried out in 2007 and 2008.

G.2 ANNUAL DOSE 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)
2004	881	1,825	404	2,302	2,706
2005	653	5,689	347	5,995	6,342
2006	573	3,231	277	3,527	3,804
2007	640	3,572	382	3,830	4,212
2008	639	6,013	588	6,064	6,652

Bruce B has four operating units.

In 2005 and 2008, there were two major planned outages at Bruce B compared to one in 2006 and one in 2007.

The increase in total collective dose is attributed to several factors including, but not limited to, human performance, increase in outage scope, equipment problems, and continually increasing source term.

G.3 ANNUAL DOSE AT DARLINGTON

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)
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
2008	220	1,516	139	1,597	1,736

Darlington has four operating units.

Reductions in collective dose during 2008 were achieved through implementation of several ALARA initiatives and outages management.

In 2007, Darlington moved towards a three-year outage cycle, which required two longer planned outages, resulting in a higher collective dose.

G.4 ANNUAL DOSE AT PICKERING A

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)
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
2008*	536	166	316	386	702

Pickering A Safe Storage (Units 2 and 3)			
Year	Total Collective Internal Dose (person-mSv)	Total Collective External Dose (person-mSv)	Total Collective Effective Dose (person-mSv)
2008*	32.7	45.2	77.9

* Beginning in 2008, the dose associated with the Safe Storage Project (i.e. Units 2 and 3) was separated from operating unit (i.e. Units 1 and 4) doses.

Up to and including 2007, Pickering-A reported collective dose based on all four units. In this period, doses for Units 1, 2, 3, and 4 were included in a single metric.

Pickering A has two operating units (i.e. Units 1 and 4), and two in shutdown state (i.e. Safe Storage Project – Units 2 and 3).

In 2008, no planned maintenance outage was executed; a planned outage in Unit 4 was deferred to 2009. All dose reported under 'Collective Dose - Outages' resulted from Forced outages in Units 1 and 4.

In 2005, the increased number of outages necessary to return Unit 1 to service contributed to the elevated collective dose in that year.

Since 2005, the total collective internal and external doses—and, therefore, the total collective effective dose—have decreased significantly. This dose reduction can be partially attributed to several ALARA initiatives.

G.5 ANNUAL DOSE AT PICKERING 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)
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
2008	662	3,292	666	3,288	3,954

Pickering B has four operating units.

The 2008 total collective effective dose is slightly higher than in 2007, due to increased outage work.

Total collective internal dose has decreased over the last five years. This reduction can be partially attributed to several airborne tritium exposure reduction initiatives.

The magnitude of the collective doses in 2005 is attributed to the scope of outage work performed that year.

G.6 ANNUAL DOSE AT GENTILLY-2

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)
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
2008	153	1001	140	1014	1154

Gentilly-2 is a single unit station.

In 2004, there was no planned outage, accounting for the lower collective doses.

In other years, the majority of the total collective effective dose is attributed to the duration and scope of the outages.

G.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)
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
2008	55	5943	374	5624	5998

Point Lepreau is a single unit station.

In late March 2008, the station was shut down for refurbishment. Due to the nature of the refurbishment work, where many tasks involve high radiological hazards, collective dose to workers is expected to be much higher than experienced at Point Lepreau in previous years.

In 2007, the collective dose was the lowest annual dose recorded since 1991, due to a short planned outage.

In 2005, the elevated collective dose is attributed in part to the duration and scope of the planned outage.

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

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