Canada's Nuclear Regulator

CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2009

INFO-0809

October 2010

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

CNSC staff integrated safety assessment of Canadian nuclear power plants for 2009

Catalogue number CC171-11/2009E-PDF
ISBN 978-1-100-17214-9

Published by the Canadian Nuclear Safety Commission (CNSC)
Catalogue number: INFO-0809

Également publié en français sous le titre de : Évaluation intégrée en matière de sûreté des centrales nucléaires au Canada par la personnel de la CCSN pour 2009

Document availability
This document can be viewed on the CNSC Web site at nuclearsafety.gc.ca
To order a printed copy of the document in English or French, please contact:

Canadian Nuclear Safety Commission
280 Slater Street
P.O. Box 1046, Station B
Ottawa, Ontario K1P 5S9
CANADA

Tel.: 613-995-5894 or 1-800-668-5284 (in Canada only)
Facsimile: 613-995-5086
Email: info@cnsc-ccsn.gc.ca
Web site: nuclearsafety.gc.ca

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 (Becancour, Quebec)
Pickering A and Pickering B Nuclear Generating Stations (Pickering, Ontario)
Point Lepreau Nuclear Generating Station (Point Lepreau, New Brunswick)

CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2009

This page left blank intentionally

TABLE OF CONTENTS

This page left blank intentionally

EXECUTIVE SUMMARY

There are seven licensed nuclear power plant (NPP) sites in Canada, operated by four different licensees. These NPP sites range in size from one to four power reactors, all of which are of the CANDU (CANada Deuterium Uranium) design.

Each year, the Canadian Nuclear Safety Commission (CNSC) publishes a report on the safety performance of Canada's NPPs. The *CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants* (NPP Report) assesses the safety performance at each NPP, while also making generic observations and identifying trends for the nuclear power industry, as a whole. As part of this assessment, the CNSC evaluates how well licensees are meeting regulatory requirements and expectations for the performance of programs in nine safety areas, as follows:

- Operating Performance
- Performance Assurance
- Design and Analysis
- Equipment Fitness for Service
- Emergency Preparedness
- Environmental Protection
- Radiation Protection
- Site Security
- Safeguards

The evaluations in this report were based on findings made throughout the year during inspections, desktop reviews, event reviews and reviews of performance indicators.

The NPP Report includes a rating for each program and safety area (except Security, which is provided in a separate, classified report) and an integrated plant rating for each NPP. The integrated plant rating is a general measure of the overall acceptability of the performance of the entire set of applicable programs and safety areas for each NPP, as measured against the relevant requirements and expectations.

Overall Performance Highlights

CNSC staff concludes that NPPs in Canada operated safely during 2009, and that licensees 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. This conclusion is based on observations that:

- There were no serious process failures at any station.
- No member of the public received a radiation dose in excess of the regulatory limits.
- There were no confirmed worker radiation exposures in excess of the regulatory dose limits.
- The frequency and severity of injuries/accidents involving workers was minimal.
- All environmental emissions from the stations were below regulatory limits.

- Licensees complied with their licence conditions concerning Canada's international obligations

The operational events that occurred at the NPPs in 2009 had minimal impact on health, safety and the environment, and Canada's obligations on the peaceful use of nuclear energy. Licensees reported all such events (as per S-99 reporting requirements) and conducted, or are conducting, appropriate follow-up activities, which include root cause analysis and corrective action, as needed. One event—the alpha contamination at Bruce A in November 2009—was still under investigation at the time of writing; preliminary investigation indicates that regulatory dose limits had not been exceeded.

These positive outcomes were the result of a multitude of provisions undertaken by each licensee. The CNSC's evaluation of the safety areas at each NPP confirmed, at a more detailed level, that the licensees' provisions to protect health, safety and the environment, and help honour Canada's international obligations met the CNSC's performance expectations. The 2009 ratings for the safety areas and the integrated plant ratings are presented in the table below for all NPPs, along with the industry averages.

Safety Area	Bruce		Darl-	Pickering		Gentilly-	Point	Industry
	A	B	ington	A	B	2	Lepreau	Average
Operating Performance	FS	FS	FS	SA	SA	SA	SA	SA
Performance Assurance	SA	SA	SA	SA	SA	SA	SA	SA
Design and Analysis	SA	SA	SA	SA	SA	SA	SA	SA
Equipment Fitness for Service	SA	SA	SA	SA	SA	SA	–	SA
Emergency Preparedness	FS	FS	FS	SA	SA	FS	–	FS
Environmental Protection	SA	SA	SA	SA	SA	SA	SA	SA
Radiation Protection	SA	SA	SA	SA	SA	SA	SA	SA
Integrated Plant Rating*	FS	FS	FS	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA	SA	SA	SA

* Safeguards is excluded from the integrated plant rating, recognizing that it corresponds to important elements of the CNSC's mandate that complements, but is separate from, the mandate to protect health, safety, and the environment.

The integrated plant ratings were either "Satisfactory" or "Fully Satisfactory" in 2009—these were the same ratings as in 2008. All the safety area ratings were either "Satisfactory" or "Fully Satisfactory" in 2009. This represents an improvement over 2008, when two of the safety area

ratings were "Below Expectations". For any safety-related deficiencies that were identified as part of the assessments, it was determined that the licensees were taking appropriate actions to address these relevant issues or deficiencies.

Performance Highlights of Each NPP

The 2009 integrated plant ratings for Bruce A and B were both "Fully Satisfactory". Both NPPs also received "Fully Satisfactory" ratings in the Operating Performance and Emergency Preparedness safety areas. All other safety areas were rated "Satisfactory". Under the Equipment Fitness for Service safety area, improvements were noted in maintenance programs at both Bruce A and B. Under the Design and Analysis safety area, improvements were noted in design activities at Bruce A.

The 2009 integrated plant rating for Darlington was "Fully Satisfactory". The Operating Performance and Emergency Preparedness safety areas maintained "Fully Satisfactory" ratings. All other safety areas were rated as "Satisfactory". Under the Equipment Fitness for Service safety area, previously identified deficiencies with implementation of environmental qualification measures continued into 2009.

The 2009 integrated plant ratings for Pickering A and B were both "Satisfactory", and all safety area ratings were "Satisfactory". For the Environmental Protection safety area, this represents an improvement in 2009, since both stations were rated "Below Expectations" for Environmental Protection in 2008. Under the Operating Performance safety area, organization and plant management improved at Pickering B, but continued to be below CNSC expectations at Pickering A. Under the Performance Assurance safety area, both stations continued to work to resolve issues related to minimum complement. Under the Design and Analysis safety area at Pickering A, design issues related mainly to the Inter-Station Transfer Bus event in 2007 remained unresolved in 2009.

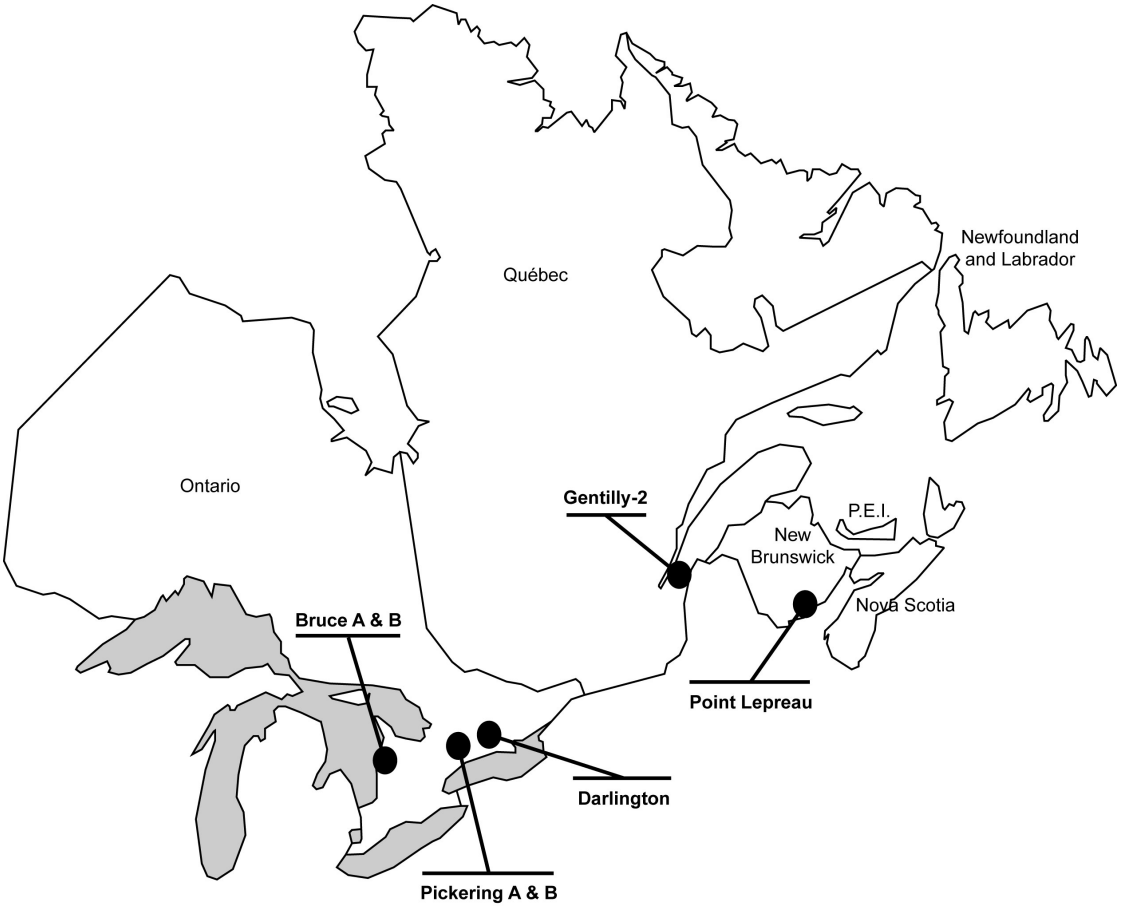
The 2009 integrated plant rating for Gentilly-2 was "Satisfactory". All safety areas were rated "Satisfactory", except for Emergency Preparedness, which was rated "Fully Satisfactory". Under the Equipment Fitness for Service safety area, improvements were noted in the performance of the maintenance and reliability programs. Under the Performance Assurance safety area, quality management issues were noted related to non-adherences with procedures and guidelines.

In 2009, refurbishment activities continued at Point Lepreau. As such, the station was not operational, and the Equipment Fitness for Service and Emergency Preparedness safety areas were not rated. All the other safety areas that were rated received "Satisfactory" ratings. The 2009 integrated plant rating for Point Lepreau was "Satisfactory".

INTRODUCTION

There are seven licensed nuclear power plant (NPP) sites in Canada. They are located in three provinces, as shown in Figure 1, and are operated by four different licensees. These NPP sites range in size from one to four power reactors, all of which are of the CANDU (CANada Deuterium Uranium) design.

Figure 1: Locations and Plant Data of Power Reactor Sites in Canada



The table on the following page shows the generating capacity of the reactors at each NPP site, their initial start-up date, the names of the licence holders, and the expiry dates of the operating licence. Seventeen reactor units were operational in 2009. Pickering A Units 2 and 3 are in laid-up state and not operating. They were defueled in 2008, and are currently being placed in a safe storage state until the eventual decommissioning of the Pickering site. Bruce A Units 1 and 2 and Point Lepreau were not operational in 2009, as they are undergoing refurbishment for life extension.

Plant Data for NPP Sites in Canada

PLANT DATA							
Plant	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
Licensee	Bruce Power	Bruce Power	Ontario Power Generation	Ontario Power Generation	Ontario Power Generation	Hydro-Québec	New Brunswick Power Nuclear
Reactor Units	4	4	4	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	2014/10/31	2014/10/31	2013/02/28	2010/06/30	2013/06/30	2010/12/31	2011/06/30

* two additional units are currently in a defueled laid-up state

The licensing basis sets the boundary conditions for acceptable performance at an NPP. It is the set of requirements and documents comprising:

- the regulatory requirements set out in the applicable laws and regulations
- the conditions and safety and control measures described in the licence and the documents directly referenced in that licence
- the safety and control measures described in the licence application and the documents needed to support that licence application

To provide confidence that licensees are meeting the boundary conditions for acceptable performance, the Canadian Nuclear Safety Commission (CNSC) publishes each year a report on the safety performance of Canada's NPPs (known as the NPP Report).

This NPP Report summarizes the CNSC staff's assessment of the safety performance of operating NPPs in 2009. The assessment is based on the legal requirements of the NSCA and its regulations, operating licence conditions, applicable standards and CNSC performance expectations. As part of this assessment, CNSC evaluated performance in nine safety areas, eight of which are reported publicly. The safety area "Site Security" is addressed in a separate, confidential report. The safety areas and associated programs are described in Appendix A.

The NPP Report presents ratings of the performance of each program and safety area at each NPP against relevant requirements and expectations. The ratings were based on findings made throughout the year during inspections, desktop reviews, event reviews and reviews of performance indicators. CNSC staff systematically considered over 2,000 findings in 2009, during this ongoing assessment. The guiding criterion that was used to assess each finding was the performance objective of the relevant program or safety area being rated. This provided a link between the very specific nature of individual findings from inspections/reviews and the very general characteristics of the programs and safety areas.

The NPP Report includes an integrated plant rating for each NPP. The integrated plant rating is a general measure of the overall acceptability of the performance of the entire set of programs and

safety areas for each NPP, as measured against their relevant requirements and expectations. The integrated plant rating is determined by combining the ratings of the individual safety areas using "weights" that represent the relative contribution of each safety area to the objective of protecting the health and safety of Canadians and the environment. In 2009, both Security and Safeguards were excluded from the integrated plant rating, in recognition of the fact that these areas correspond to important elements of CNSC's mandate that complement—but are separate from—the mandate to protect health, safety, and the environment.

Section 1 of this report describes the general performance of the industry and noteworthy trends that are relevant to more than one NPP. It is organized according to a set of programs and safety areas, and provides context for Section 2, which describes in more detail the performance of each NPP under each program and safety area. The 2009 NPP Report introduces a new subsection for each NPP, which lists regulatory milestones identified at the time of licensing (either in the licence or in the associated Licence Condition Handbook). This will help the Commission and stakeholders to follow licensees' progress with respect to these important milestones. Section 2 also describes important projects and developments at each NPP.

The 2009 NPP Report has six appendices:

- Appendix A provides the definitions and the performance objectives of the programs and safety areas.
- Appendix B provides the definitions of the rating categories for the programs, safety areas, and integrated plant ratings ("Fully Satisfactory", "Satisfactory" etc).
- Appendix C is a glossary of specialized and technical terms used in the text.
- Appendix D defines the acronyms used in the report.
- Appendix E describes the status of CANDU safety issues, including the Generic Action Items (GAIs) that were open in 2009.
- Appendix F provides worker doses at all Canadian NPPs in 2009, in addition to the five-year trend of annual collective doses to workers at each NPP.

This is the first year that stakeholders have been invited to comment on the report prior to its formal presentation to the Commission. This mechanism has been introduced as a systematic way to generate discussion on the overall safety performance of NPPs in Canada, and potentially identify areas where the NPP Report can improve to better serve the needs of stakeholders.

1.0 PERFORMANCE AND TRENDS ACROSS THE INDUSTRY

Section 1 presents the overall performance of the industry in each of the safety areas and programs defined in Appendix A, and highlights generic issues and observations. CNSC performance indicators (PIs) are also included in this section, to illustrate various trends. PIs are defined in Regulatory Standard S-99 "Reporting Requirements for Operating Nuclear Power Plants", and 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.

1.1 Operating Performance

Safety Area / Program	Rating							
	BA	**BB**	**Darl**	**PA**	**PB**	**G-2**	**PL**	**Industry Average**
Operating Performance	**FS**	**FS**	**FS**	**SA**	**SA**	**SA**	**SA**	**SA**
Organization and Plant Management	SA	SA	FS	BE	SA	SA	SA	SA
Operations	FS	FS	FS	SA	SA	SA	–	FS
Occupational Health and Safety (non-radiological)	FS	FS	FS	SA	SA	SA	FS	FS

BA=Bruce A; BB= Bruce B; Darl=Darlington; PA=Pickering A; PB=Pickering B; G-2=Gentilly-2; PL=Point Lepreau

The industry average for the Operating Performance safety area was "Satisfactory" in 2009, with three stations achieving "Fully Satisfactory" ratings and four stations achieving "Satisfactory" ratings. Details pertaining to individual station performance are provided in Section 2.

1.1.1 Organization and Plant Management

The industry average rating for Organization and Plant Management performance was "Satisfactory" in 2009. NPP licensees operated their stations safely, as evidenced by the following:

- There were no serious process failures at any station.
- Doses to the public were well below regulatory limits.
- Doses to workers were below regulatory limits[1].

[1] There were no confirmed exposures above regulatory limits at the time this report was prepared. However, an event involving radiation exposure of workers at Bruce A is being investigated (see Section 2.1.7 for details).

- The frequency and severity of injuries/accidents involving workers was minimal.
- Environmental emissions were well below regulatory limits.

These results are a general reflection of good organizational management and control.

Organizational change is becoming more prevalent as nuclear workers retire. The CNSC routinely reviews organizational changes, as a way to ensure the licensee has considered all potential safety concerns, including the potential loss of knowledge and experience. The CNSC review is based on the requirements of the Canadian Standards Association (CSA) standard N286-05 "Management System Requirements for Nuclear Power Plants", which is being implemented at all NPPs (see Section 1.2.1). Section 5.12 of CSA N286-05 requires changes to be identified, controlled, justified, and subject to review by the licensee.

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 1 and Figures 2 and 3, 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. Many of the unplanned transients in 2009 were setbacks, which typically pose little risk to plant operations.

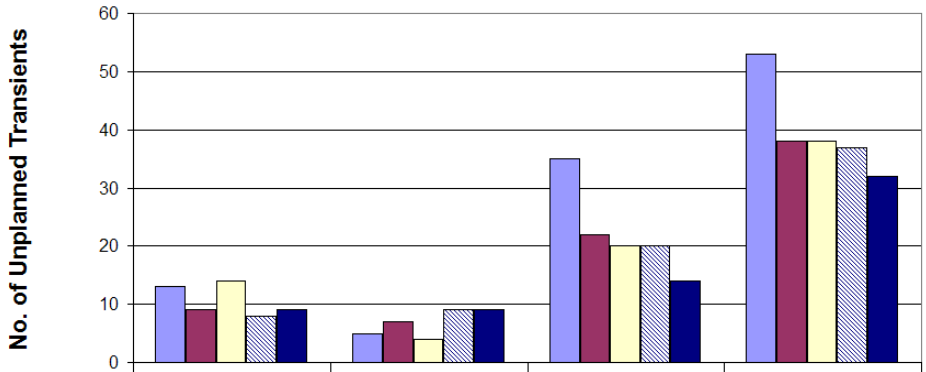
Table 1: Number of Unplanned Transients for 2009

Station	GSS Hours	Unplanned Transients at Stations in 2009			
		Trips	Stepbacks	Setbacks	Total
Bruce A	2,600	2	1	1	4
Bruce B	2,467	1	7	1	9
Darlington	3,870	0	0	0	0
Pickering A	20,983	4	n/a	5	9
Pickering B	3,787	1	0	5	6
Gentilly-2	2,537	1	1	2	4
Point Lepreau*	n/a	n/a	n/a	n/a	n/a
Industry Total	36,244	9	9	14	32

* reactor in defueled core state, due to refurbishment

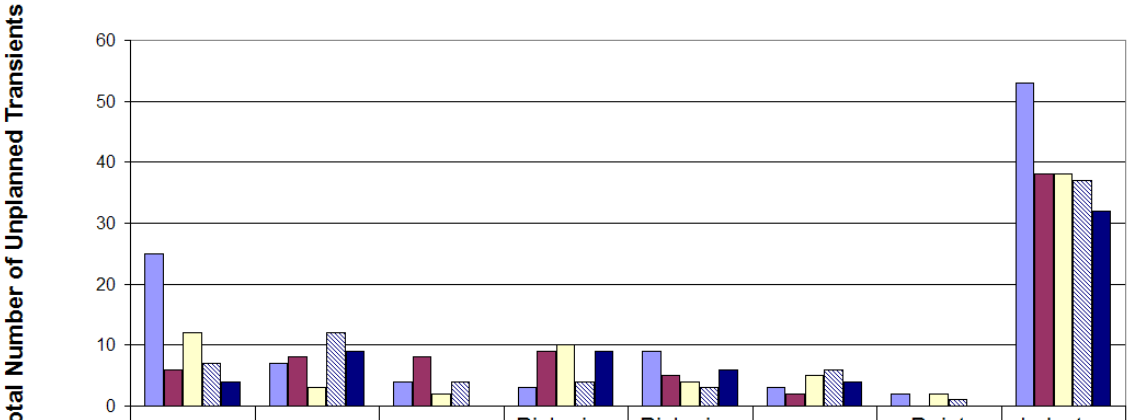
Figures 2 and 3 show the trend of this PI since 2005. Industry-wide, the total number of transients in 2009 was lower than in previous years, although the number of trips and stepbacks remained approximately the same. In 2009, there was an industry average of 6,300 hours of non-GSS time between reactor trips and stepbacks (calculation based on 17 operating units). The international performance target is one reactor trip per 7,000 hours of operation, which puts Canadian NPPs slightly below the international target.

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



	Trips	Stepbacks	Setbacks	Total
2005 (GSS hrs=25,533)	13	5	35	53
2006 (GSS hrs=32,524)	9	7	22	38
2007 (GSS hrs=17,494)	14	4	20	38
2008 (GSS hrs=36,868)	8	9	20	37
2009 (GSS hrs=36,244)	9	9	14	32

Figure 3: Trend Details for Number of Unplanned Transients for Stations



	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau	Industry Total
2005	25	7	4	3	9	3	2	53
2006	6	8	8	9	5	2	0	38
2007	12	3	2	10	4	5	2	38
2008	7	12	4	4	3	6	1	37
2009	4	9	0	9	6	4	n/a	32

1.1.2 Operations

In 2009, the industry average rating for Operations was "Fully Satisfactory". Most CNSC operations inspections found that licensees had very good compliance with CNSC requirements and licensees' governing procedures and documents. Licensees also met CNSC expectations for outage execution, and outage safety and work management. At Point Lepreau, the refurbishment activities were assessed on an ongoing basis, but there were no "operations" activities to rate.

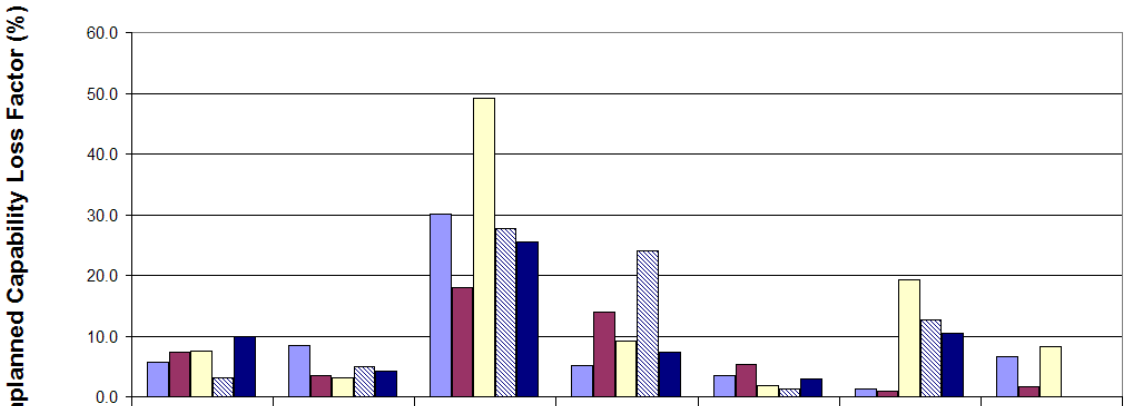
The "Unplanned Capability Loss Factor" PI is the percentage of the reference electrical output for the station lost during the period due to unplanned circumstances. The purpose of this PI is to indicate how a unit is managed, operated and maintained, in order to avoid unplanned outages.

The Unplanned Capability Loss Factor for each station in 2009 is provided in Table 2. Five-year trends for each station are illustrated in Figure 4. With the exception of Bruce A, most stations in 2009 maintained or improved their unplanned capability loss factor, compared to previous years. Bruce A experienced an increase in unplanned capability loss, due to unplanned extensions to the planned outages at Units 3 and 4. Although Pickering A showed a marginal improvement in the unplanned capability loss factor for 2009, the number remained relatively high due to several forced outages and an extension to a planned outage.

Table 2: Unplanned Capability Loss Factor for 2009

Station	Unplanned Capability Loss Factor (%)				
	Quarter				For Year
	Q1	Q2	Q3	Q4	
Bruce A	3.8	0.4	1.7	33.8	9.9
Bruce B	2.6	7.9	1.7	4.6	4.2
Darlington	0.0	1.3	9.8	0.6	2.9
Pickering A	16.5	26.6	15.7	43.3	25.5
Pickering B	1.7	15.5	6.9	5.4	7.4
Gentilly-2	1.1	17.6	20.1	2.9	10.4
Point Lepreau	n/a	n/a	n/a	n/a	n/a

Figure 4: Trend Details for Unplanned Capability Loss Factor for Stations



	Bruce A	Bruce B	Pickering A	Pickering B	Darlington	Gentilly-2	Point Lepreau
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	3.2	5.0	27.7	24.1	1.3	12.7	0.0
2009	9.9	4.2	25.5	7.4	2.9	10.4	n/a

1.1.3 Occupational Health and Safety (non-radiological)

Occupational Health and Safety was a strong performance area for NPP licensees in 2009, with an industry average rating of "Fully Satisfactory".

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 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.

The Accident Severity Rate PI is presented in Table 3, and Figures 5 and 6. Most licensee accident severity rates decreased in 2009, compared to 2008. In general, accident severity rates for Canadian NPP are low in comparison to other industries.

Table 3: Accident Severity Rate for 2009

Station	Days Lost	Person Hours	Accident Severity Rate
Bruce A and B	0	8,302,887	0.00
Pickering A and B	93	8,179,845	2.27
Darlington	26	5,450,289	0.95
Gentilly-2	0	1,310,381	0.00
Point Lepreau	155	5,253,648	5.90
Industry Average	274	28,497,050	1.92

Figure 5: Accident Severity Rate Trend for Industry

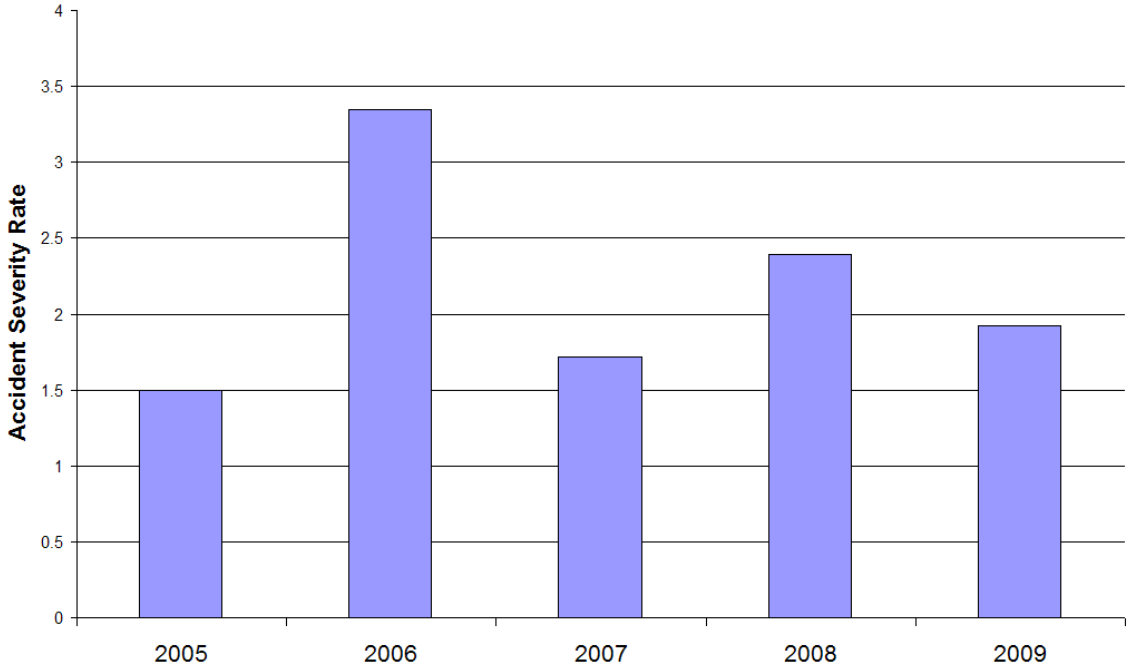
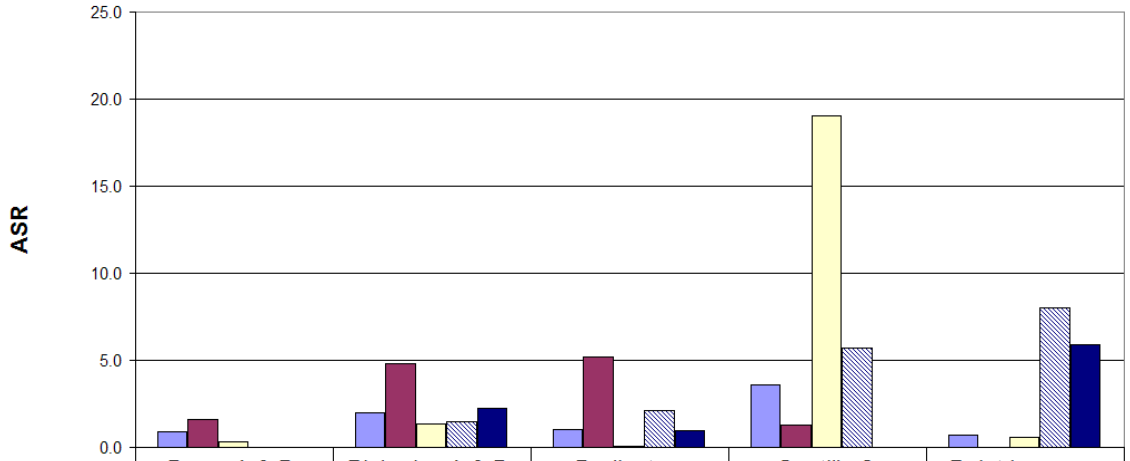


Figure 6: Trend Details of Accident Severity Rate for Stations



	Bruce A & B	Pickering A & B	Darlington	Gentilly-2	Point Lepreau
2005	0.9	2.0	1.0	3.6	0.7
2006	1.6	4.8	5.2	1.3	0.0
2007	0.3	1.4	0.1	19.1	0.6
2008	0.0	1.5	2.1	5.7	8.0
2009	0.0	2.3	1.0	0.0	5.9

1.2 Performance Assurance

Safety Area Program	Rating							
	BA	**BB**	**Darl**	**PA**	**PB**	**G-2**	**PL**	**Industry Average**
Performance Assurance	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**
Quality Management	SA	SA	SA	SA	SA	BE	SA	SA
Human Factors	SA	SA	SA	BE	BE	SA	SA	SA
Training, Examination and Certification	SA	SA	SA	SA	SA	SA	SA	SA

The industry average rating for the Performance Assurance safety area was "Satisfactory" in 2009. Each station was also rated "Satisfactory" for overall performance in this safety area.

1.2.1 Quality Management

The industry average rating for Quality Management performance was "Satisfactory" in 2009. With the exception of Gentilly-2, Quality Management program performance at the stations met CNSC expectations and—in most of the areas evaluated—licensees demonstrated adequate management oversight of the licensed activities through documented quality assurance programs.

Most NPP operating licences currently reference CSA standards N286.0 through N286.6, which state requirements for quality assurance programs for the various life cycles of a NPP (i.e., procurement, design, construction, commissioning, operation and decommissioning). The NPP industry is shifting from quality assurance programs to Management Systems. The more recent CSA standard N286-05 "Management System Requirements for Nuclear Power Plants", has incorporated the requirements of CSA standards N286.0 through N286.6 into a single document, providing the requirements for a management system for the complete life cycle of a NPP.

The CNSC has endorsed CSA N286-05 as an acceptable standard for the implementation of a quality assurance program, as required by the Class I Nuclear Facilities Regulations. The standard was included in the power reactor operating licence (PROL) for Bruce A and Bruce B, during their renewal in 2009.

Ontario Power Generation (OPG) has requested PROL amendments for Darlington and Pickering B to specify OPG's revised document N-CHAR-AS-0002 R013 "Nuclear Management System", which documents the implementation of N286-05 requirements. The N286-05 standard is also being included in the PROL renewal for Pickering A, scheduled in 2010. CNSC staff is currently reviewing the OPG's Management System documentation, to ensure all requirements of the CSA N286-05 standard are being adequately addressed across all its documents.

For Point Lepreau and Gentilly-2, the transition from quality assurance programs to a management system will be addressed upon the completion of the refurbishment activities at the plants.

Refurbishment activities challenge the quality assurance programs implemented by licensees, because the implemented programs focus on NPP operation. For refurbishment, the quality assurance programs need to focus on activities related to Quality Control: inspection and verification of workmanship and testing. CNSC staff has been monitoring the refurbishment activities at Bruce A and Point Lepreau, and has identified issues regarding their oversight of the quality control activities related to procurement, construction, and commissioning. Licensees have taken corrective actions to address these issues. As a result, no concerns regarding the safe operation upon restart for the applicable reactors were identified in 2009.

For the Point Lepreau refurbishment, CNSC staff inspected the Quality Assurance programs of NB Power's major contractors and suppliers of safety-related services and components. These types of inspections help identify issues (i.e. supplier workmanship controls and contractor control of non-conforming equipment and supplies) that can be addressed in a proactive manner. This provides the CNSC with assurance regarding the quality of materials used for the refurbishment. The presence of CNSC inspectors at supplier premises enabled CNSC staff to highlight supplier quality weaknesses and to have them addressed prior to any items being delivered. CNSC staff is evaluating the continuation of these innovative practices for future refurbishment and new-build activities.

1.2.2 Human Factors

The industry average rating for Human Factors performance was "Satisfactory" in 2009. Issues related to the minimum shift complement remained a challenge for many stations, and will continue to be monitored by CNSC staff in 2010.

The minimum shift complement is the number of staff with specific qualifications that must be present at the station at all times, in order to carry out the licensed activity safely and in accordance with the NSCA, the regulations made under the NSCA, and the licence. The numbers and qualifications of staff must be adequate to respond to the most resource-intensive conditions under all operating states. CNSC staff expressed concerns about the minimum shift complement staffing of two licensees (see Sections 2.1.1.2 and 2.3.1.2) and, as a result, projects to analyse the staffing requirements at these facilities are currently under way, using CNSC Regulatory Guide G-323 "Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement". These projects are expected to be completed in 2011. Similar projects to analyse the minimum shift complement will be initiated for all NPP licensees over the next two years.

Plant staffing levels and hours of work can be severely tested during periods of widespread illness. In response to the H1N1 pandemic of 2009, the CNSC required all licensees to submit pandemic preparedness plans. The review of these plans confirmed

that provisions and measures to ensure the maintenance of minimum shift complement have been put in place by all licensees. A CNSC/industry workshop was held to discuss mutual areas of concern, the mechanism for the plan's implementation, and the monitoring of minimum shift complement.

In August 2009, the CNSC expressed its position that regulatory requirements—specifically hours of work limits—apply to all personnel who may work on safety-related systems, as defined in CSA N286.0-92. CNSC staff advised all NPP licensees to include contractors and casual construction trades under their hours of work limits. CNSC staff and licensees will continue to address this issue in 2010.

1.2.3 Training, Examination and Certification

In 2009, the industry average rating for Training, Examination and Certification performance was "Satisfactory". CSNC inspections did not identify any significant training issues at any station. In addition, examination and certification results were acceptable across the industry.

In 2009, the Commission amended all NPP operating licences to incorporate regulatory document RD-204, thereby authorizing NPP licensees to directly administer initial certification examinations, in accordance with CNSC requirements and guidelines (a function previously held by the CNSC alone.)

CNSC staff has implemented a transition compliance strategy to verify the licensees' certification examination programs and processes, while also pilot-testing the CNSC compliance tools to be used in baseline compliance activities. This transition strategy continues into 2010.

In order for CNSC staff to obtain a high level of confidence that the persons seeking certification are competent to perform their duties, the CNSC focused its inspection activities in 2009 on the performance-based certification examination. Of the fifteen initial simulator-based examinations administered by licensees under the new regulatory requirements, CNSC staff conducted a total of fourteen inspections. There were no enforcement actions required, and all items of potential non-compliance were corrected by licensees during the administration of the examinations.

1.3 Design and Analysis

Safety Area Program	**Rating**							
	BA	**BB**	**Darl**	**PA**	**PB**	**G-2**	**PL**	**Industry Average**
Design and Analysis	**SA**	**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	SA
Design	SA	SA	SA	BE	SA	SA	SA	SA

The industry average rating for the Design and Analysis safety area was "Satisfactory" in 2009. All stations received "Satisfactory" ratings for overall performance in Design and Analysis.

1.3.1 Safety Analysis

The industry average rating for Safety Analysis performance was "Satisfactory" in 2009. This average does not include Point Lepreau, which was not rated due to its refurbishment status.

NPP licensees routinely perform safety analyses to confirm that any plant design changes would allow potential consequences of design basis accidents to still meet CNSC requirements. In addition, licensees perform probabilistic safety analyses to identify and manage all important contributors to public risk.

Updates on some of the safety analysis issues or projects common to all or most NPP licensees are discussed below.

Safety Analysis Improvement (SAI) Program

In 2008, NPP licensees established a Working Group through the CANDU Owner's Group (COG) to implement a Safety Analysis Improvement (SAI) program. The SAI program is comprised of several activities, each of which has a specific purpose and covers different subjects. These activities are directly related to the safety analysis shortcomings identified by the CNSC in 2007 and 2008, as well as other issues important to the nuclear industry. Although the NPPs' safety cases are not in question, the existing safety margins and analyses need to be confirmed.

The purpose of the SAI program includes preparing for the implementation of RD-310 "Safety Analysis for Nuclear Power Plants", assessing the impact of aging on the heat transport system, and evaluating the conservatism and correcting inconsistencies in the safety analyses. The Working Group has an established mandate and terms of reference, and in 2009 submitted a Project Execution Plan to the CNSC for information. The main activities include:

- producing a Principles and Guideline document for Safety Analysis
- performing pilot studies of Darlington Loss of Reactivity Control and Bruce A Loss of Flow
- performing gap assessments for Safety Report analyses followed by the necessary actions to disposition such gaps
- overall improvement of the Safety Report

To date, the Principles and Guidelines document has been produced and other projects under the program are in progress. The CNSC will monitor and assess all activities related to the SAI program.

Safe Operating Envelope

In 2009, a joint CNSC/industry working group was created to address aspects of Safe Operating Envelope (SOE), build on the industry's current approach to defining and implementing a SOE, and to outline a transition from the current to a future state.

Concurrently with the working group's activities, the CNSC initiated a multi-phase SOE project for overseeing CNSC and industry SOE-related work. The first phase of this project was completed in August 2009, by issuing a CNSC document entitled ”Safe Operating Envelope: Objective and CNSC Definition“. The project's second phase, currently in progress and scheduled for completion by July 2011, includes cooperating with the industry to convert the SOE COG document ”Principles and Guidelines for the Definition, Implementation and Maintenance of the Safe Operating Envelope at CANDU Power Plants in Canada” into a CSA standard. Phase II also involves monitoring the industry’s implementation of the SOE programs. Phase III— the CNSC regulatory implementation—will include developing guides for conducting type I and type II inspections for SOE, and introducing a licence condition pertaining to the CSA standard. Phase III is planned for 2011/2012.

Impact of Plant Aging on Safety Analysis

Bruce Power and OPG have introduced a new Neutron Overpower (NOP) analysis methodology to assess a phenomenon most impacted by aging, the slow Loss of Regulation (LOR) event. The methodology underwent an Independent Technical Panel (ITP) review, jointly initiated by the CNSC and the industry in 2008.

The ITP review was completed in June 2009, and concluded that the overall methodology had a sound technical basis, but recommended additional justifications, supplemental analysis and revisions prior to final acceptance in the regulatory process. CNSC staff agreed with the conclusions of the panel and advised the industry that further development work is required on this methodology before its full utilization for licensing applications.

The majority of issues identified by the ITP and CNSC staff are addressed in the current OPG and Bruce Power work plans and are expected to be resolved by 2011. The CNSC expects the licensees’ work plans and schedules for the remaining issues to be submitted later in 2010.

1.3.2 Safety Issues

Licensees continued to meet CNSC performance expectations for this program in 2009, with an industry average rating of “Satisfactory”.

In 2009, the industry continued working towards resolution of Generic Action Items (GAI). A GAI is a safety issue that is common to more than one station and complex in nature. Ten GAI were active in 2009. Of those, three (88G02, 95G01 and 96G01) were closed. Brief descriptions of current GAIs and their expected closure dates are provided in Appendix E.

In 2007, the CNSC initiated a project to systematically re-assess the status of outstanding design and analysis safety issues for Canadian CANDU reactors. The project team identified an initial list of issues using IAEA TECDOC-1554, information from currently operating reactors, life extension assessments, and pre-licensing reviews of new CANDU designs. The GAIs were also included.

The resulting CANDU safety issues were assessed for their relative risk importance, using a risk-informed decision making (RIDM) process, and were categorized into three broad categories, as follows:

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

Of the initial list of 72 CANDU safety issues, 20 were identified as Category 3 issues.

A joint CNSC/industry working group was created in 2008, to clarify the RIDM process and to develop risk control measures for the Category 3 safety issues. Revisions to the RIDM process and safety issue descriptions were completed by the end of 2008.

In 2009, the CNSC/industry RIDM Working Group updated the safety issues' risk evaluations and assessments, using the revised RIDM process and the most recent information on the various safety issues. This exercise led to the re-categorizing of four safety issues to lower categories. Of the remaining Category 3 issues, the working group determined that most can be addressed by further work in the following areas:

- validation of data, models and codes used in accident analyses
- acquisition of additional experimental data on fuel behaviour under accident conditions
- aging management of structures, systems and components (SSCs) and assessment of the impact of aging on plant response to accidents
- implementation of design improvements, where confirmed by the above-mentioned activities

The working group also proposed risk control measures and implementation schedules for each Category 3 safety issue.

General descriptions of the Category 3 issues are provided in Appendix E. Updates on seven of the highest priority issues are provided below:

- Large LOCA (LLOCA) - four Category 3 CANDU safety issues are related to positive void reactivity and fuel behaviour during a LLOCA. In 2008, a joint

CNSC/industry working group was established to address these LLOCA-related safety issues and to identify the path forward for resolution. In 2009, the LLOCA Working Group produced a document laying out two possible resolution methods for assessing LLOCA safety margins. The RIDM Working Group assessed the proposed resolution methods, and made recommendations on their acceptability to industry and CNSC executives. It is expected that all LLOCA issues will be resolved by 2013.

- NOP analysis methodology - an update on the work done in 2009 on this issue is provided in Section 1.3.1.
- Fuel bundle/element behaviour under post dry-out conditions - COG has initiated a R&D project to resolve this issue. In 2009, the project work group submitted a detailed project plan for CNSC review.
- Validation of computer codes for accident analysis applications (especially for heat transport pump operation during two phase flow conditions) - this issue will be addressed through the COG SAI program (see Section 1.3.1 for description of SAI program).

1.3.3 Design

The industry average rating for Design was "Satisfactory" in 2009.

Several Canadian NPP licensees are moving forward with projects to refurbish their plants for continued operation for another 25 to 30 years. To do so, it must be assured that structures, systems and components (SSCs) important to safety will continue to satisfy all safety requirements for the extended long term operation. Such assurance typically involves an Integrated Safety Review (ISR), which is an in-depth assessment of the actual condition of SSCs, the effects of aging on NPP safety and the effectiveness of aging management programs for future operation. An ISR includes key considerations and recommendations for long-term operation. Assurances for long-term operation also requires that national and international research programs, operating experience and practices are effectively coordinated and shared.

In 2009, CNSC staff took an active approach, including initiatives at both the national and international level, to ensure that materials degradation and aging of Canadian NPPs is understood and is being effectively managed to provide for continued safe long-term operation. CNSC staff reviewed NPP licensees' compliance with in-service and periodic inspection program standards, component life-cycle management programs, fitness-for-service guidelines, and applicable regulatory documents. CNSC staff also reviewed licensees' programs for aging management, as part of the ISR for stations undergoing life extension projects.

Configuration Management

For nuclear power plants, configuration management is the process of identifying and documenting the characteristics of the plant's SSCs (including computer systems and software) and ensuring that changes to these characteristics are properly developed, assessed, approved, issued, implemented, verified, recorded and incorporated into the

plant documentation. The licensee must ensure that all systems important to safety meet design requirements, and that plant documentation reflects the actual physical plant.

An overall configuration management baseline program has been implemented at all sites. However, all the NPPs have some weaknesses in configuration management sustaining activities, which require continued attention in other ongoing processes—such as engineering change control, performance monitoring, maintenance, aging management and corrective actions. However, no significant issues have been identified, and the CNSC staff closely monitors the situation.

Fire Protection

With the introduction of a new edition of CSA N293 "Fire Protection for CANDU Nuclear Power Plants", and its incorporation into some of the operating licences, the NPP licensees are either in the midst of, or are initiating projects to, perform code compliance reviews (gap analysis) and to revise their facilities' Fire Hazard Assessment and Fire Safe Shutdown Analyses. These analyses will be performed using modern methodologies, and will evaluate the level of fire protection, while taking into consideration current knowledge and industry best practices. CNSC staff will continue to monitor progress for the completion of the code compliance review, the Fire Hazard Assessment and the Fire Safe Shutdown Analysis, as well as any recommendations for modifications and upgrades that may arise from these.

1.4 Equipment Fitness for Service

Safety Area Program	**Rating**							
	BA	**BB**	**Darl**	**PA**	**PB**	**G-2**	**PL**	**Industry Average**
Equipment Fitness for Service	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**–**	**SA**
Maintenance	SA	SA	FS	SA	SA	SA	–	SA
Structural Integrity	SA	SA	FS	SA	SA	SA	–	SA
Reliability	SA	SA	SA	SA	SA	FS	–	SA
Equipment Qualification	SA	SA	BE	SA	SA	SA	–	SA

The industry average rating for the Equipment Fitness for Service safety area was "Satisfactory" in 2009. All stations received "Satisfactory" ratings for this safety area with the exception of Point Lepreau, which was not rated due to its refurbishment status.

1.4.1 Maintenance

In 2009, the industry average rating for Maintenance was "Satisfactory". Point Lepreau was not rated, due to its refurbishment status. However, at all the operating stations, maintenance inspections carried out during 2009 concluded that licensees have well-established maintenance organizations, with supporting policies processes and procedures.

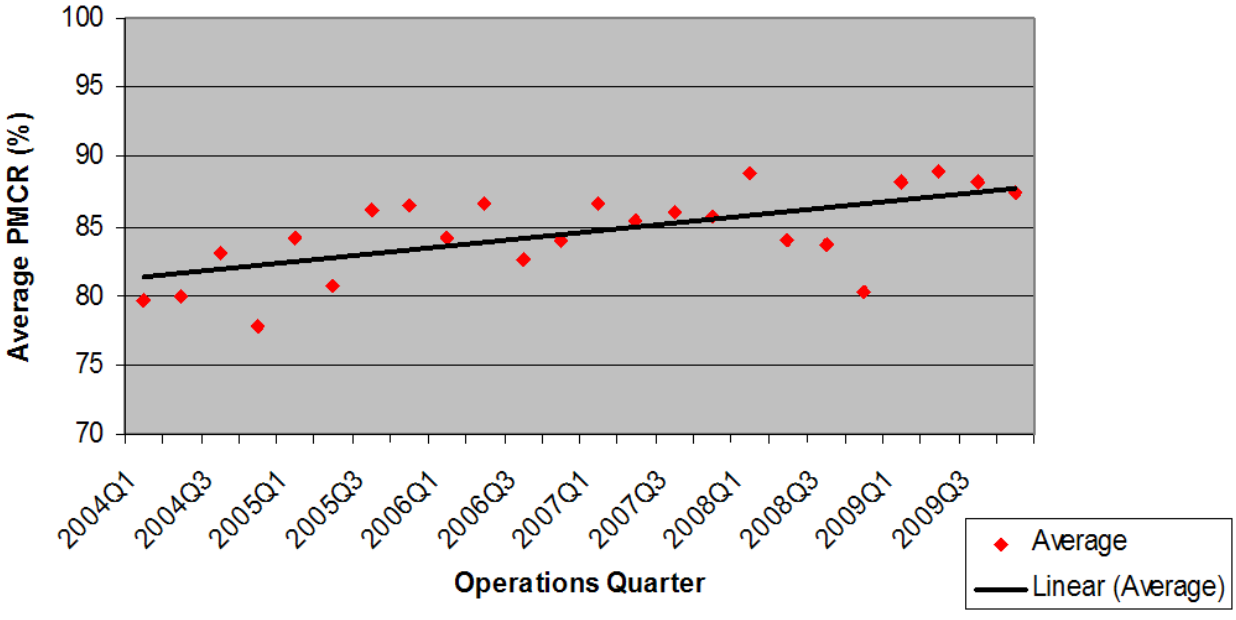
Regulatory Document S-210 "Maintenance Programs for Nuclear Power Plants" sets out expectations for maintenance programs, with a focus on managed processes. The document is being introduced as a licence condition upon PROL renewal. To date, it has been incorporated into the Bruce A, Bruce B, Darlington and Pickering B licences.

The Preventive Maintenance Completion Ratio (PMCR) PI is the ratio of preventive maintenance work orders completed on safety-related equipment, divided by the total maintenance work orders (preventative maintenance plus corrective maintenance) completed on safety-related equipment.

The ratio monitors the effectiveness of the preventive maintenance program in minimizing the need for corrective maintenance activities. Corrective maintenance is defined as work performed as a result of a failure of safety-related equipment. The PMCR is a lagging indicator of preventative maintenance program effectiveness. An optimal preventative maintenance program will minimize—but not eliminate—corrective maintenance, thus increasing the ratio.

The historical data for PMCR is given in Figure 7, below. Starting with the first quarter of 2004, the overall PMCR average data shows a positive upward trend. Best industry practice sets a target of 90% or better for this indicator.

Figure 7: Average Preventive Maintenance Completion Ratio Reported for all NPPs



Maintenance Backlog

CNSC staff monitors licensee maintenance backlogs, as an indicator of maintenance effectiveness. In particular, corrective and elective maintenance backlogs are reviewed. The corrective maintenance 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 preventative maintenance 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 an indication of the plant's material condition. There will always be a certain level of backlog, due to normal operation and equipment aging.

Corrective maintenance backlog levels at most sites decreased over the 2009 operating year. However, several stations continue to have higher than best industry practice levels for corrective maintenance and this will remain a focus area for CNSC staff in 2010.

1.4.2 Structural Integrity

NPP licensees carry out periodic inspections to confirm that major heat transport system and safety system components remain fit for service. These inspections emphasize pressure tubes, feeders and steam generators. In 2009, the industry average rating for Structural Integrity performance was "Satisfactory". Point Lepreau was not rated, due to its refurbishment status.

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. The "class" that is referred to is the code classification of the nuclear system and designates the level of importance of each system as it relates to safe operation of the plant. For example, class 1 is the highest level and refers to systems that contain fluid that directly transports heat from the fuel. Degradations are defined as instances where limits in relevant design or inspection criteria are exceeded. Typically, the number of degradations in the nuclear systems is much lower than the degradations in the conventional (non-nuclear) systems in the plant.

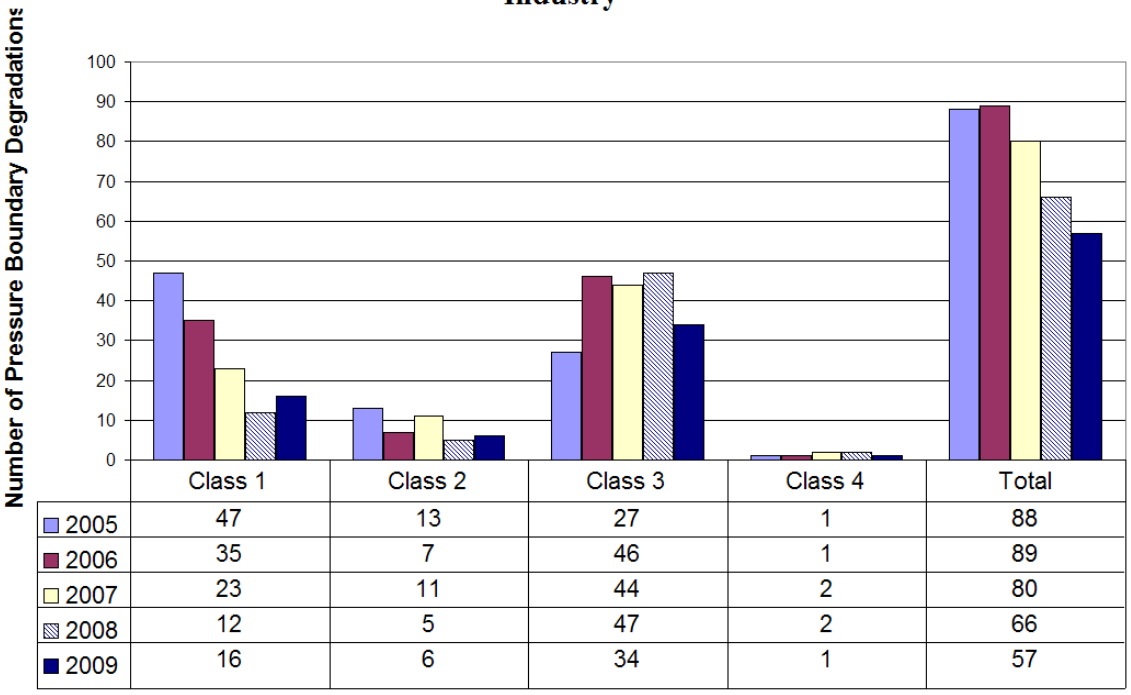
The industry data for this indicator is shown in Table 4 and Figure 8. All operating stations showed steady to improving performance in 2009, compared to previous years.

Table 4: Pressure Boundary Degradations for 2009

Station	Number of Pressure Boundary Degradations by Type				
	Class 1	Class 2	Class 3	Class 4	Total
Bruce A	1	3	6	0	10
Bruce B	2	1	15	0	18
Darlington	11	2	6	0	19
Pickering A	2	0	2	1	5
Pickering B	0	0	5	0	5
Gentilly-2	0	0	0	0	0
Point Lepreau *	n/a	n/a	n/a	n/a	n/a

* there were no pressurized nuclear systems at Point Lepreau in 2009

Figure 8: Trend Details of Pressure Boundary Degradations for Industry



	Class 1	Class 2	Class 3	Class 4	Total
2005	47	13	27	1	88
2006	35	7	46	1	89
2007	23	11	44	2	80
2008	12	5	47	2	66
2009	16	6	34	1	57

1.4.3 Reliability

NPP licensees have reliability programs to ensure that systems important to safety can and will meet their defined design and performance specifications at acceptable levels of reliability, throughout the life of the facility. In 2009, the industry average rating for reliability program performance was “Satisfactory”. Point Lepreau was not rated, due to its refurbishment status.

In November 2009, CNSC staff met with members of the CANDU Owners Group (COG), to discuss issues of common interest to all licensees, such as:

- Closing the gap between CNSC and COG members' expectations regarding how systems important to safety are selected.
- Working towards a consensus amongst all NPPs, on the criteria for determining a missed safety system test (missed safety system tests must be reported under S-99).
- Minimizing inconsistencies in the reporting format of the licensees' Annual Reliability Reports, required under S-99.
- Reaching a common understanding between CSNC staff and COG members on topics such as the scope of reliability models and failure-on-demand quantification.

CNSC staff will continue to work with the industry, towards resolving these issues, in 2010.

The purpose of the "Number of Missed Mandatory Safety System Tests" PI is to indicate the degree of 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 5 and Figures 9 and 10.

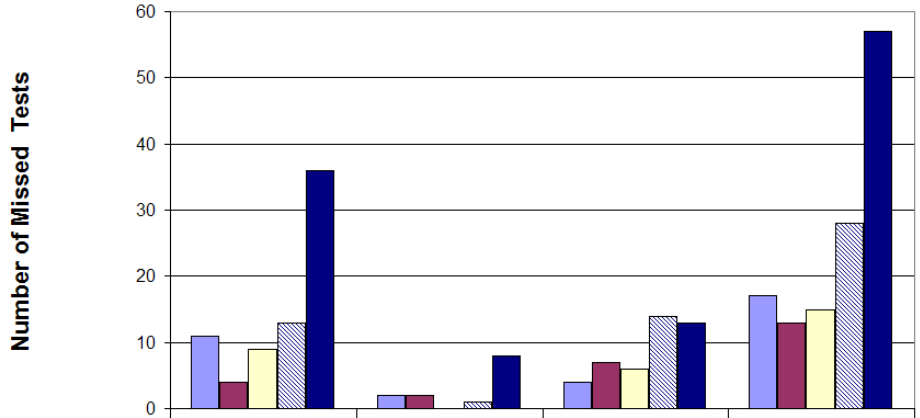
Table 5: Missed Mandatory Safety System Tests for 2009

Station	Total # Tests Performed	Missed Mandatory Safety System Tests			
		Special	Standby	Safety Related	Total
Bruce A	19,736	29	8	1	38
Bruce B	29,910	0	0	0	0
Darlington	13,500	0	0	2	2
Pickering A	10,637	1	0	5	6
Pickering B	10,984	1	0	1	2
Gentilly-2	4,383	5	0	4	9
Point Lepreau*	n/a	n/a	n/a	n/a	n/a
Industry Total	89,150	36	8	13	57

*Since entering defueled state, no tests have been scheduled at Point Lepreau

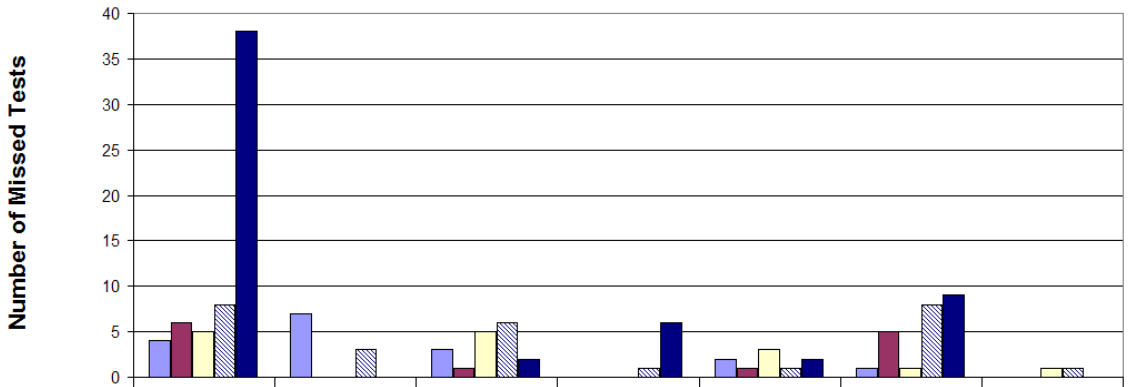
During 2009, thirty-eight safety system tests were missed at Bruce A. The majority of the missed special safety system tests were due to a miscoding problem in the station's scheduling program, which Bruce Power has since corrected. The missed tests for the standby and safety-related systems were delayed due to scheduling conflicts, but were eventually completed. These missed tests are a small percentage of the tens of thousands of tests performed each year.

Figure 9: Trend Details of Missed Mandatory Safey System Tests for Industry



	Special	Standby	Safety Related	Total
2005 (total # tests=84,099)	11	2	4	17
2006 (total # tests=85,702)	4	2	7	13
2007 (total # tests=91,454)	9	0	6	15
2008 (total # tests=90,396)	13	1	14	28
2009 (total # tests=89,150)	36	8	13	57

Figure 10: Trend of Missed Mandatory Safety System Tests for Stations



	Bruce A	Bruce B	Darlington	Pickering A	Pickering B	Gentilly-2	Point Lepreau
2005	4	7	3	0	2	1	0
2006	6	0	1	0	1	5	0
2007	5	0	5	0	3	1	1
2008	8	3	6	1	1	8	1
2009	38	0	2	6	2	9	n/a

1.4.4 Equipment Qualification

In 2009, the Equipment Qualification rating for licensees was based on the performance of their Environmental Qualification (EQ) programs. The industry average rating for EQ performance was "Satisfactory". Point Lepreau was not rated, due to its refurbishment status.

EQ requirements are defined in CSA N290.13-05 "Environmental Qualification of Equipment in CANDU NPPs". The purpose of an EQ program is to ensure that all required systems, equipment, components, protective barriers, and structures in a nuclear facility are qualified to perform their safety functions if exposed to harsh environmental conditions resulting from certain Design Basis Accidents. This capability is preserved for the life of the plant. The baseline EQ program for all sites, except Darlington, was fully implemented by 2004. Darlington is required to fully implement its EQ program by December 31, 2010.

From the initial implementation of their EQ programs, most licensees identified some weaknesses associated with activities necessary to preserve EQ. EQ preservation requires continued effective coordination of requirements across all interfacing supporting organizations and programs, such as:

- engineering change control
- performance monitoring
- maintenance
- procurement
- training
- quality assurance
- operating experience
- corrective actions

Weaknesses have also been recognized in the integration of EQ into some performance monitoring programs. However, the overall condition monitoring of EQ equipment is continually improving.

1.5 Emergency Preparedness

Safety Area	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Emergency Preparedness	**FS**	**FS**	**FS**	**SA**	**SA**	**FS**	**–**	**FS**

Emergency preparedness programs throughout the industry continued to meet, and often exceeded CNSC performance expectations in 2009. Three stations were rated "Fully Satisfactory" and three were rated "Satisfactory" for performance in this safety

area. Point Lepreau was not rated due to its refurbishment status. The industry average rating for Emergency Preparedness was "Fully Satisfactory".

Reactors undergoing refurbishment require greater emphasis on different or new areas of emergency preparedness planning. For example:

- Emergency preparedness plans and procedures for dealing with mixed work sites (i.e. major refurbishment projects on the same site as operating reactors).
- Emergency preparedness readiness, particularly with respect to working with off-site response organizations, after major lay-ups due to long term refurbishment projects.
- Potential impacts on licensee emergency preparedness programs, due to the extended lives of existing reactors and potential new reactors, with respect to the neighbouring communities, as they continue to grow and evolve around the NPP sites.

The CNSC staff assesses these elements of emergency preparedness planning for all current and future refurbishment projects, including Point Lepreau.

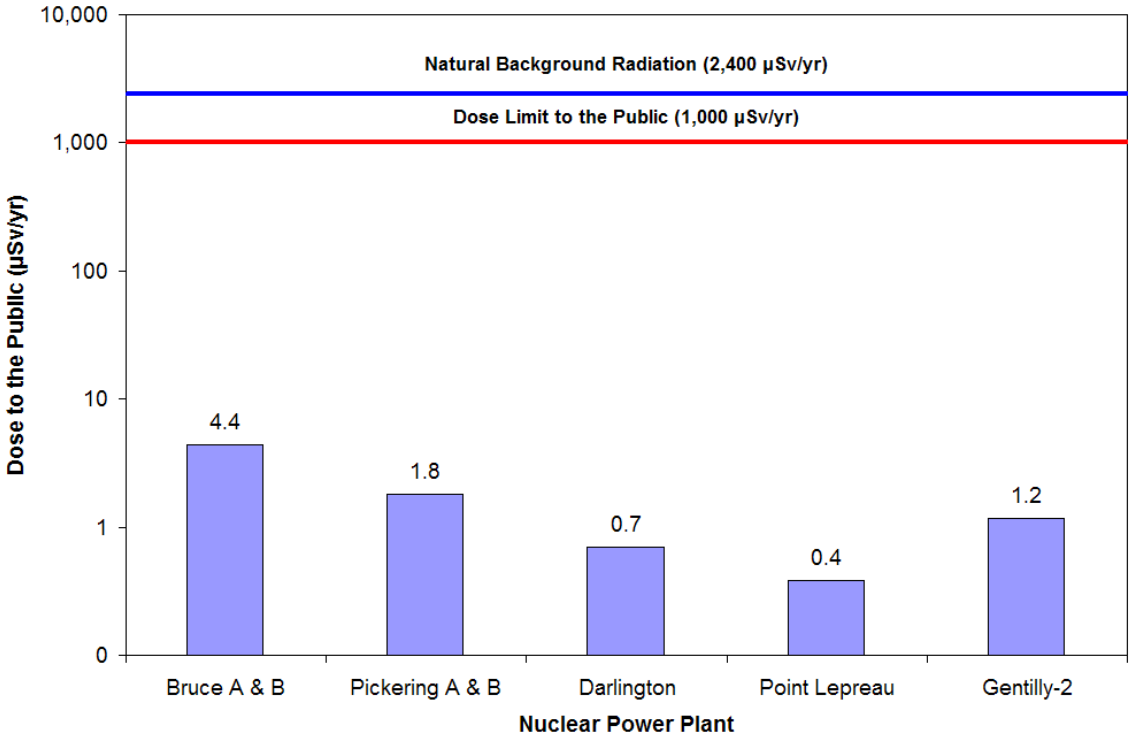
1.6 Environmental Protection

Safety Area	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Environmental Protection	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**

In 2009, all NPP licensees met CNSC expectations for Environmental Protection program performance. The industry average rating was "Satisfactory".

The dose to the public from each Canadian NPP in 2009 is provided in Figure 11. The figure shows that the doses to the public are well below the regulatory public dose limit of 1,000 μSv/year.

Figure 11: Doses to the Public from Canadian NPPs in 2009



To ensure that the public dose limit and release limits are not exceeded, the power reactor operating licence (PROL) restricts the amounts of radioactive material that may be released from the NPP. These effluent limits are derived from the public dose limit (1,000 µSv/year) and are referred to as Derived Release Limits (DRLs).

The licensees establish Action Levels which are set at 10% of the DRLs. If reached, these levels 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 for 2009 are shown in Figures 12 and 13, respectively. Both airborne emission and liquid releases were lower than the DRLs in 2009, and were always well below the Action Levels.

Figure 12: Radionuclides Emitted to Air by Canadian NPPs in 2009

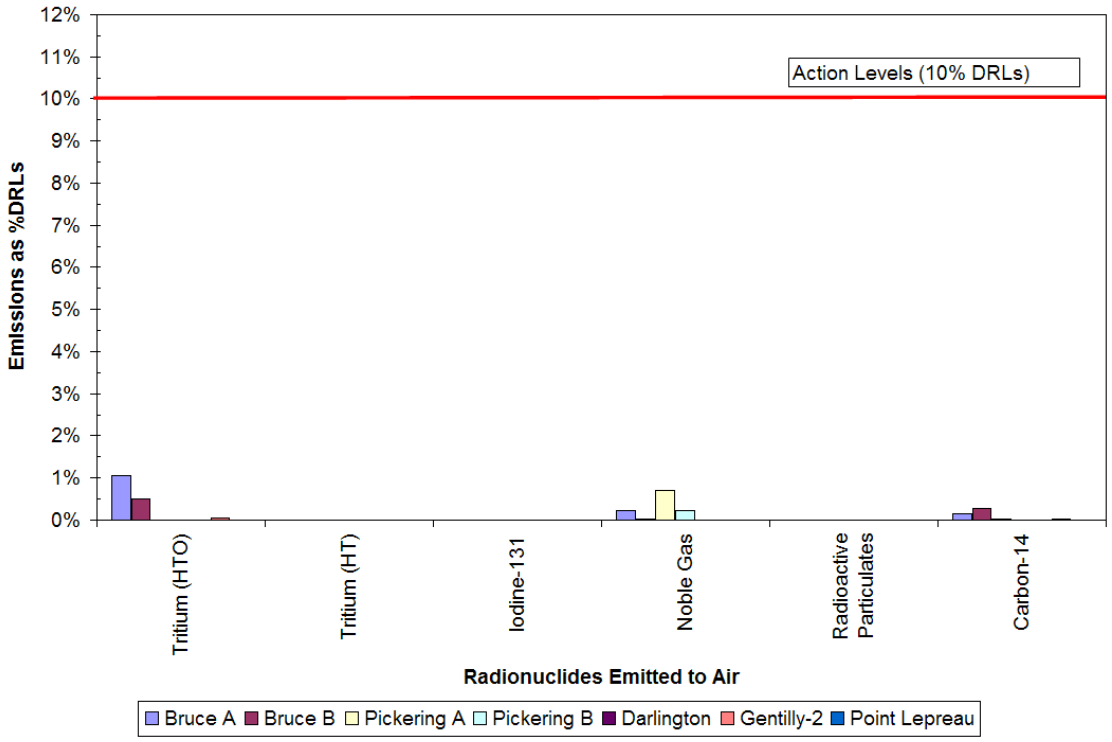
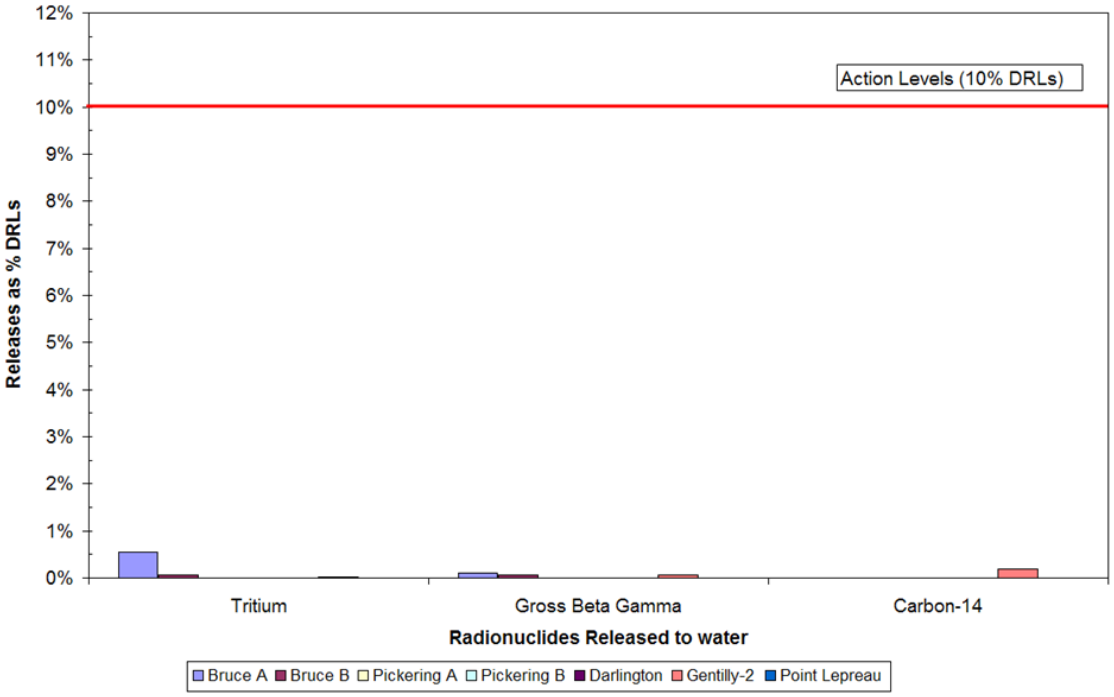


Figure 13: Radionuclides Released to Water by Canadian NPPs in 2009



DRLs should be reviewed and, if necessary, updated approximately every 5 years. In 2009, Bruce Power submitted revised DRL calculations, based on updated models and site specific surveys. The DRLs for Darlington and Pickering were last updated in 2005 and 2007, respectively. Point Lepreau and Gentilly-2 are currently revising their DRLs, which were last updated in 1996 and 1989.

1.7 Radiation Protection

Safety Area	Rating							
	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Radiation Protection	SA	SA	SA	SA	SA	SA	SA	SA

The industry average rating for Radiation Protection performance was "Satisfactory" in 2009. CNSC staff is satisfied that all licensees have Radiation Protection programs in place, to control the radiological hazards present in the facilities and to keep radiation exposures to workers and members of the public as low as reasonably achievable (ALARA).

At the time of writing this report, there were no radiation exposures at any NPP in 2009 that were reported to have exceeded regulatory limits. The 2009 dose information for all stations is provided in Appendix F.

In November 2009, high airborne radioactivity was detected at Bruce A Unit 1. The radioactivity was associated with the Unit 1 restart project work, and subsequent analysis showed that it contained alpha contamination. Bruce Power is continuing to investigate the incident and assess the magnitude of the radiological exposure to all workers potentially affected. The outcome of this work will be considered in the 2010 NPP Report. See Section 2.1.7 for more detail.

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. Tables 6 and 7 show the Radiation Occurrence Index reported for each station during 2009 and over the past 5 years. The 2009 data for Bruce A is incomplete. pending the outcome of the alpha contamination incident.

Table 6: Radiation Occurrence Index for 2009

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

TBD= to be determined.

Table 7: Trends of Radiation Occurrence Index for Stations

Station	Radiation Occurrence Index				
	2005	2006	2007	2008	2009
Bruce A	0	0	0	0	TBD
Bruce B	0	0	0	5	0
Darlington	0	0	0	0	0
Pickering A	0	12.6	10	0	0
Pickering B	18	15	0	7	0
Gentilly-2	17.1	0	0	0	5
Point Lepreau	21.8	0	0	0	0

1.8 Safeguards

Safety Area	**Rating**							
	BA	**BB**	**Darl**	**PA**	**PB**	**G-2**	**PL**	**Industry Average**
Safeguards	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**	**SA**

In 2009, all NPP licensees met applicable CNSC requirements and performance expectations for Safeguards and were rated “Satisfactory”. The industry average rating was also “Satisfactory”.

Safeguards is a system of inspection and other verification activities undertaken by the International Atomic Energy Agency (IAEA) to evaluate 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, following 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 annual assurance 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. The CNSC is the governmental authority responsible for implementing the Canada-IAEA safeguards agreement.

To implement safeguards requirements at the facility level, the CNSC requires that licensees put in place a program and appropriate procedures to ensure that safeguards can be implemented effectively and in a manner consistent with Canada's obligations. These requirements are described in the facility's licence, the *Nuclear Safety and Control Act* and CNSC regulatory documents. Through the safeguards safety area, CNSC staff evaluates the licensee's program and procedures, and their implementation, in order to assess compliance with the license conditions.

The IAEA's findings and conclusions for Canada are presented to the IAEA Board of Governors each June in the "Safeguards Implementation Report". Although there are interim reports from the IAEA on inspection activities at specific facilities, the IAEA has yet to report its final conclusion on the safeguards results for any Canadian facility for 2009; however, a positive result is expected by CNSC staff.

In 2009, CNSC safeguards staff continued their participation in a series of trilateral meetings with the IAEA and licensees, to assist in the refinement of IAEA safeguards implementation procedures. Under the new state-level integrated safeguards approach, the IAEA will carry out fewer inspections at the NPPs. However, the 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 several advantages: greater flexibility to perform activities without coordination with the IAEA (particularly for spent fuel transfers to dry storage); the ability to select their own dates for physical inventory taking; and reduced resource allocation during activities that no longer require inspector presence.

The development of the required procedures for spent fuel transfers at the single-unit stations was completed in March 2009. While the implementation of the procedures was delayed, due to the refurbishment at Point Lepreau and equipment installation at both sites, the CNSC and the IAEA have agreed that the procedures are to be in place before the next spent fuel transfer campaign begins at Gentilly-2 (in spring 2010) and at Point Lepreau (in spring 2011). A similar procedure has been in place at the multi-unit stations since 2007.

1.9 Integrated Industry Rating

	BA	BB	Darl	PA	PB	G-2	PL	Industry Average
Integrated plant rating	**FS**	**FS**	**FS**	**SA**	**SA**	**SA**	**SA**	**SA**

In 2009, the average integrated plant rating was "Satisfactory", with three stations achieving "Fully Satisfactory" ratings and four stations achieving "Satisfactory" ratings.

The integrated plant rating is a general measure of the overall acceptability of the performance of the entire set of programs and safety areas for each NPP, as measured against their relevant requirements and expectations. The integrated plant rating is

determined by combining the ratings of the individual safety areas, using "weights" that represent the relative contribution of each safety area to the objective of protecting the health and safety of Canadians and the environment. In 2009, both Security and Safeguards were excluded from the integrated plant rating, recognizing that these areas correspond to important elements of CNSC's mandate that complement—but are separate from—the mandate to protect health, safety, and the environment.

2.0 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 Site Security, as previously indicated).

2.1 BRUCE A and BRUCE B

Table 8 presents the performance ratings for Bruce A and Bruce B in 2009. All safety areas and programs received "Satisfactory" or "Fully Satisfactory" performance ratings, with improvements noted in the performance of the Operations and Maintenance programs at both stations, as well as in the Design program at Bruce A. The 2009 integrated plant ratings for Bruce A and B were both "Fully Satisfactory".

There were no serious process failures at Bruce A or B, during 2009. No member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels. At the time this report was produced, there were no confirmed worker doses above the regulatory limit.

Bruce Power reported events as per S-99 reporting requirements, and conducted—or is conducting—appropriate follow-up, which includes root cause analysis and corrective action, as needed.

Based on these observations and the assessments of the safety areas, CNSC staff concludes that Bruce A and B were operated safely in 2009.

Bruce Power also complied with licence conditions concerning Canada's international safeguards obligations in 2009.

Table 8: Performance Ratings for Bruce A and B for 2009

Safety Area Program	Rating Bruce A	 Bruce B
Operating Performance	**FS**	**FS**
Organization and Plant Management	SA	SA
Operations	FS	FS
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	SA	SA
Equipment Fitness for Service	**SA**	**SA**
Maintenance	SA	SA
Structural Integrity	SA	SA
Reliability	SA	SA
Equipment Qualification	SA	SA
Emergency Preparedness	**FS**	**FS**
Environmental Protection	**SA**	**SA**
Radiation Protection	**SA**	**SA**
Integrated plant rating*	**FS**	**FS**
Site Security	**Prescribed**	**Prescribed**
Safeguards	**SA**	**SA**

* Site Security and Safeguards were excluded from the integrated plant rating, recognizing that these areas correspond to important elements of CNSC's mandate that complement—but are separate from—the mandate to protect health, safety, and the environment.

2.1.1 Operating Performance

Safety Area Program	Rating Bruce A 2008	 2009	 Bruce B 2008	 2009
Operating Performance	**SA**	**FS**	**SA**	**FS**
Organization and Plant Management	SA	SA	SA	SA
Operations	SA	FS	SA	FS
Occupational Health and Safety (non-radiological)	FS	FS	FS	FS

The Operating Performance safety areas at both Bruce A and B were rated "Fully Satisfactory" in 2009. This is an improvement over the 2008 ratings and reflects improved performance in the Operations programs and continued fully satisfactory performance in Occupational Health and Safety programs at both stations.

2.1.1.1 Organization and Plant Management

Bruce A and B's performance in Organization and Plant Management continued to meet CNSC expectations in 2009, and was rated "Satisfactory".

Throughout 2009, the performance of Bruce Power management conformed to the requirements of the Canadian Standards Association (CSA) N286.0-N286.7 series of standards. These requirements include requirements for appropriate leadership and continued improvement, in order to achieve and maintain a high performance of plant management. CNSC staff is satisfied that Bruce Power has demonstrated capable organization and management of its safety programs and provides adequate attention to health, safety, security, environmental protection and international obligations.

Under the renewed PROLs, Bruce Power is required to conduct their licensed activities in accordance with CSA N286-05 "Management System Requirements for Nuclear Power Plants", which replaced the N286.0-N286.7 series. N286-05 will form the basis of CNSC compliance verification activities in this area, from now on.

There were four forced outages at Bruce A in 2009, and ten forced outages at Bruce B. Bruce A experienced two trips, one stepback and one setback. Bruce B experienced one trip, seven stepbacks and one setback. There were no serious process failures at either station. Operating crews followed procedures, and the stations responded as per design. All events were investigated or evaluated, and CNSC staff concluded that Bruce Power took appropriate corrective actions.

2.1.1.2 Operations

Bruce A and B's performance ratings for Operations improved in 2009, and are now "Fully Satisfactory". CNSC staff found a high degree of compliance, particularly in field and control room inspections.

There were two planned outages at Bruce A Units 3 and 4, and one planned outage at Bruce B Unit 8. The Bruce B Unit 6 planned outage scheduled for the fall was deferred until the spring of 2010. Overall, outage execution and outage safety and work management met CNSC expectations.

2.1.1.3 Occupational Health and Safety (non-radiological)

Bruce A and B's performance in Occupational Health and Safety remained "Fully Satisfactory" in 2009.

The accident severity rate (see Section 1.1.3 for definition) for Bruce A and B combined was 0.0 in 2009. Bruce Power has achieved approximately 17.9 million hours without an acute lost time accident, demonstrating a high degree of personnel safety through occupational health and safety work practices and conditions.

In April 2009, a crane cable broke and the crane's hook fell about 30 meters to the floor of the Bruce B turbine hall. Due to normal protective measures, no one was close to the fall area, and no damage to equipment occurred. The Ministry of Labour investigated

the incident and no fines or penalties were issued. CNSC staff is satisfied with Bruce Power's response to this event.

2.1.2 Performance Assurance

Safety Area / Program	Rating			
	Bruce A		Bruce B	
	2008	2009	2008	2009
Performance Assurance	**SA**	**SA**	**SA**	**SA**
Quality Management	SA	SA	SA	SA
Human Factors	SA	SA	SA	SA
Training, Examination and Certification	SA	SA	SA	SA

The Performance Assurance safety areas at Bruce A and Bruce B remained "Satisfactory" in 2009.

2.1.2.1 Quality Management

Bruce A and B's Quality Management programs continued to meet CNSC performance expectations in 2009, and were rated "Satisfactory". CNSC inspections of document control and records management at both stations, as well as the restart activities at Bruce A, did not identify any significant issues. Bruce Power continues with extensive internal reviews of its programs and processes, in order to further improve the station management system.

A Type I inspection of work management at Bruce A and B in 2009 was the first inspection to be based on the requirements of CSA N286-05. It examined Bruce Power's planning, scheduling, documenting, performing and verifying of online and outage maintenance activities. The inspection identified some deficiencies with planning and scheduling, resources, work package verification, documentation and management of staged goods. The broad scope of the findings underscores the need for stronger management support to ensure effective implementation of appropriate corrective actions. Bruce Power's response to this inspection is expected in 2010.

2.1.2.2 Human Factors

Bruce A and B maintained "Satisfactory" performance ratings for their Human Factors programs in 2009. No significant human factors issues were identified for either station. Bruce Power has made improvements in the area of fatigue management, to ensure workers remain alert and fit for duty.

Bruce Power committed to conduct a comprehensive review of their minimum complement, according to 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". CNSC staff will continue to monitor Bruce Power's progress towards completion of this review, which is expected in 2011.

In June 2009, CNSC staff inspected the Units 1 and 2 refurbishment project's human factors in design process. Although several strengths were noted, staff raised concerns

relating to the lack of independent review for some contractor deliverables, deficiencies with respect to the design, analysis, verification and validation activities, and lack of adequate review of maintenance-related human factors. CNSC staff will monitor Bruce Power's progress on resolving these issues in 2010.

2.1.2.3 Training, Examination and Certification

In 2009, the performance of Bruce A and B's Training, Examination and Certification program continued to be "Satisfactory". There were no significant issues resulting from inspections of this program area. CNSC staff is satisfied that Bruce Power has sufficient numbers of qualified workers to carry out licensed activities.

In 2009, Bruce A's pass rate for initial certification examinations was 90%, while the Bruce B pass rate was 88.3%. Bruce Power's overall pass rate for requalification was 96%. CNSC staff finds these results acceptable.

2.1.3 Design and Analysis

Safety Area / Program	Rating			
	Bruce A		Bruce B	
	2008	2009	2008	2009
Design and Analysis	**SA**	**SA**	**SA**	**SA**
Safety Analysis	SA	SA	SA	SA
Safety Issues	SA	SA	SA	SA
Design	BE	SA	SA	SA

Performance in the Design and Analysis safety areas at Bruce A and B remained "Satisfactory" in 2009.

2.1.3.1 Safety Analysis

Safety Analysis program performance at Bruce A and B continued to be "Satisfactory" in 2009. Updates on many of the issues common to all or most NPP licensees are discussed in Section 1.3.1.

Safety Report Update

In February 2009, Bruce Power submitted an update to the analysis sections of the Bruce A Safety Report, as well as a work plan for safety report improvement. The CNSC's review findings are being addressed through the Industry Safety Analysis Improvement Working Group (see Section 1.3.1 "Safety Analysis Improvement Program").

Impact of Plant Aging on Safety Analysis

This issue, common to both Bruce Power and OPG, is described in Section 1.3.1. Bruce Power has developed an action plan to deal with all outstanding issues related to the Independent Technical Panel report and CNSC review. The first quarterly progress report was provided to CNSC staff in November 2009, and is currently under review. CNSC staff concludes that Bruce Power is adequately managing this issue.

Probabilistic Risk Assessment

Under the renewed PROLs for Bruce A and B, Bruce Power is required to perform probabilistic safety assessments (PSA) in accordance with CNSC standard S-294 "Probabilistic Safety Assessment for Nuclear Power Plants". In 2009, Bruce Power submitted a PSA improvement plan for Bruce A and B risk assessments. CNSC staff is currently reviewing the plan.

Bruce Power continues to work on the Bruce A Probabilistic Risk Assessment (BAPRA) and the Bruce B Risk Assessment models. Areas such as the validity of the assumptions, reliability data, and human reliability modelling are required to make the models more plant specific and to reflect the plants as-built and operated. The use of plant specific reliability data will increase the level of confidence in the models.

2.1.3.2 Safety Issues

In 2009, Bruce Power continued its work, including participation in industry efforts, toward the resolution of GAIs and CANDU safety issues. Performance in this program area remained "Satisfactory" in 2009.

GAI 95G01 "Molten Fuel Moderator Interaction" was closed for Bruce A and B in 2009. GAI 95G05 "Moderator Temperature Predictions" was closed for Bruce B in 2009 and for Bruce A in early 2010. A brief description and the expected year of completion for each remaining GAI are provided in Appendix E.

Bruce Power continues to lead the industry and put adequate resources into its efforts towards resolving the large break LOCA issue. It is expected that all issues related to large LOCA will be resolved by 2013.

2.1.3.3 Design

Both Bruce A and Bruce B's performance in Design was rated "Satisfactory" in 2009. This is an improvement for Bruce A, which was rated "Below Expectations" in 2007 and 2008, due to legacy issues related to configuration management. CNSC staff is satisfied with the progress Bruce Power is making towards resolution.

Under the renewed PROLs, Bruce Power is required to comply with the 2008 version of CSA N285.0 "General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants". Bruce Power submitted a transition plan to meet this requirement and, as part of that plan, has committed to have all system design registrations, including system classification lists, updated by December 31, 2012. CNSC staff has reviewed the transition plan and finds it acceptable.

Bruce Power's fire protection program has shown improvements with respect to transient combustible materials and fire loading. Bruce Power's analysis indicates that fire safe shutdown cabling might be damaged in the event of a fire in the new fuel storage areas and fuel loading rooms, and recommends modifications and upgrades to address these findings. To date, Bruce Power has implemented some compensatory

measures. CNSC staff and Bruce Power will determine a path forward, based on the agreed risk determination of these issues.

CNSC staff identified several deficiencies during an inspection of the electrical distribution system function at Bruce A. Bruce Power is making progress in resolving most of the identified deficiencies, and CNSC staff will continue to monitor Bruce Power's progress to ensure that the proposed corrective actions are appropriate.

2.1.4 Equipment Fitness for Service

Safety Area Program	Rating			
	Bruce A		Bruce B	
	2008	2009	2008	2009
Equipment Fitness for Service	**SA**	**SA**	**SA**	**SA**
Maintenance	BE	SA	BE	SA
Structural Integrity	SA	SA	SA	SA
Reliability	SA	SA	SA	SA
Equipment Qualification	SA	SA	SA	SA

Performance in the Equipment Fitness for Service safety areas at Bruce A and B remained "Satisfactory" in 2009.

2.1.4.1 Maintenance

Maintenance program performance at both Bruce A and B improved in 2009 and was rated "Satisfactory" for both stations. Maintenance inspections carried out during 2009 concluded that Bruce Power has satisfactory maintenance organizations with supporting policies processes and procedures. Areas for improvement include work completion and consistent implementation of processes.

Bruce Power has taken steps to reduce maintenance backlogs at Bruce A and B to ensure continued compliance with CNSC licence conditions. In 2009, the corrective maintenance backlogs at Bruce A and B improved, although the elective maintenance backlogs were worse. CNSC staff will continue to monitor Bruce Power's progress in reducing all maintenance backlogs.

Deficiencies with the Bruce Power Temporary Change Control (TCC) process were discovered in 2008, after Bruce Power self-assessed the impact of changes to their TCC procedures and found that the number of temporary changes had increased and the procedure had not been followed correctly. The discovery was reported to the CNSC in February 2009, and a root cause analysis initiated. Bruce Power further discovered that some temporary modifications had been installed without following the Bruce Power Engineering Change Control process. CNSC staff is monitoring Bruce Power's progress with implementing corrective measures to the TCC process.

2.1.4.2 Structural Integrity

Bruce A and B's Structural Integrity performance ratings remained as "Satisfactory" for 2009.

Bruce Power inspects and tests pressure retaining and containment systems, structures and components, in accordance with the station Periodic Inspection Program (PIP) and applicable CSA standards. No significant findings related to pressure boundary degradation at Bruce A or B were identified during the 2009 inspection campaigns. There were also no significant findings identified from CNSC staff reviews of Bruce A and B S-99 operations and pressure boundary reports, submitted in 2009.

Bruce Power has committed to updating the PIP documents for nuclear components, metallic and plastic containment components, and concrete containment structures to meet the requirements of the new versions of standards CSA N285.4-05, CSA N285.5-08 and CSA N287.7-08 in 2010.

Bruce Power has performed a gap analysis between the original design code requirements of the Bruce A concrete containment structures and the requirements of CSA N287.3, as per their commitments in the Bruce A and B Licence Conditions Handbooks. Bruce Power submitted the requested information in October 2009, and these materials now are under review by CNSC staff.

2.1.4.3 Reliability

Reliability program performance remained "Satisfactory" for both Bruce A and B in 2009.

All special safety systems at Bruce A and B met their unavailability targets in 2009, with the exception of the Negative Pressure Containment (NPC) system at Bruce B. The seismically-qualified air supply to containment pressure relief valves was unavailable for 17 hours, which caused the NPC to exceed its unavailability target. The risks from this occurrence are not considered significant, because of the limited extent of the impairment and because the impairment relates to a low-probability seismic event.

Performance indicator data for missed mandatory safety system tests is provided in Section 1.4.3, Table 5. During 2009, thirty-eight safety system tests were missed at Bruce A. The majority of the missed special safety system tests were due to a miscoding problem in the station's scheduling program, which Bruce Power has now corrected. The missed tests for the standby and safety related systems were delayed, due to scheduling conflicts, but were eventually completed.

Bruce Power submitted their formal Reliability Program for CNSC review in 2008. CNSC staff's review of this program identified some issues that are currently being addressed by Bruce Power.

2.1.4.4 Equipment Qualification

Performance in the Equipment Qualification program continued to be "Satisfactory" for both Bruce A and B, in 2009.

Bruce Power has fully implemented environmental qualification (EQ) programs for Bruce A Units 3-4 and Bruce B Units 5-8. To be consistent with the requirement of their EQ program, Bruce Power is in the process of qualifying Units 1 and 2. This work must be completed prior to the restart of the units.

CNSC staff inspected the EQ program at Bruce B to verify the sustainability of the station's EQ requirements. Staff made some findings related to the Bruce B powerhouse emergency venting system documentation, health reporting, maintenance training, and condition monitoring. However, no significant issues were identified.

2.1.5 Emergency Preparedness

Safety Area	Rating			
	Bruce A		Bruce B	
	2008	2009	2008	2009
Emergency Preparedness	FS	FS	FS	FS

In 2009, CNSC staff assessments of Emergency Preparedness at Bruce A and B did not identify any significant issues. Bruce Power operates a mature Emergency Preparedness program and continues to demonstrate fully satisfactory performance.

2.1.6 Environmental Protection

Safety Area	Rating			
	Bruce A		Bruce B	
	2008	2009	2008	2009
Environmental Protection	SA	SA	SA	SA

Bruce Power maintained satisfactory performance in Environmental Protection at Bruce A and B, and continued to meet CSNC expectations in 2009.

The reported dose to the public from the Bruce site in 2009 was 4.41 μSv, which is well below the public dose limit of 1,000 μSv. In addition, gaseous and aqueous releases of nuclear substances were below Environmental Action Levels for both stations.

In 2009, Bruce Power submitted revised Derived Release Limits (DRL) calculations, based on new scientific information on dose calculations and relevant parameters, updated models and an updated site specific survey. Bruce Power also submitted revised Action Levels for the control of releases of nuclear substances. The DRL gives the CNSC assurance that emissions to the environment will not result in an exceedence of the public dose limit of 1,000 μSv/yr. Action levels are typically 10% of DRLs and are in place for the licensee to initiate control measures to prevent releases from

reaching the DRL level. CNSC staff reviewed both DRL and Action Level documents and found them to be acceptable.

2.1.7 Radiation Protection

Safety Area	Rating			
	Bruce A		Bruce B	
	2008	2009	2008	2009
Radiation Protection	SA	SA	SA	SA

Both Bruce A and B's performance in Radiation Protection remained "Satisfactory" in 2009. Based on the assessment of its findings in this area, CNSC staff is satisfied that Bruce Power provided adequate protection of the health and safety of persons inside their facilities, with respect to ionizing radiation.

In November 2009, high airborne radioactivity associated with the restart project activities was detected at Bruce A Unit 1. Analysis confirmed the presence of alpha contamination. Bruce Power reported the event to the CNSC in January 2010, when the preliminary dose estimates for the workers in the area indicated that an action level may have been exceeded. CNSC staff conducted an inspection and concluded that Bruce Power took appropriate action to contain the contamination and protect the health and safety of workers. Bruce Power continues to investigate the incident and is conducting a root cause investigation. The findings and corrective actions resulting from this investigation will be provided to the CNSC upon completion. Bruce Power is also in the process of assessing the magnitude of radiological exposures to all workers potentially affected by this event. The event's impact on radiation protection at Bruce A will be considered in the 2010 NPP Report, after a full assessment and analysis of the event is completed.

The 2009 dose information for Bruce A and B is provided in Appendix F.

2.1.8 Site Security

This safety area is presented to the Commission in a separate Commission Member Document (CMD 10-M47.A).

2.1.9 Safeguards

Safety Area	Rating			
	Bruce A		Bruce B	
	2008	2009	2008	2009
Safeguards	FS	SA	FS	SA

The Safeguards safety areas at Bruce A and B met applicable CNSC requirements and performance expectations in 2009, and both stations received a "Satisfactory" rating. These ratings are lower than the ones assigned in 2008, due to changes in the methodology for assessing Safeguards. There has been no significant change in the stations' performance. 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.

The IAEA conducted a Physical Inventory Verification (PIV) at Bruce A on June 17, 2009. The inspection was undertaken to verify that no diversion of nuclear material had taken place, to 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 reviewed 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.

The IAEA did not select Bruce B for a PIV in 2009. In its absence, the CNSC conducted a Physical Inventory Taking Evaluation, to provide assurances to the IAEA that the facility was properly prepared for a PIV, had it been selected. This was the first year that the CNSC performed this type of evaluation. No significant compliance issues were identified.

During an IAEA short-notice random inspection in May, Agency inspectors experienced an unprecedented delay of approximately five hours in gaining initial access at the facility, which was attributed to a number of coincident factors. The consistent provision of prompt access is important to both the successful implementation of safeguards in Canada and compliance with the licence conditions. The CNSC resolved the issue through normal channels of communication, and the station has taken action to ensure that such incidents will not happen again. Despite the delay, the IAEA was able to meet its safeguards objectives for the inspection.

2.1.10 Regulatory Decisions and Initiatives

Bruce A and B Licences

- Bruce A and B PROL were renewed for a 5-year period (effective from November 1, 2009, until October 31, 2014) in October 2009.
- No further amendments were made to Bruce A or B PROL, during the remainder of 2009.

The Bruce A and B operating licences were the first PROLs to be renewed under the CNSC's licence reform project. The primary objective of this project was to improve effectiveness and efficiency of regulatory oversight of NPPs, by focusing on risk-significant issues and by reducing purely administrative efforts that have little or no impact on safety.

Bruce A Unit 1 and 2 Restart

- Units 1 and 2 fuel reload approval was granted by the Commission in October 2009.
- Remaining hold points for restart:
    - refuelling the reactors
    - releasing the reactor guaranteed shutdown state (GSS) and subsequent approach to critical
    - increasing the reactor power above 50%

The CNSC Executive Vice President of Operations has been delegated the authority to approve the release of these hold points.

Out of the 27 prerequisites that must be met prior to releasing the hold points, six have been completed satisfactorily, and four items are currently under review by CNSC staff. The remainder are expected to be submitted in 2010.

Licence Conditions Handbook

The new PROLs are accompanied by a Licence Conditions Handbook (LCH). The purpose of the LCH is to:

- Provide compliance verification criteria to licensee and CNSC staff on how to ensure compliance with the PROL.
- Establish a process for managing records and documents.
- Document the implementation timelines for specific licence conditions.
- Establish the criteria required to obtain CNSC consent where required to do so by a licence condition.
- Provide a clear understanding for each regulatory requirement specified by the Commission in the licence.

Changes to the LCH must be accepted by the CNSC's Director General, Directorate of Power Reactor Regulation.

Early feedback from the CNSC site inspectors indicates that the LCH is proving to be a useful tool, particularly for answering licensee questions about CNSC expectations.

There were no updates made to the LCH in 2009.

Bruce A Environmental Assessment Program

The Bruce A Life Extension project was subject to a screening-level environmental assessment (EA) between 2004 and 2005. Since then, Bruce Power has implemented several of the activities identified in the CEAA Follow Up Program, a condition of their licence, including a long-term whitefish monitoring program, which was carried out in collaboration with stakeholders.

The Bruce A EA Follow-up Monitoring Program work continues, according to the plans approved by the CNSC in August 2009. CNSC staff has accepted final

disposition of review comments on the initial monitoring year (2007) program report, and expect to receive the Year 2 report (2008) by mid-2010 and the Year 3 report (2009) before September 2010. The preparation of these latter two reports was deferred until Bruce Power understood and resolved review comments on the initial Year 1 report. The Ontario Ministry of Natural Resources has entered the monitoring data from the 2009 site angler bass fishing survey into a specialized database, and has provided the results of its analyses to Bruce Power, for use in designing a replicate survey in 2010.

Aboriginal Consultation

With respect to activities carried out during the Bruce A Environmental Assessment Program, Bruce Power and the Saugeen Ojibway Nations (SON) are cooperating in the development of a research program to address SON's outstanding concerns related to the whitefish studies, including the possible impacts on fish populations from impingement, entrainment and the thermal plume.

The CNSC recognizes that First Nations and Metis peoples in the Bruce region may have concerns with regard to nuclear projects and has sought opportunities to work together with the various Aboriginal groups to ensure the safe and effective regulation of nuclear energy and materials at the Bruce site. The CNSC uses a good governance approach to effective and well-managed Aboriginal consultation processes at the Bruce site when Aboriginal rights or interests could be impacted.

2.1.11 Update on Major Projects

Bruce A Units 1 and 2 Life Extension

Some of the major work activities in 2009 included:

- Installation of Unit 2 calandria tubes (completed)
- Installation of Unit 2 fuel channels (in progress)
- Installation of Unit 1 calandria tubes (in progress)
- Replacement of ion chambers and vertical flux monitors
- Heavy water upgrader placed in service
- Mechanical work on turbine generators (completed)

The overall project schedule has been delayed, due to changes to the baseline refurbishment activities. Of the 54 Integrated Implementation Plan items that Bruce Power has committed to complete before restart, only 9 have been completed, while the remainder are still in progress.

Bruce A Units 3 and 4 and Bruce B Life Extension

Plans for the possible refurbishment of Bruce A Units 3 and 4 and Bruce B Units 5 to 8 are currently under discussion with interested stakeholders.

Large LOCA Margin Restoration

The Low Void Reactivity Fuel (LVRF) was 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 properties.

In April 2009, Bruce Power informed the CNSC that the LVRF project was being suspended. Bruce Power proposed an alternative approach, which includes shutdown system enhancements. These enhancements are expected to provide improved LLOCA margins, including avoidance of prompt criticality following accident initiation, and can be ready to implement at Bruce A and B within approximately 3 years. Moreover, the shutdown system enhancements do not require substantive changes to the core nuclear design.

Bruce Power successfully implemented the core reorder project in all Bruce B units to allow for power operation upgrade from 90% to 93% full power. The Bruce A and B units will remain derated from full power (Bruce A at 92.5 % and Bruce A at 93 %), in order to ensure that adequate safety margins are being maintained

2.2 DARLINGTON

Table 9 presents the performance ratings for Darlington in 2009. All safety areas and programs received "Satisfactory" or "Fully Satisfactory" performance ratings, with the exception of Equipment Qualification, which remained "Below Expectations". The 2009 integrated plant rating for Darlington was "Fully Satisfactory".

There were no serious process failures at Darlington during 2009. No worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels.

OPG reported events as per S-99 reporting requirements and conducted, or is conducting, appropriate follow-up, which includes root cause analysis and corrective actions, as needed.

Based on these observations and the assessments of the safety areas, CNSC staff concludes that Darlington was operated safely in 2009.

OPG also complied with licence conditions concerning Canada's international safeguards obligations in 2009.

Table 9: Performance Ratings for Darlington for 2009

Safety Area Program	**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	SA
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	**SA**
Integrated plant rating*	**FS**
Site Security	**Prescribed**
Safeguards	**SA**

* Security and Safeguards were excluded from the integrated plant rating,

2.2.1 Operating Performance

Safety Area Program	Rating 2008	 2009
Operating Performance	**FS**	**FS**
Organization and Plant Management	FS	FS
Operations	FS	FS
Occupational Health and Safety (non-radiological)	FS	FS

The Operating Performance safety area at Darlington remained "Fully Satisfactory" in 2009.

2.2.1.1 Organization and Plant Management

Darlington's performance in Organization and Plant Management continued to be "Fully Satisfactory" in 2009. Throughout the year, the performance of Darlington's management conformed to the OPG document "Chief Nuclear Officer Expectations" N-CHAR-AS-0002-R12, referenced in the PROL. This document includes aspects of appropriate leadership and continued improvement, so as to achieve and maintain higher performance. OPG Darlington continues to demonstrate capable organization and management of its safety programs, and to provide adequate attention to health, safety, security, environmental protection and international obligations.

In 2009, Darlington experienced three forced outages. Units 2 and 4 were briefly shut down, to repair heat transport system instrument tube leaks to containment. In both cases, the leak rates were less than 50 kg/hour, which is the allowable limit for operation. Unit 3 was also shut down briefly, to repair a malfunctioning valve on the shutdown cooling system.

There were no serious process failures, spurious reactor trips, setbacks or stepbacks at Darlington in 2009.

2.2.1.2 Operations

Darlington's performance in Operations remained "Fully Satisfactory" in 2009. Throughout the year, CNSC staff conducted numerous inspections, including field and control room inspections. There were no significant operations-related issues identified. Darlington continues to demonstrate a high degree of compliance in this area.

In 2009, Darlington underwent two planned outages, including a Vacuum Building Outage, which required the shutdown of all units. This multi-unit outage is non-routine, being scheduled to occur every 12 years, and represents a very large undertaking. Unit 3 also underwent a maintenance outage at the same time.

Overall, the outages were conducted in a safe and efficient manner. CNSC staff monitored licensee performance with respect to safety, environmental protection, structural integrity, radiation protection and overall work management. Overall, the CNSC concluded that the outages were managed appropriately, but recommended a

better level of training for the non-routine maintenance tasks that are performed during outages, particularly by the large number of temporarily-reassigned OPG staff, contractors and temporary employees. CNSC staff also concluded that a more conservative approach to discovery work on non-pressure boundary components was needed.

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.

There were no environmental non-compliance events at the TRF in 2009.

CNSC staff inspected the TRF during an outage, and concluded that it generally met expectations, but that additional efforts were needed to address issues related to outage organization, planning and execution, and staff training and qualifications. CNSC staff is monitoring the resolution of these issues.

2.2.1.3 Occupational Health and Safety (non-radiological)

Darlington's performance in Occupational Health and Safety also remained "Fully Satisfactory" in 2009.

The accident severity rate (see Section 1.1.3 for definition) reported for Darlington in 2009 was 0.95, which is very low in comparison with other industries. Darlington continues to achieve a high degree of personnel safety through its occupational health and work practices and conditions.

2.2.2 Performance Assurance

Safety Area Program	Rating 2008	 2009
Performance Assurance	**SA**	**SA**
Quality Management	SA	SA
Human Factors	FS	SA
Training, Examination and Certification	SA	SA

The Performance Assurance safety area at Darlington continued to be rated "Satisfactory" in 2009.

2.2.2.1 Quality Management

The Quality Management program at Darlington continued to meet CNSC performance expectations in 2009. CNSC inspections and assessments did not identify any significant quality management issues. CNSC staff is satisfied that the program is

adequately documented, and that there are no systematic non-adherences to the documented processes.

2.2.2.2 Human Factors

Darlington's performance in Human Factors declined from "Fully Satisfactory" in 2008, to "Satisfactory" in 2009, due to several minor issues identified over the course of the year. Despite this decline, overall performance continued to meet CNSC expectations. In particular, positive observations were made with respect to contingency planning and improvement initiatives.

OPG has submitted its latest contingency plans for maintaining staff in key positions on-site, as well as strategies for when the station is unable to meet all staff requirements. These plans address man-made and natural disasters, including pandemics. CNSC staff reviewed the plans and concluded that issues identified during previous reviews had been adequately addressed.

Beginning in 2008 and continuing into 2009, OPG has been implementing several improvements initiatives based on the Institute of Nuclear Power Operations (INPO) Performance Model. These improvements aim to reduce safety incidents, reduce re-work and eliminate forced losses due to human factors. CNSC staff is monitoring the effectiveness of these initiatives.

2.2.2.3 Training, Examination and Certification

Darlington's Training, Examination and Certification program continued to be rated "Satisfactory" in 2009. CNSC staff is satisfied that Darlington has sufficient numbers of qualified workers to carry out its licensed activities. There were no significant issues identified in this program area in 2009.

CNSC staff note that throughout 2009, Darlington continued with improvement initiatives to fully implement a Systematic Approach to Training process.

In 2009, the overall success rate in initial certification examinations at Darlington was 93%. The requalification pass rate was 97%. CNSC staff finds these results acceptable.

2.2.3 Design and Analysis

Safety Area Program	**Rating**	
	2008	**2009**
Design and Analysis	**SA**	**SA**
Safety Analysis	SA	SA
Safety Issues	SA	SA
Design	SA	SA

Performance in the Design and Analysis safety area at Darlington remained "Satisfactory" in 2009.

2.2.3.1 Safety Analysis

In 2009, Darlington's Safety Analysis program maintained a "Satisfactory" performance rating. Updates on many of the issues common to all or most NPP licensees are discussed in Section 1.3.1.

Plant Aging on Safety Analysis

This issue, common to Bruce Power and OPG, is described in detail in Section 1.3.1 "Neutron Overpower Protection (NOP) Improved Methodology". CNSC staff has accepted OPG's interim measures on the NOP issue, but additional work is required before the methodology can receive final CNSC acceptance.

Safety Report Update

In November 2009, OPG submitted the most recent update of Part 3 (Accident Analysis) of the Darlington *Safety Report* for CNSC staff review. CNSC review findings will be addressed through the Industry Safety Analysis Improvement Working Group (see section 1.3.1, "Safety Analysis Improvement Program").

Probabilistic Safety Analysis

The Darlington PROL requires OPG to perform a Level 2 PSA in accordance with S-294 "Probabilistic Safety Assessment for Nuclear Power Plants", by December 31, 2011. OPG's progress to date is satisfactory.

2.2.3.2 Safety Issues

In 2009, OPG continued its work—including participation in the industry efforts—toward the resolution of GAIs and CANDU Safety Issues. Performance in this program area remained "Satisfactory" in 2009.

Two GAIs (95G05 and 95G01) were closed for Darlington in 2009. A brief description and the expected year of completion for each remaining GAI are provided in Appendix E.

2.2.3.3 Design

Darlington's performance in Design continued to meet CSNC expectations and was rated "Satisfactory" for 2009. There were no significant performance issues identified in this program area.

2.2.4 Equipment Fitness for Service

Safety Area Program	Rating 2008	 2009
Equipment Fitness for Service	**SA**	**SA**
Maintenance	FS	FS
Structural Integrity	FS	FS
Reliability	SA	SA
Equipment Qualification	BE	BE

Darlington's overall performance in the Equipment Fitness for Service safety area remained "Satisfactory" in 2009.

2.2.4.1 Maintenance

Darlington's performance in Maintenance continued to be "Fully Satisfactory" in 2009. As in 2008, Darlington achieved very low elective and corrective maintenance backlogs and exceeded their preventative maintenance completion rate target (~91% completion rate, versus 80% target). There were no significant maintenance-related issues identified.

2.2.4.2 Structural Integrity

Darlington's performance in Structural Integrity remained "Fully Satisfactory" in 2009. OPG inspects and tests pressure retaining and containment systems, structures and components, in accordance with the station Periodic Inspection Program and applicable CSA standards. No significant findings related to pressure boundary degradation were identified during the 2009 inspection campaign. Darlington has fitness-for-service programs in place to ensure the integrity of pressure tubes, feeders, and steam generators is maintained.

Unit 3 was inspected during the 2009 spring outage. For the first time, OPG obtained scrape samples of the rolled joint area, which will allow certain model predictions to be compared with actual measurements.

The Darlington feeder inspection program was expanded in 2008 to include baseline inspections for all feeders on all units. In 2009, 100% of the baseline inspections of Unit 3 feeders were completed. Also during this outage, one feeder was successfully replaced.

All four steam generators on Unit 3 were inspected during the 2009 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.

2.2.4.3 Reliability

Darlington's Reliability program performance continued to be rated "Satisfactory" in 2009. There were no significant issues identified during CNSC assessments or inspections of this program area last year.

All special safety systems at Darlington met their unavailability targets in 2009. All systems important to safety also met their targets, with the exception of the Shutdown Cooling System (SDCS), which failed to meet an unavailability target on Unit 1 due to zebra mussel blockage on the SDCS pump cooling lines. The affected lines were cut out, the zebra mussels removed, and flow was restored.

Performance indicator data for missed mandatory safety system tests is provided in Section 1.4.3, Table 5. No special safety system tests were missed out of the 10,800 performed.

2.2.4.4 Equipment Qualification

The Equipment Qualification program at Darlington remained "Below Expectations" for 2009, due to the previously-identified deficiencies with implementation of the Environmental Qualification program.

Darlington continues its efforts to meet PROL Condition 7.1, which requires the Darlington EQ program to meet the requirements of CSA standard N290.13-05 "Environmental Qualification of Equipment for CANDU Nuclear Power Plants", by December 31, 2010.

CNSC staff has accepted the scope of the proposed work and is conducting surveillance and monitoring activities, to ensure that it is being appropriately implemented. Substantial upgrades have been completed and the work to meet the licence condition continues.

2.2.5 Emergency Preparedness

Safety Area	Rating	
	2008	2009
Emergency Preparedness	**FS**	**FS**

There were no remedial actions resulting from inspections in 2009, and no evidence that the performance at Darlington has deteriorated from the previous year. Darlington continues to exceed CNSC expectations and demonstrate fully satisfactory performance.

2.2.6 Environmental Protection

Safety Area	Rating	
	2008	2009
Environmental Protection	**SA**	**SA**

Darlington maintained satisfactory performance in Environmental Protection in 2009, and continued to meet CSNC expectations.

The reported dose to the public from Darlington in 2009 was 0.7 μSv, which is well below the public dose limit of 1,000 μSv. Gaseous and aqueous releases of nuclear substances were always below Environmental Action Levels and Derived Release Limits.

In December 2009, Darlington experienced an unplanned release, when lake water was inadvertently pumped into the Injection Water Storage Tank, causing a release of 210 m^3 of slightly contaminated demineralized water to the environment, including Lake

Ontario. Samples taken at local water treatment plants over the following three days showed no increase in tritium levels above background.

2.2.7 Radiation Protection

Safety Area	Rating	
	2008	2009
Radiation Protection	**FS**	**SA**

In 2009, Darlington's rating in Radiation Protection declined from "Fully Satisfactory" to "Satisfactory". This change is due to the collective findings from inspections conducted in 2009, and is not the result of a significant deficiency or indicative of a decline in the overall performance of the program. CNSC staff is satisfied that OPG provided adequate protection of the health and safety of persons at Darlington with respect to ionizing radiation in 2009.

CNSC staff conducted two Type II radiation protection (RP) inspections on the implementation of the RP program at Darlington, including the Waste Handling Facility. There were several minor findings, but no significant deficiencies were identified. OPG has provided a corrective action plan to address issues and continues to work towards the closure of the actions raised. CNSC staff will monitor OPG's progress in resolving these issues.

The 2009 dose information for Darlington is provided in Appendix F. In 2009, 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. During the year, OPG implemented ALARA initiatives at Darlington, including improved shielding techniques and the use of teledosimetry and wireless communications.

2.2.8 Site Security

This safety area is presented to the Commission in a separate Commission Member Document (CMD 10-M47.A).

2.2.9 Safeguards

Safety Area	Rating	
	2008	2009
Safeguards	**FS**	**SA**

The Safeguards safety area at Darlington met applicable CNSC requirements and performance expectations in 2009, and received a "Satisfactory" rating. This rating is lower than the one assigned in 2008, due to changes in the methodology for assessing Safeguards. There has been no significant change in the station's performance. 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 2009, to verify that no diversion of nuclear material had taken place, to 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 reviewed 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.

2.2.10 Regulatory Decisions

Darlington Licence

The Darlington operating license was amended six times in 2009:

PROL 13.04/2013 – Effective January 29

- Incorporated Regulatory Document RD-204 "Certification of Persons working at Nuclear Power Plants".

PROL 13.05/2013 – Effective July 24

- Replaced Revision 3 of the "Organizational Change Control" with Revision 4 in Appendix B.

PROL 13.06/2013 – Effective September 22

- Revised implementation date of CSA standard N293-95 "Fire Protection for CANDU Nuclear Power Plants", and CSA standard N293-07.
- Revised the date by which Darlington NGS is to perform a Level 2 Probabilistic Safety Assessment, in accordance with regulatory document S-294 "Probabilistic Safety Assessment (PSA) for Nuclear Power Plants"
- Incorporated the Regulatory Document RD-363 "Nuclear Security Officer Medical, Physical, and Psychological Fitness".

PROL 13.07/2013 – Effective October 1

- Replaced Revision 1 of the CNSC document "Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants" by an updated version (Revision 2), allowing OPG's implementation of the new requirements.

PROL 13.08/2013 – Effective November 27

- Updated the licence conditions and appendices related to pressure boundaries, in order to accommodate OPG's transition to the 2008 Edition and Update No. 1 of CSA N285.0 "General Requirements for Pressure Retaining Systems and Components in CANDU Nuclear Power Plants", and to accommodate the implementation of a formal agreement with an Authorized Inspection Agency (AIA).

- Replaced Revision 22 of the referenced document entitled "Operating Policies and Principles" with Revision 24.

PROL 13.09/2013 – Effective December 24

- Replaced Revision 8 of the "Consolidated Nuclear Emergency Plan" with Revision 9 in Appendix B.

2.2.11 Update on Major Projects

Modified 37-Element Fuel Bundle

In 2009, Darlington continued work on the modified 37-element fuel bundle project. The project concept consists of a fuel bundle in which the central pin diameter is reduced, while keeping other aspects of the fuel bundle design unchanged. The purpose of the modification is to offset the effects of Heat Transport System aging and restore design safety margins by improving the fuel dry out power over the current design. CNSC staff is currently considering OPG's proposal to load two fuel channels with the modified bundles, in order to visually inspect the irradiated fuel bundles prior to full implementation.

Refurbishment/Life Extension

In 2009, OPG submitted, for CNSC review, an updated procedure for conducting the Integrated Safety Review (ISR) to support plant life extension at Darlington NGS. CNSC staff has communicated the results of their review to OPG and will continue working with OPG in 2010 to resolve all outstanding issues.

In early 2010, OPG confirmed that the Darlington site would undergo a life extension project in 2016, to essentially extend its life to around 2050. Work on this initiative continues.

2.3 PICKERING A

Table 10 presents the performance ratings for Pickering A in 2009. All safety areas and programs received "Satisfactory" performance ratings, with the exception of Organization and Plant Management, Human Factors and Design, which remained "Below Expectations". The 2009 integrated plant rating for Pickering A was "Satisfactory".

There were no serious process failures at Pickering A during 2009. No worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels.

OPG reported events as per S-99 reporting requirements and conducted, or is conducting, appropriate follow-up, which includes root cause analysis and corrective action, as needed.

Based on these observations and the assessments of the safety areas, CNSC staff concludes that Pickering A was operated safely in 2009.

OPG also complied with licence conditions concerning Canada's international safeguards obligations in 2009.

Table 10: Safety Performance Ratings for Pickering A for 2009

Safety Area Program	**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	**SA**
Radiation Protection	**SA**
Integrated plant rating*	**SA**
Site Security	**Prescribed**
Safeguards	**SA**

* Security and Safeguards were excluded from the integrated plant rating,

2.3.1 Operating Performance

Safety Area Program	Rating 2008	 2009
Operating Performance	**SA**	**SA**
Organization and Plant Management	BE	BE
Operations	SA	SA
Occupational Health and Safety (non-radiological)	SA	SA

Pickering A's overall performance in the Operating Performance safety area was "Satisfactory" in 2009.

2.3.1.1 Organization and Plant Management

Organization and Plant Management performance remained "Below Expectations" at Pickering A in 2009, due to unresolved safety culture issues stemming from the Inter-Station Transfer Bus (ISTB) event in 2007 and OPG's safety culture self-assessments. Although performance was still below expectations last year, CNSC staff note that safety culture is improving at Pickering A. OPG has submitted action plans and has developed the "Say it, Do it" accountability model to address safety culture issues.

The ISTB event in 2007 exposed a number of safety management deficiencies at Pickering A. As a result, the Commission requested an independent evaluation of organization and management at Pickering A, to provide further information regarding the presence or absence of organization and management issues at the station.

CNSC staff conducted the evaluation in April and May of 2009. The framework used consisted of six safety culture characteristics, as follows:

- Safety culture is a clearly recognized value in the organization.
- Accountability for safety in the organization is clear.
- Safety is integrated into all activities in the organization.
- A safety leadership process exists in the organization.
- Safety culture is learning driven in the organization.
- A process for establishing a strong and effective Safety Conscious Work Environment is in place.

Staff identified positive observations and areas for improvement for each characteristic, namely:

- Safety is recognized as an important value by Pickering A. However, expectations and standards are not always communicated clearly and consistently, which results in the variability of behaviour with respect to safety.
- Accountability for safety is an issue at Pickering A. Individuals at all levels of the organization need to more readily accept responsibility and ownership of issues, and the performance consequences need to be managed better.

- The value of safety is recognized, but not always integrated into all activities at the station, as demonstrated by the inconsistency in the quality of the planning, implementation, and review of several work processes.
- The effectiveness of the leadership process for safety is being impacted by the perceptions of individuals concerning the communications processes, and by the impact of informal leaders in the organization.
- Many of the processes necessary to ensure that learning in the organization takes place already exist. The uses of operating experience, self-assessment, corrective actions and training have not yet been fully integrated as valuable parts of the learning process for the station.
- The behaviours important to a positive safety conscious work environment are not perceived to be clearly present by a majority of the organization. Without the perception of an open and blame-free environment, the enhancement of safety culture will be challenging.

The CNSC presented the final report to OPG in October 2009. OPG has submitted an action plan and provided an update on their early initiatives to address the areas for improvement. CNSC staff is satisfied with the proposed actions.

In 2009, Pickering A experienced six forced outages, four trips and five setbacks. There were no serious process failures. Unit 4 experienced three of the forced outages, due to irrational level indications on zone 2 in the liquid zone control system, which is part of the reactor regulating system. On the third forced outage, the investigation team determined that the irrational level indications may be caused by an inadequate gap at the bottom of the bubbler tube inside the zone. OPG repositioned the bubbler tube and restarted the reactor. The irrational level indications did not recur. CNSC staff was satisfied with OPG's response to the event.

2.3.1.2 Operations

In 2009, Pickering A continued to demonstrate satisfactory performance in Operations. CNSC staff conducted numerous inspections throughout the year, including field and control room inspections. There were no significant operations-related issues identified.

There was one planned outage at Pickering A in 2009. Overall, the outage was conducted safely.

2.3.1.3 Occupational Health and Safety (non-radiological)

In 2009, Pickering A's performance in Occupational Health and Safety also remained "Satisfactory."

In 2009, the accident severity rate (see Section 1.1.3 for definition) reported for Pickering A and B combined was 2.27, which is very low in comparison with other industries. Pickering A continues to demonstrate an adequate degree of personnel safety through its occupational health and work practices and conditions.

2.3.2 Performance Assurance

Safety Area Program	Rating 2008	 2009
Performance Assurance	**SA**	**SA**
Quality Management	SA	SA
Human Factors	BE	BE
Training, Examination and Certification	SA	SA

Pickering A's overall performance in the Performance Assurance safety area remained "Satisfactory" in 2009.

2.3.2.1 Quality Management

Pickering A's Quality Management program continued to meet CNSC performance expectations in 2009, and was rated "Satisfactory". CNSC inspections and assessments did not identify any significant quality management issues. CNSC staff is satisfied that the program is adequately documented and there are no systematic non-adherences to the documented processes.

2.3.2.2 Human Factors

Human Factors at Pickering A continued to be rated "Below Expectations" in 2009, due to unresolved minimum complement issues at Pickering A and B.

In the past few years, CNSC staff has raised concerns related to the minimum shift complement issue at the Pickering nuclear generating station (NGS), as a result of common mode events that occurred in 2003 and 2004. The current minimum shift complement is based on an event on one unit. In 2004, CNSC staff expressed concerns that OPG had not demonstrated that the minimum complement staffing levels are sufficient for common mode events such as fire, seismic, and design basis accidents. By 2008, OPG had still not provided sufficient documented evidence showing that the minimum complement numbers are adequate to deal with common mode events at Pickering NGS.

OPG has committed to provide an analysis of the minimum complement staffing levels required to address all operating scenarios, including common mode events. OPG has submitted an action plan and provided updates to demonstrate full compliance with the relevant 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". The initial reports for the scenarios analyzed so far indicate that the minimum shift complement numbers currently in place at the station should be adequate to mitigate the consequences of the worst case accident scenarios. Further field validation work is planned to confirm these results. CNSC staff is satisfied that OPG is progressing towards a resolution of this issue by the end of 2010.

2.3.2.3 Training, Examination and Certification

In 2009, Pickering A's Training, Examination and Certification program continued to meet CNSC performance expectations. CNSC staff is satisfied that Pickering A has a sufficient number of qualified workers to carry out the licensed activities. There were no significant issues resulting from inspection of this program in 2009.

In 2009, the overall success rate in initial certification examinations at Pickering A was 97%. The requalification pass rate was 95%. CNSC staff finds these results acceptable.

2.3.3 Design and Analysis

Safety Area Program	Rating 2008	 2009
Design and Analysis	**SA**	**SA**
Safety Analysis	SA	SA
Safety Issues	SA	SA
Design	BE	BE

Overall performance in the Design and Analysis safety area at Pickering A remained "Satisfactory" in 2009.

2.3.3.1 Safety Analysis

The Safety Analysis program at Pickering A continued to meet CNSC performance expectations in 2009, and was rated "Satisfactory". Updates on many of the issues common to all or most NPP licensees are discussed in Section 1.3.1.

28-Element Fuel Bundle

In 2007, full scale water tests at Stern Laboratories indicated that the dryout power for the 28-element fuel bundle are lower than what was previously assumed in the Pickering A safety analysis. The power at which the fuel sheath dryout would occur is an important indicator of fuel overheating, which might lead to fuel and/or pressure boundary failures. As an interim measure, OPG reduced the Neutron Overpower Protection (NOP) trip setpoints and—as a consequence of the resulting small operating margin—had to reduce operating power as well.

In 2009, Pickering A was able to return to full power based upon a CNSC interim position on the use of trip setpoints calculated with a new NOP methodology. The penalty related to the 2007 findings remains in effect until the findings have been fully addressed to CNSC staff's satisfaction.

2.3.3.2 Safety Issues

In 2009, OPG continued its work, including participation in the industry efforts, toward the resolution of GAIs and CANDU Safety Issues. Performance in this program area remained "Satisfactory" in 2009.

GAI 06G01 "Emergency Core Cooling System Strainer Deposits" was closed for Pickering A in 2009. A brief description and the expected year of completion for each remaining GAI are provided in Appendix E.

2.3.3.3 Design

The Design program at Pickering A remained "Below Expectations" in 2009, due to deficiencies with the temporary Inter-Station Transfer Bus (ISTB) modifications. However, this area is improving as corrective actions are being implemented, and a permanent modification will be installed in 2010.

In 2007, the design of the ISTB was found to have deficiencies which had existed since it had been installed in 1991. The ISTB under-capacity issue has been resolved with temporary modifications to ensure the ISTB can meet its design intent. The temporary modification has a lack of redundancy, reduced reliability and reliance on operator action. Six "Does Not Meet Design Intent" impairments of the ISTB were reported through S-99 in 2009. A permanent modification, which will not pose the constraints of the temporary modification, has been developed by OPG. Installation is expected during the Vacuum Building Outage beginning in April 2010. A more detailed summary of the ISTB is provided in Section 2.3.11.

2.3.4 Equipment Fitness for Service

Safety Area Program	Rating 2008	 2009
Equipment Fitness for Service	**SA**	**SA**
Maintenance	SA	SA
Structural Integrity	SA	SA
Reliability	SA	SA
Equipment Qualification	SA	SA

Performance in the Equipment Fitness for Service safety area at Pickering A remained "Satisfactory" in 2009.

2.3.4.1 Maintenance

Pickering A's performance in Maintenance continued to be "Satisfactory" in 2009. CNSC staff assessments did not identify any significant maintenance-related issues.

In 2009, Pickering A met its short-term maintenance backlogs targets for corrective maintenance and elective maintenance:

- Corrective maintenance was 12, versus a target of 15 work orders per unit.
- Elective maintenance was 333, versus a target of 375 work orders per unit.

Both backlogs have been reduced since 2008.

The Preventive Maintenance Completion Ratio (see Section 1.4.1 for definition) has been improving steadily at Pickering A over the past three years, and is currently at 95%.

2.3.4.2 Structural Integrity

Structural Integrity program performance remained "Satisfactory" in 2009. OPG inspects and tests pressure retaining and containment systems, structures and components in accordance with the station Periodic Inspection Program and applicable CSA standards. No significant findings related to pressure boundary degradation at Pickering A were identified during the 2009 inspection campaign.

There were also no significant findings identified from CNSC staff reviews of Pickering A S-99 operations and pressure boundary reports submitted in 2009.

2.3.4.3 Reliability

Pickering A's Reliability program performance was also "Satisfactory" in 2009.

All special safety systems at Pickering A met their unavailability targets in 2009, although the Emergency Coolant Injection System experienced one impairment. There were also twenty-one impairments of standby safety-related systems during the year. Most of these impairments were related to the ISTB or were on Emergency High or Low Pressure Service Water.

2.3.4.4 Equipment Qualification

The Equipment Qualification program at Pickering A continued to meet CNSC performance expectations in 2009 and was rated "Satisfactory". There were no significant issues identified in this program at Pickering A in 2009.

Some outstanding issues still remain to be resolved by Pickering A staff, with respect to the EQ self-assessment performed by OPG in response to the ISTB event in 2007. CNSC staff will continue to monitor OPG's progress in resolving these issues.

2.3.5 Emergency Preparedness

Safety Area	Rating	
	2008	2009
Emergency Preparedness	**SA**	**SA**

Emergency Preparedness at Pickering A continued to meet CNSC performance expectations in 2009, and was rated "Satisfactory".

CNSC staff's review of inspection findings, surveillance monitoring and S-99 reportable events for 2009 did not identify any significant issues relating to emergency preparedness. In addition, staff found that the performance indicators used to evaluate implementation of the emergency management response plan remained steady or, in some cases, improved throughout 2009.

Based on these results, staff concludes that OPG has adequate provisions for preparedness and response capability that would sustain appropriate protection of the environment and the health and safety of Canadians during an emergency.

2.3.6 Environmental Protection

Safety Area	Rating	
	2008	2009
Environmental Protection	**BE**	**SA**

Pickering A's performance in Environmental Protection improved in 2009, and is now rated as "Satisfactory". This improvement is attributed to the measures OPG has taken to reduce fish mortality at both Pickering A and B.

In the 2008 NPP Report, the environmental effects of the condenser cooling water system—specifically, fish mortality due to impingement and entrainment —at Pickering A and B was raised as a major issue. A barrier net surrounding the water intake was installed as an interim impingement mitigation measure, in October 2009. Longer term impingement and entrainment reduction options have been the subject of a cost-benefit analysis, including consultations with the CNSC, Department of Fisheries and Oceans, Environment Canada, Ministry of the Environment, Ministry of Natural Resources and the Toronto Region Conservation Authority. Implementation of an acceptable long term solution is expected by 2012.

No new significant issues were raised as a result of environmental protection inspections or assessments carried out in 2009.

The reported dose to the public from Pickering A and B (combined) in 2009 was 1.8 μSv, which is well below the public dose limit of 1,000 μSv. Gaseous and aqueous releases of nuclear substances were always below Environmental Action Levels and Derived Release Limits.

2.3.7 Radiation Protection

Safety Area	Rating	
	2008	2009
Radiation Protection	**SA**	**SA**

Pickering A's performance in Radiation Protection continued to meet CNSC expectations in 2009, and was rated "Satisfactory". Based on the assessments of findings in this area, CNSC staff is satisfied that OPG provided adequate protection of the health and safety of persons at Pickering A with respect to ionizing radiation.

The 2009 dose information for Pickering A is provided in Appendix F. In 2009, there were no radiation exposures at Pickering A that exceeded regulatory limits and no incidents resulting in reportable dose in excess of OPG's action levels.

2.3.8 Site Security

This safety area is presented to the Commission in a separate Commission Member Document (CMD 10-M47.A).

2.3.9 Safeguards

Safety Area	Rating	
	2008	2009
Safeguards	**FS**	**SA**

The Safeguards safety area at Pickering A met applicable CNSC requirements and performance expectations in 2009, and received a "Satisfactory" rating. This rating is lower than the one assigned in 2008, due to changes in the methodology for assessing Safeguards. There has been no significant change in the station's performance. 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 did not select Pickering NGS for a Physical Inventory Verification (PIV) in 2009. In its absence, the CNSC conducted a Physical Inventory Taking Evaluation, to provide assurance to the IAEA that the facility was properly prepared for a PIV, had it been selected. This was the first year that the CNSC performed this type of evaluation. No significant compliance issues were identified.

2.3.10 Regulatory Decisions

Pickering A Licence

The Pickering A Licence was amended six times in 2009:

PROL 04.10/2010 – Effective January 29

- Added "Beginning no later than January 1, 2010, the control room shift operating supervisor position shall be eliminated and replaced by that of control room shift supervisor" to licence condition 2.2.
- Incorporated Regulatory Document RD-204 "Certification of Persons Working at Nuclear Power Plants".

PROL 04.11/2010 – Effective August 24

- Replaced the 2004 version of the "Pickering Nuclear 1-4 Safety Report – Part 3: Accident Analysis" with the 2007 version in Appendix A.
- Replaced Revision 20 of the document "Building Development Site Plan" with Revision 25 in Appendix A.
- Removed the requirement for the environmental assessment follow-up and monitoring program in licence condition 12.2.

PROL 04.12/2010 – Effective September 22

- Incorporated Regulatory Document RD-363 "Nuclear Security Officer Medical, Physical, and Psychological Fitness"

PROL 04.13/2010 – Effective October 1

- Replaced Revision 1 of the CNSC document "Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants"

by an updated version (Revision 2), allowing OPG's implementation of the new requirements.

PROL 04.14/2010 – Effective November 27

- Referenced the 2009 version of the Safety Report Facility Description in Appendix A.
- Referenced revision 26 of the Building Development Site Plan in Appendix A.
- Updated the licence conditions and appendices related to pressure boundaries, in order to accommodate OPG's transition to the 2008 Edition and Update No. 1 of CSA N285.0 "General Requirements for Pressure Retaining Systems and Components in CANDU Nuclear Power Plants". and to accommodate the implementation of a formal agreement with an Authorized Inspection Agency (AIA).

PROL 04.15/2010 – Effective December 24

- Changed the date by which the control room shift operating supervisor position shall be eliminated and replaced by that of control room shift supervisor (from January 1, 2010, to January 1, 2011), in licence condition 2.2,

2.3.11 Update on Major Projects

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's 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.

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 2 and 3 are currently defueled, and the moderator and primary heat transport systems have been drained and dried.

During the Vacuum Building Outage beginning in April 2010, OPG will isolate the reactor building bulkheads from the pressure relief duct and move the containment boundary to the bulkheads. Where possible, systems are being electrically de-energized and pipes are being cut and capped.

Inter-Station Transfer Bus (ISTB)

In 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 a Main Steam Line Break (MSLB) in the Pickering A powerhouse. Under worst-case accident conditions, the ISTB did not have

the required load-carrying capacity, 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 in post-accident conditions. OPG's investigation into the situation revealed several past design and commissioning problems with the ISTB, which had existed since it had been installed in 1991.

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

CNSC approval was given, and the first unit was restarted in October 2007. However, the temporary modification has deficiencies involving lack of redundancy, reduced reliability and increased operator actions. A permanent modification is being developed by OPG, and is expected to be installed during the Vacuum Building Outage beginning in April 2010.

CNSC staff formed the ISTB Review Team in 2008, and conducted a review of OPG's response to the impairment of the ISTB. The ISTB Review Team studied in detail the engineering design and operational changes needed 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 as follows:

- 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 should pursue a permanent solution to meet original ISTB design requirements with expediency, and provide a firm installation date for the permanent modifications.
- CNSC should conduct a complete, thorough and unbiased independent organizational and management evaluation of the Pickering A station.

- OPG should submit further information on the numerous corrective actions detailed in this report, and the CNSC will review these submissions for adequacy.

The Review Team also determined that management deficiencies were the primary cause of the incident. These deficiencies indicated a break-down in several management activities and practices over many years.

CNSC staff has reviewed OPG's progress to date in addressing the corrective actions identified by the Review Team. Based on staff's review of documents and records and from interviews with OPG staff, including contractor staff, CNSC staff is satisfied that OPG is progressing towards closure.

2.4 PICKERING B

Table 11 presents the performance ratings for Pickering B in 2009. All safety areas and programs received "Satisfactory" performance ratings, with the exception of Human Factors which remained "Below Expectations". The 2009 integrated plant rating for Pickering B was "Satisfactory".

There were no serious process failures at Pickering B during 2009. No worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels.

OPG reported events as per S-99 reporting requirements and conducted, or is conducting, appropriate follow-up, which includes root cause analysis and corrective action, as needed.

Based on these observations and the assessments of the safety areas, CNSC staff concludes that Pickering B was operated safely in 2009.

OPG also complied with licence conditions concerning Canada's international safeguards obligations in 2009.

Table 11: Safety Performance Ratings for Pickering B for 2009

Safety Area Program	**Rating**
Operating Performance	**SA**
Organization and Plant Management	SA
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	**SA**
Radiation Protection	**SA**
Integrated plant rating*	**SA**
Site Security	**Prescribed**
Safeguards	**SA**

* Security and Safeguards were excluded from the integrated plant rating,

2.4.1 Operating Performance

Safety Area Program	Rating 2008	 2009
Operating Performance	**SA**	**SA**
Organization and Plant Management	BE	SA
Operations	SA	SA
Occupational Health and Safety (non-radiological)	SA	SA

The Operating Performance safety area at Pickering B was rated "Satisfactory" in 2009.

2.4.1.1 Organization and Plant Management

Pickering B's performance in Organization and Plant Management improved in 2009, and is now rated as "Satisfactory". This improvement is attributed to OPG's resolution of two issues that significantly affected the performance rating in 2008.

The first issue was represented by the management decisions which led to the Gadolinium reduction incident on Unit 7, in 2008. Following the incident, OPG took actions to improve its operational decision-making process. These improvements should reduce the likelihood of incorrect assumptions being made by management, and minimize the recurrence of similar incidents.

The second issue concerned several S-99 events which contributed to organizational behaviours. OPG has made improvements in this area by reducing the number of S-99 events, monitoring the Human Performance contributors to S-99 events, and implementing effective corrective action plans.

CNSC staff acknowledges that OPG senior management continues to support safety culture improvement initiatives, so as to achieve high levels of staff awareness concerning the safety culture at the facility. The senior management also continues to uphold its role in maintaining and further improving safe and reliable operations.

During 2009, Pickering B experienced five forced outages, one trip and five setbacks. There were no serious process failures.

2.4.1.2 Operations

Pickering B's performance in Operations continued to meet CNSC expectations in 2009, and remains "Satisfactory". CNSC staff conducted numerous inspections in 2009, including field and control room inspections. No significant operations-related issues were identified.

There were two planned maintenance outages at Pickering B in 2009. Overall, the outages were conducted safely.

2.4.1.3 Occupational Health and Safety (non-radiological)

Pickering B's performance in Occupational Health and Safety also remained "Satisfactory" in 2009.

The accident severity rate (see Section 1.1.3 for definition) reported for Pickering A and B combined was 2.27 in 2009, which is very low in comparison with other industries. Pickering B continues to demonstrate an adequate degree of personnel safety through its occupational health and work practices and conditions.

2.4.2 Performance Assurance

Safety Area Program	Rating 2008	 2009
Performance Assurance	**SA**	**SA**
Quality Management	SA	SA
Human Factors	BE	BE
Training, Examination and Certification	SA	SA

Pickering B's overall performance in the Performance Assurance safety area remained "Satisfactory" in 2009.

2.4.2.1 Quality Management

Pickering B's Quality Management program continued to meet CNSC performance expectations in 2009, and was rated "Satisfactory". CNSC inspections and assessments did not identify any significant quality management issues. CNSC staff is satisfied that the program is adequately documented and there are no systematic non-adherences to the documented processes.

2.4.2.2 Human Factors

Performance in Human Factors remained "Below Expectations" in 2009, due to unresolved minimum complement issues at Pickering A and B. See Section 2.3.2.2 for additional details.

2.4.2.3 Training, Examination and Certification

Pickering B's performance in Training, Examination and Certification met CNSC expectations in 2009. CNSC staff is satisfied that there are sufficient numbers of qualified workers at Pickering B to carry out the licensed activities. There were no significant issues resulting from inspections of this program in 2009.

In 2009, the overall success rate in initial certification examinations at Pickering B was 95%. The requalification pass rate was 100%. CNSC staff finds these results acceptable.

OPG's main control room staffing plan, submitted every six months, indicates constant improvements in the numbers of certified available staff. CNSC staff continues to monitor OPG's progress.

2.4.3 Design and Analysis

Safety Area Program	Rating 2008	 2009
Design and Analysis	**SA**	**SA**
Safety Analysis	SA	SA
Safety Issues	SA	SA
Design	SA	SA

Performance in the Design and Analysis safety area at Pickering B remained "Satisfactory" in 2009.

2.4.3.1 Safety Analysis

The Safety Analysis program at Pickering B continued to meet CNSC performance expectations in 2009 and was rated "Satisfactory". Updates on many of the issues common to all or most NPP licensees are discussed in Section 1.3.1.

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. As an interim measure, OPG reduced the Neutron Overpower Protection (NOP) trip setpoints. Since Pickering B had a sufficient operating margin, no immediate derating was required.

The 5% NOP penalty, related to the 2007 findings, will remain in effect until the findings have been fully addressed to CNSC staff's satisfaction.

2.4.3.2 Safety Issues

In 2009, OPG continued its work—which includes participation in the industry efforts—toward the resolution of GAIs and CANDU Safety Issues. Performance in this program area remained "Satisfactory" in 2009.

GAIs 95G05 "Moderator Temperature Predictions" and 06G01 "Emergency Core Cooling System Strainer Deposits" were closed for Pickering B in 2009. A brief description, along with the expected year of completion for each remaining GAI, are provided in Appendix E.

2.4.3.3 Design

Pickering B's performance in Design also remained "Satisfactory" in 2009. There were no significant issues identified in this area in 2009.

2.4.4 Equipment Fitness for Service

Safety Area Program	Rating 2008	 2009
Equipment Fitness for Service	**SA**	**SA**
Maintenance	SA	SA
Structural Integrity	SA	SA
Reliability	SA	SA
Equipment Qualification	SA	SA

Performance in the Equipment Fitness for Service safety area at Pickering B remained "Satisfactory" in 2009.

2.4.4.1 Maintenance

Pickering B's performance in Maintenance continued to be "Satisfactory" in 2009. CNSC staff inspections and assessments did not identify any significant maintenance-related issues.

In 2009, OPG met its short-term maintenance backlogs targets for corrective maintenance and elective maintenance:

- Corrective maintenance was 19, versus a target of 25 work orders per unit.
- Elective maintenance was 555, versus a target of 575 work orders per unit.

The Pickering B elective maintenance backlog target is high, compared to best industry practices. CNSC staff expects OPG to provide quarterly status update until the elective maintenance backlog at Pickering B is reduced to the committed long-term target of 300-400 work orders per unit. CNSC staff will continue to monitor this progress in 2010, through normal follow-up activities.

2.4.4.2 Structural Integrity

Pickering B's performance in its Structural Integrity program also remained "Satisfactory' in 2009.

OPG inspects and tests pressure retaining and containment systems, structures and components in accordance with the station Periodic Inspection Program (PIP) and applicable CSA standards. No significant findings related to pressure boundary degradation at Pickering B were identified during the 2009 inspection campaign.

There were also no significant issues identified from CNSC staff reviews of Pickering B S-99 operations and pressure boundary reports submitted in 2009.

2.4.4.3 Reliability

Pickering B's Reliability program performance was also "Satisfactory" in 2009.

All special safety systems at Pickering B met their unavailability targets in 2009.

The 2009 Reliability Report from OPG noted significant failure rates changes for the Emergency Power System. The main contributors to these changes were start failures of the emergency power generators, due to control problems. OPG has committed to upgrade the controls for the generators by early 2012.

In 2009, CNSC staff raised concerns that the probabilistic risk assessment (PRA) methodology used to conduct the Pickering B Probabilistic Risk Assessment (PBRA), Revision 2, did not fully comply with CNSC standard S-294 "Probabilistic Safety Assessment for Nuclear Power Plants". In response, OPG has committed to perform a gap analysis between PBRA Rev. 2 and supporting documents, such as the PRA quality assurance program governance and OPG's revised PRA guide. Gaps identified during the review will be addressed during the planned PBRA update. OPG is expected to comply with S-294 by December 31, 2012.

2.4.4.4 Equipment Qualification

Pickering B's Equipment Qualification program met CNSC performance expectations in 2009, and remains rated as "Satisfactory".

In 2009, CNSC staff inspected the EQ program at Pickering B to verify the sustainability of the station's EQ requirements. No significant deficiencies were identified.

2.4.5 Emergency Preparedness

Safety Area	Rating	
	2008	2009
Emergency Preparedness	**SA**	**SA**

Emergency Preparedness at Pickering B continued to meet CNSC performance expectations in 2009, and was rated "Satisfactory".

CNSC staff's review of inspection findings, surveillance monitoring and S-99 reportable events for 2009 did not identify any significant issues relating to emergency preparedness. In addition, as with Pickering A, the performance indicators used to evaluate implementation of the emergency management response plan remained steady or, in some cases, improved throughout 2009.

Based on these results, staff concludes that OPG has adequate provisions for preparedness and response capability, which would sustain the appropriate protection of the environment and the health and safety of Canadians during an emergency.

2.4.6 Environmental Protection

Safety Area	Rating	
	2008	2009
Environmental Protection	**BE**	**SA**

Pickering B performance in Environmental Protection improved in 2009, and is now rated "Satisfactory". This improvement is attributed to the measures OPG has taken to reduce fish mortality at both Pickering A and B. See section 2.3.6 for details.

No significant issues were raised as a result of environmental protection inspections or assessments carried out in 2009.

The reported dose to the public from Pickering A and B (combined) in 2009 was 1.8 μSv, which is well below the public dose limit of 1,000 μSv. Gaseous and aqueous releases of nuclear substances were always below Environmental Action Levels and Derived Release Limits.

2.4.7 Radiation Protection

Safety Area	Rating	
	2008	2009
Radiation Protection	**SA**	**SA**

Performance in the Radiation Protection safety area continued to meet CNSC expectations in 2009. Based on the assessments of findings in this area, CNSC staff is satisfied that OPG provided adequate protection of the health and safety of persons at Pickering B, with respect to ionizing radiation.

The 2009 dose information for Pickering B is provided in Appendix F. In 2009, there were no radiation exposures at Pickering B that exceeded regulatory limits, and no incidents resulting in reportable dose in excess of OPG's action levels.

2.4.8 Site Security

This safety area is presented to the Commission in a separate Commission Member Document (CMD 10-M47.A).

2.4.9 Safeguards

Safety Area	Rating	
	2008	2009
Safeguards	**FS**	**SA**

The Safeguards safety area at Pickering B met applicable CNSC requirements and performance expectations in 2009, and received a "Satisfactory" rating. This rating is lower than the one assigned in 2008, due to changes in the methodology for assessing Safeguards. There has been no significant change in the station's performance. 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 did not select Pickering NGS for a Physical Inventory Verification (PIV) in 2009. In its absence, the CNSC conducted a Physical Inventory Taking Evaluation, to provide assurance to the IAEA that the facility was properly prepared for a PIV, had it been selected. This was the first year that the CNSC performed this type of evaluation. No significant compliance issues were identified.

2.4.10 Regulatory Decisions

Pickering B Licence

The Pickering B Licence was amended six times in 2009:

PROL 08.02/2013 – Effective January 29

- Incorporated Regulatory Document RD-204 "Certification of Persons working at Nuclear Power Plants".

PROL 08.03/2013 – Effective July 24

- Replaced the 2005 version of the "Pickering NGS-B Safety Report – Part 3: Accident Analysis" with the 2008 version in Appendix A.
- Replaced revision 3 of the "Organizational Change Control" with revision 4 in Appendix B.
- Replaced revision 31 of the "Pickering NGS-B, Operating Policies and Principles" with revision 32 in Appendix B.

PROL 08.04/2013 – Effective September 22

- Revised implementation date of regulatory document S-294 "Probabilistic Safety Assessment (PSA) for Nuclear Power Plants", CSA N293-95 "Fire Protection for CANDU Nuclear Power Plants", and CSA standard N293-07.
- Incorporated the Regulatory Document RD-363 "Nuclear Security Officer Medical, Physical, and Psychological Fitness".

PROL 08.05/2013 – Effective October 1

- Replaced Revision 1 of the CNSC document "Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants" by an updated version (Revision 2) allowing OPG's implementation of the new requirements.

PROL 08.06/2013 – Effective November 27

- Updated the licence conditions and appendices related to pressure boundaries, in order to accommodate OPG's transition to the 2008 Edition and Update No. 1 of CSA N285.0 "General Requirements for Pressure Retaining Systems and Components in CANDU Nuclear Power Plants", and to accommodate the implementation of a formal agreement with an Authorized Inspection Agency (AIA).
- Referenced revision 26 of the Building Development Site Plan in Appendix A.

PROL 08.07/2013 – Effective December 24

- Updated role documents for Shift Manager, Control Room Shift Supervisor, Control Room Shift Operating Supervisor (Transitional) and Authorized Nuclear Operator in Appendix B.
- Replaced revision 8 of the "Consolidated Nuclear Emergency Plan" with revision 9 in Appendix B.

2.4.11 Update on Major Projects

Refurbishment Project

Pickering B has operated continuously since 1983. Mid-life pressure tube refurbishment is an element of CANDU plant design, and is 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. The OPG Board of Directors approved a project to undertake a study for the life extension of the Pickering B units, which included an Environmental Assessment (EA) and an Integrated Safety Review (ISR).

On February 17, 2010, OPG announced that Pickering B will not proceed with refurbishment. Instead, OPG will invest $300 million at Pickering B to ensure the continued safe and reliable performance for approximately 10 years. Following this, OPG will begin the longer term decommissioning process. OPG indicated to the Commission that they will file a high level summary of the Pickering B Operations Plan by March 31, 2010, followed by the comprehensive plan by September 30, 2010. OPG also committed during the Pickering A licence renewal Day 1 Hearing, to include a site strategic plan in the Pickering B Operations Plans.

Additionally, OPG will provide CNSC staff a comprehensive Operations Plan for Pickering A by December 31, 2011.

Integrated Safety Review (ISR)

In 2009, OPG submitted its ISR Final Report, including results of the Global Assessment, to the CNSC for review. CNSC staff reviews to date have identified problems with the rigour of assessments carried out as part of the ISR and the clarity and quality of reports produced. In lieu of OPG's announcement that it will not proceed with the Pickering B refurbishment, CNSC staff will be finalizing the their reviews of the refurbishment ISR by early 2010, and will advise OPG of the CNSC draft requirements for the transition to end-of-life.

2.5 GENTILLY-2

Table 12 presents the 2009 performance ratings for Gentilly-2. All safety areas and programs received "Satisfactory" or "Fully Satisfactory" performance ratings, with the exception of Quality Management, which remained "Below Expectations". The 2009 integrated plant rating for Gentilly-2 was "Satisfactory".

There were no serious process failures at Gentilly-2 during 2009. No worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels.

Hydro-Québec reported events as per S-99 reporting requirements and conducted (or is conducting) appropriate follow-up, which includes root cause analysis and corrective action, as needed. Based on these observations and the assessments of the safety areas, CNSC staff concludes that Gentilly-2 was operated safely in 2009.

Hydro-Québec also complied with licence conditions concerning Canada's international safeguards obligations in 2009.

Table 12: Performance Ratings for Gentilly-2 in 2009

Safety Area Program	**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	SA
Structural Integrity	SA
Reliability	FS
Equipment Qualification	SA
Emergency Preparedness	**FS**
Environmental Protection	**SA**
Radiation Protection	**SA**
Integrated plant rating*	**SA**
Site Security	**Prescribed**
Safeguards	**SA**

* Security and Safeguards were excluded from the integrated plant rating,

2.5.1 Operating Performance

Safety Area Program	Rating 2008	 2009
Operating Performance	**SA**	**SA**
Organization and Plant Management	SA	SA
Operations	SA	SA
Occupational Health and Safety (non-radiological)	SA	SA

The Operating Performance safety area at Gentilly-2 was rated "Satisfactory" in 2009.

2.5.1.1 Organization and Plant Management

In 2009, Gentilly-2's performance in Organization and Plant Management continued to meet CNSC expectations. CNSC staff is satisfied that Hydro-Québec continues to demonstrate capable organization and management of its safety programs and provide adequate attention to health, safety, security, environmental protection and international obligations.

There were two forced outages, two stepbacks and two setbacks at Gentilly-2 in 2009. There were no serious process failures.

2.5.1.2 Operations

Gentilly-2's performance in Operations continued to meet CNSC expectations in 2009 and remains "Satisfactory". No significant operations-related issues were identified during CNSC inspections.

CNSC inspections of station systems identified positive findings with respect to organization, specifically during the planned outage in the spring of 2009. Overall, the planning and conduct of the outage was satisfactory, despite occasional difficulties that led to delays in completing some important work. These delays did not lead to a reduction in safety.

2.5.1.3 Occupational Health and Safety (non-radiological)

In 2009, the Occupational Health and Safety program at Gentilly-2 continued to meet CNSC performance expectations and remains "Satisfactory".

The accident severity rate (see Section 1.1.3 for definition) reported for Gentilly-2 in 2009 was 0, with 0 days lost. Gentilly-2 continues to demonstrate an adequate degree of personnel safety through its occupational health and work practices and conditions.

2.5.2 Performance Assurance

Safety Area Program	Rating 2008	 2009
Performance Assurance	**SA**	**SA**
Quality Management	BE	BE
Human Factors	SA	SA
Training, Examination and Certification	SA	SA

Gentilly-2's overall performance in the Performance Assurance safety area remained "Satisfactory" in 2009.

2.5.2.1 Quality Management

Performance of the Quality Management program at Gentilly-2 continued to be "Below Expectations" in 2009, due to non-adherences with procedures and guidelines, and shortcomings in management oversight. Improper work on piping supports was also a major contributor to inadequate performance.

CNSC inspections in 2009 found multiple instances where licensee staff did not follow procedures and guidelines. In addition, Hydro-Québec did not reinforce its expectations for procedural adherence and work review. CNSC staff concluded that overall, basic quality assurance concepts were poorly understood by Hydro-Québec and were not applied. Hydro-Québec is investigating the root cause of the situation and is showing, through analysis and action, a will to improve its organizational culture.

2.5.2.2 Human Factors

Gentilly-2's Human Factors program continued to meet CNSC performance expectations in 2009 and was rated "Satisfactory". No significant human factors issues were identified in 2009.

2.5.2.3 Training, Examination and Certification

In 2009, Gentilly-2's Training, Examination and Certification program continued to meet CNSC performance expectations. CNSC staff is satisfied that Gentilly-2 has sufficient numbers of qualified workers to carry out its licensed activities. There were no significant issues identified in this program area in 2009.

There were no certification examinations conducted at Gentilly-2 in 2009.

2.5.3 Design and Analysis

Safety Area Program	Rating 2008	 2009
Design and Analysis	**SA**	**SA**
Safety Analysis	SA	SA
Safety Issues	SA	SA
Design	SA	SA

Performance in the Design and Analysis safety area at Gentilly-2 remained "Satisfactory" in 2009.

2.5.3.1 Safety Analysis

In 2009, Gentilly-2's Safety Analysis program maintained a "Satisfactory" performance rating. Updates on many of the issues common to all or most NPP licensees are discussed in Section 1.3.1.

2.5.3.2 Safety Issues

In 2009, Hydro-Québec continued its work, including participation in the industry efforts, toward the resolution of GAIs and CANDU Safety Issues. Performance in this program area remained "Satisfactory" in 2009.

GAIs 88G02 and 95G01 were closed for Gentilly-2 in 2009. A brief description and the expected year of completion for each remaining GAI are provided in Appendix E.

2.5.3.3 Design

Gentilly-2 continued to demonstrate "Satisfactory" performance in its Design program in 2009. There were no significant issues identified in this area in 2009.

In 2008, staff reported weaknesses with Gentilly-2's fire protection program. However, improvements were noted in 2009. Despite observing, on several occasions, some build-up of combustible material, CNSC staff found that, overall, the fire protection program at Gentilly-2 was well implemented.

2.5.4 Equipment Fitness for Service

Safety Area Program	Rating 2008	 2009
Equipment Fitness for Service	**SA**	**SA**
Maintenance	BE	SA
Structural Integrity	SA	SA
Reliability	SA	FS
Equipment Qualification	SA	SA

Performance in the Equipment Fitness for Service safety area at Gentilly-2 remained "Satisfactory" in 2009.

2.5.4.1 Maintenance

Maintenance program performance at Gentilly-2 improved in 2009, and is now rated "Satisfactory". CNSC inspections found that maintenance work at the station is prioritized and well executed. CNSC staff also observed good compliance with Gentilly-2's guidelines on work approval.

Gentilly-2's response time for corrective maintenance was satisfactory in 2009.

2.5.4.2 Structural Integrity

Gentilly-2's performance in Structural Integrity remained "Satisfactory" in 2009. Hydro-Québec inspects and tests pressure retaining and containment systems, structures and components in accordance with the station Periodic Inspection Program and applicable CSA standards. No significant findings related to pressure boundary degradation at Gentilly-2 were identified during the 2009 inspection campaign. Nevertheless, Hydro-Québec has to improve some aspects of its periodic inspection program reporting. CNSC staff will monitor Hydro-Québec's progress in resolving this issue.

2.5.4.3 Reliability

In 2009, the performance of Gentilly-2's Reliability program was rated "Fully Satisfactory".

No initiating event occurred at Gentilly-2 during the year and all special safety systems met their unavailability targets. There was one impairment on the moderator, but it did not impact plant safety.

Performance indicator data for missed mandatory safety system tests is provided in Section 1.4.3, Table 5. Five special safety system tests were missed at Gentilly-2 in 2009; however, they did not affect system reliability.

2.5.4.4 Equipment Qualification

Gentilly-2's Equipment Qualification program performance was "Satisfactory" in 2009.

CNSC and Hydro-Québec staff meet regularly to discuss the progress being made in addressing Equipment Qualification program weaknesses first identified in 2006. CNSC staff has observed some improvements with respect to equipment qualification activities at Gentilly-2, but additional work is needed to complete the activities. CNSC staff will continue to follow up on this issue with Hydro-Québec staff in 2010.

2.5.5 Emergency Preparedness

Safety Area	Rating	
	2008	2009
Emergency Preparedness	**FS**	**FS**

In 2009, CNSC staff assessments of Emergency Preparedness at Gentilly-2 did not identify any significant issues. Gentilly-2 operates a mature Emergency Preparedness program, and continues to demonstrate fully satisfactory performance.

2.5.6 Environmental Protection

Safety Area	Rating	
	2008	2009
Environmental Protection	**SA**	**SA**

Environmental Protection at Gentilly-2 continued to be rated "Satisfactory" in 2009.

The reported dose to the public from Gentilly-2 in 2009 was 1.2 μSv, which is well below the public dose limit of 1,000 μSv. Gaseous and aqueous releases of nuclear substances were always below Environmental Action Levels and Derived Release Limits.

In 2009, Gentilly-2 reported some minor spills, which were well managed and did not have any impact on the public or the environment.

2.5.7 Radiation Protection

Safety Area	Rating	
	2008	2009
Radiation Protection	**SA**	**SA**

Gentilly-2's performance in Radiation Protection continued to meet CNSC expectations in 2009 and was rated "Satisfactory". Based on the assessments of findings in this area, CNSC staff is satisfied that Hydro-Québec provided adequate protection of the health and safety of persons at Gentilly-2 with respect to ionizing radiation.

The 2009 dose information for Gentilly-2 is provided in Appendix F. There were no radiation exposures at Gentilly-2 that exceeded regulatory limits. In July 2009, an action level for tritium in bioassay was exceeded slightly due to an unplanned tritium uptake (2.07 mSv committed effective dose, versus 2.0 mSv action level). Hydro-Québec investigated the incident, but no significant deficiencies in the radiation protection program were identified. Appropriate corrective actions have been taken to restore the effectiveness of the radiation protection program.

2.5.8 Site Security

This safety area is presented to the Commission in a separate Commission Member Document (CMD 10-M47.A).

2.5.9 Safeguards

Safety Area	Rating	
	2008	2009
Safeguards	**FS**	**SA**

The Safeguards safety area at Gentilly-2 met applicable CNSC requirements and performance expectations in 2009, and received a "Satisfactory" rating. This rating is lower than the one assigned in 2008, due to slight changes in the methodology for assessing Safeguards. There has been no significant change in the station's performance. 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 did not select Gentilly-2 for a Physical Inventory Verification (PIV) in 2009. In its absence, the CNSC conducted a Physical Inventory Taking Evaluation, to provide assurance to the IAEA that the facility was properly prepared for a PIV, had it been selected. This was the first year that the CNSC performed this type of evaluation. No significant compliance issues were identified.

In order to implement an Integrated Safeguards approach for the transfer of spent fuel to dry storage at Gentilly-2, the installation of IAEA equipment at both the spent fuel bay and the dry storage site is required. While delays with the installation did not significantly impact the facility's rating in 2009, CNSC staff will closely monitor the progress of equipment installations in 2010.

2.5.10 Regulatory Decisions

Gentilly-2 Licence

The Gentilly-2 licence was amended twice in 2009.

PROL 10.03/2009 – Effective May 11

- Incorporated Regulatory Document RD-204 "Certification of Persons working at Nuclear Power Plants", following approval by Director General, Directorate of Power Reactor Regulation, of licensee documents MG-01-01 and DR-46.

PROL 10.04/2009 – Effective December 11

- Replaced Revision 1 of the CNSC document "Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants," with Revision 2.

2.5.11 Update on Major Projects

The Gentilly-2 refurbishment project, which had been under consideration since 2001 as part of the preliminary design phase, was officially approved by Hydro-Québec's senior management in August 2008.

Meanwhile, Hydro-Québec has made a formal commitment to abide by the intent of regulatory guide RD-360 "Extension of Nuclear Power Plants". Hydro-Québec has expressed its intention to submit an Integrated Safety Review (ISR) document and a Global Assessment Report, including an integrated implementation plan, as described in RD-360. It is expected that the ISR will be submitted before the end of 2010. So far, Hydro-Québec has been late in submitting necessary related key documents to the CNSC and this may impact the schedule of the regulatory review.

2.6 POINT LEPREAU

In 2009, New Brunswick Power (NB Power) continued refurbishment activities at Point Lepreau. As such, the station was not operational, and the performance of certain programs and safety areas could not be rated.

After the reactor core was defueled in May 2008, CNSC staff replaced baseline operational inspections with inspections and reviews targeted at refurbishment activities related to safe long-term operation of the station. All regulatory obligations under the licence remain applicable during the refurbishment outage. The refurbishment outage is expected to end in early 2011.

Table 13 presents the performance ratings for Point Lepreau for 2009. Of the safety areas and programs that were rated, all received "Satisfactory" ratings, except for Occupational Health and Safety which received a "Fully Satisfactory" rating. The 2009 integrated plant rating for Point Lepreau was "Satisfactory".

In 2009, no worker or member of the public received a dose in excess of the regulatory dose limits, and all environmental emissions were below regulatory limits and station action levels.

NB Power also complied with licence conditions concerning Canada's international safeguards obligations.

Table 13: Safety Performance Ratings for Point Lepreau for 2009

Safety Area Program	Rating
Operating Performance	**SA**
Organization and Plant Management	SA
Operations	–
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	–
Safety Issues	SA
Design	SA
Equipment Fitness for Service	–
Maintenance	–
Structural Integrity	–
Reliability	–
Equipment Qualification	–
Emergency Preparedness	–
Environmental Protection	**SA**
Radiation Protection	**SA**
Integrated plant rating*	**SA**
Site Security	**Prescribed**
Safeguards	**SA**

* Security and Safeguards were excluded from the integrated plant rating,

2.6.1 Operating Performance

Safety Area Program	Rating 2008	 2009
Operating Performance	**FS**	**SA**
Organization and Plant Management	SA	SA
Operations	FS	–
Occupational Health and Safety (non-radiological)	FS	FS

The Operating Performance safety area at Point Lepreau was rated "Satisfactory" in 2009. This is lower than the 2008 rating, however only two programs within the safety area were rated in 2009 due to the refurbishment status of the station.

2.6.1.1 Organization and Plant Management

In 2009, Point Lepreau's performance in Organization and Plant Management met CNSC expectations. Throughout the year, the performance of Point Lepreau

management conformed to the NB Power document "The Nuclear Management Manual". This manual includes the aspects of adequate leadership and continued improvements required to achieve and maintain higher performance. CNSC staff is satisfied that NB Power continues to demonstrate capable organization and management of its safety programs and provide adequate attention to health, safety, security, environmental protection and international obligations.

2.6.1.2 Operations

Point Lepreau was not operational in 2009, due to the continuing refurbishment. As a consequence, there is no performance rating for the Operations program in 2009.

CNSC site staff activities during the year included surveillance and monitoring, walk-down inspections of construction zones, and verification of installation and commissioning of modifications and upgrades.

2.6.1.3 Occupational Health and Safety (non-radiological)

The performance rating for Occupational Health and Safety at Point Lepreau remained "Fully Satisfactory" for 2009. CNSC staff is satisfied that occupational health and safety work practices and conditions have resulted in an adequate degree of personnel safety at Point Lepreau, even with the large increase in contractors working at the site due to refurbishment activities.

WorkSafeNB[2] has routinely conducted inspections at the PLGS site since the beginning of the refurbishment outage. CNSC inspectors participated in the majority of these inspections in 2009, and routinely attended the weekly contractor safety meetings led by NB Power.

The accident severity rate (see Section 1.1.3 for definition) reported for Point Lepreau in 2009 was 5.9. There were 4 lost time injuries reported in 2009, mostly due to muscle sprains and falls.

2.6.2 Performance Assurance

Safety Area Program	Rating 2008	 2009
Performance Assurance	**SA**	**SA**
Quality Management	SA	SA
Human Factors	SA	SA
Training, Examination and Certification	SA	SA

Point Lepreau's performance within the Performance Assurance safety area remained "Satisfactory" in 2009.

[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.

2.6.2.1 Quality Management

Point Lepreau's Quality Management program met CNSC performance expectations in 2009, and was rated "Satisfactory."

In 2009, CNSC staff conducted detailed assessments of the NB Power quality management programs, 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
- documentation and records management

CNSC staff determined that change control process processes at Point Lepreau are robust and well implemented. Some minor deficiencies identified in 2008 were corrected in 2009, to CNSC staff's satisfaction.

Prior to the station's return to service, CNSC staff will verify the completion of commissioning activities and the station's safe operational configuration.

2.6.2.2 Human Factors

Point Lepreau's performance rating in Human Factors remained "Satisfactory" in 2009, despite concerns with the minimum shift complement at the station.

In 2009, CNSC staff inspected Point Lepreau's process for monitoring and complying with minimum shift complement requirements. Some deficiencies were identified, and the CNSC staff is tracking this issue.

CNSC staff continues to oversee human factors activities conducted as part of the refurbishment project at Point Lepreau. Quarterly update meetings are held between the CNSC, NB Power and Atomic Energy of Canada Limited (AECL), to discuss the project's progress as well as any issues and their resolution. CNSC staff observed modifications made in the Main Control Room, the simulator and the field. In addition, staff visited the training facility in Saint John to observe the mock-up facility used for re-tube tooling procedure development, validation and training. The activities of the Re-tube Operations Centre (ROC) were also observed.

CNSC staff is satisfied that a systematic process is followed to include human factors considerations into the design activities for refurbishment. CNSC staff will continue to monitor human factors in design activities in 2010.

In 2008, CNSC staff identified concerns with the availability of internal human factors expertise to provide oversight for design work led by NB Power designers or by

external contractors. Progress has been made in addressing this issue. CNSC staff will continue to monitor NB Power's consideration of human factors in the design process through review of design packages.

Nuclear power plants limit the number of hours that can be worked by staff, in order to reduce the risk of impaired performance due to fatigue. CNSC staff is monitoring NB Power's attempts to improve the implementation of its procedures on hours of work and to better monitor this issue.

2.6.2.3 Training, Examination and Certification

In 2009, performance of Point Lepreau's Training, Examination and Certification program continued to be "Satisfactory".

The CNSC has reviewed NB Power refurbishment training materials since the early stages of their development, and met with NB Power staff on a quarterly basis to monitor the implementation of training for certified operators and non-certified staff.

The Continuing Training Program for certified operators covers topics such as defueling activities, upgrades to station systems during the refurbishment, and (more recently), the approach to criticality theory and fresh core operation. A CNSC inspection of the program found that the training, to date, has been well presented and well received by Point Lepreau staff. CNSC staff concluded that the training is effective and has met the selected inspection objectives and supporting criteria.

In 2009, the overall success rate in initial certification examinations at Point Lepreau was 83%. The requalification examination rate was 100%. CNSC staff finds these results acceptable.

2.6.3 Design and Analysis

Safety Area Program	Rating 2008	 2009
Design and Analysis	**SA**	**SA**
Safety Analysis	SA	–
Safety Issues	SA	SA
Design	SA	SA

Overall performance in the Design and Analysis safety area at Point Lepreau remained "Satisfactory" in 2009.

2.6.3.1 Safety Analysis

The performance of the Safety Analysis program at Point Lepreau was not rated for 2009, due to the ongoing refurbishment activities.

At the end of 2009, Point Lepreau issued a full safety report update, reflecting all of the safety analysis done to support refurbishment.

Point Lepreau's Safety Analysis program is based on compliance with modern quality assurance standards. Overall, CNSC staff is satisfied that the station has an adequate safety analysis program in place, to support the continued safe operation at Point Lepreau once operation resumes.

2.6.3.2 Safety Issues

In 2009, NB Power continued its work, including participation in the industry efforts, toward the resolution of GAIs and CANDU Safety Issues. Performance in this program area remained "Satisfactory" in 2009.

GAI 95G01 was closed for Point Lepreau in 2009. A brief description and the expected year of completion for each remaining GAI are provided in Appendix E.

2.6.3.3 Design

Overall, the performance of Point Lepreau's Design program continued to be "Satisfactory" in 2009, although some weaknesses were identified in fire protection practices.

On several occasions, CNSC staff identified excessive combustible materials (mostly wooden scaffolding) being used within the reactor building. NB Power took action to resolve the issue. CNSC staff expects that NB Power will continue to execute the refurbishment project in a manner that ensures adequate provisions for health and safety. Staff will continue to monitor this issue in 2010.

2.6.4 Equipment Fitness for Service

Safety Area Program	Rating 2008	 2009
Equipment Fitness for Service	**SA**	–
Maintenance	SA	–
Structural Integrity	SA	–
Reliability	SA	–
Equipment Qualification	SA	–

The performance of programs in the Equipment Fitness for Service safety area was not rated in 2009, due to the refurbishment activities at Point Lepreau.

2.6.5 Emergency Preparedness

Safety Area	Rating 2008	 2009
Emergency Preparedness	**FS**	–

Performance of the Emergency Preparedness safety area was not rated in 2009, due to the refurbishment activities at Point Lepreau.

The emergency planning basis at Point Lepreau 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 2009. Emergency management performance was monitored through regular reviews of S-99 reports, Point Lepreau quarterly compliance reports, and CNSC site staff weekly reports.

2.6.6 Environmental Protection

Safety Area	Rating	
	2008	2009
Environmental Protection	**SA**	**SA**

Environmental Protection at Point Lepreau continued to be "Satisfactory" in 2009.

In 2009, the reported dose to the public from Point Lepreau was 0.38 μSv, which is well below the public dose limit of 1,000 μSv. Gaseous and aqueous releases of nuclear substances were always below Environmental Action Levels.

2.6.7 Radiation Protection

Safety Area	Rating	
	2008	2009
Radiation Protection	**SA**	**SA**

Point Lepreau's performance in Radiation Protection remained "Satisfactory" in 2009.

The 2009 dose information for Point Lepreau is provided in Appendix F. There were no radiation exposures at Point Lepreau that exceeded regulatory limits or Point Lepreau's Action Levels in 2009.

In early 2009, a worker received a minor unplanned radiation exposure while mishandling a pressure tube waste container. As identified in 2008, waste management continues to pose some challenges, which have been taken seriously by NB Power. Corrective action plans have been put in place to restore the effectiveness of waste management practices at Point Lepreau.

CNSC staff inspected a number of areas of Point Lepreau's Radiation Protection Program, including radioactive waste management, radiation exposure and dose control, and refurbishment activities. Some findings were positive, but improvement is required in effectively executing whole body counting for ascertaining and recording workers' doses. CNSC staff will closely monitor the effectiveness of the corrective measures NB Power is implementing to resolve these deficiencies.

2.6.8 Site Security

This safety area is presented to the Commission in a separate Commission Member Document (CMD 10-M47.A).

2.6.9 Safeguards

Safety Area	Rating	
	2008	2009
Safeguards	**FS**	**SA**

The Safeguards safety area at Point Lepreau met applicable CNSC requirements and performance expectations in 2009, and received a "Satisfactory" rating. This rating is lower than the one assigned in 2008, due to changes in the methodology for assessing Safeguards. There has been no significant change in the station's performance. NB 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.

The IAEA conducted a Physical Inventory Verification at Point Lepreau between September 9 and 11, to verify that no diversion of nuclear material had taken place, to 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 reviewed 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.

2.6.10 Regulatory Decisions

Point Lepreau Licence

The Point Lepreau Licence was amended two times in 2009:

PROL 17.08/2011 – Effective August 14

- Update of "Nuclear Management Manual – NMM-00660" to Revision 5.

PROL 17.09/2011 – Effective October 6

- New Licence Condition 2.10: "Each control room operator and shift supervisor who has completed, prior to the effective date of this licence, the applicable written and simulator-based requalification tests, as specified in the document "Requirements for the Requalification Testing of Certified Shift Personnel at Canadian Nuclear Power Plants" Rev. 1, listed in Appendix C, with the transitional amendments of Appendix F regarding written requalification tests, shall also be deemed to meet the requirements of condition 2.9."
- New Licence Condition 2.15: "Requalification tests developed, conducted and graded by the licensee prior to the effective date of this licence and in accordance with the relevant parts of the document "Requirements for the Requalification Testing of Certified Shift Personnel at Canadian Nuclear Power Plants" Rev. 1, listed in Appendix C, with the transitional amendments of Appendix F regarding written requalification tests, shall also be deemed to meet the requirements of condition 2.14."

2.6.11 Update on Major Projects and Initiatives

Point Lepreau Refurbishment Project

Point Lepreau refurbishment project activities continued in 2009, with the overall progress remaining approximately 18 months behind schedule. In September 2009, NB Power reported that AECL, who is responsible for the refurbishment retube work, estimated that this work would be completed by mid-October 2010. Following the retube, NB Power will complete the remaining commissioning and return-to-service activities. The new target date for reactor restart is the first quarter of 2011.

NB Power staff members presented an update on the Point Lepreau refurbishment outage to the Commission at the CNSC public meetings held in December 2009 (CMD 09-M28). During the presentations, NB Power staff reported to the Commission on current project status and the challenges leading up to the One Day Public Hearing for fuel reload.

3.0 SUMMARY AND CONCLUSIONS

This report summarizes the CNSC staff's assessment of the safety performance of nuclear power plant (NPP) licensees and of the NPP industry as a whole in 2009. It also discusses generic issues and identifies industry trends. As part of this assessment, the CNSC evaluates how well licensees are meeting regulatory requirements and CNSC expectations for the performance of programs in nine safety areas. The evaluations in this report were based on the consideration of findings from inspections, desktop reviews, event reviews and performance indicators against relevant requirements, expectations and performance objectives.

CNSC staff concludes that NPPs in Canada were operated safely during 2009, and that licensees 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. This conclusion is based on the following observations:

- There were no serious process failures at any station.
- No member of the public received a radiation dose in excess of the regulatory limits.
- There were no confirmed worker radiation exposures in excess of the regulatory dose limits.
- The frequency and severity of injuries/accidents involving workers was minimal.
- All environmental emissions from the stations were below regulatory limits.
- Licensees complied with their licence conditions concerning Canada's international obligations.

The NPP operational events that occured in 2009 had minimal impact on health, safety and the environment and Canada's obligations on the peaceful use of nuclear energy. Licensees reported all such events, as per S-99 reporting requirements, and conducted (or are conducting) appropriate follow-up, which includes root cause analysis and corrective action, as needed. One event, the alpha contamination at Bruce A in November 2009, was still under investigation at the time of writing; the preliminary investigation indicates that the regulatory dose limits have not been exceeded.

These positive outcomes were the result of a multitude of provisions undertaken by each licensee. The CNSC's evaluation of the safety areas at each NPP confirmed, at a more detailed level, that the licensees' provisions to protect health, safety and the environment and help honour Canada's international obligations met the CNSC's performance expectations. The 2009 ratings for the safety areas and the integrated plant ratings are presented below in Table 14, for all NPPs, along with the industry averages.

Table 14: Safety Area Ratings for 2009

Safety Area	Bruce		Darl-	Pickering		Gentilly-	Point	Industry
	A	B	ington	A	B	2	Lepreau	Average
Operating Performance	FS	FS	FS	SA	SA	SA	SA	SA
Performance Assurance	SA	SA	SA	SA	SA	SA	SA	SA
Design and Analysis	SA	SA	SA	SA	SA	SA	SA	SA
Equipment Fitness for Service	SA	SA	SA	SA	SA	SA	–	SA
Emergency Preparedness	FS	FS	FS	SA	SA	FS	–	FS
Environmental Protection	SA	SA	SA	SA	SA	SA	SA	SA
Radiation Protection	SA	SA	SA	SA	SA	SA	SA	SA
Integrated Plant Rating*	FS	FS	FS	SA	SA	SA	SA	SA
Safeguards	SA	SA	SA	SA	SA	SA	SA	SA

***** Safeguards was excluded from the integrated plant rating.

All integrated plant ratings were "Satisfactory" or "Fully Satisfactory" in 2009—these were the same ratings as in 2008.

In addition, all the safety area ratings were either "Satisfactory" or "Fully Satisfactory" in 2009. This is an improvement over 2008, when two of the safety area ratings were "Below Expectations".

Safeguards ratings went from "Fully Satisfactory" in 2008 to "Satisfactory" in 2009 for all stations. However, this was due to changes in the methodology for assessing safeguards, and did not originate from any significant change in the stations' performance.

Program grades are not shown in Table 14, but are available in Section 2 of this report. At the program level, the industry average was either "Satisfactory" or "Fully Satisfactory" for all programs, while for individual stations, the program ratings ranged from "Below Expectations" to "Fully Satisfactory". For any safety-related deficiencies that were identified as part of the assessments at the program level, CNSC staff determined that the licensees were taking appropriate actions to address the relevant issues or deficiencies.

Performance improved in numerous programs. Five programs improved from "Below Expectations" in 2008 to "Satisfactory" in 2009, and three programs improved from "Satisfactory" in 2008 to "Fully Satisfactory" in 2009. Only one program had a decline in performance, from "Fully Satisfactory" in 2008 to "Satisfactory" in 2009. This indicates positive trend in overall industry performance.

APPENDIX A – DEFINITIONS OF SAFETY AREAS AND PROGRAMS

The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in nine safety areas as follows:

Safety Area	Program
Operating Performance	Organization and Plant Management
	Operations
	Occupational Health and Safety
Performance Assurance	Quality Management
	Human Factors
	Training, Examination and Certification
Design and Analysis	Safety Analysis
	Safety Issues
	Design
Equipment Fitness for Service	Maintenance
	Structural Integrity
	Reliability
	Equipment Qualification
Emergency Preparedness	
Environmental Protection	
Radiation Protection	
Site Security	
Safeguards	

Definitions and performance objectives for each safety area and program are provided below.

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, 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 the performance of other programs and the effectiveness of overall plant management.

Performance Objective

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

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

Performance Objective

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

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 programs
- performance monitoring and 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, 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 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 in order to verify that licensees employ adequate assumptions, that they use validated models and analytical tools, as required by plant operating licences, and that these analyses have appropriate scope and demonstrate acceptable results.

Performance Objective

Demonstrated acceptability of the consequences of design basis events, 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 common to more than one station and complex in nature have been designated as Generic Action Items (GAIs). GAIs identify areas where there is uncertainty in the knowledge basis of the safety assessment, or where regulatory decisions need

to be confirmed. Further work or experimental research is required, in order to more accurately determine the overall safety impact on the facility. CNSC staff allows station operation, because GAIs deal with situations where safety margins still exist. Issues with confirmed, immediate safety significance are addressed by other means, on a priority basis.

Performance Objective

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

3.3 Design

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

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

Performance Objective

Up-to-date plant specifications aligned to applicable regulatory requirements.

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 that 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.

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

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

- have a documented EQ program and associated processes in place for establishing and maintaining environmental qualification, and have all EQ-related documentation available at the station

- ensure that EQ processes and procedures meet recognized industry standards
- have a condition monitoring program in place, to assess degradation and failures of qualified equipment during normal operation
- have an environmental monitoring program in place, to assess changes in environmental conditions in rooms that contain qualified components
- have procedural controls in place, to preserve environmental qualification of equipment for the life of the plant
- ensure that the EQ program complies with the station quality assurance program
- 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 emergency exercises. These assessments provide evidence of the effectiveness of the licensee's emergency response strategy and a level of assurance of the licensee's state of readiness.

Performance Objective

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

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 in place to protect persons inside a nuclear facility from unnecessary exposure to ionizing radiation.

The *Radiation Protection Regulations* prescribe dose limits for workers who may be exposed to radioactive material. In addition, the regulations require licensees to establish a radiation protection program to keep exposures to radiation as low as reasonably achievable (ALARA) through the implementation of a number of control programs, including:

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

Performance Objective

Adequate protection of the health and safety of 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 the licensees' site security program, as follows:

- 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 DEFINITIONS

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

Fully Satisfactory (FS)
Compliance with regulatory requirements is fully satisfactory. Compliance within the area exceeds requirements and CNSC expectations. Compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)
Compliance with regulatory requirements is satisfactory. Compliance within the area meets requirements and CNSC expectations. Any deviation is only minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC expectations. Appropriate improvements are planned.

Below Expectations (BE)
Compliance with regulatory requirements falls below expectations. Compliance within the area deviates from requirements or CNSC expectations. to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant is taking appropriate corrective action.

Unacceptable (UA)
Compliance with regulatory requirements is unacceptable, and is seriously compromised. Compliance within the overall area is significantly below requirements or CNSC expectations, or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

APPENDIX C – GLOSSARY OF TERMS

The following terms appear throughout the text:

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
When referring to the Canadian Nuclear Safety Commission (CNSC), this designates 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 nuclear power plant 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.

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.

minimum staff (shift) complement
The minimum number of qualified workers who must be present at all times to ensure the safe operation of the nuclear facility and to ensure adequate emergency response capability.

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. This includes a final safety analysis report demonstrating the adequacy of the design of the nuclear facility.

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

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

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

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

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

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

Type I inspection
An audit or evaluation carried out by CNSC staff of a licensee's programs, processes and practices.

Type II inspection
An equipment or system inspection or operating practice assessment carried out by CNSC staff, which includes item-by-item checks and rounds that focus on outputs or performance of licensee programs, processes and practices. Findings play a key role in identifying where a Type I inspection may be required to determine systemic problems in programs, processes or practices.

APPENDIX D – ACRONYMS

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

AECL	Atomic Energy of Canada Limited
ALARA	as low as reasonably achievable
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
EQ	environmental qualification
GAI	generic action item
GSS	guaranteed shutdown state
IAEA	International Atomic Energy Agency
ISR	Integrated Safety Review
ISTB	Inter-Station Transfer Bus
LLOCA	Large loss of coolant accident
LOCA	loss of coolant accident
LVRF	low void reactivity fuel
NGS	nuclear generating station
NOP	Neutron Overpower
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
PSA	probabilistic safety assessment
ROP	Regional Overpower
RP	radiation protection
SDS	shutdown system
SSC	structures, systems and components

APPENDIX E – CANDU SAFETY ISSUES

As described in Section 1.3.2, the CNSC initiated a project in 2007 to identify safety issues associated with the design, analysis and aging management of Canadian CANDU reactors. The identified issues were grouped into 3 categories, based on risk considerations. This included the GAIs (see Table E.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.

In 2008, a joint CNSC/industry working group was established to review, assess and progress the resolution of the pending Category 3 issues. After application of a risk-informed decision making methodology, four of the original Category 3 issues were re-assigned to lower categories. The remaining Category 3 issues can be broadly grouped as follows:

Large LOCA Issues

Four CANDU safety issues are related to Large LOCA: two concern fuel behaviour and the other two concern positive void reactivity during Large LOCA conditions. The Large LOCA design basis event is one of the most difficult accidents to analyze for a CANDU reactor, because many aspects of the reactor behaviour under accident conditions and its computer modeling are subject to considerable uncertainties. A CNSC/industry joint working group was established to resolve these issues and, in 2009, produced a document outlining two possible resolution methods.

GAIs 95G05, 95G04, 99G02 and 00G01 are included under this safety issue.

Analysis Methodology for NOP/ROP

The Neutron Overpower/Regional Overpower (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.

OPG and Bruce Power developed a new (improved) NOP/ROP analysis methodology, which was submitted to an Independent Technical Panel for review in 2008. In 2009, the panel completed its review and concluded that the overall methodology had a sound technical basis, but recommended additional justification, supplemental analysis and revisions prior to final acceptance in the regulatory process. CNSC staff agreed with the conclusions of the panel, and advised licensees that further development work is required on the methodology for its full utilization for licensing applications.

Emergency Core Coolant Sump Screen Adequacy

The issue, as described in the IAEA TECDOC, has been closed. However, a related issue was identified in United States research into chemical effects in sump water. The CNSC raised GAI 06G01 “ECC Strainer Deposits” to address this concern.

The results of testing performed under CANDU-specific conditions indicated that the chemical effects are minor. In 2009, GAI 06G01 was closed for all stations, after calculations presented by

licensees provided confidence that chemical precipitates will not impair Emergency Coolant Injection recirculation in the limiting Large Break LOCA.

Hydrogen Control Measures during Accidents

Although this has been a long-standing issue, the industry has developed a sufficient understanding of hydrogen behaviour 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 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, due to the aging of important safety-related functions.

Licensees have Aging Management programs, as well as Fitness-For-Service Guidelines for life limiting components (i.e., feeders, pressure tubes, steam generator tubes). However, licensee programs for management of aging of other systems and components, have not been implemented systematically as yet, and there are concerns that aging degradation in components other than feeders, pressure tubes, steam generators and reactor power control instrumentation are 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

This issue is applicable to the multi-unit stations. In these stations, steam line breaks and feedwater line breaks are the largest contributors to core damage frequency and large release frequency, accounting for about 70% to 80%. A high energy line break, such as a steam line break or feed water line break, could lead to widespread damage of many electrical cabinets and systems which are not protected enough (or simply open). The turbine hall is an open design with very little steam protection.

To address this issue, licensees need to consider practicable measures to reduce the probability of consequential failures of support systems to control, cool, and contain (e.g., instrument air, electrical, Heating Ventilation Air Conditioning, emergency forced air discharge system, air cooling units).

Systematic Assessment of High Energy Line Break Effects

On the secondary side, all CANDU NPPs have constructed isolation barriers/engineered restraints and 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 pipe rupture. By constructing isolation barriers/engineered restraints against jet impingement/pipe whip, or being satisfied with the Leak-Before-Break criteria, Darlington has adequately protected the SSCs from the consequences associated with a postulated rupture of high-energy piping. However, the issue of high energy line break on the primary side was not fully addressed in the design stage for other stations. It is important to note that a probabilistic justification was used to minimize the number of locations of high concern.

Licensees need to do an assessment to identify vulnerabilities and implement corrective measures where practicable. In addition, licensees should carry out appropriate inspection and maintenance activities to support the fitness-for-service status of high energy pipes.

Analysis for Pressure Tube Failure with Consequential Loss of Moderator

Tests have shown that in circumstances where the calandria tube fails after a pressure tube break, there is a possibility of ejecting the end fitting and draining of the moderator. The current Safety Reports do not include scenarios involving a LOCA and a loss of moderator. The issue is relevant only to the dual failure in-core LOCA and loss of Emergency Core Cooling (LOECC), since the moderator is credited as the ultimate heat sink for the reactor.

The unavailability of the moderator as a backup heat sink, during an in-core LOCA and LOECC could lead to a severe core damage accident. Furthermore, the results of fuel channel burst tests conducted by the industry suggest that pressure tube rupture events leading to a large loss of moderator are more probable than previously assumed.

GAI 95G02 is included under this safety issue. The industry has submitted the plans of actions to reduce the potential risk associated with this postulated event. CNSC staff has, in principle, agreed with the proposed administrative measures taken to mitigate the potential consequences of this event, and also agreed that implementation of any substantial design changes to reduce the likelihood of the event could be done during plant refurbishment and replacement of fuel channels.

Molten Fuel/Moderator Interaction

This safety issue is captured under GAI 95G01. High pressure injection of molten fuel in the cold moderator may occur during an in-core LOCA, that follows a stagnation feeder break or flow blockage, possibly leading to a steam explosion. The additional loads due to molten fuel/metal interaction may cause impairment of the shut-down function (failure of SDS1 rods guide tubes). In addition, the fuel cooling function may be impaired if several channels consequentially fail due loads generated during the molten fuel/metal interaction. If neither the shut-down function nor cooling function fails, there is 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, the completion of the planned sets of experiments is recommended, in order to improve the confidence in the adequacy of the design, as well as the understanding of molten fuel/metal interaction phenomena.

Test results confirmed that the dominant mode of molten fuel moderator interaction is "forced interaction", as assumed in the current safety analysis. As a result, GAI 95G01 was closed for all stations in 2009.

Computer Code and Plant Model Validation

Computer code validation measures a computer code's ability to predict plant behaviour. To provide the necessary confidence in the safety analyses being performed, NPP licensees have established specific validation programs for industry standard tool codes.

In 2009, CNSC staff continued to review the existing validation work on some of the principal computer codes used by licensees and to monitor the implementation of the validation process established by the industry. While staff noted that progress was being made in some areas, existing code validation work does not, in general, comply with the requirements that would allow a full qualification of these codes.

Table E.1 provides brief descriptions of the GAIs that were open in 2009. Several of these GAIs are on track for closure in 2010.

Table E.1: Generic Action Items Open in 2009

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
94G02	Impact of fuel bundle condition on reactor safety	The effects of bundle degradation on reactor safety are not fully known, partially because of the 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. - Work in progress for G-2.	2010
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.	- All tests and analysis completed. - Closed for all stations in October 2009	Closed
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. - Work in progress for G-2.	2010
95G04	Positive void reactivity uncertainty - treatment in large	Accuracy of void reactivity calculations is a significant safety issue in the analysis of design basis	Closure will depend on final recommendations	2013

GAI	Title	Brief Description	Notes	Expected Closure Date
	LOCA analysis	accidents involving channel voiding especially for large LOCAs. Uncertainties and safety margin adequacy are the main questions.	by a joint industry/CNSC RIDM team.	
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.	- Closed for all site except BA and PA. - Additional experiments are requested for BA and PA.	2010
99G02	Replacement of reactor physics computer codes used in safety analyses of CANDU reactors	Shortcomings need to be rectified, with respect to inaccurate computer code predictions of key parameters for accident conditions, lack of proper validation and a lag of licensees' methods and codes behind the state of knowledge in this area.	- Linked to GAI 95G04. - Closure will depend on final recommendations from joint industry/CNSC RIDM team.	2013
00G01	Channel voiding during a LOCA	At issue is the adequate validation of computer codes used for the prediction of overpower transients for CANDU reactors with a positive coolant void reactivity coefficient.	Work in progress.	2010
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.	2010
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. - Closed for OPG sites in 2009.	Closed

APPENDIX F – 2009 NPP DOSE INFORMATION

The following tables provide a five-year trend (2005 to 2009) 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 the Routine and Outage dose information is based on estimated doses from electronic dosimetry. The data provided for Total Internal, External, and Collective Effective Dose represents 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 and duration of the work, 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.

In 2009, no radiation exposures at any of the stations have been confirmed to exceed regulatory dose limits. Note that the analysis of the radiation exposures resulting from the alpha contamination event at Bruce A, Unit 1, in November 2009, has not been finalized at the time of the completion of this report, and will be included in the 2010 NPP Report.

F.1 Annual Doses at Bruce A

Bruce A - Units 3 and 4					
Year	**Collective Dose - Routine Operations (person-mSv)**	**Collective Dose - Outages (including forced outages) (person-mSv)**	**Total Collective Internal Dose (person-mSv)**	**Total Collective External Dose (person-mSv)**	**Total Collective Effective Dose (person-mSv)**
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
2009	341	2,402	244	2,499	2,743

Bruce A has two operating units.

There were two planned outages at Bruce A in both 2008 and 2009. The outage collective dose at Bruce A decreased in 2009, due to the limited scope of one of the planned outages.

Total collective effective doses were higher in 2007 and 2008, due to increased outage work associated with aging reactors. In 2007, there were four planned outages, while in 2008, there were two planned and one forced outage, which contributed significantly to the increase in the total collective dose at Bruce A.

Bruce A - Units 1 and 2			
Year	**Total Collective Internal Dose (person-mSv)**	**Total Collective External Dose (person-mSv)**	**Total Collective Effective Dose (person-mSv)**
2005	16	62	78
2006	214	1,291	1,505
2007	403	3,928	4,331
2008	88	3,116	3,204
2009	53*	4,545	4,598

* This dose does not include internal doses resulting from the alpha event at Unit 1 in November, 2009.

Bruce A Units 1 and 2 have been shutdown since 1997 and 1995, respectively, and have been under refurbishment since 2005. A significant portion of dose intensive work has been carried out since 2007. Total collective effective dose has been increasing at Bruce A Units 1 and 2, due to the scope of the work in the refurbishment project.

F.2 Annual Doses at Bruce B

Bruce B – Units 5 to 8					
Year	**Collective Dose - Routine Operations (person-mSv)**	**Collective Dose - Outages (including forced outages) (person-mSv)**	**Total Collective Internal Dose (person-mSv)**	**Total Collective External Dose (person-mSv)**	**Total Collective Effective Dose (person-mSv)**
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
2009	570	3,737	333	3,974	4,307

Bruce B has four operating units.

There were higher total collective doses in 2005 and 2008, due to two major planned outages, compared to one major planned outage in 2006, 2007 and 2009.

Dose from forced outages contributed to small fluctuations in the collective outage dose in years with the same number of planned outages.

F.3 Annual Doses at Darlington

Darlington – Units 1 to 4					
Year	**Collective Dose - Routine Operations (person-mSv)**	**Collective Dose - Outages (including forced outages) (person-mSv)**	**Total Collective Internal Dose (person-mSv)**	**Total Collective External Dose (person-mSv)**	**Total Collective Effective Dose (person-mSv)**
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
2009	256	2,937	393	2.800	3,193

Darlington has four operating units.

The 2009 total collective effective dose is higher than in 2008, due to several forced outages and a vacuum building outage, which required the shut down of all four units.

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

F.4 Annual Dose at Pickering A

Pickering A - Units 1 and 4					
Year	**Collective Dose - Routine Operations (person-mSv)**	**Collective Dose - Outages (including forced outages) (person-mSv)**	**Total Collective Internal Dose (person-mSv)**	**Total Collective External Dose (person-mSv)**	**Total Collective Effective Dose (person-mSv)**
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
2009	473	1,970	551	1,892	2,443

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	33	45	78
2009	87	97	185

Pickering A has two operating units, and two in shutdown state.

Up to and including 2007, Pickering-A reported collective dose for all units in a single metric. 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.

In 2005, the increased number of outages necessary to return Unit 1 to service contributed to the elevated collective dose in that year.

In 2008, no planned maintenance outage was executed; a planned outage in Unit 4 was deferred to 2009, resulting in a lower collective dose in 2008. All dose reports made in 2008 under "Collective Dose – Outages" resulted from forced outages in Units 1 and 4.

In 2009, most of the dose reported resulted from the Unit 4 planned outage and several forced outages. The reduction in routine operations dose is due to improvements in human performance and reduced on power time on Unit 4.

The increase in dose on the safe storage units is due to the significant increase in the scope of work in 2009, compared to 2008.

F.5 Annual Dose at Pickering B

Pickering B – Units 5 to 8					
Year	**Collective Dose - Routine Operations (person-mSv)**	**Collective Dose - Outages (including forced outages) (person-mSv)**	**Total Collective Internal Dose (person-mSv)**	**Total Collective External Dose (person-mSv)**	**Total Collective Effective Dose (person-mSv)**
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
2009	573	2,836	532	2,877	3,409

Pickering B has four operating units.

Since 2005, there has been a decreasing trend in the total collective internal and external doses; therefore, the total collective effective dose has been decreased significantly. This dose reduction can be partially attributed to several ALARA initiatives. The magnitude of the collective doses in 2005 is attributed to the scope of outage work performed that year.

The 2009 outage and internal collective doses are lower than in 2008, due to the length and the scope of the outage.

The 2009 performance for the internal dose component is the lowest collective internal at Pickering-B to date, and can be attributed to several airborne exposure reduction initiatives.

F.6 Annual Dose at Gentilly-2

Year	**Collective Dose - Routine Operations (person-mSv)**	**Collective Dose - Outages (including forced outages) (person-mSv)**	**Total Collective Internal Dose (person-mSv)**	**Total Collective External Dose (person-mSv)**	**Total Collective Effective Dose (person-mSv)**
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	1,001	140	1,014	1,154
2009	156	521	106	571	677

Gentilly-2 is a single unit station.

The magnitude of the collective doses in 2005 is attributed to the scope of outage work performed that year. In other years, the majority of the total collective effective dose is attributed to the duration and scope of the outages.

Total collective internal dose and total collective dose for routine operations have decreased. This reduction can be partially attributed to some of ALARA initiatives.

F.7 Annual Dose at Point Lepreau

Year	Collective Dose - Routine Operations (person-mSv)	Collective Dose - Outages (including forced outages) (person-mSv)	Total Collective Internal Dose (person-mSv)	Total Collective External Dose (person-mSv)	Total Collective Effective Dose (person-mSv)
2005	137	1,440	134	1,443	1,577
2006	156	745	131	770	901
2007	129	535	68	596	664
2008	55	5,943	374	5,624	5,998
2009	Not Applicable	4,082	123	3960	4,082

Point Lepreau is a single unit station.

In late March 2008, the station was shut down for refurbishment. In 2009, the station remained shutdown, as the refurbishment outage continued. Due to the nature of the refurbishment work, where many tasks involve high radiological hazards, collective dose to workers is significantly 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 was attributed in part to the duration and scope of the planned outage.