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Canadian National Report for the Convention on Nuclear Safety

Third Report

September 2004

Canada

Canadian National Report for the Convention on Nuclear Safety — Third Report

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This report demonstrates how Canada has implemented its obligations under the Convention on Nuclear Safety. The report follows closely the guidelines, regarding form and structure, that were established by the contracting parties under Article 22 of the Convention.

This report is produced by the Canadian Nuclear Safety Commission on behalf of Canada. Contributions to the report were made by representatives from Ontario Power Generation, Bruce Power, New Brunswick Power, Hydro-Québec, Health Canada, Natural Resources Canada, Foreign Affairs Canada, Atomic Energy of Canada Limited (also representing the CANDU Owners Group), the Canadian Nuclear Association, and the Emergency Response Organizations of the provinces of Ontario, Québec and New Brunswick.

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Canadian National Report on Nuclear Safety
Third Report

In conformance with Article 5 of the Convention on Nuclear Safety

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EXECUTIVE SUMMARY

This Canadian 3rd Report demonstrates how Canada continues to meet its obligations under the terms of the Convention on Nuclear Safety by reporting on the systematic monitoring of safety-related programs and their implementation in Canada. This report also addresses specific topics raised at the 2nd Review Meeting regarding subjects that are either unique to Canada or of interest to other countries. The focus in this report is placed on updates, advancements, upgrades and initiatives that were effected during the reporting period (April 2001 to March 2004).

The main themes of this report include:

- the specific improvements made to the regulatory framework of the Canadian Nuclear Safety Commission (CNSC);
- the transitioning and implementation of the Integrated Improvement Programs (IIP) of two Canadian licensees into their routine nuclear power plant (NPP) site operational project programs;
- the return to service of three power reactor units;
- the use of the CNSC rating scheme to assess the nuclear industry safety-related programs and their implementation;
- the extension of the licence periods of NPPs in Canada beyond two years; and
- the progress made on numerous generic and specific safety issues.

The main aspects that are addressed in this report include improvement in power reactor licensees' safety performance, closure of several generic safety issues, effect on NPPs of the loss of electricity grid event of August 14, 2003 in Ontario and the Northeastern United States, changes made in the emergency preparedness infrastructure and efforts made on maintenance of competence.

The report also addresses several initiatives such as the use of a risk-informed approach to planning and resource allocation, assurance of safety margins for specific accident scenarios, future licensing requirements, the transfer of examination of key personnel to licensees, a project on safe operating envelope, and the preparation of a licensing basis for potential new reactors.

This Canadian 3rd Report is the product of a core team comprising more than 20 representatives from the CNSC, federal and provincial departments and the nuclear power industry in Canada.

The full text of the Canadian 1st, 2nd and 3rd Reports on Nuclear Safety, as well as related or referenced documents, can be found on the CNSC's website (www.nuclearsafety.gc.ca) as well as on the website of the International Atomic Energy Agency (IAEA) (http://www-ns.iaea.org/nusafe/s_conv/s_conv.htm).

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List of Acronyms, Abbreviations and Specific Expressions

AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable, social and economic factors being taken into account.
Bruce Power	Bruce Power Inc.
CANDU	Canadian Deuterium Uranium
CMD	Commission Member Documents are prepared for Commission hearings and meetings by CNSC staff, proponents and intervenors. Each CMD is assigned a specific identification number.
CNSC	The Canadian Nuclear Safety Commission as an organization
CNSC Staff	The staff of the CNSC
COG	CANDU Owners Group
Commission	The tribunal component of the CNSC
Compliance	The CNSC program that includes three elements: promotion, verification and enforcement.
Convention	The Convention on Nuclear Safety
CSA	Canadian Standards Association
Desktop Review	All verification activities limited to the review of documents and reports submitted by licensees. This includes quarterly technical reports, annual compliance reports, special reports and documentation related to design, safety analysis, programs and procedures.
FNEP	Federal Nuclear Emergency Plan
FP	Full Power
DRL	Derived Release Limits
ECC	Emergency Core Cooling
ECCS	Emergency Core Cooling System
EMO	Emergency Management Ontario
Enforcement	All activities to compel a licensee back into compliance and to deter further non-compliances with the regulatory requirements. Enforcement activities include legal investigation, event investigation, the processing of Orders, Directives, and Action Notices, and all follow up activities related to processing and verifying completion of actions requested to correct a non-compliance identified by a compliance verification activity.
EPRI	Electric Power Research Institute
EQ	Environmental Qualification
Event Review	All verification activities related to reviewing, assessing and trending of licensees’ event reports.
Focused Inspection	A special Type I or Type II inspection that is performed as a regulatory follow-up in response to an event, inspection findings or a licensee’s performance.
G8	Group of eight nations (Canada, United States of America, France, United Kingdom, Germany, Italy, Japan and Russia, and representatives of the European Union)
GAI	Generic Action Item
GSS	Guaranteed Shutdown State
HC	Health Canada
HQ	Hydro-Québec
HT	Heat Transport
IAEA	International Atomic Energy Agency
IGSCC	Intergranular Stress Corrosion Cracking
IIP	Integrated Improvement Program
INES	International Nuclear Event Scale

LLOCA	Large Loss of Coolant Accident
LOCA	Loss of Coolant Accident
LOECC	Loss of Emergency Core Cooling
LOR	Loss of Regulation
LVR Fuel	Low-Void-Reactivity Fuel
mSv	Millisieverts
NBEMO	New Brunswick Emergency Measures Organization
NBPN	New Brunswick Power Nuclear Corporation
NEA	Nuclear Energy Agency
NPP	Nuclear Power Plant
NRCan	Natural Resources Canada
NSCA	Nuclear Safety and Control Act
OP&P	Operating Policies and Principles
OPEX	Operating Experience
OPG	Ontario Power Generation Inc.
OSART	Operational Safety Review Team
OSCQ	Organisation de sécurité civile du Québec
PMUNE-G2	Plan des mesures d'urgence nucléaire externe à la centrale Gentilly-2
PROL	Power Reactor Operating Licence
Promotion	All activities related to fostering licensees' compliance with the regulatory requirements. This includes replying to requests for information, attending seminars and workshops, and explaining regulatory requirements or positions.
PSA	Probabilistic Safety Assessment
PSEPC	Public Safety and Emergency Preparedness Canada
PSR	Periodic Safety Review
QA	Quality Assurance
R&D	Research and Development
Reporting period	April 2001 to March 2004
S-99	CNSC Standard for Reporting Requirements
SAT	Systematic Approach to Training
SOE	Safe Operating Envelope
Transitioning	The process by which programs, processes and procedures are transferred, integrated and streamlined into existing operations, ensuring both the continuity of the activities contained therein and their follow-up to completion.
SSCs	Systems, Structures and Components
Type I Inspection	All verification activities related to on-site audits and evaluations of licensees' programs, processes and practices.
Type II Inspection	All verification activities related to routine (item by item) checks and rounds.
USNRC	United States Nuclear Regulatory Commission
Verification	The compliance program elements that includes Type I and Type II inspection, Desktop Review and Event Reviews. These include all regulatory activities related to determining and documenting if a licensee's performance meets the regulatory requirements and expectations.
WANO	World Association of Nuclear Operators

1. INTRODUCTION

1.0 General

Canada was one of the first signatories of the Convention on Nuclear Safety (the Convention) which came into force on October 24, 1996. As one of the promoters of the Convention and one of the staunchest supporters of its objectives, Canada has endeavoured to fulfil its obligations under the Convention as demonstrated in the Canadian 1st and 2nd Reports presented at the 1st and 2nd Review Meetings held in April 1999 and 2002, respectively.

In the Canadian 2nd Report, the implementation of Articles 6 to 19 of the Convention was described in 245 pages of detailed information on the Canadian regulatory system and the nuclear power generation industry. The main themes of the Canadian 2nd Report encompassed the coming into force in May 2000 of the *Nuclear Safety and Control Act* (NSCA) and its accompanying regulations, which have both changed the Canadian legislative framework for regulation and control of the nuclear industry in Canada. The NSCA established the Canadian Nuclear Safety Commission (CNSC) as the Canadian regulatory body. The Canadian 2nd Report also included detailed information on progress made by the licensees in their performance improvement programs, the preparation to return to service of a few nuclear reactor units, the impact of privatization on the nuclear industry and the performance indicators developed by the CNSC. One of two main safety issues in the Canadian 2nd Report addressed the challenges faced by the licensees in developing and implementing performance improvement programs, and how the rate of improvements was slower than anticipated in some areas while meeting or exceeding expectations in other areas. The other safety issue identified in the Canadian 2nd Report was related to a number of unresolved safety challenges that, in some cases, resulted in the CNSC imposing limits on the power output of a few power reactor units.

As required by Article 5 of the Convention on Nuclear Safety, this 3rd Report demonstrates how Canada fulfilled its obligations under Articles 6 to 19 of the Convention during the reporting period, which extends from April 2001 to March 2004. Based on recommendations made during the Canadian 2nd Review Meeting, this Canadian 3rd Report focuses on changes that have taken place since the publication of the Canadian 2nd Report. For consistency, the structure of this report has been kept as close as possible to that of the Canadian 1st and 2nd Reports, to enable readers to follow an issue from one report to the next. Two exceptions are the inclusion of an Executive Summary and the inclusion of a separate chapter – Chapter 2 – that deals exclusively with issues raised in the previous Review Meeting.

Chapter 2 of this report contains follow-up information on issues raised or requested by other countries at the 2nd Review Meeting. Chapter 3 includes detailed material that demonstrates how Canada implemented its obligations under Articles 6 to 19 of the Convention during the reporting period. Chapter 4 describes challenges and new initiatives that surfaced in the last three years. The annexes at the end of the report contain expanded information that is presented in tabulated, visual or textual formats.

The full text of the Canadian 1st and 2nd Reports, as well as related documents, can be found on the CNSC's website and on the website of the International Atomic Energy Agency (IAEA). A list of websites of relevant organizations mentioned throughout this report is included in Annex 1.1. This Canadian 3rd Report will be available on the website of the CNSC in early 2005.

1.1 National Safety Policy

The Canadian legislation on nuclear safety is the NSCA and its associated regulations. The two main themes of this legislation are:

- Health, safety, security and environmental protection; and
- Non-proliferation and safeguards.

The first theme – health, safety, security and environmental protection – works to limit, to a reasonable level, risks to national security, and the health and safety of persons and the environment that are associated with the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed sources and prescribed information.

The second theme – non-proliferation and safeguards – works to implement measures to which Canada has agreed respecting international control of the development, production and use of nuclear energy, including the non-proliferation of nuclear weapons and nuclear explosive devices, and to support international efforts to develop, maintain and strengthen the nuclear non-proliferation and safeguards regimes.

With regard to the implementation of the national nuclear safety policy, the CNSC is supported by other federal organizations. Among them are Natural Resources Canada, Foreign Affairs Canada, Health Canada and its Radiation Protection Bureau, Environment Canada and Department of Fisheries and Oceans. Implementation of the national nuclear safety policy is undertaken by the nuclear power plant (NPP) operators (called licensees in Canada), Atomic Energy of Canada Limited, provincial organizations and municipal units. These organizations all operate in an integrated manner guided by the legislative and regulatory frameworks.

Canada is also actively involved with the International Nuclear Regulators Association, the Organization for Economic Cooperation and Development's Nuclear Energy Agency and the G8's Nuclear Safety and Security Group. These groups afford Canada the opportunity to coordinate activities at the international level, to influence and enhance nuclear safety from a regulatory perspective and to exchange information and experience among regulatory organizations. Additionally, Canada is a signatory to two other multilateral conventions on nuclear safety, nuclear waste and the physical protection of nuclear materials. These ensure that Canada conforms to international norms of conduct.

1.2 Nuclear Power Plants in Canada

In Canada, there are twenty-two nuclear power reactor units (see Annex 3.6.1) that are operated by four licensees (see Article 6), licensed by one federal nuclear regulatory body (see Articles 7 and 8). During the reporting period, two reactor units remained defuelled, three units remained in a guaranteed shutdown state and three units were returned to service (see Articles 6 and 14, and Annexes 3.6.1 and 3.14.1). Hence, the number of operating units connected to the grid increased from 14 to 17 units during the reporting period.

1.3 Main Themes of This Report

Special attention was given to six themes in this report:

1) Specific improvements made to the CNSC regulatory framework (subsection 3.7.2.1).
2) Transitioning and implementation of the Integrated Improvement Programs (IIP) into the routine NPP site operational project programs (subsection 2.2).
3) Return to service of three power reactor units: one at the Pickering site and two at the Bruce site (subsections 3.14.1.3 and 3.14.1.4).

4) The use of the CNSC rating scheme to assess the industry safety-related programs and their implementation (subsections 3.7.2.3.2 and 3.14.8).
5) Extending the licence periods of NPPs in Canada beyond two years (subsection 3.7.2.2.3).
6) Progress on numerous generic and specific safety issues (subsections 3.14.5 and 3.14.7).

1.4 Main Safety Issues in This Report

Five main safety issues are addressed in this report:

1) Licensees improved the safety performance of their nuclear power units. Systematic reviews of NPP performance as related to meeting CNSC regulatory requirements, and as compared to IAEA guidelines, resulted in the licensees initiating, expediting or completing several performance improvement programs. The industry strengthened its performance in several safety areas that the CNSC uses to assess the licensees' safety performance (see subsections 3.14.0 to 3.14.8).
2) A number of generic safety issues have been closed for the licensees. Specific safety issues have been addressed resulting in removing power limits imposed previously by the CNSC on a number of nuclear power units (see subsection 3.14.5).
3) The loss of electricity grid event of August 14, 2003 in Ontario and the Northeastern United States had a limited effect on the Canadian nuclear industry (see subsections 3.16.5 and 3.19.5.1).
4) Emergency preparedness update (see subsections 3.16.0 to 3.16.5).
5) Maintenance of competence and infrastructure (see subsection 2.4).

At the 2nd Review Meeting in April 2002, the issue of assuring the security of nuclear installations from terrorist attacks was a matter of significant concern in light of the events of September 11, 2001. Canada has responded comprehensively to this and other emerging threats, based on international standards. Noting that security and physical protection matters do not lie within the scope of the Convention, and that the sensitivity of information related to the issue would make it difficult to conduct meaningful discussion in this forum, the 2nd Review Meeting decided that consideration of this issue be excluded from the scope of the Country Group sessions. Participating countries were encouraged to address this issue in other appropriate international fora and in bilateral consultations. Therefore, this issue will not be discussed in this report.

1.5 Challenges and Initiatives

Several initiatives were begun during the reporting period. The following initiatives, and the challenges they represent, are addressed in Chapter 4 of this report:

1. Risk-informed approach to planning and resource allocation at the CNSC (subsection 4.1).
2. Restoring safety margins for Large Loss of Coolant Accidents (subsection 4.2).
3. Severe Accident Management programs (subsection 4.3).
4. Future licensing requirements (subsection 4.4).
5. Transfer of examination of qualified personnel to licensees (subsection 4.5).
6. Safe Operating Envelope project (subsection 4.6).
7. Licensing basis for new reactors (subsection 4.7).

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2. FOLLOW-UP FROM THE 2ND REVIEW MEETING

2.0 General

At the 2nd Review Meeting in 2002, several countries raised issues and made recommendations for Canada to follow up on its reporting of specific topics. These topics are discussed in the following subsections.

2.1 Changes in Industry Structure including Deregulation

2.1.1 New Operator for Bruce A and B Nuclear Power Units

Currently, Bruce Power Inc. (Bruce Power) is Canada's only privately-owned nuclear generating company. It leases eight reactor units at the Bruce site from Ontario Power Generation Inc (OPG). Six of these eight reactors are operational, while the remaining two units are defuelled, but are currently being considered for restart.

In May 2001, licences were issued to Bruce Power for the Bruce A and Bruce B NPPs. Licence conditions were introduced requiring that operational financial guarantee arrangements be maintained in effect during the term of the licence, that the licensee submit to the CNSC quarterly status reports in relation to this operational financial guarantee requirement and that the licensee report any changes made to the Lease Agreement (see also subsection 3.11.6).

In 2003, Bruce Power requested five-year licences for both the Bruce A and Bruce B NPPs. The then existing licences were extended by the Commission (the tribunal component of the CNSC) for several months in order to determine the specific financial arrangements to be incorporated into the new licences and to ensure that OPG, the Bruce site owner, concurred with the extent of these financial guarantees. Following successful resolution, the Commission subsequently granted both NPPs five-year licences in March 2004, based on required programs and implementation of these programs as well as acceptance of the financial guarantees.

2.1.2 New Brunswick *Electricity Act*

An *Electricity Act* is expected to come into force in New Brunswick on September 1, 2004. One of the provisions in this act is the restructuring of New Brunswick Power Corporation into a corporation with 4 wholly-owned subsidiary companies owned by the province of New Brunswick. One of these companies is the New Brunswick Power Nuclear Corporation (NBPN), which would be responsible for the Point Lepreau NPP, and would be the new licensee for the nuclear facility.

2.1.3 Deregulation Update in the Province of Ontario

Ontario's electricity sector was opened to competition on May 1, 2002. Provincial measures were put in place for transmission and distribution, as well as licensing requirements for all of the participants in the competitive market. In December 2002, the commodity price of electricity was fixed at 4.3 Canadian cents per kilowatt hour for certain low volume and designated customers. This rate will increase to 4.7 Canadian cents in April 2004.

The Government of Ontario has undertaken a series of studies to determine what further changes, if any, are required to the electricity market. In particular, the government is assessing the rate structure for the market and the role of OPG in this market. These studies have recommended that market rates be regulated based on the type of power generation. This is expected to assist industry in determining whether to invest in new power supply projects. These studies have also recommended that OPG continue, as a provincial utility, to ensure electricity supply within the province. The province is expected to determine what changes to make to the electricity market and OPG at a time beyond the reporting period of this 3rd Report.

The change to a competitive market has had no impact on the safe operation of nuclear facilities located in Ontario.

2.2 Integrated Improvement Program

When Bruce Power became the licensee for the Bruce nuclear power units in May 2001, it also became responsible for the continuation of appropriate projects as part of the Integrated Improvement Program (IIP). Bruce Power reviewed and prioritized the IIP projects, which had been started by OPG, and incorporated them into the overall Bruce site project program.

OPG adopted a similar approach to that of Bruce Power. The IIP projects were transitioned to the facilities in 2001 for management as part of the site improvement projects. The transition was completed in 2002.

An IAEA Operational Safety Review Team (OSART) assessment was conducted in February 2004 at the Pickering A nuclear power plant. The OSART provided a "snapshot" view of how well this OPG facility is being operated as judged by an international expert team. The OSART complements the reviews that have been, and continue to be, performed by the CNSC as part of the compliance program. The OSART assessment report was provided to the CNSC and OPG following the end of the reporting period for this report.

In addition, and for ease of implementation, some of the individual IIP projects were combined into a single project. For example, the Configuration Management Closure Project combines the configuration management restoration effort with the safe operating envelope review effort. Also, the Environmental Qualification project, which re-established the basis for assurance that the system components would continue to function following a serious event in the plant, is the subject of a licence condition (see Annexes 3.14.1 and 3.14.3).

During the reporting period, CNSC staff continued to monitor the major IIP projects being carried out at the facilities as part of the ongoing compliance program. However, in March 2003, CNSC management decided to discontinue the centrally-coordinated tracking and monitoring of the OPG and Bruce Power IIP projects. This decision was taken so that CNSC staff could proceed to integrate the review of the IIP projects into their normal regulatory activities. CNSC staff officially closed the report documents on IIP projects in September 2003. Consequently, the IIP Projects ceased to exist as stand-alone activities. The IIP projects will therefore no longer be mentioned in subsequent Canadian reports on nuclear safety under the obligations of the Convention. Background and historical information on the Bruce Power and OPG IIP projects can be found in the Canadian1st and 2nd Reports.

2.3 Seismic Re-evaluation: Earthquake Readiness – Pickering A Restart

In the assessments undertaken prior to the restart of Pickering A, OPG confirmed that:

- Information collected during oil company exploration shows undisturbed sedimentary rock over deep crustal structures underlying Pickering, and no major rifting under Lake Ontario.
- An independent panel of experts has concluded that there is no evidence of a continuous earthquake-related fault in the Rouge River Valley in Scarborough, Ontario. Exposed faults are

glacial in origin. This means that the exposed faults do not present a seismic hazard for the Pickering nuclear power plant. The Rouge River Fault Investigation report, released by OPG in July 2001, documents the investigation's process and findings.

- OPG and the Geological Survey of Canada continue to monitor seismological activity in southern Ontario, using seismometers capable of locating even small magnitude earthquakes. They have found significantly less seismic activity around Pickering than in other parts of Ontario.
- Earthquakes felt in the area are consistent with historical patterns. High-rises, or buildings on soft soils, can experience significant motion. Very little damage can be expected to modern construction, or to buildings located on firm foundations (such as the Pickering nuclear plant).

Nevertheless, in returning Unit 4 of Pickering A to service, 24 modifications to improve the earthquake resistance of the facility were performed. The modifications included:

- Strengthened key masonry and concrete walls in several locations;
- Strengthened anchors that hold key electrical panels to the floors;
- Improved anchoring and support for a variety of equipment, including heat exchangers, standby generator batteries, tanks, pipes, valves and fire-fighting equipment;
- Improved anchoring for instrument panels and lighting fixtures in the Main Control Room and Control Equipment Room;
- Improved emergency air systems;
- Improved switches and relays for key systems;
- Improved plans, testing procedures and training to help plant personnel prepare for and deal with the aftermath of a significant earthquake.

Identical modifications are required before the remaining Pickering A units can be returned to service.

2.4 Maintenance of competence and infrastructure

2.4.0 General

The Canadian nuclear industry and the CNSC are facing challenges similar to those of other nuclear industries and regulators around the world. The characteristics of these challenges, the response of the Canadian nuclear industry to these challenges and the CNSC's statutory responsibilities are summarized in the Canadian 2nd Report. Since the release of that report, the following progress has been made on specific fronts.

2.4.1 Support and Development of Nuclear Power Competence in Canada

The University Network of Excellence in Nuclear Engineering (UNENE) was established as a not-for-profit corporation by the Government of Canada with Letters Patent issued on July 22, 2002. UNENE is an alliance of universities, nuclear power utilities, research and regulatory agencies for the support and development of nuclear education, as well as research and development capability in Canadian universities. The main objective of UNENE is to assure a sustainable supply of qualified nuclear engineers and scientists to meet the current and future needs of the Canadian nuclear industry and regulatory body through university education, and university-based training, as well as by encouraging young people to choose careers in the nuclear industry. The primary means of achieving this objective are to establish new nuclear professorships in six Ontario universities and to enhance funding for nuclear research in selected universities in order to retain and sustain nuclear capability in the universities. Through its member universities, UNENE organizes and delivers educational programs appropriate to students planning to enter the nuclear industry and to those already employed therein. The first UNENE-sponsored course was given in September 2003, with additional courses planned or in development.

The University of Ontario Institute of Technology (UOIT), Canada's newest publicly-funded university, was created on June 27, 2002, and accepted its first students in September 2003. The UOIT includes the School of Energy Engineering and Nuclear Science (SEENS). SEENS offers undergraduate (Bachelor) degrees in nuclear engineering, radiation science and related areas. The program focus is on reactor kinetics, reactor design, plant design and simulation, radiation detection and measurement, radiation protection, radiation biophysics and dosimetry, environmental effects of radiation, production and utilization of radioisotopes, radiation chemistry and material analysis with radiation techniques.

The CANTEACH program continued to accumulate information contributed by the Canadian nuclear industry, universities and the CNSC. The CANTEACH program was established by Atomic Energy of Canada Limited (AECL), OPG, the CANDU Owners Group (COG), Bruce Power, McMaster University, l'École Polytechnique de Montréal and the Canadian Nuclear Society. The aim of the CANTEACH program is to develop a comprehensive set of web-accessible education and training documents, with university participation.

2.4.2 Workforce Sustainability Strategy at the CNSC

One of the CNSC's strategic objectives is to attract and retain excellent staff. For this purpose, a Workforce Sustainability Strategy (WSS) was developed and updated routinely. The WSS is a five-year strategy that is intended to guide current and future human resource initiatives in recruitment and retention of staff. The WSS is designed to ensure that:

1. a sufficient number of "qualified" employees successfully take over key functions as staff retire/resign;
2. new competency profiles are developed as required;
3. emphasis is continued on strengthening leadership and management competencies;
4. core skills and competencies responsive to program requirements remain available;
5. initiatives are implemented congruent with present and future organizational needs.

Examples of WSS initiatives are the development of an on-line applicant tracking system for internal and external selection processes and the development of core training plans for all operational divisions. Core training plans are used to develop individual learning plans for CNSC staff.

2.4.3 Intern Program at the CNSC

The CNSC introduced a two-year, entry-level intern program in June 2001. A second 18-month program started in June 2003, and subsequent programs are planned to start annually. Each program includes several three-month work assignments in line divisions, along with common training and group activities. Recruits are engineering and science graduates from Canadian universities. The CNSC offers the interns training opportunities, helps in fulfilling their potential, ensures a positive work culture, gives them roles that meet their personal needs and facilitates opportunities for career progression. In return, the CNSC benefits by transferring corporate knowledge from experienced staff to less experienced staff, ensuring that critical information is retained within the organization. The graduates of the intern program gain a broader understanding of the organization and therefore become more versatile. All of the interns remained with the CNSC after the first program was completed in May 2003.

2.4.4 Maintaining Capabilities at NPP Sites

The licensees are addressing issues arising from loss of institutional knowledge due to the expected retirement of many senior and experienced personnel. Managing the loss of institutional knowledge will provide assurance of competence in the safety culture, in general engineering (technical and scientific knowledge and skills), in plant-specific design, and in operations and maintenance knowledge and skills.

Subsection 3.19.6 of this report describes how OPG and Bruce Power currently obtain certain technological and technical services from external services providers. NBPN and Hydro-Québec (HQ) rely on their own technical staff, the staff of AECL and consultants in providing similar services. The industry at large also benefits from the activities and the provisions described in subsection 2.4.1 in recruiting and maintaining personnel competence.

In addition, all licensees undertake and maintain training and refresher programs specific to each site. Qualification and certification of key positions continue to be reviewed and authorized by the CNSC, as prescribed in the NSCA.

2.5 Use of Probabilistic Safety Assessments

For licensees, Probabilistic Safety Assessment (PSA) forms a basis for risk-informed decision-making in regard to operational, plant maintenance and outage management strategies. Past Canadian practice focussed on deterministic assessments, and consequently, operational limits and conditions were generally assumed to be conservative in many areas of operation, maintenance and outage management. Consideration is currently being given to PSAs as appropriate tools for a more comprehensive risk-informed evaluation of safety that may eventually both allow the relaxation of overly conservative limits and suggest new limits and conditions in areas that may have inadequately been considered in past deterministic studies. The CNSC is following this development and participating in relevant discussions with the licensees. Progress in this area is continuing.

2.6 Aging and Plant Life Management

Aging of nuclear power plant systems, structures and components (SSCs) must be effectively managed throughout the facility's life to ensure that safety and performance remain within acceptable limits, and that the projected plant design life can be attained.

Changes in plant conditions and equipment due to aging have the potential to increase both the probability of equipment failures and the consequences of failures. Increases in consequences can result from reduced availability or effectiveness of safety systems intended to respond to equipment failures.

Plant life management programs were developed by the licensees to provide for the systematic assessment, timely detection, mitigation, recording and reporting of significant aging effects in SSCs. Relevant activities include:

- Identifying SSCs important to safety and performance;
- Assessing degradation mechanisms, and detecting and understanding their aging effects;
- Assessing obsolescence;
- SSC life prognosis;
- Proactive mitigation measures;
- Maintenance optimization;
- Documentation of assessments and mitigation measures;
- Program review and revision to account for operating experience (OPEX).

Many of the above activities require considerable co-ordination effort as they involve aspects of system-health monitoring, testing, maintenance and adjustments during normal day-to-day operations, as well as periodic inspections, fitness for service assessments, testing and maintenance undertaken during plant outages.

2.7 Support for R&D programs

2.7.1 The CNSC Research Review Group

In October 2002, the CNSC established a Research Review Group (RRG) in an advisory capacity. The objective of the RRG is to obtain independent expert advice on the state of Canadian nuclear safety research in the fields directly related to the CNSC's mandate. The RRG has conducted literature reviews and consulted CNSC stakeholders and relevant organizations. It reviewed the research practices of other nuclear regulatory agencies, Canadian research activities and the infrastructure, and resources and capability to support them.

The RRG submitted its report to the CNSC in March 2004. The CNSC is reviewing the report to determine what follow-up actions are required.

2.7.2 COG R&D Program

The COG's Research and Development (R&D) program is co-funded by domestic CANDU licensees and AECL. The majority of COG-funded R&D is carried out by AECL, with the remainder being undertaken at other private companies and Canadian universities. The focus of COG R&D is on emerging operating issues to support the safe, reliable and economic operation of CANDU reactors. The program currently addresses four technical areas, namely: 1) Chemistry, Materials and Components, 2) Fuel Channels, 3) Health, Safety and Environment, and 4) Safety and Licensing.

During the reporting period, the COG R&D program continued to support the resolution of outstanding CNSC Generic Action Items (see subsection 3.14.5). The program also supports the safety assessments of new plant designs, and assists in the maintenance of core capabilities, scientific expertise and the R&D infrastructure necessary to support long-term safe operation of CANDU power reactors.

The Canadian 1st and 2nd Reports describe in detail further information on the COG R&D program.

2.7.3 AECL R&D Program

As indicated in subsection 2.7.2, most of the COG-funded R&D projects are performed by AECL. In addition, AECL performs R&D activities in each of the CANDU technology areas. These activities ensure that the basic science and engineering underlying each area of technology are understood, and the knowledge grows as necessary to address ensuing issues. Further information on the AECL R&D program can be found in the Canadian 2nd Report.

2.7.4 CNSC Research and Support Program

The CNSC research and support program continues to provide staff with information that confirms or supports their findings on current and emerging issues related to the CNSC's mandate and activities. Each year, the program is reviewed and evaluated, and consequently, the need for research and support in the following year is identified and a commensurate budget is allotted. Additional information on the CNSC Research and Support Program is provided in the Canadian 2nd Report.

2.7.5 International Initiatives

Several Canadian organizations routinely participate and collaborate in international safety research and development through such forums as the IAEA and the Nuclear Energy Agency (NEA), as well as through bilateral and multinational arrangements.

3. COMPLIANCE WITH ARTICLES OF THE CONVENTION

Article 5 of the Convention requires each signatory country to submit a report on the measures it has taken to implement each of the obligations of the Convention. This report demonstrates the measures that Canada has taken to implement its obligations under Articles 6 to 19 of the Convention. Obligations under the other articles of the Convention are implemented through administrative activities and participation in relevant fora.

A. General Provisions

Article 6 - Existing Nuclear Power Plants

3.6.0 General

The safety of all nuclear power plants in Canada is continually assessed and enhanced. This is achieved by performing and acting on results from deterministic and probabilistic safety reviews, compliance programs, reviews of OPEX, reviews of operating performance and safety research. The following subsections offer the updated status of, and progress on, relevant topics.

3.6.1 Canadian Philosophy and Approach to Safety of NPPs

The Canadian 2nd Report describes in detail the Canadian philosophy and approach to safety, and gives a historical account of its evolution since the creation in 1946 of the CNSC (formerly known as the Atomic Energy Control Board). The Canadian 2nd Report also gives some accounts of the relationship between the nuclear regulator and the nuclear industry as they jointly advanced the safety philosophy over the last 50 years. This information remains fundamentally unchanged for the reporting period.

3.6.2 List of Existing Nuclear Power Reactor Units in Canada

Out of a total of 22 nuclear power reactor units in Canada, there are 17 currently licensed to produce power. A list of all reactor units and their status can be found in Annex 3.6.1. The Canadian reactor units are operated by four licensees: 1) Ontario Power Generation Inc. (OPG), a private company wholly owned by the Province of Ontario, 2) Bruce Power Inc. (Bruce Power), a private corporation, 3) Hydro-Québec (HQ), a crown corporation of the Province of Québec, and 4) New Brunswick Power Nuclear Corporation (NBPN), a crown corporation of the Province of New Brunswick. These four licensees operate five nuclear power plants (Darlington, Pickering, Bruce, Gentilly, and Point Lepreau) involving seven licences (two each for Pickering A & B and Bruce A & B, and one each for Darlington, Gentilly and Point Lepreau).

3.6.3 Lessons Learned from National and International Operating Experiences

In response to national and international safety-significant incidents and OPEX, safety assessments are performed by CNSC staff and by the licensees. Examples of lessons learned and corrective actions resulting from national and international occurrences, events and OPEX are included in Annex 3.6.2.

3.6.4 Measures and Corrective Actions for Safety Maintenance and Upgrading of NPPs

Performance improvement programs were initiated in 1996 at several NPP sites in Canada, and they continued during the reporting period. Progress on, and updates to information on the return to service of Pickering A, Unit 4, and Bruce A, Units 3 and 4, as well as on the refurbishment programs at the Gentilly-2 and Point Lepreau NPPs are found in subsections 3.14.1.3 to 3.14.1.6. In addition, safety assessments were performed on operating NPPs as a result of specific OPEX and performances. Subsection 3.14.7 describes the results of several safety assessment and the corresponding corrective actions taken.

3.6.5 Canadian Position for Continued Operation of NPPs

During the reporting period, all Canadian nuclear power units were operating with acceptable safety margins and material and component conditions. The level of defence-in-depth at all Canadian NPPs remains acceptable and the CNSC’s requirements were effectively met or exceeded in the majority of safety areas (see subsection 3.14.8). The licensees and the CNSC, each within their corresponding roles and responsibilities, ensure that the NPPs are operating under the conditions and within the safety margins included in the licences. The CNSC monitors licensees’ commitments to plans and programs to improve the performance of their NPPs in a timely manner.

Most of the Canadian nuclear power units are reaching the end of their assumed life. The assumed life was based on an initial forecast of the time by which major components would need to be replaced. The current life cycle management programs (see subsection 2.6) are being used to afford more accurate assessments of the condition of the SSCs. The refurbishment efforts at Point Lepreau and Gentilly-2 will result in the replacement and improvement of many SSCs, and are expected to extend the life of these plants.

The current licensing process used in Canada (see section 3.7.2.2) includes the ongoing licensing of nuclear power plants, provided that the condition of the facility supports continued safe operation. CNSC staff are assessing whether Periodic Safety Reviews would provide any additional safety benefit within the Canadian regulatory context, particularly when licensing facilities that have passed the end of their assumed life. See section 3.14.1.2 for more information on the Canadian approach to Periodic Safety Reviews.

In Ontario, the government policy decision to eliminate the use of coal-powered generation will likely result in further investment in nuclear power generation. Restart of other units at Pickering A and Bruce A is being studied by the licensees.

B. Legislation and Regulation

Article 7 - Legislative and Regulatory Framework

3.7.1 Legislative Framework

3.7.1.0 General

As Canada's nuclear regulatory body, the CNSC regulates the use of nuclear energy and materials to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy. The CNSC's regulatory authority comes from the *Nuclear Safety and Control Act* (NSCA). Under its mandate, the CNSC seeks to limit risks to the health, safety and security of persons and the environment that are associated with the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information.

An abundance of information on the legislative framework is found in the Canadian 2nd Report. Only one update is reported in this subsection.

3.7.1.1 NSCA – Clause Amendment

Under Section 46 of the NSCA, the CNSC has the authority to conduct investigations to determine if contamination exists at a site. Previously, subsection 46(3) gave the CNSC the authority to order the owner, occupant or "any other person with a right to or interest in the affected land" to take prescribed measures to reduce the level of contamination. This could have included a lender who was not involved in the management or operation of the site. Subsection 46(3) was amended to delete reference to a "person with a right to or interest in" the land while maintaining the CNSC's authority to take action against the owner or occupant, or "any other person who has the management and control of the affected land". The amendment became effective on February 13, 2003.

3.7.2 Regulatory Framework

3.7.2.0 General

The CNSC fulfils its regulatory mandate through three main results-based functions: licensing, compliance and the production of regulatory documents. Progress in each of these functions is presented in subsections 3.7.2.2 through 3.7.2.4. However, information on specific improvements to the CNSC regulatory framework is first presented in the following subsection.

3.7.2.1 Specific Improvements to the CNSC Regulatory Framework

In the last few years, the CNSC regulatory framework has been subject to a set of specific improvements that encompasses several risk-informed programs and initiatives. Of interest to this report are the approval of longer licence periods (subsection 3.7.2.2.3), more frequent reporting at the CNSC public hearings and meetings on licensees' performance (subsection 3.7.2.2.4), compliance program (subsection 3.7.2.3.1), expanded evaluation of licensee performance (subsections 3.7.2.3.2 and 3.14.8), and more effective approach to licensing and resource allocation (subsection 4.1). For example, greater attention is currently placed on, and more resources are devoted to, compliance verification and enforcement. Also, the flexibility to recommend licence periods longer than 2 years allowed some of the resources currently spent by both licensees and the CNSC on administrative licensing activities to be more effectively devoted to safety evaluation, performance assessment and compliance activities.

3.7.2.2 Licensing

3.7.2.2.1 Licensing Process

In subsection 7.3 of the Canadian 1st and 2nd Reports, a detailed description is given of the licensing process used for NPPs in Canada. The process covers all licensing stages from siting acceptance, construction approval, commissioning, issuance of operating licence, decommissioning and abandonment. The licensing process did not fundamentally change during the reporting period. The following subsections, therefore, only address specific updates such as licence amendments, extended licence periods and increased reporting on licensing issues.

3.7.2.2.2 Licence Amendments

The CNSC continuously amends nuclear power reactor operating licences (PROLs) to include CNSC-approved revisions to licensee documents referenced in the licence. Examples of such documents include operating policies and principles (OP&P), station shift complement, radiation protection requirements and security reports. The following table includes only major amendments that were effected during the reporting period. A full list and description of the CNSC regulatory documents mentioned in this table are found on the CNSC's website (listed in Annex 1.1).

Issue	Amendment
Pickering A, Unit 4 Restart	On November 5, 2001, the CNSC authorized the restart of Unit 4 after the licensee completed identified improvements and upgrades to the unit. On May 4, 2003, CNSC approved the removal of the unit from guaranteed shutdown state (GSS).
Certification and Training of Staff at NPPs	Subsection 9(2) of the *Class I Nuclear Facilities Regulations* stipulates that the CNSC may certify a person for a position at a Class IA facility, such as an NPP, when that position is referred to in the facility operating licence. Requirements related to the qualification, training and examination of operations staff seeking certification at NPPs are currently described in conditions contained in the PROL for each facility. The CNSC intends to consolidate these requirements into a Regulatory Standard, a draft of which has been issued for public comment (C-204, on *Certification of Persons Working at Nuclear Power Plants*).
Action Levels	Following the publication of CNSC Regulatory Guide G-228 on *Developing and Using Action Levels*, licensees were requested to develop and implement acceptable environmental and occupational action levels. Current licences include this requirement.
Decommissioning Plans and Financial Guarantees	Decommissioning plans are currently explicitly listed as a requirement for a licensing application in various CNSC regulations. CNSC Regulatory Guides G-206 on *Financial Guarantees for the Decommissioning of Licensed Activities* and G-219 on *Decommissioning Planning for Licensed Activities* were published to provide guidance to the licensees in these areas. Current licences contain conditions requiring the licensees to review and revise decommissioning plans and to implement and maintain valid and sufficient documents related to financial guarantees.
Bruce A Refuelling and Restart of Units 3 and 4	In January 2003, an Environmental Assessment Screening Report was found to be acceptable by the Commission and the licence was amended to permit fuel loading in reactor units 3 and 4 while maintaining them in a shutdown state. In April 2003, the licence was further amended to include additional conditions as prerequisite to restart. Subsequently, Bruce Power gave assurance to the CNSC that they met all

	the restart conditions, and the licence for Bruce A was then amended to allow for the restart and removal of the shutdown state of Units 3 and 4.
Re-qualification Tests for Certified/Authorized Operating Staff	CNSC certifications to individuals are issued for a five-year period. Subsection 9(3) of the *Class I Nuclear Facility Regulations* allows the CNSC to renew an individual's certification. One requirement for this renewal is the successful completion of the applicable re-qualification examinations, when these examinations are referred to in the facility operating licence. On July 21, 2003, following lengthy consultations with NPP licensees, the CNSC endorsed the use of the document titled *Requirements for the Re-qualification Testing of Certified Shift Personnel at Canadian Nuclear Power Plants*. This document, which contains the requirements for the formal implementation of re-qualification tests, is now referred to in the PROLs. These licences also include transitional provisions for certification renewals required before December 31, 2005.

3.7.2.2.3 Extended Licence Periods

Section 24 of the NSCA gives the CNSC the power to authorize a person to undertake a licensed activity for a period that is specified in a licence. The CNSC is required before renewing a licence to assure itself, among other things, that the applicant is qualified to carry on the proposed activity. Section 30 of the NSCA authorizes CNSC staff to carry out inspections to promote, verify and enforce compliance of the licensee with regulatory requirements, including any licence conditions.

Historically, licences were issued for a renewable period of two years. This has permitted close scrutiny of the licensees' performance by CNSC staff and provided frequent opportunities for public intervention during public hearings involving applications for licence renewals. However, it became apparent that the usual two-year licence period may not be adequate to enable either the licensee or CNSC staff to complete actions relating to the requirements of section 24 of the NSCA. As a result, the CNSC introduced flexible licence periods in 2002. The criteria for decisions on licence length are documented in a CNSC document issued early in 2002 (CMD 02-M12). Licence periods longer than two years enable the CNSC to regulate NPPs in a more risk-informed manner through the adjustment of the licence period to the licensee's performance and the findings of compliance-verification activities of the licensed NPP. This means that a shorter licence period will continue to be an option where overall licensee performance is unsatisfactory.

To assist CNSC staff in making recommendations on licence periods that are based on a sound and consistent rationale, a set of factors was compiled in the CNSC document CMD 02-M12. These factors include things such as the hazards associated with the facility, presence and effective implementation of licensee's quality management programs, implementation of an effective compliance program from both the licensee and the CNSC, extent of licensee experience, demonstrated acceptable rating of licensee performance, requirements of cost recovery fees regulations and planning cycle of the facility.

A transition to longer licences with increased emphasis on licensee performance evaluation is consistent with established practices in many other countries for NPPs, especially with the use of Periodic Safety Reviews (PSRs) (see subsection 3.14.1.2 of this report on use of PSRs in Canada).

3.7.2.2.4 Increased Reporting at CNSC Public Hearings and Meetings

Public hearings and meetings of the CNSC are the primary opportunity for staff to present reports on licensees to the Commission, and for the public to review this information and participate in the regulatory process. Licence periods longer than two years mean a reduced frequency of these opportunities – a situation that is balanced by increased reporting by CNSC staff to the Commission.

CNSC staff regularly make reports at Commission public hearings and meetings on NPP status, performance of licensees, overall industry performance, mid-term assessments and findings resulting from licensing and compliance activities. The scope and depth with which each of these areas is covered reflect the complexity and level of risk of the licensed facilities at the time of reporting. In addition, CNSC staff present at every Commission public meeting "Significant Development Reports" on safety-significant issues that may arise during or as a result of the conduct of any regulated activity and on any other matter of interest to the CNSC or to the public. Guiding criteria have been established for CNSC staff to select issues that are included in the Significant Development Reports.

3.7.2.3 Compliance

A detailed description of the CNSC compliance program was included in the Canadian 2nd Report. Thus, the following subsections include only updates and progress that occurred in specific areas during the reporting period.

3.7.2.3.1 Compliance Program

Compliance Program Elements
The CNSC compliance program consists of three elements: promotion, verification and enforcement. These elements were applied during the reporting period, as explained in the following paragraphs.

Promotion refers to all activities related to fostering compliance with the legal requirements. Promotion activities can take the form of consultation, training, acknowledgement of good performance, participation in seminars, workshops and conferences, and collaboration with other regulatory bodies to disseminate CNSC requirements to a wider audience.

Verification includes all activities related to determining and documenting whether a licensee's performance meets the legal requirements. Verification activities include Type I inspections, Type II inspections, desktop reviews and event reviews. Type I inspections include activities such as audits and evaluations, while Type II inspections include rounds and routine systems and component inspections. Desktop reviews include reviewing documents such as licensees' safety reports. Event review consists of the examination of and follow-up on licensee-submitted event reports and possible CNSC response and regulatory actions. There is also one verification/enforcement tool that is specific to power reactors – the generic action items (GAI). This tool is discussed in detail in subsection 3.14.5.

Enforcement includes all activities to compel a licensee into compliance and to deter non-compliance with the legal requirements. Enforcement is applied using a graduated approach, where severity of the enforcement measure depends on the safety-significance and other factors related to the non-compliance. Graduated enforcement tools include written notices, written warnings, increased regulatory scrutiny, requests from the Commission or an authorized person, orders, licensing actions and prosecution. Examples of CNSC actions and licensees' responses are included in subsection 3.14.7.

Significance Determination
Significance determination is an important part of the compliance program. The CNSC uses significance determination to select the appropriate regulatory response to events. Progress has also been made in using the same approach to assess the safety significance of inspection findings. Criteria and procedures for significance determination are evolving at the CNSC using both deterministic and risk-informed methodologies.

Implementation
The CNSC's compliance policy was officially issued during the reporting period. A project was also initiated to normalize and upgrade the elements of the compliance program and to offer guidance on their

use. A “baseline” compliance program is being developed that delineates promotion and verification activities that should be regularly carried out for each licensee, or group of licensees, to ensure they meet the regulatory requirements and performance expectations. The baseline compliance program activities will be prioritized using a risk-informed approach. In addition to the baseline compliance, the concept of “focused” compliance activities was introduced to address specific objectives identified during baseline inspections. Planning, reporting and monitoring instruments were also developed as part of the project.

3.7.2.3.2 Rating System and Industry Reports

Since the release of the Canadian 2nd Report, the CNSC instituted a new rating system for use in conjunction with licensing and compliance activities, as well as in producing the annual industry report. The new system aids in evaluating licensee programs and implementation, as measured against CNSC regulatory requirements and performance expectations.

The rating system consists of five categories: “A-Exceeds requirements”, “B-Meets requirements”, “C-Below requirements”, “D-Significantly below requirements”, and “E-Unacceptable”. These categories are assigned to summarize all assessment and inspection results, and are also used to summarize licensees’ programs and performance in nine safety areas that are evaluated for licensing purposes. Analysis of the industry reports produced during the reporting period as well as full definitions of each of the above rating categories are detailed in subsection 3.14.8 and the associated Annex 3.14.4. The rating scheme is described in the CNSC document CMD 02-M5.

The current system is under review and is likely to evolve.

3.7.2.3.3 Event Reporting, Follow-up, Recording and Tracking

A new regulatory standard, S-99 *Reporting Requirements for Operating Nuclear Power Plants*, went into effect on April 1, 2003, replacing a previous standard that had been in effect since January 1, 1995. The new standard was required since the legislative framework had changed with the coming into force of the NSCA on May 31, 2000. The S-99 standard consolidates in one document almost all legislated reporting requirements contained in the NSCA and its associated regulations that apply to NPPs. It also expands upon legislated general reporting requirements relating to nuclear power plants.

One of the objectives of S-99 is to redirect industry focus to prompt reporting of only safety-significant and regulatory-significant events or situations. Other events or situations are required to be reported quarterly or annually, primarily for trending and analysis of long-term safety and regulatory issues.

S-99 was incorporated into the operating licences of all nuclear power plants in 2003, making compliance with the document mandatory. Consequently, event reporting and follow-up systems, including procedures and databases at both the licensees and the CNSC, were subject to modifications to accommodate the requirements of S-99. During the first few months of using the S-99 standard, the CNSC offered numerous interpretations to several clauses of S-99 to ensure consistency of reporting. A CNSC regulatory guide is being developed that includes these interpretations and additional clarifications.

3.7.2.4 Production of Regulatory Documents

A full description of the CNSC regulatory document framework, as well as related “purpose”, “scope”, and “relevant legislation” for high priority documents is available on the CNSC website listed in Annex 1.1.

3.7.2.4.1 Enhanced Regulatory Document Framework

The CNSC's regulatory document framework is based on a matrix of CNSC-designated service lines against the CNSC-established safety areas and associated programs. The framework was created with a number of high-priority documents using a risk-informed ranking approach. Licensees, the public and other stakeholders were consulted on the framework, the choice of high-priority documents and their purpose and scope. The framework was then revised and issued for use. As well, the status of existing regulatory documents was simultaneously clarified. Work plans were produced and began to be developed for the high-priority documents. The framework is currently populated with documents whose development will start in the following year.

3.7.2.4.2 Changes made to Specific Regulatory Documents

During the reporting period, changes were made which affect a number of CNSC regulatory and consultative documents. The lists included in items (a) to (c) below update similar lists stated in the Canadian 2nd Report.

a) The following document was issued as "Policy":

P-211	Compliance

b) The following documents were issued as "Standards":

S-98	Reliability Programs for Nuclear Power Plants
S-99	Reporting Requirements for Operating Nuclear Power Plants

c) The following documents were issued as "Guides":

G-91	Ascertaining and Recording Radiation Doses to Individuals
G-147	Radiobioassay Protocols for Responding to Abnormal Intakes of Radionuclides
G-205	Entry to Protected and Inner Areas
G-208	Transportation Security Plans for Category I, II or III Nuclear Material
G-217	Licensee Public Information Programs
G-225	Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills
G-228	Developing and Using Action Levels
G-273	Making, Reviewing and Receiving Orders under the Nuclear Safety and Control Act
G-274	Security Programs for Category I or II Nuclear Material for Certain Nuclear Facilities
G-276	Human Factors Engineering Program Plans
G-278	Human Factors Verification and Validation Plans

Article 8 - Regulatory Body

3.8.0 General

The Canadian 2nd Report provided detailed information on the CNSC's position within the federal government structure. That position did not change during the reporting period. The following subsections therefore provide clarification or information on initiatives or improvements.

3.8.1 The CNSC and its Position within the Government

The CNSC is the nuclear regulatory body in Canada. The mission of the CNSC is to regulate the use of nuclear energy and materials to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy. This is accomplished by the work of a Commission, a quasi judicial tribunal comprising up to seven members, and an organization of approximately 500 staff. As stated earlier, the Canadian Nuclear Safety Commission is referred to as the 'CNSC' when referring to the organization and its staff in general (also referred to as 'CNSC staff'), and as the 'Commission' when referring to the tribunal component.

Commission members are appointed by the federal government for a term not exceeding five years, and can be reappointed. One member of the Commission is designated as both the President of the Commission and the Chief Executive Officer of the CNSC as an organization. Information on the background of the current Commission members can be found on the CNSC's website (listed in Annex 1.1). The Commission functions as an administrative tribunal that establishes regulatory policy on matters relating to health, safety, security and the environment, makes independent licensing decisions, and establishes legally binding regulations and implements programs. In doing so, the Commission takes into account the opinions and concerns of interested parties.

The CNSC reports directly to the Canadian parliament via the Minister of Natural Resources Canada. In performing its activities, the CNSC interacts with other federal departments and several provincial and municipal organizations as necessary.

Additional information on the CNSC, its mandate, authority and activities can be found in the Canadian 2nd Report and on the CNSC website.

3.8.2 Planning Process for Regulatory Activities

The CNSC organizes its regulatory activities relating to nuclear power reactors by creating, implementing, monitoring and adjusting regulatory work plans for each licensed facility. The work plans are reviewed to ensure they cover specific goals, to ensure consistency among nuclear power reactor sites regarding the planning of inspections, reviews and other regulatory activities. The work plans for all power reactor sites constitute the work plan for the entire power reactor service line within the CNSC. The activities in each site plan are also consolidated into a summary plan, called the Regulatory Activity Plan, which is sent to the licensee concurrent with the annual licence fee charged to the licensee for the site.

3.8.3 Maintaining Competent Staff

Information related to the challenges faced by the CNSC, as well as the programs that were initiated regarding recruiting and maintaining competent staff, are included in subsection 2.4.

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Article 9 - Responsibility of the Licensees

3.9.1 Main Responsibilities of the Licensees and the CNSC Related to Safety Enhancement

The Canadian regulatory philosophy is based on two accountability principles:

1. The licensees are directly responsible for ensuring that their licensed activities are managed so as to protect health, safety, security and the environment, and to respect Canada's international commitments on the peaceful use of nuclear energy.
2. The CNSC is responsible to the Canadian public for regulating licensees to assure that they are properly discharging their responsibilities, as stated above.

The licensees fulfil their responsibilities by:

- Implementing a managed system for controlling the risks associated with operation of the facility.
- Developing an organizational culture that is committed to ensuring the safe operation of the facility.
- Defining and operating within the safe operating limits for the facility's SSCs.
- Monitoring both human and facility performance to ensure that the facility and the personnel perform as expected.

The CNSC fulfils its responsibilities by:

- Establishing a clear and pragmatic regulatory framework.
- Establishing and implementing programs to ensure licensees' conformity to nuclear non-proliferation commitments.
- Establishing and implementing programs to ensure high levels of regulatory compliance by licensees.
- Cooperating effectively at both the national and international levels.
- Ensuring that stakeholders understand the CNSC regulatory framework.

See subsection 3.10.2 for more information on organizational culture and subsection 3.12.1 for further information on human performance. Details on the main responsibilities and activities of both the licensees and the CNSC were given in the Canadian 2nd Report.

3.9.2 Mechanisms to Maximize Compliance with Safety Responsibilities

The CNSC undertakes measures to maximize licensees' compliance with regulatory requirements through a combination of regulatory assessment, promotion, verification and enforcement activities. These activities are performed within the legislative and regulatory frameworks described in subsection 3.7.1 and 3.7.2.

The NSCA specifies a number of other enforcement actions, including the issuance of orders and laying of charges, which the CNSC can apply when needed. In almost all cases, regulatory promotion and compliance verification followed by tracking issues to resolution were adequate mechanisms to maximize licensees' compliance with regulatory requirements.

Further information on this topic can be found in the Canadian 2nd Report.

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C. General Safety Considerations

Article 10 - Priority to Safety

3.10.1 Principles Emphasizing the Overriding Priority of Safety and Their Implementation

The safety principles, design safety principles, operational safety principles and regulatory-control safety principles are fundamentally unchanged from those described in the Canadian 2nd Report.

3.10.2 Development of the CNSC Organization and Management Review Method

The CNSC has developed an objective and systematic approach, called the Organization and Management Review Method, to evaluate licensees' organizational influence on safety performance. During the reporting period, the CNSC employed this approach to conduct baseline measurements of licensees' safety performance. The CNSC also went back to assess to one of the licensees to evaluate changes in performance. These evaluations provided information concerning the impact of organizational and management influences on safety performance of the licensees. The results were used in concert with the results of other types of regulatory inspections to yield a more comprehensive profile of that licensee.

From the data collected, and the continuing analysis that has been performed thus far, one major outcome offered insight into the influence that culture imposes on the other organizational processes. This work has resulted in a shift from an 'organization and management' framework to a 'safety culture' framework, within which the organization and management processes reside. "Safety Culture Characteristics" were then developed from the extensive analysis that confirmed their importance within the organization. The characteristics were then used to develop performance objectives (or indicators), and sample performance criteria that should be met to ensure good safety performance. Safety performance is measured through the comparison of organizational behaviours (previously called dimensions) that tap the underlying assumptions about the organization with the performance indicators. When they do not match, the differences will be examined so that corrective actions can be taken to improve performance. The Organization and Management Review Method continues to provide the CNSC with the measurement tools needed to examine those behaviours. CNSC staff can now look at the licensees' organizations in terms of the Safety Culture Characteristics and their accompanying performance indicators.

In March 2004, the CNSC held a two-day Symposium on Safety Culture for the industry. The purpose of the symposium was to provide the industry with the conceptual framework of safety culture as well as practical examples of its implementation in the field. The CNSC developed a regulatory guide for licensees to conduct self-assessments and report their findings to the CNSC on a continuing basis. The CNSC will continue to conduct safety culture evaluations during a facility's licensing period. The CNSC is planning a follow-up workshop with a representative of licensees, to further develop its regulatory framework to assess safety culture.

3.10.3 Enhancement of Operational Safety Culture

In response to relevant international events, Canadian licensees and the CNSC have increased their attention to the enhancement of safety culture, as well as the influence of human and organizational performance on the margin of safety.

From the perspective of the licensees, enhancing safety culture is interconnected with three "improvement focus areas"; namely, plant material condition, work planning and human performance (all of which are relevant to licensees' quality management programs (see Annex 3.14.1)). Operating with plant material in a degraded condition can lead to the development of complacency regarding the safety of the facility. Inefficient work planning processes perpetuate the degraded condition of plant material, and result in personnel frustration and inattention to detail. Inadequate human performance results in more challenges to the work planning processes and degraded condition of plant material. The licensees' improvement efforts are geared towards strengthening each aspect of the operation of the facility by focusing leadership attention on the three "improvement focus areas".

Several licensees have made efforts to communicate with facility personnel and the CNSC regarding their safety cultures. Licensees are developing programs for enhancing their safety cultures on an ongoing basis. These programs communicate to staff how they contribute to improving safety at the facilities, and where the organization is heading in terms of performance in the short and long term. The licensees are also co-operating with each other in the development of leading indicators that can be used to signal weaknesses in the safety culture.

The licensees are also participating in the development of self-assessment programs. For example, in response to behavioural causes associated with an external event, OPG performed formal external safety culture assessments. These assessments involved observing the behaviour of the organization over the span of a week and comparing the observations against a series of defined safety culture characteristics. The assessment teams were composed of internal personnel, personnel from other Canadian facilities and personnel from facilities located in the United States.

Established policies ensure a cohesive set of principles and values that all personnel are expected to demonstrate on a daily basis. The process framework for safety in the nuclear facilities is unchanged from the Canadian 2nd Report.

The challenge for licensees in the future will be to ensure that their safety culture is maintained and improved during periods of organizational change associated with the retirement of experienced employees.

Article 11 - Financial and Human Resources

3.11.1 Human Resources of Licensees to Support NPP Operating Life

During the reporting period, OPG began the process of restarting four units located at the Pickering A NPP. Bruce Power has also restarted two of the four units located at the Bruce A NPP. Both licensees have hired new personnel to ensure sufficient human resources for all operating facilities.

All licensees are taking steps to ensure they have the requisite knowledge necessary to operate the plants in the future. Due to the relatively short span of time over which the Canadian nuclear facilities were built, a large portion of the original workforce will be able to retire in the next 5 to 10 years. Steps such as involvement in university programs in nuclear engineering have been taken to increase the availability of new graduates to fill vacancies which will be left as a result of a retiring workforce (see subsection 2.4.1). The licensees also anticipate hiring experienced engineers to ensure sufficient resources. For example, the licensees have, in combination, hired approximately 150 engineers over the last three years, the majority of whom were recent university graduates. Over the next five years, the licensees anticipate hiring, in combination, approximately 100 engineering graduates and 100 experienced engineers. This staffing is solely to address the demographics within the industry, and is limited to supporting the operation of the existing facilities. Similar hiring plans exist for the operations and maintenance resources.

Efforts are also underway to manage the potential loss of knowledge as a result of the retiring staff, including efforts to re-document the ‘ideal’ configurations and operating parameters for the facilities. Further information on this subject can be found in the Canadian 2nd Report.

3.11.2 Financing of Safety Improvements Made to NPPs during Operating Life

The licensees continue to maintain budgets for operation and maintenance, and for capital improvements of their nuclear power reactor units. Relevant information contained in the Canadian 2nd Report is effectively unchanged.

3.11.3 Financial Resources for Decommissioning and Radioactive Waste Management

Licensees of nuclear power reactors in Canada are required by conditions of their licences (imposed pursuant to subsection 24(5) of the NSCA) to provide financial guarantees for the costs of decommissioning the power reactors. The four nuclear power reactor licensees in Canada have opted for different methods of supplying decommissioning financial guarantees, as allowed by Regulatory Guide G-206, *Financial Guarantees for the Decommissioning of Licensed Activities*. In all four licensees’ cases, the financial guarantee arrangements include a legal agreement granting the CNSC access to the guaranteed funds in the event of default by the operator, as well as licence conditions which require the operator to revise the decommissioning plans, cost estimates and financial guarantees periodically or as required by the regulator. These latter requirements are the means by which the decommissioning plans and financial guarantees are kept up-to-date in response to events such as changes to the operating plans for the NPP, changes in financial conditions and developments of plans for the long-term management of spent fuel under the *Nuclear Fuel Waste Act*. Preliminary Decommissioning Plans and Financial Guarantees for the performance of those plans have now been included as conditions in the operating licences (see subsection 3.7.2.2.2).

Under the *Nuclear Fuel Waste Act*, the major owners of nuclear fuel waste were required to establish the Nuclear Waste Management Organization. This organization is required to develop recommendations on the strategy for long-term management of nuclear fuel waste and present them to the Minister of Natural Resources Canada by November 2005. Once the government reaches a decision on the matter, the

Nuclear Waste Management Organization will be tasked with implementing the decision. The major owners of nuclear fuel waste were also required by the same Act to establish trust funds that will cover the costs of long-term management of nuclear fuel waste. The amount of money in these trust funds has been taken into account when establishing the amount of the Financial Guarantees to the CNSC.

3.11.4 Impact of Electricity Market Deregulation

The safe operation of Canadian nuclear power plants has not been affected by the deregulation of the electricity market in Canada, notably in Ontario.

In Ontario, the division of the nuclear facilities between OPG and Bruce Power has resulted in the establishment of independent nuclear service providers. This allows both licensees to have access to the specialized knowledge and resources that formerly existed in the single operator's organization. Further information on this topic can be found in subsection 3.19.6.

3.11.5 Qualification, Training and Retraining of NPP Personnel

Information contained in the Canadian 2nd Report is unchanged.

3.11.6 Operational Financial Guarantees

In addition to financial guarantees for decommissioning costs, the CNSC may also require financial guarantees for other costs in cases where it considers that the financial and safety risks warrant such a requirement. The CNSC has required Bruce Power, the only private-sector operator of nuclear reactor units in Canada, to provide a financial guarantee to cover the contingency costs of an unanticipated shutdown (i.e. the costs of removing fuel and placing the affected units in a safe shutdown state), in order to address the possibility that the resulting loss of operating revenue might leave the operator in financial difficulty. A proposal from Bruce Power in response to this requirement was presented and accepted at a CNSC public hearing in February 2004.

3.11.7 Capability Maintenance

Information on challenges facing the Canadian nuclear industry and initiatives undertaken regarding recruiting and maintaining competent staff are included in subsection 2.4.4.

Article 12 - Human Factors

3.12.1 Methods to Prevent, Detect and Correct Human Errors

The programs used by the licensees to prevent, detect and correct human errors were described in the Canadian 2nd Report. Updates are presented in the following paragraphs.

Events that occurred throughout the industry during the reporting period indicate the need to focus greater attention on human performance. A human performance improvement program, established for the facilities, encourages assessment of internal and external events and OPEX as opportunities to address problems prior to errors occurring.

Other improvements addressed man-machine interface errors that had been experienced. Improvements to the marking and identification of components and independent verification were undertaken to ensure that staff performing field work were working on the correct component. These efforts have reduced the occurrence of this type of events. A system of “work in progress” tagging was also developed as part of the pre-job briefing to identify for staff the components involved in the task.

Additional emphasis was also placed on the performance of pre-job and post-job briefings. The briefings provide an opportunity for management to explain the performance expected during the particular task, and to learn of instances in which the task could not be performed exactly as assessed. These efforts reduce the likelihood of situations arising during the performance of the tasks which require staff to make determinations in the field.

3.12.2 Managerial and Organizational Issues

The managerial and organizational framework described in the Canadian 2nd Report continues to be used.

The licensees are addressing shortcomings identified in the training of management-level staff, and efforts on training first-line managers continue. Additional training is also offered to more senior management-level positions. These efforts focus on the manager’s ability to provide direction and support to employees and the organization as a whole.

The assessment of organizational issues that impact on the culture of the organization is reported in subsection 3.10.2. Quality Assurance (QA) standards referenced in the operating licences specify the organizational requirements for the safe operation of NPPs (see Annex 3.14.1, Safety Area: Management, and Table A3.14.4.2 of Annex 3.14.4).

3.12.3 Role of the Regulatory Body and the Operator Regarding Human Performance Issues

The licensee has principal responsibility for the safe operation of the facilities. Accordingly, the licensee has principal responsibility for managing human performance (see also subsections 3.10.2 and 3.10.3 related to the enhancement of safety culture).

The licensees strive to maintain learning environments to ensure that all issues are identified and successfully resolved. In keeping with a learning environment, the licensees also strive to operate in a “blame free” environment. This curtails punishment of human performance errors to those circumstances in which the error is flagrant or deliberate, and provides the licensee with greater benefits in terms of the willingness of all staff to identify errors that they may have made in the performance of their functions.

Where possible, the licensees ensure independent verification of actions or assessments prior to completion. This minimizes the occurrence of errors in the completed work, and is a key step in mitigating the potential for human performance issues.

The CNSC assesses the adequacy of the licensees' efforts to manage human performance. The programs developed by the licensees are assessed, and results from the programs are monitored. The CNSC also assesses the root cause evaluations and corrective action plans of the licensees following significant events, to ensure that human performance causes are identified and resolved.

Article 13 - Quality Assurance

3.13.1 Quality Assurance Policies

During the reporting period, information on QA policies was unchanged from that given in the Canadian 2nd Report.

3.13.2 Life-Cycle Application of Quality Assurance Programs

The Canadian 1st and 2nd Reports offer detailed description of the CNSC QA requirements and the licensees' programs for the various phases of the NPP life-cycle. During the reporting period, there were no fundamental changes effected in these regards.

3.13.3 Implementation and Assessment of Quality Assurance Programs

An operational QA program is an integrated series of management processes that are necessary for safe operation of the plant, and which are required to be documented in manuals, policies, standards and procedures. A licence condition for all plants specifies the Canadian Standards Association (CSA) N286 series of standards as the regulatory requirement for power reactor QA programs. Relevant information presented in the Canadian 2nd Report is fundamentally unchanged. The following, however, gives an update of the implementation and assessment of licensees' QA programs.

During the reporting period, the industry continued to advance its QA programs and their implementation. However, implementation measures of QA programs for pressure-boundary work for three licensees remain a particular concern to CNSC staff (see subsection 3.14.8 and the related Annex 3.14.4). To mitigate this shortcoming until the licensees obtain appropriate certification for pressure-boundary work, CNSC staff has limited some licensees' authorization to perform pressure-boundary work and/or required them to subcontract fabrication work to certified companies. CNSC staff conducted numerous Type I and Type II inspections during the reporting period. The results of these inspection activities were used to assess the QA programs of the licensees and their implementation measures. In general, licensees are addressing the CNSC's concerns and showing progress, albeit at a slower pace than anticipated.

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Article 14 - Assessment and Verification of Safety

3.14.0 General

Canadian nuclear power plants are subject to routine and specific safety assessments throughout their life-cycles. These safety assessments are documented and updated by the licensees based on OPEX and new safety significant information. They are also reviewed and evaluated by the CNSC.

Safety verification by analysis, surveillance, testing and inspection is routinely conducted by the licensees and the CNSC, each within their roles and responsibilities, to ensure that the physical state and operation of the nuclear installations continue to be in accordance with their design, safety requirements and operational limits and conditions.

3.14.1 Monitoring and Periodic Safety Assessment of NPPs in Canada

3.14.1.1 Canadian Licensing and Compliance Processes for Monitoring and Periodic Assessment of Safety

In Canada, power reactor operating licences (PROLs) are currently granted by the CNSC for periods of more than two years (see subsection 3.7.2.2.3). However, safety analysis reports and safety system reliability studies are reviewed on a regular basis, typically at a frequency greater than that of operating licence renewal. In addition, Canadian processes for the periodic renewal of PROLs encompass a comprehensive scope of activities important to safety. These activities include mid-term assessments, audits and annual comparative multi-part safety assessments, all undertaken by the regulator. In addition, routine evaluations, daily operational reviews, audits by plant and CNSC personnel, learning from OPEX, and assessment of safety-significant events, human factors and modifications are performed. Licensees also submit, under S-99 (see subsection 3.7.2.3.3), reports of events to the CNSC, as well as quarterly and annual reports on matters such as operations, performance indicators, periodic inspections, status of pressure boundaries, radiation protection and reliability. Specific safety significant situations are pursued by special reviews or focused inspections that are often followed-up through specific action items to correct specific situations (see subsections 3.6.3 and 3.19.5), or under Generic Action Items (GAIs) (see subsection 3.14.5) that address issues common to more that one NPP.

3.14.1.2 IAEA Periodic Safety Review

The IAEA Periodic Safety Review (PSR) Safety Guide NS-G-2.10 introduced the expectation that comprehensive reviews of the safety of an NPP would be conducted from time to time to compare its safety-case against current practices. A PSR is a comprehensive assessment of an operational NPP, to determine whether the NPP is safe as judged by current safety standards and practices, and whether adequate arrangements are in place to maintain the safety of the plant.

During the reporting period, the CNSC standardized nine “safety areas”; each encompasses one or more programs that are used by the licensees and the CNSC to assess the safety of the NPPs in Canada. These nine safety areas were determined based on their relationship with the risk associated with plant operation. Table 3.14.1 relates these CNSC safety areas and programs to the safety factors of the IAEA Periodic Safety Review (NS-G-2.10).

Table 3.14.1: Comparison of CNSC Safety Areas and Programs with the Safety Factors of the IAEA PSR

CNSC Safety Area	CNSC Program	IAEA Periodic Safety Review Safety Factors*
1. Operating Performance	1. Organization and Plant Management 2. Operations 3. Occupational Health and Safety (non-radiological)	Plant Design (safety factor #1) Actual Conditions of SSCs (#2) Safety Performance (# 8) Organization/Administration (#10)
2. Performance Assurance	1. Quality Management 2. Human Factors 3. Training	Use of Experience of Other Plants and Research Findings (#9) Organization/Administration (#10) Procedures (#11) Human Factors (#12)
3. Design And Analysis	1. Safety Analysis 2. Safety Issues 3. Design	Plant Design (#1) Actual Conditions of SSCs (#2) Aging (#4) Deterministic Safety Analysis (#5) Probabilistic Safety Analysis (#6) Hazard Analysis (#7) Use of Experience of Other Plants and Research Findings (#9)
4. Equipment Fitness for Service	1. Maintenance 2. Structural Integrity 3. Reliability 4. Equipment Qualification	Actual Conditions of SSCs (#2) Equipment Qualification (#3) Aging (#4) Probabilistic Safety Analysis (#6)
5. Emergency Preparedness	1. Emergency Preparedness	Emergency Planning (#13)
6. Environmental Performance	1. Environmental Protection Systems 2. Effluent and Environmental Monitoring	Safety Performance (# 8) Radiological Impact on the Environment (#14)
7. Radiation Protection	1. Personnel Exposure 2. Plant Waste Management	Safety Performance (# 8)
8. Site Security	1. Site Security	
9. Safeguards	1. Safeguards	

* *Each of the Radiological Protection, Quality Assurance and Safety Culture are NOT considered an independent Safety Factor because they should be an integral part of every activity affecting safety.*

The current comprehensive operational safety reviews undertaken as part of the Canadian licensing and compliance processes, as described in subsection 3.14.1.1, could be considered equivalent to the intent of all the safety factors found in the IAEA guide on PSR. Other examples can be found in subsections 3.14.1.3 to 3.14.1.6 and Annex 3.14.1, which contain information on how the safety factors of the IAEA PSR are satisfied for the restart of Pickering A Unit 4, Bruce A Units 3 and 4, as well as for the refurbishment of Gentilly-2 and Point Lepreau power reactors.

Currently, CNSC staff and the Canadian nuclear industry are engaged in discussions on the need for and the merits of using PSR for assessing the performance of Canadian NPPs. These discussions may lead to recommendations made in late 2004. If the CNSC makes the decision to use the PSR, it is anticipated that at least 5 years will be needed to introduce and implement PSRs in Canada. If the decision is against adopting PSRs in Canada, adjustments will be made to the current licensing and compliance processes to fill any potential identified gaps when these processes are compared with the IAEA PSR expectations.

3.14.1.3 Restart of Pickering A

The scope of work involved in the restart of all Pickering A units was described in the Canadian 2nd Report. The effort includes:

- Improved fire detection, suppression and prevention equipment.
- Enhanced resistance to earthquakes (see subsection 2.3 for more information).
- Refurbishment and replacement of the standby generators and condensers to reduce environmental impacts.
- Completion of an extensive training program on the new or upgraded systems.

On May 4, 2003, the work for the restart of Pickering A, Unit 4, was completed. The CNSC approved the removal from the GSS of the reactor and the increase in power to less than 1% full power. To obtain approval to exceed 1% full power, OPG had to commission and test the safety and safety-related systems. Additional approvals were required to exceed 5%, 30% and 60% reactor power. These approvals were obtained during 2003, and the restart of Unit 4 was completed on September 25, 2003 with the declaration that the unit was available to the grid operator for dispatch.

The Government of Ontario commissioned two independent assessments of OPG and the restart of Pickering A during the reporting period. The first assessment focused on the management of the restart project, which exceeded initial cost and schedule estimates. This report concluded that the project management framework necessary for a project of this size had not been established, the scope of work had not been fully assessed and costed and the effort to complete the work had been underestimated. OPG has addressed these findings in its restart project. The second independent assessment considered whether the restart project should continue. This assessment recommended that the restart effort on Unit 1 continue, and thereafter to base the restart decision on Units 2 and 3 on the performance obtained from Units 4 and 1.

Annex 3.14.1 compares the IAEA PSR safety factors and CNSC requirements with activities related to the restart of Pickering A.

3.14.1.4 Restart of Bruce A

In November 2001, Bruce Power completed its *Bruce A Basis for Return to Service* assessment. This assessment considered environmental issues, improvement program initiatives, nuclear safety enhancements, regulatory commitments and obligations and plant material condition improvements with the view to restore Units 3 and 4 to operate safely, reliably and in compliance with regulatory requirements to the end of their useful lives (an additional six and thirteen years respectively). The assessment assumed Units 1 and 2 would remain defuelled.

In conducting this comprehensive assessment, Bruce Power reviewed previous and current Safety Reports, as well as the progressing Bruce A seismic assessment and PSA. Bruce Power then conducted a comparison of these assessments against the safety factors of the IAEA PSR (see Annex 3.14.1). Bruce Power concluded that Units 3 and 4 at Bruce A could be operated safely, reliably and in compliance with regulatory requirements for the balance of their useful lives following completion of the restart project scope of work which included:

- Fire detection and suppression upgrades.
- Design and construction of a new Secondary Control Area.
- Upgrades to the Emergency Power Generators.
- Shutdown-System-Number-One detection system enhancements.
- Negative Pressure Containment airlock air supply enhancements.

3.14.1.5 Refurbishment of Gentilly-2

Hydro-Québec (HQ) began a safety review as part of the Gentilly-2 refurbishment project. HQ also performed a review of the plant against current codes and standards, as well as a comparison of the scenarios of the Safety Report against current regulatory documents. Studies related to the following topics have also been completed:

- Condition assessment of SSCs.
- Determination of upgrades to the Shutdown Systems.
- Possible changes to address pressure tube ejection.
- Improvement of the moderator subcooling margin.
- Determination of changes to reduce the predicted future unavailability of ECC.
- Review of Gentilly-2 against the generic CANDU 6 PSA.

Annex 3.14.1 compares the IAEA PSR safety factors and CNSC requirements with activities related to the refurbishment of Gentilly-2 reactor unit.

3.14.1.6 Refurbishment of Point Lepreau

As part of the preparations for the refurbishment of Point Lepreau, a comprehensive Integrated Safety Review (ISR) was undertaken by NBPN to compare the current safety state of the facility and the various safety review programs and processes in place to the requirements and expectations of the IAEA PSR (see Annex 3.14.1). The methodology for this review was developed in 2001; the review was undertaken between late 2001 and early 2003, and published in June 2003.

NBPN has also embarked on a project, intended to complement the plant refurbishment, which will provide for the development of an Operational Risk Informed Management Process along with a reconstituted design basis for safety significant systems and a more comprehensively defined safe operating envelope.

3.14.2 Use of Probabilistic Safety Assessments

The use of PSAs by the Canadian industry and the participation of the CNSC in discussions on this topic are described in subsection 2.5.

3.14.3 Design Modification Processes

As a condition of the PROLs, licensees are required to establish design modification processes that satisfy the requirements of the CSA standards. During the reporting period, improvements were made to the licensees' design modification processes in response to identified challenges and operating experience. Additional information on this subject is found in subsection Annex 3.14.1.

3.14.4 Change Control and Approval

The licences issued by the CNSC contain requirements for the review and approval of changes to the safety and safety-related SSCs, operating documentation and limits and other specified documentation. These conditions permit the CNSC to exercise change control over proposed modifications to SSCs, operating procedures or other limits that will reduce the existing margin of safety for the plant, which was agreed upon at the time of licensing.

In keeping with the CNSC's strategic direction to adopt a risk-informed approach to regulation, the CNSC advised the licensees that its review and approval was limited to proposed modifications that had a potential to reduce the safety margins. Modifications that improved safety could be pursued by the licensee without CNSC approval. In addition, the CNSC advised the licensees that the obligation to determine whether the proposed modification could reduce the safety margins belonged to the licensee. To ensure licensees were making appropriate determinations, the CNSC assessed the change control processes that had been implemented. Prior to this advice from the CNSC, the practice had developed wherein the licensees submitted nearly all modifications to the CNSC for consideration as to whether approval was required. This change in practice is viewed by the CNSC and the licensees as an improvement to the effectiveness of the regulatory regime.

3.14.5 Generic Action Items

The role and objectives of the generic action items (GAIs) were described in detail in the Canadian 2nd Report. Specific issues covered by currently open and recently closed GAIs are noted in Annex 3.14.2.

The GAI program has helped maintain regulatory focus on complex safety-related issues. Several GAIs require the licensees to demonstrate the degree of certainty and conservatism in the safety analyses of design basis accidents. The GAI program has provided a vehicle for the CNSC to offer some degree of guidance on licensees' power reactor safety research. Many GAIs have contributed to an improved understanding of safety issues, while others have led to changes to procedures, equipment and analysis at power reactor sites in Canada.

3.14.6 Aging - Plant Life Management – Example of Verification of Safety at Point Lepreau

The management of aging of SSCs in Canadian NPPs is discussed in subsection 2.6, where information is given on the licensee plant life management (PLM) programs. In this subsection, an example is given to demonstrate the implementation of the PLM program at the Point Lepreau NPP.

The Point Lepreau PLM process was developed from existing practices within the IAEA safety series and technical reports on Age Management, the NBPN System Health Monitoring Program and AECL CANDU Plant Life Management Programs and methodologies for performing life assessment studies. The NBPN process for PLM, initiated and documented in late 2001, provides the methodology for the development of system-specific and component-specific monitoring programs. The process includes:

- Identifying critical SSCs (for example, pressure tubes, feeders, steam generators and valves).
- Understanding their aging characteristics.
- Detecting their aging effects.
- Assessing degradation mechanisms and life prognosis.
- Assessing obsolescence.
- Recommending proactive monitoring and mitigation measures.
- Reporting of life assessments and other PLM assessments.
- Identifying PLM actions and, where needed, implementing changes to other plant programs.
- Updating PLM reports based on operating experience.
- Periodic review of the PLM process.

By late 2001, seven of nineteen identified PLM studies had been completed with seven additional studies underway at that time. Completed studies covered various aspects of the reactor and containment structures, steam generators, fuel channels, nuclear and conventional piping and supports.

3.14.7 Changes at NPPs Resulting from Safety Monitoring and Assessment

Annex 3.14.3 lists examples of significant CNSC regulatory action items and licence conditions, as well as corresponding activities undertaken by licensees in response to these regulatory measures.

3.14.8 Summary of CNSC Report Cards on NPPs' Programs and Performance

CNSC staff assesses licensee programs ("P") and their implementation ("I") separately, according to five ratings categories and in nine safety areas. Annex 3.14.4 gives more information on the safety areas and the rating categories and their meaning. The Annex also gives a summary of the ratings for the licensees' programs and the implementation of these programs from 2001 to 2003.

Article 15 - Radiation Protection

3.15.0 General

A full description was given in the Canadian 2nd Report of the laws, regulations and requirements dealing with radiation protection and measures taken in Canada to ensure that radiation exposures of workers and the public are kept as low as reasonably achievable. The following subsections give information on changes and updates that were effected in the reporting period.

3.15.1 Dose Limits

During the reporting period, there were no doses at any of the Canadian NPPs that exceeded the regulatory limits. Licensees' radiation protection performance indicators showed an improving trend. These indicators, used to measure the radiological protection of workers, included collective radiation exposure, radiation protection related reportable events and personal contamination events. Aggressive radiation dose targets are established by licensees each year based on planned activities and outages for the year. As a result of these activities, both the targets and the dose vary from year to year. Doses to personnel at Canadian NPPs are noted in Annex 3.15.1.

3.15.2 Application of the ALARA Principle

ALARA stands for 'As Low As Reasonably Achievable, social and economic factors being taken into account'. Licensees implement comprehensive ALARA strategies to minimize doses to the workers. Three strategies are described in the following paragraphs.

<u>a) Radiological Exposure Permits</u>
Under this system, permits are prepared and approved in advance by the NPPs' ALARA section for all planned radioactive work. Permits are also prepared as required for emergent work. Radiation exposure permits help to control doses by allowing them to be tracked by job, aiding in presenting radiation protection issues during pre-job briefings, reducing the probability of unplanned exposures that exceed the internal investigation level, and facilitating post-work ALARA reviews of high hazard or high dose jobs.

<u>b) Airborne Tritium Reduction</u>
Several initiatives have been undertaken to reduce doses from tritium, including more frequent replacement of desiccant in drier units, improvement of the material condition of the drier system and, with some licensees, use of a dehumidifier on the air inlet of the reactor building, placement of alarming area tritium monitors, emphasizing training on the potential hazard of tritium and detritiation of the heavy water inventory. The majority of doses due to airborne tritium arise from the heat transport system due to its higher temperature and pressure relative to those of the moderator system.

<u>c) Source Term Reduction Program</u>
Wherever consistent with the principle of ALARA, hot spots, which can increase radiation fields and contribute to radiation doses, are identified and removed. In addition to the removal of existing hot spots, the licensees are working to reduce the recurrence of hot spots through initiatives involving the reduction of the filter pore size or the increase in the flow rate in the heat transport purification system.

3.15.3 Regulatory Control Activities and Radiation Protection

The regulatory control activities dealing with radiation protection are unchanged from those described in the Canadian 2nd Report.

3.15.4 Environmental Radiological Surveillance

Routine operation and maintenance of the reactors results in small amounts of radioactivity being released. Licensees monitor airborne emissions for tritium, iodine, noble gases, carbon-14 and particulates, as well as waterborne emissions for tritium, carbon-14 and gross radioactivity. The CNSC restricts the amount of radioactive material that may be released in effluents. These effluent limits are derived from the public dose limit and are referred to as “Derived Release Limits” (DRL). All except one nuclear power plant in Canada have DRLs which are based on the most recent public dose limit (2000) of 1 mSv. The exception to this is the Gentilly-2 NGS. Its DRLs are based on the previous public dose limit of 5 mSv. Updated DRLs are expected in the very near future. All licensees routinely operate at emission levels that are approximately at 1% of the DRL for any radiological emissions to air on an annual basis. In addition to tracking radiological emissions from the plant, a radiological environmental monitoring program monitors radioactivity near the facilities in the air and in substances that people eat, drink and contact. This information is used to determine radiation doses to the public in the area surrounding the nuclear facility beyond what they receive from natural background radiation.

Health Canada (HC) carries out monitoring programs around all nuclear power plants. These programs were discussed in the Canadian 1st and 2nd Reports. Presently, HC’s Canadian Radioactivity Monitoring Network consists of monitoring ambient gamma radiation at 35 locations, radioactive aerosols at 26 locations and atmospheric tritium at 14 locations. In addition, HC is in the process of establishing a network of radiation detectors around nuclear facilities and in regional population centres. These detectors will allow near real-time measurements of doses to the public from atmospheric gamma radiation and will have the capability of spectral analysis. The analyses will allow for the differentiation between background radiation and man-made isotopes. The detectors will be used to both monitor the day-to-day emissions from nuclear facilities, and evaluate doses to the public in case of a nuclear/radiological event. When completed, the network will consist of over 50 detectors, and will be called the Fixed Point Surveillance Network.

3.15.5 Release of Radioactive Materials

Releases of gaseous and liquid effluents from Canadian nuclear power plants from 2001 to 2003 are tabulated in Annex 3.15.2. During the reporting period, releases from all Canadian NPPs were kept at approximately 1% of the DRLs.

3.15.6 Regulatory Control Activities and Release of Radioactive Materials

Detailed information on the regulatory control activities dealing with release of radiological materials and environmental protection can be found in the Canadian 2nd Report.

Article 16 - Emergency Preparedness

3.16.0 General

Nuclear emergency preparedness and response in Canada is a multi-jurisdictional responsibility shared by the federal, provincial and municipal governments, as well as the licensees. Nuclear emergency planning includes both on-site and off-site plans. The on-site nuclear emergency plans are a condition of the licence issued by the CNSC and are the responsibilities of the licensees. The off-site plans are primarily the responsibility of the provinces and their designated municipalities, as well as the licensees. Health Canada (HC) has been designated as the lead federal department for the Federal Nuclear Emergency Plan, and coordinates federal preparedness and response to a nuclear emergency in Canada and abroad.

In subsections 16.1 to 16.4 of the Canadian 2nd report, a full description was given of the legislative and regulatory requirements, implementation measures, training and exercises and international arrangements related to emergency preparedness. However, during the reporting period, particularly following the events of September 11, 2001, all levels of government re-evaluated their existing structures, plans and procedures. Such effort resulted in relevant upgrades to security measures and new initiatives that are described in the following subsections.

3.16.1 New Federal Department - Public Safety and Emergency Preparedness Canada

A federal department, Public Safety and Emergency Preparedness Canada (PSEPC), was created in December 2003 to integrate into a single portfolio the core activities that secure the safety of Canadians in non-radiological/nuclear emergencies. Canada's "critical infrastructure" was defined as those physical and information technology facilities, networks and assets which, if disrupted or destroyed, would have a serious impact on the health, safety, security or economic well-being of Canadians. Nuclear power reactors and nuclear technologies were identified as part of this critical infrastructure.

As a result of this new portfolio, the Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) and other agencies were integrated into the PSEPC. Among the objectives of this integration are to increase the government accountability to all Canadians and to improve interagency communications and connections to provincial and territorial emergency preparedness networks.

3.16.2 National Emergency Preparedness and Response

During the reporting period, the Federal Nuclear Emergency Plan (FNEP) was revised and distributed to national and provincial stakeholders.

HC, as part of its lead responsibilities for the FNEP, is in the process of implementing new information management tools for emergency preparedness and response. One of the key aspects of this initiative is the implementation of the Danish ARGOS Decision Support System for radiological and nuclear emergencies. As part of the implementation of this system, HC has worked closely with Environment Canada to enhance Canadian meteorological and atmospheric modelling capabilities, and to make these fully accessible to the ARGOS system in real-time. ARGOS Canada will be used to provide overall technical data integration and dose modelling for radiological-nuclear event consequence assessment.

In order to improve the dissemination of geographically-distributed event data, HC is also in the process of implementing a web-based geographical information system. This system will be used by federal emergency response partners to rapidly exchange and manage critical emergency management information between various emergency operations centres.

3.16.3 Provincial Emergency Plans - Updates

3.16.3.1 Province of Ontario

During the reporting period, the following reforms were undertaken to keep Emergency Management Ontario (EMO) in line with the best international practices:

1. Upgrading of legislation, policies and operational framework to ensure a shift from voluntary to mandatory establishment of programs and plans.

2. Strengthening of the accountability process at the municipal and provincial levels.

3. Identification and implementation of emergency management programs and plans with a well-defined timeframe to achieve essential, enhanced and comprehensive levels of emergency preparedness and response.

4. Incorporation of Hazard Identification and Risk Assessment in the planning process.

5. Broadening of the emergency management approach from preparedness and response to also include mitigation/prevention and recovery, in harmony with the best international practices.

6. A significant increase in the capability of the EMO to respond to widespread, prolonged and complex emergencies. This included doubling the strength of EMO staff, reorganizing and restructuring of EMO and establishment of 24 hours/7 days operational capability through duty officers and duty managers.

7. Extensive and frequent consultation with the nuclear-designated communities, nuclear facilities and other stakeholders with a view to improving the existing off-site emergency management plans and procedures (including public alerting, administration of potassium iodide (KI) pills, evacuation strategy and notification procedures).

3.16.3.2 Province of Québec

Within the province of Québec, the "Organisation de la sécurité civile du Québec" (OSCQ) has the lead responsibility for emergency planning and response to all hazards, including off-site nuclear emergencies. The nuclear component of the OSCQ plan is described in a document entitled "Plan des mesures d'urgence nucléaire externe à la centrale nucléaire Gentilly-2" (PMUNE-G2), in accordance with the Québec provincial bill "*Loi sur la sécurité civile*" (Civil Protection Act). The PMUNE-G2 clearly defines the government agencies' responsibilities in a nuclear emergency at the Gentilly-2 site, with the objectives of minimizing the consequences, protecting the public and providing support to the municipality's authorities.

In effect since 1983, the PMUNE-G2 is updated regularly. In 2002, response procedures and support programs were edited, and are currently being implemented. This process began with an important prevention information campaign combined with the distribution of potassium iodine pills to residents and workers in the urgent protective action planning zone (UPZ) within an 8 km radius around the Gentilly-2 NPP. This information campaign was also applied to the citizens living in the food restriction planning zone of a 70 km radius around Gentilly-2. Specialized detection and analysis equipment was acquired to establish the appropriate response. A website was also established for the general public to obtain information on nuclear emergencies (www.urgencenucleaire.qc.ca).

Under the PMUNE-G2, HQ and the OSCQ have separate but complementary responsibilities for emergency planning and response to an accident at the Gentilly-2 site. For example, the Gentilly-2 shift supervisor is responsible for recognizing and declaring the appropriate level of radiation alert. In the event of a site or a general alert, the shift supervisor informs the “Direction générale de la sécurité civile et de la sécurité incendie du Québec” within the “Ministère de la Sécurité publique”. Depending on the urgency level of the emergency, the OSCQ will either assume a standby position, or initiate an off-site emergency response in accordance with the PMUNE-G2. As part of this response, the OSCQ would open the operations centre to coordinate the actions of the stakeholders, including communications and public information. This centre would then issue the necessary safety advisories to the public (such as those concerning the need for confinement or evacuation), respond to media enquiries and coordinate the administration of protective measures. The centre would also liaise with personnel at Gentilly-2, and with Health Canada, which is responsible for the FNEP.

3.16.3.3 Province of New Brunswick

During the reporting period, the Government of New Brunswick consolidated public safety and public security responsibilities under the mandate of the Department of Public Safety.

The province established the Security and Emergencies Initiative, comprising work on some ten business lines. One of the affected business lines is Nuclear Emergency Preparedness. Highlights are as follows:

1. Strengthening prevention, preparedness and response for all hazards, including the integration of crisis and consequence management apparatus under a single emergency management system.

2. Investing significantly in provincial government internet infrastructure to make it more reliable, more fault-tolerant and to improve capacity.

3. Updating and strengthening operational capability at the provincial New Brunswick Emergency Measures Organization’s (NBEMO) Joint Emergency Operations Centre, including enhancements to the business process, investments in infrastructure to improve connectivity and collaboration among federal and provincial intervening organizations, and more focus on operational readiness.

4. Development of a training and exercise strategy for major scenarios, including nuclear response, to see the provincial nuclear emergency organization exercised annually, rather than every three years as in the past.

5. Replacing the inventory of KI pills, updating demographic information for the Emergency Planning Zone (EPZ) and improving communications systems linking the Off-site Emergency Centre and the Joint Emergency Operations Centre.

3.16.4 Training and Exercises

3.16.4.1 Nuclear Emergency Management Workshops

The CNSC sponsored three workshops, hosted by the CNSC, HC and PSEPC, on nuclear emergency management between November 2002 and February 2003. Invited participants represented a cross-section of organizations responsible for emergency management associated with the major nuclear facilities in the provinces of Ontario, Québec and New Brunswick.

The objective of the workshops was to strengthen the nuclear emergency management programs in Canada by facilitating networking and discussions among participants at all levels, and by looking at best practices, strengths, issues and areas for improvement. Some 200 participants attended the three workshops and appreciated the unique opportunity to discuss and learn about plans, best practices, roles and responsibilities and areas for improvement.

The overall conclusions are that there is a continued need to:

- Facilitate the continued development of the nuclear emergency management network and the resolution of issues at all levels.
- Enhance funding and resources for off-site emergency preparedness.
- Increase and improve the quality of participation by relevant parties.
- Develop additional regulatory requirements.
- Finalize and issue general guidelines for nuclear off-site emergency preparedness and response.
- Promote assessment and continual improvement.
- Develop guidelines for recovery.
- Monitor progress of issue resolution.

A report was published and distributed to all participants and to organizations that have mutual interest in nuclear emergency management. HC, as lead for the FNEP, has taken over this initiative, and will address the development of a follow up action plan.

3.16.4.2 Exercises and Drills

Emergency exercises are designed to provide a training opportunity to enhance the ability of involved parties to respond to emergency situations and protect public health and safety during an event at a nuclear power plant or other licensed nuclear facility. Exercises serve to share information among the various organizations to ensure all response efforts are coordinated and communicated effectively.

In May 2003, the CNSC and federal partners participated in the TOPOFF2 exercise. The exercise was designated to provide a training opportunity for top officials designated in national plans in Canada and the USA. In August 2003, the CNSC and provincial and federal partners practiced their internal and national emergency response with NBEMO and NB Power in a scenario involving an earthquake and a LOCA at the Point Lepreau nuclear power plant. Four exercises took place in October 2003. The first was a “tabletop” exercise involving a security incident at the Pickering facility. For the second exercise, the CNSC and federal partners participated in AS IS, a “live” field exercise where expert responders searched and retrieved radioactive sources in a controlled environment. Finally, the CNSC participated in two exercises at the Pickering and Bruce A sites. These were full-scale exercises that included representatives from the licensees and all levels of federal, provincial and municipal governments. In November 2003, the CNSC and HC participated in the IAEA’s Convex-2A exercise. The CNSC is involved in emergency drills with the licensees of nuclear power plants throughout the year to ensure communication lines are in place and in a state of readiness. In the same time frame, the federal departments participated in provincial nuclear emergency exercises focused on emergencies originating at NPPs to evaluate the transfer of information and deployment of federal resources.

3.16.5 Emergency Response to Events - Loss of the Electricity Grid (Blackout) of August 14, 2003

The loss of the electricity grid event in Ontario and the Northeastern United States and the subsequent responses of NPPs are described in detail in subsection 3.19.5.1 of this report. The following paragraphs describe how the event impacted on the emergency response capabilities of the CNSC and the licensees.

The Gentilly-2 and Point Lepreau NPPs were not affected by the blackout.

In Ontario, OPG and Bruce Power followed a deliberate process controlled by plant procedures and regulations in order to return to power operations. They took an appropriate conservative approach to their restart activities, placing a priority on safety. Emergency Management Ontario (EMO) responded to the blackout, and the Province of Ontario declared a state of emergency. Safety functions were effectively accomplished, and the nuclear plants that tripped were maintained in a safe shutdown condition until their restart. The restarts were carried out in accordance with approved OP&Ps at each NPP. Three units at Bruce B and one at Darlington were resynchronized with the grid within 6 hours of the event. The remaining three units at Darlington were reconnected by August 17 and 18. Units 5, 6 and 8 at Pickering B and Unit 6 at Bruce B returned to service between August 22 and August 25.

The CNSC emergency operations centre operates using public electricity and, at the time of the event, experienced difficulties with the power supply. The offices of another federal agency which were equipped with backup power were available to be used as an alternate site if needed. CNSC staff monitored the situation and communications were established with licensees and the US Nuclear Regulatory Commission. Although the lack of electric power made communications more difficult, the CNSC was able to get essential information about the affected NPP sites.

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D. Safety of Installations

Article 17 – Siting

3.17.1 Siting Regulatory Requirements, Licensing Process and Implementation Measures

The Canadian 1st Report describes in detail the siting licensing process, including the regulatory requirements, the criteria affecting the safety of the site and the surrounding environment, the implementation measures and the international arrangements with neighbouring countries. A portion of this information was reproduced in Annex 17.1 of the Canadian 2nd Report.

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Article 18 - Design and Construction

3.18.1 National Laws, Regulations and Requirements relating to the Design and Construction of NPPs

The design and construction of NPPs in Canada conform to national and international laws, regulations, requirements and standards. They are also in compliance with other requirements imposed by local levels of governments as well as the norms of several industries. An abundance of information on this topic as well as on the evolution of the design and construction of CANDU-type NPPs is given in the Canadian 1st and 2nd Reports.

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Article 19 - Operation

3.19.1 National Laws, Regulations and Requirements relating to the Operation of NPPs

National laws, regulations and requirements relating to the operation of nuclear power reactors were effectively unchanged during the reporting period. However, one amendment was effected, as described in subsection 3.7.1.1.

3.19.2 Initial Authorization to Operate a Nuclear Power Plant

The siting, construction and commissioning requirements did not change since they were reported in the Canadian 2nd Report. There were no initial licensing activities relating to new nuclear power reactor units during the reporting period.

3.19.3 Operational Limits and Conditions

The information given in the Canadian 2nd Report is unchanged. However, Chapter 4 of this report details new initiatives that are currently under consideration by the licensees and the CNSC.

3.19.4 Maintenance, Inspection and Testing of NPPs

The operation, maintenance, inspection and testing programs and procedures used by the licensees did not change from those described in the Canadian 2nd Report.

3.19.5 Response to Operational Occurrences and Events

3.19.5.0 General

The fundamental elements of the licensees' procedures for responding to anticipated occurrences and events are unchanged. Some adjustments, however, were made to licensees' procedures due to the introduction in 2003 of the CNSC standard S-99 (see subsection 3.7.2.3.3). In general, and as described in the Canadian 2nd Report, licensees have developed and continue to maintain operating procedures for dealing with operational occurrences, situations and events. Such procedures include determination of root causes and effecting remedial and corrective actions commensurate with the situations. Examples of operational events and how the licensees and the CNSC have consequently and accordingly acted are given in subsection 3.6.3. One event in particular, the loss of the electricity grid on August 14, 2003 in Ontario and Northeastern United States, is described in detail in the following subsection.

3.19.5.1 Loss of the Electricity Grid (Blackout) of August 14, 2003

The Canadian and United States governments participated in a joint Task Force to investigate the cause of the power outage of August 14, 2003 in Ontario and the Northeastern United States. One of the conclusions reached by the task force's Nuclear Working Group is that the nuclear power plants in both countries did not trigger the power system outage or inappropriately contribute to its spread. It also concluded that safety functions were effectively accomplished, and the nuclear power plants that were affected by the blackout were maintained in safe shutdown conditions until their restart. A copy of the report of the Joint Canada - U.S. Task Force on the Power Outage is available at http://www.nrcan.gc.ca/media/docs/final/finalrep_e.htm.

The following is a synopsis of the effect of the August 14, 2003 loss of electricity grid on Canadian nuclear facilities.

a) Pickering A and Pickering B

Unit 4 at Pickering A was at low power and was being prepared to be synchronized to the grid for the first time since its restart when the blackout occurred. The reactor automatically shut down on heat transport low flow and heat transport low pressure. Units 1, 2 and 3 of Pickering A were in a GSS.

For Pickering B, the loss of grid caused the turbine-generators on Units 5 and 6 to trip which in turn caused the reactors of these two units to trip and shut down. The Unit 8 reactor was automatically setback and was being manually stabilized at 20% power when it further setback to 2% power. The reactor subsequently tripped on shutdown-system-one low boiler feedline pressure due to a power mismatch between the reactor and the turbine. Unit 7 was returning from a planned maintenance and was at 0.09% power at the time of the event, and was manually shut down in accordance with procedures. For Units 5 and 6, the blackout resulted in a loss of heat transport system forced circulation with the units at high power (Unit 8 was able to reduce power below 2% before it lost forced circulation).

The high-pressure emergency core cooling system (ECCS), which is common to both Pickering A and B, was unavailable for 5.5 hours because of loss of power to the high pressure pumps. In addition, the emergency high-pressure service water system restoration for all Pickering B units was delayed because of low suction pressure supplying the emergency high-pressure service water pumps. During that time, there was no fire water available to Pickering B. Manual operator intervention was required to restore some pumps to service. The standby generators started automatically and picked up required Class III loads. All units at Pickering were cooled down and de-pressurized within 12 hours and then placed in a GSS.

The CNSC subsequently performed a focused inspection of specific aspects as well as of the licensee's analyses related to the loss of electricity grid at the Pickering NPP. The event demonstrated that some of the design and operation assumptions could be challenged by such an event. Accordingly, the CNSC has requested that OPG identify what changes in the design, analyses, testing and maintenance could be implemented at the facility to mitigate future occurrence of the results observed. Concurrent with the focused inspection, the CNSC determined that the Pickering B response to the loss of grid warranted reporting to the IAEA, and was rated as a level 2 event on the International Nuclear Event Scale (INES).

b) Darlington

Following the loss of grid, Units 1 and 2 automatically reduced power on “load rejection”. The control room operators completed the required system reviews, and determined it was safe to place the units in “poison prevent mode”. This allows the unit to be returned to power quickly if needed. However, the shift supervisors were not able to carry out the required review in the available time, and the units were manually shut down as a result. Unit 3 automatically reduced power on “load rejection”. The shift supervisors were able to complete their independent system checks for this unit, and the reactor was placed in the “poison prevent mode”. Unit 4 automatically reduced power on “load rejection”, but was subsequently manually shut down due to failure of some of the system indicators. The plant's four standby generators automatically started when the blackout occurred. Two were used to supply Class III power to the plant, and two were left idling and available, but not connected. Unit 3 was later reconnected to the grid.

c) Bruce A

At the time of the event, Units 3 and 4 had not yet been connected to the grid. These two units were manually tripped as per operating procedures for a loss of Class IV power event. Shutdown-System-Number-One was re-poised on both units when the plant power supplies were stabilized. The emergency transfer system functioned as per design, with the Class III standby generators picking up plant electrical loads. The new Qualified Diesel Generators received a start signal and were available to pick up emergency loads if necessary. Units 1 and 2 were defuelled at the time of the event.

d) Bruce B

Following the loss of grid, the power levels of all four Bruce B reactor units were automatically reduced. Unit 6 experienced an automatic shutdown while the adjuster rods were being withdrawn to offset build-up of xenon in the reactor. One of the adjuster rods could not be automatically removed from the core due to a malfunction of the position feedback indicator. Units 5, 7 and 8 were synchronized to the grid as soon as it became available.

e) Point Lepreau

A significant reversal of power flow on a transmission interconnection between New England and New Brunswick occurred during the power interruption. Point Lepreau rapidly dropped power by about 140 MW to match demand and remained operational, supplying loads in New Brunswick. The plant operated in quiet mode for several hours.

f) Gentilly-2

The HQ grid was not affected and Gentilly-2 continued to operate normally.

3.19.6 Engineering and Technical Support

In order to respond to changing conditions in Ontario, particularly the transfer of operating responsibility for the Bruce reactor units to Bruce Power, OPG embarked on a process of contracting out non-core activities. In 2001, information technology services and certain research and development activities were transferred to external service providers. In 2002, OPG sold its nuclear safety analysis division to Nuclear Safety Solutions Limited (NSS), an external service provider. NSS acquired the resources and technology to provide safety analysis services to OPG, Bruce Power and other customers.

3.19.7 Reporting Incidents Significant to Safety

In 2003, the CNSC introduced an updated standard (S-99) for reporting requirements of operational situations and events (see subsection 3.7.2.3.3). The licensees modified their procedures accordingly and continued to report to the CNSC all operational situations significant to safety in a timely manner and in accordance with the requirements of S-99. S-99 also requires periodical reporting of non-significant situations, because their cumulative effect may indicate emerging performance issues.

3.19.8 Programs to Collect and Analyze Information on Operating Experience

Relevant programs described in the Canadian 2nd Report are effectively unchanged. These programs include OPEX feedback system amongst the Canadian licensees and COG. The programs also include the participation of the licensees and the CNSC in information exchange with other national and international organizations. The main sources of information for OPEX remain the reports submitted by licensees pursuant to the CNSC Standard S-99 (see subsections 3.7.2.3.3 and 3.19.5) and international sources such as the Incident Reporting System and the World Association of Nuclear Operators (WANO) (see subsection 3.6.3). Issues arising from OPEX, events, inspection findings or performance indicators continue to be identified and addressed by the licensees and by the CNSC. As indicated in subsections 3.7.2.3.2 and 3.14.8, licensees' performance is rated by the CNSC, which accordingly issues quarterly report cards as well as an annual industry report.

3.19.9 Minimum Generation of Radioactive Waste

All licensees continue to minimize the generation of radioactive waste from their corresponding power reactor units. Subsection 19.2.8 of the Canadian 2nd Report on Nuclear Safety and subsection 8.4 of the Canadian 1st National Report for the IAEA Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management give information on this issue, and refer to the CNSC draft policy P-290 on Managing Radioactive Waste (all can be found on the CNSC website listed in Annex 1.1).

4. PLANNED ACTIVITIES TO IMPROVE SAFETY

4.0 General

A number of challenges (stated below) surfaced during the reporting period, and each challenge was addressed in a timely manner by both the CNSC and licensees so the safety of the operating NPPs was never compromised. However, these challenges led to the initiation of several activities with the objectives of increasing the effectiveness and efficiency of the licensees' operations, improving the regulatory framework of the CNSC, and addressing specific safety issues that may require medium or long term solutions to reach a permanent resolution. The following subsections give examples of these challenges.

4.1 Risk-informed Approach to Decision-Making and Resource Allocation at the CNSC

Within the CNSC, a risk-informed process is being developed that is focused on resource allocation and decision making.

The nine "Safety Areas" established by the CNSC represent an example of applying the risk-informed process. Subsection 3.14.1.2 relates such safety areas to the elements of the IAEA Periodic Safety Review.

Another example is the risk-informed compliance program in which promotion, verification and enforcement activities are aligned to the performance of the licensee in meeting the regulatory requirements. The frequency of inspection is commensurate with the risk associated with the licensees' programs or activities. The results of the CNSC inspection reports are used for rating licensees' performance (see subsection 3.7.2.3.2), and for determining the need for additional regulatory activities. The outcomes of CNSC assessments of licensee performance are summarized in "Report Cards" (see subsection 3.14.8) that are available on the CNSC website listed in Annex 1.1. When shortcomings are identified, improvement objectives are defined and regulatory effort is focused with the objective of improving licensee performance in the relevant safety areas.

In addition to developing the risk-informed compliance program, the CNSC and the Canadian nuclear industry are considering the following initiatives:

- Developing a rigorous Cost-Benefit Analysis methodology.
- Developing a standard on the application of Probabilistic Safety Analysis (S-294).
- Implementing a reliability standard (S-98).
- Considering licensing bases for CANDU reactors in view of risk-significance.
- Developing Risk-informed maintenance activities.
- Establishing specifications for the Safe Operating Envelope.
- Revising the Safety Analysis standard.
- Developing Severe Accident Management programs by licensees.
- Revising the approach to code classification of pressure retaining components.
- Refining the risk-informed significance determination process.

4.2 Initiative to restore margins for Large Loss of Coolant Accidents

4.2.1 CNSC Requests and Licensees' Response

The CNSC has requested that all power reactor licensees implement measures to restore and improve safety margins for Large LOCA (LLOCA) events. Approaches adopted by different utilities vary depending on the specific situation and include:

- Optimization of operational limits and conditions.
- Refinement of safety analysis tools and methods (in particular, development of a best estimate and uncertainty methodology, which is described in subsection 4.2.2).
- Further experimental investigation to better validate tools used in accident analysis.
- Implementation of design changes (the most significant being the new fuel design described in subsection 4.2.3).
- Development of an integrated risk informed licensing methodology to demonstrate that the overall risk is not significantly affected by the recent discoveries.
- Implementation of accident management strategies as a tool to address residual risks.

Many of these activities require significant effort and are novel in application. It is likely that these activities will be ongoing for several years before any safety benefits will be achieved.

4.2.2 Best-Estimate-and-Uncertainty Analysis

Canadian licensees have been developing a new analysis methodology, called the "Best Estimate and Uncertainty" (BEAU methodology) to augment their deterministic safety analysis. The objective of developing the BEAU methodology is to demonstrate the existence of larger safety margins as compared to the margins produced by the conservative deterministic safety analysis methodology for design basis events such LLOCA and Loss-of-Flow accidents. This analysis methodology assumes more realistic initial and boundary conditions with all the uncertainties (associated with assumptions, models, and thermalhydraulic and physics codes) defined to a high level of confidence. The BEAU methodology is not considered to be a licensing tool. However, after some remaining uncertainty and validation issues are resolved, and as it matures and gains increased confidence by both the regulator and the licensees, the BEAU methodology may be used as a licensing safety analysis tool. A pilot BEAU project for the Darlington NPP was completed in March 2003. Additional developments of the BEAU project are nearing completion.

4.2.3 Low-Void-Reactivity Fuel

To restore the safety margin for a LLOCA, Bruce Power is evaluating a low-void-reactivity (LVR) fuel. The conceptual fuel design is well-established, but burnable poison concentration and enrichment are still being optimized. A safety case for a demonstration irradiation is being developed and a safety case for a full core loading is being planned.

4.3 Severe Accident Management

The Canadian industry took steps in January 2002 to form a Severe Accident Working Group, which is coordinated by the COG, with key objectives to formulate effective Severe Accident Management (SAM) provisions and to develop SAM strategies to complement existing Emergency Operating Procedures.

The CNSC is developing a regulatory guide for SAM programs for nuclear power reactors, and has requested the licensees to implement formal SAM programs as a means of further reducing the risk posed by severe accidents. The CNSC considers it to be prudent to provide plant operators with enhanced procedural capabilities to control the progress and to minimize consequences of severe accidents.

It is expected that a SAM program will add a defence barrier against consequences of those accidents which fall beyond the scope of events considered in the reactor design basis. SAM programs are envisaged to ensure that personnel with responsibilities for accident management are adequately prepared to take effective on-site actions. It will also make sure that the reactor and plant systems' capabilities to cope with severe accidents are evaluated and enhanced where necessary. The SAM program will take into consideration the reactor design, particularly the reactor power and available protective systems, as well as the risk posed by reactor-specific severe accidents. To the extent practical, SAM programs build on the existing framework of emergency operating procedures and emergency preparedness measures.

4.4 Future Licensing Requirements

4.4.1 Authorized Nuclear Operator per unit

All multi-unit NPPs will be required to have an "Authorized Nuclear Operator" in direct attendance at each unit's main control room panels by a specific deadline, in order to reflect commitments made by the licensees in 2001. This will make main control room staffing consistent with single-unit plants in Canada and with international practice.

4.4.2 Reliability Programs for NPPs

CNSC Regulatory Standard S-98 *Reliability Programs for Nuclear Power Plants* will be incorporated into the PROLs by a specific deadline. The standard describes reliability program requirements for risk-significant systems of the NPP.

4.5 Transfer of Certification Examination of Licensee Personnel from the CNSC to Licensees

In an effort to improve regulatory effectiveness in the area of training and qualification of NPP operation personnel, the CNSC decided that it will withdraw from the direct examination of Reactor Operators (RO) and Shift Supervisors (SS). Instead, the CNSC will rely on the soundness of the training programs and on certification examinations set by licensees to gain assurance of the competence of candidates prior to their initial certification. However, the CNSC will continue to certify ROs and SSs under the legal authority in the NSCA and the *Class 1 Nuclear Facilities Regulations*. The assurance required for certification will be obtained from regulatory oversight of the licensees' training and examination processes, through a combination of appropriate regulatory guidance and compliance activities.

4.6 Safe Operating Envelope Project

OPG and Bruce Power continue to work on preparing Operation Safety Requirements documents. They are also performing a gap analysis to ensure that the current compliance documentation (OP&P, Impairments Manual, etc.) is consistent with these requirements. Discrepancies are dispositioned using normal change control processes, such as engineering change control, document revision, and safety-report update. No serious discrepancies have been discovered.

4.7 Licensing Basis for New Reactors

The CNSC has undertaken a project to produce a Licensing Basis (LB) document that will be used to assess the licensability of new reactors in Canada. The main objectives of the LB project are:

- Closer alignment of Canadian requirements with international practices.
- Adoption of a more risk-informed approach to licensing.

The project also considers current regulatory and industry practices in Canada and interacts with other concurrent CNSC projects. The LB document will be first applied to the Advanced CANDU Reactor being designed by AECL.

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ANNEXES

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Annex 1.1: List of Relevant Websites

Organization	Website
Atomic Energy of Canada Limited (AECL)	http://www.aecl.ca/
Bruce Power Inc.	http://www.brucepower.com/brucepower/
Canadian Nuclear Safety Commission (CNSC)	http://www.nuclearsafety.gc.ca
CANDU Owners' Group (COG)	http://www.candu.org
CANTEACH	http://canteach.candu.org
Health Canada (HC)	http://www.hc-sc.gc.ca
Hydro-Québec (HQ)	http://www.hydroquebec.com/
International Atomic Energy Agency (IAEA)	http://www-ns.iaea.org/nusafe/s_conv/s_conv.htm
New Brunswick Power Nuclear (NBPN)	http://www.nbpower.com
Natural Resources Canada (NRCan)	http://www.nrcan-rncan.gc.ca
Ontario Power Generation (OPG)	http://www.opg.com
University Network of Excellence in Nuclear Engineering (UNENE)	http://www.unene.com

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Annex 3.6.1: List and Status of Nuclear Power Units in Canada

Reactor[1]	Licensee[2]	Gross Capacity MW(e)	Construction Start	First Criticality	Operating Status
Bruce A, Unit 1	BP	904	June 1, 1971	Dec. 17, 1976	Defuelled: Dec. 31, 1997
Bruce A, Unit 2	BP	904	Dec. 1, 1970	Jul. 27, 1976	Defuelled: Oct. 8, 1995
Bruce A, Unit 3	BP	904	July 1, 1972	Nov. 28, 1977	Restarted: Criticality - Dec. 08, 2003, synchronized to grid on Jan. 08, 2004.
Bruce A, Unit 4	BP	904	Sept. 1, 1972	Dec. 10, 1978	Restarted: Criticality - Aug. 30, 2003, synchronized to grid on Oct. 07, 2003.
Bruce B, Unit 5	BP	915	July 1, 1978	Nov. 15, 1984	Operating
Bruce B, Unit 6	BP	915	Jan. 1, 1978	May 29, 1984	Operating
Bruce B, Unit 7	BP	915	May 1, 1979	Jan. 7, 1987	Operating
Bruce B, Unit 8	BP	915	Aug. 1, 1979	Feb. 15, 1987	Operating
Darlington, Unit 1	OPG	935	Apr. 1, 1982	Oct. 29, 1990	Operating
Darlington, Unit 2	OPG	935	Sept. 1, 1981	Nov. 5, 1989	Operating
Darlington, Unit 3	OPG	935	Sept. 1, 1984	Nov. 9, 1992	Operating
Darlington, Unit 4	OPG	935	July. 1, 1985	Mar. 13, 1993	Operating
Gentilly-2	HQ	675	Apr. 1, 1974	Sept. 11, 1982	Operating
Pickering A, Unit 1	OPG	542	June 1, 1966	Feb. 25, 1971	GSS[3]: Dec. 31, 1997
Pickering A, Unit 2	OPG	542	Sept. 1, 1966	Sept. 15, 1971	GSS[3]: Dec. 31, 1997
Pickering A, Unit 3	OPG	542	Dec. 1, 1967	Apr. 24, 1972	GSS[3]: Dec. 31, 1997
Pickering A, Unit 4	OPG	542	May 1, 1968	May 16, 1973	Restarted: Criticality – July 6, 2003, synchronized to grid on Sept. 25, 2003
Pickering B, Unit 5	OPG	540	Nov. 1, 1974	Oct. 23, 1982	Operating
Pickering B, Unit 6	OPG	540	Oct. 1, 1975	Oct. 15, 1983	Operating
Pickering B, Unit 7	OPG	540	Mar. 1, 1976	Oct. 22, 1984	Operating
Pickering B, Unit 8	OPG	540	Sept. 1, 1976	Dec. 17, 1985	Operating
Point Lepreau	NBPN	680	May 1, 1975	July 25, 1982	Operating

1. All operating reactors are Pressurized Heavy Water Reactors (PHWR)
2. BP = Bruce Power Inc.; OPG = Ontario Power Generation Inc.; HQ = Hydro Québec; NBPN = New Brunswick Power Nuclear
3. Placed in a GSS. Work is ongoing to refurbish these plants.

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Annex 3.6.2: Examples of lessons learned and Corrective Actions resulting from National and International Events and Operating Experience

Event/Operating Experience	Examples of Lessons Learned/Corrective Actions
Loss of regulation during start-up at Quinshan, China	• Ensure that failure modes of reactor regulating system will not lead to power increase. • Ensure that OPEX information from CANDU 6 operators is shared and modifications implemented.
Emergency Power Reliability (WANO-SOER 2002-2)	• Review design for emergency power system vulnerabilities. • Review operating and maintenance practices for vulnerabilities. • Review modification processes for independent review and verification, new equipment/component quality requirements, document/drawing/procedure timely updates, and post-modification testing. • Review performance monitoring practices to ensure monitoring for degradation. • Review testing practices to ensure representative of actual demand conditions and to ensure equipment exercised appropriately. • Review maintenance practices for both contract and NPP personnel.
Reactor pressure vessel head degradation at Davis-Besse NPP, USA (WANO-SOER 2003-2)	• Discuss Davis-Besse case study with all managers and supervisors. • Conduct self-assessment to determine the extent to which organization has health respect for nuclear safety and that nuclear safety is not compromised by production priorities. • Identify and document abnormal plant conditions or indications at plant which cannot be readily explained. Follow-up with an investigation of causes, corrective actions. Ensure that senior management is aware of these conditions.
LOCA-generated debris identified at Barsebäck, Sweden	• A finned strainer design has been developed by AECL that gives a compact strainer with a large area. • The new strainers are of a modular design and are seismically and environmentally qualified. • Strainer replacement has been completed at Pickering A, Pickering B, Point Lepreau and Gentilly-2. Replacement at Darlington was completed in 2003. Finned strainers were not found to be necessary at the Bruce plants. Bruce A strainers have been modified to increase the area of the original box strainers. Bruce B added additional coarse strainers to remove large debris but did not modify the original box strainers. • Installation of strainer modifications at all sites has been (or will be) verified by CNSC staff.
Workers worked on the wrong unit at Darlington NPP, Canada	In October 2001, two workers started work on the wrong equipment on the wrong unit, causing the turbine generator to trip, and an automatic reduction in the reactor power. In response to the event, additional barriers were established such as

Event/Operating Experience	Examples of Lessons Learned/Corrective Actions
	improvements to the identification of the units through colour coding, enhancements to the equipment verification step used to ensure that the correct component has been identified and establishment of a process for tagging the equipment before and during the maintenance work. This event, and similar events, also highlighted the need to focus resources on improving human performance. Programs were established to monitor and assess human performance and to develop systematic improvements to address the issues identified. The corrective action program was also improved to include the assessment of human performance causes for events. The initiatives and focus on human performance have resulted in improvements to the safe operation of the facilities.
Opened vents in cold weather affecting other systems at Pickering B, Canada	On January 27, 2003, operating staff at Pickering B opened venting panels because of a potential release of hydrogen gas into the turbine building. The very cold air on that day prevented normal operation of these panels, which then had to be closed manually. A number of other systems at the plant were also adversely affected by the cold air. OPG has reviewed this event in order to take the appropriate corrective actions to prevent a recurrence.
Loss of Electricity Grid (Blackout) of August 14, 2003, Canada	Detailed description of the event and the response of both the industry and the CNSC are found in subsections 3.16.5 and 3.19.5.1 of this report. An International Nuclear Event Scale (INES) level 2 rating was given for the effects of the event on the Pickering B plant.

Annex 3.14.1: Alignment of the Restart and Refurbishment Activities of Specific Canadian NPPs with Generic Canadian Licensing Requirements and the IAEA PSR Safety Factors

PSR Safety Factor IAEA NS-G-2.10	**Generic Licensing Requirement**	**Pickering A Restart**	**Bruce A Restart**	**Point Lepreau (PL) Refurbishment**	**Gentilly-2 (G2) Refurbishment**
Safety Area: PLANT					
Safety Factor 1: Plant Design Determine the adequacy of the nuclear power plant design and its documentation in an assessment against current international standards and practices.	The Power Reactor Operating Licences (PROL) require CNSC approval of all modifications to safety or safety-related equipment that may result in a hazard or risk different in nature or greater in probability than that of the intended design. Licensees are also required to have Quality Assurance (QA) programs that provide continuing assurance that the plant design is being maintained and the design is accurately documented.	OPG performed a review against the current codes and standards as part of the assessment leading to the scope of work to restart Pickering A. Deficiencies in the management of configuration were addressed to the extent practicable during the restart activity. All design changes were processed through an engineering change control process. OPG also has a general configuration management restoration effort underway. The improvements in process developed through this effort were implemented at Pickering A.	Bruce A was designed and constructed to meet the codes, standards and regulatory requirements of the 1960s and 1970s. Bruce Power assessed the plant design against the current codes, standards and regulatory requirements as part of the restart program. These included: • CSA 'N' series standards • National Building Code • CNSC relevant regulatory and consultative documents • IAEA Safety Series (e.g. INSAG-8)	AECL undertook a review for NBPN of the PL plant design against current codes and standards in 2000. NBPN's continuous safety analysis program and review of nuclear industry problems identified by OPEX have kept the safety design of the plant up to date with current Canadian and international standards. A design configuration management project and development of core process documentation on design configuration assure the adequacy of plant design and configuration.	A review of the G2 plant design against codes, standards and practices was completed in 2002. Programs are in place to keep the safety design of G2 up to date with national and international standards. A Design Configuration Management Project is underway.

PSR Safety Factor IAEA NS-G-2.10	Generic Licensing Requirement	Pickering A Restart	Bruce A Restart	Point Lepreau (PL) Refurbishment	Gentilly-2 (G2) Refurbishment
Safety Factor 2: Actual Condition of Systems, Structures and Components Determine the actual condition of systems, structures and components (SSCs) important to safety and whether it is adequate for them to meet their design requirements, and confirm that the condition of SSCs is properly documented.	Licensees are required to assess the condition of major plant systems and to perform inspections. The results of the assessments and inspections are compared against current fitness for service guidelines and regulatory documents to judge the adequacy of the condition. Repairs or replacements are performed as necessary, based on the assessment and inspections.	In addition to the ongoing licensing requirement to which OPG conforms, assessments were also performed to compare the physical condition of the plant against defined events (for example, seismic disturbances and fires).	Prior to the restart activities, Bruce A systems were maintained in a defuelled state consistent with the Electric Power Research Institute (EPRI) guidelines. Inspections and assessments of plant systems and equipment were conducted. Modifications, maintenance or replacement of equipment were undertaken as required to ensure safe, reliable operation. A Readiness for Restart process was used to ensure that all required work was complete and documentation in place to ensure safe unit operation.	During 2000 and 2001, AECL undertook a thorough condition assessment of the complete plant for NBPN to determine which equipment would need to be refurbished or replaced due to aging or obsolescence. NBPN is also developing a comprehensive Plant Life Management Program focused on SSCs important to safety. Included are in-depth life assessments, systematic maintenance optimization and system health monitoring and inspection programs.	Condition assessment of specific SSCs was performed by HQ from 2001 to 2003 to show which equipment has to be considered for the refurbishment project. During the same period, AECL undertook the same work for generic SSCs for G2. A Plant Life Management Program is being developed.
Safety Factor 3: Equipment Qualification Determine whether equipment important to safety is qualified to perform its designated safety function throughout its installed service life.	The CNSC included a licence condition requiring the licensee to establish that all required SSCs are qualified to perform their safety functions by a specific deadline.	OPG developed a project to provide assurance that the essential safety-related equipment would perform its safety-related function when exposed to post-accident environmental conditions. This project has been implemented at all of OPG's plants including Pickering A. A portion of the effort involved in the restart of Unit 4 was establishing through assessment or replacement that the equipment was environmentally qualified.	The implementation of the Environmental Qualification (EQ) program continued so as to ensure that a reliable, qualified line of defence exists. This line of defence would shutdown and control reactor power, cool the fuel, contain the radioactivity and monitor key plant parameters following a single or dual failure accident during which harsh environmental consequences might occur.	EQ requirements for designated safety functions were developed as part of the original design of PL. During reviews undertaken by NBPN in the 1980s and 1990s, it appeared that these early EQ requirements might not be sufficiently comprehensive. A program to review potential accident conditions and associated EQ requirements led to a number of changes to equipment components and design, and to changes in maintenance and procurement practices.	In the 1980s, a review of the original EQ requirements started. As a result of the review, a project to improve EQ was initiated in the 1990s, and potential accident conditions were reviewed. As a result, the EQ requirements stemming from the analysis brought changes to components and changes in procurement practices and maintenance.

PSR Safety Factor IAEA NS-G-2.10	Generic Licensing Requirement	Pickering A Restart	Bruce A Restart	Point Lepreau (PL) Refurbishment	Gentilly-2 (G2) Refurbishment
Safety Factor 4: Aging Determine whether aging in a nuclear power plant is being effectively managed so that required safety functions are maintained, and whether an effective aging management program is in place for future plant operation.	The PROLs require the implementation of a maintenance program to limit, during the lifetime of the nuclear facility, the risks related to the failure or unavailability of any SSC whose performance may affect the safe operation or security of the nuclear facility. The CNSC required all licensees to develop Life Cycle Management Strategies and Plans for all of the major SSCs. These detail the expected effects of aging, and the monitoring and inspections to be performed to confirm the condition of the SSCs.	OPG improved its maintenance program as part of the Integrated Improvement Project. These improvements were pursued as part of the restart effort. OPG also achieved appropriately low targets for backlogs in operating corrective maintenance. Addressing the backlog of maintenance activities that had accrued prior to the defuelling of the plant was a condition to obtaining CNSC approval to restart the unit. An aging management program has been developed for all of OPG's plants.	All necessary equipment was maintained, modified or replaced to ensure safe, reliable operation prior to restart. Subsequently, a maintenance optimization program has been undertaken so as to effectively and efficiently maintain structures, systems and components. Periodic inspection programs of critical components such as pressure tubes, boiler and preheater tubes and feeders are consistent with current codes, standards and regulatory requirements.	Age Management at PL is part of the comprehensive Plant Life Management (PLM) Program being developed. A review of the program for the refurbishment Integrated Safety Review (ISR) found that improvements were required in two areas: the selection of SSCs to include in the program, and the co-ordination of the many separate activities of the program. These activities include programs on Safety Related Systems Reliability, Monitoring and Managing System Health, maintenance optimization and a wide range of inspection and testing programs.	The Aging Management Program implementation is in progress; it is part of the (PLM) Program. A refurbishment Safety Review (SR) was performed at G2, giving some input to the PLM.
Safety Area: SAFETY ANALYSIS					
Safety Factor 5: Deterministic Safety Analysis Determine the extent to which the existing deterministic safety analysis remains valid, when the following aspects have been taken into account: actual plant design; the actual condition of SSCs and their predicted state at the end of the period covered by the PSR; current deterministic methods; and current	An ongoing component of Canadian NPP licensing is the requirement to update the safety analysis every three years.	A condition of the restart of Pickering A was to update the safety analysis to include all design and safety analysis changes that had previously occurred. Probabilistic risk assessments were used to identify improvements that could reduce the probability of severe core damage. Completion of these improvements was a condition of the restart effort. The restart effort also included the review of the	The Safety Analysis was updated for LLOCA with increased void reactivity error allowance, loss of Class IV power, loss of coolant flow and accidents during pre-equilibrium fuel. The Safety Report was rewritten to reflect the new Analyses of Record which also included material changes to safety systems such as the addition of a Secondary Control Area, faster Shutdown System #1 and a new Emergency Power System.	The refurbishment ISR concluded that PL has maintained a comprehensive deterministic safety analysis program throughout plant operation. The program ensures that the safety analysis is updated when reviews indicate continued validity may be questionable. These reviews take into account actual plant conditions and aging, OPEX, research findings and developments in safety analysis technology. When the analysis is updated, the methodology used is	The Gentilly-2 Safety Report (SR) is updated every three years as required by the CNSC. In the process of keeping the SR up to date, research findings, new safety analysis and developments in safety analysis technology are taken into account. Plant conditions, aging and operating experience are also considered.

PSR Safety Factor IAEA NS-G-2.10	Generic Licensing Requirement	Pickering A Restart	Bruce A Restart	Point Lepreau (PL) Refurbishment	Gentilly-2 (G2) Refurbishment
safety standards and knowledge. In addition, the review should also identify any weaknesses relating to the application of the defence-in-depth concept.		existing safety analysis to confirm that the conclusions stated in the safety analysis remained valid.		compatible with the current industry best practices. The PL Safety Report has consistently been updated and submitted to the regulator as required by the PROL.	
Safety Factor 6: Probabilistic Safety Assessment Determine to what extent the existing PSA remains valid as a representative model of the plant when the following aspects have been taken into account: changes in the design and operation of the plant; new technical information; current methods; and new operational data.	Requirements are stated in CNSC Standard S-98.	PSAs have been performed. Changes to the assessments caused by operational experience will result in the revision of the assessment.	A Level 1, 2, 3 PSA was completed prior to the restart. However, no significant SSC changes were implemented as a result of the PSA. (Significant changes were initiated in advance of the PSA as a result of improved codes, standards and regulatory requirements, internal/external OPEX.)	The refurbishment ISR found that the Safety Design Matrices, which were the PSAs undertaken for initial plant licensing, were outdated and significant improvements were required in this area to meet current international expectations. The refurbishment project undertook a review of the Generic CANDU-6 PSA and changes made at more recent CANDU-6 plants for which PSAs were done. Potential gaps in safety were evaluated for inclusion in the refurbishment change scope. A risk baseline study was also performed and a PL specific PSA is currently underway.	At the start-up of G2, PSA called Safety Design Matrices (SDM) were produced. Some of the SDM were kept up to date. A PSA is now being developed for G2.
Safety Factor 7: Hazard Analysis Determine the adequacy of protection of the nuclear power plant design against internal and external hazards, taking into account the actual plant design, actual site characteristics, actual condition of the SSCs	The PROLs require the performance of fire hazard assessments and ongoing fire safety assessments.	OPG performed fire hazard assessments at all of its plants, including Pickering A. As a result, the restart conditions included the completion of upgrades to the fire detection and suppression systems that the assessment indicated did not provide the level of protection required.	A fire hazard assessment was conducted consistent with CSA Standard N293-95, “Fire Protection for CANDU Nuclear Plants”. Upgrades were made to fire detection and suppression systems: notably, smoke detection upgrades within the Main Control Room and Control Equipment Rooms, and fire suppression upgrades for the Turbine-	The Safety Report and other program specific studies together provide a comprehensive all-hazards approach to safety assessment. The Safety Report, which is frequently updated as required by the PROL, includes reviews of natural events such as floods, tornadoes and seismic events and human related risks as might arise	The design review is almost completed. This review includes: • flooding protection • fire detection and suppression • chlorine detection • seismic margin assessment (which is currently planned) The Safety Report which is

PSR Safety Factor IAEA NS-G-2.10	Generic Licensing Requirement	Pickering A Restart	Bruce A Restart	Point Lepreau (PL) Refurbishment	Gentilly-2 (G2) Refurbishment
and their predicted states at the end period covered by the PSR, and current analytical methods, safety standards and knowledge.		OPG also performed seismic hazard assessments and flooding assessments as part of the restart activities. Improvements to the plant design were included in the restart conditions by the CNSC.	Generator sets. A Seismic Margin Assessment was conducted per EPRI guidelines. The results of this assessment led to reinforcement of the Main Control Room and large water tanks in the vicinity of critical equipment.	from changes in population distribution, neighbouring land use and transportation routes. Comprehensive reviews of fire detection and suppression capability have been undertaken and upgrades made where needed.	updated every three years includes natural events and human related risks. Upgrades for fire detection and suppression capability have been made.
Safety Factor 8: Safety Performance Determine the safety performance of the nuclear power plant and its trends from records of operating experience.	There are ongoing reporting requirements in the PROLs that include the description of operating events and performance trends. Licence renewal includes the CNSC public review of the operating performance and the trends over time. Improving performance is a consideration in determining the licence renewal conditions.	No special effort was undertaken for the restart. Performance monitoring was maintained during the restart for applicable measures.	Bruce A safety performance will be monitored and reported as per the CNSC performance reporting criteria stipulated in S-99.	Regular reports are made to the regulator on a comprehensive range of safety performance indicators as stipulated in S-99. The refurbishment ISR found several areas in need of improvement, including frequency and scope of audits, keeping maintenance procedures current, progress on documentation of work processes, procurement and storage of spare parts and materials, and the development of performance indicators for the Systems Health Monitoring Program.	As required by S-99, regular reports are made to the CNSC.
Safety Factor 9: Use of Experience from Other Plants and Research Findings Determine whether there is adequate feedback of safety experience from other nuclear power plants and of the findings of research.	The PROLs require the establishment of operating experience programs to ensure that the lessons learned from other operating plants are assessed for the possible impact on operations.	No special effort was undertaken for the restart. OPG's OPEX program has been implemented at all sites.	Lessons learned from several OPEX events were incorporated into the restart program at Bruce A. These resulted in: • Improved independent assessments of systems prior to return to service. • Improved calibration and installation of start-up neutronic instrumentation	NBPN is a member of COG. The COG provides comprehensive programs for the exchange and review of safety OPEX and also run extensive R& D projects through the COG Safety & Licensing Committee, which provides a joint utility forum for the assessment of safety significant research findings.	An OPEX program is in place at G2. This program provides exchange and review of safety information and operating experience. Lessons learned from OPEX are taken into account.

PSR Safety Factor IAEA NS-G-2.10	Generic Licensing Requirement	Pickering A Restart	Bruce A Restart	Point Lepreau (PL) Refurbishment	Gentilly-2 (G2) Refurbishment
Safety Area: MANAGEMENT					
Safety Factor 10: Organization and Administration Determine whether the organization and administration are adequate for safe operation of the nuclear power plant.	The QA standards referenced in the PROLs specify the organizational requirements for safe operation. Additional requirements are imposed through requirements for the minimum shift complement that must be present at all times in the main control room and in the facility.	Organizational measures were taken to insulate the personnel responsible for safe operations from the demands of the restart project. The operations personnel ensured that the facility was at all times kept in a safe configuration, and maintained their approval authority over changes to the plant configuration. Improvement initiatives in the conduct of operations, maintenance and engineering were implemented. Training was also a key improvement area. Training specific to the restart was developed to ensure that both the staff involved in the restart activities and individuals who would assume operations following the completion of the restart were qualified to perform their particular tasks.	The Bruce A Restart QA Plan describes the quality management arrangements for all aspects of the project including design, procurement, installation/modification/ maintenance of SSCs, commissioning, return to service inspections and testing, and operations. The plan also includes arrangements for key interfaces such as those with the design authority, the regulator, consultants and contractors.	As part of an initiative to improve quality management, a plant-wide review of work processes was initiated in 2000 and development of a new management system is underway, scheduled for completion in 2005. The ISR found the following areas for improvement: setting and managing safety targets, recognizing safety programs as cross-functional as well as process verification of compliance with regulatory obligations, job descriptions for staff, basis of criteria for audit cycles and implementation plans for independent assessment of work processes.	Organization and administration are submitted to various audits and assessments made by the G2 QA group, the CNSC and other external organizations such as WANO. Findings of the assessments help improve organization and administration at G2. Review of all works processes was initiated as part of a review of G2 QA program. As required by Gentilly-2 operating licence, this new QA program should be in place in the fall of 2004.
Safety Factor 11: Procedures Determine whether nuclear power plant procedures are of an adequate standard.	The PROLs require the development of procedures for the safe operation and maintenance of the facility, for the quality of the design, for procurement and for overall quality assurance.	OPG's QA program and related procedures were improved as part of the Integrated Improvement Project. The restart activities included the improvement of the operating procedures, particularly the Abnormal Incident Manuals.	As part of the readiness for service process, procedures for systems and plant operations under normal, abnormal and emergency conditions were reviewed and rewritten as required prior to restart.	The plant is currently revamping its operating procedures based on the new process model for management. The new format and style will improve clarity and ease-of use. Formal mechanisms such as internal and self-assessment are in place to improve procedures. Challenges include	Operating procedures are maintained. In the late 1980s, a major project was initiated to revise all the operating procedures. A new HQ Standard was developed and operating procedures were revised and are maintained accordingly.

PSR Safety Factor IAEA NS-G-2.10	Generic Licensing Requirement	Pickering A Restart	Bruce A Restart	Point Lepreau (PL) Refurbishment	Gentilly-2 (G2) Refurbishment
				development of a methodology to ensure procedures incorporate regulatory and code compliance and inter-process interfaces.	
Safety Factor 12: Human Factors Determine the status of the various human factors which may affect the safe operation of the nuclear power plant.	Human factors are required to be assessed as part of the design change process.	No specific actions were undertaken as part of the restart. OPG's engineering change control processes were applied. These processes include the evaluation of human factors.	All modifications to SSCs were reviewed to ensure that human factors were given due consideration. Bruce Power introduced the International Safety Rating System loss control program. This business-wide program has had a positive impact on personnel behaviour and safety culture.	This Safety Factor includes staff selection, training, development and performance management. Over the past few years, NBPN has been transitioning to Systematic Approach to Training (SAT) for all staff positions important to safety. SAT was initially focused on Shift Operations and Maintenance staff. The following challenges have been identified in relation to Technical Unit and Nuclear Safety staff: development of SAT, human resource planning, succession planning, and professional development. In some cases, staffing level changes have been implemented without identifiable reference to process requirements.	Human factors will be implemented in the design modification process. The current human factors program will be used for the refurbishment project.
Safety Factor 13: Emergency Planning Determine: a) whether the owner/operator has adequate plans, staff, facilities and equipment for dealing with emergencies, and b) whether the owner/operator's	All licensees are required to have approved emergency plans in place which are adequately staffed and resourced. Evaluated drills are performed routinely to ensure co-ordination between the licensee and the off-site emergency response agencies.	No activities specific to the restart were required. OPG's emergency plan was unaffected by the restart.	Emergency planning is a site-wide function. An emergency at Bruce A is addressed similarly to that at Bruce B. A successful emergency response drill involving a Bruce A LOCA scenario was conducted with support from the province in the fall of 2003.	PL has recently transitioned from on-site emergency management by shift operations supported by a Technical Advisory Group of Senior Site Management, to the provision of two separate teams to support operations, an Emergency Management Team (EMT) responsible for oversight	Emergency plans are in place. A successful emergency response drill was conducted in 2002 with support from the province of Québec and the “Sûreté du Québec”, the provincial police force.

PSR Safety Factor IAEA NS-G-2.10	Generic Licensing Requirement	Pickering A Restart	Bruce A Restart	Point Lepreau (PL) Refurbishment	Gentilly-2 (G2) Refurbishment
arrangements are adequately co-ordinated with local and national systems and are regularly exercised.				and resource management and an Emergency Technical Team (ETT) tasked with support for technical issues related to an incident. Exercises of major events have revealed some challenges related to training and resourcing of the ETT.	
Safety Area: ENVIRONMENT					
Safety Factor 14: Radiological Impact on the Environment Determine whether the operating organization has an adequate program for surveillance of the radiological impact of the nuclear power plant on the environment.	All licensees are required to measure and report on the radiological emissions from the plant and to report annually on the dose impact associated with those emissions.	The restart activities included specific improvements that would reduce the risk of environmental events. The restart also included an environmental assessment that provided a reasonable prediction that continued operation of the plant, after it had been refurbished and modified, would have no significant environmental impacts. Some monitoring improvements were established following the environmental assessment to ensure that the predicted impact is accurate. Monitoring equipment was upgraded.	The environmental assessment was a significant component of the restart project. This comprehensive review of Bruce A determined that its operation is unlikely to cause any significant environmental effects (radiological or conventional). Some improvements in environmental management include: carbon-14 emissions monitoring enhancements, upgraded stack, radioactivity monitors, and thermal plume monitoring and impact on fish habitat. Bruce A, as part of Bruce Power, is ISO 14001 certified.	The refurbishment ISR found that the Radiation Protection and Environmental Management programs at PL meet all the requirements and expectations of current international standards. This has been confirmed by regulatory reviews and audits performed by the CNSC.	An Environmental Impact Study has been issued. It concluded that refurbishment and extension of plant operations are unlikely to cause any significant environmental effects (conventional or radiological). The actual Radiation Protection and Environmental Management programs meet all the requirements of current standards.
Safety Area: GLOBAL ASSESSMENT					
Overall Assessment Present an assessment of plant safety that takes into account all	- Annual Industry Report on the Operating Performance of Canadian NPPs - Action Items - Generic Action Items	No activities specific to the restart were required.	No activities specific to the restart were required.	No activities specific to the restart were required.	No activities specific to the restart were required.

PSR Safety Factor IAEA NS-G-2.10	Generic Licensing Requirement	Pickering A Restart	Bruce A Restart	Point Lepreau (PL) Refurbishment	Gentilly-2 (G2) Refurbishment
unresolved shortcomings, all corrective actions and/or safety improvements and the plants strengths identified in the overall review.					

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Annex 3.14.2: Generic Action Items

Descriptions of "safety issues" and "closure criteria" relevant to Generic Action Items (GAIs) are found in the Canadian 2nd Report on Nuclear Safety. Progress and updates are therefore the focus of this annex. There are currently 15 open GAIs; four were closed since the Canadian 2nd Report, and one new GAI was opened.

A. Continuing Generic Action Items

GAI 88G02 "Hydrogen Behaviour in CANDU Nuclear Generating Plants" - Evaluation and redesign of passive autocatalytic recombiners (PARS) are continuing. PARS were tested by two licensees and will be tested by the other two licensees. Results of early tests suggest that the self-start threshold of the PARS was higher when the PARS were located in areas of the containment that are not well ventilated. In parallel, the industry is proposing a rationale for addressing low-probability scenarios involving LOCA with impaired ECCS, as well as the corresponding methods and assumptions to estimate the source-term; the CNSC is evaluating this proposal.

GAI 90G02 "Core Cooling in the Absence of Forced Flow" - The position statement for this GAI was revised to reflect changing the completion date for the only licensee for which this GAI remains open. A specific analysis case for small LOCA was determined to require a change in the ECC trip setpoint.

GAI 91G01 "Post-Accident Filter Effectiveness" - Emergency filtered air discharge system (EFADS) filters and non-EFADS filters were assessed for three nuclear facilities operated by two licensees, and the results were submitted to CNSC. Work included identification of filters and systems involved as well as various relevant accident scenarios, determination of bounding conditions for filters and assessment of the filters' capability to perform under design conditions. Questions regarding the EQ of filters will be resolved through licensees' EQ Programs, while questions regarding hydrogen burn within filters will be addressed through GAI 88G02. Request for closure of this GAI is being followed up by the CNSC.

GAI 94G01 "Best Effort Analysis of ECCS Effectiveness" - This GAI was superseded by GAI 98G02.

GAI 94G02 "Impact of Fuel Bundle Condition on Reactor Safety" - This GAI was closed for two licensees. A closure request by another licensee is being followed up by the CNSC.

GAI 95G01 "Molten Fuel/Moderator Interaction" - The position statement for this GAI was revised and sent to licensees in 2002. Therefore, the safety issue and closure criteria are repeated below since they are different from those in the position statement submitted in the Canadian 2nd Report.

<u>SAFETY ISSUE</u> - Fuel melting may occur following a severe power-cooling mismatch in a single channel of a CANDU reactor. This may lead to the rupture of the fuel channel and subsequent ejection of molten fuel into the moderator. The resulting molten fuel/moderator interaction (MFMI) could cause damage to the shut-off rod guide tubes, and/or propagation of damage to other fuel channels and/or the calandria vessel.

Licensees' safety analyses indicated that MFMI would not cause significant in-core structure damage to alter the effectiveness of the shutdown systems, nor would it threaten the integrity of either the adjacent channels or the calandria vessel. The CNSC, however, indicated that there is inadequate experimental data to justify ruling out a potential steam explosion.

MFMI experiments, prototypic of CANDU geometries and conditions, are being performed to identify the predominant mode of interaction (free or forced) and to produce data for the validation of the model used in the safety analysis.

CLOSURE CRITERIA - Closure criteria were clarified in early 2003. Among these was the following criterion:

- Licensees must demonstrate whether the dominant mode of MFMI is free or forced.

Licensees are not expected to do any more as part of this GAI. Code validation is not a necessary criterion for closure of this GAI. If the mode of interaction is determined to be free, then a steam explosion is possible and the issue will have to be addressed separately. In the event that the experimental results are inconclusive, the measured pressure transient will serve as the primary tool for evaluating the safety margin or potential damage resulting from the MFMI, regardless of its mode.

PROGRESS - The experimental program is progressing. Dry corium melt tests were performed at the Argonne National Laboratory to develop a CANDU-typical corium mixture and to proof-test the proposed experimental technique to eject up to 25 kg of the molten mixture from a simulated CANDU fuel channel. Large-scale and separate-effects tests were performed including a corium-ejection test with a driving pressure of 10 MPa into air. Construction of a test facility that will be used for ejecting melt into a simulated moderator-filled calandria was completed at Chalk River Laboratories (CRL). Licensing of the facility and commissioning tests are underway.

GAI 95G02 "Pressure Tube Failure with Consequential Loss of Moderator" - The closure criteria for this GAI were revised in 2001 and are included in the next paragraph.

CLOSURE CRITERIA - To achieve closure, licensees must:

- demonstrate that the hydrogen mitigation measures are such that the integrity of the calandria and the containment are assured;
- submit proposals for a course of action that would result in the reduction of risk associated with such an event; and
- submit the following, in the event that cost-benefit arguments are used in support of the proposals mentioned in the second criterion: a) a description of the cost-benefit assessment process, b) the cost-benefit tools and associated documentation, c) the consequence assessment methodology, d) the consequence assessment results, e) an examination of the various options (e.g., design, procedural) for event mitigation, f) studies on pressure and calandria tube failures and end-fitting ejection, and g) the final cost-benefit analysis report.

PROGRESS - The industry submitted reports, including cost-benefit analyses, in support of closure of this GAI. These reports identified the replacement of calandria tubes with a stronger design as the best approach to reduce the risk and create a net benefit. The industry stated that the only practical time to replace calandria tubes is during a rehabilitation outage. The qualification of a new, stronger calandria-tube design is deferred until detailed planning and preparations are done for such an outage. Other measures, such as changes to the emergency water system, were proposed to mitigate the effects of the scenario. Evaluation of the industry's cost-benefit approach will be finalized after a guide for use of cost-benefit is issued by the CNSC.

GAI 95G04 "Positive Void Reactivity - Treatment in Large LOCA Analysis" - An independent expert panel (also relevant to GAI 99G02) made recommendations following a review of reactor physics uncertainties. The industry dispositioned these recommendations and proposed relevant R&D activities. The CNSC continues to review options to address remaining issues.

GAI 95G05 “Moderator Temperature Predictions” - Testing was completed at CRL. Validation of the MODTURC computer code continues.

GAI 98G01 “HT Pump Operation under Two-Phase Flow Conditions” - This GAI is now closed except for one licensee which must submit additional analytical results to confirm the integrity of the heat transport system under two-phase flow conditions.

GAI 98G02 “Validation of Computer Programs Used in Safety Analysis of Power Reactors” - This GAI was closed for three licensees and closure was requested by the fourth licensee.

GAI 99G01 “Quality Assurance of Safety Analysis” - The GAI was closed for one licensee in 2003. Closure for two other licensees will be considered following audits that also involve GAI 98G02. The decision by the fourth licensee to divest its safety analysis function has added a new dimension to the issue that is being considered by the CNSC via a special project.

GAI 99G02 “Replacement of Reactor Physics Computer Codes Used in Safety Analysis of CANDU Reactors” - Licensees continued with programs to replace reactor physics computer codes. A report from an independent expert panel (see GAI 95G04) addressed the acceptability of estimated uncertainties of key parameters predicted by the codes. Two licensees completed an agreed set of activities and declared that the new reactor physics toolset would be used for future accident analysis. The only adverse result was for design-basis large-break LOCA analysis due to differences between coolant-void reactivity and fuel-temperature reactivity feedbacks. Accordingly, changes were made to several operating limits at the reactors of two licensees (e.g., revised limits on channel and bundle power, RIH temperature, moderator and heat transport isotopics, and shutoff rod performance). Work is continuing on a second set of activities on code validation.

GAI 00G01 “Channel Voiding During a Large LOCA” - Although the position statement for this GAI was finalized in late 2001, there were no changes to the safety issue or the closure criteria from what was included in the Canadian 2nd Report. Channel voiding measurements were made using a neutron scatterometer, and code validation was performed. Important issues remain to be addressed, such as the treatment of the voiding rate uncertainty in the safety analysis and the appropriate scaling of the test results to reactor conditions.

B. New Generic Action Items (since the Canadian 2nd Report):

Item 01G01 “Fuel Management and Surveillance Software Upgrade” - This GAI was initiated as a follow-up to the closure of GAI 95G03. The GAI relates only to two licensees.

<u>SAFETY ISSUE</u> - Reactor physics safety limits that define the Safe Operating Envelope (SOE), such as channel and bundle power limits, are essentially based on analyses performed with a fuel management computer code. Recently, more rigorous scrutiny of the accuracy of methods, acceptance criteria, assumptions and results of safety analyses of various design-basis accidents led to imposing restrictions to operating parameters, including channel and bundle powers, and to the introduction of additional physics parameters for compliance purposes. This has enhanced the need for an improved analytical model validated over a broader range of applications and conditions, better-defined compliance allowances and more consistent procedures. Two main areas of improvement have been explicitly identified: i) code methodology, modelling and data, and ii) code validation. In addition, there are various issues related to the methodology used for deriving the compliance error allowances at 98% confidence level and plant-specific compliance procedures and practice. At issue are several areas, both in the compliance analyses and procedures, where, in the view of the CNSC, improvements are needed to ensure adequate

compliance with the OP&P's limits related to reactor physics parameters and reactor core status at various plants.

The CNSC's review of work done by one licensee to address closure criteria for GAI 95G03 identified several issues related to the adequacy of the method used in the fuel management and surveillance code and supporting validation process. In response, the licensee proposed a software upgrade program that incorporates specific elements related to software model improvement and validation, based on requirements in GAI 98G02 and GAI 99G02, as well as specific activities related to the methodology for deriving the compliance error allowances.

The CNSC has given increased attention to the level of accuracy of licensees' reactor-physics methods and codes, their validation, and the acceptability of allowances and assumptions used in safety analysis and compliance procedures. More restrictive operating conditions were implemented in recent years to compensate for reduction in safety margins for certain design-basis accidents. This has led to an increase in the significance of the impact of uncertainties related to computed-parameters for compliance with SOE limits.

The licensee framework for computer code validation has also evolved in recent years. A specific process for verification and validation of nuclear engineering software was implemented to ensure that all elements of a validation process planning conform with requirements of applicable higher level standards (such as CSA-N286.7-99 "Quality Assurance Manual for Analytical, Scientific and Design Computer Programs for Nuclear Power Plants", and the CNSC G-149 "Regulatory Guide for Computer Programs Used in Design and Safety Analyses of Nuclear Power Plants and Research Reactors").

<u>CLOSURE CRITERIA</u> - To achieve closure, licensees are required to undertake a structured program for reactor core surveillance that should cover the fuel management software upgrade and validation, as well as the validation and qualification of the error compliance methodology. The program should include the following:

- software upgrade to a level at least similar to the Industry Standard Toolset (IST) reactor physics code RFSP-IST, and in conformance with CSA Standard N286.7 and CNSC Regulatory Guide G-149;
- validation, verification and qualification for production use of the software, meeting the requirements in relevant licensee's governing QA process to ensure compliance with CSA Standard N286.7 and CNSC Regulatory Guide G-149;
- verification, validation and qualification of error compliance methodology and associated assessment database for the full range of computed parameters and applications;
- estimation of compliance uncertainties for computed parameters (the allowances should, at 98% confidence level, account for: i) error in total reactor power normalization, ii) error in code methodology and modelling, iii) error in measurements, and iv) xenon transients initiated by fuelling);
- implementation of a plant-specific monitoring program for periodic confirmation of accuracy of fuel management code predictions and compliance uncertainties for computed parameters to ensure operation of reactors is within SOE. The program should include periodic measurements and analyses with the fuel management code for the plant's actual conditions. The program should also address issues such as changes in reactivity devices' worth (for example: cobalt adjuster burnout), changes to the neutron overpower reference power shape, evaluation of aging effects on reactor physics calculations (impact of core and fuel channel geometry distortions on reference power shape and bundle and pin maximum powers) and effect of xenon transients initiated by fuelling.

<u>PROGRESS</u> - The program is expected to be completed by the end of 2004, and commensurate progress has been made so far. Two licensees submitted detailed work plans and schedules as well as semi-annual

progress reports. Work is divided into two phases: Phase I deals with modeling improvements to the SORO code, and Phase II deals with estimation of error allowances.

C. Recently Closed Generic Action Items:

During the reporting period, four industry-wide GAIs were closed. For a list of previously closed GAIs, please refer to the Canadian 2nd Report.

GAI 90G03 “Assurance of Continued Nuclear Generating Plant Safety” - This GAI was closed for all licensees with the understanding that assessment of aging issues in CANDU plants will continue under the compliance/inspection programs.

GAI 91G02 “Operation with a Flux Tilt” - This GAI dealt with the effect of perturbed flux shapes on the error allowance used to determine trip setpoints for regional overpower protection and neutron overpower protection.

GAI 95G03 “Compliance with Bundle and Channel Power Limits” - This GAI was concerned with the demonstration, via analysis, of compliance with the limits on bundle and channel powers specified in plant operating licences, as well as with the demonstration that the analytical results meet all relevant acceptance criteria for design-basis accidents. The GAI was closed for all licensees, and a new generic action item 01G01 was opened as a follow-up for two licensees.

GAI 96G01 “Fire Protection for CANDU NPPs” - This GAI had already been transferred to plant-specific action items for individual licensees, where applicable.

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Annex 3.14.3: Summary of Changes Resulting from Safety Monitoring and Assessment

This annex contains examples of specific licence conditions and regulatory actions, and corresponding undertakings or initiatives carried out by licensees in response to such CNSC regulatory activities. The list is not comprehensive; it only represents a fraction of a number of actions and licence conditions assigned by the CNSC. Some of the actions affected all NPPs in Canada, while other actions were issued to effect changes at a specific nuclear reactor unit.

A3.14.3.1 Licence Conditions and Actions Affecting all Licensees

1. Environmental Qualification

A licence condition was included in the NPP operating licences. This licence condition states that by a specific deadline "…*the licensee shall establish that all required systems, equipment, components, protective barriers and structures in the nuclear facility are qualified to perform their safety functions under the environmental conditions defined by the nuclear facility's design-basis accidents*." Licensees are working to meet this licence condition.

2. Fire Protection Upgrades

Licensees made a commitment to the CNSC to upgrade their fire protection systems. For example, new equipment has been installed to improve protection of the turbine generator, cable spreading rooms and computer rooms. Examples of licensees' activities relating to implementing such equipment are found in Annex 3.14.1, under Safety Factor 7: Hazard Analysis.

A3.14.3.2: Safety Assessments and Follow-up Actions Affecting Specific Nuclear Installations

DARLINGTON

1. Shutdown Trip Coverage for Loss of Single HT Pump

During analyses performed for updating the safety report in 1997, OPG identified a lack of shutdown trip coverage for loss of single heat transport (HT) pump events (which are a subset of Loss of Flow (LOF) events). The analyses identified trip coverage gaps in the primary and backup trip parameters on both shutdown systems for certain reactor operating states. As a result, OPG took immediate measures to limit prolonged reactor operation within certain operating states. In the short term, OPG devised, among other measures, a robust primary trip parameter on both shutdown systems. In addition, the four units at the Darlington site were de-rated to 98% full power (FP) until a permanent design solution had been identified and implemented. In 1998, OPG identified several design solutions and performed a feasibility study for each of the alternatives. The design, procurement, commissioning and other activities associated with the installation of a new trip parameter were completed in early 2003. Following the completion of permanent design changes to the shutdown systems, loss of single HT pump events were no longer considered an impediment to high power operation. (In an event reported in 2003, unit 2 tripped on HT delta-p after a bus trip took out one HT pump following a turbine trip, indicating that the new trip coverage worked as modified.) However, during this period, and following the completion of a project related to the reactor physics code replacement (see GAI 99G02 in Annex 3.14.2), another issue was identified that was related to the large LOCA (LLOCA) design basis accident analysis (which is explained in some detail in item 2 below) and has further delayed Darlington NPP to resume 100% FP.

2. LLOCA Trip Margin

In 2001, as part of a study performed under generic action item GAI 99G02 (see Annex 3.14.2), OPG discovered potential non-conservatism in the reactor physics simulation of the power pulse and predictions of fuel and fuel channel energy deposition. The discovery indicated reduced LLOCA safety margins when compared with previous results from licensing LLOCA analyses. Consequently, more restrictive operating and safety system performance limits were imposed in support of continued safe operation at 98% FP. Design changes, in conjunction with the new Shutdown System (SDS) LOF trip parameter mentioned in item 1 above, were implemented to the shutdown system software to reduce delay times. Later in 2002, and in support of returning the NPP to 100% FP operation, the licensee completed an extended licensing LLOCA analysis using new reactor physics codes that employ a Limit of Operation Envelope (LOE) methodology. Based on the aforementioned design changes and other changes in the NPP operating conditions due to the LOE safety analysis, the CNSC approved Darlington NPP to resume operation at 100% FP in early 2003. Consequently, OPG has proposed a comprehensive safety analysis to demonstrate LLOCA margins by using the BEAU methodology described in subsection 4.2.2. The licensee expects that the BEAU results would reduce the burden on operation due to unnecessarily limiting conservative assumptions in the safety analyses.

BRUCE B

Low void reactivity fuel project at Bruce Power
Bruce Power plans to refuel the Bruce B reactors with modified fuel containing slightly enriched uranium beginning in 2006. The Bruce B reactors are currently operating at 90% FP based on an operating limit imposed by the CNSC. This limitation was placed on Bruce Power when studies revealed that the shutdown systems may not provide sufficient safety margins for certain low probability accidents. The de-rating to 90% FP ensures that the necessary safety margin is maintained. In order to improve existing safety margins, and thereby provide the basis for restoring Bruce B reactors to 100% full reactor power, Bruce Power plans to replace the existing 37-element fuel bundles with low void reactivity (LVR) fuel designed by AECL. The LVR fuel uses a geometry (43-element bundle) that consists of an array of 42 fuel elements in 3 rings around a central element. In order to reduce the positive void reactivity effect associated with a large loss of coolant accident, the central element contains a neutron absorber (Dysprosium) mixed with natural uranium. All remaining elements of the bundle will contain slightly enriched uranium. The bundle geometry also features non-load bearing appendages aimed at promoting turbulence and coolant mixing between sub-channels; this results in increased thermalhydraulic margins. Bruce Power is planning to conduct a demonstration irradiation in 2004.

PICKERING

Focused Inspection Team in 2003
As part of its regulatory follow-up on significant events, the CNSC performed an independent in-depth inspection of the response of Pickering B plant to the August 14, 2003 loss of electricity grid event. A multidisciplinary inspection team, including an inspector from the USNRC, conducted an on-site review of the plant’s performance during the event, and also assessed the licensee’s analysis of the event and the consequent corrective actions. CNSC staff identified a number of safety significant findings, related both to system design and equipment conditions, in the electrical, emergency core coolant, fire water and service water systems, and has required the licensee to submit action plans to correct the identified deficiencies.

BRUCE A
Most of the CNSC’s regulatory actions on Bruce A were related to the restart of Units 3 and 4. Licensee responses, such as improving the Emergency Power Supply availability and the addition of a Secondary Control Area, are described in detail in Annex 3.14.1.

GENTILLY-2 AND POINT LEPREAU

Quality Assurance
This is an ongoing activity since the late 1990s for HQ and NBPN. Licence condition 3.4 currently includes a target date on which the two licensees shall implement a quality assurance program that conforms to the requirements of a set series of CSA Standards. HQ and NBPN are in the process of developing their QA programs. Progress is ongoing, and all indications are that HQ and NBPN will meet the deadline. It is the intent of CNSC staff to audit the programs once completed and implemented.

GENTILLY-2

1. Suspected Feeder IGSCC at a Weld
HQ advised the CNSC on July 2, 2003, of a possible feeder leak on feeder G-09 (outlet) in the north feeder cabinet. This is a straight piece of pipe, and not an elbow. The leak was identified as coming from a weld on the pipe, under a freezing jacket. Based on current information, this was a weld that had been repaired during the construction phase of the plant. Monitoring indicated that the leak rate was from 0.5 to 1 kg/hour. Initial analysis done by AECL seemed to indicate that the cracking (at the weld) is Intergranular Stress Corrosion Cracking (IGSCC), which was the same kind of degradation mechanism identified for the Point Lepreau feeder bends. HQ and AECL (also, the industry as a whole, through COG) are still in the process of determining the exact causes of the G-09 cracking.

HQ replaced the affected feeder pipe at the end of October 2003. In addition, and at the request of CNSC staff, HQ enlarged the scope of feeder inspections to include all feeder hub welds (repaired and non-repaired) considered significant for cracking. No additional cracked welds were found.

OPG, Bruce Power and NBPN were notified about the potential existence of IGSCC at repaired welds and were requested to provide information on: a) repaired welds on feeders, b) surveillance methods to ensure that IGSCC is not present, and c) any preventive or predictive measures to address this issue. All three licensees provided the requested information. Bruce Power reported that inspections were completed with no indication of IGSCC found in any unit. NBPN indicated its intention to meet with CNSC staff to discuss ongoing work and plans to manage the risk of IGSCC in feeder weld repairs. OPG indicated that their limits and leakage monitoring procedures are adequate to detect leaks in a timely manner. OPG inspected several hundred outlet feeder bends (cold rolled) and no cracks were detected. The program will be expanded to include other tight-radius bends with low bend angles. Weld repairs, where accessible, will be inspected in 2004. Darlington plans to implement improved feeder cabinet leak data analysis software in 2004. OPG is also assessing alternative leak detection concepts.

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Annex 3.14.4: Summary of CNSC Report Cards on NPPs' Programs and Performance

The CNSC uses five rating categories to assess the licensees' programs and performance in nine designated "safety areas". The definitions of the rating categories are contained in Table A3.14.4.1. The nine safety areas, associated programs and review factors used in the assessment are described in Table 3.14.14.2. While the rating scheme of the review factors of these two tables focus mainly on the regulatory requirements, performance expectations provide guidance and add completeness to the review process, always taking into account that licensees are free to propose alternate means for meeting these expectations. To provide guidance to CNSC staff on the application of the rating scheme, the ratings categories and their corresponding meaning as related to compliance with requirements and to meeting expectations are summarized in Table A3.14.4.3.

A summary of the rating of all Canadian NPPs for the years 2001, 2002 and 2003 is given in Table A3.14.4.4. This table includes detailed ratings for each of the safety areas of licensees' programs and their implementation. CNSC staff used this information and rated all Canadian NPPs during the reporting period at "B - Meets requirements". CNSC staff arrived at this position by considering each of the safety areas and the importance of the corresponding programs and their implementation to the overall performance of the plant. However, the following paragraphs shed some light on specific observations reported by CNSC staff on the information in Table A3.14.4.4.

<u>Bruce A and Bruce B</u>: During the reporting period, Bruce Power operated the four units of Bruce B and, in the latter part of 2003, returned to service Units 3 and 4 of Bruce A. Bruce Power currently operates as a six-unit organization, and, accordingly, all safety programs are generic to the six operating units. For 2003, Bruce Power's program descriptions and actual implementation of these programs met or exceeded the CNSC regulatory requirements in all safety areas. For the Radiation Protection safety area, a new expectation was introduced in 2003 to meet CSA standards for use of respirators. In 2003, CNSC staff's evaluation of Bruce Power's respiratory protection program found that it covered only non-radiological applications. In response, Bruce Power submitted a plan to revise its respiratory protection program to include respirators to protect against radiological hazards. For the Performance Assurance safety area, Bruce Power's improvements in the area of quality assurance resulted in meeting CNSC regulatory requirements for 2003. Bruce Power is currently considering the feasibility of restarting Units 1 and 2 of Bruce A.

<u>Darlington</u>: During the reporting period, OPG met or exceeded regulatory requirements in most of the safety areas. Operating Performance implementation improved from a "C – Below requirements" in 2001 to a "B – Meets requirements" in subsequent years. An independent review conducted in 2001 by CNSC staff showed that some weaknesses in several program areas were contributing to an increase in plant transients. In the Performance Assurance safety area, specific implementation deficiencies in quality assurance, human performance and training and certification of personnel continue to be under close scrutiny by CNSC staff. The licensee was unable to satisfy the requirements for QA as identified in the CSA standards when conducting maintenance or repair work on pressure retaining components and systems. Also, CNSC staff continue to monitor and evaluate the licensee's progress, which remained slower than anticipated, to establish SAT-based training programs for all operations and maintenance work groups. CNSC staff will use a variety of regulatory compliance activities to monitor and assess progress of the licensee in meeting requirements for the implementation of Performance Assurance programs. The radiation protection program at Darlington will be evaluated against a new expectation to meet CSA standards for use of respirators.

<u>Pickering A</u>: OPG met or exceeded regulatory requirements and expectations in most of the safety areas at Pickering A. However, within the performance assurance safety area, the implementation was rated "C – Below requirements". This resulted from the difficulty Pickering A had with the implementation of two

of the programs in this area, quality management and training. Difficulties experienced with the quality management program were related to the timely and effective implementation of corrective actions by the licensee in response to CNSC inspection findings. CNSC staff continues to monitor OPG's progress with an expected closure by mid-2004. As for training, the implementation status of the SAT does not meet CNSC staff expectations at this time, although improvements were observed in 2003 and the licensee continues to address the issues related to the transfer of examination certification of licensee personnel from the CNSC to licensees.

Pickering B: OPG met or exceeded regulatory requirements in all but two safety areas - operating performance and design and analysis. Within the operating performance safety area, the assigned rating was "C – Below requirements" because of the increasing occurrence of equipment problems that both initiate plant transients and challenge the plant's correct response to transients. Pickering B also experienced an increasing number of planned outage extensions caused by equipment problems. In August 2003, the loss of electricity grid event in Ontario and the Northeastern United States resulted in a serious process failure at two power reactor units. The CNSC performed a focused inspection to assess the adequacy of OPG's response and planned corrective actions for the design issues which contributed to plant problems during this event. This assessment resulted in a rating of "C – Below requirements" for the program and implementation of the design safety area, due to the significance of the design issues which need to be resolved. For the Radiation Protection safety area, a new expectation was introduced in 2002 to meet CSA standards for use of respirators. In late 2002, CNSC staff's evaluation of OPG's respiratory protection program found that it covered only non-radiological applications. In response, OPG submitted a plan to revise its respiratory protection program to include respirators to protect against radiological hazards.

Gentilly-2: HQ met or exceeded regulatory requirements in most of the safety areas during the reporting period. However, there were several programs or their implementation that CNSC staff rated as being "below CNSC requirements". The majority of these programs were improved during the latter part of the reporting period. For example, the environmental performance program was rated "C – Below requirements" for the first two years, but improvements to the program has elevated its rating to "B – Meets requirements". The most serious issue is the development and implementation of a quality assurance program that would meet the CSA standards. The licensee expended great effort in this area, but CNSC staff have concerns with the length of time required to achieve success. Consequently, a licence condition on quality assurance was added to the operating licence. HQ has made good progress towards meeting the deadline of October 31, 2004 imposed by this licence condition. For the Radiation Protection safety area, the radiation protection program at Gentilly-2 will be evaluated against a new expectation to meet CSA standards for use of respirators. The implementation portion was rated as "C – Below requirements" during the reporting period. This rating is based on weaknesses found during on-site evaluations, including procedural adherence and work related to the moderator system. CNSC staff will continue to monitor the licensee's progress in addressing these deficiencies.

Point Lepreau: NBPN met or exceeded CNSC requirements in most of the safety areas. However, in 2003, two programs and/or their implementation did not fully meet the CNSC's requirements, although NBPN undertook improvement initiatives. The most significant of these initiatives is the development and implementation of a quality assurance program that conforms to the requirements of relevant CSA standards. Progress has been made since 2000, but has been slower than expected. As a result, the target date for completion was pushed back to March 2005. NBPN currently reports progress on this initiative to the CNSC every six months. The other improvement initiative on the emergency preparedness program is progressing well. Emergency preparedness documents have been revised and submitted to the CNSC for review. In addition, the CNSC evaluated a full scale emergency response exercise conducted by NBPN during the latter part of 2003. The exercise helped validate emergency plans and procedures, and involved participants from many external organizations. The CNSC concluded that NBPN met CNSC requirements during this emergency response exercise. In 2003, the International Atomic Energy Agency (IAEA) had to verify the nuclear material in the spent fuel storage bays of Point Lepreau after electrical power to the IAEA-installed safeguards equipment was temporarily lost. This is why the rating of the safeguard implementation was reduced to “B - Meets requirements”. For the Radiation Protection safety area, a new expectation was introduced in 2003 to meet CSA standards for use of respirators. In 2003, CNSC staff’s evaluation of NBPN’s respiratory protection program found that it covered only non-radiological applications. In response, NBPN submitted a plan to revise its respiratory protection program to include respirators to protect against radiological hazards.

Table A3.14.4.1: List and Definitions of CNSC Rating Categories

A - Exceeds requirements
Assessment topics or programs meet and consistently exceed applicable CNSC requirements and performance expectations. Performance is stable or improving. Any problems or issues that arise are promptly addressed, such that they do not pose an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed.

B - Meets requirements
Assessment topics or programs meet the intent or objectives of CNSC requirements and performance expectations. There is only minor deviation from requirements or the expectations for the design and/or execution of the programs, but these deviations do not represent an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. That is, there is some slippage with respect to the requirements and expectations for program design and execution. However, those issues are considered to pose a low risk to the achievement of regulatory performance requirements and expectations of the CNSC.

C - Below requirements
Performance deteriorates and falls below expectations, or assessment topics or programs deviate from the intent or objectives of CNSC requirements, to the extent that there is a moderate risk that the programs will ultimately fail to achieve expectations for the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. Although the risk of failing to meet regulatory requirements in the short term remains low, improvements in performance or programs are required to address identified weaknesses. The licensee or applicant has taken, or is taking appropriate action.

D - Significantly below requirements
Assessment topics or programs are significantly below requirements, or there is evidence of continued poor performance, to the extent that whole programs are undermined. This area is compromised. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. Issues are not being addressed effectively by the licensee or applicant. The licensee or applicant has neither taken appropriate compensating measures nor provided an alternative plan of action.

E - Unacceptable
Evidence of either an absence, total inadequacy, breakdown, or loss of control of an assessment topic or a program. There is a very high probability of an unreasonable risk to the maintenance of health, safety, security, environmental protection, or conformance with international obligations to which Canada has agreed. An appropriate regulatory response, such as an order or restrictive licensing action has been or is being implemented to rectify the situation.

Table A3.14.4.2 CNSC Safety Areas, Programs, Review Topics and Performance Measures used in Rating Canadian NPP Performance

Safety Area	Programs	Review Topics
1. Operating Performance	1. Organization and Plant Management	• Global Program Integration • Financial Guarantees • Review of Station Transients • Overall Plant Status and Material Condition • Reporting Requirements (Self-assessment and Records) • Public Information Program
	2. Operations	• Field Inspections • Control Room Inspections • Procedural Adherence • Communications • Change Control (Approvals Process, Configuration Management) • Outage Management • Plant Walk downs (Fire Protection, Environmental Qualification, Emergency Preparedness, Configuration Management, Emergency Core Cooling Flow Path, Seismic, etc.) • Operator Certifications (Internal Certification Process, Records)
	3. Occupational Health and Safety (Non-radiological)	• Industrial Health and Safety Standards • Hazardous Materials Management • Worker Health and Safety Committees • Work Planning ,Work Practices and Protection, Reporting and Records Other Government Programs or Requirements
2. Performance Assurance	1. Quality Management	• Program Definition (Quality Management Manual, Policies, Procedures) • Identification and Resolution of Problems • Management Self-Assessments • Work Planning, Change Control, Documentation Control, Control of Items Processes and Practices, Records • Use of Experience (OPEX) • Organization Design, Departmental Roles and Responsibilities, Communication, Accountability
	2. Human Factors	• Human System Interface • Fitness for Duty • Work Environment • Staffing (Process, Levels) • Procedures and Job Aids, Maintenance of Procedures • Organizational Factors including Safety Culture
	3. Training	• Personnel Qualifications, Capabilities • Training Processes and Procedures • Certified Staff Training (Examination/Standards/Procedures) • Non-Certified Staff Training • Facilities and Support Services (Simulator/Aids/Classroom)

Safety Area	Programs	Review Topics
3. Design and Analysis	1. Safety Analysis	• Safety Report Update • Licensing Basis (Assumptions) • Safe Operating Envelope (Operating Policies and Principles) • Methodology and Model Verification and Validation • Aging (Impact on Safety Analysis)
	2. Safety Issues	• Research and Incorporation of New Knowledge • Action Item Placement and Management (Generic, Site Specific) • Hazard Analyses (Internal, External, Fire Hazard Assessment) • Accident Mitigation and Management
	3. Design	• Description of Plant Design (Documentation of Design Basis, System Classification, Configuration Management) • Fire Protection • Design Change Projects (Safety Enhancements, Links to Events, Corrective Actions, OPEX, Human Factors)
4. Equipment Fitness for Service	1. Maintenance	• Work Control and Conduct of Maintenance (Permits and Procedures) • Procedural Adherence (Procedures and Job Aids) • Planning (Maintenance Activities and Backlog Reduction, Corrective Maintenance, Preventive Maintenance) • Surveillance and Inspection • Plant Life Management (Aging/Obsolescence) • Facilities, Equipment and Materials • Stores and Warehouses • Configuration Management
	2. Structural Integrity	• Pressure Retaining Components • In Service Inspection • Fitness for Service Programs
	3. Reliability	• Probabilistic Risk Assessment, Models and Methodology • System Unavailability Performance
	4. Equipment Qualification	• Environmental • Seismic • Fire Protection • Quality Level • Electronic/Magnetic Interference • Chemistry Control
5. Emergency Preparedness	1. Emergency Preparedness	• Emergency Response • Consolidated Emergency Plan (Fire Response and Mitigation Considerations, Security, Other Events) • Emergency Response Training Exercises • Emergency Response Facilities and Procedures

Safety Area	Programs	Review Topics
6. Environmental Performance	1. Environmental Management Systems	• Environmental Protection Systems • Emissions Reduction • Pollution Prevention
	2. Effluent and Environmental Monitoring	• Contaminated Land • Hazardous Materials • Waste Minimization and Forecasting • Releases of Nuclear and Hazardous Substances • Review of Unplanned Releases • Ecological Risk Assessment
7. Radiation Protection	1. Personnel Exposure	• Radiation Exposure Control (ALARA, Dose Control during Outages) • Action Levels • Contamination Control
	2. Plant Waste Management	• Inventory of Nuclear Substances • Waste Processing and Storage • Waste Transportation and Disposal
8. Site Security	1. Site Security	• Facilities and Equipment • Access Control • Site Security Drills
9. Safeguards	1. Safeguards	• Communication Protocol • Obligations • Reporting and Records • Facilities and Equipment

Table A3.14.4.3: Guidance to Rating and Corresponding Possible CNSC Response and Actions

Rating	Possible CNSC Regulatory Response and Actions
A - Exceeds requirements	No special CNSC compliance activities will typically be required. Usual compliance program will be applied.
B - Meets requirements	CNSC compliance activities can typically include providing additional information and recommendations to promote better compliance or to suggest improvements. Deviations in programs or gaps in performance do not warrant special compliance activities.
C - Below requirements	CNSC compliance activities can typically include providing further information to promote compliance, identifying issues to be followed up by CNSC staff in subsequent focused compliance reviews and inspections, and issuing specific requests and action notices with clear objectives and time frames to be met. Consideration may also be given to recommending the addition of licence conditions to address the identified deficiencies.
D - Significantly below requirements	CNSC compliance activities can typically include progressively more stringent enforcement actions, recommending licensing action to add more restrictive licence conditions and, where conditions warrant, issuing of an order.
E - Unacceptable	Depending on the nature of the risk and topic, CNSC compliance activities can typically involve progressively more stringent enforcement action, including formal investigation for the purpose of considering prosecution, as well as recommending licensing action to add more restrictive licence conditions or, where conditions warrant, the issuing of an order to take remedial action or to suspend activities.

Table A3.14.4.4: Summary of Report Cards for Canadian Licensees' Programs (P) and Implementation (I) for the years 2001, 2002 and 2003

		Bruce A			Bruce B			Darlington			Pickering A			Pickering B			Gentilly 2			Point Lepreau		
	Year	'01	'02	'03	'01	'02	'03	'01	'02	'03	'01	'02	'03	'01	'02	'03	'01	'02	'03	'01	'02	'03
Safety Area																						
Operating	**P**	-	B	B	B	B	B	B	B	B	-	B	B	B	B	B	B	B	B	B	B	B
Performance	**I**	-	B	B	B	B	B	C	B	B	-	B	B	C	B	C	B	B	B	B	B	B
Performance	**P**	-	B	B	B	B	B	B	B	B	-	B	B	B	B	B	C	C	C	C	C	C
Assurance	**I**	-	C	B	C	C	B	C	C	C	-	B	C	C	C	B	C	C	C	C	C	C
Design &	**P**	-	B	B	B	B	B	B	B	B	B	B	B	B	B	C	B	B	B	B	B	B
Analysis	**I**	-	B	B	B	B	B	B	B	B	B	B	B	B	B	C	B	B	B	B	B	B
Equipment	**P**	-	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Fitness for Service	**I**	-	C	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Emergency	**P**	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	A	A
Preparedness	**I**	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B	C	C
Environmental	**P**	B	B	B	B	B	B	C	B	B	B	B	B	B	B	B	C	B	B	C	B	B
Performance	**I**	A	B	B	A	B	B	A	B	B	A	B	B	A	B	B	A	B	B	A	B	B
Radiation	**P**	A	A	B	A	A	B	A	A	A	A	A	B	A	A	B	A	A	A	A	A	B
Protection	**I**	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	C	C	B	B	B
Site	**P**	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Security	**I**	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Safeguards	**P**	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
	I	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	B

Legend

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

*	P	Program
**	I	Implementation
Year	'01, '02, '03	the years 2001, 2002, and 2003

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Annex 3.15.1: Doses to Personnel at Canadian NPPs

The CNSC *Radiation Protection Regulations*, issued in May 2000, include the 1990 recommendations of the International Commission on Radiological Protection. Workers at Canadian NPPs are restricted by dose limits of 50 mSv in any one year and 100 mSv in a five-year period. In addition, Canadian licensees must ensure that all doses are 'As Low As Reasonably Achievable, social and economic factors being taken into account' (the ALARA principle). Radiation dose is assured to be ALARA through the implementation of:

- management control over work practices;
- personnel qualification and training;
- control of occupational and public exposure to radiation; and
- planning for unusual situations.

Nuclear energy workers must be monitored for radiation exposure through a CNSC licensed dosimetry service. Dosimetry services are licensed by the CNSC according to stringent accuracy, precision and quality assurance criteria. Occupational dose results are submitted by the dosimetry service on a quarterly basis to the Canadian National Dose Registry (NDR), which is maintained by Health Canada.

The data provided by the NDR in Table A3.15.1 present the average annual worker dose, the collective dose and the maximum worker dose at Canadian nuclear power plants for the period of 1997-2002. As indicated, no worker has exceeded the annual dose limit of 50 mSv. In addition, although not indicated in the table, no worker has exceeded the five-year dose limit of 100 mSv.

Table A3.15.1: Occupational Dose Summary from 1997 to 2002

	Year	**Average Dose*** (mSv)	**Collective Dose** Person-Sievert	**Maximum Individual Dose** (mSv)
Bruce A	1997	0.93	3.05	19.48
	1998	0.39	0.95	18.41
	1999	0.10	0.33	7.77
	2000	0.09	0.26	6.57
	2001	0.16	0.96	9.30
	2002	0.62	3.38	21.88
Bruce B	1997	0.90	1.64	21.85
	1998	1.24	3.03	19.26
	1999	0.96	4.00	19.31
	2000	1.13	4.71	19.03
	2001	0.67	5.53	24.13
	2002	0.72	3.62	17.03
Darlington	1997	0.45	0.97	9.3
	1998	0.36	0.93	8.03
	1999	0.66	2.27	12.98
	2000	0.52	1.69	10.21
	2001	0.52	2.13	12.31
	2002	0.47	1.98	10.92
Gentilly-2	1997	1.69	1.92	19.34

	1998	1.44	1.73	18.06
	1999	0.76	1.79	17.42
	2000	0.45	1.14	14.73
	2001	0.52	1.18	17.33
	2002	0.66	1.52	15.54
Pickering A & B	1997	0.70	3.45	22.26
	1998	0.60	2.63	12.61
	1999	0.60	2.66	13.57
	2000	0.55	2.67	13.20
	2001	0.62	5.14	14.33
	2002	0.62	5.72	17.23
Point Lepreau	1997	1.17	1.32	30.63
	1998	0.66	0.81	14.01
	1999	0.98	1.29	15.13
	2000	0.52	0.85	14.25
	2001	0.47	0.62	12.02
	2002	0.70	1.26	15.17

* Dose means Effective Dose

Annex 3.15.2: Radiological Emissions from Canadian NPPs

All nuclear power plants release insignificant quantities of radioactive materials in a controlled manner into both the atmosphere (as gaseous effluents) and adjoining water bodies (as liquid effluents). This annex reports the magnitude of these releases for each operating NPP in Canada for three years (2000 to 2002). This annex also indicates how these releases compare with the limits imposed by the CNSC. The data show that, in almost all the cases, the levels of gaseous and liquid effluents from all currently-operating NPPs are below 1% of the values authorized by the CNSC.

Radioactive material released into the environment through gaseous and liquid effluents from NPPs can result in radiation doses to members of the public through direct irradiation. Such doses are subject to statutory dose limits for members of the public, which are set out in the CNSC *Radiation Protection Regulations*. For example, the regulatory limit for the effective dose is 1 mSv.

The doses received by members of the public from routine releases from NPPs are too low to measure directly. Therefore, to ensure that the public dose limit is not exceeded, the CNSC restricts the amount of radioactive materials that may be released by licensees. These effluent limits are derived from the public dose limit and are referred to as "derived release limits" (DRLs). In addition, the industry sets operating targets that are a small percentage of the derived release limits. These targets are based on the ALARA principle. Targets are unique to each facility depending on the factors that exist at each one.

As methods of calculating DRLs become more sophisticated, it becomes necessary for licensees to revise their DRLs. At the same time, licensees review the assumptions affecting the exposure of critical groups; for example, location and lifestyle habits of critical groups and the location of dairy farms. In addition, licensees may use more site-specific data obtained from their routine environmental monitoring programs, such as liquid dispersion factors or surveys of the local population. The net effect of these changes on the methodology for calculating DRLs has been that some limits increased while others decreased, depending on the relative importance of the various pathways. As new information on dose calculation methods or parameters becomes available, the DRLs may require subsequent revisions. In addition, since the DRLs are based on the regulatory public dose limit, changes in the regulatory limits may also produce changes in the DRLs.

The various DRLs for Canadian NPPs, as well as the actual gaseous and liquid effluent releases from these NPPs, are included in Tables A3.15.2.1 and A3.15.2.2. These tables indicate that the releases are, in the majority of cases, below 1% of the DRLs for the corresponding NPPs.

Table A3.15.2.1 Gaseous Effluent Release from Canadian NPPs (2000 to 2002)

	Tritium Oxide (TBq)	Carbon-14 (TBq)	Nobel Gases (TBq-Mev)	Iodine-131 (TBq)	Particulates (TBq)
Bruce A (see note 1)					
DRL, 2000	*3.8 E05*	*2.8 E03*	*2.5 E05*	*1.2 E00*	*2.7 E00*
Since 2001	*8.8 E04*	*5.7 E02*	*5.0 E04*	*1.2 E00*	*2.1 E00*
2000	2.1 E 02	3.5 E-01	1.1 E01	1.2 E-5	6.1 E-06
2001	2.3 E02	3.9 E-01	NA*	NA	4.1 E-06
2002	1.5 E02	3.9 E-01	NA	NA	4.7 E-06
Bruce B (see note 1)					
DRL, 2000	*4.7 E05*	*3.0 E03*	*6.1 E05*	*1.3 E00*	*4.8 E00*
Since 2001	*9.3 E04*	*6.0 E02*	*1.2 E05*	*1.3 E00*	*2.5 E00*
2000	4.9 E02	4.1 E00	7.2 E01	5.5 E-05	7.9 E-05
2001	4.2 E02	2.7 E00	6.1 E01	2.8 E-05	1.4 E-04
2002	4.3 E02	2.1 E00	5.6 E01	4.9 E-05	1.1 E-04
Darlington (see note 1)					
DRL, 2000	*2.1 E05*	*1.4 E03*	*2.1 E05*	*6.0 E-01*	*4.4 E00*
Since 2001	*4.6 E04*	*1.5 E02*	*3.1 E04*	*3.3 E-01*	*9.4 E-01*
2000	2.3 E02	2.8 E00	1.5 E02	7.5 E-05	8.6 E-05
2001	2.4 E02	2.6 E00	1.8 E01	1.3 E-04	5.6 E-05
2002	1.9 E02	2.8 E00	1.5 E01	1.5 E-04	8.7 E-05
Gentilly					
DRL	*4.4 E05*	*9.1 E02*	*1.7 E05*	*1.3 E00*	*1.9 E00*
2000	2.5 E02	2.3 E-01	2.6 E00	6.4 E-08	9.0 E-06
2001	1.9 E02	4.0 E-01	1.9 E00	ND	8.3 E-06
2002	1.8 E02	3.7 E-01	6.9 E-01	1.4 E-07	5.0 E-06
Pickering A (see note 1)					
DRL, 2000	*3.4 E05*	*8.8 E03*	*8.3 E04*	*2.4 E-00*	*5.0 E00*
Since 2001	*7.0 E04*	*1.8 E03*	*1.7 E04*	*2.2 E-00*	*1.2 E-00*
2000	1.8 E02	1.9 E-01	2.7 E02	6.7 E-05	3.5 E-04
2001	3.1 E02	1.6 E-01	2.8 E02	7.8 E-05	3.5 E-04
2002	2.3 E02	1.9 E-01	2.7 E02	6.7 E-05	3.6 E-04
Pickering B (see note 1)					
DRL, 2000	*3.4 E05*	*8.8 E03*	*8.3 E04*	*2.4 E00*	*5.0 E00*
Since 2001	*7.0 E04*	*1.8 E03*	*1.7 E04*	*2.2 E00*	*1.2 E00*
2000	2.7 E02	1.1 E01	2.1 E02	9.8 E-05	2.4 E-05
2001	2.7 E02	6.3 E00	2.1 E02	1.0 E-04	2.6 E-05
2002	2.8 E02	1.8 E00	2.0 E02	9.8 E-05	2.0 E-05
Point Lepreau					
DRL	*4.3 E05*	*3.3 E03*	*7.3 E04*	*9.9 E00*	*5.2 E00*
2000	1.3 E02	2.3 E-01	5.0 E00	ND**	1.1 E-06
2001	1.4 E02	2.2 E-01	5.9 E00	ND	ND
2002	1.3 E02	2.9 E-01	3.2 E00	ND	ND

Note 1: Since 2001, the DRLs have been reported by OPG and Bruce Power as interim DRLs. They were revised in 2001 mainly in response to changes in the public dose limit. They will be replaced when a more comprehensive revision has been completed.

* NA Not Applicable (Note: In 2000, OPG shut down all non-contaminated stack monitors and all contaminated stack noble gas and iodine monitors at Bruce A)

** ND Not Detected

Table A3.15.2.2: Liquid Effluent Release from Canadian NPPs (2000 to 2002)

	Tritium Oxide (TBq)	Gross Beta-Gamma (TBq)	Carbon-14 (TBq)
Bruce A			
DRL, Until 2000 *Since 2001*	*1.7 E06* *4.5 E04*	*2.0 E01* *5.8 E-01*	*4.5 E02* *1.1 E01*
2000	9.0 E00	1.0 E-3	2.4 E-02
2001	1.3 E01	7.0 E-4	6.4 E-03
2002	6.4 E01	8.1 E-4	1.4 E-03
Bruce B			
DRL, Until 2000 *Since 2001*	*3.0 E06* *6.0 E05*	*2.3 E01* *4.9 E00*	*4.8 E02* *9.1 E01*
2000	2.7 E02	1.7 E-03	5.2 E-03
2001	1.5 E02	2.4 E-03	3.1 E-03
2002	3.5 E02	3.0 E-03	7.1 E-03
Darlington			
DRL, Until 2000 *Since 2001*	*5.3 E06* *8.8 E05*	*1.3 E02* *2.6 E01*	*3.2 E03* *6.0 E02*
2000	1.1 E02	1.3 E-02	2.8 E-03
2001	9.4 E01	5.6 E-03	3.0 E-03
2002	6.9 E01	8.5 E-03	1.7 E-03
Gentilly			
DRL	*1.2 E06*	*5.3 E00*	*1.0 E02*
2000	3.4 E02	9.4 E-04	3.2 E-02
2001	4.5 E02	1.2 E-03	3.4 E-02
2002	5.0 E02	1.3 E-03	2.6 E-02
Pickering A			
DRL, Until 2000 *Since 2001*	*8.3 E05* *1.7 E05*	*9.7 E00* *2.0 E00*	*Note 1*
2000	1.1 E02	2.9 E-03	Note 1
2001	1.3 E02	2.1 E-03	Note 1
2002	7.7 E01	2.9 E-03	Note 1
Pickering B			
DRL, Until 2000 *Since 2001*	*8.3 E05* *1.7 E05*	*9.7 E00* *2.0 E00*	*1.4 E02* *2.6 E01*
2000	1.1 E02	1.3 E-02	7.3 E-03
2001	2.0 E02	1.1 E-02	3.3 E-03
2002	2.1 E02	1.4 E-02	1.5 E-03
Point Lepreau			
DRL	*1.6 E07*	*1.6 E01*	*3.0 E02*
2000	9.6 E01	1.2 E-03	1.8 E-03
2001	1.5 E02	1.3 E-03	2.8 E-03
2002	1.4 E02	3.0 E-03	3.4 E-03

Note 1: Since 1999, carbon-14 releases in liquid effluent from Pickering A have been reported in the carbon-14 liquid release data for Pickering B.