Canada's Nuclear Regulator

Regulatory Oversight Report for Canadian Nuclear Power Plants: 2014

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Regulatory Oversight Report for Canadian Nuclear Power Plants: 2014

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Cover images: Canadian nuclear power plants

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

Executive summary

Each year, the Canadian Nuclear Safety Commission (CNSC) produces a report on the safety performance of Canada's nuclear power plants (NPPs). *Regulatory Oversight Report for Canadian Nuclear Power Plants: 2014* (the 2014 NPP Report), provides the CNSC staff's assessment of the Canadian nuclear power industry's safety performance during 2014 and details the progress of regulatory issues and initiatives up to April 30, 2015.

In 2014:

- Six NPPs had operating licences
- Nineteen reactor units were operational
- Gentilly-2 was transitioning to safe storage throughout the year and completed the transition on December 2, 2014
- Pickering Units 2 and 3 remained in safe storage, consistent with previous years, since they were defuelled in 2008

Overall performance highlights

Through site inspections, reviews and assessments, CNSC staff concluded that the NPPs operated safely during 2014. The evaluations of all findings for the safety and control areas (SCAs) show that, overall, NPP licensees made adequate provisions for the protection of the health, safety and security of persons and the environment from the use of nuclear energy, and took the measures required to implement Canada's international obligations.

The following observations support the conclusion of safe operation:

- There were no serious process failures at the NPPs
- No member of the public received a radiation dose that exceeded the regulatory limit
- No worker at any NPP received a radiation dose that exceeded the regulatory limits
- The frequency and severity of non-radiological injuries to workers were minimal
- No radiological releases to the environment from the stations exceeded the regulatory limits
- Licensees complied with licence conditions concerning Canada's international obligations
- No NPP events, above level 0 on the International Nuclear and Radiological Event Scale (INES), were reported to the International Atomic Energy Agency (IAEA)

Table 1 summarizes the 2014 ratings for Canada's NPPs. This table presents the SCAs for each station, the industry averages, and the integrated plant ratings that gauge a plant's overall safety performance. The rating categories are "fully satisfactory" (FS), "satisfactory" (SA), "below expectations" (BE) and "unacceptable" (UA). A rating of "satisfactory" indicates that the licensee's safety and control measures are effective, while a "fully satisfactory" indicates they are highly effective. An SCA rating of "below expectations" indicates the safety and control measures are marginally ineffective, while "unacceptable" indicates the safety and control measures are significantly ineffective.

All NPPs received SCA ratings of either "fully satisfactory" or "satisfactory". There were 14 "fully satisfactory" ratings across the stations – a net increase of three in comparison to 2013. Improvements resulted in increases in the safety performance ratings for Bruce B in operating

performance to "fully satisfactory" and for Bruce A and B and Darlington in waste management to "fully satisfactory". The conventional health and safety rating for Darlington for 2014 returned to "satisfactory" from "fully satisfactory".

NPP ratings are based on findings from inspections, desktop reviews and other compliance verification activities conducted by CNSC staff. For the first time since the SCA framework was introduced in 2010, there were no medium- or higher-rated findings assessed for the licensees. This outcome reflects the continuous improvements being implemented by NPP licensees.

The industry average was "satisfactory" for 11 SCAs and "fully satisfactory" for three SCAs, an increase of one "fully satisfactory" (in waste management) in comparison to 2013. The safety performance ratings of "fully satisfactory" for conventional health and safety, and security remained unchanged from 2013.

The integrated plant ratings in 2014 were "fully satisfactory" for Darlington and Bruce B and "satisfactory" for all other stations. The change in comparison to the 2013 integrated plant ratings is that Bruce B has improved to "fully satisfactory". Darlington has remained at "fully satisfactory", the same rating as it achieved in 2013. None of the plants received an integrated plant rating of "below expectations" or "unacceptable".

Table 1: Canadian nuclear power plant safety performance ratings for 2014

Safety and control area	Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
Management system	SA	SA	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA	SA	SA
Operating performance	SA	FS	FS	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA	SA	SA
Radiation protection	SA	SA	FS	FS	SA	SA	SA
Conventional health and safety	FS	FS	SA	SA	SA	FS	FS
Environmental protection	SA	SA	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA	SA	SA
Waste management	FS	FS	FS	SA	SA	SA	FS
Security	FS	FS	FS	FS	SA	SA	FS
Safeguards and non-proliferation	SA	SA	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA	SA	SA
Integrated plant rating	SA	FS	FS	SA	SA	SA	SA

Performance highlights of each NPP

Bruce A and B

The 2014 integrated plant rating for Bruce A was "satisfactory", which is unchanged from 2013;

for Bruce B the rating was "fully satisfactory", which is an improvement from "satisfactory" in 2013.

While most SCA ratings were "satisfactory", the CNSC noted "fully satisfactory" performance for Bruce A in three areas and for Bruce B in four areas as shown:

Bruce A

- conventional health and safety
- waste management
- security

Bruce B

- operating performance
- conventional health and safety
- waste management
- security

These SCA ratings were unchanged from 2013 for conventional health and safety, and security. Improvements were noted in waste management for both Bruce A and B in comparison to 2013.

In addition, the operating performance rating determined by CNSC staff for Bruce B for 2014 improved to "fully satisfactory" from "satisfactory".

Operating performance at Bruce B was highly effective, and the station had no unplanned trips during the year. Bruce Power's staff adhered to their station procedures and operated the stations within their safe operating boundaries.

In March 2014, Bruce Power applied for, and the Commission approved, an amendment of the operating licences until May 31, 2015, in order to facilitate an appropriate level of participation in the public hearing process. The two-part public hearing for the Bruce A and B licence renewal was held in February and April 2015. On May 27, 2015, the Commission renewed the operating licences issued to Bruce Power as a single licence for both Bruce A and B, valid from June 1, 2015 until May 31, 2020.

In September 2014, the Commission authorized Bruce Power to operate Bruce B Units 5 and 6 beyond 210,000 equivalent full power hours (EFPH), up to a maximum of 245,000 EFPH. In its May 2015 licence renewal decision, the Commission authorized the operation of Bruce A and B, Units 1 to 8 up to a maximum of 247,000 EFPH.

Darlington

The 2014 integrated plant rating for Darlington was "fully satisfactory", which is unchanged from 2013.

While most SCA ratings were "satisfactory", CNSC staff noted "fully satisfactory" performance in the following areas:

- operating performance
- radiation protection
- waste management
- security

CNSC staff noted that, regarding the four SCAs above, the waste management rating had improved from "satisfactory" in 2013 to "fully satisfactory" in 2014 and the remaining three were unchanged from the previous year. As well, the conventional health and safety rating determined by CNSC staff for Darlington for 2014 returned to "satisfactory" from "fully satisfactory".

Ontario Power Generation Inc. (OPG) completed the implementation of changes to the organizational structure and management system at Darlington as part of OPG's adoption of a centre-led matrix organization model. OPG made these changes through its business transformation initiatives. CNSC staff noted no negative impact on plant safety due to the changes.

OPG's radiation protection program at Darlington continued to be fully satisfactory and initiatives have been implemented to ensure the continuous improvement of its program. Radiation protection at Darlington includes a highly effective as low as reasonably achievable (ALARA) program, which is based on industry best practices.

OPG was involved in the major joint nuclear emergency response exercise called Unified Response and held at Darlington in 2014. The exercise involved more than 50 offsite agencies, including the CNSC, and spanned three days (May 26 to 28, 2014). This exercise allowed emergency response organizations the opportunity to test and make improvements to their capabilities. The exercise was a success and provided valuable lessons learned and experiences for participants.

In June 2014, OPG applied for an amendment of the licence period until December 31, 2015 in order to allow sufficient time to prepare additional material for the upcoming licence renewal hearing and to allow the public adequate time to review this additional material. The Commission approved this amendment in July 2014. The two-part public hearing for the Darlington licence renewal is scheduled for August and November 2015.

Pickering

The 2014 integrated plant rating for Pickering was "satisfactory", which is unchanged from 2013.

While most SCA ratings were "satisfactory", the CNSC noted "fully satisfactory" performance in two areas:

- radiation protection
- security

CNSC staff noted that the SCA ratings for Pickering were unchanged from 2013.

OPG's radiation protection program at Pickering continued to be fully satisfactory and initiatives have been implemented to ensure the continuous improvement of the program. Radiation protection at Pickering includes a highly effective ALARA program that is based on industry best practices.

In June 2014, the Commission removed a regulatory hold point prohibiting operation of Pickering beyond 210,000 EFPH, which is the original assumed design life of the pressure tubes. In its decision, the Commission allowed OPG to continue operating Pickering up to 247,000 EFPH.

In its 2014 decision, the Commission also required increased monitoring, inspection and reporting by OPG and CNSC staff on the operation of the Pickering reactor units. Annual updates regarding enhancements of OPG's aging management program, status of pressure tubes, feeder pipes and other safety issues of the facility would be made through NPP reports. Furthermore, the Commission expected the NPP report to include the status of additional Fukushima Daiichi-related actions and improvements identified through the probabilistic safety assessment (PSA), as well as a clear timeline for the development and implementation of whole-site based safety goals and PSA methodology. In accordance with the requirements of the 2014 decision, OPG submitted

an aging management plan and a detailed risk improvement plan in August 2014 and an update in February 2015. CNSC staff reviewed these submissions and were satisfied with the current status of fitness for service of major components at Pickering. Additionally, CNSC staff were satisfied with the current status of the implementation of the risk improvement plan and the updated timeline for completing the remaining tasks.

OPG continues with planning and implementing measures to ensure safe operation of Pickering to the end of commercial operation. This is being done through OPG's continued operations plan and the sustainable operations plan. Particular focus areas include the periodic inspection program and the integrated aging management program as the Pickering units approach the end of commercial operation. In 2014, OPG informed CNSC staff that the permanent shutdown dates for the Pickering units have not yet been determined. OPG will formally communicate to the CNSC its plan for the end of commercial operation of Pickering by June 30, 2017, in accordance with the Pickering operating licence. Through increased inspections, CNSC staff are satisfied that OPG is adhering to its aging management program as submitted to the Commission and that safety and control measures are in place for the continued safe operation of Pickering while the NPP approaches the end of commercial operation.

Gentilly-2

The 2014 integrated plant rating for Gentilly-2 was "satisfactory", which is unchanged from 2013.

CNSC staff noted that all SCA ratings were "satisfactory". During 2014, Hydro-Québec completed the transition activities to a safe shutdown state following the shutdown of the plant at the end of 2012. The plant reached the safe shutdown state on December 2, 2014. Stabilization operations and activities were conducted during 2014 to transition Gentilly-2 to a safe storage state, with all irradiated fuel stored in the irradiated fuel bay and all main station systems no longer in service drained, dried, and placed in a safe layup state.

The CNSC site office at Gentilly-2 was closed in 2014 since direct regulatory oversight at the site was no longer needed, given its shutdown state. Inspections of Gentilly-2 are now conducted by CNSC staff from the Ottawa office.

The Commission amended the operating licence for Gentilly-2 in July 2014 to better align its requirements with the stabilization activities taking place at Gentilly-2 and with the state of the station systems and equipment. The licence expires in 2016 and CNSC and Hydro-Québec staff have begun the preparatory work and activities required for the renewal of the Gentilly-2 licence.

As a result of the reactor shutdown, Hydro-Québec must submit a revision to its decommissioning plan and the related financial guarantee for Gentilly-2. These revisions were submitted to CNSC staff at the end of March 2015 and are currently being reviewed.

Point Lepreau

The 2014 integrated plant rating for Point Lepreau was "satisfactory", which is unchanged from 2013.

CNSC staff noted that the safety performance rating in conventional health and safety was "fully satisfactory", which is unchanged from 2013. All other SCA ratings were "satisfactory".

As a prerequisite for continued operation of the plant, the Commission, in its relicensing decision of 2012, included a regulatory hold point for New Brunswick (NB) Power's compliance with

N293-07, *Fire protection for CANDU nuclear power plants*, by December 31, 2014. NB Power demonstrated that the emergency management and fire protection program was in compliance with the standard by December 31, 2014. Therefore, on December 16, 2014, the CNSC Executive Vice-President, who is authorized by the Commission under licence condition 16.4, consented to remove the Point Lepreau continued operation hold point, the last one on the Point Lepreau operating licence.

The draft site-specific seismic hazard assessment was completed at the end of 2014 by a company contracted by NB Power. The licensee posted the executive summary of the assessment on its website. In May 2015, CNSC staff received the final seismic hazard assessment from NB Power and this assessment is currently being reviewed by CNSC and Natural Resources Canada staff.

The conventional health and safety program at Point Lepreau was fully satisfactory. Both the accident severity rate and accident frequency at Point Lepreau decreased to zero in 2014.

Response to the Fukushima Daiichi accident

During 2014, CNSC staff verified that licensees continued to implement safety enhancements in response to the Fukushima Daiichi accident. The Fukushima action items (FAIs), as specified in the *CNSC Integrated Action Plan* and implemented by NPP licensees, address safety improvements aimed at strengthening defence in depth, and enhancing onsite emergency response. All Canadian NPP licensees have made considerable progress in addressing and implementing the 36 FAIs at their stations. As of April 2015, all short-term and medium-term FAIs were closed, with the exception of two medium-term FAIs at Point Lepreau related to PSA for external hazard assessments. However, the Canadian nuclear power industry is on track to complete all enhancements by the December 2015 deadline set forth in the *CNSC Integrated Action Plan*.

Darlington new nuclear project

The nuclear power reactor site preparation licence (PRSL) for the Darlington new nuclear project was issued by the Commission for a period of 10 years – from August 17, 2012 to August 17, 2022.

As required by the *Canadian Environmental Assessment Act* (1992), prior to any licensing decision, for a PRSL, an environmental assessment (EA) of the project was required. The EA was carried out by the Joint Review Panel (JRP) in 2011. This EA and the PRSL were challenged through an application for judicial review before the Federal Court of Canada.

In May 2014, the Federal Court allowed the application in part and ordered that the licence be quashed and the matter be returned to the JRP, or a duly constituted panel, for further consideration and determination of the specific issues set out in the Court's decisions and reasons. The decision by the Federal Court has been appealed and argument before the Federal Court of Appeal is planned for June 2, 2015.

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Regulatory Oversight Report for Canadian Nuclear Power Plants: 2014

1. Overview

The Canadian Nuclear Safety Commission (CNSC) is the federal government body that regulates, the use of nuclear energy and materials to protect health, safety, security and the environment, and to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public. Licensees are responsible for operating their facilities safely and are required to implement programs that make adequate provision for meeting the CNSC's mandate.

Each year, CNSC staff assess the overall safety performance of the Canadian nuclear power industry – the industry as a whole and the performance of each nuclear power plant (NPP). This assessment is summarized in the *Regulatory Oversight Report for Canadian Nuclear Power Plants: 2014* (the 2014 NPP Report). For 2014, the title for the NPP report has changed from last year's title of *CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2013*. The change was necessary as the report has evolved to provide more than a safety assessment. It now includes information on regulatory developments involving licences and the licence conditions handbook (LCH), and updates on emerging issues and regulatory activities.

This assessment aligns with the regulatory oversight of NPPs using the licensing basis (as defined in INFO-0795, *Licensing Basis Objective and Definition* [1]). The licensing basis comprises the legal requirements of the *Nuclear Safety and Control Act* (NSCA), the regulations made under the NSCA, the conditions of operating licences, applicable standards and regulatory documents, and the safety and control measures in licence applications and licensees' documents. The evaluations are supported by information obtained through inspections, site surveillance activities, field rounds, document assessments, desktop reviews and performance indicator data. The report makes comparisons and shows trends where possible. It also highlights emerging regulatory issues pertaining to the industry at large and to each licensed station.

In addition, the 2014 NPP Report provides an update on regulatory development activities at the industry level and for each station. The information given in this area includes updates on licensing, LCHs, projects and initiatives, and public communication. The report consists of the following sections (listed in the order in which they appear in the report):

- overview which provides a summary of the nuclear power industry throughout Canada
- the assessment and ratings of the safety performance for the overall nuclear power industry, covering the 2014 calendar year (January to December)
- detailed information on licensing and other regulatory issues pertaining to the industry, covering an extended period of January 1, 2014 to April 30, 2015 (to permit the most up-to-date view of issues for the industry)
- the assessment and ratings of the safety performance for each licensed station, covering the 2014 calendar year (January to December)
- detailed information on licensing and other regulatory issues pertaining to each licensed station, covering an extended period of January 1, 2014 to April 30, 2015 (to permit the most up-to-date view of issues at each station)

The report also includes eight appendices and concludes with a glossary and a list of references. New to this year's report is the addition of appendix H, which provides details of the licence amendments approved by the Commission and licence conditions handbook revisions as authorized by the Director General, Directorate of Power Reactor Regulation during the reporting period for each station. This information was previously given in the body of the report.

In addition to providing the CNSC staff integrated safety assessment of Canadian NPPs, the 2014 NPP Report includes, in sections 2 and 3, updates on activities conducted by the industry as a whole and by licensees following the Fukushima Daiichi nuclear accident and in response to the *CNSC Integrated Action Plan* [2].

This report contains, in section 2, the annual update on improvements performed by the licensee and the CNSC regulatory oversight during 2014 with respect to the Darlington new nuclear project (DNNP) and the annual neutron overpower protection (NOP) update.

Details of the Pickering annual updates for 2014 for the risk improvement plan and the aging management program can be found in section 3.3.2.3.

For the reader's information, this report uses the terms NPP, plant and station interchangeably throughout.

Canada's nuclear power plants

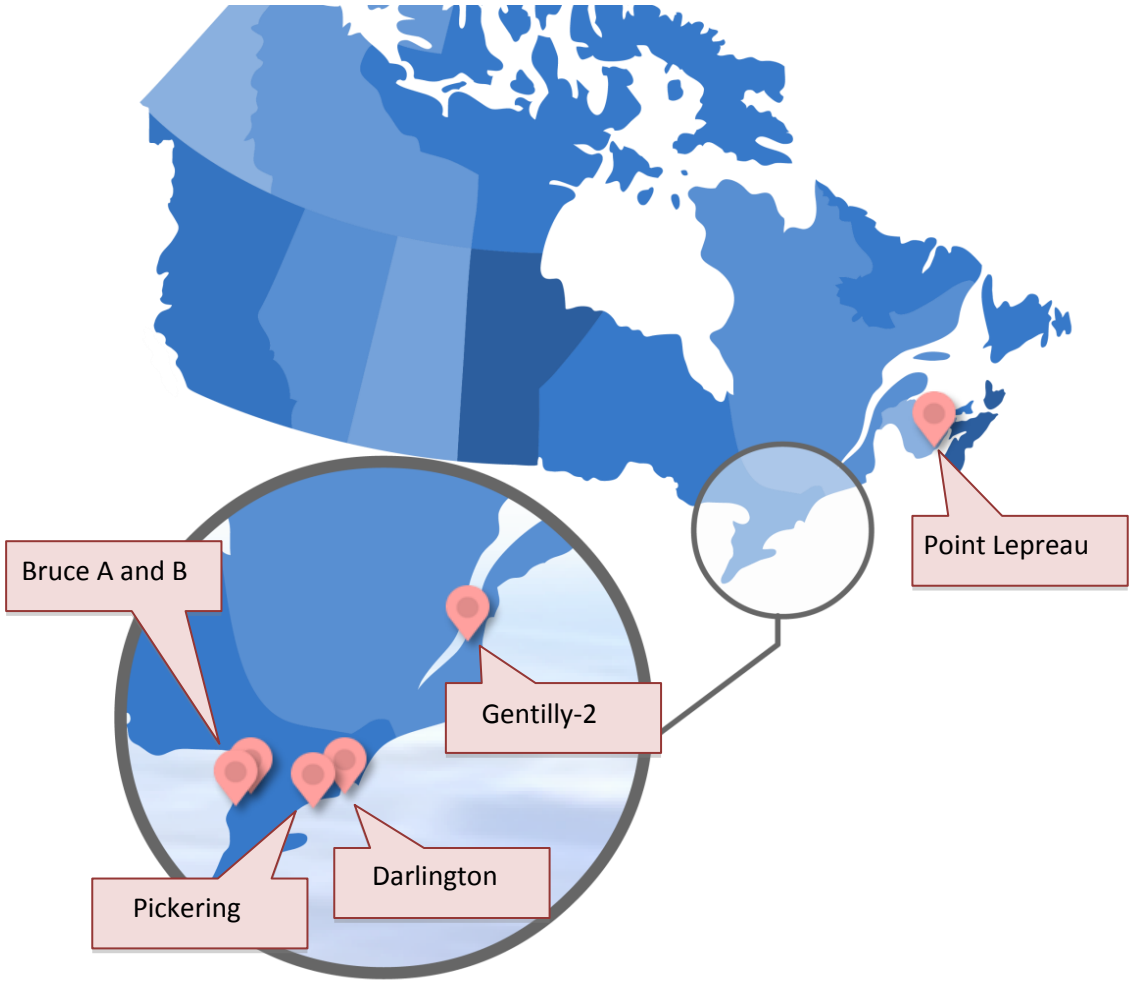
There are six licensed NPPs in Canada, located in three provinces (as shown in figure 1), and operated by four separate licensees. These NPPs range in size from one to eight power reactors, all of which are of the CANDU (CANada Deuterium-Uranium) design. This design was originally developed by the Canadian Crown corporation Atomic Energy of Canada Limited (AECL), and it is licensed to the SNC-Lavalin Group Inc. through its wholly owned subsidiary, Candu Energy Inc.

Figure 1 also provides plant data for each of the NPPs, including the generating capacity of the reactor units, their initial startup dates, the names of the licensees and the expiry dates of the operating licences.

In 2014:

- Six NPPs had operating licences
- Nineteen reactor units were operational
- Gentilly-2 was transitioning to safe storage throughout the year and completed the transition on December 2, 2014
- Pickering, Units 2 and 3 remained in safe storage, consistent with previous years, after they were defuelled in 2008

Figure 1: Locations and data for Canadian nuclear power plants



NPP	Licensee	Location	State of reactor units	Gross capacity per unit (MWe)	Startup[1]	Licence expiry
Bruce A	Bruce Power Inc.	Tiverton, ON	Four operating	805	1977	May 31, 2020
Bruce B	Bruce Power Inc.	Tiverton, ON	Four operating	872	1984	May 31, 2020
Darlington	Ontario Power Generation Inc.	Darlington, ON	Four operating	935	1990	Dec. 31, 2015[2]
Pickering	Ontario Power Generation Inc.	Pickering, ON	Six operating, Two defuelled and in safe storage	Units 1, 4: 542 Units 5-8: 540	Units 1, 4: 1971 Units 5-8: 1982	August 31, 2018
Gentilly-2	Hydro-Québec	Bécancour, QC	One defuelled and in safe storage[3]	675	1983	June 30, 2016
Point Lepreau	New Brunswick Power Corp.	Lepreau, NB	One operating	705	1982	June 30, 2017

[1] For the multi-unit NPPs, this indicates the startup of the first reactor unit
[2] Relicensing is in progress
[3] Gentilly-2 ended commercial operation in 2012 and completed the transition to safe storage in 2014

Regulatory oversight

The CNSC regulates the nuclear sector in Canada, including NPPs, through licensing, reporting, verification and enforcement. For each NPP, CNSC staff conduct inspections, assessments, reviews and evaluations of licensee programs, processes and safety performance.

The Power Reactor Regulatory Program involves the direct efforts of 230 CNSC staff, plus support from other members of the organization. This total effort includes 31 CNSC employees who are located onsite at all NPPs with operating reactors. Among their many tasks they perform inspections and audits, monitor safety performance and provide regulatory oversight.

Table 2 shows the compliance activities conducted by CNSC staff by station and for the industry as well as the status of action items that have been opened for the NPP licensees. There were over 17,400 person-days of effort by CNSC staff in conducting inspections, event reviews and other compliance activities.

Table 2: Compliance activities for stations and industry for 2014

Compliance activities effort (person-days)	Bruce A and B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry total
Inspections	1,520	1,226	1,460	490	1,079	5,775
Event reviews	250	214	228	28	76	796
Other compliance activities *	3,597	2,290	3,245	303	1,405	10,840
Total effort (person-days)	5,367	3,730	4,933	821	2,560	17,411

* Includes verification activities such as station walkdowns and reviews of licensee submitted documents and reports.

In 2014, the CNSC site office at Gentilly-2 was closed, since direct regulatory oversight at the site was not needed following defuelling of the reactor and dewatering and draining of the station process systems. Inspections of Gentilly-2 are now conducted by CNSC staff from the Ottawa office.

Safety and control area framework

CNSC staff use the safety and control area (SCA) framework in evaluating each licensee's safety performance. The framework includes 14 SCAs. Each SCA is sub-divided into specific areas that define its key components. For a complete list of the SCAs and specific areas used in this report, see appendix A.

In response to RD/GD-99.3, *Public Information and Disclosure* [3], licensees implemented public information and disclosure programs to disseminate objective scientific, technical and regulatory information to the public, detailing anticipated effects on the health and safety of persons and the environment of their activities under the SCA framework. Specific details on the licensees' efforts in this area are included in section 2.2.3, under "Public communication".

Licensing

In March 2014, Bruce Power applied for, and the Commission approved, an amendment of the operating licences for Bruce A and Bruce B until May 31, 2015 in order to facilitate an appropriate level of public participation in the public hearing process. The two-part public hearing for the Bruce A and B licence renewal was held in February and April 2015. On May 27,

2015, the Commission renewed the operating licences issued to Bruce Power as a single licence for both Bruce A and B, valid from June 1, 2015 until May 31, 2020.

In March 2014, Ontario Power Generation Inc. (OPG) submitted a request for the removal of the regulatory hold point for Pickering. This was to reassess the operation of the pressure tubes beyond the original assumed design life – initially projected to be 210,000 equivalent full power hours (EFPH).

The hold point also covered the completion of the probabilistic safety assessment for Pickering A meeting the requirements of S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* [4]. The updated PSA models were to account for the Fukushima enhancements and the development of a methodology for multi-unit station PSAs. The Commission heard the request for removal of the hold point at the May 7, 2014 public hearing. In June 2014, the Commission removed the hold point and allowed OPG to proceed with the operation of Pickering beyond 210,000 EFPH, up to 247,000 EFPH as given in the *Record of Proceedings, Including Reasons for Decision – Application to Request Removal of a Hold Point for the Pickering Nuclear Generating Station* [5]. The Commission also directed OPG to submit a detailed risk improvement plan in August 2014 and to submit annual updates on enhancements to its aging management program, the status of pressure tubes and feeder pipes, and related safety issues. The Commission requested increased monitoring, inspection and annual reporting by both OPG and CNSC staff on the operation of the Pickering units by providing clear descriptions of measures implemented by OPG.

In June 2014, OPG applied for an amendment of the Darlington operating licence until December 31, 2015 in order to allow sufficient time to prepare additional material for the upcoming licence renewal hearing and to allow the public adequate time to review this additional material. CNSC staff recommended a 12 month extension of the current Darlington licence provided OPG maintained the necessary CNSC regulatory requirements for the continued safe operation of Darlington. In July 2014, the Commission amended the licence issued to OPG until December 31, 2015.

In July 2014, the Commission approved a licence amendment request from Hydro-Québec to remove the requirements that do not apply to an operating NPP, as the NPP is in transition to safe storage. Details regarding this amendment are given in appendix H, table H.7.

In July 2014, Bruce Power requested the removal of the EFPH hold point in the Bruce B licence conditions handbook. The Commission authorized in September 2014 the operation of Units 5 and 6, up to a maximum of 245,000 EFPH based on CNSC staff evaluations and recommendations to the Commission. In its May 2015 licence renewal decision, the Commission authorized the operation of Bruce A and B, Units 1 to 8, up to a maximum of 247,000 EFPH.

In October 2014, the Commission approved a licence amendment request from New Brunswick (NB) Power for the Point Lepreau operating licence to update the table containing the list of maximum allowable quantities of unsealed sources of activation products and fission products approved for use at the facility. Details regarding this amendment are given in appendix H, table H.9.

The Commission was kept informed of events and activities at NPPs through eight status reports on power reactors, two event initial reports (EIRs) and presentations made at public meetings (see section 2.2.3 for details regarding the presentations made).

CNSC staff conducted several engagement activities, including consultation with a number of Aboriginal communities in relation to the 2015 Darlington and 2015 Bruce Power operating licence renewals. Specific details on the licensees' efforts in this area are included in section 2.2.3, under "Aboriginal consultation activities".

Reporting requirements

In April 2014, the Commission approved REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* [6], to replace S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. This new regulatory document was implemented commencing January 1, 2015 through an amendment to the individual NPP operating licences. The final year the licensees can report using S-99 was 2014. REGDOC-3.1.1 reporting entered into force in 2015. Therefore, this report refers to S-99 for licensee reporting to the CNSC.

During 2014, NPP licensees reported to CNSC staff on 378 events and submitted 122 scheduled reports as a result of the requirements of S-99. None of the event reports resulted in findings of medium or high safety significance, and all findings were either low safety-significant, negligible or compliant. Two events were reported to the Commission during 2014 as EIRs (see details in sections 3.2.2.4 and 3.3.2.4).

Compliance verification program

The safety performance of NPPs presented in this report was determined by CNSC staff using the results of activities planned through the compliance verification program (CVP). These compliance verification activities included surveillance and monitoring by full-time, onsite inspectors, announced and unannounced inspections supported by subject matter experts and desktop reviews by a wide range of technical specialists. These activities were performed through an effective combination of document review, workplace observation and worker interview. All compliance verification activities were fully documented and recorded the objective evidence that forms the basis of the compliance results.

At its foundation, the CVP consists of a collection of compliance verification activities covering the 14 SCAs and conducted with varying frequency over a rolling five-year period. This collection shapes the baseline and is used to systematically and comprehensively verify whether licensees are complying with all of the safety and control measures established as the basis for the licensing of their station.

Each year, approximately 100 to 150 applicable compliance verification activities are selected for the year's compliance plan. The annual plan is then validated by CNSC technical specialist and licensing staff using a risk-informed approach that considers the status, performance history, and conditions and challenges of each station to ensure appropriate regulatory oversight and safety performance evaluation. Where necessary, additional reactive compliance verification activities are added that focus on known or potential licensee challenges. Additional supplemental

A CNSC site staff member inspects the airlock at the Bruce Nuclear Generating Station.

compliance verification activities may also be added as necessary during the year in response to new or emerging licensee challenges.

The goal is to ensure that the CVP for NPPs is always timely, risk-informed, performance-based and tailored to individual stations.

Safety performance assessment

The 2014 NPP Report presents safety performance ratings for each SCA at each NPP. The ratings are based on the CVP activities. In generating the performance ratings, CNSC staff considered more than 1,100 findings. All findings were assessed as being either compliant, negligible or low safety-significant – in other words, each of these findings met requirements, deviated insignificantly from requirements or deviated from requirements, but the significance to safety was low. For the first time since the SCA framework was introduced in 2010, there were no medium- or higher-rated findings assessed for the licensees. This outcome reflects the continuous improvements being implemented by NPP licensees. The findings were categorized into appropriate SCAs and assessed against a set of CNSC-developed performance objectives and criteria.

The assessment presented in the 2014 NPP Report includes an integrated plant rating for each NPP. The rating is a general measure of the overall safety performance at each NPP. It is determined by combining the ratings of the 14 individual SCAs.

2. Industry safety performance and regulatory developments

This section presents the details of industry safety performance and issues of regulatory developments for the industry.

The industry safety performance portion is found in section 2.1. It provides the Canadian Nuclear Safety Commission (CNSC) staff's integrated assessment of the safety performance of the industry in each of the safety and control areas (SCAs), including highlights of generic issues and observations. The overall performance of the industry is determined by calculating an "industry average" rating for each SCA.

CNSC staff evaluated how well licensees' programs met regulatory requirements and expectations, contributed to protect the overall health, safety and security of persons and the environment, and helped to implement Canada's international commitments on the peaceful use of nuclear energy. The evaluations are based on findings made throughout the year during inspections, desktop reviews, field rounds and follow-ups on licensee progress on enforcement actions and are categorized according to the following 14 SCAs:

- management system
- human performance management
- operating performance
- safety analysis
- physical design
- fitness for service
- radiation protection
- conventional health and safety
- environmental protection
- emergency management and fire protection
- waste management
- security
- safeguards and non-proliferation
- packaging and transport

The SCA definitions, performance objectives and specific areas are given in appendix A, "Definitions of safety and control areas". The definitions of the performance ratings and the rating methodology used in this report can be found in appendix B, "Rating definitions and methodology".

CNSC and World Association of Nuclear Operators (WANO) performance indicators (PIs) are included in this section to illustrate various trends. CNSC PIs are defined in S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. Note that, while useful for trending the performance of an individual station, comparing nuclear power plant (NPP) data between stations in any particular year is difficult because many factors – such as the number of operating units, design, unit capacity, or NPP governing documents – contribute to differences in PI data.

Detailed information on various regulatory developments and issues for the nuclear power industry can be found in section 2.2. In recognition of the complexity and ongoing nature of many regulatory issues, the reporting period for section 2.2 is from January 2014 to April 2015.

2.1 Overall safety assessment

2.1.1 Management system

The management system SCA covers the framework that establishes the processes and programs required to ensure that an organization achieves its safety objectives, continuously monitors its performance against those objectives, and fosters a healthy safety culture. The industry average for management system was "satisfactory", unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the management system SCA at NPPs met all applicable regulatory requirements.

Management system ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	SA	SA	SA	SA	SA

Management system encompasses the following specific areas:

- management system
- organization
- change management
- safety culture
- configuration management
- records management (no significant observations to report)
- management of contractors (no significant observations to report)
- business continuity (no significant observations to report)

Management system

All NPP licensees are required to develop and implement a management system that adheres to the requirements of N286-05, *Management system requirements for nuclear power plants* [8]. As a result of oversight activities, CNSC staff identified some minor deficiencies with process adherence and documentation clarity; however, staff did not identify any non-compliances with the requirements of the standard. CNSC staff concluded that NPP licensees' management systems continue to meet CNSC requirements.

Organization

The organizational structure established by each NPP is documented as per the management system requirements. The documentation includes descriptions of roles and responsibilities for all licensed activities.

Ontario Power Generation Inc. (OPG) completed the implementation of a centre-led matrix organization model through its business transformation initiatives. CNSC staff are monitoring these organizational changes and the OPG stations' alignments with their management system documentation.

Change management

NPP licensees have implemented a baseline program at their stations for change management. However, CNSC staff identified some minor deficiencies in the change management processes related to updating documentation to show the changes made. These were evaluated as having low or negligible safety significance. Licensees provided corrective action plans to address these deficiencies.

Safety culture

Licensees conduct periodic safety culture self-assessments at planned intervals at their facilities, typically every three years. CNSC staff will continue to monitor these assessments and the associated follow-up actions. There were no significant findings or compliance verification activities to report in this specific area for 2014.

Configuration management

Configuration management is a systematic approach for identifying, documenting and changing the characteristics of a facility's structures, systems and components and ensuring that conformance is maintained between design requirements, physical configuration and facility configuration information. This process is adequately implemented at all station and the overall evaluation across the industry is satisfactory.

Business continuity

All licensees have adequately prepared their business continuity plans to ensure that minimum shift complement at the facilities is not affected by labour actions, severe weather or other disruptions.

2.1.2 Human performance management

The human performance management SCA covers activities that enable effective human performance through the development and implementation of processes that ensure that licensees have sufficient personnel in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. The industry average rating for human performance management was "satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the human performance management SCA at NPPs met all applicable regulatory requirements.

Human performance management ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	SA	SA	SA	SA	SA

Human performance management encompasses the following specific areas:

- human performance program
- personnel training
- personnel certification
- initial certification examinations and requalification tests
- work organization and job design
- fitness for duty

Human performance program

All NPP licensees utilize a human performance program to minimize human and organizational errors. CNSC staff determined, through compliance verification activities, that licensees have implemented a comprehensive human performance program. CNSC staff confirmed that the licensees' performance in this area remained satisfactory during 2014.

Personnel training

All NPP licensees employ systematic approach to training (SAT)-based training systems. Implementation of these systems for the training programs at each facility met regulatory requirements in 2014.

REGDOC-2.2.2, *Personnel Training* [9], which was published in August 2014, sets out the CNSC requirements for licensees regarding the development and implementation of a training system. REGDOC-2.2.2 also provides guidance on how these requirements should be met. REGDOC-2.2.2 has not yet been added to the licensing basis of the NPPs. However, each licensee will be expected to conduct a gap analysis of existing practices against REGDOC-2.2.2, and the estimated timeline for implementation is between 2016 and 2018. At present, licensees continue to meet the SAT requirements as specified in RD-204, *Certification of Persons Working at Nuclear Power Plants* [10].

Fire protection training at the Point Lepreau Nuclear Generating Station.

Personnel certification

All licensees are required to have certified shift managers, control room operators and health physicists. All licensees maintained sufficient numbers of personnel for the certified positions in 2014. CNSC staff are satisfied that NPP licensees' programs certify the competency of personnel at Canadian NPPs to perform their duties safely.

For information purposes, table 3 shows the number of certified personnel at each station in excess of minimum requirements for 2014.

Table 3: Number of certifications per station and certified position

Station	Reactor operator[a]	U0O[a, b]	Shift manager	Health physicist	Total
Bruce A					
Actual	41	19	19	4[d]	83
Minimum	30	10	10	1	51
Bruce B					
Actual	53	23	18	4[d]	98
Minimum	30	10	10	1	51
Darlington					
Actual	49	17	17	2	85
Minimum	30	10	10	1	51
Pickering 1,4					
Actual	40		16	4[d]	60
Minimum	20		10	1	31
Pickering 5-8					
Actual	55		19	4[d]	78
Minimum	30		10	1	41
Gentilly-2					
Actual				3[e]	3
Minimum				1	1
Point Lepreau					
Actual	8		9[c]	3	20
Minimum	5		5	1	11

Notes:

a. The reactor operator and Unit 0 operator (U0O) positions form the control room operator cadre.
b. There are no U0O positions at Pickering 1, 4, Pickering 5-8 and Point Lepreau stations. The corresponding cells are therefore left empty and shaded grey.
c. One shift manager left in October 2014 and Point Lepreau ended 2014 with eight shift managers.
d. Four health physicists are certified for both stations.
e. The three health physicists positions are the only positions at Gentilly-2 requiring certification.

Initial certification examinations and requalification tests

The initial certification examinations and requalification tests programs at all NPPs met regulatory requirements for initial certification of workers and renewal of certification of workers in 2014.

Work organization and job design

Minimum shift complement

Licensees are required, in accordance with the *General Nuclear Safety and Control Regulations*, to ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely. For NPP licensees this means they are required to maintain a minimum shift complement present at all times in accordance with their power reactor operating licences. In 2014, licensees continued to ensure the presence of a sufficient number of qualified workers at their respective facilities.

Fitness for duty

Hours of work

All licensees have procedures that specify station requirements related to the hours of work and processes in place to enable them to monitor compliance with the hours of work limits. Overall, licensees met the hours of work requirements.

2.1.3 Operating performance

The operating performance SCA includes an overall review of the conduct of licensed activities and the activities that enable effective performance. The industry average rating for operating performance was "satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that NPP licensees operated their facilities safely and met all applicable regulatory requirements.

Operating performance ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	FS	FS	SA	SA	SA	SA

Operating performance encompasses the following specific areas:

- conduct of licensed activity
- procedures
- reporting and trending
- outage management performance
- safe operating envelope
- severe accident management and recovery
- accident management and recovery (no significant observations to report)

Conduct of licensed activity

Throughout 2014, 19 reactors continued to operate in Canada, unchanged from the previous year. Pickering Units 2 and 3 are in safe storage. Gentilly-2 is in a core-defuelled state and stabilization operations and activities continued during the year for transitioning this reactor to its safe storage. The transition to safe storage was completed by late December 2014. There were no serious process failures at any of the NPPs.

The term number of unplanned transients in table 4 denotes the unplanned reactor power transients due to all causes while the reactor was operating and not in a guaranteed shutdown state. Unplanned transients include stepbacks, setbacks, and reactor trips where the trip resulted in a reactor shutdown. Unexpected power reductions can indicate problems within the plant and/or place unnecessary strain on systems. CNSC staff will continue to monitor trends in this indicator.

Table 4 shows the number of power reductions from actuation of the shutdown, stepback or setback systems. All transients were controlled properly and, where necessary, power reduction

was initiated by the reactor control systems. The stepbacks and setbacks are gradual power changes to eliminate potential risks to plant operations.

Table 4: Number of unplanned transients

NPP	Number of operating reactors	Number of hours of operation	Un-planned reactor trips[1]	Step-backs	Set-backs	Total unplanned transients[2]	Number of trips per 7,000 operating hours[3]
Bruce A	4	32,070	7[4]	0	4	11	1.53
Bruce B	4	30,492	0	1	2	3	0.0
Darlington	4	33,323	0	2	1	3	0.0
Pickering 1, 4	2	15,457	1	n/a[5]	1	2	0.45
Pickering 5-8	4	29,733	0	1	0	1	0.0
Gentilly-2	n/a[6]						
Point Lepreau	1	7,544	0	1	2	3	0.0
Industry total	19	148,619	8	5	10	23	0.38

Notes:

1 Automatic reactor trips only; does not include manual reactor trips or trips during commissioning testing.

2 Unplanned transients consist of unplanned reactor trips, stepbacks and setbacks.

3 Nuclear power industry performance target is less than 0.5 reactor trips per 7,000 operating hours.

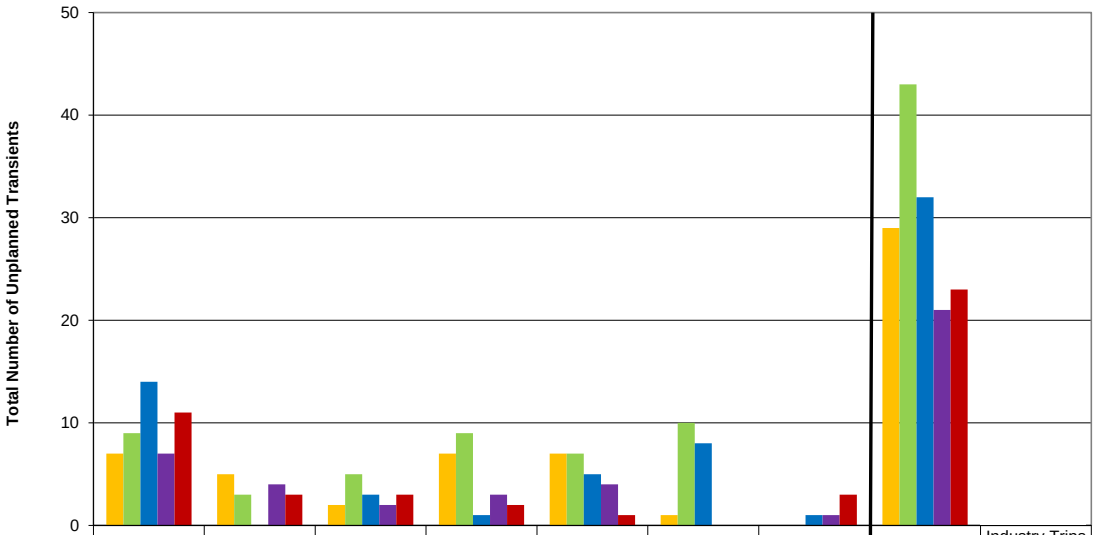
4 The Bruce A reactor trips are discussed in section 3.1.1.3.

5 Stepbacks are not implemented at Pickering 1, 4.

6 Gentilly-2 is shutdown and transitioning to safe storage during 2014.

Figure 2 shows the individual station and industry trend in the number of unplanned transients from 2010 to 2014. For three stations, the number of unplanned transients decreased, in comparison to 2013. However, for the industry, the total number of unplanned transients increased by three in comparison to 2013.

Figure 2: Trend details for the number of unplanned transients for stations and industry



	Bruce A	Bruce B	Darlington	Pickering 1, 4	Pickering 5-8	Gentilly-2	Point Lepreau	Industry Total	Industry Trips per 7,000 Hours
2010	7	5	2	7	7	1	n/a	29	0.54
2011	9	3	5	9	7	10	n/a	43	0.53
2012	14	0	3	1	5	8	1	32	0.30
2013	7	4	2	3	4	n/a	1	21	0.34
2014	11	3	3	2	1	n/a	3	23	0.38

Note: "Not applicable" (n/a) in the above table in figure 3 for Gentilly-2 and Point Lepreau are due to the reactors being shutdown for the year. The shutdown at Point Lepreau was for refurbishment and the shutdown at Gentilly-2 was due to the end of commercial operation.

Figure 3 shows the number of unplanned reactor trips per 7,000 operating hours for the Canadian nuclear power industry in comparison to international nuclear power industry values as published by the World Association of Nuclear Operators (WANO). As shown in figure 3, the reactor trip rate increased slightly from 2013 to 2014 – from 0.34 to 0.38 – but it remains within the industry performance target of 0.5 unplanned trips per 7,000 operating hours.

The industry average was one unplanned reactor trip per 18,577 hours or about 25 percent better than the nuclear power industry performance target of less than 0.5 reactor trips per 7,000 hours of operation (or one trip per 14,000 hours).

Figure 3: Trend details for the number of unplanned reactor trips per 7,000 operating hours, compared to WANO values

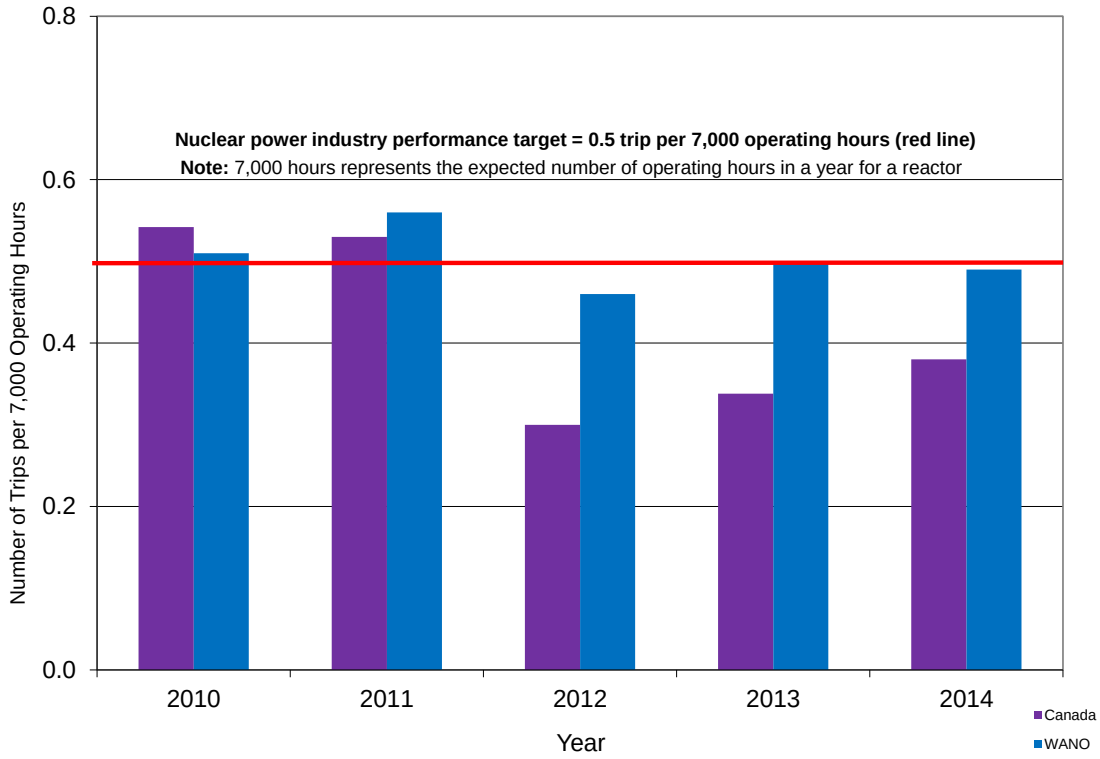
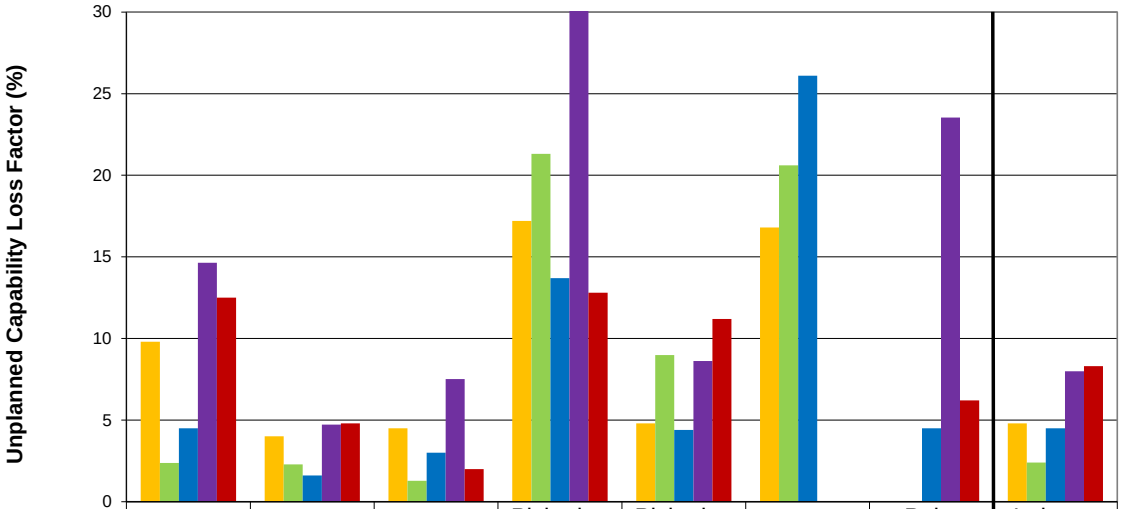


Figure 4 shows the unplanned capability loss factor (UCLF) from 2010 to 2014 for Canadian NPP licensees and the industry, and presents the median value for the industry (consistent with WANO methodology). The UCLF is the percentage of the reference electrical output for the station not produced during the period due to unplanned circumstances. The UCLF reflects how a unit is managed, operated and maintained in order to avoid forced outages. The UCLF is both an economic indicator and a reflection of the overall plant management.

As shown in figure 4, the relatively low increase in the industry UCLF, from 8.0 percent to 8.3 percent, was due to the increased values for Bruce B and Pickering 5-8. The industry UCLF value is the median of the values for the 19 operating reactor units in Canada. Therefore, the effect of changes in station UCLFs may have a small impact on the industry UCLF. For example, in figure 4, three stations (out of six with operating reactors) had significant decreases in their UCLF (Darlington, Pickering 1, 4 and Point Lepreau for a total of seven reactors) and yet, due to the increase at Bruce B and Pickering 5-8 (eight reactors), the overall industry value increased.

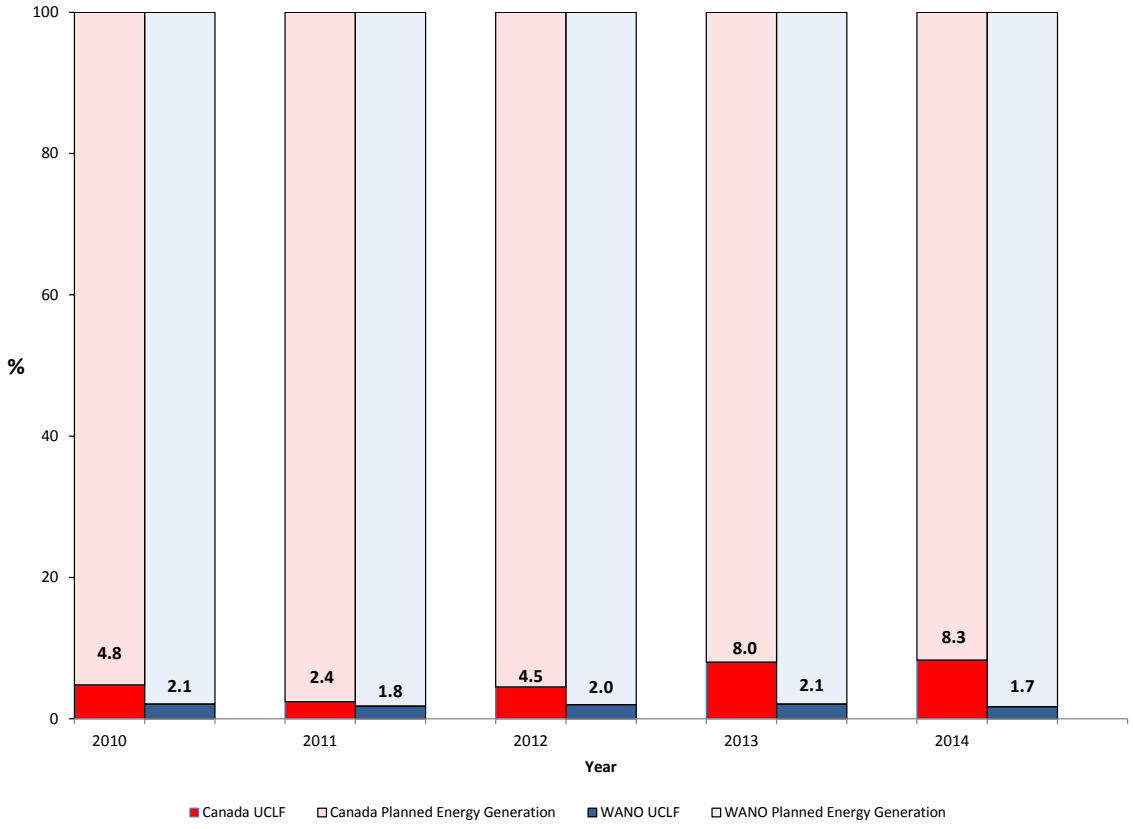
Figure 4: Trend details for unplanned capability loss factor for stations and industry



	Bruce A	Bruce B	Darlington	Pickering 1, 4	Pickering 5-8	Gentilly-2	Point Lepreau	Industry Median
2010	9.8	4.0	4.5	17.2	4.8	16.8	0.0	4.8
2011	2.4	2.3	1.3	21.3	9.0	20.6	0.0	2.4
2012	4.5	1.6	3.0	13.7	4.4	26.1	4.5	4.5
2013	14.6	4.7	7.5	30.3	8.6	n/a	23.5	8.0
2014	12.5	4.8	2.0	12.8	11.2	n/a	6.2	8.3

Figure 5 shows the UCLF for the Canadian nuclear power industry in comparison to international nuclear power industry values as published by WANO. The Canadian nuclear power industry values are higher than the world median values. The reason for the difference between the world and the Canadian industry values is not clearly understood, but could be due to differences in reactor technologies and the number of operating reactors in each group (19 for Canada versus more than 400 reporting units for the WANO values). In all cases, the forced outages and outage extensions were managed safely and in accordance with regulatory requirements.

Figure 5: Trend of unplanned capability loss factor compared to WANO values



Procedures

CNSC staff oversight of procedures has demonstrated that licensees have documented processes for the development, verification, validation, implementation, modification and use of procedures that take into account human performance considerations. The format and organization of procedures are based on licensees' style guides for station system procedures, which include emergency operating procedures, emergency mitigating equipment procedures and severe accident management guidelines.

The verification and validation processes of procedures are two very important elements in the procedure preparation and review phases. Licensees verify their procedures for technical accuracy and validate them to ensure that they are usable and function as intended. Overall, CNSC staff are satisfied that licensees work continuously to improve the efficiency and technical accuracy of their procedures.

Reporting and trending

All licensees were required to submit quarterly reports on operations and performance indicators and annual and quarterly compliance monitoring reports, as described in S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. NPP licensees complied with the submission of reports as per S-99.

Outage management performance

All licensees continued to meet CNSC expectations for outage executions, outage safety and work management. CNSC staff verified that outages were completed by the licensees with a high level of efficiency and effectiveness and in accordance with planned objectives.

Safe operating envelope

All licensees are required to establish a safe operating envelope (SOE) program according to the requirements of N290.15-10, *Requirements for the safe operating envelope of nuclear power plants* [11]. To date, Bruce Power, OPG and NB Power have completed the development and the baseline implementation of their SOEs, and continued to make improvements to their SOE programs. Program compliance assessments are being conducted through CNSC compliance monitoring activities, and CNSC staff were satisfied with the results from monitoring activities in 2014.

After SOE programs were implemented, CNSC staff identified variations among the stations with respect to the plant systems explicitly included in the SOE scope. To address this issue, the industry has submitted a report to rationalize the differences and improve the consistency among stations. CNSC staff reviewed the submission, and provided feedback to the industry. These comments were mainly related to the mandatory SOE scope; for example, a system cannot be excluded from the mandatory SOE scope based only on risk impact. The industry addressed CNSC staff's comments in 2014 and proposed to update N290.15 to further improve the clarity of certain requirements such as SOE mandatory scope. CNSC staff agree with the industry's proposal to update N290.15. This standard is expected to be revised in 2015. Through this rationalization exercise, all licensees now have an improved interpretation of the mandatory requirements with respect to N290.15.

Since Hydro-Québec ended commercial operation at Gentilly-2 and nuclear fuel has been removed from the reactor core, an SOE program is no longer applicable to Gentilly-2.

Severe accident management and recovery

To mitigate the consequences of a severe accident, REGDOC-2.3.2, *Severe Accident Management Programs for Nuclear Reactors* [12], published in 2013, describes the CNSC expectations that licensees develop and implement measures for:

- preventing the escalation of a reactor accident into an event involving severe damage to the reactor core
- mitigating the consequences of an accident involving severe damage to the reactor core
- achieving a safe, stable state of the reactor and plant over the long term

Bruce Power conducting emergency mitigation equipment drills.

Published in 2014, REGDOC-2.3.2, *Accident Management* [13] sets out the regulatory requirements and guidance for the development, implementation and validation of accident management programs for reactor facilities. This document reflects current international views on accident management and addresses findings from the *CNSC Fukushima Task Force Report* [14]. It

supersedes REGDOC-2.3.2, *Severe Accident Management Programs for Nuclear Reactors* [12]. The industry is in discussion with the CNSC regarding revisions to REGDOC-2.3.2, *Accident Management* [13], prior to implementation.

2.1.4 Safety analysis

The safety analysis SCA pertains to maintaining the safety analysis that supports the overall safety case for each facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility, and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards.

For NPPs, safety analysis is primarily deterministic in demonstrating the effectiveness of implementing the fundamental safety functions of "control, cool and contain" through a "defence-in-depth" strategy. Risk contributors are considered and assessed by using probabilistic safety analysis to identify challenges to physical barriers. However, appropriate safety margins should be applied to address uncertainties and limitations of probabilistic safety approaches.

In 2014, the industry average for safety analysis was "satisfactory", which is unchanged from the previous year. Overall, based on the information assessed, CNSC staff concluded that the safety analysis SCA at NPPs met all applicable regulatory requirements.

Safety analysis ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	SA	SA	SA	SA	SA

Safety analysis encompasses the following specific areas:

- deterministic safety analysis
- probabilistic safety analysis
- criticality safety (no significant observations to report)
- severe accident analysis
- environmental risk assessment
- management of safety issues (including R&D programs)

Deterministic safety analysis

CNSC staff reviewed the topics, listed below, to continue to develop an overall assessment of deterministic safety analysis.

Safety analysis improvement program

The CANDU Owners Group (COG)/CNSC initiative on safety analysis improvement and implementation of RD-310, *Safety Analysis for Nuclear Power Plants* [15], has progressed to the implementation phase. The RD-310 implementation allows the deterministic safety analysis to be updated in a systematic and staged manner. In addition, it is aimed at enhancing the safety reports and thus at continued support of the safe operation of CANDU reactors. In implementing RD-310, the industry had adopted a three-phase approach:

- phase 1 – preparation and development of a framework for transition to compliance with RD-310
- phase 2 – identification of generic gaps against RD-310 and development of principles and guidelines for safety analysis to comply with RD-310
- phase 3 – development and execution of station-specific plans to update safety reports for compliance with RD-310

The industry has completed the phase 1 and phase 2 work activities to establish a common approach to address analysis shortcomings and to develop the *Principles and Guidelines for Deterministic Safety* (COG-11-9026 R2) for RD-310 compliance.

The industry effort is now moving through phase 3, and progress in implementing the plans is on track. Plant-specific safety analysis improvement activities and prerequisites required to upgrade safety report analyses for REGDOC-2.4.1, *Deterministic Safety Analysis* [16], compliance have been identified and are planned for execution. Meanwhile, the CNSC continues to provide feedback to the industry on their pilot analyses aimed at demonstrating REGDOC-2.4.1 compliance. Examples of these analyses are the Darlington loss-of-moderator heat sink analysis and the Darlington loss-of-reactivity-control analysis. The Commission approved the replacement of RD-310 by REGDOC-2.4.1 in May 2014.

Impact of aging on the safety analysis

Aging of the reactor heat transport system changes certain characteristics of the system, which results in a gradual reduction of the safety margins unless compensatory measures are taken. As the reactor core ages, the integrated impact of simultaneous aging effects in various structures, systems and components (SSCs) on the overall safety case of the NPP needs to be assessed and the existing safety margins quantified.

Licensees have aging management programs in place that include systematic monitoring of aging related parameters important to safety analysis, along with assessment of the impact of the change in core conditions on existing safety margins. CNSC staff reviewed the Bruce Power and OPG programs to monitor, assess and mitigate the impact of heat transport system aging on safety analysis and found them satisfactory. All stations have adequate safety margins and these meet the required acceptance criteria for safe operation of the NPP.

Large loss-of-coolant accident: composite analytical approach

In 2014, CNSC staff completed their assessment of the industry's proposed composite analytical approach (CAA) which was submitted for CNSC staff review in late 2013. The CAA is a new large loss-of-coolant accident (LLOCA) analysis framework being proposed by industry to resolve the CANDU safety issues (CSIs) AA 9, PF 9 and PF 10 listed in table C.3 (appendix C). This assessment includes an evaluation of the knowledge base to support each technical element of CAA, as well as an evaluation of the work performed in two fundamental activities related to re-evaluation of the reactor physics parameters and the applicable acceptance criteria.

CNSC staff acknowledge the significant effort taken by the industry to complete the CAA and consolidate the current state of knowledge in key areas. However, with respect to the regulatory use of the proposed CAA, CNSC staff concluded that the approach needs further validation. The results of the CNSC staff review were communicated to licensees in January 2015. Bruce Power and OPG responded to the CNSC staff findings shortly after and CNSC staff are reviewing their submissions. NB Power provided a formal response to the CNSC in May 2015.

Bruce Power plans to fully demonstrate the validity of the CAA in an upcoming licensing

analysis, expected to be completed in 2018 and to become part of its licensing basis. OPG and NB Power plan to cooperate with Bruce Power in generic aspects of this project. Furthermore, OPG intends to submit its licensing analysis applying the CAA to its reactors upon CNSC's acceptance of Bruce Power's licensing analysis. NB Power believes that CAA has demonstrated that sufficient margins exist for the large-break loss-of-coolant accident (LBLOCA) scenario. Additionally, NB Power may perform a similar licensing analysis upon CNSC's acceptance of the other licensees' licensing cases in the event that additional discoveries may erode their existing safety margin.

While the industry is working on the CAA for LBLOCA safety analysis, and CNSC staff continue to review the industry submissions, the licensing basis of Canadian stations for the LBLOCA scenario will continue to be based on traditional safety analysis results and the CNSC LLOCA interim regulatory position. The safety analysis results were based on the assumption that the operating parameters were conservative, which included an instantaneous opening of the large break. The interim position established a set of action levels and acceptance criteria for all NPPs.

In the event of LBLOCA discovery issue(s) uncovered during this transition/interim period, the latest CAA results may be used as part of a risk-informed decision making process to assess the safety significance of the discovery issue(s).

Large LOCA safety margins

Licensees submitted research discovery reports related to assumptions and input data used in the safety analysis for the unlikely event of a LLOCA. The licensees have determined that there are no negative safety impacts on continued operation. All licensees with operating reactors are in the process of submitting a detailed impact assessment.

Independent technical panel on shutdown system effectiveness criteria

In late 2010, COG members and CNSC staff initiated a joint project to reassess the criteria for demonstrating the effectiveness of shutdown systems in ensuring fuel and fuel channel integrity for various design-basis events, many of which are affected by heat transport system aging. The independent technical panel created to accomplish this task issued its final report in November 2011.

The panel proposed new acceptance criteria, which take into account the effects of aging on both fuel and fuel channel integrity. The new criteria are intended to replace the current limits applied in the licensees' deterministic safety analyses. These derived acceptance criteria are intended for application to operating CANDU plants in Canada. CNSC staff are in the process of completing a review of the technical basis document for these new criteria, including the approach developed by the industry to demonstrate compliance with these derived acceptance criteria. It is anticipated that CSI PF 18 (see table C.3, appendix C for details) will be re-categorized by the third quarter of 2015.

The CNSC is expected to be in a position to make recommendations regarding development of a regulatory document or another alternative to replace G-144, *Trip Parameter Acceptance Criteria for the Safety Analysis of CANDU Nuclear Power Plants* [17] by the end of 2015.

Probabilistic safety analysis

All NPP licensees are in compliance with S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* [4]. The PSA methodology and reports have been submitted to the CNSC for all NPPs.

The CNSC's regulatory requirements with regard to probabilistic safety assessments have been integrated into REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* [18]. Transition plans for implementation of this regulatory document are in progress.

The industry is making acceptable progress towards a whole-site PSA, and a CNSC-sponsored conference with significant international participation was held in 2014. Issues related to the multi-site PSA and the proposed path forward were discussed at this conference.

Severe accident analysis

In response to severe accident management guideline (SAMG)-related Fukushima action item 3.1.1, *Development and Implementation of SAMG*, all Canadian NPPs have completed the existing SAMGs implementation. All SAMG-related Fukushima action items for all Canadian NPPs are now closed. CNSC staff desktop reviews and evaluations of the station-specific SAMGs for a single-unit station were completed. CNSC staff reviews for multi-unit station licensees are ongoing and expected to be completed by 2018.

In response to the *CNSC Integrated Action Plan* [2], the NPP licensees have developed improved methods for deterministic analysis of multi-unit severe accidents. Specifically, Fukushima action items (FAIs) 3.2.1 and 3.2.2 are now closed for multi-unit stations. Industry is working to improve the multi-unit modelling capability. Action items have been raised to track progress against this activity.

Environmental risk assessment

Environmental risk assessments performed at all stations have demonstrated adequate provision for the protection of the environment and public as verified by ongoing monitoring. Work has been completed or is underway at all operating NPPs to document an environmental risk assessment consistent with N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* [19].

All licensees are developing and implementing programs to verify that fish are being protected at all stations from the effects of thermal discharge of water as well as intake water withdrawal – both necessary to operate condenser-cooling water systems. This work is taking place under direction from the CNSC and advice from agencies such as Fisheries and Oceans Canada and Environment Canada.

Management of safety issues (including R&D programs)

In 2007, the CNSC initiated a project to systematically reassess the status of potential design and analysis safety issues for CANDU reactors and to categorize them in order of risk importance. This project complemented the ongoing work at that time on generic action items.

By February 2015, six of the original 21 CSIs remained to be reassessed in the highest risk category (Category 3). A Category 3 CSI is one that has measures in place to maintain safety margins, but the adequacy of these measures needs to be confirmed. Three of those CSIs were related to LLOCAs, three were non-LLOCA-related.

During the continued development of the CAA, the licensing basis of existing CANDU reactors for the LLOCA scenario will continue to be based on traditional conservative safety analysis for which acceptance criteria are clearly established.

For non-LLOCA issues, the industry has applied to re-categorize most of the issues into lower risk categories based on empirical and analytical evidence and actions taken. The industry and

CNSC staff are monitoring and coordinating the implementation of the plan for re-categorization of the few remaining issues.

Industry is making progress on the LLOCA and non-LLOCA CSIs, and CNSC staff are monitoring their efforts (see appendix C for more information on CSIs, including their status). There are no safety concerns arising from their continuous reassessment efforts. A Commission member document (CMD) giving an update on the status of CSIs is being prepared for presentation to the Commission in early 2016.

2.1.5 Physical design

The physical design SCA relates to activities that affect the ability of SSCs to meet and maintain their design basis as new information arises over time and changes take place in the external environment. The industry average rating for physical design was "satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the physical design SCA at NPPs met all applicable regulatory requirements.

Physical design ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	SA	SA	SA	SA	SA

Physical design encompasses the following specific areas:

- design governance
- site characterization (no significant observations to report)
- facility design (no significant observations to report)
- structure design
- system design
- component design

Design governance

CNSC staff reviewed a number of topics under this specific area to develop an overall assessment of design governance. The two topics with significant observations – environmental qualification and human factors in design – are reported on below.

Environmental qualification

The environmental qualification (EQ) program ensures that all required SSCs are capable of performing their designated safety function in a postulated harsh environment resulting from design-basis accidents.

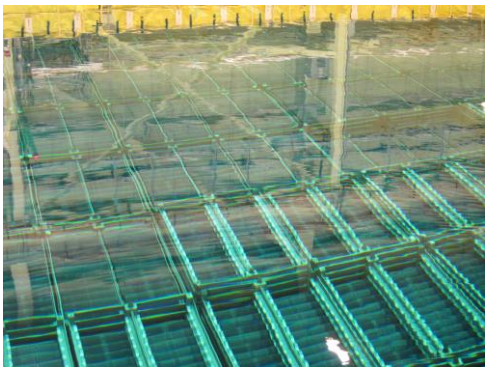
Overall, the industry continued to perform well in this area, and all stations are rated "satisfactory". The licensees' EQ programs implemented at all NPPs are compliant with N290.13-05, *Environmental qualification of equipment for CANDU nuclear power plant* [20]. Although all licensees have mature EQ programs, maintaining a high standard in this area is becoming a greater challenge due to increased reactor aging.

Human factors in design

In December 2014, N290.12-14, *Human factors in design for nuclear power plants* [21], was published as an industry-led initiative. This standard was designed to work in conjunction with N286-05, *Management system requirements for nuclear power plants* [8] and reflects the operating experience of Canadian NPPs. In 2015, the CNSC will develop plans for implementing this standard within each NPP licensing basis.

Structure design

Through action items that were raised following the Fukushima Daiichi accident, all licensees completed evaluations of the structural integrity of their irradiated fuel bays at high temperatures. The evaluations were performed to understand the expected response of the reinforced concrete structural behaviour of the bays under beyond-design-basis condition where the internal temperature may rise up to 100ºC. CNSC staff are satisfied with the structural evaluations and mitigation plans for potential leakage.



Used fuel is stored in irradiated fuel bays for 6 to 10 years of wet storage. The fuel is then transferred to dry storage casks for longer term management.

CNSC staff verified that there were no issues regarding structural design in 2014. CNSC staff concluded that the structural design continued to meet CNSC regulatory requirements for the design basis in all NPPs.

System design

CNSC staff reviewed a number of topics, listed below, to develop an overall assessment of system design.

Reactor control, process and control, and instrumentation and control, including software

The industry has improved the performance and reliability of instrumentation and control systems through the verification of compliance with code and standards, and the corrective maintenance program. All stations met the performance objectives in this area.

Service water, including emergency service water systems

The service water systems provide water to a large number of components and systems. However, from the perspective of nuclear safety, the most important service water loads are associated with:

- the removal of heat in the reactor core (such as moderator heat exchanger cooling and end-shield cooling)
- cooling functions to ensure proper functioning of SSCs important to safety (such as instrument air compressors and boiler room air cooling units)

During 2014, the service water systems functioned well at each station. CNSC staff identified no significant compliance issues.

Electrical power systems

Electrical power systems are important for cooling, controlling, containing and monitoring the reactor and auxiliary systems. To address the various electrical requirements within a nuclear power plant, electrical power systems are subdivided according to groups (I and II), classes (I, II,

III and IV) and divisions (odd and even). The systems are designed, operated and maintained to supply power to safety-related loads to meet the nuclear safety requirements of the plant.

During 2014, the overall performance of the electrical power systems was satisfactory across all stations.

Fire protection design

In 2014, all NPPs continued to maintain satisfactory fire protection programs. Licensees require a comprehensive fire protection program (a set of planned, coordinated, controlled and documented activities) to ensure that the licensed activities do not result in unreasonable risk to the health and safety of persons and to the environment due to fire, and to ensure that the licensee is able to efficiently and effectively respond to emergency fire situations.

Fire protection provisions are applicable to all work related to the design, construction, operation, and maintenance of the nuclear facility, including SSCs that directly support the plant and the protected area.

Seismic qualification

All NPP licensees have established seismic qualifications for their sites.

All licensees have performed site-specific seismic hazard analyses. The Point Lepreau analysis was undergoing a third party review in 2014 and the final site-specific seismic hazard assessment was submitted in May 2015. CNSC and Natural Resources Canada staff are reviewing the assessment. However, NB Power's previous PSA-based seismic margin assessment demonstrates the ability of the facility to maintain core safety functions for earthquakes exceeding the design basis. Therefore CNSC staff concluded that these analyses – along with the seismic safety evaluations – demonstrate that there is high confidence in the ability of the stations to maintain core safety functions for earthquakes exceeding the design basis.

Robustness design

Robustness design and assessment covers the physical design of nuclear facilities for sufficient robustness against anticipated threats, such as protection against a malevolent aircraft crash. The assessment and ratings for this specific area are based on licensee performance in meeting the commitments made to CNSC staff, including the submission of detailed aircraft impact assessments. Licensees have demonstrated, through analysis using conservative initial assumptions and significant safety margins, that vital areas and critical SSCs are protected to the extent that no offsite consequences are expected for general aviation aircraft impact.

CNSC staff have fully addressed concerns regarding defence in depth and the regulatory oversight of NPPs in Canada with respect to high-risk malevolent acts that are characterized as beyond-design-basis threats. Operating licences and licence conditions handbooks (LCHs) will be updated to reflect the expectations and compliance verification criteria related to robustness design with reference to the series of International Atomic Energy Agency (IAEA) safety reports on protecting NPPs against human-induced events. These reports are scheduled to be published by the end of 2015. CNSC staff had a leading role in drafting these safety reports.

CNSC staff requested that licensees carry out reassessments to resolve residual compliance issues identified at their stations, and to do the reassessments using CNSC staff-developed aircraft impact loading functions for large commercial aircraft crash impact. Licensees responded with additional assessments of the bounding scenarios and their submissions were reviewed by CNSC staff and presented to the Commission in December 2014. The focus of the review was on

mitigating the potential consequences of these accidents. CNSC staff have opened site-specific action items as a follow-up for the implementation of the CNSC's recommendations.

Component design

Fuel inspection program

All operating NPPs had well-developed reactor fuel inspection programs during 2014.

However, there were issues at most stations in fuel performance and the specific issues for each station are detailed in section 3. Licensees continue to work to resolve these outstanding issues. CNSC staff will continue to monitor the licensees' progress.

Cables

Cables have key importance to the safe and reliable operation of NPPs due to their widespread use as the connection medium with many systems important to safety. Canada's operating reactors are aging and cables are affected by the aging process. Therefore, licensees have implemented cable condition monitoring or surveillance programs, and cable aging management programs, which are responsible for the assessment, over time, of cable insulation degradation and the associated trend. Based on compliance verification activities, the CNSC concluded that the licensees have demonstrated acceptable progress in the development and implementation of their respective programs and that the cables at NPPs are safe. CNSC staff are satisfied with the licensees' overall performance in this area.

2.1.6 Fitness for service

The fitness for service SCA covers activities that affect the physical condition of SSCs to ensure that they remain effective over time. This includes programs that ensure that all equipment is available to perform its intended design function when called upon to do so. The industry average rating for fitness for service was "satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the fitness for service SCA at NPPs met all applicable regulatory requirements.

Fitness for service ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	SA	SA	SA	SA	SA

Fitness for service encompasses the following specific areas:

- equipment fitness for service/equipment performance
- maintenance
- structural integrity
- aging management
- chemistry control
- periodic inspection and testing

Equipment fitness for service/equipment performance

All licensees met regulatory requirements in this specific area and safety and control measures implemented were effective.

Maintenance

Maintenance inspections carried out in 2014 did not identify any major compliance issues.

Although usually not safety-significant in themselves, maintenance backlogs are monitored by CNSC staff because they can be a useful indicator of overall maintenance effectiveness and plant operation. In particular, the corrective maintenance backlog and the deficient maintenance backlog are reviewed. There will always be a certain level of backlog, due to normal work management processes and equipment aging. Corrective and deficient maintenance backlog levels at most stations both improved during 2014. CNSC staff will continue to focus on these backlogs until all stations meet industry best practice levels.

Preventive maintenance at an NPP.

S-210, *Maintenance Programs for Nuclear Power Plants* [22] has been incorporated into the licences of all operating NPPs. In December 2012, the new regulatory document, RD/GD-210, *Maintenance Programs for Nuclear Power Plants* [23], was published. Since RD/GD-210 retains the same requirements as S-210, no plan is needed by licensees to transition to RD/GD-210. All licensees were in compliance with the requirements in RD/GD-210.

Structural integrity

All operating NPP licensees continued to inspect and demonstrate structural integrity of NPP components and structures, such as those for pressure boundary systems, containment systems or safety-significant balance-of-plant (BOP) systems, in accordance with the station's periodic inspection programs (PIPs) and the applicable standards.

To develop the engineering methodologies and analytical tools to assess the fitness for service of pressure tubes operating beyond their original assumed design life, OPG, Bruce Power and AECL (now Canadian Nuclear Laboratories Ltd.) developed the Fuel Channel Life Management Project (FCLMP) in 2009 under the administration of the COG. CNSC staff are reviewing submissions based on the methodologies (new pressure tube fracture toughness models, and new methodologies for probabilistic leak before break or PLBB) developed under FCLMP. CNSC staff have accepted the licensees' plans, and are currently reviewing new PLBB assessments from Bruce Power and OPG.

The CNSC staff's PIP compliance monitoring activities included the review of governing program documents and inspection reports, and the disposition of inspection findings submitted in accordance with the relevant CSA Group (formerly called Canadian Standards Association (CSA)) standards and S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. CNSC staff also monitored the licensees' quarterly pressure boundary reports, operations reports and specific event reports, for evidence of degradation of safety-significant SSCs.

Inspections and tests were performed by the operating NPP licensees on the pressure boundary and concrete containment SSCs, in compliance with the scope of N285.4, *Periodic inspection of CANDU nuclear power plant components* [24], N285.5, *Periodic inspection of CANDU nuclear power plant containment components* [25], and N287.7, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants* [26]. CNSC staff reviewed the results of these inspections and tests and identified no component degradation that would affect nuclear safety.

Reliability of systems important to safety

As determined through the reviews of station reports, all licensees were in compliance with the regulatory requirements described in RD/GD-98, *Reliability Programs for Nuclear Power Plants* [27].

NPP licensees are required to report annually to the CNSC the results of their reliability program in accordance with S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. This includes the reliability of the multiple special safety systems available on all CANDU reactors operating in Canada that provide protection against unlikely but possible process system failures and thus ensure safety. These special safety systems include two shutdown systems which are independent of each other. The first system uses shutoff rods, which drop into the reactor core by gravity, with an initial spring assist. The second system uses the injection of a neutron-absorbing solution into the moderator. At no time are the shutdown systems allowed to be ineffective. In some rare circumstances their capability might be reduced, but coverage is always assured by the other redundant system and immediate actions are always taken by the operating crew to restore the capability. At least one shutdown system will operate, if required, following any process system failure. In addition to the special safety systems, the CANDU design provides other safety-related systems and features to solely perform safety functions. No reactor is allowed to operate unless the safety systems are available. If unavailability is detected, immediate actions are taken to ensure that safety is maintained at all times.

Overall, the special safety systems performed well with respect to meeting their unavailability targets with the exceptions as noted in section 3. Notwithstanding backup systems in place, licensees took appropriate actions to address the incidents leading to unavailability, and corrective actions were put in place.

Safety system test performance indicates the number of missed safety system tests required by licence conditions. It is a measure of a licensee's ability to successfully complete routine tests on safety-related systems, and to calculate the predicted availability of systems. Data for the stations and industry as a whole is shown in table 5 and figure 6.

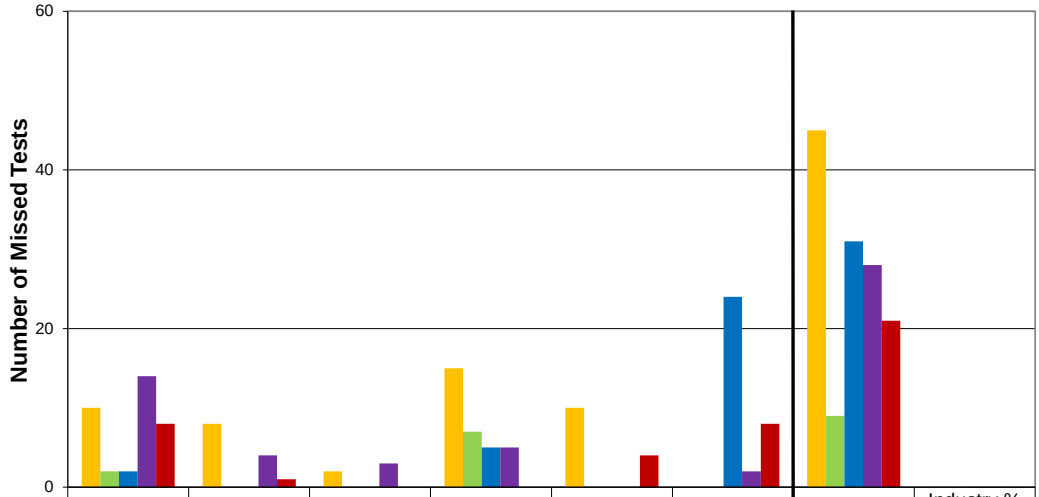
The number of missed safety system tests decreased from 28 in 2013 to 21 in 2014. The total number of tests performed was 73,595. The overall industry percentage of missed tests remained very low at 0.03 percent. The number of missed tests represents negligible risk since the tests will be performed in the next outage or shortly after the required time. Also, the safety systems involved in the tests have sufficiently high redundancy to ensure continuous safety system availability. As can be seen in table 5, Gentilly-2 had a relatively high number of missed tests at 0.50 percent; however, given the shutdown state of the facility and the transition to safe storage, this did not affect the safety of the NPP.

Table 5: Safety system test performance for 2014

NPP	Annual total number of tests	Missed safety system tests				Missed tests [percent]
		Special safety systems	Standby safety systems	Safety-related process systems	Total	
Bruce A	16,182	2	5	1	8	0.05
Bruce B	12,107	1	0	0	1	0.01
Darlington	14,400	0	0	0	0	0.00
Pickering	17,424	0	0	0	0	0.00
Gentilly-2	794	0	0	4	4	0.50
Point Lepreau	12,688	5	2	1	8	0.06
Industry total	73,595	8	7	6	21	0.03

* Safety systems tests consists of special safety systems tests, standby safety systems tests and safety-related process system tests

Figure 6: Trend details of safety system test performance for stations and industry



	Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry Total	Industry % Missed Tests
2010	10	8	2	15	10	n/a	45	0.05%
2011	2	0	0	7	0	n/a	9	0.01%
2012	2	0	0	5	0	24	31	0.03%
2013	14	4	3	5	0	2	28	0.04%
2014	8	1	0	0	4	8	21	0.03%

Aging management

All operating NPPs have implemented processes and programs that ensure the condition of SSCs important to safety is understood and that required activities are in place to ensure the health of these SSCs as a plant ages. REGDOC-2.6.3, *Aging Management* [28], which supersedes RD-334, *Aging Management for Nuclear Power Plants* [29], was published in 2014 and sets out the CNSC's requirements for aging management programs during each stage of the plant life,

including operation and safe-storage for decommissioning. All operating NPPs are reviewing and updating their processes and programs in accordance with the updated regulatory document. All operating NPPs have component-specific aging management programs, also known as lifecycle management programs, for the major primary heat transport components of their CANDU reactors (feeders, pressure tubes and steam generators) and for concrete containment structures and BOP safety-related civil structures. CNSC staff conducted onsite inspections in accordance with the compliance verification program to confirm the licensees' implementation of their aging management programs.

Hydro-Québec is preparing an aging management program suitable for the safe storage state of Gentilly-2. CNSC staff will continue to follow-up on this activity in 2015.

A new CSA standard is currently being developed to establish aging management requirements for concrete containment structures and is planned for release by 2016. The future adoption of this standard in operating licences will establish consistent, industry-wide aging management program requirements for concrete containment structures.

Chemistry control

Canadian NPPs maintained good chemistry performance as indicated by S-99 [7] performance indicators. Important nuclear safety-related chemistry parameters such as moderator liquid poison and moderator cover gas deuterium were maintained within specification limits.

Periodic inspections and testing

Inspection and testing of NPP components and structures, such as those for pressure boundary systems, containment systems or safety-significant BOP systems, are mandatory requirements in all operating licences. Applicable CSA standards and CNSC regulatory documents define these requirements, which are continually updated by the responsible organization to reflect important operating experience. As a result, all operating NPPs have inspection and testing programs in place to provide ongoing monitoring of the fitness for service and structural integrity of their safety-significant SSCs.

Results of these inspections and tests are submitted to CNSC staff, after every inspection campaign, in accordance with reporting requirements. CNSC staff performed desktop reviews of the submissions and conducted onsite inspections to verify the licensees' implementation of their periodic inspection and testing programs for operating NPPs. During the reporting period, CNSC staff did not identify compliance issues affecting operating NPP safety in this area.

Hydro-Québec is preparing an inspection management program suitable for the safe storage state of Gentilly-2. CNSC staff will continue to follow-up on this activity in 2015.

N291-08, *Requirements for safety-related structures for CANDU nuclear power plants* [30], is currently being revised to update the requirements, including inspection, for the BOP safety-related civil structures, and is planned for release by 2016.

2.1.7 Radiation protection

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that surface contamination levels and radiation doses received by individuals are monitored, controlled and

maintained as low as reasonably achievable (ALARA). The industry average rating for the radiation protection SCA was "satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the radiation protection SCA at NPPs met all applicable regulatory requirements and that doses to workers and members of the public were below regulatory limits.

Radiation protection ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	FS	FS	SA	SA	SA

Radiation protection encompasses the following specific areas:

- application of ALARA
- worker dose control
- radiation protection program performance
- radiological hazard control
- estimated dose to the public

The data presented is based on the radiation exposure records for every individual monitored at a Canadian NPP. The 2014 NPP Report presents and analyzes these dose records with respect to annual collective dose,[1] average measurable effective dose,[2] and the distribution of doses among the monitored individuals.

Figures 7, 8 and 9 present the measurable doses (average and maximum) and dose distributions based on the dose records provided by each NPP.

Application of ALARA

As required by the *Radiation Protection Regulations*, all NPP licensees continued to implement radiation protection (RP) measures to keep the doses to persons ALARA, taking into account social and economic factors.

In 2014, the collective dose for monitored individuals at all Canadian NPPs was 17.2 person-sieverts (p-Sv). This represents an increase of approximately 7 percent compared to the industry-wide collective dose reported for 2013 (of 16.1 p-Sv). The number of persons who received a measurable dose in 2014 remained comparable to 2013 values (from 7,426 in 2013 to 7,411 in 2014).

The annual average effective measurable dose in 2014 for all Canadian NPPs was 2.32 millisieverts (mSv), an increase of approximately 7 percent from the 2013 value of 2.17 mSv.

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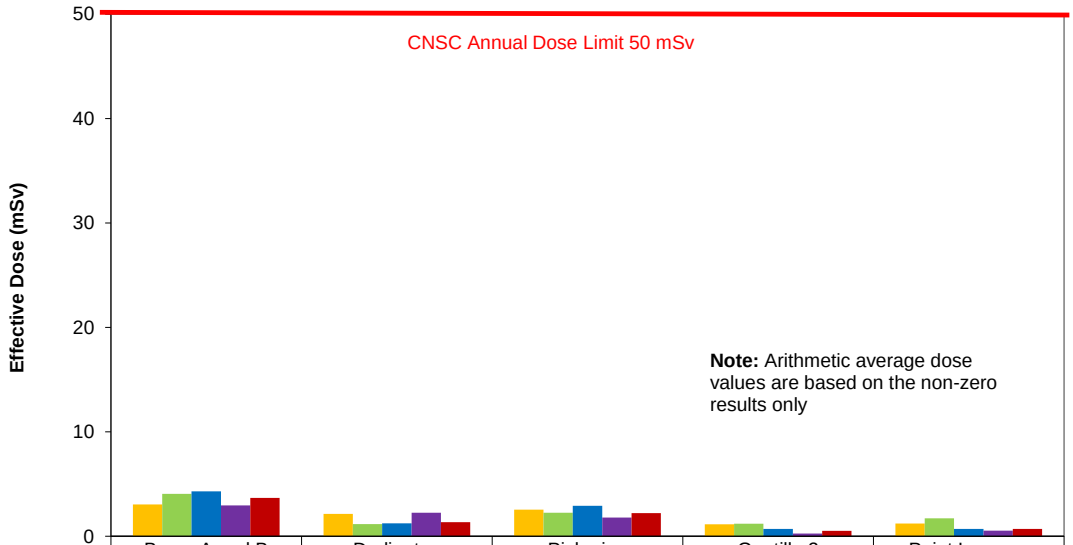
1 The annual collective dose is the sum of the effective doses received by all the workers at that NPP in a year. It is measured in person-sieverts (p-Sv).

2 The "average measurable effective dose" or "average effective dose – non-zero results only" is obtained by dividing the total collective dose by the total number of individuals receiving a measurable dose. The minimum reporting level to be considered "measurable" is 0.01 mSv

Figure 7 shows the average measurable effective doses to workers at each Canadian NPP for the period from 2010 to 2014. This figure shows that for 2014 the average measurable effective dose at each station ranged from 0.52 to 3.68 mSv per year.

The average dose fluctuations from year to year reflect the type and scope of work being performed at each facility, and no negative trends were identified in 2014. A minimal, industry-wide increase in worker occupational dose exposures (e.g., higher industry-wide collective and average dose for workers) was identified in 2014, with the exception of Darlington. The annual collective effective dose for workers at each NPP is presented in appendix D.

Figure 7: Average effective doses to workers at each Canadian nuclear power plant, 2010 to 2014



	Bruce A and B	Darlington	Pickering	Gentilly-2	Point Lepreau
2010	3.04	2.14	2.54	1.15	1.22
2011	4.06	1.16	2.26	1.20	1.72
2012	4.30	1.24	2.92	0.71	0.70
2013	2.95	2.25	1.79	0.25	0.54
2014	3.68	1.35	2.21	0.52	0.70

Worker dose control

As required by the *Radiation Protection Regulations*, all Canadian NPP licensees implemented radiation protection programs to control the doses received by nuclear energy workers (NEWs).

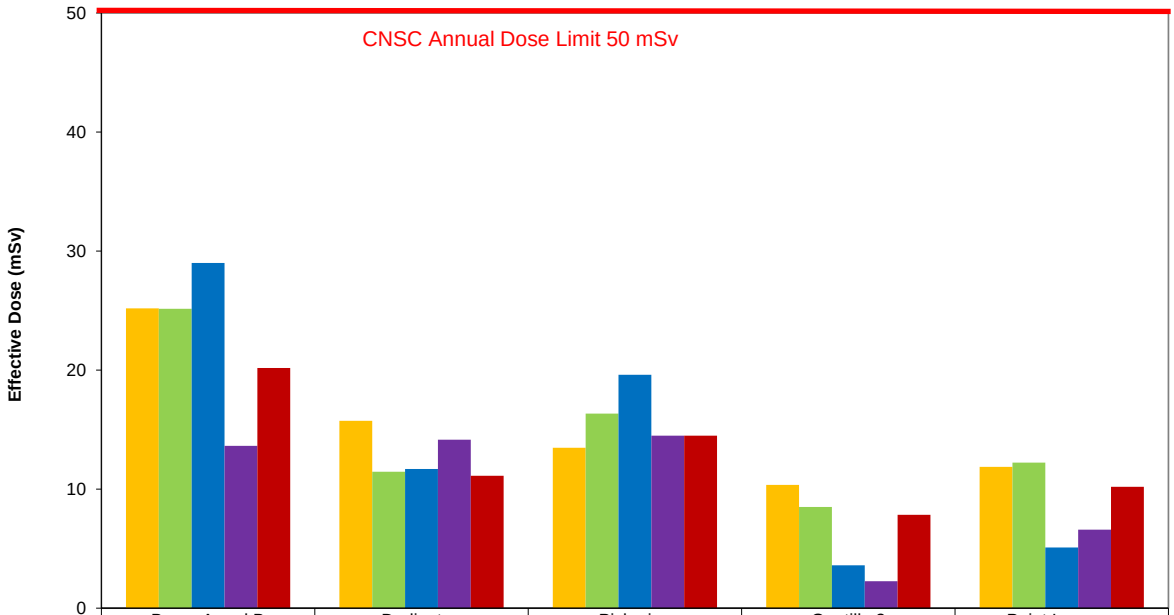
In addition to regulatory dose limits[3], all Canadian NPP licensees have established action levels[4] for worker exposures that are set below the regulatory dose limits. During 2014, no worker at any NPP received a radiation dose that exceeded the regulatory dose limits.

[3] The effective dose limits for NEWs are 50 millisievert (mSv) per year and 100 mSv over a five-year fixed dosimetry period.

[4] An action level is defined in the *Radiation Protection Regulations* as a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program and triggers a requirement for specific action to be taken.

The maximum annual individual effective doses as reported for each NPP for the period 2010 to 2014 are presented in figure 8. In 2014, the maximum individual effective dose received was 20.17 mSv at the Bruce site.

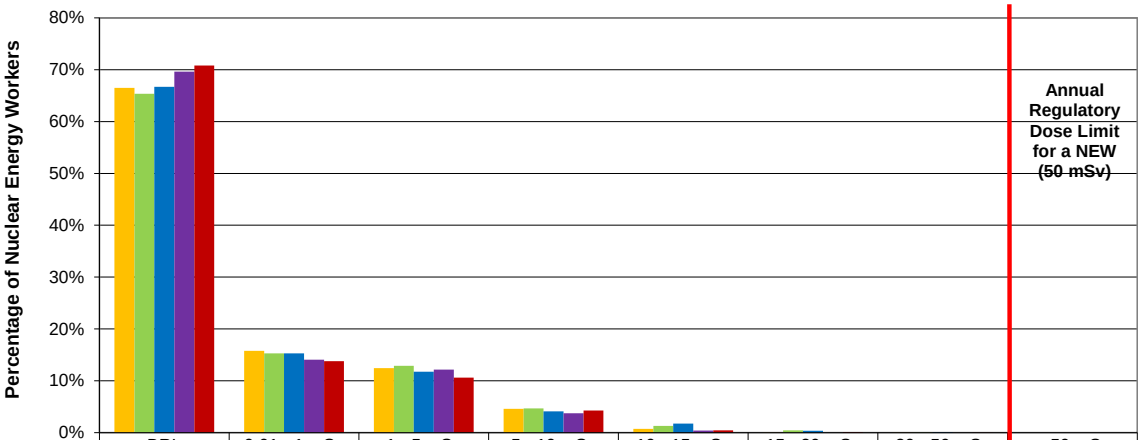
Figure 8: Maximum effective doses to workers at each Canadian nuclear power plant, 2010 to 2014



	Bruce A and B	Darlington	Pickering	Gentilly-2	Point Lepreau
2010	25.18	15.74	13.47	10.36	11.88
2011	25.16	11.47	16.34	8.51	12.22
2012	29.00	11.70	19.60	3.60	5.10
2013	13.63	14.15	14.50	2.26	6.59
2014	20.17	11.13	14.50	7.85	10.20

Figure 9 provides the distribution of annual effective doses to workers at all Canadian NPPs from 2010 to 2014 according to dose information provided by each licensee. Figure 9 shows that in 2014, there were no radiation exposures reported at any Canadian NPP that exceeded the annual regulatory dose limits and that approximately 85 percent of worker doses reported were at or below the annual regulatory dose limit of 1 mSv for non-NEWs.

Figure 9: Distribution of annual effective doses to workers at Canadian NPPs, 2010 to 2014



Year: Number of Workers Monitored	BRL	0.01 - 1 mSv	1 - 5 mSv	5 - 10 mSv	10 - 15 mSv	15 - 20 mSv	20 - 50 mSv	> 50 mSv
2010: 31,104	66%	16%	12%	5%	1%	0.03%	0.003%	0%
2011: 28,974	65%	15%	13%	5%	1%	0.4%	0.07%	0%
2012: 27,532	67%	15%	12%	4%	2%	0.3%	0.1%	0%
2013: 24,440	70%	14%	12%	4%	0.4%	0%	0%	0%
2014: 25,378	71%	14%	11%	4%	0.4%	0.09%	0.01%	0%

Dose Range (mSv)

Note: The sum of the percentages may not add up to 100%, due to rounding.
BRL: Below Reportable Level (below 0.01 mSv)

Radiation protection program performance

CNSC staff performed regulatory oversight activities in the area of radiation protection at all NPPs during 2014 in order to verify compliance of the licensees' RP programs with regulatory requirements. This regulatory oversight consisted of reviews of RP program and performance documents and radiation protection-specific inspections at all NPPs. Routine surveillance of the licensees' performances in the area of radiation protection were also conducted by onsite inspectors at each NPP.

Through these oversight activities, CNSC staff confirmed that all Canadian NPP licensees have adequately implemented their RP programs to control occupational exposures to workers.

Radiological hazard control

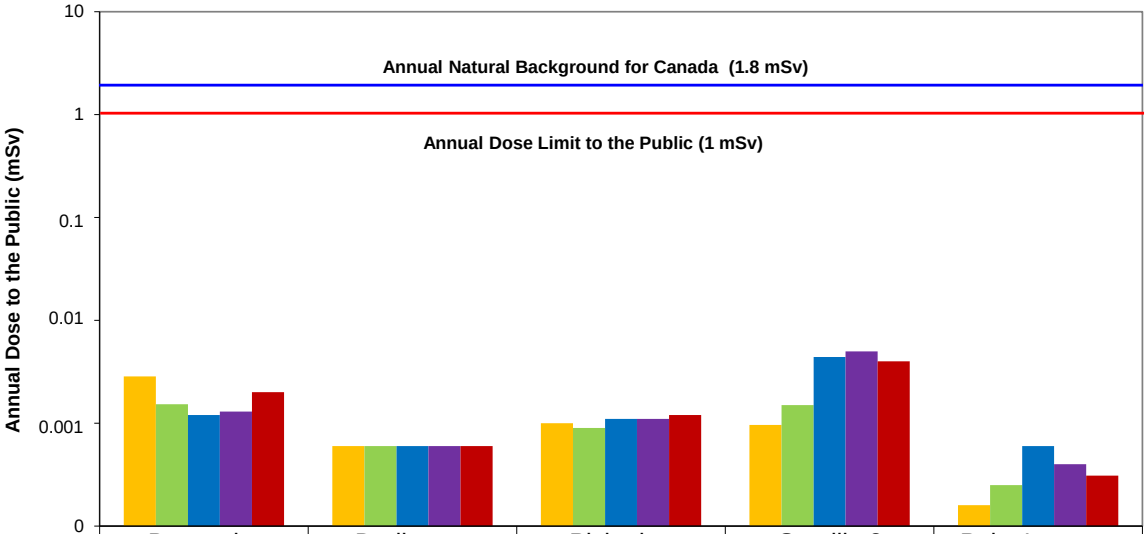
All NPP licensees have implemented radiation protection programs to ensure that adequate measures are in place to monitor and control radiological hazards in their facilities. These measures include, but are not limited to, the use of radiological zoning systems, ventilation systems that control the direction of air flow, air monitoring instrumentation and radiation monitoring equipment at zone boundaries. All NPP licensees continued to implement their workplace monitoring programs to protect workers and demonstrate that levels of radioactive contamination are controlled within the site boundary.

Estimated dose to public

The estimated dose to the public for both airborne emissions and liquid releases from 2010 to 2014 are provided in figure 10 (please note the use of a logarithmic scale). This figure shows that the doses to the public are below the annual regulatory public dose limit of 1 mSv.

The comparison shows that the 2014 doses to the public for Canadian NPPs are within the general range of the 2010 to 2013 values for most stations.

Figure 10: Comparison of estimated dose to the public from Canadian nuclear power plants, 2010 to 2014*



	Bruce site	Darlington	Pickering	Gentilly-2	Point Lepreau
2010	0.0029	0.0006	0.0010	0.0010	0.0002
2011	0.0015	0.0006	0.0009	0.0015	0.0003
2012	0.0012	0.0006	0.0011	0.0044	0.0006
2013	0.0013	0.0006	0.0011	0.0050	0.0004
2014	0.0020	0.0006	0.0012	0.0040	0.0003

Annual Dose (mSv)

* Note that a logarithmic scale is used for the purpose of direct comparison.

2.1.8 Conventional health and safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment. The industry average rating for conventional health and safety was "fully satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the conventional health and safety SCA at NPPs met or exceeded all applicable regulatory requirements.

Conventional health and safety ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
FS	FS	SA	SA	SA	FS	FS

Conventional health and safety encompasses the following specific areas:

- performance
- practices
- awareness

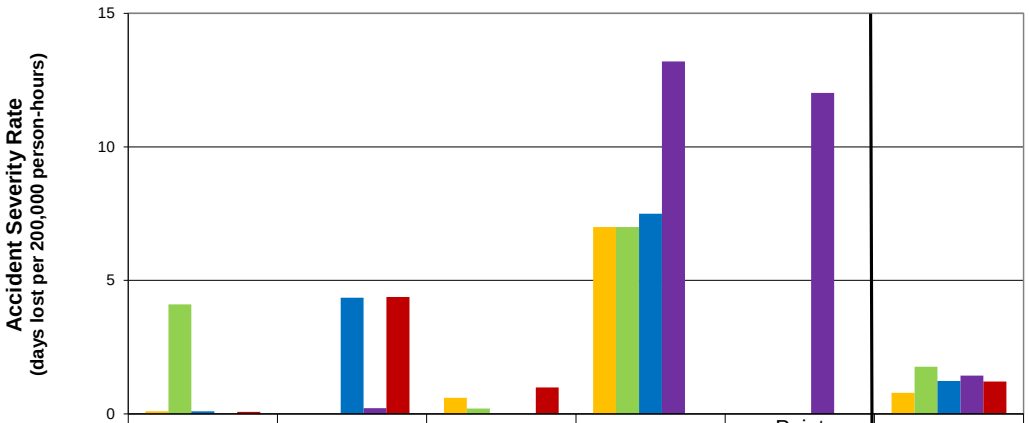
Performance

The accident severity rate (ASR) and accident frequency (AF) are two parameters reported by NPP licensees that measure the effectiveness of the conventional health and safety program with respect to worker safety. The ASR measures the total number of days lost due to injury for every 200,000 person-hours (approximately 100 person-years) worked at an NPP. The AF is a measure of the number of fatalities and injuries (lost-time and medically treated) due to accidents for every 200,000 person-hours worked at an NPP.

The ASR and AF values for the stations and the industry average are presented in figures 11 and 12, respectively. These figures show that:

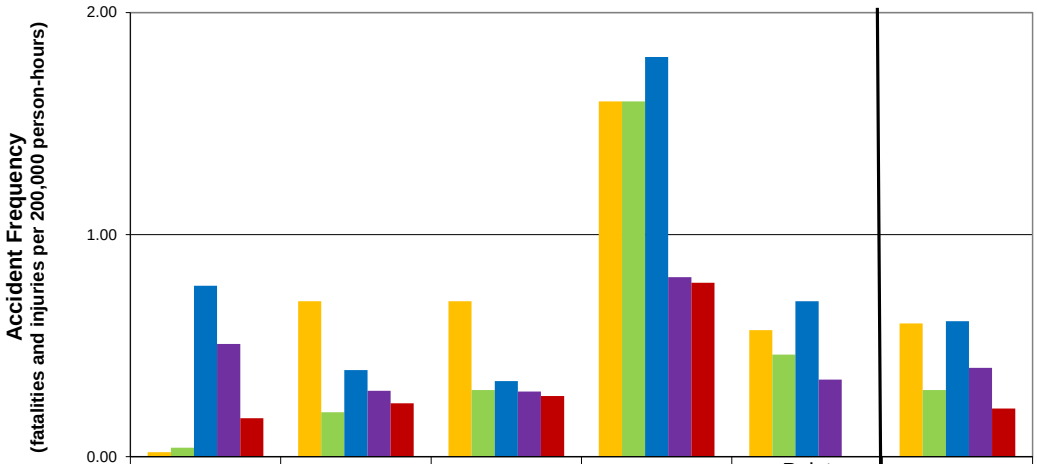
- the ASR values for the industry as a whole decreased slightly from 1.4 in 2013 to 1.2 in 2014. Point Lepreau achieved the lowest ASR, a value of zero. The ASR increased for all stations, except for Point Lepreau and Gentilly-2.
- the AF value for the industry as a whole continued to decrease from 0.40 in 2013 to 0.22 in 2014. Specifically, the AF decreased for all licensees. Point Lepreau achieved the lowest AF, a value of zero.

Figure 11: Trend details of accident severity rate for stations and industry



	Bruce A & B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry
2010	0.1	0.0	0.6	7.0	0.0	0.8
2011	4.1	0.0	0.2	7.0	0.0	1.8
2012	0.1	4.4	0.0	7.5	0.0	1.2
2013	0.0	0.2	0.0	13.2	12.0	1.4
2014	0.1	4.4	1.0	0.0	0.0	1.2

Figure 12: Trend details of accident frequency for stations and industry

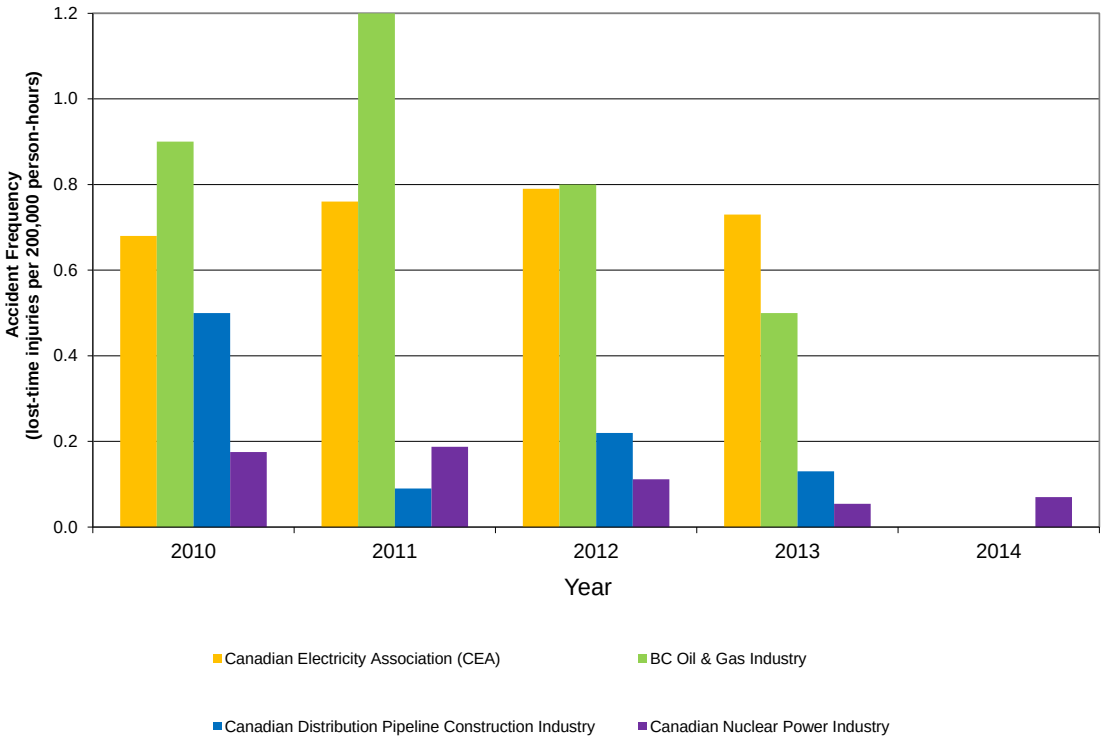


	Bruce A & B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry
2010	0.02	0.70	0.70	1.60	0.57	0.60
2011	0.04	0.20	0.30	1.60	0.46	0.30
2012	0.77	0.39	0.34	1.80	0.70	0.61
2013	0.51	0.30	0.29	0.81	0.35	0.40
2014	0.17	0.24	0.27	0.78	0.00	0.22

Figure 13 shows the AF values for the Canadian nuclear power industry from 2010 to 2014 in comparison with values from selected energy-related Canadian industries. The Canadian industries shown in the figure are Canadian Electricity Association (CEA) members, the BC upstream oil and gas industry, and the Canadian distribution pipeline construction industry.

As shown in figure 13, the AF value for the Canadian nuclear power industry is much lower than those of the selected Canadian energy-related industries. Note that for this graph, only the AF values calculated using the number of lost-time injuries (LTIs) are considered. The AF calculation for figure 13 does not include the number of fatalities and medically treated injuries (MTIs).

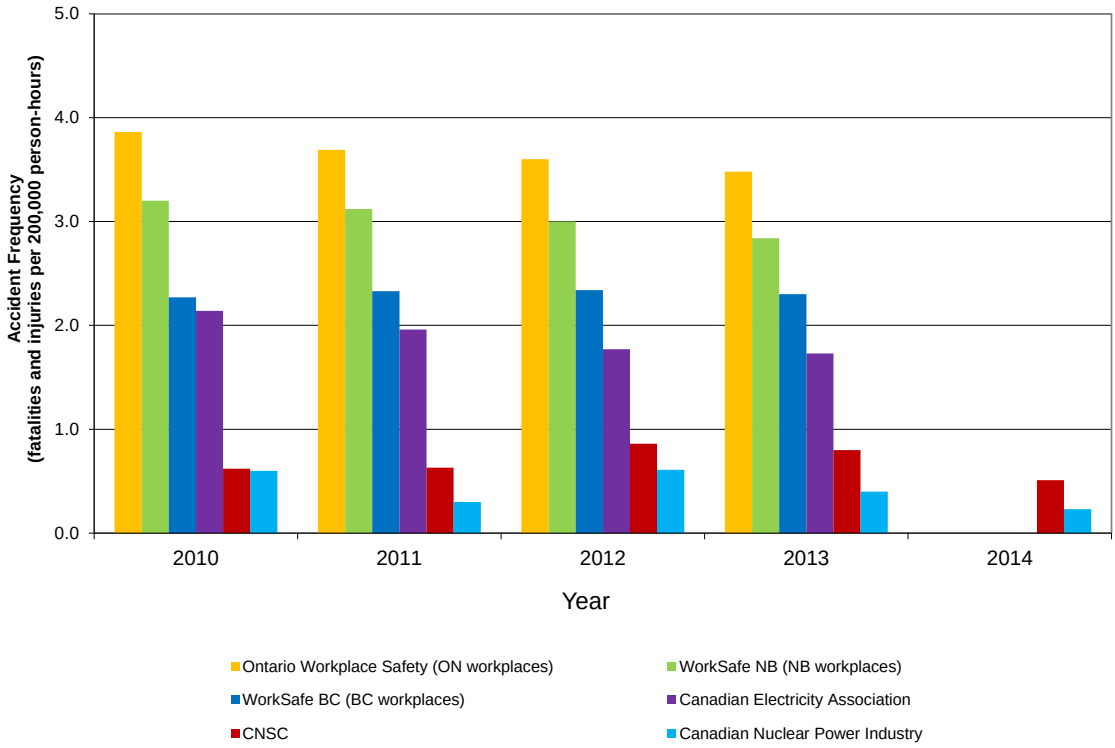
Figure 13: Trend details of accident frequency (based on LTIs only) within the Canadian energy industry



In addition to the information provided in figure 13, figure 14 shows the AF values for Canadian workplaces, where the AF values are based on fatalities, lost-time injuries and medically treated injuries. There were no work-related fatalities at Canadian NPPs in 2014. As shown in figure 14, the Canadian nuclear power industry's AF is lower than that of other Canadian workplaces.

CNSC staff concluded that, for the overall nuclear power industry, the industry ASR and AF remained very low during the year. This is an indication of the strength of the health and safety programs implemented by the nuclear power licensees in Canada.

Figure 14: Trend details of accident frequency (based on fatalities, LTIs and MTIs) for Canadian workplaces



Practices

Each licensee has a conventional health and safety program that was implemented in compliance with the *Canada Labour Code* and/or referenced provincial legislation. CNSC staff determined that all NPP licensees met or exceeded all relevant regulatory requirements in this area.

Awareness

In 2014, NPP licensees met CNSC performance objectives and requirements for this specific area in accordance with their operating licences and licence conditions handbooks. There were no safety-significant issues from compliance verification activities to report. There were minor housekeeping deficiencies and improper storage issues. Licensees are focusing on improvements and CNSC staff will follow-up and continue to monitor licensee's actions with respect to this area.

2.1.9 Environmental protection

The environmental protection SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and the effects on the environment from facilities or as a result of licensed activities. The industry average rating for environmental protection was "satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the environmental protection SCA at NPPs met all applicable regulatory requirements.

Environmental protection ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	SA	SA	SA	SA	SA

Environmental protection encompasses the following specific areas:

- effluent and emissions control (releases)
- environmental management system (no significant observations to report)
- assessment and monitoring (no significant observations to report)
- protection of the public (no significant observations to report)

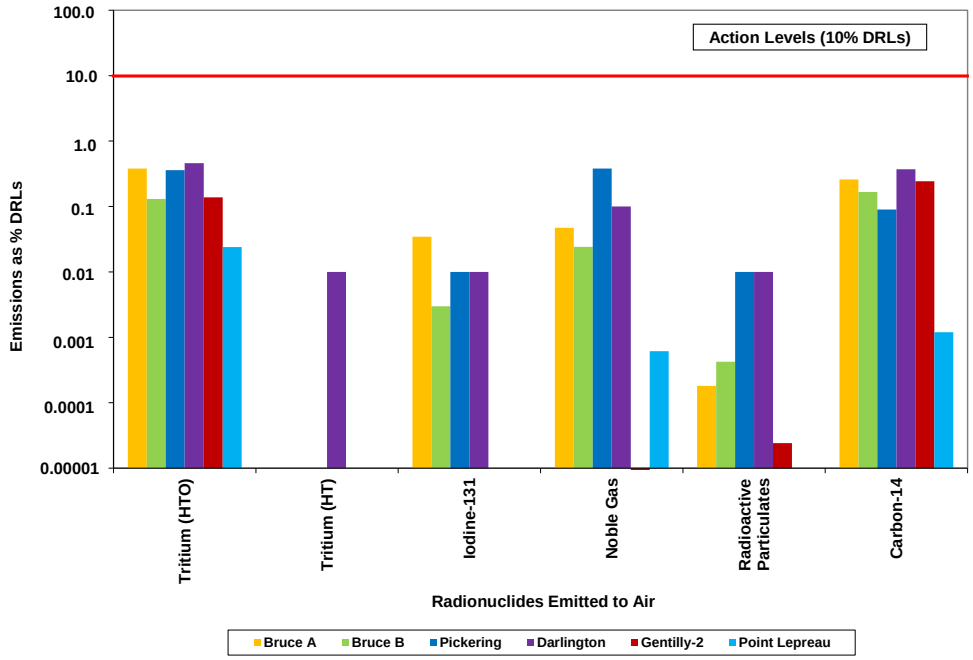
Effluent and emissions control (releases)

Airborne emissions and liquid releases for 2014 are shown in figures 15 and 16. Note that a logarithmic scale is used for the purpose of direct comparison of the radionuclides. Derived release limits (DRLs) have been developed by licensees to ensure release limits to the environment that will not exceed the annual regulatory public dose limit of 1 mSv per year. The DRLs are stated in each operating licence/licence conditions handbook and are given in appendix E, "Derived release limits (DRLs) for Canadian nuclear power plants".

Licensees establish action levels that are set at 10 percent of the DRLs. Action levels, if reached, could indicate a loss of control of part of a licensee's environmental program and the need for specific actions to be taken and reported to the CNSC.

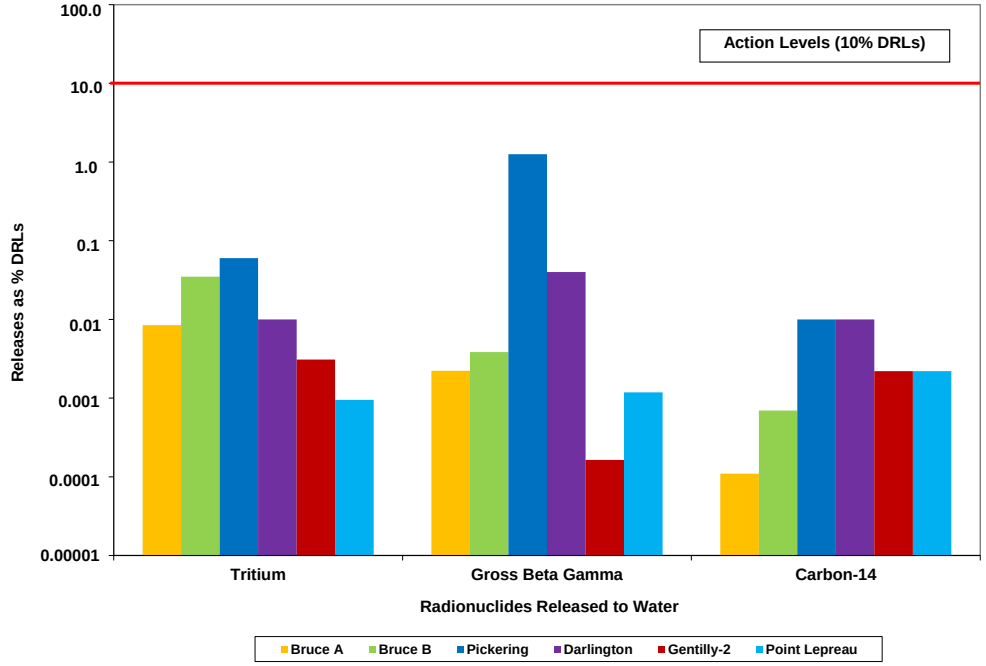
During 2014, all releases were below action levels and almost negligible compared to the derived release limits.

Figure 15: Radionuclides emitted to air by Canadian nuclear power plants in 2014*



* Note that a logarithmic scale is used for the purpose of direct comparison of the radionuclides.

Figure 16: Radionuclides emitted to water by Canadian nuclear power plants in 2014*



* Note that a logarithmic scale is used for the purpose of direct comparison of the radionuclides.

2.1.10 Emergency management and fire protection

The emergency management and fire protection SCA covers emergency plans and emergency preparedness programs for dealing with radiological, nuclear and conventional emergencies. It also includes the results of participation in exercises during the year. For the specific area of fire emergency preparedness and response, only the performance of the fire response organization is addressed in this SCA. Design issues are described under section 2.1.5. Based on the data collected and the observations made during CNSC inspections, the industry average for emergency management and fire protection was rated as "satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that NPP licensees continued to maintain comprehensive and well-documented emergency management programs that met all applicable regulatory requirements.

Emergency management and fire protection ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	SA	SA	SA	SA	SA

Emergency management and fire protection encompasses the following specific areas:

- conventional emergency preparedness and response
- nuclear emergency preparedness and response
- fire emergency preparedness and response

Conventional emergency preparedness and response

All licensees continued to maintain and improve their conventional emergency preparedness and response capabilities at their respective facilities. CNSC staff verified the response programs against the regulatory criteria set out in the operating licences and licence conditions handbooks. Maintenance of proficiency within this area was maintained through training programs, drills and exercise programs.

CNSC staff member inspecting portable diesel emergency water pumps. These can be used in emergency situations to keep water circulating in the reactor.

Nuclear emergency preparedness and response

All licensees continued to maintain and improve their nuclear emergency preparedness and response capabilities. CNSC staff verified the response programs against the regulatory criteria set out in the operating licences and LCHs. Maintenance of proficiency within this area was achieved through training programs, drills and exercise programs.

Fire emergency preparedness and response

All licensees continued to maintain and improve their fire protection and response programs at their respective facilities. CNSC staff verified the response programs against the regulatory criteria set out in the operating licences and licence conditions handbooks. Maintenance of proficiency within this area was achieved through training programs, drills and exercise programs.

2.1.11 Waste management

The waste management SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility. This SCA also covers any planning for eventual decommissioning of the facility. The industry average rating for the waste management SCA in 2014 was "fully satisfactory", which is an improvement from the "satisfactory" rating in 2013.

Overall, based on the information assessed, CNSC staff concluded that the waste management SCA at NPPs met or exceeded all applicable regulatory requirements.

Waste management ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
FS	FS	FS	SA	SA	SA	FS

Waste management encompasses the following specific areas:

- waste characterization
- waste minimization
- waste management practices
- decommissioning plans

Waste characterization

There were no significant issues from compliance verification activities to report in this specific area for 2014. All licensees met the CNSC's requirements for this specific area during the year. Furthermore, CNSC staff concluded that the performance in this specific area was satisfactory.

Waste minimization; waste management practices

CNSC staff determined that Bruce A and B and Darlington have highly effective waste management programs for the minimization, segregation, handling, monitoring and processing of radioactive and hazardous wastes. The remaining licensees have effective programs for radioactive and hazardous wastes. According to assessment of the hazard levels, all radioactive waste was disposed of appropriately in compliance with regulatory requirements and licensees' procedures.

Decommissioning plans

Licensees are required to maintain an acceptable decommissioning plan that sets out how the facility will be decommissioned in the future. This plan must be reviewed and updated by the licensee on a regular five-year schedule. The plan also forms the basis for developing a cost

estimate for decommissioning. The associated financial guarantee gives the assurance that funds for decommissioning will be available when the facility is ready to be dismantled.

NPP licensees in Canada have a financial guarantee that has been accepted by the Commission. In all cases, the decommissioning strategy proposed by the licensees is to allow for an extended period of storage with surveillance after the end of normal operations (which allows for radioactive decay) under the authority of a licence three or four decades prior to the onset of active dismantling.

With the closure of the Gentilly-2 in late 2012, Hydro-Québec's decommissioning plan as well as the related cost estimate and financial guarantee needed to be updated. New versions of these documents were submitted by the licensee in March 2015 and will be reviewed by CNSC staff.

2.1.12 Security

The security SCA covers the programs that licensees are required to implement and that support the security requirements stipulated in the regulations, in their licences, in orders or in expectations for their facilities or activities. The industry average rating for security was "fully satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the security SCA at NPPs met or exceeded all applicable regulatory requirements.

Security ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
FS	FS	FS	FS	SA	SA	FS

Security encompasses the following specific areas:

- facilities and equipment
- response arrangements
- security practices
- drills and exercises

Measures to effectively prevent theft or sabotage of nuclear material in use, storage or transport are in place at all licensed NPPs. There have been no significant adverse findings as a result of routine inspection and other compliance verification activities or reportable events regarding the nuclear security programs at NPPs during the review period.

The security evaluations are based on findings made throughout the year from inspections and desktop reviews as well as through performance testing. Licensees are sustaining their programs through life-cycle management and modernization of security equipment.

Facilities and equipment

Activities associated with major equipment upgrades, including screening devices to be used prior to entry into the protected area and response vehicles for nuclear security officers, are completed at NPP locations. All NPP licensees met the requirements of CNSC regulatory documents RD-321, *Criteria for Physical Protection, Systems and Devices at High Security Sites* [31] and RD-361, *Criteria for Explosive Substance Detection, X-ray Imaging, and Metal*

Detection Devices at High-Security Sites [32]. Screening processes for entry or exit from the protected area have been satisfactory at all sites. Licensees are maintaining protected area physical protection systems, such as vehicle denial barriers, perimeter fences, perimeter intrusion detection and alarm assessment devices in accordance with regulations and regulatory requirements.

Response arrangements

NPP licensees are maintaining robust nuclear response forces (NRFs) at their facilities. The NRFs are supported by offsite response forces such as the Ontario Provincial Police and the Royal Canadian Mounted Police, through memoranda of understanding. Nuclear security officers continue to meet the requirements of CNSC regulatory document RD-363, *Nuclear Security Officer Medical, Physical and Psychological Fitness* [33]. CNSC staff verified that the licensees' NRFs are supported by effective training programs. Licensees are providing action plans for implementing CNSC regulatory document REGDOC-2.12.1, *Nuclear Response Force* [34]. CNSC staff will monitor the progress of the document's implementation at each NPP in 2015.

Security practices

NPP licensees have effective security programs that meet the requirements of the *Nuclear Security Regulations*, as described in their station security reports. Quarterly security reports are recording events adequately and trending them effectively. The number of such events is diminishing at some stations. Program implementation at the facilities provides adequate security to counter the design-basis threat. CNSC staff have determined that the licensees' security clearance programs are satisfactory and continue to improve. Processes and procedures are supporting access control measures and meeting REGDOC-2.12.2, *Site Access Security Clearance* [35]. Licensees have provided action plans for implementing CNSC REGDOC-2.12.3, *Security of Nuclear Substances: Sealed Sources* [36].

In 2015, CNSC staff will begin to examine the effectiveness of the supervisory awareness training at NPP facilities and the measures licensees are implementing in reaction to recent global security events.

CNSC staff determined that the industry continued to improve cyber security by performing self-assessments and implementing cyber security controls. A new CSA standard, N290.7, *Cyber security for nuclear power plants and small reactor facilities* [37], was published in December 2014. The implementation plan for this CSA standard is being developed by CNSC staff. CNSC staff are satisfied with the industry's overall progress in this area.

Drills and exercises

NPP licensees have implemented effective drill and exercise programs. The programs include basic officer training, realistic training scenarios and acceptable frequency of re-certifications and management review and approval. Training programs include the collective and integrated training of both the armed nuclear response force and unarmed nuclear security officers.

Onsite response forces routinely perform drills and exercises at their stations. The police agencies of jurisdiction are participating in training activities and are conducting familiarization tours at all facilities. Security personnel are introducing tabletop exercises involving outside agencies and positive results are being realized. The performance testing program encompasses limited-scope and force on force exercises and continues to test and validate each licensee's security program to ensure that it is adequate, effective and compliant with regulatory requirements. This activity is

one component of the overall compliance verification activities undertaken by CNSC staff to ensure effective compliance with requirements.

Bruce Power's Nuclear Response Force during a training exercise.

Performance testing force-on-force exercises were conducted at Pickering in March 2014 and at Bruce Power in May 2014. Security forces were successful in demonstrating their ability to counter the design-basis threat during these exercises. Security exercises met the requirements of the *Nuclear Security Regulations*. In addition, the police forces within the jurisdictions of these facilities were actively involved in the exercises. This was acknowledged as a progressive step forward. Force-on-force exercises will be conducted at Point Lepreau in June 2015.

2.1.13 Safeguards and non-proliferation

The safeguards and non-proliferation SCA covers the programs and activities required for the successful implementation of the obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements as well as other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons* [38]. The industry average rating for safeguards and non-proliferation was "satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the safeguards and non-proliferation SCA at NPPs met all applicable regulatory requirements.

Safeguards and non-proliferation ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	SA	SA	SA	SA	SA

Safeguards and non-proliferation encompasses the following specific areas:

- nuclear material accountancy and control
- access and assistance to the IAEA
- operational and design information
- safeguards equipment, containment and surveillance

The scope of the non-proliferation program for the NPPs is limited to the tracking and reporting of foreign obligations and origins of nuclear material, as required by RD-336, *Accounting and Reporting of Nuclear Material* [39]. This tracking and reporting assists the CNSC in the implementation of Canada's bilateral nuclear cooperation agreements with other countries.

Nuclear material accountancy and control
All NPP licensees complied with the CNSC's regulatory requirements, in accordance with RD-336.

The CNSC launched its new nuclear material accountancy reporting e-business system in November 2013, which allows licensees to electronically upload their nuclear materials accountancy reports through the CNSC's secure website. NPP licensees have expressed interest in using this system and are evaluating the updates required for their internal nuclear material accountancy software to allow them this capability.

Access and assistance to the IAEA
All NPP licensees granted access and assistance to the IAEA both for inspection activities and for the maintenance of the IAEA's equipment.

Operational and design information
All NPP licensees submitted their annual operational programs on time with quarterly updates as well as the annual update pursuant to the *Additional Protocol* [40] to the CNSC. Although minor issues were identified in the reports from NB Power in 2013, CNSC staff noted improvements in 2014 comparable to the strong performance of the other NPP licensees in terms of the timely submission of the required information.

Safeguards equipment, containment and surveillance
There was no major IAEA equipment installation in 2014. Nonetheless, licensees were cooperative in supporting the maintenance and upgrade of IAEA equipment, including the core discharge monitors at Darlington and Bruce B, and repair work to IAEA remote monitoring components.

2.1.14 Packaging and transport

The packaging and transport SCA pertains to programs that cover the safe packaging and transport of nuclear substances to and from the licensed facility. The industry average rating for this SCA was determined to be "satisfactory", which is unchanged from the previous year.

Overall, based on the information assessed, CNSC staff concluded that the packaging and transport SCA at NPPs met all applicable regulatory requirements.

Packaging and transport ratings

Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
SA	SA	SA	SA	SA	SA	SA

Packaging and transport encompasses the following specific areas:
- package design and maintenance (no significant observations to report)
- packaging and transport
- registration for use (no significant observations to report)

Packaging and transport

All NPP licensees have a packaging and transport program that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations* and the *Transportation of Dangerous Goods Regulations* [41]. The programs are effectively implemented and the transport of nuclear substances to and from each facility is done safely.

CNSC staff have reviewed the licensees' procedures for radioactive shipments and are satisfied that the procedures ensure compliance with the regulations.

There were no events reported in 2014 by licensees with regard to the packaging and transport of nuclear substances.

2.2 Regulatory developments

2.2.1 Licensing

Between January 2014 and April 2015, the Commission approved amendments of the licence periods for the power reactor operating licences (PROLs) for Bruce A and B and for Darlington.

The Bruce A and B power reactor operating licences were scheduled to expire on October 31, 2014. In April 2014, the Commission amended the dates until May 31, 2015. This amendment allowed an appropriate level of public participation in the public hearing process in 2015. The two-part public hearing for the Bruce A and B licence renewal was held in February and April 2015. The Bruce A and Bruce B licences are being consolidated into a single licence, similar to what was done for Pickering A and B. On May 27, 2015, the Commission renewed the operating licences issued to Bruce Power as a single licence for both Bruce A and B, valid from June 1, 2015 until May 31, 2020.

The Darlington power reactor operating licence was valid from March 1, 2013 to December 31, 2014. In June 2014, OPG applied for an amendment of the Darlington licence until December 31, 2015 in order to allow OPG sufficient time to prepare additional material for the upcoming licence renewal hearing and allow the public adequate time to review this additional material. The Commission amended the licence issued to OPG for Darlington in July 2014. The two-part public hearing for the Darlington licence renewal is scheduled for August and November 2015.

The 2015 Bruce Power licence renewal hearing resulted in the introduction into the LCH of updated CNSC regulatory documents and CSA standards as shown in tables 6 and 7, respectively. The documents support the practice of continuous regulatory improvement.

Table 6: Updated requirements for CNSC regulatory documents

CNSC regulatory document identifier and title	Implementation date
REGDOC-2.3.2, *Severe Accident Management Programs for Nuclear Reactors*	Sep. 30, 2015
REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*	Jan. 1, 2015
RD-336, *Accounting and Reporting of Nuclear Material*	Jun. 1, 2015

CNSC regulatory document identifier and title	Implementation date
REGDOC-2.3.3, *Periodic Safety Reviews*	Dec. 31, 2015
REGDOC-2.4.1, *Deterministic Safety Analysis*	Dec. 31, 2017
REGDOC-2.4.2, *Probabilistic Safety Analysis (PSA) for Nuclear Power Plants*	Jun. 30, 2019
RD/GD-210, *Maintenance Programs for Nuclear Power Plants*	Dec. 31, 2017
RD/GD-98, *Reliability Programs for Nuclear Power Plants*	Dec. 31, 2015
REGDOC-2.6.3, *Aging Management*	Dec. 31, 2016
REGDOC-2.9.1, *Environmental Protection: Policies, Programs and Procedures*	Dec. 31, 2018
REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*	Dec. 31, 2018
REGDOC-2.12.1, *High-Security Sites: Nuclear Response Force*	Jun. 1, 2015
REGDOC-2.12.2, *Site Access Security Clearance*	Jun. 1, 2015
RD-321, *Criteria for Physical Protection Systems and Devices at High-Security Sites*	Jun. 1, 2015
RD-361, *Criteria for Explosive Substance Detection, X-ray Imaging, and Metal Detection Devices at High-Security Sites*	Jun. 1, 2015
RD-327, *Nuclear Criticality Safety*	Oct. 31, 2015

Table 7: Updated requirements for CSA standards

CSA standard identifier and title	Implementation date
N286-12, *Management system requirements for nuclear facilities*	Dec. 31, 2019
N290.15-10, *Requirements for the safe operating envelope of nuclear power plants*	Sep. 30, 2015
N285.0-12, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*	Aug. 31, 2015
N290.13-10, *Environmental qualification of equipment for CANDU nuclear power plants*	Jun. 1, 2015
N285.4-11, *Periodic inspection of CANDU nuclear power plant components*	Dec. 31, 2018
N288.1-08, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities*	Jun. 1, 2015
N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*	Dec. 31, 2018
N288.5-11, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*	Dec. 31, 2018
N288.6-12, *Environmental risk assessment at class I nuclear facilities and uranium mines and mills*	Dec. 31, 2018
N293-12, *Fire protection for nuclear power plants*	Jun. 1, 2015

2.2.2 Updates on significant regulatory issues

Neutron overpower protection (NOP) methodology annual update

Background

CNSC staff provide to the Commission an annual progress report on the status of the review of a new enhanced neutron overpower protection (E-NOP) methodology. The fifth progress report, CMD 14-M50 [42], was presented at the Commission meeting held on October 2, 2014. The 2014 NPP Report includes, in this section, the next progress report on neutron overpower protection (NOP) methodology.

The NOP system is composed of a number of fast-response, in-core detectors that provide prompt measurements of neutron flux throughout the core. The design function of the NOP system is to initiate a reactor shutdown whenever the neutron flux reaches a set level anywhere in the reactor core.

The shutdown systems will be actuated once the NOP detector signal reaches a pre-established value which is called a trip setpoint (TSP). The TSP value is chosen by analysis so that shutdown systems will be activated to prevent the onset of fuel sheath dryout. Additionally, the TSP value ensures that safety margins are always protected or are always in the safe range. The analysis methodology is referred to as the NOP methodology and the design-basis accident scenario is a postulated slow-loss-of-regulation (SLOR) event.

The adequacy of NOP trips for reactor operation under different conditions, such as various flux shapes and possible flux tilt, is demonstrated by analyses and simulations, which take into account different plant states for which continued operation is permitted.

The impact of aging on the NOP TSPs is that they may have to be lowered in order to ensure continuous trip coverage as core characteristics change. Hence, there is an incentive for the industry to try to improve the NOP analysis method in the hope of gaining additional operational margins to NOP trip. One such proposal is to assign weights to flux shapes considered in the NOP analysis reflecting the probability of those flux shapes occurrences. CNSC staff are currently reviewing this proposal.

Information regarding the NOP system and its role, as well as information regarding the role that a NOP methodology has in determining the NOP TSP, is provided in section 1 of CMD 14-M50.

The Point Lepreau unit was recently refurbished and therefore does not have the same heat transport system aging issues as the Bruce Power and OPG units. NB Power currently uses the original NOP methodology to set its NOP TSPs, not the E-NOP methodology.

Status

Bruce Power and OPG have completed all major activities related to E-NOP methodology committed to in their work plans and submitted several reports documenting the results. They are confident, based on the results of the completed activities, that the current NOP TSPs are adequate for safe operation of their stations.

CNSC staff's technical evaluation of the above mentioned submissions found that:

- The new statistical model, EVS 2010, is sound and provides a future solution for NOP TSPs

- There are no fundamental flaws in the proposed approach to compute the critical channel powers in an aging reactor

However, there are some residual concerns regarding the formal use of E-NOP for real NOP TSP problem application for which CNSC staff requested Bruce Power and OPG to provide:

- Proposed physical, operational and analytical measures, and compensatory actions, as well as any relevant empirical evidence for OPG stations to enhance confidence in the values of installed TSPs under current and the next three years' projected aging conditions
- Proposed activities and time frames for developing and qualifying a practical method for derivation of NOP TSPs

The information provided was generated using a method based on the original NOP methodology and incorporated the effect of aging. It was, therefore, independent of the E-NOP methodology.

Subsequently, CNSC staff applied the risk-informed decision-making (RIDM) process to determine the adequacy of the installed NOP TSPs.

CNSC staff concluded that the installed NOP TSPs provide adequate margins for a SLOR event and no compensatory measures are required until August 2017.

A more detailed account of the information and criteria used in the CNSC staff RIDM process, and of the actions on the licensees to support CNSC staff decision, is provided in section 4 of CMD 14-M50.

CNSC staff requested that Bruce Power and OPG provide annual NOP compliance reports with the results of surveillance and monitoring for impact of aging on minimum margin to dryout, based on actual plant configuration and data and to continue working on the methodology to resolve the issues related to practical implementation.

In the meantime, CNSC staff held two high level meetings with Bruce Power and OPG in November 2014 to discuss the path forward for acceptance of the proposed E-NOP methodology. The purpose of the first meeting was to articulate CNSC high level expectations regarding E-NOP methodology and to map key review findings against those expectations. The second meeting focused on the measures and improvements to the methodology that the licensees were putting in place to address key review findings. Bruce Power and OPG provided their final response to CNSC concerns in March 2015. These submissions are currently being reviewed by CNSC staff. An update will be provided to the Commission on the status of the CNSC staff review of the current submissions at the public meeting in August 2015.

Overall, CNSC staff concluded that there is no impact on safety of current operations as a result of the installed NOP TSPs.

Update on potassium iodide pills distribution in the vicinity of Canadian NPPs

Background

REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* [43], which was published in 2014, states that NPP operators have to provide the necessary resources and support to provincial and municipal authorities for the implementation of provincial and municipal plans related to potassium iodide (KI) pill availability. KI pills are iodine thyroid blocking agents that prevent the uptake of radioactive iodine. This regulatory document calls for the pre-distribution of KI pills to residents living near an NPP and a broader stockpiling extending to 50 km from the NPP. In addition, based on the direction from the Commission from the May 7, 2014 Commission hearing and the results of the CNSC report, *Study of the Consequences of a Hypothetical Severe Nuclear Accident* [44], CNSC staff have included in the LCHs for all NPP licensees with operating power reactors, compliance verification criteria on the pre-distribution of KI pills, with a completion date of December 2015. CNSC staff updated the Commission on the status of the distribution of KI pills on March 26, 2015. The status of the distribution plan for each licensee with operating power reactors follows.

Potassium iodide pills – often referred to as KI pills – are used to protect your thyroid gland from radioactive iodine that could be released into the air during a nuclear radiological emergency.

OPG-operated NPPs (Darlington and Pickering)

OPG anticipates receiving KI pills from its vendor by the end of May 2015. A public education campaign is expected to be held in September 2015 followed by pre-distribution of KI pills in October 2015 with a target completion of November 2015.

Focus group meetings have been held with residents in the Durham Region to determine how best to manage the pre-distribution efforts. In addition, OPG has conducted a survey with the residents to obtain feedback on the preference for the distribution of KI pills.

The City of Toronto task group for the pre-distribution of KI pills continues to work closely with its counterparts in Durham Region and OPG. In March 2015, the City of Toronto presented its program and strategy for the pre-distribution to the Ontario Emergency Management Program Committee.

Bruce Power-operated NPPs (Bruce A and B)

KI pills have been procured and distribution has started for the 10 km primary zone. Bruce Power has held four information sessions where residents could receive KI pills and discuss any concerns or issues. Bruce Power has now started its next phase, the door-to-door distribution campaign with a target completion of summer 2015.

NB Power-operated NPP (Point Lepreau)

NB Power procured KI pills, which have been distributed since 1982 to residents in the 20-km planning zone of Point Lepreau. Every household receives a bottle containing 28 KI pills. The distribution was conducted door-to-door by local emergency wardens and included an information

pamphlet.

The province of New Brunswick maintains stockpiles of KI pills outside the 20-km planning zone. In addition, there are three stockpile locations beyond the 50-km planning zone.

The last distribution campaign was held in 2011, and the New Brunswick Emergency Measures Organization has initiated preparatory work for a refresher distribution in early 2016.

2.2.3 Public communication

Reports and presentations to the Commission related to power reactor regulation

During 2014, the Commission was kept informed of events and activities at NPPs through a total of eight status reports on power reactors presented by CNSC staff at public meetings. These reports summarize the status of the power reactors in such areas as operations, licensing, areas of regulatory interest and significant events.

In addition, CNSC staff made 21 presentations to the Commission related to NPP issues and regulation during 2014. These presentations covered topics such as fitness for service of pressure tubes, consequences of a severe nuclear accident, review of NOP methodology, Exercise Unified Response, removal of hold points and others.

Event initial reports

Throughout the year, licensees are required to notify the CNSC of events that have a public and media interest, or that may pose potential risks to safety or security, and to the health and safety of persons or the environment. CNSC staff use event initial reports (EIRs) to ensure the Commission is aware of those events that have the potential to involve the Commission in its decision-making capacity.

Overall, two EIRs were presented to the Commission during the period of January 2014 to April 2015. Summary details of the EIRs are provided in section 3 of this report for each station.

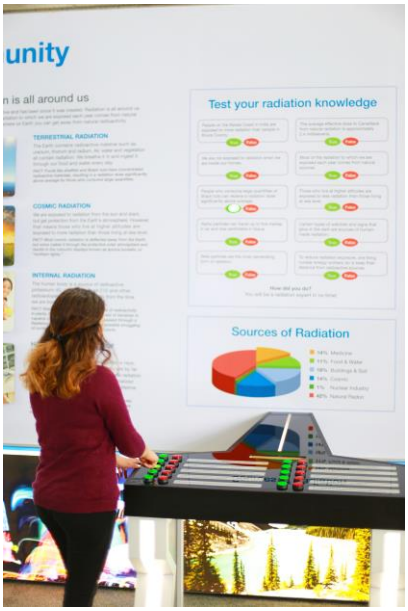
The number of EIRs in a given year is not indicative of the safety of Canada's NPPs. For example, the events reported during 2014 and early 2015 were of low safety significance that did not require immediate regulatory action by the CNSC. The general topics of the submitted reports included environmental protection and radiation protection.

Public information and disclosure programs

In accordance with their power reactor operating licences, all licensees in Canada are required to implement public information and disclosure programs. These programs are supported by disclosure protocols, which outline the type of information on the facility and its activities that will be shared with the public (e.g., incidents, major changes to operations, periodic environmental performance reports) and how that information will be shared. The objective is to ensure that timely information about the health, safety and security of persons and the environment and other issues associated with the lifecycle of nuclear facilities are effectively communicated.

In 2014, NPP licensees were in compliance with RD/GD-99.3, *Public Information and Disclosure* [3]. They provided information on the status of their facilities through numerous activities. CNSC staff have reviewed the communications activities during this period and noted innovative methods and best practices for licensees to share information. These include:

- OPG distributed a new Nuclear Safety Guide to provide information about what to do in the unlikely event of a nuclear emergency and provided tours of the new Darlington Energy Complex, a training facility built for the Darlington refurbishment
- Bruce Power launched a new Summer Bus Tour Program for its site and created an electronic version of its monthly newsletter
- NB Power proactively informed community members about the updated evaluation of the seismic study being completed as part of post-Fukushima Daiichi response activities
- Hydro-Québec produced an informative video about the decommissioning process for Gentilly-2



A member of the public checks out a new interactive radiation exhibit at Bruce Power's Visitors' Centre.

Public outreach involving CNSC and NPP licensee staff

The CNSC is committed to outreach and engagement as a way to share information and to promote openness and transparency. CNSC's Outreach Program provides information and two-way dialogue with interested parties, thereby encouraging discussion, reflection and learning regarding technical and regulatory topics. In 2014, more than 40 outreach activities took place with various NPP stakeholders.

Outreach attendees included: members of First Nations communities; municipal residents; representatives from municipal, provincial, and federal organizations; officials from local and regional health organizations; union leaders; members of professional societies; employees of non-governmental organizations; and community liaison groups.

Throughout the year, the outreach sessions provided opportunities to discuss items of interest including:

- Emergency preparedness including regional communication
- Potassium iodide pills
- Cyber security
- Bruce Power licence renewal applications
- Pickering end of life and transition to safe storage
- Pickering hold point licence condition
- Darlington refurbishment
- Regulatory documents and developments
- 2013 NPP Report

In addition, outreach sessions were held with Aboriginal communities as described in the next section.

The CNSC Outreach Program is a mature program that responds to community concerns and developments at the local, national, and international levels.

Aboriginal consultation activities

CNSC staff conducted several engagement activities, including consultation with a number of Aboriginal communities in 2014 and 2015 in relation to the 2015 Bruce Power and 2015 Darlington operating licence renewals.

For both licence renewals, CNSC staff commenced engagement activities in 2013, including letters of information with details regarding the licence applications, notice of participant funding availability, and follow-up telephone calls. With the postponement of both licence renewal hearings, CNSC staff advised groups of these decisions and shared information as it became available, such as new hearing dates and, in the case of Bruce Power, copies of the CNSC's and Bruce Power's licence renewal documents. Since 2013, CNSC staff have met with a number of Aboriginal groups to discuss licence renewals and have encouraged all Aboriginal groups with interests or concerns to participate in the regulatory review processes, including the public hearings scheduled in 2015.

During the Bruce A and B licence renewal hearing, three Aboriginal groups – Saugeen Ojibway Nation, Historic Saugeen Métis and the Métis Nation of Ontario – participated. All three identified the importance of the CNSC's role as a representative of the Crown and ensuring it meets its duty to consult obligations with each group and continue to recognize the importance of building trusting relationships. The groups also identified the importance of environmental protection to ensure that their communities can continue their traditional practices such as fishing, hunting and gathering without having to worry that the NPP is having an adverse impact. A special concern raised from each was the importance of their participation in the review process for Bruce Power's *Fisheries Act* authorization. Finally, Bruce Power provided CNSC staff with monthly updates on its Aboriginal engagement activities and informed CNSC staff of issues raised by groups that require the Crown's attention in a timely manner.
The CNSC is also aware that Bruce Power has developed and is implementing protocol agreements with each of the three Aboriginal groups. These agreements include quarterly meetings between Bruce Power and the groups to discuss matters of interest to the Aboriginal community and ensuring that Bruce Power has the capacity to assist community representatives so they can participate in meetings as well as regulatory reviews, including the *Fisheries Act* authorization. The Commission encouraged each group to continue participating in CNSC regulatory reviews, including annual reports. Since the hearing, CNSC staff have continued to consult with each group on their concerns related to the Bruce Power facility.

Aboriginal groups that have requested to be kept informed of activities at NPPs will be provided copies of the draft 2014 NPP Report and notified of the opportunity to observe the presentation of this report to the Commission.

As the 2014 NPP Report is for informational purposes only and no decision is requested from the Commission, the duty to consult is not required.

2.2.4 Fukushima Daiichi response

Following the Fukushima Daiichi accident in 2011, the CNSC issued a regulatory request under subsection 12(2) of the *General Nuclear Safety and Control Regulations*. Licensees were requested to review the lessons learned from the event, re-examine their safety cases, and report

on implementation plans to address significant gaps. The initial effort has been completed by licensees.

Subsequently, the CNSC convened a task force to evaluate the operational, technical and regulatory implications of the Fukushima Daiichi accident for the Canadian nuclear industry. The CNSC Task Force was created with the objective of reviewing the capability of NPPs in Canada to withstand conditions similar to those that triggered the Fukushima Daiichi accident.

Specifically, the CNSC Task Force examined the response of NPPs to external events of higher magnitude than had previously been considered in the approved design bases. It also examined the licensees' capacity to respond to such events. The focus was on the need to anticipate the unexpected, including events such as earthquakes, tornadoes or hurricanes that may cause a prolonged loss of electrical power, resulting in operators being unable to continue cooling the reactors.

The *CNSC Fukushima Task Force Report* [14] was published on October 28, 2011. CNSC staff subsequently embarked on a series of consultations with stakeholders and the public to seek their input and increase their understanding of what happened at Fukushima Daiichi. The consultations also allowed CNSC staff to share the measures being planned by the CNSC and the nuclear power industry to address lessons learned from the Fukushima Daiichi accident. Following these consultations, the *CNSC Integrated Action Plan* [2] was published and it is now largely implemented.

The *CNSC Integrated Action Plan* consolidated all public and stakeholder comments and recommendations received during public consultations on the *CNSC Fukushima Task Force Report*. As well, it incorporated recommendations from two independent reviews related to lessons learned in light of the Fukushima accident: one by an External Advisory Committee entitled, *Examining the Response of the Canadian Nuclear Safety Commission to the 2011 Japanese Nuclear Event* [45] and the other by the IAEA Integrated Regulatory Review Service (IRRS) follow-up mission entitled, *2011 IRRS Follow-up Mission Report* [46]. The *CNSC Integrated Action Plan* is applied across all major nuclear facilities, by using a risk-informed approach. The implementation of the action plan was prioritized into short-, medium- or long-term actions, with implementation dates of 2012, 2013 and 2015 respectively.

Since the last Fukushima status update included in the 2013 NPP Report, Canadian NPP licensees have submitted two update reports on the progress made in implementing Fukushima lessons learned: one in July 2014 (*Update Report No. 5*) and another in January 2015[5] (*Update Report No. 6*). These reports provided details on activities completed to-date by NPP licensees, together with the status on the implementation of the Fukushima follow-up activities. Specifically, the update reports presented progress achieved by the NPP licensees in implementing the *CNSC Integrated Action Plan* to address safety improvements aimed at strengthening defence in depth, and enhancing onsite emergency response. From the *CNSC Integrated Action Plan*, 36 Fukushima action items (FAIs) applicable to Canadian NPP were derived and are described in appendix G.

Appendix G presents the status of the FAIs as of May 1, 2015. Updates on the activities leading up to the closure of Fukushima action items, since the last update to the Commission in the 2013 NPP Report, are available in section 3, under "Updates on significant regulatory issues" for each

[5] OPG's *Update Report No. 6* was submitted in October 2014

station.

As reported in the 2012 NPP Report, all short-term FAIs for Canadian NPPs, related to lessons learned in the aftermath of the Fukushima Daiichi nuclear accident, were closed to the satisfaction of CNSC staff, as per deadlines established in the *CNSC Integrated Action Plan*. Following the Update Report No. 6 submitted in January 2015, all medium-term FAIs were closed for all stations with the exception of two Fukushima action items (FAIs 2.1.1 and 2.1.2), related to external hazard assessments at Point Lepreau, which remain open. NB Power is planning to request closure of these external hazards related FAIs by June 2015. Details on the progress made by NB Power for FAIs 2.1.1 and 2.1.2 are found in section 3.5.2.3. One long-term Fukushima action item (FAI 1.3.2) remained open for Bruce A and B in 2015; however, Bruce Power plans to complete this FAI by December 2015. Details on the progress made by Bruce Power for FAI 1.3.2 are found in section 3.1.2.3. All FAIs were closed for OPG (Pickering and Darlington) as well as for Hydro-Québec (Gentilly-2). Therefore, the Canadian nuclear power industry has either completed or is on track to complete all long-term FAIs by the December 2015 deadline as set forth in the *CNSC Integrated Action Plan*.

To follow through on the closure of FAIs in the *CNSC Integrated Action Plan*, station-specific action items were raised where necessary. CNSC staff will continue to monitor FAI implementation at Canadian NPPs through 21 station-specific action items as part of its compliance verification program.

These station-specific actions will form part of the day-to-day operation and will be tracked through closure under established compliance verification criteria.

In the long-term, improvements to the design, additional equipment or its availability will be integrated into the licensees' systems and programs, and will continue to be monitored through the CNSC baseline compliance verification program, such as desktop reviews or inspections.

Annual updates on FAI implementation will be provided to the Commission as part of the NPP report.

Compliance oversight of Fukushima-related plant modifications and equipment implementation

As part of the overall CNSC compliance verification program, CNSC staff are conducting compliance verification of Fukushima-related equipment implementation with the objective of ensuring that licensees have procured, installed and/or assembled all equipment that they have committed in their disposition of the respective FAIs. Specifically, CNSC staff coordinated inspection activities to verify implementation of plant modifications and emergency mitigating equipment (EME) at Canadian NPPs into a four-level approach, as follows:

- Level 1 - Field verification of equipment installation and availability for service. This level corresponds to onsite verifications that the equipment has been purchased and installed.

- Level 2 - Confirmation of equipment commissioning and turnover to operations.

- Level 3 - Sampling of follow-up verification via normal compliance based on a risk-informed approach.

- Level 4 - In-situ demonstration of equipment performance during training, drills and exercises. In some instances, the effectiveness of new equipment, such as backup power supplies or means of adding water to various systems to mitigate or arrest the progression of a severe accident, is not proven merely by the existence of the equipment in the field. For those cases, a demonstration of the capability to deploy these resources within a specified mission time is required. This is demonstrated in the field during training, drills and exercises.

Since the last Fukushima response status update in the 2013 NPP Report, CNSC site staff continued to confirm that all post-Fukushima-related equipment, currently installed in the field, pre-staged in the field, or purchased and kept in designated storage facilities, has been deployed in accordance with licensees' commitments and is available for service. This four-level approach will also be applied for the compliance verification of equipment still to be delivered to the licensees. Additionally, CNSC staff have witnessed and participated in two separate large-scale exercises (Bruce Power's Exercise Huron Challenge in 2012 and OPG's Exercise Unified Response in 2014) that were designed to test the response to a severe accident, the deployment of EME and performance standards. NB Power plans to conduct Exercise Intrepid at Point Lepreau in the fall of 2015. The licensees have made enhancements as a result of these exercises, and CNSC staff will continue to monitor implementation.

As stated in the previous section, verification of design upgrades, analysis or procedural changes that are specific to a station are tracked through station-specific action items, through the CNSC baseline compliance verification program. Of note is the fact that, in some instances, the timeline for completion or implementation of a design upgrade specific to a station will coincide with scheduled outages.

2.2.5 Darlington new nuclear project

On August 17, 2012 a panel of the Commission announced its decision to issue a nuclear power reactor site preparation licence (PRSL) to OPG for the Darlington new nuclear project (DNNP) at the Darlington nuclear site for a period of 10 years (from August 17, 2012 to August 17, 2022).

As required by the *Canadian Environmental Assessment Act* (1992), prior to any licensing decision, for a PRSL, an environmental assessment (EA) of the project was required. The EA was carried out by the Joint Review Panel (JRP) in 2011. This EA and the PRSL were challenged through an application for judicial review before the Federal Court of Canada.

In May 2014, the Federal Court allowed the application in part and ordered that the licence be quashed and the matter be returned to the JRP, or a duly constituted panel, for further consideration and determination of the specific issues set out in the Court's decisions and reasons. The decision by the Federal Court has been appealed and argument before the Federal Court of Appeal is planned for June 2, 2015.

Although the PRSL was quashed, OPG continued to pursue several work activities[6] in 2014 related to the JRP recommendations, specifically:

- Bank swallow monitoring and mitigation
- Support for CNSC activities to engage stakeholders in developing policy for land use around nuclear generating stations

The DNNP site continued to be used as a temporary staging area to support ongoing operations and planned refurbishment of the existing Darlington station. The area will be restored to its existing condition once the work activities have been completed.

Bank swallow monitoring and mitigation

The construction and operation of a new NPP at the Darlington site as proposed by OPG will require, to some extent, the removal of natural bluffs along the northern shoreline of Lake Ontario. These natural bluffs are known to provide habitat for the bank swallow, which could therefore potentially be lost by the development of a new NPP. The JRP recommended that artificial bank swallow nest habitat should be constructed to maintain the population as close to the original bluff site as possible.

Surveys of the bank swallow burrows at the Darlington site and surrounding area have been conducted since 2008. In April 2015, OPG submitted the monitoring results for the earthen embankment artificial nest habitat structure. CNSC staff are currently reviewing these results.

Land use planning

The JRP was of the opinion that a situation where residential areas are located within 3 kilometres of a nuclear site must be avoided and that appropriate steps must be taken to evaluate and define buffer zones around nuclear facilities in Canada, taking into consideration the lessons learned from the Fukushima Daiichi nuclear accident. Given this, the JRP directed recommendations towards the CNSC, government of Ontario and the municipality of Clarington regarding land use planning.

The recommendations were in relation to:

- Development of policy for land use around nuclear generating stations
- Provincial prevention of sensitive land uses within three kilometres of the site boundary
- Municipal prevention of sensitive land uses within three kilometres of the site boundary
- Management of development in the vicinity of the project site to ensure capacity for evacuation

In 2013, the CNSC organized a land use planning workshop with provincial, regional and municipal stakeholders, as well as OPG. The Ontario's Ministry of Municipal Affairs and Housing has since replaced its 2005 Provincial Policy Statement (PPS) with the 2014 PPS, which significantly strengthens land use planning in the vicinity of NPPs.

In addition, a workshop summary was written and has undergone several rounds of review by the participants in 2014. The key outcomes as a result of the workshop are as follows:

[6] The work activities indicated that can be performed without a licence (i.e., not licensed activities). OPG is performing the work at its own discretion, regardless of the outcome of the appeal decision to the Federal Court of Appeal.

- The Municipality of Clarington and Region of Durham have indicated that the 2014 PPS will support an Ontario Municipality in an appeal for a sensitive land use in the vicinity of the NPP
- The workshop summary can be used as a point of reference for future discussions with other provinces that are considering a new nuclear station
- The PPS is effective on a go-forward basis (i.e., it is not retroactive). Future sensitive land uses will be guided by the PPS
- There are no impacts to existing sensitive land uses in the vicinity of NPPs in Ontario

3. Nuclear power plant safety performance and regulatory developments

This section is organized by station, with performance ratings provided for each safety and control area (SCA) in the first 14 subsections for each nuclear power plant (NPP). The ratings reflect the Canadian Nuclear Safety Commission (CNSC) staff's evaluation of how well the licensees' programs met regulatory requirements and expectations to protect the overall health, safety and security of persons and the environment, in addition to meeting Canada's international commitments on the peaceful use of nuclear energy.

The safety performance ratings were determined by using a risk-informed approach of integrating findings from surveillance, inspections, and desktop reviews of events as well as progress on enforcement actions by CNSC staff.

This section also provides detailed information on various regulatory developments and issues for each NPP, including licensing, major projects and descriptions of event initial reports. Information in this section is kept as current as allowed by the annual NPP report deadlines.

3.1 Bruce A and Bruce B

Bruce A and B are located on the shores of Lake Huron, in the Municipality of Kincardine, in Bruce County, Ontario. The facility is operated by Bruce Power under a lease agreement with the owner of the facility, Ontario Power Generation Incorporated (OPG).

The Bruce A station has four CANDU reactors with gross power 805 MWe (megawatts electrical) at Units 1-4, which were fully operational throughout 2014. The Bruce B station has four CANDU reactors with gross power 872 MWe at Units 5-8, and all four units were fully operational throughout 2014.

This report groups the Bruce A and B stations together because Bruce Power uses common programs at both stations. However, the performance of each station is assessed separately due to the differences in implementation of some programs at Bruce A and Bruce B.

3.1.1 Safety assessment

The CNSC staff safety assessment of Bruce A and B for 2014 resulted in the performance ratings as shown in table 8. Based on the observations and assessments of the SCAs, CNSC staff concluded that Bruce A and B operated safely. For 2014, the integrated plant ratings

were "satisfactory" (SA) for Bruce A, which is unchanged from the previous year and "fully satisfactory" (FS) for Bruce B, which is improved from the previous year. The increase in the Bruce B integrated plant rating to "fully satisfactory" is based upon maintaining "fully satisfactory" for conventional health and safety and security together with the improvements in 2014 to a "fully satisfactory" rating for operating performance and waste management.

Table 8: Performance ratings for Bruce A and B

Safety and control area	Bruce A	Bruce B	Industry average
Management system	SA	SA	SA
Human performance management	SA	SA	SA
Operating performance	SA	FS	SA
Safety analysis	SA	SA	SA
Physical design	SA	SA	SA
Fitness for service	SA	SA	SA
Radiation protection	SA	SA	SA
Conventional health and safety	FS	FS	FS
Environmental protection	SA	SA	SA
Emergency management and fire protection	SA	SA	SA
Waste management	FS	FS	FS
Security	FS	FS	FS
Safeguards and non-proliferation	SA	SA	SA
Packaging and transport	SA	SA	SA
Integrated plant rating	SA	FS	SA

Note:

- For specific areas within the SCAs where there were no significant observations from CNSC staff compliance verification activities, no information is given in this subsection of the report.
- The information presented below is station specific; general trends are not identified here (refer to section 2 for industry-wide observations).

3.1.1.1 Management system

Based on the information assessed, CNSC staff concluded that the management system SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

Management system

Bruce Power's management system complied with the requirements of N286-05, *Management system requirements for nuclear power plants* [8].

Change management

During compliance verification activities to assess the change management of documented programs, CNSC staff verified that processes were followed at Bruce A and B. Minor issues identified by CNSC staff related to the effectiveness of the process of documenting changes for maintenance and operations procedures have been adequately addressed by Bruce Power.

Safety culture

In February 2014, Bruce Power finalized and submitted information regarding its 2013 safety

culture self-assessment including its method, findings, corrective action plans and implementation. CNSC staff concluded that Bruce Power followed the established processes for self-assessments and will continue to monitor Bruce Power's site-wide initiatives on these improvements.

Bruce Power plans to undertake narrower but more frequent assessments and to extend the time between full assessments of safety culture to every three to five years. The frequency of self-assessments established by Bruce Power, currently meets CNSC staff expectations.

3.1.1.2 Human performance management

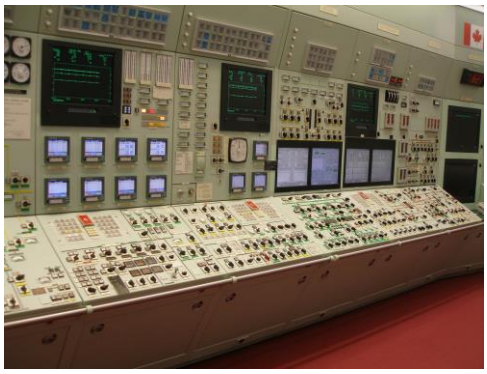
Based on the information assessed, CNSC staff concluded that the human performance management SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

Human performance program

CNSC staff assessed Bruce Power's human performance program and concluded that Bruce A and B are in compliance with regulatory requirements.

Personnel training

Both Bruce A and Bruce B have a well-documented and robust systematic approach to training-based training system. The implementation of this system for the training programs at Bruce A and B in 2014 met regulatory requirements.



To train staff, Bruce Power uses its control room simulator located at the Bruce Nuclear Generating Station.

Personnel certification

Bruce Power had sufficient certified personnel for all certified positions at Bruce A and B in accordance with CNSC regulatory requirements. CNSC staff are satisfied that Bruce Power's program certifies the competency of personnel at Bruce A and B to perform their duties safely.

Initial certification examinations and requalification tests

The initial certification examinations and requalification tests programs for certified staff at Bruce A and B met all regulatory requirements. The design and development of a requalification written test, inspected at Bruce A and B in 2014, met applicable requirements. No significant compliance issues were identified at either station. CNSC staff concluded that the personnel certification processes and procedures were adequate at Bruce A and B.

Work organization and job design

Minimum shift complement

Bruce Power has a sufficient number of personnel for all certified positions. CNSC staff concluded that both Bruce A and B stations are in compliance with the requirements for the

minimum shift complement. In 2014, the licensee reported instances whereby the minimum shift complement was not met for short periods of time due to unforeseen circumstances. CNSC staff did not identify any significant operations-related issues from these reports as Bruce Power took appropriate actions to ensure that safety was maintained.

Fitness for duty

Hours of work

Several significant winter storms occurred in the vicinity of Bruce A and B during 2014. For each of these storms, Bruce Power maintained minimum shift complement and ensured that staff were accommodated, along with assessing staff fatigue. Bruce Power has incorporated lessons learned into its response to severe weather and continues to strengthen its practices to mitigate the risk of fatigue-related errors.

3.1.1.3 Operating performance

Based on the information assessed, CNSC staff concluded that the operating performance SCA at Bruce A met performance objectives and all applicable regulatory requirements and at Bruce B met or exceeded performance objectives and all applicable regulatory requirements. As a result, Bruce A received a "satisfactory" rating, which is unchanged from the previous year, and Bruce B received "fully satisfactory", which is an improvement from "satisfactory" the previous year.

Conduct of licensed activity

Bruce Power operates the stations within the bounds of the operating policies and principles. Bruce Power complied with the licence conditions concerning reactor power and met regulatory requirements for this area. No significant operations-related compliance issues were identified by CNSC staff during onsite inspections. Both stations operated safely.

Bruce A experienced seven trips, no stepbacks and four setbacks. Bruce B experienced no trips, one stepback and two setbacks. Bruce A experienced six reactor trips caused by boiler low level indications at Units 1 and 2 due to turbine trips. Four of these events were the direct result of an offsite disturbance on the electrical grid or switchyard equipment issues (Note, the Bruce A switchyard is maintained by the grid operator). CNSC staff requested Bruce Power to review these types of reoccurring trips. Bruce Power identified the cause and implementation of corrective actions is progressing. Bruce Power is also working with the grid operator to improve switchyard equipment reliability.

CNSC staff verified that, for all transients and events, Bruce Power staff followed approved procedures, investigated or evaluated the cause and took appropriate corrective actions. It should be noted that stepbacks and setbacks address issues at domains far below those of regulatory concern. Consequently, there was no impact on nuclear safety.

The power history graphs for the Bruce A and Bruce B nuclear reactor units for 2014 are shown in appendix F. These graphs show the occurrences (and causes) of outages and the associated power reductions during the year.

Procedures

CNSC staff found that Bruce Power has well-defined processes for procedure preparation, review, validation, issuance and revisions. CNSC staff are satisfied with Bruce Power's quality of

procedures and their usage and found that Bruce Power's procedures met CNSC requirements in 2014.

Reporting and trending

Bruce Power is required to submit quarterly reports on operations and performance indicators as described in S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7], and follow up on all events with corrective actions and root cause analyses, when appropriate. CNSC staff followed up on all events in a graded approach based on the risk significance of the event.

CNSC staff found that Bruce Power's reporting and trending met CNSC regulatory requirements in 2014; however, some deficiencies for preliminary event reporting were found. CNSC staff expect Bruce Power to focus on improving in this area in 2015.

Outage management performance

There was one planned outage at Bruce A (for Unit 3) and two planned outages at Bruce B (for Units 5 and 7) in 2014. Details are in appendix F. Bruce Power completed all outages successfully and met the requirements for verification of reactor shutdown guarantees (RSGs). CNSC staff verified and confirmed that the RSGs were applied correctly and the application met the requirements for reactor safety. Minor issues in this specific area were adequately addressed throughout the year to the satisfaction of CNSC staff. Bruce Power followed-up appropriately on all planned and forced outages. All outage-related undertakings, including heat sink strategy management at Bruce A and B, were performed safely by Bruce Power staff.

Turbine hall at the Bruce A Nuclear Generating Station.

In 2014, Bruce A experienced 14 forced outages among four reactors (mostly at Unit 1). Bruce B experienced one forced outage among four reactors. The forced outages were mostly caused by turbine and service equipment events. These outages were communicated to the Commission through status reports on power reactors. Outage implementations, safety and work management met regulatory requirements.

Safe operating envelope

Bruce Power's implementation of the safe operating envelope (SOE) maintained the reactors operating in their analyzed state thereby ensuring adequate safety at all times. The SOE implementation level was satisfactory at Bruce A and B in 2014 and in compliance with N290.15, *Requirements for the safe operating envelope of nuclear power plants* [11].

Severe accident management and recovery

CNSC staff monitored the execution of a simulated severe accident involving the use of severe accident management guidelines procedures at Bruce A in September 2014. No significant issues and actions were raised as a result of this simulation. CNSC staff concluded that severe accident management and recovery met regulatory requirements in 2014.

Accident management and recovery

Bruce Power has a series of abnormal incident manuals and emergency operating procedures for mitigating situations and returning the plant to a safe and controlled state as well as preventing

the further escalation of an abnormal incident into a more serious accident. CNSC staff found that Bruce Power's accident management and recovery programs met CNSC requirements in 2014.

3.1.1.4 Safety analysis

Based on the information assessed, CNSC staff concluded that the safety analysis SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

Deterministic safety analysis

Bruce Power has an effective, well-managed program for performing deterministic safety analysis. As the current Bruce Power safety report improvement plan refers to RD-310, *Safety Analysis for Nuclear Power Plants* [15], the plan will be updated to the requirements of REGDOC-2.4.1, *Deterministic Safety Analysis* [16], published in May 2014. CNSC staff confirmed that the current safety reports submitted by Bruce Power in accordance with the licence renewal application met regulatory requirements.

In 2014, CNSC staff reviewed Bruce Power's safety analysis for the impact of aging on safety margins for the 2015-2020 licence period. Based on this review, CNSC staff concluded that both Bruce A and B have adequate safety margins and met the required acceptance criteria.

Probabilistic safety analysis

Bruce Power is in compliance with S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* [4]. In 2014, Bruce Power submitted the PSA methodologies in accordance with S-294 and is transitioning towards implementation of the updated requirements of REGDOC-2.4.2, *Probabilistic Safety Analysis (PSA) for Nuclear Power Plants* [18], published in May 2014.

Following CNSC staff acceptance of the PSA methodologies and computer codes, Bruce Power performed the analyses in accordance with S-294 requirements. Based on the results of the focused inspection in September 2014, CNSC staff concluded that Bruce Power has followed the methodology for conducting the PSAs, although some low risk, minor gaps were identified for fault trees and data analysis. As per the normal compliance oversight process, CNSC staff will carry out further reviews to ensure that Brue Power adequately addresses these gaps during the next licence period.

Criticality safety

CNSC staff confirmed that there were no criticality events at Bruce A and B during 2014. Bruce Power's criticality safety program met the requirements of RD-327, *Nuclear Criticality Safety* [47].

Severe accident analysis

In 2014, Bruce Power continued to make progress in completing its severe accident analysis for the Fukushima action items (FAIs). CNSC staff are satisfied with the severe accident analysis implemented by Bruce Power.

Environmental risk assessment

In January 2014, Bruce Power submitted an environmental risk assessment in accordance with N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* [19]. The risk assessment for fish continued to be updated through the results from the

Bruce A environmental assessment follow-up program and ongoing industry and/or academic whitefish research programs. Details on the *Fisheries Act* authorization application for Bruce Power are found in section 3.1.2.3. CNSC staff concluded that Bruce Power has a well-developed environmental risk assessment program to assess, evaluate and mitigate environmental risks.

3.1.1.5 Physical design

Based on the information assessed, CNSC staff concluded that the physical design SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

Design governance

Environmental qualification

CNSC staff found that Bruce Power's environmental qualification (EQ) program is in compliance with N290.13-05, *Environmental qualification of equipment for CANDU nuclear power plants* [20], which is the design governing document. There were no significant compliance verification observations for Bruce A and B's EQ program in 2014.

Pressure boundary design

Bruce Power continued the transition to N285.0-08, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants* [48]. Bruce A and B confirmed that structures, systems and components (SSCs) important to nuclear safety and security meet the design basis.

On the basis of ongoing oversight activities in 2014, CNSC staff concluded that Bruce Power's pressure boundary program is in compliance with the requirements of N285.0-08. Bruce Power continues to implement a comprehensive pressure boundary program.

System design

Electrical power systems

The qualified power supply standby diesel generator 2 in Bruce A was initially procured without obtaining the documentation normally required for a generator providing safety-related service. CNSC staff confirmed that the standby diesel generator 2 is environmentally qualified, seismically qualified and passes all required safety system tests. Currently, Bruce Power is in the process of going through commercial grade dedication using the industry proven process defined in EPRI NP-5652, *Guideline for the Utilization of Commercial Grade Items in Nuclear Safety Applications* [49], in order to fully demonstrate that the equipment is qualified. Bruce Power's most recent semi-annual update to the CNSC (including milestones for the completion of the project) was provided in January 2015.

In May 2014, CNSC staff performed an inspection of the electrical power systems at Bruce A. The inspection confirmed that electrical power systems are being maintained and tested to ensure that they will be able to perform their design functions. Minor non-safety-related issues such as documentation revision were identified and will be resolved in 2015. The overall conclusion of the inspection was that the electrical systems support the safe operation of Bruce A.

Electrical inspections at Bruce B in previous years confirmed that electrical power systems are

being maintained and tested to ensure that they will be able to perform their design functions. However, some areas for improvement have been identified. Overall, there remains one outstanding item related to the "as-found conditions" of the battery capacity testing. This issue will be resolved by the end of 2016 and is of low safety significance.

Fire protection design

In November 2014, CNSC staff carried out a focused fire protection inspection against the requirements of N293-07, *Fire protection for CANDU nuclear power plants* [50], as well as conducted oversight activities including document reviews and walk-downs. CNSC staff concluded that the Bruce A and B's fire protection program is both comprehensive and in compliance with the requirements of N293-07.

Component design

Fuel inspection program

Bruce Power has a well-developed reactor fuel inspection program. The defect rate for Units 1 and 2 is higher than the industry average due to damage by debris introduced by the recent refurbishment of the units. However, this rate of defects is trending downwards and is expected to return to the industry average over the next few years. The fuel defect rate for Units 3 to 8 is below the industry average of about one bundle per year. Bruce Power has been effective at locating and defuelling defective bundles. No regulatory limits were exceeded during the year.

Cables

During an electrical power systems inspection performed in May 2014, CNSC staff found that Bruce Power has processes in place for condition monitoring; however, there was no component performance monitoring plan established for cables at Bruce A, whereas there was one at Bruce B. As a result, no component health reports have been issued for cables at Bruce A. This was an area of improvement that Bruce Power has since adequately addressed as of September 2014.

3.1.1.6 Fitness for service

Based on the information assessed, CNSC staff concluded that the fitness for service SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

Equipment fitness for service/equipment performance

On the basis of inspections and compliance verifications, CNSC staff concluded the overall equipment fitness for service and performance at Bruce A and B was satisfactory and met regulatory requirements.

Maintenance

Bruce Power's overall maintenance program met the requirements of CNSC regulatory document RD/GD-210, *Maintenance Programs for Nuclear Power Plants* [23].

In 2014, maintenance program performance at both Bruce A and B remained at a satisfactory level with improvements identified on maintenance backlog reduction. Bruce Power reduced its corrective maintenance backlogs and reached the range of industry best practice. The deficient maintenance backlogs remain above the range of industry best practice and are being continuously monitored by CNSC staff. CNSC staff determined that the deficient maintenance backlog at Bruce A and B is not safety-significant.

Structural integrity

Bruce Power inspected selected pressure boundary and containment components, including steam generators, feeders and pressure tubes. CNSC staff compliance monitoring activities indicated that SSCs important for safe operation at Bruce A and B continued to meet regulatory requirements.

Bruce Power continued to implement the Fuel Channel Life Management Project (FCLMP) to demonstrate pressure tube fitness for service for continued operation.

Reliability of systems important to safety

The reliability program at Bruce A and B continued to meet regulatory requirements as described in S-98, *Reliability Programs for Nuclear Power Plants* [51]. Currently, Bruce Power is in transition from S-98 to the updated RD/GD-98, *Reliability Programs for Nuclear Power Plants* [27]. A transition plan has been submitted by Bruce Power with implementation by December 2015.

For Bruce A, all special safety systems met their unavailability targets in 2014, with the exceptions of the emergency coolant injection system (ECIS) and the negative pressure containment system (NPCS). For Bruce B, all special safety systems met their unavailability targets in 2014, with the exception of ECIS. For ECIS and NPCS, two incidents, described below, led to increased unavailability. In each case, Bruce Power, per its operating policies and principles, took immediate corrective actions and assessed the potential impact on nuclear safety.

The first incident that led to Bruce A and Bruce B ECIS not meeting their unavailability targets was the discovery that, at Bruce B, if the ECIS was in recirculation mode, it could not be proven that the sump pumps would operate as required. Given that Bruce A and Bruce B have similar designs, this discovery was applicable to Bruce A units as well. This situation has been corrected at both Bruce A and Bruce B.

In the second incident, Bruce A NPCS did not meet its unavailability target because a motorized containment boundary valve could not be closed manually when its handle broke. The handle was repaired.

Bruce Power took appropriate actions to address the temporary impairments, and corrective actions to prevent recurrence have been completed at Bruce A and Bruce B. CNSC staff verified the actions of the licensee and concluded there was no significant impact on nuclear safety as a result of the incidents. CNSC staff concluded that the actions taken by Bruce Power are acceptable to the CNSC.

Aging management

Bruce Power has implemented an integrated aging management program to ensure that the condition of SSCs important to safety is well understood and that the required activities are in place to assure the health of these SSCs while the plant ages.

As part of licence renewal, Bruce Power also submitted component condition assessments and aging management program reviews. CNSC staff review and assessments concluded that Bruce Power meets the regulatory requirements for continued operation.

Chemistry control

Bruce Power's chemistry control program performance at Bruce A and B has been satisfactory. There were no significant chemistry control related issues that impact the safety of Bruce A and B.

Periodic inspections and testing

Bruce Power has adequate periodic inspection programs (PIPs) in place at Bruce A and B for the pressure boundary and containment components important to safety. CNSC staff monitored compliance with the established PIPs during the year and concluded that their implementation meets regulatory requirements including applicable CSA standards. Inspection results were reported to the CNSC after each outage and their review revealed no safety-significant issues in 2014.

3.1.1.7 Radiation protection

Based on the information assessed, CNSC staff concluded that the radiation protection SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

Application of ALARA

Bruce Power continued to implement a well-documented and mature as low as reasonably achievable (ALARA) program. CNSC staff have verified that Bruce's five-year collective radiation exposure dose projection and reduction plans includes dose reduction initiatives, which are continuously monitored.

In 2014, CNSC staff conducted a focused inspection on ALARA planning and control at Bruce Power. CNSC staff noted an overall improving trend in the area's performance, including extensive work planning and implementation of several ALARA initiatives resulting in dose savings. CNSC staff identified a few areas for improvement during this inspection and Bruce Power is addressing these. CNSC staff found that application of ALARA at Bruce Power meets regulatory requirements.

Worker dose control

Bruce Power continued to comply with the regulatory requirements to measure and record doses received by workers. Routine compliance verification activities indicate that performance in the area of worker dose control at Bruce A and B is effective. In 2014, no worker or member of the public received a radiation dose in excess of the regulatory dose limits or action levels established in Bruce Power's radiation protection (RP) program. The dose information for Bruce A and B is provided in section 2.1.7 and appendix D.

Radiation protection program performance

Bruce Power's RP program performance meets the requirements of the *Radiation Protection Regulations.* RP program documents and supporting procedures are maintained in terms of industry best practices. The oversight applied by Bruce Power in implementing and improving the RP program has been effective in protecting workers at Bruce A and B. Routine compliance verification activities indicate that Bruce A and B are effective in the area of RP program performance.

Radiological hazard control

No action levels were exceeded for surface contamination at either Bruce A or Bruce B in 2014. Routine compliance verification activities indicate that performance in the area of radiological hazard control at Bruce A and B is effective.

Estimated dose to public

Bruce Power continued to ensure the protection of members of the public in accordance with the *Radiation Protection Regulations*. In 2014, the reported estimated dose to a member of the public from the Bruce site (which includes Bruce A, Bruce B, Central Maintenance and Laundry Facility, Western Waste Management Facility, and the decommissioned Douglas Point reactor) was 0.002 mSv, which is well below the annual regulatory public dose limit of 1 mSv.

3.1.1.8 Conventional health and safety

Based on the information assessed, CNSC staff concluded that the conventional health and safety SCA at Bruce A and B met or exceeded performance objectives and all applicable regulatory requirements. As a result, each station received a "fully satisfactory" rating, which is unchanged from the previous year.

Performance

As reported by Bruce Power, for Bruce A and B, combined:

- the accident severity rate (ASR) was 0.1, which is an increase from zero in 2013
- the accident frequency (AF) was 0.17, which is a decrease from 0.51 in 2013

The increase in the ASR for Bruce A and B was due to two lost-time injuries (LTIs). Nevertheless, Bruce Power achieved about 16 million hours without an LTI by the end of 2014.

The decrease in the AF for Bruce A and B is an indication of an improvement in health and safety performance in this area through reducing the number of accidents that resulted in injuries.

Practices

CNSC staff found that Bruce Power's performance exceeded regulatory requirements at Bruce A and B in 2014.

Bruce Power was compliant at Bruce A and B with the relevant requirements of the *Occupational Health and Safety Act of Ontario* and the *Labour Relations Act*, and Bruce Power's *Occupational Health and Safety Policy*.

Awareness

Bruce A and B met CNSC requirements in this area in 2014. All issues from inspections were adequately addressed by Bruce Power throughout the year. However, there was an adverse trend with respect to housekeeping findings in 2014.

3.1.1.9 Environmental protection

Based on the information assessed, CNSC staff concluded that the environmental protection SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

Effluent and emissions control (releases)

All radiological releases from Bruce A and B were below their respective regulatory limits.

Groundwater monitoring at the Bruce site indicated no adverse impact on the groundwater environment due to station operation.

During 2014, there were no accidental hydrazine releases from the Bruce Power facility into the environment. Bruce Power continued to make satisfactory progress in the implementation of the remedial measures with respect to hydrazine releases into the environment from previous years. This work is expected to be completed by December 2015.

Environmental management system (EMS)

Bruce Power has established and implemented an environmental management program to assess environmental risks associated with its nuclear activities, and to ensure that these activities are conducted such that adverse environmental effects are prevented or mitigated.

Assessment and monitoring

An environmental compliance inspection, conducted by CNSC staff in September 2014, verified that Bruce Power is in compliance with regulatory requirements and Bruce Power's staff are following approved procedures.

Protection of the public

There were no hazardous substances released from Bruce A and B that posed unacceptable risk to the environment or the public.

The reported annual radiation dose to the public from the Bruce site was 0.2 percent of the public dose limit.

3.1.1.10 Emergency management and fire protection

Based on the information assessed, CNSC staff concluded that the emergency management and fire protection SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

Conventional emergency preparedness and response

During 2014, CNSC staff conducted regulatory oversight activities at Bruce A and B, including review of documentation, onsite observations and participation in drills. There were no negative observations from compliance verification activities to report in this area. Bruce Power maintained its conventional emergency preparedness and response commitments including enhancements to its emergency drill program.

Nuclear emergency preparedness and response

Bruce Power's updated nuclear emergency plan was submitted to the CNSC in May 2014. CNSC staff reviewed this document and were satisfied that it meets regulatory requirements. All components of the emergency response plan are in place and are in a state of readiness. By July 2015, Bruce Power is to submit a transition plan for implementing the recently published REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* [43].

Bruce Power performed a site emergency exercise in October 2014 to validate enhancements to its emergency response program. No significant nuclear emergency preparedness and response issues were identified. CNSC staff inspection of this exercise concluded that Bruce Power and offsite agencies continue to successfully demonstrate their readiness to respond to a nuclear emergency.

Fire emergency preparedness and response

CNSC staff performed a fire drill inspection at Bruce A and B in 2014 to evaluate the response capabilities of the industrial fire brigade. CNSC staff concluded that Bruce Power continues to implement a comprehensive fire response capability that includes effective procedures, training and maintenance of proficiency. Live fire training for Bruce Power's fire brigade staff is held at OPG's Wesleyville fire training facility until Bruce Power's new fire training ground becomes operational. The new fire training ground on the Bruce site was opened in April 2015 and is expected to be operational by the summer of 2015.

3.1.1.11 Waste management

Based on the information assessed, CNSC staff concluded that the waste management SCA at Bruce A and B met or exceeded performance objectives and applicable regulatory requirements. As a result, each station received a "fully satisfactory" rating, an improvement from "satisfactory" in the previous year.

Waste minimization

Bruce Power's nuclear waste management program exceeded CNSC requirements at Bruce A and B. Based on compliance verification activities, CNSC staff determined that waste minimization procedures and practices were highly effective at both Bruce A and Bruce B stations.

Waste management practices

Bruce Power was in compliance with the requirements for the management and control of radioactive waste in 2014. Both Bruce A and Bruce B stations met CNSC regulatory requirements with respect to waste management practices.

Decommissioning plans

OPG maintains the decommissioning plan and an associated consolidated financial guarantee for all of its Ontario facilities – including Bruce A and Bruce B stations – operated by Bruce Power. The associated decommissioning plan and the consolidated financial guarantee for Bruce A and B were reviewed and accepted by CNSC staff in June 2012 and remain valid. The next revision of the decommissioning plan for Bruce A and B will be in 2017.

CNSC staff concluded that OPG's decommissioning plan and financial guarantee for Bruce A and B exceeded regulatory requirements and remained fully satisfactory in 2014.

3.1.1.12 Security

Based on the information assessed, CNSC staff concluded that the security SCA at Bruce A and B met or exceeded performance objectives and all applicable regulatory requirements. As a result, each station received a "fully satisfactory" rating, which is unchanged from the previous year.

Response arrangements

Bruce Power maintained a highly robust nuclear response force (NRF) at its facilities, which is supported by a strong training program. CNSC staff verified that Bruce Power has continued to improve with respect to integration of their NRF with offsite response forces. The police force of jurisdiction was actively involved in the force-on-force (FoF) exercise in May 2014. This was acknowledged as a progressive step forward.

Drills and exercises

Bruce Power has implemented highly effective drills and exercises at both the Bruce A and Bruce B sites. The results of the performance testing program FoF exercise, conducted in May 2014 demonstrated the effectiveness of the Bruce A and B security force's ability to counter a design-basis threat.

CNSC staff verified that corrective action plans in response to inspection findings were implemented to a satisfactory level.

3.1.1.13 Safeguards and non-proliferation

Based on the information assessed, CNSC staff concluded that the safeguards and non-proliferation SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

Nuclear material accountancy and control

CNSC staff have determined that Bruce A and B complied with regulatory requirements in accordance with RD-336, *Accounting and Reporting of Nuclear Material* [39].

Access and assistance to the IAEA

The International Atomic Energy Agency (IAEA) performed a physical inventory verification (PIV) and a design information verification at Bruce B to verify the non-diversion of safeguarded nuclear materials. CNSC staff were informed by the IAEA that the results of these inspections were satisfactory.

The IAEA did not select Bruce A for a PIV in 2014. As a result, CNSC staff performed an evaluation of the Bruce A preparedness for a PIV in July 2014. From this evaluation, CNSC staff were satisfied that Bruce A was adequately prepared for an IAEA PIV in 2014 had it been selected.

Operational and design information

Bruce Power submitted its annual operational program to the CNSC on time, with quarterly updates, and an annual update to the information, pursuant to the *Additional Protocol* [40].

Safeguards equipment, containment and surveillance

Bruce Power supported IAEA equipment operation and maintenance activities including those that related to the core discharge monitor in Unit 7, as well maintenance and repair work on remote monitoring components to ensure effective implementation of safeguards measures at Bruce A and B.

3.1.1.14 Packaging and transport

Based on the information assessed, CNSC staff concluded that the packaging and transport SCA at Bruce A and B met performance objectives and all applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which is unchanged from the previous year.

CNSC staff reached this conclusion based on onsite monitoring activities and a review of the reports submitted in accordance with S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. There were no significant events reported under the *Packaging and Transport of Nuclear Substances Regulations* for consignments transported to and from the Bruce site. Bruce Power continued to implement and maintain an effective packaging and transport program at Bruce A and B.

3.1.2 Regulatory developments

3.1.2.1 Licensing

In March 2014, Bruce Power applied for, and the Commission approved, an amendment of the operating licences for Bruce A and Bruce B for an additional seven months until May 31, 2015. This amendment allowed an appropriate level of public participation in the public hearing process. In early 2015, the Commission held a two-part public hearing on the application by Bruce Power to renew, for a period of five years, its power reactor operating licences for Bruce A and Bruce B. The hearing was held in Ottawa, Ontario on February 5, 2015 and in Kincardine, Ontario between April 13 and 16, 2015. On May 27, 2015, the Commission renewed the operating licences issued to Bruce Power as a single licence for both Bruce A and B, valid from June 1, 2015 until May 31, 2020.

Licence amendments

The Bruce A licence and the Bruce B licence were each amended three times between January 1, 2014 and April 30, 2015. Details of the amendments are given in appendix H.

Revisions to the licence conditions handbooks

Between January 2014 and April 2015, three revisions were made to the Bruce A licence conditions handbook (LCH) and three revisions were made to the Bruce B LCH. The changes were mostly administrative in nature and details of the significant changes can be seen in appendix H.

The revisions were approved by the Director General, Directorate of Power Reactor Regulation. The changes to the LCHs have not resulted in an unauthorized change of scope and remain within the licensing envelope.

3.1.2.2 Updates on major projects and initiatives

Bruce A environmental assessment follow-up program

At Bruce A, Bruce Power continued to implement the environmental assessment (EA) follow-up monitoring program related to the Units 1 and 2 refurbishment project and to confirm the EA conclusion that there have been no significant adverse environmental effects. CNSC staff continued to work with Environment Canada and Aboriginal groups on environmental issues,

such as any potential effects on smallmouth bass and lake and round whitefish.

37M fuel bundle

The 37M fuel bundle is a minor design modification of the central element of the fuel bundle. The central element has a reduced diameter, allowing more coolant to flow through the centre of the bundle that will offset the effects of heat transport system aging.

Fuelling of Bruce A with 37M fuel bundles was started in March 2013. After a year of 37M fuel operation at Bruce A, Bruce Power submitted the fuel monitoring results to CNSC staff. Based on the review of this submission, CNSC staff concluded that no changes or operating anomalies associated with the use of 37M fuel have occurred during the year of operation and the modified fuel (37M) design performance is consistent with that of the original fuel (37R) design.

Fuelling of Bruce B with 37M fuel bundles was started in March 2014. CNSC staff expect similar fuel monitoring results after a year of 37M fuel operation at Bruce B. Implementation of 37M fuel is being monitored by CNSC staff.

3.1.2.3 Updates on significant regulatory issues

Fisheries Act authorizations

Bruce Power, Fisheries and Oceans Canada (DFO) and CNSC staff have been meeting regularly to discuss the potential requirements under the *Fisheries Act* for both Bruce stations. Under the recently signed memorandum of understanding (MoU) between the CNSC and DFO, CNSC staff are reviewing this information and providing feedback to DFO. The authority to issue an authorization remains within the mandate of the Minister of Fisheries and Oceans.

Bruce Power submitted a draft self-assessment to CNSC staff on the need for a *Fisheries Act* authorization in February 2015. As the first project being reviewed under the MoU, this information was requested to support the on-going discussions regarding the technical information required in an application. CNSC staff reviewed this information and also met with Bruce Power in March 2015, and requested that Bruce Power provide additional information specific to the quantification of fish loss in order to have an updated assessment of the impact due to impingement and entrainment. Bruce Power submitted an update on March 31, 2015, clarifying the technical data, as well as a commitment to completing the authorization process, including Aboriginal engagement.

The CNSC has assumed the role of Crown consultation coordinator under the MoU and will report to DFO on whether the duty to consult has been met. In the meantime, Bruce Power continues to engage Aboriginal communities on the *Fisheries Act* authorization application prior to submitting it to the CNSC for review.

Response to the Fukushima Daiichi accident

Bruce Power has made considerable progress in addressing Fukushima action items (FAIs) at Bruce A and B in 2014-15. Of the 36 FAIs applicable to nuclear power plants, Bruce Power has completed 35 for each of the Bruce A and B stations. The one remaining action (FAI 1.3.2) is on track for completion by December 2015, as per the established timeline in the *CNSC Integrated Action Plan* [2] (see appendix G).

The activities completed in 2014 by Bruce Power, and the status of defence in depth and onsite emergency response are described below for the following areas:

- ***Habitability of control facilities during a severe accident (FAI 1.9.1):*** In its *Update Report No. 6,* Bruce Power requested closure of FAI 1.9.1 regarding the habitability of control facilities. In this submission, Bruce Power adopted the generic CANDU Owners Group (COG) methodology for CANDU habitability assessment following a severe accident, completed under a COG joint project in 2014 and including a more comprehensive review of non-radiological hazards specific to Bruce A and Bruce B. CNSC staff reviewed this generic guidance and found it meets regulatory requirements.

  In addition, CNSC staff conducted a review of the submission provided by Bruce Power and confirmed that the closure criteria of FAI 1.9.1, for determining onsite habitability during a severe accident, have been met. Therefore, FAI 1.9.1 was closed.

- ***Modelling improvements of external hazard (FAIs 2.1.1 and 2.1.2):*** In its *Update Reports No. 5 and No. 6,* Bruce Power completed and submitted an assessment of the site specific design protection for each external event, extending beyond the design basis. CNSC staff reviewed the assessment regarding external hazard and confirmed that the closure criteria of the FAIs have been met. Therefore, FAIs 2.1.1 and 2.1.2 were closed, based upon the established closure criteria and expectations in CNSC staff document *Fukushima Action Items Closure Criteria and Expectations*. These closure criteria were based on the deliverables published in the *CNSC Integrated Action Plan*. It is important to note that reviews of the submissions, related to external hazards specific to the Bruce site, are still in progress. Should any issues be identified from these reviews, resolution of the issues and implementation will be tracked under the CNSC compliance verification program as station-specific action items.

- ***Evaluation of means to prevent unfiltered releases (FAI 1.3.2):*** In its *Update Report No. 6,* Bruce Power provided information pertaining to FAI 1.3.2 regarding containment integrity. Bruce Power has completed the analysis and assessment activities to evaluate options for ensuring containment integrity and filtered venting in the event of a multi-unit severe accident. This information is still undergoing CNSC staff technical reviews. Additionally, Bruce Power is to complete the engineering evaluations and feasibility studies for the installation of a containment filtered venting system to further enhance defence in depth. FAI 1.3.2 remains open for Bruce Power; however, this FAI is on track for closure by December 2015 as per the *CNSC Integrated Action Plan*.

CNSC staff will continue to monitor FAI implementation at Bruce A and B through its established compliance verification program. Annual updates on FAI implementation will be provided to the Commission as part of future NPP reports.

3.1.2.4 Public communication

Event initial reports

No event initial reports (EIRs) were submitted for Bruce A and B from January 2014 to April 2015.

Aboriginal consultation and engagement activities

CNSC staff and Bruce Power continued to work together and cooperate with the First Nations and Métis peoples in the Bruce Peninsula region with respect to nuclear projects, and to work together with the various Aboriginal groups to ensure personal safety and environmental protection.

Members of the public, Aboriginal groups and other stakeholders were informed through a series of public communications about the Participant Funding Program, which makes funds available for participating in the licence renewal process, and were provided with CNSC staff contact details. A funding review committee, independent from CNSC staff, reviewed the funding applications received, and made recommendations on the allocation of funding to eligible applicants.

In May 2014, CNSC staff met with Historic Saugeen Métis (HSM) representatives on details of the licence renewal applications and Participant Funding Program. CNSC staff provided an overview of the licensing review process and information on the status of the proposed Bruce Power licence renewal applications in the licensing review process. HSM representatives provided an update on the status of their activities and information on the history of its Métis community. No specific concerns with respect to the proposed Bruce Power licence renewal applications were raised.

Throughout 2014, CNSC staff met with the Saugeen Ojibway Nation (SON) several times and discussed their concerns with respect to potential thermal effects and fish impingement and entrainment associated with the Bruce Power licence renewal applications. In particular, a one-day workshop in October 2014 was held with the SON to discuss these matters in detail. No decisions came out of this workshop but both parties made a commitment to have further meetings.

3.2 Darlington

Darlington is located on the north shore of Lake Ontario, in the municipality of Clarington, in the Regional Municipality of Durham, in Ontario. The facility is 5 kilometres outside the town of Bowmanville, and about 10 kilometres southeast of Oshawa. The facility is owned by Ontario Power Generation Inc. (OPG), a Canadian corporation with its head office located in Toronto.

Construction of the facility started in 1981 and the first criticality of a reactor unit was in 1989. The nuclear facility consists of four CANDU reactors, with each reactor rated at 881 MWe (megawatts electrical), and a tritium removal facility.

3.2.1 Safety assessment

The CNSC staff safety assessment of Darlington for 2014 resulted in the performance ratings as shown in table 9. Based on the observations and assessments of the SCAs, CNSC staff concluded that Darlington operated safely. The integrated plant rating was “fully satisfactory”, which is unchanged from the previous year.

Table 9: Performance ratings for Darlington

Safety and control area	Rating	Industry average
Management system	SA	SA
Human performance management	SA	SA
Operating performance	FS	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	FS	SA
Conventional health and safety	SA	FS
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Waste management	FS	FS
Security	FS	FS
Safeguards and non-proliferation	SA	SA
Packaging and transport	SA	SA
Integrated plant rating	FS	SA

Note:

- For specific areas within the SCAs where there were no significant observations from CNSC staff compliance verification activities, no information is given in this subsection of the report.
- The information presented below is station specific; general trends are not identified here (refer to section 2 for industry-wide observations).

3.2.1.1 Management system

Based on the information assessed, CNSC staff concluded that the management system SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Management system

OPG's management system complied with the requirements of N286-05, *Management system requirements for nuclear power plants* [8]. OPG continued to make changes in its management system documentation to align with the centre-led matrix organization. OPG made revisions to top tier and lower tier governing documents such as policies and programs. CNSC staff review of revised documents has identified issues that OPG is addressing through its business transformation initiatives (BTI).

Organization

OPG completed the transition to a centre-led matrix organizational structure through the BTI.

Change management

The BTI have resulted in changes to the OPG organization including that of Darlington. Records were provided by OPG and CNSC staff determined that that changes to the nuclear organization followed OPG's organizational change control process.

3.2.1.2 Human performance management

Based on the information assessed, CNSC staff concluded that the human performance management SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Human performance program

CNSC staff assessed OPG's human performance program and concluded that Darlington is in compliance with regulatory requirements.

Personnel training

OPG has a well-documented and robust fleet-wide systematic approach to training-based training system. Three compliance inspections conducted in 2014 have confirmed that the various training programs at Darlington met the regulatory requirements.

Personnel certification

OPG had sufficient certified personnel at Darlington for all certified positions in accordance with CNSC regulatory requirements. CNSC staff are satisfied that OPG's program certifies the competency of personnel at Darlington to perform their duties safely.

Initial certification examinations and requalification tests

The initial certification examinations and requalification tests program for the certified staff at Darlington met all regulatory requirements.

In 2014, CNSC staff conducted an inspection of the design, verification, conduct and grading of a simulator-based certification examination. CNSC staff concluded that OPG met its program and regulatory requirements.

Work organization and job design

Minimum shift complement

OPG has implemented an effective process at Darlington to ensure that a sufficient number of qualified workers are available at the facility at all times to ensure safe operation and adequate emergency response capability. OPG uses the minimum complement coordination program to track the availability of minimum complement and to ensure that even short-duration minimum complement violations are avoided.

3.2.1.3 Operating performance

Based on the information assessed, CNSC staff concluded that the operating performance SCA at Darlington met or exceeded performance objectives and all applicable regulatory requirements. As a result, the station received a "fully satisfactory" rating, which is unchanged from the previous year.

Conduct of licensed activity

OPG continued to operate Darlington with a high level of performance. OPG operated within the limits of the Darlington licence, the operating policies and principles and the operational safety requirements.

Darlington experienced no unplanned reactor trips, two stepbacks and one setback. It should be noted that the transients were controlled properly by the licensee and that stepbacks and setbacks address issues at domains far below those of regulatory concern. Consequently, there was no impact on nuclear safety.

The power history graphs for the Darlington nuclear reactor units for 2014 can be seen in appendix F. These graphs show the occurrences (and causes) of outages and the associated power reductions during the year.

CNSC staff conducted inspections, including field and control room inspections. No significant operations-related compliance issues were identified. Darlington has continued to demonstrate a high degree of compliance in this area.

Procedures

OPG has governance in place that ensures that procedures are written in a consistent and usable manner. Darlington has clearly documented expectations for procedural use and adherence and a process is in place to manage procedural change. Based upon compliance verification activities carried out by CNSC staff in 2014, it was noted that OPG's procedures at Darlington comply with the regulatory requirements.

Reporting and trending

OPG is required to submit quarterly reports on operations and performance indicators as described in S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. CNSC staff review did not identify any significant regulatory issues from these reports.

Outage management performance

Darlington scheduled one planned outage and experienced six forced outages. Details are in appendix F. Darlington continues to demonstrate high levels of performance and achievement of objectives during outages. OPG followed-up appropriately on all planned and forced outages. All outage-related undertakings, including heat sink strategy management at Darlington, were performed safely by OPG staff.

Safe operating envelope

OPG's implementation of the safe operating envelope maintained the Darlington reactors operating in their analyzed state thereby ensuring adequate safety at all times. The SOE implementation level was satisfactory at Darlington in 2014 and in compliance with N290.15, *Requirements for the safe operating envelope of nuclear power plants* [11].

Tritium removal facility

Darlington is the only NPP in Canada that operates a tritium removal facility (TRF). Tritium builds up gradually in some plant systems as a result of day-to-day operations. Removing it minimizes the amount released into the environment and reduces the potential radiation exposure of workers. The tritium is extracted from the reactor's heavy water and safely stored in stainless steel containers within a concrete vault. The operation of the TRF did not exceed any environmental limits.

In 2014, the availability of the TRF was adversely impacted due to impurity ingress in one of the TRF systems. The increased number of restarts due to the degraded operability of the TRF resulted in higher emissions in 2014 compared to previous years, but still well below regulatory limits and action levels. OPG has developed an action plan to address this issue and CNSC staff will continue to maintain oversight on this matter.

3.2.1.4 Safety analysis

Based on the information assessed, CNSC staff concluded that the safety analysis SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Deterministic safety analysis

Darlington has an effective, well-managed program for performing deterministic safety analysis. The station has adequate safety margins and these meet the CNSC's acceptance criteria for safe operation of the NPP.

REGDOC-2.4.1, *Deterministic Safety Analysis* [16], replaced RD-310, *Safety Analysis for Nuclear Power Plants* [15], in 2014. OPG provided CNSC with its implementation plan for REGDOC-2.4.1 in October 2014. OPG's approach will be to conduct all new analyses in accordance with REGDOC-2.4.1 and to update existing analyses, which will provide the most

value in terms of demonstrable safety benefit. CNSC staff will continue to review OPG's implementation of REGDOC-2.4.1 as part of the compliance verification program.

Probabilistic safety analysis

OPG is in compliance with S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* [4], and is transitioning towards implementation of the recently issued REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* [18], at Darlington. OPG requested an amendment to the operating licence in October 2014, to implement REGDOC-2.4.2 and submitted a detailed and acceptable transition plan for implementation. The next PSA update will be made in 2020.

As a follow-up from the 2013 Pickering licence renewal hearing, OPG is developing a methodology for Pickering's whole-site PSA, which includes the aggregation of risks from different hazards and from all units. OPG will use lessons learned from the Pickering pilot to develop the path forward for Darlington.This work is ongoing and is being undertaken in collaboration with the nuclear industry in Canada as a whole.

Severe accident analysis

The severe accident management guideline (SAMG)-related Fukushima action items for Darlington are now all closed based on work completed and committed plans. OPG has completed implementation of the single-unit accident SAMGs. OPG is working on implementation of extended SAMGs to include multi-unit events and the irradiated fuel bays and these are scheduled for completion by the end of 2015.

Environmental risk assessment

OPG continued to maintain and implement an effective environmental risk assessment and management program at Darlington in accordance with CNSC regulatory requirements. Work is ongoing towards documenting an environmental risk assessment consistent with N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* [19]. Risk assessment continued to be informed by baseline monitoring results and reports from the Darlington refurbishment environmental assessment.

A round whitefish population survey was conducted by the Ontario Ministry of Natural Resources and Forestry in partnership with OPG along the north-central shoreline of Lake Ontario near Darlington and Pickering. Results of this population study, which is expected to be completed by 2016, will help inform ongoing management of the species.

3.2.1.5 Physical design

Based on the information assessed, CNSC staff concluded that the physical design SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Design governance

Environmental qualification

The environmental qualification (EQ) program is fully implemented in all Darlington operating units. Darlington demonstrated EQ compliance in accordance with its governing document by maintaining EQ program sustainability.

Pressure boundary design

OPG continued to operate Darlington in compliance with the requirements of N285.0-08, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants* [48], and implements a comprehensive pressure boundary program.

System design

Electrical power systems

There were no significant reportable events during the year that had an effect on the electrical power systems at Darlington. An inspection performed by CNSC staff confirmed the class I, II and III power systems are being maintained and tested to ensure that they will be able to perform their design functions. However, areas for improvement have been identified, which OPG is addressing. CNSC staff will continue to monitor OPG's performance in this area as part of the compliance verification program.

Fire protection design

CNSC staff conducted ongoing oversight activities at Darlington in 2014, including specialist document reviews and CNSC site inspector walk downs. CNSC staff concluded that the Darlington's fire protection program is both comprehensive and in compliance with requirements of N293-07, *Fire protection for CANDU nuclear power plants* [50].

Component design

Fuel inspection program

OPG has a well-developed reactor fuel inspection program. Fuel performance at Darlington was acceptable in 2014, although there was an increase in the number of fuel defects found in operating units. OPG continued to investigate the root cause, and to develop and implement corrective actions. CNSC staff considered OPG's fuel program to be robust and that OPG is able to adequately manage this issue while maintaining safe operations.

Cables

At Darlington, OPG has fully implemented an *in-situ* testing and condition monitoring program of its installed low voltage cables. OPG also implemented a cable surveillance program, supplemented with a cable aging program to focus on safety-related and operationally-important cables at Darlington. CNSC staff continued to monitor OPG's progress in this area. In addition, CNSC staff were satisfied with OPG's performance in this area.

3.2.1.6 Fitness for service

Based on the information assessed, CNSC staff concluded that the fitness for service SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Equipment fitness for service/equipment performance

On the basis of inspections and compliance verifications, CNSC staff concluded the overall equipment fitness for service and performance at Darlington was satisfactory and met regulatory requirements.

Maintenance

The maintenance program performance at Darlington remained satisfactory. The corrective maintenance backlog and deficient maintenance backlog at Darlington were within the range of the industry best practice.

Structural integrity

OPG inspected selected pressure boundary and containment components. CNSC staff's assessment of the final inspection reports and other compliance monitoring activities indicated that the existing programs at Darlington are in compliance with CNSC regulatory requirements.

OPG continued to implement the Fuel Channel Life Management Project (FCLMP) to demonstrate pressure tube fitness for service for continued operation.

OPG also developed a long-term plan to ensure spacer integrity and mobility. CNSC staff have reviewed and accepted this plan and are closely monitoring its implementation.

Reliability of systems important to safety

The reliability program at Darlington continued to meet regulatory requirements as described in RD/GD-98, *Reliability Programs for Nuclear Power Plants* [27].

Shutdown system number 1 (SDS1) met its unavailability target in 2014. Shutdown system number 2 (SDS2), the emergency coolant injection system (ECIS) and the negative pressure containment system (NPCS) exceeded their targets, which are conservatively defined in the regulatory reporting requirements due to indirect causes from a single situation, which is described below. The special safety systems themselves were actually available throughout 2014. For this situation, OPG, per its operating policies and principles, took immediate corrective actions and assessed the potential impact on nuclear safety.

A common mode situation discovered at Unit 0 involving SDS2, ECIS and NPCS of the four operating units resulted in a high observed unavailability from indirect causes. That meant, in the unlikely event of a main steam line break, confined to a specific area of the plant and a potential consequential power outage, the air conditioning unit (ACU) auto start logic would not start automatically and would have to be manually started. This potential event thereby affected the observed unavailability values for these three systems. There were no direct impairments of the Darlington special safety systems during 2014 and no impact on the safety of operations.

In response to this incident, OPG implemented compensatory actions to ensure the ACU performed as designed. OPG continues to place high priority on implementing the permanent design changes, which are expected to be finalized in 2015. CNSC staff verified the actions of the licensee and concluded there was no significant impact on nuclear safety. CNSC staff concluded that the actions taken by OPG are acceptable to the CNSC.

All systems would have performed as designed for all other postulated accident scenarios. Other measures indicate that the predicted future unavailability will continue to meet their targets.

Aging management

OPG has implemented an integrated aging management program to ensure that the condition of SSCs important to safety is well understood and that the required activities are in place to assure the health of these SSCs while the plant ages.

Darlington has also submitted component condition assessments and aging management program

reviews, as part of the integrated safety review for the refurbishment project. The results were found to be acceptable and met regulatory requirements for continued safe operation.

Chemistry control

OPG's chemistry control program performance at Darlington was satisfactory. Compliance verification activities conducted during the year confirmed that the program remained in compliance with regulatory requirements, OPG's governance documents, codes and standards and industry best practices.

Periodic inspections and testing

OPG has adequate periodic inspection programs (PIPs) in place at Darlington for the pressure boundary and containment components important to safety. CNSC staff monitored compliance with the established PIPs and concluded that their implementation meets regulatory requirements. Inspection results were reported to the CNSC after each outage and subsequent reviews revealed no safety-significant issues in 2014.

3.2.1.7 Radiation protection

Based on the information assessed, CNSC staff concluded that the radiation protection SCA at Darlington met or exceeded performance objectives and all applicable regulatory requirements. As a result, the station received a "fully satisfactory" rating, which is unchanged from the previous year.

Application of ALARA

At Darlington, OPG continued to implement a highly effective, well-documented and mature ALARA program that they have implemented in past years, the foundations of which are based on industry best practices. CNSC compliance activities verified that, through numerous ALARA initiatives, work planning, and dose monitoring and control, Darlington continued to meet the challenging targets established by OPG.

In 2014, CNSC staff conducted an inspection of occupational ALARA planning and control within Darlington. Compliance verification activities indicated that performance in the area of application of ALARA at Darlington is highly effective.

Worker dose control

OPG continued to comply with the regulatory requirements to measure and record doses received by workers at Darlington. Routine compliance verification activities indicate that performance in the area of worker dose control at Darlington is effective. No worker or member of the public received a radiation dose in excess of the regulatory dose limits or action levels established in the Darlington radiation protection (RP) program. The dose information for Darlington is provided in section 2.1.7 and appendix D.

Radiation protection program performance

Darlington implements OPG's corporate RP program, which exceeds the requirements of the *Radiation Protection Regulations* and includes performance indicators to monitor program performance. The RP program documents and supporting procedures are kept current, taking into consideration operating experience and industry best practices.

CNSC staff confirmed that challenging goals and targets have been established and met. The RP program documents and the oversight applied by OPG in implementing and continuously improving this program have ensured the protection of workers at Darlington.

Routine compliance verification activities indicate that Darlington is highly effective in the area of radiation protection program performance.

Radiological hazard control

No action levels were exceeded for surface contamination at Darlington in 2014.

Routine compliance verification activities indicate that performance in the area of radiological hazard control at Darlington is effective.

Estimated dose to the public

OPG continued to ensure the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported dose to the public from Darlington was 0.0006 mSv, well below the annual regulatory public dose limit of 1 mSv.

3.2.1.8 Conventional health and safety

Based on the information assessed, CNSC staff concluded that the conventional health and safety SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is a decrease from the previous year. OPG had recurring issues in the area of scaffolding, thus the station received a "satisfactory" rating, a decrease from the previous year. OPG has since taken appropriate compensatory corrective measures.

Darlington demonstrated acceptable performance in the area of conventional health and safety throughout 2014. CNSC staff noted that workers practiced safe working behaviours, have conservative attitudes and were well protected by programs and equipment provided by OPG.

Performance

As reported by OPG, the accident severity rate (ASR) for Darlington increased from 0.2 to 4.4, while the accident frequency (AF) decreased from 0.30 to 0.24. The ASR is higher than the industry average while the AF is in the area of the industry average. There was one lost-time injury reported in 2014 due to a knee injury. This event resulted in an increase in the days lost, which affected the ASR.

Practices

OPG was compliant at Darlington with the relevant provisions of the *Occupational Health and Safety Act of Ontario* and the *Labour Relations Act*.

Awareness

OPG continued to maintain a safe and efficient working environment at Darlington. The station was clean and tidy, although various instances of improperly stored transient material, including combustibles and hazardous materials, were noted. OPG's performance in this area in 2014 met the CNSC's expectations. CNSC staff will continue to monitor OPG's progress in improving the storage of ladders and scaffolding.

3.2.1.9 Environmental protection

Based on the information assessed, CNSC staff concluded that the environmental protection SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Effluent and emissions control (releases)

All radiological releases from Darlington remained below their respective regulatory limits.

Groundwater monitoring at the Darlington site indicated no adverse impact on the groundwater environment due to station operation.

Environmental management system

OPG has established and implemented an environmental management program to assess environmental risks associated with its nuclear activities and to ensure that these activities are conducted such that adverse environmental effects are prevented or mitigated.

Protection of the public

There were no hazardous substances released from Darlington that posed unacceptable risk to the environment or the public.

The reported annual radiation dose to the public from Darlington was 0.06 percent of the public dose limit.

3.2.1.10 Emergency management and fire protection

Based on the information assessed, CNSC staff concluded that the emergency management and fire protection SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Conventional emergency preparedness and response

During 2014, CNSC staff conducted regulatory oversight activities at Darlington, including review of documentation, onsite observations and participation in drills. OPG maintained its conventional emergency preparedness and response commitments including enhancements to its emergency drill program.

Nuclear emergency preparedness and response

CNSC staff monitored and participated in a major joint nuclear emergency exercise known as Unified Response at Darlington in May 2014. CNSC staff concluded that during this exercise there were no significant issues that would have impacted the operating units or offsite action completions. The scale of the exercise was significant. It included OPG and more than 50 offsite agencies, spanned three days (May 26 to 28, 2014) and allowed the affected emergency response organizations

Testing of emergency mitigating equipment at the Darlington Nuclear Generating Station.

the opportunity to test their response capability. The validation of emergency plans and lessons learned provided valuable information and experience for the participating organizations. CNSC staff concluded that Darlington and offsite agencies continue to successfully demonstrate readiness to respond to a nuclear emergency.

Fire emergency preparedness and response

CNSC staff performed a fire drill inspection at Darlington in 2014 to evaluate the response capabilities of the industrial fire brigade. From the results of this inspection, CNSC staff concluded that Darlington continues to implement a comprehensive fire response capability that includes effective procedures, training and maintenance of proficiency by OPG staff.

3.2.1.11 Waste management

Based on the information assessed, CNSC staff concluded that the waste management SCA at Darlington met or exceeded performance objectives and all applicable regulatory requirements. As a result, the station received a "fully satisfactory" rating, which is an improvement from "satisfactory" in the previous year.

Waste minimization

OPG maintains a highly effective waste management program at Darlington for radioactive and hazardous wastes that promotes minimization, segregation, storage and handling. Field inspection observations revealed no deficiencies in 2014.

Waste management practices

CNSC staff confirmed that OPG's programs at Darlington met requirements for managing radioactive waste. OPG's programs are adequate for the management of radioactive waste associated with current operations and refurbishment activities. Additional information on Darlington's waste management can be found in CMD 15-M22, *Regulatory Oversight Report for 2010 – 2014 Ontario Power Generation Inc.'s Darlington, Pickering and Western Waste Management Facilities* [52].

Decommissioning plans

OPG maintains decommissioning plans and an associated consolidated financial guarantee for all of its Ontario facilities. The consolidated financial guarantee and the associated decommissioning plans were reviewed and accepted by the Commission in 2012 and will be reviewed again in 2017.

CNSC staff concluded that OPG's decommissioning plan and financial guarantee for Darlington are current, exceeded regulatory requirements and remained fully satisfactory in 2014.

3.2.1.12 Security

Based on the information assessed, CNSC staff concluded that the security SCA at Darlington met or exceeded performance objectives and all applicable regulatory requirements. As a result, the station received a "fully satisfactory" rating, which is unchanged from the previous year.

Response arrangements; drills and exercises; security practices

At Darlington, OPG maintains a highly robust nuclear response force (NRF), which is supported by a strong training program. CNSC staff verified that OPG has continued to improve the integration of its NRF to include unarmed nuclear security officers. OPG has implemented highly effective drills and exercises at Darlington and has introduced enhanced screening technology in the search area, which will improve access control.

CNSC staff verified that corrective action plans in response to inspection findings were implemented to a satisfactory level.

3.2.1.13 Safeguards and non-proliferation

Based on the information assessed, CNSC staff concluded that the safeguards and non-proliferation SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Nuclear material accountancy and control

OPG complied with regulatory requirements at Darlington in accordance with RD-336, *Accounting and Reporting of Nuclear Material* [39].

Access and assistance to the IAEA

The IAEA did not select Darlington for a physical inventory verification (PIV) in 2014. As a result, CNSC staff performed an evaluation of Darlington's preparedness for a PIV in October 2014 and concluded that Darlington would have been adequately prepared had it been selected.

In April 2014, the IAEA replaced the detectors and associated wiring of the core discharge monitors installed in Unit 1 for unattended monitoring of bundle discharges from the reactor core.

Operational and design information

OPG submitted its annual operational program for Darlington to the CNSC on time, with quarterly updates, and the annual update to the information provided pursuant to the *Additional Protocol* [40].

Safeguards equipment, containment and surveillance

OPG supported IAEA equipment operation and maintenance activities at Darlington, including those related to the core discharge monitor re-wiring at Unit 1, and maintenance and repair work on remote monitoring components, to ensure the effective implementation of safeguards measures at the station.

3.2.1.14 Packaging and transport

Based on the information assessed, CNSC staff concluded that the packaging and transport SCA at Darlington met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

CNSC staff reached this conclusion based on onsite monitoring activities and a review of the reports submitted in accordance with S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. There were no significant events reported under the *Packaging and Transport of*

Nuclear Substances Regulations for consignments transported to and from Darlington. OPG continued to implement and maintain an effective packaging and transport program at Darlington.

3.2.2 Regulatory developments

3.2.2.1 Licensing

OPG's licence for Darlington was renewed in February 2013 for a 22-month period (effective until December 31, 2014). The Darlington licence has been issued under the new licence format with the accompanying LCH.

In December 2013, OPG submitted an application to the Commission for the renewal of the power reactor operating licence for Darlington. This was followed by a request in June 2014 to amend the operating licence by one year to allow OPG sufficient time to provide additional material to support the December 2013 licence renewal application and to allow the public adequate time to review this additional material. In July 2014, the Commission approved an amendment of the operating licence until December 31, 2015. In December 2014, OPG submitted an updated application for the renewal of the operating licence for Darlington. The two-part public hearing is scheduled to take place in Ottawa, Ontario in August 2015 and in Courtice, Ontario in November 2015.

Environmental assessment screening regarding the proposal to refurbish and continue to operate Darlington

The 2013 Commission decision [53] for the environmental assessment (EA) screening regarding the proposal to refurbish and continue to operate Darlington was challenged through an application for judicial review in the Federal Court of Canada. In November 2014, the Federal Court dismissed the application; however, this decision dismissing the application for judicial review has been appealed to the Federal Court of Appeal and a decision of this Court is anticipated in 2016.

Study of consequences of a hypothetical severe nuclear accident and effectiveness of mitigation measures

In the Commission's *Record of Proceedings, Including Reasons for Decision* [53] for the EA screening regarding the proposal to refurbish and continue to operate Darlington, the Commission requested CNSC staff to assess the health and environmental consequences of severe accident scenarios in order to address the concerns raised during the December 2012 public hearing. CNSC staff, with contributions from OPG, Pacific Northwest National Laboratories and Dr. L. Zablotska, completed the assessment, entitled *Study of Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures* [44]. Details of the assessment were presented to the Commission at the June 19, 2014 public meeting.

A number of conservative assumptions were made in the study, which contributed to an overestimation of risk. There were assumptions about the progression of the accident (i.e., it was assumed releases happen) and about the human health risk assessment (i.e., overestimation of dose due to modelling as opposed to direct measurements). What the study did not take into account were enhancements in the plant's design, operating provisions, accident management and emergency preparedness emanating from the *CNSC Integrated Action Plan* [2]. These ongoing enhancements would ensure that the likelihood of a severe accident is further reduced, and if it were to occur, emergency response measures would be effective in mitigating offsite releases.

Based on the results of this theoretical study, regardless of the scenario examined, dose would decrease rapidly with distance. Highest doses would occur at 1 km from the plant, an area that is within OPG's property boundary. Furthermore, for all scenarios examined in this study, the emergency planning zones established under the Ontario Provincial Nuclear Emergency Response Plan (PNERP) using the established evacuation criteria would generally be sufficient in size to accommodate the evacuation needed. The radiological impact as a result of this theoretical study is equivalent to the Fukushima Daiichi accident, categorized at International Nuclear and Radiological Event Scale (INES) level 7.

The study was made available for public comments from June 4 to August 29, 2014 with 505 comments received. CNSC staff reviewed and dispositioned the comments and presented the updated report to the Commission on March 26, 2015. The updated report will be published on the CNSC website in September 2015.

Licence amendments

The Darlington licence was amended twice between January 1, 2014 and April 30, 2015. Details of the amendments are given in appendix H.

Revisions to the licence conditions handbook

Darlington's LCH was issued on March 1, 2013. Four revisions were made to the Darlington LCH between January 2014 and April 2015. These revisions were primarily to update titles and numbers of OPG documents referenced, which are reviewed and tracked by CNSC staff as part of the LCH-revision process. The changes were mostly administrative in nature and details of the significant changes can be seen in appendix H.

The revisions were approved by the Director General, Directorate of Power Reactor Regulation. The changes to the LCH have not resulted in an unauthorized change of scope and remain within the licensing envelope.

3.2.2.2 Updates on major projects and initiatives

Refurbishment/life extension

CNSC staff completed their assessment and have accepted OPG's global assessment report and integrated implementation plan (IIP) on condition that OPG make specific changes to the IIP. OPG submitted a revised IIP incorporating CNSC staff's feedback. The revised IIP will be presented to the Commission as part of the Darlington licence renewal hearing in 2015.

During refurbishment licensees need to replace major components such as the reactor calandria tubes.

Darlington refurbishment environmental assessment follow-up program

As directed by the record of decision on the Darlington refurbishment EA, OPG developed a more detailed follow-up program in consultation with the CNSC, Fisheries and Oceans Canada (DFO) and other stakeholders. It issued this program in October 2013. OPG continues to work with the CNSC, DFO and Environment Canada (EC) on detailed sampling plans for the pre-refurbishment phase regarding aquatic

matters. These studies are expected to be completed before the first unit refurbishment outage anticipated in 2016.

As part of the environmental assessment (EA) follow-up monitoring program, OPG is developing a thermal monitoring program to be implemented during continued operations. This includes consideration of the results of a research study on thermal effects on round whitefish eggs. The study was published by the CANDU Owners Group (COG) in 2014 and submitted to the CNSC, EC and DFO staff. CNSC staff are currently reviewing the COG report in collaboration with EC.

OPG has also continued to participate in the round whitefish action plan with the CNSC, DFO, EC and the Ontario Ministry of Natural Resources and Forestry (OMNRF). A key aspect of this initiative includes consideration of a round whitefish population study. This study, led by the OMNRF commenced in 2014 with OPG working collaboratively with OMNRF to collect samples of round whitefish in the vicinity of the Darlington and Pickering stations. The results of this study will allow for a better understanding of the population dynamics of this species in Lake Ontario and help inform this species' ongoing management.

3.2.2.3 Updates on significant regulatory issues

***Fisheries Act* authorizations**

Darlington impinges and entrains fish of many species despite the use of an offshore, submerged, porous-veneer velocity-cap intake. In response to a commitment made during the Darlington refurbishment EA, OPG submitted to DFO an application for authorization pursuant to the *Fisheries Act.* The need for the authorization was identified prior to the implementation of the DFO-CNSC memorandum of understanding and therefore, the application was submitted directly to DFO in August 2014. In early 2015, DFO staff requested further information and documentation from OPG in relation to details of the monitoring plan as part of offsetting measures. DFO received this additional information from OPG in February and March 2015. DFO and OPG staff are currently discussing the details of the authorization prior to it being issued.

Response to the Fukushima Daiichi accident

OPG has made considerable progress in addressing Fukushima action items (FAIs) at Darlington and Pickering. As of January 2015, all FAIs applicable to OPG stations have been closed (see appendix G).

CNSC staff concluded that OPG has strengthened reactor defence in depth and enhanced its emergency response at Darlington and Pickering stations in response to lessons learned from the Fukushima nuclear accident.

The activities undertaken in 2014 by OPG to disposition outstanding FAIs were completed for the following area:

- ***Evaluation of the habitability of control facilities during a severe accident (FAI 1.9.1):*** CNSC staff reviewed OPG's *Update Report No. 6* on the FAIs. In this progress update, OPG requested closure of FAI 1.9.1 for Darlington and Pickering to address habitability of control facilities during a severe accident. The OPG submission is based upon the generic methodology completed under a COG joint project in 2014 and on a more exhaustive review specific to non-radiological hazards for the Darlington and Pickering units than established

by the COG (generic) habitability methodology. CNSC staff found this approach to be acceptable. Therefore, the related FAI 1.9.1 was closed for all OPG stations.

Furthermore, OPG has committed to additional future enhancements under the refurbishment project for Darlington, many of which are targeted for completion prior to the first unit refurbishment in late 2016. These include the provision of a containment filtered venting system for a severe accident, and the installation of a third emergency power generator. As reported in previous NPP reports, FAIs related to these activities were closed on the basis of an approved implementation plan.

CNSC staff will continue to monitor FAI implementation at Darlington through the established compliance verification program. Annual updates on FAI implementation will be provided to the Commission as part of the NPP report.

3.2.2.4 Public communication

Event initial reports

One event initial report (EIR) was submitted for Darlington from January 2014 to April 2015, as shown in table 10. The EIR event had low safety significance.

Table 10: Event initial reports for Darlington

Subject	Brief description
Generator seal oil release to the environment at Unit 3 Darlington	The CNSC received notice from OPG of an unintended release of a maximum estimated 1,500 litres of generator seal oil to Lake Ontario from one of two Unit 3 heat exchangers at the Darlington Nuclear Generating Station. This heat exchanger is part of the non-nuclear systems. The leak was identified on August 6, 2014, during routine sampling and was immediately isolated. Samples taken downstream after isolation of the heat exchanger were below nominal detectable limits, which indicated that the leak had been isolated. There was no radiological release to the environment. This event was reported to the Commission through Commission member document (CMD) 14-M56 on August 20, 2014. CMD 14-M56 completed CNSC staff notification to the Commission on this event.

3.3 Pickering

Pickering is located on the north shore of Lake Ontario, in the city of Pickering and the regional municipality of Durham, in Ontario. The facility lies 32 kilometres northeast of Toronto and 21 kilometres southwest of Oshawa. The facility is owned by Ontario Power Generation Incorporated (OPG), a Canadian corporation with its head office in Toronto.

The nuclear facility consists of eight CANDU reactors. Units 2 and 3 are not operating. These two units were defuelled in 2008 and will be maintained in safe storage until the eventual decommissioning of the Pickering station.

Each operating reactor has a gross electrical output of 542 MWe (megawatts electrical) for Pickering 1, 4 (this refers to Pickering Units 1 and 4) and 540 MWe for Pickering 5-8 (this refers to Pickering Units 5 to 8).

Construction of the facility started in 1966 and the first criticality of a reactor unit was in 1971. The in-service dates for Units 1 to 4 ranged from 1971 to 1973; for Units 5 to 8, from 1983 to 1986.

3.3.1 Safety assessment

The CNSC staff safety assessment of Pickering for 2014 resulted in the performance ratings as shown in table 11. Based on the observations and assessments of the SCAs, CNSC staff concluded that Pickering operated safely. The integrated plant rating was “satisfactory”, which is unchanged from the previous year.

Table 11: Performance ratings for Pickering

Safety and control area	Rating	Industry average
Management system	SA	SA
Human performance management	SA	SA
Operating performance	SA	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	FS	SA
Conventional health and safety	SA	FS
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Waste management	SA	FS
Security	FS	FS
Safeguards and non-proliferation	SA	SA

Safety and control area	Rating	Industry average
Packaging and transport	**SA**	**SA**
Integrated plant rating	**SA**	**SA**

Note:

- For specific areas within the SCAs where there were no significant observations from CNSC staff compliance verification activities, no information is given in this subsection of the report.
- The information presented below is station specific; general trends are not identified here (refer to section 2 for industry-wide observations).

3.3.1.1 Management system

Based on the information assessed, CNSC staff concluded that the management system SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Management system
OPG's management system complied with the requirements of N286-05, *Management system requirements for nuclear power plants* [8]. OPG continued to make changes in its management system documentation to align with the centre-led matrix organization. OPG made revisions to top tier and lower tier governing documents such as policies and programs. CNSC staff review of the revised documents has identified issues that OPG is addressing through its business transformation initiatives (BTI).

Organization
OPG completed the transition to a centre-led matrix organizational structure through the BTI.

Change management
The BTI have resulted in changes to the OPG organization including that of Pickering. Records were provided by OPG, and CNSC staff determined that the changes to the nuclear organization followed OPG's organizational change control process.

3.3.1.2 Human performance management

Based on the information assessed, CNSC staff concluded that the human performance management SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Human performance program
CNSC staff assessed OPG's human performance program and concluded that Pickering is in compliance with regulatory requirements.

Personnel training
OPG has a well-documented and robust fleet-wide systematic approach to training-based training system. Three compliance inspections conducted in 2014 confirmed that the various training programs at Pickering met the regulatory requirements.

Personnel certification

OPG had sufficient certified personnel at Pickering for all certified positions, in accordance with CNSC regulatory requirements. CNSC staff are satisfied that OPG's program certifies the competency of personnel at Pickering to perform their duties safely.

Initial certification examinations and requalification tests

The initial certification examinations and requalification tests program for certified staff at Pickering met all regulatory requirements. In 2014, CNSC staff conducted an inspection of the design, conduct and grading of an authorized nuclear operator simulator-based certification examination. CNSC staff concluded that OPG met its program and regulatory requirements.

Work organization and job design

Minimum shift complement

OPG has implemented an effective process to ensure that a sufficient number of qualified workers are available at Pickering at all times. Throughout 2014, the minimum shift complement was maintained at Pickering.

CNSC staff monitored the Pickering operations training exercise conducted in 2014. The exercise aimed to demonstrate response to an event in which the main control room was uninhabitable and CNSC staff concluded that the response was satisfactory.

3.3.1.3 Operating performance

CNSC staff concluded that the operating performance SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Conduct of licensed activity

OPG continued to operate Pickering within the bounds of the operating policies and principles, and all reactor units operated within the reactor power limits prescribed by Pickering's operating licence.

With two reactors, Pickering 1, 4 experienced one unplanned reactor trip and one setback (Pickering 1, 4 does not have stepbacks).

With four reactors, Pickering 5-8 experienced no unplanned reactor trips, one stepback and no setbacks.

It should be noted that the transients were controlled properly by the licensee and that stepbacks and setbacks address issues at domains far below those of regulatory concern. Consequently, there was no impact on nuclear safety.

The power history graphs for the Pickering nuclear reactor units for 2014 can be seen in appendix F. These graphs show the occurrences (and causes) of outages and the associated power reductions during the year.

There was a significant number of fuelling machine breakdowns, which resulted in several forced deratings on all units. This issue is primarily related to production; however, unplanned and forced reactor power changes are undesirable because they represent operation in off-normal conditions. OPG implemented a comprehensive reliability plan and from late 2014 through early 2015, has been able to significantly improve the forced loss rate due to fuelling machine issues. OPG continues to work at resolving ongoing challenges related to fuelling machine reliability. CNSC staff are monitoring this issue and have not noted any impact on safety.

On November 21, 2014, there was a loss-of-moderator inventory event at Unit 7. The unit was in a planned outage when the moderator collection tank high level alarm was received in the main control room and the moderator level in the calandria vessel was identified to trend downwards. Moderator heavy water passed through openings of an auxiliary system under maintenance and spilled onto the reactor building floor inside containment. A station emergency was declared to provide additional management oversight, to direct personnel to evacuate the incident area and to assemble for accounting. The moderator level stabilized four hours later and all the spilled heavy water (approximately 6,200 litres) was contained within the reactor building. Containment ventilation was isolated during the station emergency to ensure retention of airborne tritium inside the reactor building and to minimize release to the environment. The spilled heavy water was subsequently cleaned-up.

CNSC site staff inspected and confirmed the findings made by OPG in its preliminary investigation of the event. This event was reported to the Commission as an event initial report (EIR) and details are given in section 3.3.2.4.

There were no serious process failures at Pickering during 2014. CNSC staff conducted site inspections, including field and control room inspections. No significant operations-related compliance issues were identified. OPG was found to be compliant with its governing procedures, documents and regulatory requirements.

Procedures

OPG has governance in place that ensures that procedures are written in a consistent and usable manner. Based upon compliance verification activities carried out by CNSC staff in 2014, it was noted that OPG's procedures at Pickering comply with the regulatory requirements.

Reporting and trending

OPG is required to submit quarterly reports on operations and performance indicators as described in S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. CNSC staff did not identify any significant regulatory issues from these reports.

Outage management performance

Pickering 1, 4 had one planned outage and five forced outages. Pickering 5-8 had two planned outages and four forced outages. Details are in appendix F. OPG continued to demonstrate high levels of performance and achievement of objectives during outages. OPG followed-up appropriately on all planned and forced outages. All outage-related undertakings, including heat sink strategy management at Pickering, were performed safely by OPG staff.

CNSC staff continued to monitor the issue of fuel bundle (black) deposits. OPG's corrective actions have stabilized the situation and deposit sizes are trending down. No safety-significant findings have been identified as a result of the deposits.

Safe operating envelope

OPG's implementation of the safe operating envelope (SOE) ensured that the Pickering reactors operated in their analyzed states, thereby ensuring adequate safety at all times. The SOE implementation level was satisfactory at Pickering in 2014 and in compliance with N290.15, *Requirements for the safe operating envelope of nuclear power plants* [11].

Accident management and recovery

All of the required passive autocatalytic recombiners have been installed at Pickering in accordance with FAI 1.4.1 given in the *CNSC Integrated Action Plan* [2] and as shown in appendix G.

3.3.1.4 Safety analysis

Based on the information assessed, CNSC staff concluded that the safety analysis SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Deterministic safety analysis

OPG has an effective, well-managed program at Pickering for performing deterministic safety analysis. CNSC staff reviewed the topics, listed below, in its determination of the overall assessment of deterministic safety analysis at Pickering. The station has adequate safety margins and these meet the CNSC's acceptance criteria for safe operation of the NPP.

REGDOC-2.4.1, *Deterministic Safety Analysis* [16], replaced RD-310, *Safety Analysis for Nuclear Power Plants* [15], in 2014. OPG provided CNSC staff with its implementation plan for REGDC-2.4.1 in October 2014. OPG's approach will be to conduct all new analyses in accordance with REGDOC-2.4.1 and to update existing analyses, which will provide the most value in terms of demonstrable safety benefit. CNSC staff will continue to review OPG's implementation of REGDOC-2.4.1 as part of the compliance verification program.

Pickering 5-8 2013 best estimate and uncertainty (BEAU) compliance annual report

CNSC staff reviewed the Pickering 5-8 2013 best estimate and uncertainty (BEAU) methodology compliance annual report. Based on the review conducted, CNSC staff are satisfied that the operation of Pickering 5-8 is compliant with the assumptions made in its 2007 large loss-of-coolant accident (LLOCA) analysis using BEAU methodology for Pickering 5-8 reactors.

Probabilistic safety analysis

OPG is in compliance at Pickering with S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* [4].

Through the *Summary Record of Proceedings, Including Reasons for Decision – Application to Request Removal of a Hold Point for the Pickering Nuclear Generating Station* [5] for the May 7, 2014, public hearing, the Commission directed OPG to submit a report on the detailed risk improvement plan for Pickering. The Commission also directed OPG and CNSC staff to report annually on matters related to:

- OPG's risk improvement plan
- The development and implementation of whole-site based safety goals and PSA methodology

OPG had submitted the risk improvement plan in August 2014. This detailed risk improvement plan encompassed a combination of physical improvements, changes to operating procedures and improvements to the PSA methodologies as requested by the Commission. The Commission was satisfied with the detailed risk improvement plan for Pickering.

CNSC staff revised the Pickering LCH by including a clause that directed OPG to submit annual reports to the CNSC on the status of implementation of the risk improvement plan for Pickering, as well as status updates for the timeline for the development and implementation of whole-site based safety goals and PSA methodology. OPG provided the first risk improvement plan update on February 27, 2015. A detailed update on OPG's risk improvement plan is given in section 3.3.2.3 as directed by the Commission in the *Record of Proceedings, Including Reasons for Decision – Application to Request Removal of a Hold Point for the Pickering Nuclear Generating Station* [5] for the May 7, 2014 public hearing.

Severe accident analysis

The SAMG-related Fukushima action items for Pickering are now all closed based on work completed and committed plans. OPG has completed implementation of the single-unit accident SAMGs. OPG is working on implementation of extended SAMGs to include multi-unit events and the irradiated fuel bays, and these are scheduled for completion by the end of 2015.

Environmental risk assessment

OPG continued to maintain and implement an effective environmental risk assessment and management program at Pickering in accordance with regulatory requirements. OPG completed work for Pickering towards documenting an environmental risk assessment consistent with N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* [19].

A round whitefish population survey was conducted in 2014 as part of a study by the Ontario Ministry of Natural Resources and Forestry in partnership with OPG along the north-central shoreline of Lake Ontario near Darlington and Pickering. Results of this population study, which is expected to be completed by 2016, will help inform ongoing management of the species.

3.3.1.5 Physical design

Based on the information assessed, CNSC staff concluded that the physical design SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Design governance

Environmental qualification

The environmental qualification (EQ) program is fully implemented in all Pickering operating units. Pickering demonstrated EQ compliance in accordance with its governing document by maintaining EQ program sustainability.

Remaining Pickering EQ restoration corrective actions will be completed in 2015. CNSC staff will continue to monitor OPG's progress on the completion of the planned corrective actions and their effectiveness.

Pressure boundary design

CNSC staff carried out a focused pressure boundary inspection against the requirements of N285.0-08, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants* [48], and conducted oversight activities including document reviews. CNSC staff concluded that OPG's pressure boundary program is in compliance with the regulatory requirements and that OPG continues to implement a comprehensive pressure boundary program at Pickering.

System design

Electrical power systems

Areas for improvement remain, following a CNSC staff inspection of the electrical power systems at Pickering with regard to the standby generator (SG) improvement work and documentation consistency in the SG block loading. These areas are all of low safety significance, and OPG is addressing them. CNSC staff will continue to monitor OPG's progress on the corrective actions.

Fire protection design

In 2014, CNSC staff conducted a focused fire protection inspection against the requirements of N293-07, *Fire protection for CANDU nuclear power plants* [50], as well as conducted oversight activities including document reviews and walk downs. CNSC staff concluded that OPG's fire protection program is in compliance with the regulatory requirements and that OPG continues to implement a comprehensive fire protection program at Pickering.

Component design

Fuel inspection program

OPG has a well-developed reactor fuel inspection program. CNSC staff confirmed that OPG has implemented its corrective action plan to address the issue of iron oxide (black) deposits on the fuel. Inspection results are showing an improving trend and that fuel defect rates have not been affected by the deposits. CNSC staff will continue to monitor the corrective actions. CNSC considered OPG's fuel program to be robust and is able to adequately manage this issue while maintaining safe operations.

Cables

OPG improved the cable surveillance program in 2013 at Pickering and CNSC staff are satisfied with the risk-informed inspection plan and results at Units 5 to 8. The upcoming CNSC electrical power systems inspection scheduled for 2015 will allow staff to verify OPG's progress in this area including the review of the outstanding cable testing. Cabling in Units 1 and 4 was replaced during refurbishment activities conducted between 1999 and 2005.

3.3.1.6 Fitness for service

Based on the information assessed, CNSC staff concluded that the fitness for service SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year. A detailed update on fitness for service of the pressure tubes and major components is given in section 3.3.2.3 as directed by the Commission in the *Record of Proceedings, Including Reasons for Decision – Application to Request Removal of a Hold Point for the Pickering Nuclear Generating Station* [5] for the May 7, 2014 public hearing.

Equipment fitness for service/equipment performance

On the basis of inspections and compliance verifications, CNSC staff concluded that the overall equipment fitness for service and performance at Pickering was satisfactory and met regulatory requirements.

Maintenance

The maintenance program performance at Pickering remained satisfactory. The corrective and deficient maintenance backlogs are within the average range of the industry. CNSC staff continued to monitor OPG's measures to reduce the maintenance backlogs through routine maintenance-related desktop reviews and inspections.

Structural integrity

OPG inspected selected pressure boundary and containment components. CNSC staff's assessment of the final inspection reports and other compliance monitoring activities indicated that the existing programs at Pickering are in compliance with CNSC regulatory requirements.

OPG continued to implement the Fuel Channel Life Management Project (FCLMP) to demonstrate pressure tube fitness for service for continued operation.

CNSC staff conducted an inspection of the implementation of N285.4-05, *Periodic inspection of CANDU nuclear power plant components* [24], focusing primarily on the selection of pressure tubes for periodic and in-service inspections. CNSC staff concluded that OPG meets the requirements of N285.4 and RD-334, *Aging Management for Nuclear Power Plants* [29].

Reliability of systems important to safety

The reliability program at Pickering continued to meet regulatory requirements as described in RD/GD-98, *Reliability Program for Nuclear Power Plants* [27].

All special safety systems at Pickering met their unavailability targets in 2014.

Aging management

OPG has implemented an integrated aging management program to ensure that the condition of SSCs important to safety is well understood and that the required activities are in place to assure the health of these SSCs while the plant ages.

OPG also conducted component condition assessments and aging management program reviews for the continued operation of Pickering 5-8. The results were found to be acceptable for continued operation.

Chemistry control

OPG's chemistry control program performance at Pickering was satisfactory. CNSC staff conducted an inspection of the chemistry control program, which confirmed that the program is in compliance with the regulatory requirements, OPG's governance documents, codes and standards and industry best practices. The chemistry optimization efforts to control the fuel bundle black deposits in Pickering Unit 1 have been effective as shown through regular periodic updates submitted by OPG.

Periodic inspections and testing

OPG has adequate periodic inspection programs (PIPs) in place at Pickering for the pressure boundary and containment components important to safety. CNSC staff monitored compliance with the established PIPs and concluded that their implementation meets regulatory requirements. Inspection results were reported to CNSC staff after each outage and their review revealed no safety-significant issues in 2014.

3.3.1.7 Radiation protection

Based on the information assessed, CNSC staff concluded that the radiation protection SCA at Pickering met or exceeded performance objectives and all applicable regulatory requirements. As a result, the station received a "fully satisfactory" rating, which is unchanged from the previous year.

Application of ALARA

OPG continued to implement a highly effective, well-documented and mature ALARA program at Pickering, based on industry best practices. CNSC staff verified that Pickering's five-year ALARA plan includes dose reduction initiatives based on a review of operational experience, including an initiative to reduce overall collective radiation exposure. CNSC compliance activities verified that ALARA is implemented into work planning, and dose monitoring and control processes.

Routine compliance verification activities indicate that performance in the area of application of ALARA at Pickering is highly effective.

Worker dose control

OPG continued to comply with the regulatory requirements to measure and record doses received by workers at Pickering. Routine compliance verification activities indicate that performance in the area of worker dose control at Pickering is highly effective. No worker or member of the public received a radiation dose in excess of the regulatory dose limits or action levels established in the Pickering radiation protection (RP) program. The dose information for Pickering is provided in section 2.1.7 and in appendix D.

CNSC staff verified that worker dose information is readily available and used for planning work and for individual dose control. In 2014, Pickering has initiated a new approach to monitor worker doses for focused dose reduction.

Radiation protection program performance

Pickering implements OPG's corporate RP program, which exceeds the requirements of the *Radiation Protection Regulations* and includes indicators to monitor program performance. The

RP program documents and supporting procedures are kept current, taking into consideration operating experience and industry best practices.

CNSC staff confirmed that challenging goals and targets were established and initiatives have been implemented to ensure the continuous improvement of the program. The RP program documents and the oversight applied by OPG in their implementation have ensured the protection of workers at Pickering.

Routine compliance verification activities indicate that Pickering is highly effective in the area of radiation protection program performance.

Radiological hazard control

No action levels were exceeded for surface contamination at Pickering in 2014. CNSC staff conducted an inspection of radiological hazard control at Pickering and confirmed that processes governed by OPG's RP program were effective in monitoring and controlling radiological hazards.

Routine compliance verification activities indicate that performance in the area of radiological hazard control at Pickering is effective.

Estimated dose to public

OPG continued to ensure the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported dose to the public from Pickering was 0.0012 mSv, well below the annual regulatory public dose limit of 1 mSv.

3.3.1.8 Conventional health and safety

Based on the information assessed, CNSC staff concluded that the conventional health and safety SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Performance

As reported by OPG, the accident severity rate for Pickering increased to 1.0 in 2014 from zero in 2013, and the accident frequency remained unchanged at 0.3.

There were three reported lost-time injuries in 2014; two ankle injuries and a back injury. These events resulted in an increase in the days lost, which affected the accident severity rate.

Practices

OPG was compliant at Pickering with the relevant provisions of the *Occupational Health and Safety Act of Ontario* and the *Labour Relations Act*.

Awareness

In 2014, most of the findings within this specific area were non-conformances with OPG internal procedures and policies related to housekeeping practices, material conditions, temporary warning signs, space allocation for transient material and storage of material. However these non-conformances had low or negligible safety significance and did not impact the overall safety of the plant.

OPG's performance in 2014 met the CNSC's expectations. The targets for the conventional health and safety program were met during the outages and OPG was very proactive in remediating the adverse conditions and poor housekeeping deficiencies in the field.

3.3.1.9 Environmental protection

Based on the information assessed, CNSC staff concluded that the environmental protection SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Effluent and emissions control (releases)
All radiological releases from Pickering remained below their respective regulatory limits.

Groundwater monitoring at the Pickering site indicated no adverse impact on the groundwater environment due to station operation.

Environmental management system
OPG has established and implemented an environmental management program to assess environmental risks associated with its nuclear activities and to ensure that these activities are conducted such that adverse environmental effects are prevented or mitigated.

Protection of the public
There were no hazardous substances released from Pickering that posed unacceptable risk to the environment or the public.

The reported annual radiation dose to the public from Pickering was 0.12 percent of the public dose limit.

3.3.1.10 Emergency management and fire protection

Based on the information assessed, CNSC staff concluded that the emergency management and fire protection SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Conventional emergency preparedness and response; nuclear emergency preparedness and response
During 2014, CNSC staff conducted regulatory oversight activities at Pickering, including review of documentation, onsite observations and participation in drills. OPG maintained its conventional and nuclear emergency preparedness and response commitments while providing enhancements to its emergency drill program.

Fire emergency preparedness and response
CNSC staff performed a fire drill inspection at Pickering in 2014 to evaluate the response capabilities of the industrial fire brigade. CNSC inspectors and third-party auditors identified a number of performance areas requiring improvement. OPG staff promptly corrected the deficiencies and subsequently demonstrated appropriate performance. CNSC staff followed up on OPG corrective actions and concluded that this was an isolated occurrence and that Pickering continues to implement a comprehensive fire response capability that includes effective

procedures, training and maintenance of proficiency.

3.3.1.11 Waste management

Based on the information assessed, CNSC staff concluded that the waste management SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Waste minimization

OPG maintains an effective waste management program at Pickering for radioactive and hazardous wastes that promotes minimization, segregation, storage and handling.

Waste management practices

CNSC staff confirmed that OPG's programs at Pickering met requirements for managing radioactive waste. OPG's programs are adequate for the management of radioactive waste associated with current operations. Additional information on Pickering's waste management can be found in CMD 15-M22, *Regulatory Oversight Report for 2010 – 2014 Ontario Power Generation Inc.'s Darlington, Pickering and Western Waste Management Facilities* [52].

Used fuel is stored in large, reinforced concrete containers known as dry storage casks. Each cask holds approximately 400 fuel bundles.

Decommissioning plans

OPG maintains decommissioning plans and an associated consolidated financial guarantee for all of its Ontario facilities. The associated decommissioning plan, consolidated financial guarantee and cost estimate for Pickering were reviewed and accepted by the Commission in 2012 and remained current in 2014. CNSC staff concluded that Pickering met regulatory requirements for decommissioning plans. As per the Pickering operating licence, the decommissioning plan will be revised and submitted to CNSC staff for review by January 31, 2017.

3.3.1.12 Security

Based on the information assessed, CNSC staff concluded that the security SCA at Pickering met or exceeded performance objectives and all applicable regulatory requirements. As a result, the station received a "fully satisfactory" rating, which is unchanged from the previous year.

Response arrangements; drills and exercises; security practices
At Pickering, OPG maintained a highly robust nuclear response force (NRF), which is supported by a strong training program. CNSC staff verified that Pickering has continued to improve with respect to the integration of their NRF to include unarmed nuclear security officers. OPG has implemented highly effective drills and exercises at Pickering. OPG will also be introducing enhanced screening technology in the search area, which will improve access control.

CNSC staff verified that corrective action plans in response to inspection findings were implemented to a satisfactory level.

3.3.1.13 Safeguards and non-proliferation

Based on the information assessed, CNSC staff concluded that the safeguards and non-proliferation SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Nuclear material accountancy and control
CNSC staff have determined that OPG complied with regulatory requirements in accordance with RD-336, *Accounting and Reporting of Nuclear Material* [39].

Access and assistance to the IAEA
The International Atomic Energy Agency (IAEA) performed a physical inventory verification and a design information verification to verify the non-diversion of safeguarded nuclear materials. The CNSC was informed by the IAEA that the results of these inspections were satisfactory.

Operational and design information
OPG submitted its annual operational program for Pickering to the CNSC on time, with quarterly updates and the annual update to the information provided pursuant to the *Additional Protocol* [40]. OPG submitted an updated design information questionnaire, which is currently under review by the CNSC.

Safeguards equipment, containment and surveillance
OPG supported IAEA equipment operation and maintenance activities including those related to the core discharge monitors in Unit 4, and maintenance and repair work on remote monitoring components, to ensure the effective implementation of safeguards measures at the station.

During an inspection in 2014, the IAEA discovered three of its fibre-optic seals had been damaged. All three damaged seals were replaced and relocated to mitigate the possibility of a repeat occurrence.

3.3.1.14 Packaging and transport

Based on the information assessed, CNSC staff concluded that the packaging and transport SCA at Pickering met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

CNSC staff reached this conclusion based on onsite monitoring activities and a review of the reports submitted in accordance with S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. There were no significant events reported under the *Packaging and Transport of Nuclear Substances Regulations* for consignments transported to and from Pickering. OPG continued to implement and maintain an effective packaging and transport program at Pickering.

3.3.2 Regulatory developments

3.3.2.1 Licensing

OPG's licences for Pickering A and Pickering B were combined into a single site licence for Pickering in August 2013 and renewed for a five-year period (effective until August 31, 2018).

Licence amendments

The Pickering licence was amended once between January 1, 2014 and April 30, 2015. Details of the amendment are given in appendix H.

Revisions to the licence conditions handbook

The Pickering licence conditions handbook (LCH) was revised once between January 2014 and April 2015. The changes were mostly administrative in nature and details of the significant changes can be seen in appendix H.

The revision was approved by the Director General, Directorate of Power Reactor Regulation. The changes to the LCHs have not resulted in an unauthorized change of scope and remain within the licensing envelope.

3.3.2.2 Updates on major projects and initiatives

Fuel channel life management project

In 2009, Bruce Power, OPG and AECL (now Canadian Nuclear Laboratories Ltd.) jointly initiated a comprehensive R&D project, referred to as the Fuel Channel Life Management Project (FCLMP) to investigate the feasibility of operating pressure tubes beyond their original assumed design life. In 2011, a protocol was signed that provides governing roles and responsibilities between the licensees and CNSC staff.

This project addresses issues that affect life-limiting degradation mechanisms in fuel channels. As the hours of operation increase (measured in equivalent full power hours, EFPH), the concentration of hydrogen in the pressure tubes increases, affecting material properties such as the fracture toughness. OPG must ensure that these changes in material properties will not affect the pressure tube's performance, known as its fitness for service. CNSC staff have provisionally accepted OPG's approach to assessing the fitness for service of pressure tubes for continued operation. Acceptance is conditional on enhancing the new fracture toughness models by completing additional burst tests, and on addressing the recommendations made by the third-party

reviewers of project deliverables and arising from continuing research and development activities. OPG is providing semi-annual updates to CNSC staff on progress in these areas.

End-of-life project activities

OPG continues to plan and implement measures that will ensure Pickering continues to operate safely to the end of its commercial operation. The continued operations plan (COP) deals with the implementation of the results of the Pickering B 2010 Integrated Safety Review to ensure the safe operation of Pickering 5-8 beyond 210,000 EFPH. Focus areas in the COP include actions related to fitness for service, safety analysis and physical design. The COP is targeted for completion in December 2015. The sustainable operations plan (SOP) will become effective in January 2016, and its focus is on the actions required to ensure the continued safe operation of all units while approaching the end of commercial operation. In 2014, OPG informed CNSC staff that the permanent shutdown dates for the Pickering units have not yet been determined. OPG will formally communicate to the CNSC their plan for the end of commercial operation of Pickering by June 30, 2017 in accordance with the Pickering operating licence.

OPG has made good progress in dispositioning actions related to the COP, with only three COP actions remaining open, with all expected to be completed before the end 2015. If commercial operation of Pickering extends past 2020, CNSC staff will review all COP actions to ensure that operation is justified to the schedule to be provided by OPG by June 2017. Given the uncertainty of the start of the stabilization activity, OPG re-structured the SOP to address this uncertainty. OPG will operate Pickering according to all of its existing operational policies and procedures to the end of commercial operation. Approaching the end of commercial operation will cause changes in only three areas: organizational change plan, human performance initiatives and maintenance and reliability strategy. The first versions of these documents were submitted in December 2014 to CNSC staff for their review.

CNSC staff are satisfied with the safety and control measures in place and are confident that the end of commercial operation at Pickering will proceed safely.

3.3.2.3 Updates on significant regulatory issues

Annual follow-up to Commission request from the 2014 Pickering hold point hearing

When the Pickering operating licence was renewed in 2013, the Commission included a regulatory hold point for reassessing operation of the pressure tubes beyond the original assumed design life – initially projected to be 210,000 EFPH.

The hold point, as requested by the Commission, also covered the completion of the probabilistic safety assessment for Pickering 1, 4 that meets the requirements of S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* [4]. The updated PSA models are to account for the Fukushima enhancements and the development of a methodology for multi-unit station PSAs. OPG requested the removal of the hold point by the Commission. This request was heard by the Commission at the May 7, 2014 public hearing and a summary of the decision was published on June 3, 2014.

The Commission decided to remove the hold point associated with the Pickering operating licence. With this decision, the Commission allowed OPG to proceed with Pickering's operation beyond 210,000 EFPH, up to 247,000 EFPH.

OPG and CNSC staff each submitted a report on the detailed risk improvement plan for Pickering and presented it during the Commission meeting held on August 19, 2014.

Pursuant to the *Record of Proceedings, Including Reasons for Decision – Application to Request Removal of a Hold Point for the Pickering Nuclear Generating Station* [5] and the Pickering operating licence, CNSC staff and OPG made a commitment to provide updates on the fitness for service of major components, the risk improvement plan, the whole-site based safety goals and PSA methodology annually in the NPP report. The details for each of these issues are given below.

Aging management program/fitness for service of major components update

On February 27, 2015, OPG submitted the annual summary report on the status of fitness for service of major components.

OPG inspects each of the operating units approximately every two years during planned outages. Part of the inspection scope focuses on selected samples from all of the major components (fuel channels, feeders and steam generators). Unit 1 was inspected in 2012, Unit 4 in 2014, Units 5 and 6 in 2013, Units 7 and 8 in 2014.

For the units inspected in 2014, OPG completed the fuel channels' inspection scope, except for body of tube (BOT) deuterium scrapes for Unit 4. OPG inspected five of the planned ten pressure tubes for BOT scrapes and deferred the balance to a later outage within the same periodic inspection program window. CNSC staff assessed this deferral and found it to be satisfactory. The measured maximum mean diameter of the pressure tubes for Units 1 and 4 was 104.9 mm against the fitness for service limit of 107.6 mm, whereas for Units 5 to 8, it was 106.9 mm against the fitness for service limit of 108.8 mm. The highest hydrogen concentrations were found to be in the rolled joint areas (generally in the outlet region) and the highest concentration was 54 ppm against the limit of 80 ppm (based on the fracture toughness of pressure tube material).

For the specific units inspected in 2014, OPG completed the feeders' inspection scope. The three lead feeders with respect to the measured wall thickness were:

- Feeder P4-F13E with a measured thickness of 4.17 mm against the minimum allowable of 3.66 mm
- Feeder P6-B12W with a measured thickness of 3.37 mm against the minimum allowable of 2.91 mm
- Feeder P8-F20W with a measured thickness of 4.12 mm against the minimum allowable of 3.05 mm

For the specific units inspected in 2014, OPG completed the steam generators' inspection scope. OPG assessed and confirmed that there are no steam generators in Pickering exceeding the limits of tube plugging and that sufficient margins exist for future operation of these steam generators.

CNSC staff are satisfied with the current status of fitness for service of major components at Pickering.

Pickering risk improvement plan update

On February 27, 2015, OPG submitted the annual report on the status of implementation of the risk improvement plan for Pickering as well as the status of the development of whole-site safety goals and PSA methodology.

Based on OPG's status report, all risk improvement items to be completed by the end of February 2015 have been completed. Several new risk improvement items have been also proposed and added to the risk improvement plan. The timelines for completion of the remaining risk improvement tasks have been updated and these items will be completed by December 31, 2015.

CNSC staff are satisfied with the current status of the implementation of risk improvement tasks and the updated timeline for completing the remaining tasks. Details of the February 2015 Pickering risk improvement update are given in table 12.

Table 12: Details of the 2015 Pickering risk improvement update

Description of the improvement	Timeline and status from August 2014 update	Timeline and status from February 2015 update
Committed improvement		
Emergency mitigating equipment (EME) modifications (Phase I enhancement, e.g. quick connect and Phase II)	Implementation per the plan and schedule provided for the closure of FAI 1.7.1.	Implementation per the plan and schedule provided for FAI 1.7.1 closure.
Extension of auxiliary power supply mission time to 72 hours	February 28, 2015	Completed
Analysis to remove conservatism from level 2 outage assumptions	2015	Completed
Trace cables for select systems that are currently not credited in the fire probabilistic safety analysis (PSA)	Further details to be provided in the 2015 action plan update.	Significant progress has been made on this item Due date: December 31, 2015.
Crediting of some severe accident management guidelines (SAMGs) operator actions where possible, e.g., filtered air discharged system activation	Further details to be provided in the 2015 action plan update.	Some procedures and instructions have been developed Due date: December 31, 2015.
Improvements being considered		
Update risk reduction calculation for all committed improvements	Further details to be provided in the 2015 action plan update.	During 2015, work will continue on EME enhancements and on the other improvements. Based on the target dates, by the end of 2015 it will be possible to estimate the resulting risk improvement. This estimate will be provided in the next annual update of this plan. Detailed risk re-quantification will be provided in the 2017 Pickering B and 2018 Pickering A PSA updates (per the update cycle in REGDOC-2.4.2 [18]).
Cost/benefit analysis for various additional physical and analytical possible improvements	Further details to be provided in the 2015 action plan update.	**1. Additional cable tray fire barriers** Cost/benefit analysis has been performed for the installation of side barriers for the cable trays. The analysis concluded that only a small risk improvement (~10 percent risk reduction) can be realized by doing this. Given the high cost of barrier installation, this potential improvement will not be pursued further as part of the risk improvement plan.

Description of the improvement	Timeline and status from August 2014 update	Timeline and status from February 2015 update
		2. Maintenance optimization OPG indicates the predicted large-release frequency (LRF) is elevated due to common-mode failures attributable to harsh plant environment conditions (e.g., steam or fire). For such consequential failures, better maintenance is unlikely to afford significant risk improvement. Therefore, maintenance optimization will not be pursued further as part of this risk improvement plan. **3. Re-assessment of large fire scenarios** Re-assessment has been performed for some scenarios. It was decided to create a new improvement initiative. Specifically, to reduce severe core damage frequency/LRF for at-power fire and at-power process failures (particularly, large secondary side breaks), OPG will improve EME capability and coverage by facilitating multiple deployment and hook-up options (including hook-up locations remote from the turbine building). Due date: December 31, 2015. **4. Offsite EME** OPG considered the possibility of reducing risk by using offsite EME, including EME from Darlington. Significant progress has been made on this initiative. Although OPG is pursuing this initiative, it is concluded that it is not likely to significantly affect this risk improvement plan. Therefore, while OPG intends to pursue sharing of EME, this activity will not be included as part of this risk improvement plan.
Implementation of selected additional improvements	Further details to be provided in the 2015 action plan update.	**1. Manual containment box-up after major turbine-generator fires** This is a new committed improvement. An estimate of the resulting risk improvement will be provided in the 2016 improvement plan update. **2. Facilitate EME hook-up to improve EME benefit for accident scenarios that impose environmental restrictions on turbine building accessibility (e.g., large secondary side line breaks and large turbine hall fires)**

Description of the improvement	Timeline and status from August 2014 update	Timeline and status from February 2015 update
		This is an improvement in the plan that has arisen from work on an initiative previously identified as "being considered". Expected completion date: December 31, 2015.

CNSC staff's activity with respect to risk improvement plan

As a follow-up to the Commission's request at the Pickering licensing hearing in May 2013 for the licensee to perform a whole-site PSA, the CNSC hosted the International Workshop on Multi-Unit Probabilistic Safety Assessment (MUPSA) in Ottawa, from November 17 to 20, 2014. This workshop brought together eminent international experts (regulators, academics, consulting organizations and industry), staff representing the Organization for Economic Co-operation and Development (OECD)/Nuclear Energy Agency (NEA) Working Group on Risk (WGRISK), International Atomic Energy Agency and U.S. Nuclear Regulatory Commission to share experiences on the topic of multi-unit PSA and site-based safety goals. In addition, OPG actively participated in this international workshop.

Overall, 115 participants from 15 countries attended the workshop. The workshop provided an opportunity to capture the current international status of development and practice in the areas of multi-unit PSA and site safety goals. The workshop also included panel discussions around:

- methodological challenges in performing multi-unit PSAs
- site-based risk metrics
- challenges in establishing safety goals for whole-sites
- risk aggregation across all units and all hazards

As a direct output of this workshop, CNSC staff have introduced a proposal for the development of an NEA/WGRISK activity on multi-unit PSA. The CNSC proposal was accepted in March 2015.

OPG plans to perform the whole-site PSA work in three phases, as follows:

- Phase A – Safety goal framework (target completion date (TCD): 2015)
- Phase B – Risk aggregation studies (TCD: 2016)
- Phase C – Pilot whole-site PSA for Pickering (TCD: 2017)

CNSC staff also created a Working Group on Safety Goals (WGSG) to help develop whole-site safety goals. WGSG is making good progress in its work by proposing a hierarchical structure for the safety goals. WGSG is aiming at defining a quantitative health objective (QHO) with the objective to demonstrate that meeting the lower level safety goals (e.g., core damage frequency, large-release frequency) will ultimately ensure that the high level QHO is satisfied.

OPG's phase A results will be provided to the CNSC in the 2016 risk improvement plan annual update.

Fisheries Act authorizations

CNSC staff to initiate discussions with OPG regarding the key amendments to the *Fisheries Act*, and to provide highlights of the CNSC-Fisheries and Oceans Canada (DFO) memorandum of understanding and key DFO policy documents related to the interpretation of the amended

Fisheries Act – specifically, the Habitat Protection Prohibitions clauses. Items to be discussed also include ongoing fish impingement and entrainment studies and initial discussions of OPG's self-assessment to determine the requirement for a *Fisheries Act* application. OPG is required to complete its self-assessment for Pickering on the need for a *Fisheries Act* authorization. If the self-assessment determines that there is serious harm to fish, OPG would need to submit an application for a *Fisheries Act* authorization by 2018.

Fish mortality

In the 2008 NPP Report, fish mortality due to cooling water intake (impingement and entrainment) and discharge (thermal plume) was raised as a major issue. OPG is making progress in addressing this issue. CNSC staff are satisfied with the progress made by OPG in this area.

Intake fish impingement and entrainment

OPG has implemented a seasonally deployed barrier net as mitigation to reduce fish mortality due to impingement. In 2014, OPG continued to monitor year-round screen house fish counts and seasonal net performance to confirm the performance of the barrier net. Preliminary results show that, as with previous years, the barrier net performance in 2014 met and exceeded the CNSC reduction target of 80 percent. These results will be confirmed once the final report for 2014 is received.

Netting serves as a mitigation measures to reduce the amount of fish loss from impingement and entrainment at the Pickering Nuclear Generating Station.

Residual impingement issues remain for northern pike, a species of concern, since pike become impinged during the winter when the barrier net is not in place. OPG has entered into a contract with the Toronto and Region Conservation Authority to upgrade a portion of Duffins Creek to meet the CNSC's request to implement a 3-hectare wetland improvement project to offset residual impingement issues. The area to be upgraded is a 4.6-hectare wetland, which is sufficient to offset the residual impingement losses. CNSC staff will continue to follow up with the implementation of this impingement offset project, as was done with entrainment fish losses offsets, which is now completed. OPG funded a 0.2-hectare offset project to offset fish loss caused by entrainment.

Thermal plume

Acting on advice from Environment Canada (EC), the CNSC placed an action on OPG to study round whitefish mortality caused by the Pickering 5-8 thermal plume. OPG responded with several years of study and completed reports on habitat mapping, winter spawning habitat water temperatures and a review of potential mitigation options. Thermal plume risk to round whitefish was offset using indirect measures since there was no direct plume mitigation that was cost effective and feasible. OPG implemented an action to increase the number of mature round whitefish locally, by eliminating lethal sampling of this species for annual radiological fish tissues by using an alternative more common species. OPG is also participating in a round whitefish meta-population study coordinated by the Ontario Ministry of Natural Resources and Forestry (OMNRF). This study will be used to demonstrate that round whitefish populations around Pickering and Darlington are not isolated but are biologically linked to other round whitefish populations known to exist in unexposed areas further east in Lake Ontario.

Response to the Fukushima Daiichi accident

OPG has made considerable progress in addressing Fukushima action items (FAIs) at Darlington and Pickering. As of January 2015, all FAIs applicable to OPG stations have been closed (see appendix G).

CNSC staff concluded that OPG has strengthened reactor defence in depth and enhanced its emergency response at Darlington and Pickering stations in response to lessons learned from the Fukushima nuclear accident.

The activities undertaken in 2014 by OPG to disposition outstanding FAIs were completed for the following area:

- ***Evaluation of the habitability of control facilities during a severe accident (FAI 1.9.1):*** CNSC staff have reviewed OPG's *Update Report No. 6* on the FAIs. In this progress update, OPG requested closure of FAI 1.9.1 for Darlington and Pickering to address habitability of control facilities during a severe accident. The OPG submission is based upon the generic methodology completed under a COG joint project in 2014 and on a more exhaustive review specific to non-radiological hazards for the Darlington and Pickering units than that established by the COG (generic) habitability methodology. CNSC staff found this approach to be acceptable. Therefore, the related FAI 1.9.1 was closed for all OPG stations.

CNSC staff will continue to monitor FAI implementation at Pickering through the established compliance verification program. Annual updates on FAI implementation will be provided to the Commission as part of the NPP report.

3.3.2.4 Public communication

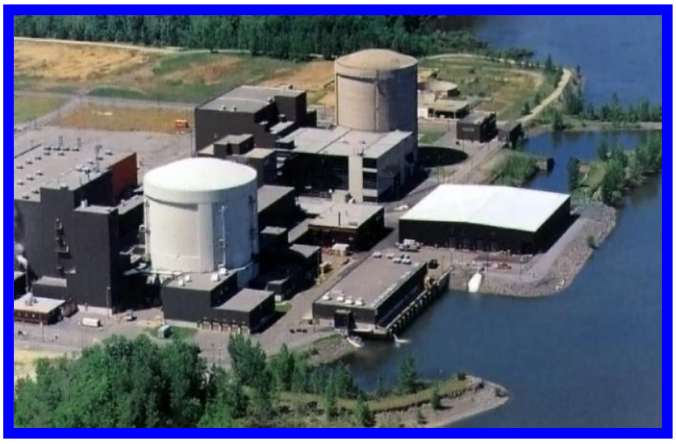
Event initial reports

One event initial report (EIR) was submitted for Pickering from January 2014 to April 2015, as shown in table 13. The EIR event had low safety significance.

Table 13: Event initial reports for Pickering

Subject	Brief description
Leak of heavy water within containment at Unit 7 of Pickering	A station emergency was initiated at Pickering due to a loss-of-moderator inventory at Unit 7 on November 21, 2014. At the time of the event, the unit was in a planned outage and the reactor in an over-poisoned moderator reactor shutdown guarantee when the moderator collection tank high-level alarm was received. Moderator heavy water passed through openings of an auxiliary system under maintenance and spilled onto the reactor building floor inside containment. A station emergency was declared to provide additional management oversight, to direct personnel to evacuate the incident area and to assemble for accounting. The moderator level stabilized four hours later and all the spilled heavy water (approximately 6,200 litres) was contained within the reactor building. Containment was isolated as per approved procedures to ensure retention of airborne tritium inside the reactor building during the station emergency to minimize release to the environment. The spilled heavy water was cleaned-up. CNSC site inspectors conducted an inspection and confirmed findings of OPG's investigation of the event. This event was reported to the Commission through CMD 14-M80 on December 17, 2014. CMD 14-M80 completed CNSC staff notification to the Commission on this event.

3.4 Gentilly-2



Gentilly-2, operated by Hydro-Québec, is located on the south shore of the Saint Lawrence River, in the Bécancour municipality, about 15 kilometres east of Trois-Rivières, Québec.

The CANDU reactor has a nominal capacity of 675 MWe (megawatts electrical). It went into commercial operation in 1983.

Based on a recommendation from Hydro-Québec, the Québec government decided in 2012 to close Gentilly-2. The reactor was shutdown on December 28, 2012, and completely defuelled by September 3, 2013. The Gentilly-2 transition to the safe storage state with the fuel stored in the irradiated fuel bay was completed on December 2, 2014.

3.4.1 Safety assessment

The CNSC staff safety assessment of Gentilly-2 for 2014 resulted in the performance ratings as shown in table 14. Based on the observations and assessments of the SCAs, CNSC staff concluded that Gentilly-2 was maintained in a safe state. The integrated plant rating was "satisfactory", which is unchanged from the previous year.

Table 14: Performance ratings for Gentilly-2

Safety and control area	Rating	Industry average
Management system	SA	SA
Human performance management	SA	SA
Operating performance	SA	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	SA	SA
Conventional health and safety	SA	FS
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Waste management	SA	FS
Security	SA	FS
Safeguards and non-proliferation	SA	SA
Packaging and transport	SA	SA
Integrated plant rating	SA	SA

Note:

- For specific areas within the SCAs where there were no significant observations from CNSC staff compliance verification activities, no information is given in this subsection of the report.
- The information presented below is station specific; general trends are not identified here (refer to section 2 for industry-wide observations).

3.4.1.1 Management system

Based on the information assessed, CNSC staff concluded that the management system SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Management system; organization

Hydro-Québec complied with the requirements of N286-05, *Management of system requirements for nuclear power plants* [8]. The Hydro-Québec staffing levels and organizational structure continued to change during 2014 as Gentilly-2 transitioned to the safe storage state. The size of the permanent organization at Gentilly-2 was reduced from approximately 300 staff members to approximately 100 staff members by the end of 2014. The organizational structure was also consolidated into three main divisions as follows:

- Maintenance
- Environment and Nuclear Security
- Nuclear Technical Support

CNSC oversight of the changes in this specific area was maintained during 2014 with CNSC staff closing actions from previous inspections and noting some new deficiencies with regard to the Hydro-Québec documentation and record keeping practices. CNSC staff will follow-up in 2015 on the corrective actions being implemented by Hydro-Québec to address these deficiencies.

3.4.1.2 Human performance management

Based on the information assessed, CNSC staff concluded that the human performance management SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Human performance program

The Hydro-Québec organization continued to evolve in 2014 as Gentilly-2 transitioned to the safe storage state. Hydro-Québec continued to maintain an effective human performance program during the year, and a CNSC staff review of activities within this specific area will be conducted in 2015, if necessary, to confirm that this program remains effective.

Personnel training

In 2014, Hydro-Québec developed a training program adapted to the new organizational structure and activities required for the current state of the plant. CNSC staff will review activities within this specific area in 2015, if necessary, to confirm the adequacy of the Gentilly-2 training program and processes.

Personnel certification; initial certification examinations and requalification tests
The positions of shift manager and control room operator that requires certification by the CNSC no longer exist at Gentilly-2.

The position of health physicist is the only position at Gentilly-2 that requires certification by the CNSC. There were three certified health physicists at Gentilly-2 during 2014. There were no initial certification examinations or requalification tests administered during the year.

Work organization and job design

Minimum shift complement
Hydro-Québec began to perform an analysis, together with some preparatory design modification work, aimed at reducing the minimum shift complement requirements for the safe storage state with irradiated fuel stored in the irradiated fuel bay and heavy water stored at Gentilly-2. CNSC staff continued to monitor the progress of this work in 2014 through meetings and updates with Hydro-Québec staff and will continue to oversee the analysis and validation work as it progresses in 2015.

3.4.1.3 Operating performance

Based on the information assessed, CNSC staff concluded that the operating performance SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Conduct of licensed activity
Gentilly-2 did not produce any electrical power in 2014.

During 2014, stabilization operations and activities were conducted to transition Gentilly-2 to a safe storage state with all the irradiated fuel stored in the irradiated fuel bay and all the main station systems no longer in service drained, dried, and placed in a safe layup state. CNSC staff maintained regulatory oversight of these stabilization operations and did not identify any significant operations-related compliance issues. The transition to the safe storage state was completed on December 2, 2014.

3.4.1.4 Safety analysis

Based on the information assessed, CNSC staff concluded that the safety analysis SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

During 2014, Hydro-Québec completed the revision of the Gentilly-2 safety report in accordance with regulatory requirements. CNSC staff attended a technical meeting on August 28, 2014 to review and discuss the methodology used by Hydro-Québec to revise the safety report. Hydro-Québec submitted the Gentilly-2 safety report on December 18, 2014, and CNSC staff are currently reviewing the revised safety report.

3.4.1.5 Physical design

Based on the information assessed, CNSC staff concluded that the physical design SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Design governance

Environmental qualification

The environmental qualification program requirements were removed from the Gentilly-2 operating licence and licence conditions handbook in 2014 to align the regulatory requirements with the state of the station systems, which are no longer in service.

Pressure boundary design

On the basis of compliance verification activities, CNSC staff were satisfied with the implementation of the pressure boundary program at Gentilly-2.

System design

Fire protection design

Hydro-Québec submitted a revised fire protection program in 2014. A CNSC staff review of the program concluded the Gentilly-2 fire protection program was acceptable and in compliance with the applicable regulatory requirements.

3.4.1.6 Fitness for service

Based on the information assessed, CNSC staff concluded that the fitness for service SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Maintenance

On the basis of compliance verifications, CNSC staff concluded the maintenance program performance at Gentilly-2 remained satisfactory and met regulatory requirements.

Structural integrity; periodic inspections and testing; aging management

An update of the surveillance, inspection and aging management programs for the safety-significant structures, systems and components at Gentilly-2 was expected before or shortly after the permanent shutdown of Gentilly-2 on December 28, 2012. Hydro-Québec submitted updated program documents to reflect the current state of the plant on July 3, 2014. CNSC staff reviewed these documents and determined that additional information and details were required. CNSC staff will hold a technical meeting with Hydro-Québec staff in early 2015 to clarify the nature of the information needed so that the updated program complies with the applicable regulatory requirements. CNSC staff are also planning an inspection on this subject later in 2015 to verify that updated program has been effectively implemented.

The ratings for these three specific areas remain unchanged from 2013.

Reliability of systems important to safety

The reliability program at Gentilly-2 continued to meet regulatory requirements commensurate with the core-defuelled state of the plant.

Chemistry control

Since Gentilly-2 has been permanently shutdown with most of the systems now drained, there are fewer chemistry control requirements. Based on the desktop reviews conducted in 2014, CNSC staff concluded the performance was satisfactory.

3.4.1.7 Radiation protection

Based on the information assessed, CNSC staff concluded that the radiation protection SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Application of ALARA

At Gentilly-2, Hydro-Québec continued to implement an ALARA program that integrates the ALARA principle into planning, scheduling and work control. ALARA plans were developed for work activities that presented a higher risk, in order to ensure that doses to workers were optimized. CNSC staff have reviewed the ALARA plans and confirmed that the radiation protection (RP) measures implemented by Hydro-Québec were satisfactory.

Routine compliance verification activities indicate that performance in the area of application of ALARA at Gentilly-2 was effective.

Worker dose control

Hydro-Québec continued to comply with the regulatory requirements to measure and record doses received by workers. Routine compliance verification activities indicate that performance in the area of worker dose control at Gentilly-2 is effective. No worker or member of the public received a radiation dose in excess of regulatory limits, and there were no incidents that resulted in a dose in excess of the Hydro-Québec action levels. The dose information for Gentilly-2 is provided in section 2.1.7 and in appendix D.

Radiation protection program performance

The Gentilly-2 RP program meets the requirements of the *Radiation Protection Regulations*. The RP program consists of a series of standards and procedures for the conduct of radiological activities at Gentilly-2.

In 2014, Hydro-Québec continued to implement the RP program developed during the operation of the plant; however, a new RP program structure will be submitted in 2015. This new RP program will be aligned with the Hydro-Québec revised management system program and will support future radiological activities to be completed onsite.

CNSC staff will continue to maintain regulatory oversight and conduct an inspection in 2015 to verify the implementation of the revised RP program.

Radiological hazard control

There were no action level exceedances for surface contamination at Gentilly-2 in 2014.

In 2014, CNSC staff conducted an inspection at Gentilly-2 in the specific area of radiological hazard control. The inspection identified areas for improvement, specifically in the calibration of RP instruments used to support the conduct of radiological activities and in the area of radiation hazard posting. Hydro-Québec has completed all corrective action plans to address the opportunities for improvement.

CNSC staff will perform a follow-up visit in 2015 to verify the effective implementation of the licensee corrective actions identified as a result of RP inspections.

Estimated dose to public

Hydro-Québec continued to ensure the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to a member of the public from Gentilly-2 was 0.004 mSv, well below the annual regulatory public dose limit of 1 mSv.

3.4.1.8 Conventional health and safety

Based on the information assessed, CNSC staff concluded that the conventional health and safety SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Performance

As reported by Hydro-Québec, the accident severity rate at Gentilly-2 decreased from 13.2 to 0, and the accident frequency (AF) decreased slightly from 0.81 to 0.78.

There were no lost-time injuries and only two medically treated injuries at Gentilly-2 in 2014.

Practices

Hydro-Québec was compliant at Gentilly-2 with the relevant provisions of the Québec provincial law (*An Act respecting occupational health and safety)* and relevant regulations.

Awareness

Hydro-Québec met CNSC regulatory requirements in this area in 2014. Field inspections conducted during the year identified minor non-compliances that, in all cases, were corrected immediately once Hydro-Québec was informed.

3.4.1.9 Environmental protection

Based on the information assessed, CNSC staff concluded that the environmental protection SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Effluent and emissions control (releases)

Based on the assessment of the licensee's environmental monitoring report, CNSC staff

concluded that the radiological releases to the environment from Gentilly-2 remained below regulatory limits.

Environmental management system (EMS)
Hydro-Québec has established and implemented an environmental management program to assess environmental risks associated with its nuclear activities, and to ensure that these activities are conducted such that adverse environmental effects are prevented or mitigated.

Assessment and monitoring
CNSC staff continued to monitor Hydro-Québec's environmental program activities at Gentilly-2 during the transition to the safe storage state.

Protection of the public
There were no hazardous substances released from Gentilly-2 that posed unacceptable risk to the environment or the public.

The reported annual radiation dose to the public from Gentilly-2 was 0.4 percent of the public dose limit.

3.4.1.10 Emergency management and fire protection

Based on the information assessed, CNSC staff concluded that the emergency management and fire protection SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Conventional emergency preparedness and response; nuclear emergency preparedness and response
CNSC staff provided regulatory oversight of the activities at Gentilly-2 in both conventional and nuclear emergency preparedness and response through review of documentation and site inspections. Hydro-Québec maintained acceptable conventional and nuclear emergency preparedness and response capability and conducted an emergency exercise in May 2014.

Fire emergency preparedness and response
Hydro-Québec transitioned in 2014 from a Gentilly-2 operators-based emergency response team to an onsite, full-time, and private fire brigade. CNSC specialist staff evaluated these changes and concluded that the fire response performance objectives and regulatory requirements continued to be met.

3.4.1.11 Waste management

Based on the information assessed, CNSC staff concluded that the waste management SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Waste management practices

CNSC staff conducted an inspection of the Gentilly-2 waste management area in September 2014. CNSC staff concluded the Hydro-Québec performance was in compliance with the applicable codes and regulations. Based on the inspection findings, CNSC staff issued two action notices, both of which were administrative in nature and of low safety significance. Hydro-Québec implemented the corrective measures required to address the action notices.

Dry storage modules for used nuclear fuel at Gentilly-2.

Decommissioning plans

The Québec government announced the permanent closure of Gentilly-2 in September 2012. The existing decommissioning plan and related financial guarantee were based on completion of a refurbishment of the station and the resulting extended operational life. During 2014, Hydro-Québec conducted work required to update the decommissioning plan and financial guarantee to reflect the permanent closure of the station. Hydro-Québec presented the final draft of the updated decommissioning plan and financial guarantee along with an overview of the supporting methodology, to CNSC staff in November 2014. The final documents were submitted at the end of March 2015 and CNSC staff are currently reviewing them.

3.4.1.12 Security

Based on the information assessed, CNSC staff concluded that the security SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a “satisfactory” rating, which is unchanged from the previous year.

Measures to effectively prevent theft or sabotage of nuclear material in use, storage or transport have been established at Gentilly-2. There were no significant adverse findings as a result of routine inspections and other compliance verification activities during the year. Hydro-Québec continued to maintain and implement an effective security program in 2014.

3.4.1.13 Safeguards and non-proliferation

Based on the information assessed, CNSC staff concluded that the safeguards and non-proliferation SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a “satisfactory” rating, which is unchanged from the previous year.

Nuclear material accountancy and control

CNSC staff have determined that Hydro-Québec complied with regulatory requirements in accordance with RD-336, *Accounting and Reporting of Nuclear Material* [39].

Access and assistance to the IAEA

The International Atomic Energy Agency (IAEA) did not select Gentilly-2 for a physical inventory verification (PIV) in 2014. As a result, CNSC staff performed an evaluation of the Gentilly-2 preparedness for a PIV in July 2014. From this evaluation, CNSC staff were satisfied that Gentilly-2 was adequately prepared for an IAEA PIV in 2014 had it been selected.

Operational and design information

Hydro-Québec submitted its annual operational program for Gentilly-2 to the CNSC on time, with quarterly updates and the annual update to the information provided pursuant to the *Additional Protocol* [40]. Gentilly-2 staff submitted an updated design information questionnaire in 2014, which CNSC staff are currently reviewing.

Safeguards equipment, containment and surveillance

Hydro-Québec supported IAEA equipment operation and maintenance activities to ensure the effective implementation of safeguards measures at Gentilly-2.

In April 2014, Gentilly-2 staff discovered that an IAEA fibre-optic seal wire was broken at the CANDU storage (CANSTOR) site. The IAEA was informed and replaced the damaged seal in June 2014.

Radiation profiling and sealing activities at the CANSTOR site were performed by the IAEA in June 2014 to recover from an interruption in surveillance caused by a loss of power to IAEA remote monitoring equipment in October 2013. The IAEA found the results of these activities satisfactory.

In September 2014, the IAEA undertook an extensive radiation profiling and sealing campaign at the Gentilly-2 CANSTOR site. No issues were identified by this activity.

3.4.1.14 Packaging and transport

Based on the information assessed, CNSC staff concluded that the packaging and transport SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the station received a “satisfactory” rating, which is unchanged from the previous year.

CNSC staff reached this conclusion based on onsite monitoring activities and a review of the reports submitted in accordance with S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. In addition, CNSC staff conducted a packaging and transport inspection at Gentilly-2 to verify compliance with the requirements of the *Packaging and Transport of Nuclear Substances Regulations*, and the *Transportation of Dangerous Goods Regulations* [41]. There were no significant events reported for consignments transported to and from Gentilly-2. Hydro-Québec continued to implement and maintain an effective packaging and transport program at Gentilly-2.

3.4.2 Regulatory developments

3.4.2.1 Licensing

Hydro-Québec's licence for Gentilly-2 was renewed in June 2011 for a five-year period (effective until June 30, 2016); however, Hydro-Québec ended commercial operation at Gentilly-2 on December 28, 2012. CNSC and Hydro-Québec staff have begun the preparatory work and activities required for the renewal of the Gentilly-2 licence in 2016.

Licence amendments

The Gentilly-2 licence was amended once between January 2014 and April 2015. This extensive amendment, which came into effect on July 22, 2014, was requested by Hydro-Québec to better align the requirements of the licence with the stabilization activities taking place at Gentilly-2 and with the state of the station systems and equipment. Details of the amendment are given in appendix H.

Revisions to the licence conditions handbook

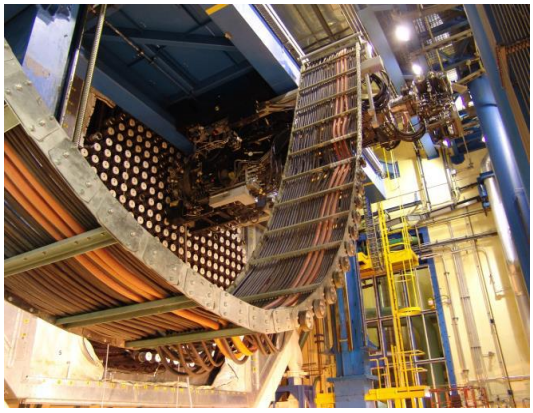
The Gentilly-2 licence conditions handbook (LCH) was revised once between January 2014 and April 2015. The revision was consistent with the July 22, 2014 licence amendment. The changes were administrative in nature and details can be seen in appendix H.

The revision was approved by the Director General, Directorate of Power Reactor Regulation. The changes to the LCH have not resulted in an unauthorized change of scope and remain within the licensing envelope.

3.4.2.2 Updates on major projects and initiatives

Progress of transition to safe storage state

Hydro-Québec ended commercial operation of the Gentilly-2 station on December 28, 2012 and placed the station in a guaranteed shutdown state. Defuelling of the reactor core started on January 17, 2013 and was completed on September 3, 2013. The used fuel is now stored in the onsite irradiated fuel bay where it will stay for approximately 5 more years, following which it will be transferred to the CANSTOR dry storage site.



Fuelling machine, at Gentilly-2, used to defuel the core and drain heavy water from the pressure tubes (photo courtesy Hydro-Québec).

During 2014, Hydro-Québec completed the draining and drying of the main nuclear systems and other activities required to transition Gentilly-2 into the safe storage state with the irradiated fuel stored in the onsite irradiated fuel bay. These activities were conducted in accordance with the final operations plan, which was reviewed and accepted by CNSC staff in May 2014.

Focused technical meetings involving CNSC and Hydro-Québec staff continued to be held during 2014 to facilitate the review and oversight of the activities required to transition Gentilly-2 into

the safe storage state. CNSC staff also conducted onsite inspections to oversee the conduct of specific activities. CNSC staff concluded that the Hydro-Québec plans and procedures met the regulatory requirements and were correctly implemented to ensure the safe conduct of the operations and activities.

Gentilly-2 reached the safe storage state with the irradiated fuel stored in the onsite irradiated fuel bay on December 2, 2014.

3.4.2.3 Updates on significant regulatory issues

Transition to safe storage and future decommissioning

An administrative protocol between the CNSC and Hydro-Québec was signed on January 15, 2013. Updates to this protocol were subsequently made on April 29, 2013, March 3, 2014, and April 1, 2015. This last update covers the current phase of operation up to the next licence renewal in 2016.

The Hydro-Québec/CNSC liaison committee, set up immediately after the protocol was signed in 2013, continued to meet on a bi-weekly basis to address operational issues as well as issues related to the implementation of the current licence and regulations.

The Hydro-Québec/CNSC working group, set up to address specialized regulatory and technical issues, including changes needed to the operating licence and the LCH following completion of reactor defuelling, removal from service and layup of several station systems and equipment, met several times during 2013 and early 2014. Following these meetings, Hydro-Québec requested, in February 2014, an amendment to the Gentilly-2 licence based on the results achieved by this working group. CNSC staff completed a review of this licence amendment request and recommended that the licence be amended in accordance with the Hydro-Québec request. The Commission approved the Gentilly-2 licence amendment in July 2014. The licence conditions handbook revision was approved by the Director General, Directorate of Power Reactor Regulation in July 2014.

***Fisheries Act* authorizations**

CNSC staff plan to discuss with Hydro-Québec the key amendments to the *Fisheries Act*, highlights of the CNSC-Fisheries and Oceans Canada (DFO) memorandum of understanding (MoU), and key DFO policy documents related to the interpretation of the amended *Fisheries Act*, specifically, the Habitat Protection Prohibitions of the *Fisheries Act*. Hydro-Québec was notified of the implementation of CNSC-DFO MoU in March 2014. Fish impingement and entrainment studies may be requested in 2015 to determine whether an application for a *Fisheries Act* authorization will be required.

Response to the Fukushima Daiichi accident

Having ended commercial operation at the Gentilly-2 nuclear station in December 2012, Hydro-Québec began transitioning the reactor to a safe storage state in preparation for decommissioning. As a result, most of the Fukushima action items (FAIs) were suspended for the Gentilly-2 station with the exception of those related to improving mitigation measures for the irradiated fuel bays (IFBs) and enhancing emergency response. Therefore, progress on Fukushima safety improvements for Gentilly-2 has been limited to actions related to IFBs and emergency response. Of the 36 FAIs, 19 apply to Gentilly-2 (see appendix G).

Hydro-Québec submitted its last Fukushima update in early March 2014, which included a request for closure of all of the remaining FAIs for Gentilly-2. CNSC staff completed review for the remaining open FAIs and concluded that all related FAIs are closed for Hydro-Québec.

The activities undertaken in 2014 by Hydro-Québec to disposition all outstanding FAIs were completed for the following area:

- ***Modelling improvements of external hazard (FAIs 2.1.1 and 2.1.2):*** Hydro-Québec submitted its final progress update on the remaining FAIs 2.1.1 and 2.1.2, which addressed assessments of external hazards for the irradiated fuel bay. CNSC staff found Hydro-Québec's submission contained sufficient information to meet the established closure criteria for FAIs 2.1.1 and 2.1.2. Therefore, FAIs 2.1.1 and 2.1.2 are closed.

CNSC staff will continue to monitor FAI implementation at Gentilly-2 through its established compliance verification program and site-specific action items. Annual updates on FAI implementation will be provided to the Commission as part of the NPP report.

3.4.2.4 Public communication

Event initial reports

No event initial reports (EIRs) were submitted for Gentilly-2 from January 2014 to April 2015.

Aboriginal consultation and engagement activities

In November 2014, Hydro-Québec presented an outline of the process being considered to consult and engage Aboriginal communities during the Gentilly-2 licence renewal and requested CNSC staff confirmation of the acceptability of the proposed process, which includes the following three main elements:

- Notice of the Gentilly-2 licence renewal application
- The provision of information pertaining to the licence renewal application
- A description of how to obtain additional information pertaining to the licence renewal application if needed

CNSC staff reviewed the proposed Hydro-Québec process to consult and engage Aboriginal communities during the Gentilly-2 licence renewal and confirmed that it was acceptable.

3.5 Point Lepreau

Point Lepreau is located on the Lepreau Peninsula, 40 kilometres southwest of Saint John, New Brunswick. The station is owned and operated by New Brunswick Power Corporation (NB Power), and consists of a single CANDU reactor with a rated capacity of 705 MWe (megawatts electrical).

3.5.1 Safety assessment

The CNSC staff safety assessment of Point Lepreau for 2014 resulted in the performance ratings as shown in table 15. Based on the observations and assessments of the SCAs, CNSC staff concluded that Point Lepreau operated safely. The integrated plant rating was "satisfactory", which is unchanged from the previous year.

Table 15: Performance ratings for Point Lepreau

Safety and control area	Rating	Industry average
Management system	SA	SA
Human performance management	SA	SA
Operating performance	SA	SA
Safety analysis	SA	SA
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	SA	SA
Conventional health and safety	FS	FS
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Waste management	SA	FS
Security	SA	FS
Safeguards and non-proliferation	SA	SA
Packaging and transport	SA	SA
Integrated plant rating	SA	SA

Note:

- For specific areas within the SCAs where there were no significant observations from CNSC staff compliance verification activities, no information is given in this subsection of the report.
- The information presented below is station specific; general trends are not identified here (refer to section 2 for industry-wide observations).

3.5.1.1 Management system

Based on the information assessed, CNSC staff concluded that the management system SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Management system
NB Power's management system complied with the requirements of N286-05, *Management system requirements for nuclear power plants* [8].

Change management
As part of the compliance verification activities related to the removal of the continued operation hold point for NB Power's compliance with N293-07, *Fire protection for CANDU nuclear power plants* [50], CNSC staff conducted an inspection to verify the compliance of the engineering change control process with the potential to impact protection from fire. Some minor deficiencies were identified as a result and these are being addressed by the licensee.

Safety culture
In 2014, NB Power conducted a safety culture self-assessment and identified various strengths and opportunities for the organization to improve nuclear safety culture. The CNSC encourages licensees to conduct periodic assessments and act upon areas that were identified as areas for improvement. A healthy safety culture is a key factor in reducing the likelihood of nuclear events. Creating and maintaining an environment conducive to a healthy safety culture is an ongoing process, requiring the attention of licensees and the CNSC.

3.5.1.2 Human performance management

Based on the information assessed, CNSC staff concluded that the human performance management SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Human performance program
NB Power continued to improve its human performance program. In 2014, NB Power benchmarked its human performance program against industry peers, conducted a self-assessment and updated its program accordingly.

Personnel training
NB Power has a documented and defined systematic approach to training (SAT)-based training system. The implementation of this system for the training programs at Point Lepreau meets regulatory requirements. Identified challenges in the implementation of the training system are being addressed by the licensee in accordance with its submitted training improvement plan and training program update initiative, and do not represent an increased risk to nuclear safety.

As part of the compliance verification activities related to the removal of the continued operation hold point for NB Power's compliance with N293-07, *Fire protection for CANDU nuclear power plants* [50], two Point Lepreau site visits and desktop reviews were conducted in 2014 for verification of SAT for fire training. CNSC staff confirmed that NB Power has progressively developed a fire training program that is based on the SAT principles.

Personnel certification
NB Power had sufficient certified personnel for all certified positions at Point Lepreau in accordance with CNSC regulatory requirements. It should also be noted that NB Power has had a number of new candidates successfully progress through the control room operator certification training and examinations in preparation for CNSC certification in the forthcoming year. CNSC

staff are satisfied that NB Power's program certifies the competency of personnel at Point Lepreau to perform their duties safely.

Initial certification examinations and requalification tests

The initial certification examinations and requalification tests programs for certified personnel at Point Lepreau met all CNSC regulatory requirements. In 2014, CNSC staff conducted an inspection of the design, verification, conduct and grading of a reactor operator simulator-based certification examination. CNSC staff concluded that NB Power met the requirements of its program as well as CNSC requirements.

Work organization and job design

Minimum shift complement

NB Power met the regulatory requirements for the minimum shift complement at Point Lepreau. CNSC staff conducted an inspection and verified that records of minimum shift complement were retrievable and complete.

In 2014, CNSC staff concluded that NB Power's emergency response team of nine qualified members per shift, which was established in 2012, is adequate.

NB Power has submitted a licensing assessment to the CNSC to meet G-323, *Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities - Minimum Staff Complement* [54], which is referenced in the Point Lepreau licence. CNSC staff will continue to review this submission throughout 2015.

Fitness for duty

Hours of work

CNSC staff had previously raised enforcement actions against NB Power hours of work reporting process. NB Power continues to address these actions. CNSC staff are satisfied with the progress to date and expect the licensee will be requesting closure in 2015.

In 2014, NB Power incorporated emergency response team members assigned to a rotating 12-hour shift schedule into their hours of work governance. This change is acceptable to CNSC staff.

3.5.1.3 Operating performance

Based on information assessed, CNSC staff concluded that the operating performance SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Conduct of licensed activity

NB Power operates its facilities within the bounds of the operating policies and principles.

Point Lepreau experienced no unplanned reactor trips, one stepback and two setbacks. It should be noted that the transients were controlled properly by the licensee and that stepbacks and setbacks address issues at domains far below those of regulatory concern. Consequently, there was no impact on nuclear safety.

The power history graph for the Point Lepreau nuclear reactor unit for 2014 can be seen in appendix F. This graph shows the occurrences (and causes) of outages and the associated power reductions during the year.

CNSC staff conducted inspections, including field and control room inspections. No significant operations-related compliance issues were identified.

A control room operator and CNSC inspector at Point Lepreau. Key safety-related positions at nuclear facilities must have personnel who have been certified by the CNSC as being qualified, trained and capable of performing their duties.

Procedures
Previous CNSC inspections identified issues related to procedural non-adherence at Point Lepreau. NB Power provided a plan to address these issues but progress to date in some areas has been slower than anticipated. CNSC staff continue to monitor NB Power's implementation and will conduct a follow-up inspection in 2015.

Reporting and trending
NB Power is required to submit quarterly reports on operations and performance indicators as described in S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. CNSC staff did not identify any significant regulatory issues from these reports.

Outage management performance
Point Lepreau had one planned outage and one forced outage. In addition, Point Lepreau experienced unexpected maintenance work during the planned outage and properly returned the unit to service. All outage-related undertakings, including heat sink strategy management at Point Lepreau, were performed safely by NB Power staff. Details are in appendix F.

Safe operating envelope
The safe operating envelope (SOE) implementation at Point Lepreau is acceptable. The SOE program has entered its maintenance phase since N290.15, *Requirements for the safe operating envelope of nuclear power plants* [11], was included in the current licence. Assessment of compliance will be part of ongoing compliance monitoring activities during the next year.

3.5.1.4 Safety analysis

Based on the information assessed, CNSC staff concluded that the safety analysis SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Deterministic safety analysis
NB Power has an effective, well-managed program at Point Lepreau for performing deterministic safety analysis. The station has adequate safety margins and these meet the CNSC's acceptance

criteria for safe operation of the NPP. NB Power submitted its RD-310, *Safety Analysis for Nuclear Power Plants* [15], implementation plan in early 2014. Currently, NB Power is in the final phases of its gap assessment with respect to REGDOC-2.4.1, *Deterministic Safety Analysis* [16], published in May 2014 and will be providing a path forward once the assessment is completed.

Probabilistic safety analysis

NB Power's probabilistic safety assessment (PSA) submissions are in compliance with S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* [4]. To maintain compliance with S-294, NB Power is expected to submit an updated PSA to CNSC by August 2016.

Severe accident analysis

NB Power has completed its severe accident management guidelines (SAMGs) implementation at Point Lepreau. CNSC staff conducted an evaluation of SAMG implementation at Point Lepreau in 2014. The evaluation highlighted many positive aspects of SAMG implementation and no actions were raised as a result of this evaluation. CNSC staff concluded that there were no regulatory issues in the area of severe accident analysis.

Environmental risk assessment

NB Power continued to maintain and implement an effective environmental risk assessment and management program for the protection of the environment at Point Lepreau in accordance with CNSC requirements. An intake fish mortality (impingement and entrainment) monitoring and reporting program commenced in July 2013 and continued throughout 2014. NB Power has prepared a draft environmental risk assessment and continues to work on reviews and gap analysis of the existing environmental protection programs according to N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* [19]. An update on the progress of improvements resulting from this activity is expected in 2015. CNSC staff concluded that there were no regulatory issues in 2014 in the area of environmental risk assessment.

3.5.1.5 Physical design

Based on the information assessed, CNSC staff concluded that the physical design SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

System design

Electrical power systems

Follow-up actions on the 2011 electrical power systems inspection are ongoing between CNSC and NB Power staff. CNSC staff are reviewing NB Power's February 2015 update. Remaining compliance issues are of low safety significance.

Design governance

Environmental qualification

The environmental qualification program is fully implemented by NB Power at Point Lepreau. CNSC staff reviewed NB Power's update on its environmental qualification program plant life extension. NB Power has made progress and CNSC staff are monitoring these issues.

Pressure boundary design

CNSC staff conducted ongoing regulatory oversight activities including document reviews against the requirements of N285.0-08, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants* [48]. CNSC staff concluded that the licensee's pressure boundary program is in compliance with the licence requirements and that the licensee continues to implement a comprehensive pressure boundary program at Point Lepreau.

Fire protection design

As a prerequisite for continued operation of Point Lepreau, the Commission, in its relicensing decision of February 2012, included a regulatory hold point for NB Power to comply with N293-07, *Fire protection at CANDU nuclear power plants* [50], by December 31, 2014. During 2014, NB Power continued to implement the required upgrades and removed the compensatory measures, which had previously been implemented to ensure adequate fire safety during implementation of the upgrades. CNSC staff concluded that NB Power met the requirements of N293-07 in December 2014, and the continued operation hold point was lifted.

CNSC staff will continue to monitor the program implementation in 2015.

Component design

Fuel inspection program

NB Power has a well-developed reactor fuel inspection program. Fuel performance at Point Lepreau was acceptable in 2014.

Cables

NB Power's aging management program does not include cable condition monitoring that will assure adequate assessments of non-environmentally qualified cable aging and degradation (this includes underground cables). NB Power is working with the Canadian nuclear industry to develop an overall cable condition monitoring program. CNSC staff are continuing to monitor NB Power's progress in this area. The overall impact of this issue is deemed to be of low safety significance.

3.5.1.6 Fitness for service

Based on the information assessed, CNSC staff concluded that the fitness for service SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Equipment fitness for service/equipment performance

On the basis of inspections and compliance verifications, CNSC staff concluded the overall equipment fitness for service and performance at Point Lepreau was satisfactory and met regulatory requirements.

Maintenance

The maintenance program performance by NB Power at Point Lepreau remained satisfactory. As a result of reviews and inspections, CNSC staff concluded that there were no safety-significant maintenance findings. The corrective maintenance backlog was reduced and reached the range of the industry best practice. The deficient maintenance backlog was higher than the average range of industry in the past two years but with positive trending. CNSC staff continued to monitor the

licensee's measures to reduce the deficient maintenance backlog through routine maintenance-related desktop reviews and inspections. CNSC staff determined that the deficient maintenance backlog at Point Lepreau is not safety-significant.

Structural integrity

NB Power inspected selected pressure boundary components and performed a positive pressure leakage rate test for the reactor building and no significant degradation was identified. CNSC staff's assessment of the final inspection reports and other compliance monitoring activities indicated that the existing programs at Point Lepreau are in compliance with CNSC regulatory requirements.

Reliability of systems important to safety

The reliability program at Point Lepreau continued to meet regulatory requirements as described in RD/GD-98, *Reliability Programs for Nuclear Power Plants* [27].

All special safety systems at Point Lepreau met their unavailability targets in 2014, with the exception of the containment system. For the containment system, two incidents, described below, led to increased unavailability. In each case, NB Power, per its operating policies and principles, took immediate corrective actions and assessed the potential impact on nuclear safety.

The first incident, which occurred during normal operation, and led to the containment system not meeting its unavailability target, was caused by a valve that was found to be leaking during a routine airlock leakage test. The defective valve was replaced and this corrected the situation.

In the second incident, a mispositioned valve during the planned outage led to containment system unavailability. The actions in response to the incident were completed as required and corrective actions were implemented to avoid recurrence.

CNSC staff verified the actions of the licensee and concluded there was no significant impact on nuclear safety as a result of the containment system incidents. CNSC staff concluded that the actions taken by NB Power are acceptable to the CNSC.

Aging management

NB Power has implemented processes and programs that ensure that the condition of structures, systems and components (SSCs) important to safety is well understood and that the required activities are in place to assure the health of these SSCs while the plant ages.

Chemistry control

Based on the desktop reviews conducted in 2014, CNSC staff concluded that the performance of the NB Power chemistry control program was satisfactory.

Periodic inspections and testing

NB Power has adequate periodic inspection and testing programs in place at Point Lepreau for the pressure boundary and containment components important to safety. CNSC staff monitored compliance with the established programs and concluded that their implementation meets regulatory requirements.

3.5.1.7 Radiation protection

Based on the information assessed, CNSC staff concluded that the radiation protection SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Application of ALARA

NB Power continued to implement its ALARA program. The five-year ALARA plan was completed in the first quarter of calendar year 2014 as scheduled. In 2014, NB Power identified initiatives to reduce worker exposures. CNSC staff are monitoring progress in this area.

Routine compliance verification activities indicate that performance in the area of application of ALARA at Point Lepreau was effective.

Worker dose control

NB Power continued to comply with the regulatory requirements to measure and record doses received by workers. No worker received a radiation dose in excess of the regulatory dose limits or action levels established in the Point Lepreau radiation protection (RP) program. The dose information for Point Lepreau is provided in section 2.1.7 and appendix D.

CNSC staff performed a worker dose control inspection in 2014 and found that performance in the area of worker dose control at Point Lepreau was effective.

Radiation protection program performance

The NB Power RP program meets the requirements of the *Radiation Protection Regulations* and includes performance indicators to monitor program performance. In 2014, improvements were made to relevant procedures to address CNSC requirements for programmatic enhancements in the area of alpha monitoring and control.

NB Power revised their top level RP program document SI-01335-A108, *Radiation Protection Directives*, in the fall of 2014 to more clearly define key program requirements and improve references to implementing procedures. NB Power is addressing comments from CNSC staff.

CNSC staff confirms that NB Power has established challenging goals and targets for RP program performance and these are being monitored on an ongoing basis to improve performance. Routine compliance verification activities indicate that NB Power is effective in the area of radiation protection program performance.

Radiological hazard control

No action levels were exceeded for surface contamination at Point Lepreau in 2014.

Routine compliance verification activities indicate that performance in the area of radiological hazard control at Point Lepreau is effective.

Estimated dose to public

NB Power continued to ensure the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to a member of the public from Point Lepreau was 0.0003 mSv, well below the annual regulatory public dose limit of 1 mSv.

3.5.1.8 Conventional health and safety

Based on the information assessed, CNSC staff concluded that the conventional health and safety SCA at Point Lepreau met or exceeded performance objectives and all applicable regulatory requirements. As a result, the station received a "fully satisfactory" rating, which is unchanged from the previous year.

Performance

As reported by NB Power, the accident severity rate for Point Lepreau decreased from 12.0 to zero in 2014 and the accident frequency decreased from 0.35 to zero. The accident frequency for Point Lepreau was the lowest for Canadian NPPs.

Practices; awareness

The practices and awareness areas exceeded CNSC regulatory requirements at Point Lepreau in 2014.

NB Power was compliant at Point Lepreau with the relevant portions of *New Brunswick's Occupational Health and Safety Act*, *Worker's Compensation Act* and *Workplace Health, Safety and Compensation Commission Act*.

3.5.1.9 Environmental protection

Based on the information assessed, CNSC staff concluded that the environmental protection SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Effluent and emissions control (releases)

Based on the assessment of the licensee's environmental monitoring report, CNSC staff concluded that the radiological releases to the environment from Point Lepreau remained below regulatory limits. NB Power continued its implementation of N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills* [55], during 2014.

Groundwater monitoring at the Point Lepreau site indicated no adverse impact on the groundwater environment due to station operation.

Environmental management system

NB Power has established and implemented an environmental management program to assess the environmental risks associated with its nuclear activities and to ensure that these activities are conducted such that adverse environmental effects are prevented or mitigated.

Protection of the public

There were no hazardous substances released from Point Lepreau that posed unacceptable risk to the environment or the public.

The reported annual radiation dose to the public from Point Lepreau was 0.03 percent of the public dose limit.

3.5.1.10 Emergency management and fire protection

Based on the information assessed, CNSC staff concluded that the emergency management and fire protection SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Conventional emergency preparedness and response; nuclear emergency preparedness and response

During 2014, CNSC staff conducted regulatory oversight activities at Point Lepreau, including review of documentation, onsite observations and participation in drills. NB Power maintained their conventional and nuclear emergency preparedness and response commitments including enhancements to their emergency drill program. CNSC staff concluded that the performance of NB Power in these areas was satisfactory.

Fire emergency preparedness and response

CNSC staff maintained enhanced regulatory oversight in this area during 2014. CNSC inspectors verified that new industrial fire brigade equipment and performance enhancements were successfully deployed in 2014. Point Lepreau completed implementation of a comprehensive fire response program that includes effective response capability, procedures, training and expected maintenance of proficiency.

Inspecting emergency response equipment at Point Lepreau.

3.5.1.11 Waste management

Based on the information assessed, CNSC staff concluded that the waste management SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous year.

Waste minimization

CNSC staff confirmed that NB Power has taken the necessary steps to minimize, segregate and characterize the nuclear wastes generated as a result of operating Point Lepreau. NB Power has an operating policies and principles document in place that describes its nuclear waste management within the NPP.

Waste management practices

The Point Lepreau site includes the Solid Radioactive Waste Management Facility (SRWMF). This site is not co-located with the power reactor, so waste must be transported for a short distance inside the exclusion zone. CNSC staff provide regulatory oversight for the waste transfers. Waste storage includes very short-lived storage within the NPP before being transferred for long-term storage at the SRWMF. NB Power has demonstrated consistent and compliant management and control of waste storage throughout its operations. Findings from 2014 reflected minor issues that were adequately addressed by the licensee.

Decommissioning plans

NB Power's decommissioning plan and associated cost estimate and financial guarantee were reviewed and accepted by the Commission in 2011 and will be reviewed again in 2016, prior to licence renewal in 2017. Consequently, CNSC staff concluded that NB Power's decommissioning plan, cost estimate and financial guarantee remain current and in effect and met regulatory requirements.

3.5.1.12 Security

Based on the information assessed, CNSC staff concluded that the security SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a rating of "satisfactory", which is unchanged from the previous year.

Response arrangements

NB Power has shown improvements in response arrangements at Point Lepreau. NB Power held a 12-week, in-house nuclear response force training course that began in November 2014 and continued into 2015. This activity required an extensive amount of resources.

CNSC staff verified that corrective action plans in response to inspection findings were implemented to a satisfactory level.

3.5.1.13 Safeguards and non-proliferation

Based on the information assessed, CNSC staff concluded that the safeguards and non-proliferation SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. The station received a "satisfactory" rating, which is unchanged from the previous year.

Nuclear material accountancy and control

CNSC staff have determined that NB Power complied with regulatory requirements in accordance with RD-336, *Accounting and Reporting of Nuclear Material* [39].

Access and assistance to the IAEA

The International Atomic Energy Agency (IAEA) performed a physical inventory verification and a design information verification at Point Lepreau in 2014 to verify the non-diversion of safeguarded nuclear materials. The CNSC was informed by the IAEA that the results of these inspections were satisfactory.

Operational and design information

NB Power submitted its annual operational program for Point Lepreau to the CNSC on time, with quarterly updates, and the annual update to the information provided pursuant to the *Additional Protocol* [40].

In 2013, CNSC staff advised NB Power of their concerns regarding a lack of operator training, which led to late or missed operational reports for Point Lepreau and resulted in CNSC enforcement actions. NB Power has since implemented corrective measures to address the deficiencies. CNSC staff continue to closely monitor NB Power's performance in this area.

Safeguards equipment, containment and surveillance
NB Power supported IAEA equipment operation and maintenance activities at Point Lepreau to ensure the effective implementation of safeguards measures at the station.

In October 2014, the IAEA undertook an extensive radiation profiling and sealing campaign at Point Lepreau's used fuel dry storage site. No issues were encountered.

3.5.1.14 Packaging and transport

Based on the information assessed, CNSC staff concluded that the packaging and transport SCA at Point Lepreau met performance objectives and all applicable regulatory requirements. As a result, the station received a "satisfactory" rating, which is unchanged from the previous years.

CNSC staff reached this conclusion based on onsite monitoring activities and a review of the reports submitted in accordance with S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7]. There were no significant events reported under the *Packaging and Transport of Nuclear Substances Regulations* for consignments transported to and from Point Lepreau. NB Power continued to implement and maintain an effective packaging and transport program at Point Lepreau.

3.5.2 Regulatory developments

3.5.2.1 Licensing

NB Power's licence for Point Lepreau was renewed in February 2012 for a five-year period (effective until June 30, 2017). As a prerequisite for continued operation of the plant, the Commission, in its relicensing decision in 2012, included a regulatory hold point for NB Power compliance with N293-07, *Fire protection at CANDU nuclear power plants* [50], by December 31, 2014. In addition, the Commission required that NB Power complete a site-specific seismic hazard assessment and disclose the results through its public information program.

Regulatory hold point for fire protection compliance
To ensure that NB Power implements an adequate emergency management and fire protection program in an acceptable timeframe, the Commission found it necessary to include a regulatory hold point for NB Power's compliance with N293-07, for Point Lepreau. This hold point serves as a pre-requisite for continued operation of the plant.

To meet this hold point, the licensee had to demonstrate that the Point Lepreau emergency management and fire protection program was in compliance with N293-07 by December 31, 2014. This included additional fire-related analysis, revisions to operating procedures and practices, revisions to the fire protection program, additional training of staff, installation of emergency response equipment, and physical modifications to the station.

CNSC staff confirmed, through the evaluation of documents and onsite inspections, that NB Power had met all of the prerequisites and milestones established by the Commission in the Point Lepreau operating licence and licence conditions handbook (LCH) for the removal of the continued operation hold point and that NB Power had achieved compliance with N293-07.

On December 16, 2014 pursuant to licence condition 16.4 of the Point Lepreau licence, the CNSC Executive Vice-President and Chief Regulatory Operations Officer consented to the removal of the Point Lepreau continued operation hold point. This was the last hold point in the licence.

Site-specific seismic hazard assessment

In its decision to renew the Point Lepreau licence in 2012, the Commission required that NB Power complete a site-specific seismic hazard assessment and share the results through its public information program. In addition to the above, NB Power made a commitment to complete tsunami and wind-hazard assessments for Point Lepreau. These studies are being tracked via Fukushima action items (FAIs) 2.1.1 and 2.1.2 (see appendix G for details).

The draft site-specific seismic hazard assessment was completed by AMEC, a company contracted by NB Power, and submitted to the licensee at the end of 2014. At that time, the executive summary of the assessment was posted on the licensee's website. In May 2015, CNSC staff received the final seismic hazard assessment from NB Power and this assessment is currently being reviewed by CNSC and Natural Resources Canada staff.

In addition, NB Power submitted status updates in 2014 on its tsunami study, as well as the wind hazard study for Point Lepreau. The completed studies, including any further evaluations and plans for corrective actions (if necessary), are planned for submission to the CNSC in June 2015. An update will be provided to the Commission on the results from the external hazards (seismic, tsunami and wind hazard) studies at the public meeting in August 2015.

Licence amendments

The Point Lepreau licence was amended twice between January 2014 and April 2015. Details of these amendments are given in appendix H.

Revisions to the licence conditions handbook

Point Lepreau's LCH was issued on February 20, 2012. Between January 2014 and April 2015, three revisions were made to the Point Lepreau LCH. The changes were mostly administrative in nature and details of the significant changes can be seen in appendix H.

The revisions were approved by the Director General, Directorate of Power Reactor Regulation. The changes to the LCH have not resulted in an unauthorized change of scope and remain within the licensing envelope.

3.5.2.2 Updates on major projects and initiatives

Environmental monitoring

NB Power continued to maintain and implement an effective environmental risk assessment and management program for the protection of the environment at Point Lepreau in accordance with CNSC requirements. An intake fish mortality (impingement and entrainment) monitoring and reporting program commenced in July 2013 and continued throughout 2014. NB Power has prepared a draft environmental risk assessment and continues to work on reviews and gap analysis of the existing environmental protection programs according to N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* [19]. An update on the progress of improvements resulting from this activity is expected in 2015.

3.5.2.3 Updates on significant regulatory issues

Fisheries Act authorizations

CNSC staff have discussed with NB Power the key amendments to the *Fisheries Act*, highlights of the CNSC-Fisheries and Oceans Canada (DFO) memorandum of understanding, and key DFO policy documents related to the interpretation of the amended *Fisheries Act*, specifically, the Habitat Protection Prohibitions clauses of the *Fisheries Act*. Discussions included NB Power's ongoing fish impingement and entrainment studies and initial discussions of NB Power's self-assessment to determine the requirement for a *Fisheries Act* application. NB Power is required to complete their self-assessment for Point Lepreau on the need for a *Fisheries Act* authorization. If the self-assessment determines that there is serious harm to fish, NB Power would need to submit an application for a *Fisheries Act* authorization by 2017.

Response to the Fukushima Daiichi accident

Prior to the Fukushima Daiichi accident, NB Power had completed extensive reviews and safety upgrades in support of the Point Lepreau life extension and refurbishment project. Some of these reviews and safety upgrades, such as the installation of passive autocatalytic recombiners and the emergency filtered containment venting system, were performed to specifically address severe accidents such as the station blackout scenario experienced at Fukushima Daiichi.

As of May 2015, all FAIs applicable to Point Lepreau were closed with the exception of FAIs 2.1.1 and 2.1.2 related to the probabilistic safety assessment for external hazards. The activities undertaken in 2014 by NB Power to disposition all outstanding FAIs were completed for the following areas:

- ***Habitability of control facilities during a severe accident (FAI 1.9.1):*** CNSC staff completed reviews related to FAI 1.9.1 submitted in *Update Report No. 6*. In their submission, NB Power applied the generic CANDU Owners Group (COG) methodology for determining onsite habitability at Point Lepreau. Overall, CNSC staff found the information contained in NB Power's submission meets the intent of the CNSC FAI 1.9.1 deliverables and closure criteria. Therefore, FAI 1.9.1 was closed. Nonetheless, CNSC staff detailed review of NB Power's habitability assessment for Point Lepreau is ongoing. Any issues, gaps and opportunities for improvement identified will be communicated to NB Power.

- ***Modelling improvements of external hazard (FAIs 2.1.1 and 2.1.2):*** As per a Commission request, NB Power agreed to submit a revised seismic hazard assessment to staff. CNSC staff are tracking this commitment under FAIs 2.1.1 and 2.1.2. In their submission (*Update Report No. 6*), NB Power provided further information on the progress of the work related to external hazard assessments for: probabilistic seismic hazard; probabilistic tsunami hazard and inundation study; and wind hazard, with a planned submission date in June 2015. CNSC staff received the seismic hazard assessment in May 2015. As the site-specific deterministic and probabilistic modelling for assessing external hazards is a first-of-a-kind assessment in Canada, some technical challenges have been encountered that have resulted in delays. NB Power is addressing these challenges. FAIs 2.1.1 and 2.1.2 remain open for NB Power; however, NB Power is planning to request closure by June 2015 with the submission of the remaining external hazards assessments.

CNSC staff will continue to monitor FAI implementation at Point Lepreau through its established compliance verification program. Annual updates on FAI implementation will be provided to the Commission as part of the NPP report.

3.5.2.4 Public communication

Event initial reports

No event initial reports (EIRs) were submitted for Point Lepreau from January 2014 to April 2015.

4. Summary and conclusions

This report summarizes the Canadian Nuclear Safety Commission (CNSC) staff's assessment of the safety performance of nuclear power plant (NPP) licensees and of the industry as a whole in 2014. The report also provides information on CNSC staff evaluation of how well licensees met regulatory requirements and CNSC expectations for the 14 safety and control areas (SCAs) of the regulatory framework. The assessment reviews generic issues, identifies industry trends and compares Canadian NPP industry safety performance indicators with those of international NPP operators and other industries. The assessments in this report were based on the consideration of findings from inspections, desktop reviews, site surveillance activities, field rounds and other compliance verification activities against relevant requirements, expectations and performance objectives.

CNSC staff concluded that NPPs in Canada were operated safely during 2014, and that licensees made adequate provisions to protect the health, safety and security of persons and the environment, as well as to ensure that Canada continued to meet its international obligations on the peaceful use of nuclear energy. Licensees complied with the requirements to report events requiring regulatory oversight and conducted follow-ups, as necessary.

These conclusions are based on the following observations:

- There were no serious process failures at the NPPs
- No member of the public received a radiation dose that exceeded the regulatory limit
- No workers at any NPP received a radiation dose that exceeded the regulatory limits
- The frequency and severity of non-radiological injuries to workers were minimal
- No radiological releases to the environment from the stations exceeded the regulatory limits
- Licensees complied with licence conditions concerning Canada's international obligations
- No NPP events, above level 0 on the International Nuclear and Radiological Event Scale (INES), were reported to the International Atomic Energy Agency (IAEA)

Table 16 summarizes the 2010-14 ratings for Canada's NPPs. For each station, the SCAs are presented along with the industry averages and the integrated plant ratings (IPRs) that reflect a plant's overall safety performance. Overall, the trend is one of maintaining or improving performance with respect to SCA ratings and IPRs. Specifically, in 2014:

- A total of 14 SCAs across the NPPs were rated as 'fully satisfactory" (FS). This is the highest number since the SCA framework was introduced in 2010, and it is an increase of three from the previous maximum recorded in 2013.
- In the conventional health and safety, waste management and security SCAs, the Canadian nuclear power industry achieved an average rating of "fully satisfactory" – for waste management, four of the six stations received ratings of "fully satisfactory" while for conventional health and safety, and security, three of the six stations received "fully satisfactory". The waste management industry average rating improved from "satisfactory" in 2013, while the industry average ratings in conventional health and safety, and security were unchanged from 2013.
- The IPRs were "fully satisfactory" for Darlington and Bruce B and "satisfactory" (SA) for all other stations. The IPR for Darlington was unchanged from 2013, while the IPR for Bruce B improved to "fully satisfactory" in 2014 from "satisfactory" in 2013.

Table 16: Trends of ratings from 2010 to 2014

Safety and control area	Year	Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
Management system	2010	SA	SA	SA	SA	SA	SA	SA
	2011	SA	SA	SA	SA	SA	SA	SA
	2012	SA	SA	SA	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***
Human performance management	2010	SA	SA	SA	SA	SA	SA	SA
	2011	SA	SA	SA	SA	SA	SA	SA
	2012	SA	SA	SA	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***
Operating performance	2010	SA	SA	FS	SA	SA	SA	SA
	2011	SA	SA	FS	SA	SA	SA	SA
	2012	SA	SA	FS	SA	SA	SA	SA
	2013	SA	SA	FS	SA	SA	SA	SA
	2014	***SA***	***FS***	***FS***	***SA***	***SA***	***SA***	***SA***
Safety analysis	2010	SA	SA	SA	SA	SA	SA	SA
	2011	SA	SA	SA	SA	SA	SA	SA
	2012	SA	SA	SA	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***
Physical design	2010	SA	SA	SA	SA	SA	SA	SA
	2011	SA	SA	SA	SA	SA	SA	SA
	2012	SA	SA	SA	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***
Fitness for service	2010	SA	SA	FS	SA	SA	SA	SA
	2011	SA	SA	FS	SA	SA	SA	SA
	2012	SA	SA	FS	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***
Radiation protection	2010	BE	SA	FS	SA	SA	SA	SA
	2011	SA	SA	FS	SA	SA	SA	SA
	2012	SA	SA	FS	SA	SA	SA	SA
	2013	SA	SA	FS	FS	SA	SA	SA
	2014	***SA***	***SA***	***FS***	***FS***	***SA***	***SA***	***SA***
Conventional health and safety	2010	SA	SA	FS	SA	SA	SA	SA
	2011	FS	FS	FS	SA	SA	SA	SA
	2012	FS	FS	FS	SA	SA	FS	FS
	2013	FS	FS	FS	SA	SA	FS	FS
	2014	***FS***	***FS***	***SA***	***SA***	***SA***	***FS***	***FS***
Environmental protection	2010	SA	SA	SA	SA	SA	SA	SA
	2011	SA	SA	SA	SA	SA	SA	SA
	2012	SA	SA	SA	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***
Emergency management and	2010	SA	SA	SA	SA	SA	BE	SA
	2011	SA	SA	SA	SA	SA	SA	SA

Safety and control area	Year	Bruce A	Bruce B	Darlington	Pickering	Gentilly-2	Point Lepreau	Industry average
fire protection	2012	SA	SA	SA	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***
Waste management	2010	SA	SA	SA	SA	SA	SA	SA
	2011	SA	SA	SA	SA	SA	SA	SA
	2012	SA	SA	SA	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***FS***	***FS***	***FS***	***SA***	***SA***	***SA***	***FS***
Security	2010	FS	FS	SA	SA	SA	SA	SA
	2011	FS	FS	SA	SA	SA	SA	SA
	2012	FS	FS	SA	SA	SA	SA	SA
	2013	FS	FS	FS	FS	SA	SA	FS
	2014	***FS***	***FS***	***FS***	***FS***	***SA***	***SA***	***FS***
Safeguards and non-proliferation	2010	SA	SA	SA	SA	SA	SA	SA
	2011	SA	SA	SA	SA	SA	SA	SA
	2012	SA	SA	SA	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***
Packaging and transport	2010	SA	SA	SA	SA	SA	SA	SA
	2011	SA	SA	SA	SA	SA	SA	SA
	2012	SA	SA	SA	SA	SA	SA	SA
	2013	SA	SA	SA	SA	SA	SA	SA
	2014	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***	***SA***
Integrated plant rating	2010	SA	SA	FS	SA	SA	SA	SA
	2011	SA	SA	FS	SA	SA	SA	SA
	2012	SA	SA	FS	SA	SA	SA	SA
	2013	SA	SA	FS	SA	SA	SA	SA
	2014	***SA***	***FS***	***FS***	***SA***	***SA***	***SA***	***SA***

- No SCA received a rating of “below expectations” (BE) or “unacceptable” (UA). This was also the case in the final results for 2011 to 2013.

Furthermore, as shown in table 16, in 2014, within the industry:

- Darlington received four “fully satisfactory” ratings (in operating performance, radiation protection, waste management, and security). The number of “fully satisfactory” SCAs for Darlington remained unchanged from 2013, at four. The safety performance rating for waste management improved from “satisfactory” in 2013 to “fully satisfactory” in 2014. However, CNSC staff determined that the rating for conventional health and safety at Darlington for 2014 returned to “satisfactory” from “fully satisfactory”
- Bruce A received three “fully satisfactory” safety performance ratings (in conventional health and safety, waste management, and security), an increase of one from 2013, specifically, in waste management
- Bruce B received four “fully satisfactory” safety performance ratings (in operating performance, conventional health and safety, waste management, and security), an increase of two from 2013, specifically, in operating performance, and waste management

- Pickering received two “fully satisfactory” safety performance ratings (in radiation protection, and security), unchanged from 2013
- Point Lepreau received a “fully satisfactory” safety performance rating in conventional health and safety, unchanged from 2012
- In summary, there were 14 “fully satisfactory” ratings across the SCAs. Improvements resulted in increases in the safety performance ratings for Bruce B in operating performance to “fully satisfactory” and for Bruce A, Bruce B and Darlington in waste management to “fully satisfactory”. The conventional health and safety rating for Darlington returned to “satisfactory” in 2014 from “fully satisfactory” in 2013. The number of “fully satisfactory” ratings increased by three from 2013 and this is following an increase of two in 2012

During 2014, CNSC staff verified that licensees continued to implement safety enhancements in response to the Fukushima Daiichi accident. The Fukushima action items (FAIs) as specified in the *CNSC Integrated Action Plan* [2] and implemented by NPP licensees address safety improvements aimed at strengthening defence in depth and enhancing onsite emergency response. All Canadian NPP licensees have made considerable progress in addressing and implementing the 36 FAIs at their stations. As of May 2015, all short-term and medium-term FAIs were closed, with the exception of two medium-term FAIs at Point Lepreau related to probabilistic safety assessment for external hazard assessments. However, the Canadian nuclear power industry is on track to complete all enhancements by the December 2015 deadline set forth in the *CNSC Integrated Action Plan*.

Appendix A: Definitions of safety and control areas

The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas (SCAs).

These SCAs are further divided into 69 specific areas that define the key components of the SCA. The SCAs and specific areas used in the CNSC's safety performance evaluation for 2014 are given in table A.1.

Table A.1: The CNSC's SCAs and specific areas for assessing licensee safety performance

SCA	Specific area
Management system	• Management system • Organization • Change management • Safety culture • Configuration management • Records management • Management of contractors • Business continuity
Human performance management	• Human performance program • Personnel training • Personnel certification • Initial certification examinations and requalification tests • Work organization and job design • Fitness for duty
Operating performance	• Conduct of licensed activity • Procedures • Reporting and trending • Outage management performance • Safe operating envelope • Severe accident management and recovery • Accident management and recovery
Safety analysis	• Deterministic safety analysis • Probabilistic safety analysis • Criticality safety • Severe accident analysis • Environmental risk assessment • Management of safety issues (including R&D programs)
Physical design	• Design governance • Site characterizations • Facility design • Structure design • System design • Component design

SCA	Specific area
Fitness for service	• Equipment fitness for service/equipment performance • Maintenance • Structural integrity • Aging management • Chemistry control • Periodic inspections and testing
Radiation protection	• Application of as low as reasonably achievable (ALARA) • Worker dose control • Radiation protection program performance • Radiological hazard control • Estimated dose to public
Conventional health and safety	• Performance • Practices • Awareness
Environmental protection	• Effluent and emissions control (releases) • Environmental management system • Assessment and monitoring • Protection of the public
Emergency management and fire protection	• Conventional emergency preparedness and response • Nuclear emergency preparedness and response • Fire emergency preparedness and response
Waste management	• Waste characterization • Waste minimization • Waste management practices • Decommissioning plans
Security	• Facilities and equipment • Response arrangements • Security practices • Drills and exercises
Safeguards and non-proliferation	• Nuclear material accountancy and control • Access and assistance to the International Atomic Energy Agency • Operational and design information • Safeguards equipment, containment and surveillance
Packaging and transport	• Package design and maintenance • Packaging and transport • Registration for use

1. Management system

The management system SCA covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives and fosters a healthy safety culture.

Performance objectives

There is an effective management system that integrates provisions for addressing all regulatory and other requirements that enable the licensee to achieve its safety objectives, continuously monitor its performance against those objectives and maintain a healthy safety culture.

2. Human performance management

The human performance management SCA covers activities that enable effective human performance through the development and implementation of processes that ensure that licensees have sufficient personnel in all relevant job areas – people with the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

Performance objectives

Workers are sufficient in number in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

3. Operating performance

The operating performance SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

Performance objectives

Plant operation is safe and secure, with adequate regard for health, safety, security, radiation and environmental protection, and international obligations.

4. Safety analysis

The safety analysis SCA involves maintaining the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility. It considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards. For nuclear power plants, safety analysis is primarily deterministic in demonstrating the effectiveness of implementing the fundamental safety functions of "control, cool and contain" through a "defence-in-depth" strategy. Risk contributors are considered and assessed using probabilistic safety analysis to identify challenges to physical barriers. However, appropriate safety margins should be applied to address uncertainties and limitations of probabilistic safety analysis.

Performance objectives

The organization demonstrates that it accepts the consequences of design-basis events. Its protective systems can adequately control power, cool the fuel and contain any radioactivity that could be released from the plant.

5. Physical design

The physical design SCA relates to activities that affect the ability of structures, systems and components (SSCs) to meet and maintain their design basis as new information arises over time and taking into account changes in the external environment.

Performance objectives

There is confirmation that SSCs important to nuclear safety and security continue to meet their design basis in all operational states until the end of their design life.

6. Fitness for service

The fitness for service SCA covers activities that affect the physical condition of SSCs to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.

Performance objectives

SSCs, the performance of which may affect safety or security, remain available, reliable and effective, and consistent with the design, analysis and quality control measures.

7. Radiation protection

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that surface contamination levels and radiation doses received by individuals are monitored, controlled and maintained ALARA.

Performance objectives

The health and safety of persons are protected through the implementation of a radiation protection program that ensures that radiation doses are kept below regulatory dose limits and are optimized and maintained ALARA.

8. Conventional health and safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

Performance objectives

Conventional health and safety work practices and conditions achieve a high degree of personnel safety.

9. Environmental protection

The environmental protection SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.

Performance objectives

The environment and the health and safety of persons are protected by the licensee taking all reasonable precautions, including identifying, controlling and monitoring the release of nuclear substances and hazardous substances to the environment.

10. Emergency management and fire protection

The emergency management and fire protection SCA covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions, including any results of participation in exercises.

Performance objectives

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

11. Waste management

The waste management SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This also covers the planning for decommissioning.

Performance objectives

There is full development, implementation and auditing of a facility- and waste stream-specific waste management program to control and minimize the volume of nuclear waste generated by the licensed activity; waste management is included as a key component of the licensee's corporate and safety culture; and a decommissioning plan is maintained.

12. Security

The security SCA covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, in orders, or in expectations for the facility or activity.

Performance objectives

Loss, theft or sabotage of nuclear material or sabotage of the licensed facility is prevented.

13. Safeguards and non-proliferation

The safeguards and non-proliferation SCA covers the programs and activities required of a licensee for the successful implementation of obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.

Performance objectives

The licensee conforms with measures required by the facility to meet Canada's international safeguards obligations through:

- timely provision of accurate reports and information
- provision of access and assistance to IAEA inspectors for verification activities
- submission of annual operational information and accurate design information on plant structures, processes and procedures
- development and satisfactory implementation of appropriate facility safeguards procedures
- demonstration of capability, as confirmed through CNSC onsite evaluations, to meet all requirements in support of physical inventory verifications of nuclear material by the IAEA

14. Packaging and transport

The packaging and transport SCA covers the programs for the safe packaging and transport of nuclear substances to and from the licensed facility.

Performance objectives

All shipments leaving the site adhere to the *Packaging and Transport of Nuclear Substances Regulations* and the *Transportation of Dangerous Goods Regulations* [41]. Shipments of nuclear substances within the nuclear facility where access to the property is controlled are exempted from the application of the *Packaging and Transport of Nuclear Substances Regulations*.

Appendix B: Rating definitions and methodology

B.1 Definitions

Performance ratings used in this report are defined as follows:

Fully satisfactory (FS)
Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory and compliance within the SCA or specific area exceeds requirements and CNSC expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)
Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the area meets requirements and CNSC expectations. Any deviation is minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC expectations. Appropriate improvements are planned.

Below expectations (BE)
Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the area deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee is taking appropriate corrective action.

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

B.2 Rating methodology

The methodology for rating licensees is a detailed one that relies on multiple sources of inputs that are derived primarily from CNSC staff findings. These findings are based on regulatory activities such as inspections, field rounds, follow-ups on the licensee's progress on enforcement actions and desktop reviews. The methodology is not based entirely on a computational system; it also requires engineering judgment and inputs from the regulatory program managers for rating results that are on the rating interfaces.

The rating methodology is based on ratings made at three distinct levels:

- specific areas
- safety and control areas (SCAs)
- overall plant (also known as the integrated plant rating (IPR))

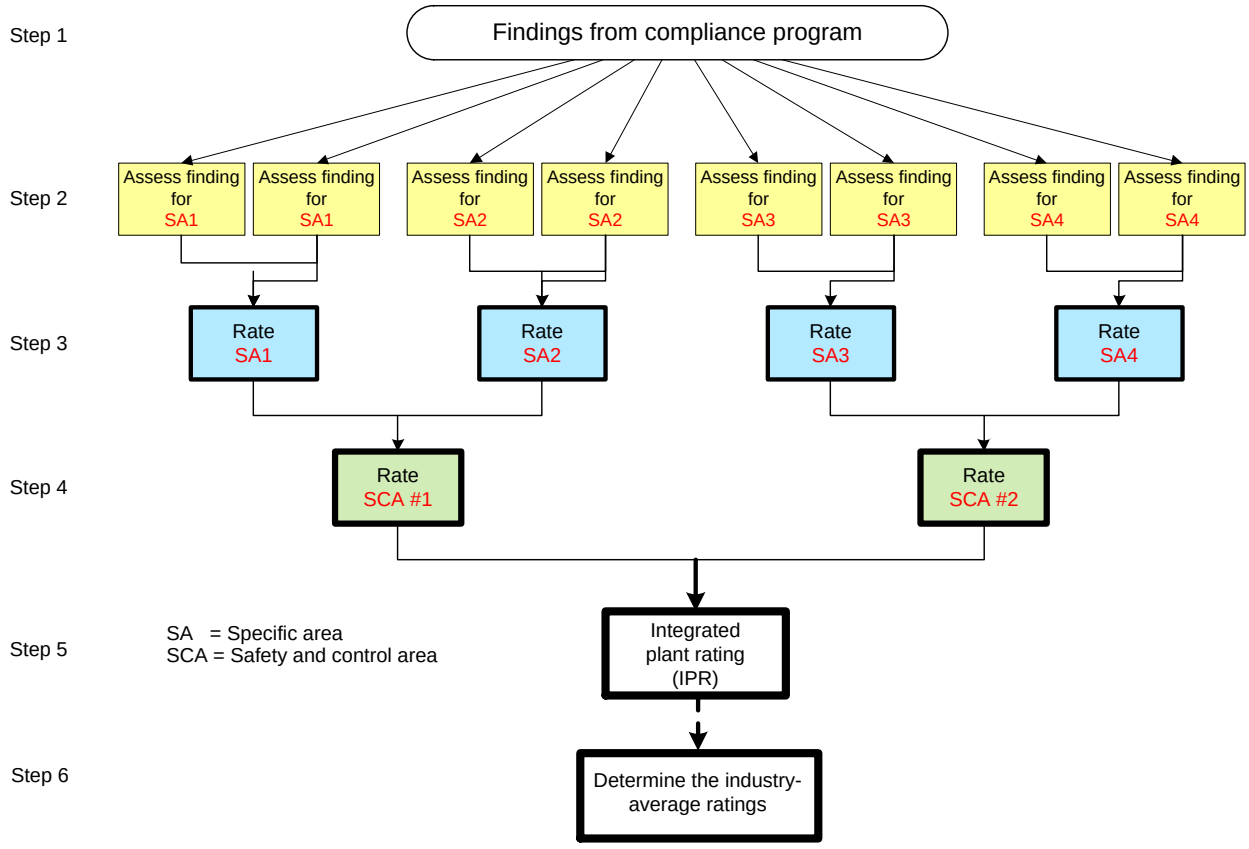
The significance of findings within a specific area is used to determine the performance rating within that specific area for a plant. This rating process results in performance ratings for each of the SCAs, as given in appendix A.

An algorithm is applied to determine the individual SCA performance rating for each station. The algorithm converts that SCA's specific area ratings to numeric values (based on a conversion table), computes the average value, and converts that average value (based on a rating grid) into an SCA performance rating. The result is 14 SCA performance ratings for each of the six Canadian nuclear power plants (NPPs).

For each NPP, its IPR is calculated by averaging the 14 SCA performance ratings for that NPP. The 14 ratings are mathematically combined, using weighting factors, to give a single, overall value for each NPP. This overall value is converted (based on the rating grid) to an overall IPR for the NPP.

Figure B.1 shows a graphical representation of the methodology to determine the IPR for each NPP. To simplify the process, only four specific areas are shown.

Figure B.1: Methodology for determining performance ratings



Steps shown, from top to bottom of figure B.1, are as follows:

Step 1: Identify the findings
The findings are identified for each specific area using information from a variety of sources, including inspections, field rounds, follow-ups on the licensee's progress on enforcement actions and desktop reviews. Findings are evaluated against a set of compliance criteria developed for each specific area that measures the degree of conformity with legal requirements.

Step 2: Assess the findings
CNSC staff evaluate the findings against the compliance criteria and assign an assessment: high, medium, low, negligible or positive. The assessment of the finding depends on the degree of negative impact on the effectiveness of the specific area, as defined here:

High – Licensee's measures are absent, completely inadequate or ineffective in meeting expectations or intent of the CNSC requirements and compliance expectations

Medium – Performance significantly deviated from expectations or from the intent or objectives of the CNSC requirements and compliance expectations

Low – Performance deviated from expectations or from the intent or objectives of the CNSC requirements and compliance expectations

Negligible – Performance insignificantly deviated from expectations or objectives of the CNSC requirements and compliance expectations

Compliant – Performance meets applicable CNSC requirements and compliance expectations

Step 3: Rate the specific area
CNSC staff consider the relevant findings for the specific area and determine the effectiveness using a CNSC-developed guideline. The findings are judged in the context of the performance objective for the relevant SCA. The assessed effectiveness categories for all findings of a specific area are converted into a performance rating of FS, SA, BE or UA:

FS – Safety and control measures were highly effective

SA – Safety and control measures were sufficiently effective

BE – Safety and control measures were marginally ineffective

UA – Safety and control measures were significantly ineffective

The performance rating definitions are applied for the rating of the specific areas, SCAs and IPRs.

Step 4: Rate the SCA
The specific area ratings are converted to an integer-based value. The individual specific area values are averaged to determine the overall SCA value, which is then converted to an SCA rating using the rating grid.

Step 5: Determine the integrated plant rating
The IPR is determined for each station by mathematically combining the values for all 14 SCA ratings for each station using weighting factors. The weighting factor for each SCA is determined by applying a risk-informed regulatory approach. The weighting factors provide a comparison of the relative risk of each SCA to overall plant safety. The calculated integrated value is converted to a performance rating using the rating grid.

Step 6: Determine the industry-average ratings

In addition, the industry-average ratings are determined by averaging the individual SCA and IPR ratings for all the stations. The SCA ratings for each NPP are used to determine the overall industry-average rating for each SCA, and the individual IPRs for each NPP are used to determine the average IPR for the overall industry.

Summary

The annual ratings are based on a methodology that employs, at its foundation, the significance of findings from inspections, field rounds, follow-ups on the licensee's progress on enforcement actions and desktop reviews conducted by CNSC staff. In addition, CNSC staff judge, using engineering and professional inputs, the effectiveness of the safety and control measures associated with the specific area to determine its rating.

Once all the specific area ratings have been determined, the SCA values are determined, using the integer-based values obtained from the conversion of their specific area ratings, and then converted to performance ratings. A similar process is used for the IPR using the SCA values.

A rating of full satisfactory is given if the findings demonstrate that the licensee has exceeded regulatory requirements and expectations. A satisfactory rating demonstrates that the licensee has met requirements. Ratings of below expectations and unacceptable indicate that the licensee is either marginally or significantly ineffective and that the licensee must take corrective action to improve the station's performance.

The performance rating methodology is based on a standardized approach that allows for consistency in the ratings across the nuclear power industry and between each annual NPP report.

The complete results for 2014 are shown in table 1 (in the executive summary), and the five-year trend is shown in table 16 (in section 4, the summary and conclusions section).

Appendix C: Research and development efforts in support of NPP regulation

This appendix provides information on research and development (R&D) activities being conducted by the industry and CNSC to enhance the safety of NPP operations.

C.1 Industry R&D activities

The CANDU Owners Group (COG) R&D program and the Industry Standard Toolset (IST) program are sponsored by three Canadian utilities - Bruce Power, OPG and NB Power, by the Romanian Societatea Nationala NuclearElectrica, and by Atomic Energy of Canada Limited. In 2012-13 the Korea Hydro and Nuclear Power Company sponsored the Safety and Licensing and IST R&D Programs. In 2012-13 Hydro Québec sponsored the Safety and Licensing R&D program. As specified in COG-12-9007, *COG R&D Program Overview: 2012/13* [56], the COG R&D and IST programs were established to support the safe, reliable and efficient operation of CANDU reactors, and are managed under five technical areas:

- fuel channels
- safety and licensing
- health, safety and the environment
- chemistry, materials and components
- IST

Throughout the year, the CNSC has reviewed submissions from the industry on the work plans, analysis methodology and results for these ongoing safety analysis programs.

Bruce Power and OPG are continuing a COG Joint R&D initiative - the Fuel Channel Life-Management Program. This program aims to develop the engineering methodologies and analytical tools necessary to continue demonstrating pressure tube fitness for service beyond the nominal design life of 210,000 equivalent full power hours.

C.2 CNSC R&D activities

CNSC regulatory research and evaluation

The CNSC has an active research program that focuses on regulatory issues; it is managed by the CNSC's Regulatory Research and Evaluation Division. Although the program includes all safety and control areas (SCAs), much of the effort is focused on safety analysis, physical design and fitness for service. The program also contributes to a number of international programs relevant to safety at NPPs. Examples of research activities that were active in 2014 and that are relevant to NPPs include the following:

Safety analysis

An important study, *Incorporating Ageing Effects into PSA Applications - Phase 3* was completed. The objective of this study is to allow the incorporation of aging effects into probability safety assessments (PSA).

The *Expert Review of Containment Radionuclide Behaviour*, an independent review of the Simple Model for Activity Removal and Transport (SMART) code, is currently in progress. The SMART code was developed by industry as an IST to model aerosol transport/behaviour and calculate public dose. The results of the study will be fed back to industry and perhaps lead to further improvements in the SMART-IST code.

A series of six *Contact Boiling Water Experiments* is in progress at the Canadian Nuclear Laboratories Ltd. (CNL), and is due to be completed by March 31, 2015. Experiments such as these have been carried

out before by industry. These new tests sponsored by the CNSC are intended to gather additional information. In particular, the CNSC needs to confirm the acceptance criterion for calandria tube strain and to obtain more data to support the correlation adopted for the calandria tube quench temperature.

A study entitled *Feasibility of uncertainty quantification framework with application to steady-state and transient reactor physics simulations* is in progress. The objective of this study is to evaluate the feasibility of a comprehensive framework for uncertainty characterization with application to CANDU core steady state and transient reactor physics simulations. The proposed framework would provide a rigorous basis for independent regulatory verification and enhance confidence in the uncertainties reported by industry.

Work has started on the "*Enhancement and maintenance of the NESTLE-CANDU computer code*". The Nodal Eigenvalue, Steady-state Le core Evaluator (NESTLE) code is used to study nuclear reactor kinetic effects and to simulate postulated transients and accidents (Note, the "Le" used in NESTLE acronym stands for "low enrichment"). NESTLE-CANDU is a variant of the code adapted to the CANDU reactor. The CNSC plans to incorporate the enhanced code in a formal framework for quantification of the uncertainties in predicted output parameters and a generalized procedure for coupled 3D neutronic thermal hydraulic simulations.

Physical design

The Seismic soil-structure interaction is a key issue in seismic analysis of nuclear facilities. It is important to find a balanced and comprehensive regulatory approach to this interaction. Two projects are under way. One is to develop better analytical tools to study the soil-structure interaction and the other is to develop a comprehensive analytical approach to the soil-structure interaction.

Modular, composite structures are part of new build designs, but currently there is no code provision or regulatory requirement for this type of structure. A three year research project entitled *Testing and Development of Regulatory Requirements for Steel Plate Concrete Structures* has been started to address this gap. It is expected to assist CNSC staff in developing regulatory requirements for composite structures.

Over the past three years, the CNSC has financially contributed to research conducted by the VTT Technical Research Centre of Finland for the development of design guidelines to protect NPPs against an aircraft crash.

Fitness for service

The CNSC has been researching steam generator tube vulnerability in both design-basis and beyond design-basis postulated accidents. Under a project entitled *Loading of Steam Generator Tubes during Main Steam Line Break,* a series of experiments using the CANDU designed steam generator experimental loop at McMaster University, has been carried out. The results are being analyzed to determine the dynamic tube loading of model steam generator tubes during a simulated main steam pipe rupture. This work may assist in evaluating the tube integrity safety margins during such a rupture.

The CNSC has embarked on research into *Piping Reliability Analysis Including Seismic Events* (PRAISE) methodology. The research project *Third party review of PRAISE-CANDU Probabilistic Fracture Mechanics code*, which addresses large-break loss-of-coolant accident (LBLOCA) safety margins is in progress and due for completion in 2015.

In considering the life extension of NPPs, there is a need to investigate the degradation mechanisms of existing structures. One of the most common concrete degradations is due to alkali aggregate reactions. The chemistry of the problem is relatively well understood; however, the potential mechanical

consequences are unknown. A three-year program, *Investigation of Consequences of Concrete Alkali Aggregate Reaction on Existing Nuclear Structures* is to be completed in late 2015.

The CNSC is also providing support for the International Atomic Energy Agency's International Generic Aging Lessons Learnt program. Through this cooperation we hope to benefit from extensive international experience on the aging of NPP components.

Radiation protection

Workers at CANDU facilities may potentially be exposed to aerosols contaminated by alpha emitting radionuclides during refit and maintenance operations. To address this issue, the CNSC has been funding a study entitled *Characterization of alpha radiation hazards: bio-solubility of radionuclides within CANDU reactor aerosols and implications for internal dosimetry*. A final report is due in 2015.

Exposure to tritium beta radiation is a potential hazard at CANDU facilities. However, there has been some debate as to the toxicity of this form of radiation. Work to establish the toxicity of tritium, which was started in 2011, is continuing and due to be completed in 2015. Since a need for research in this area was also identified in France, this work is being carried out in cooperation with the Institut de Radioprotection et de Sûreté Nucléaire.

The CNSC also supports the North American Technical Centre, which maintains the Information System of Occupational Exposure, a program in which Canadian NPP operators also participate.

Waste management

An increasing number of nuclear facilities are approaching their end of life and decommissioning is becoming a part of CNSC regulatory activities. To assist with future guidance in waste management, a study into the regulatory requirements in Canada and internationally regarding the decommissioning strategies for nuclear facilities was completed. This study included a literature review of international best practices and lessons learned from experience in decommissioning nuclear facilities elsewhere. The study identified some gaps in Canada's regulatory approach and made recommendations.

C.3 CANDU safety issues

Issues identified as CANDU safety issues (CSIs) should not be viewed as questioning the safety of operating reactors, which have attained a very high operational safety record. Rather, these are areas where uncertainty in knowledge exists, where the safety assessment has been based on conservative assumptions, and where regulatory decisions are required or need to be confirmed. Further work, including experimental research, may be required to more accurately determine the overall effect of an issue on the safe operation of the facility and to confirm that adequate safety margins exist. Note that some of the safety issues identified for CANDU reactors are common to other reactor types as well.

CSIs are categorized according to their safety significance categories as Category 1, 2 or 3, as shown in table C.1. Since January 2014, as shown in table C.2, five CSIs were re-categorized for all licensees to a lower safety significance category where appropriate measures are in place to maintain safety margins and CNSC staff will continue to monitor the licensees' management of these safety issues. Six CSIs requiring further experimental and/or analytical studies were pending resolution, as shown in tables C.3 and C.4. Three of these are related to large loss-of-coolant accidents (LLOCAs), while the other three belong to the group of non-LLOCA issues.

A CNSC/industry working group was set up to better define the issues pertaining to LBLOCA and to identify effective risk control measures (RCMs). The composite analytical approach (CAA) was chosen by the working group as the most practical from the stand point of implementation of RCMs. During the

continued development of the CAA approach, the licensing basis of existing CANDU reactors for the LBLOCA scenario will continue to be based on traditional conservative safety analysis for which acceptance criteria are clearly established.

Table C.1: Categories of CSI safety significance

Category	Meaning
1	The issue has been satisfactorily addressed in Canada.
2	The issue is a concern in Canada. However, the licensees have appropriate control measures in place to address the issue and to maintain safety margins.
3	The issue is a concern in Canada. Measures are in place to maintain safety margins, but further experiments and/or analyses are required to improve knowledge and understanding of the issue, and to confirm the adequacy of the measures.

Table C.2: Details of the CSIs re-categorized to Category 2 for all licensees

CSI	Title	Brief description	Notes	Re-categori-zation date
CI 1	Fuel channel integrity and effect on core internals	Safety-related functions in NPPs must remain effective throughout the life of the plant. Licensees are expected to have a program in place to prevent, detect and correct significant degradation, due to aging.	Licensees have adequate aging management programs, that reduce the consequences of aging on fuel channel integrity, while at the same time ensuring appropriate information is collected to confirm safety analysis assumptions.	May 2014
PF 19	Impact of aging on safe plant operation	Safety-related functions in NPPs must remain effective throughout the life of the plant. Licensees are expected to have a program in place to prevent, detect and correct significant degradation, due to aging.	Licensees have aging management programs, as well as fitness for service guidelines for life limiting components (e.g., feeders, pressure tubes, steam generator tubes). However, licensee programs for management of aging of other systems and components have not been systematically implemented.	December 2014

CSI	Title	Brief description	Notes	Re-categori-zation date
PF 20	Analysis methodology for neutron/regional overpower	The neutron/regional overpower trip setpoint function is designed to provide the reactor trip for the analyzed core states prior to fuel dryout. The trip setpoint is designed to prevent any potential fuel damage, primarily for slow-loss-of-regulation events.	Licensees provided physical, operational, and analytical measures, as well as relevant empirical evidence to enhance the confidence in the values of installed trip setpoints. Industry will continue to propose activities and time frame for developing and qualifying a practical method for derivation of neutron overpower protection trip setpoints.	February 2015
PSA 3	Design of the balance of plant – steam protection	This issue is applicable to the multi-unit stations where steam line breaks and feedwater line breaks are the largest contributors to core damage frequency and large-release frequency, accounting for about 70 percent to 80 percent. These line breaks could lead to widespread damage of many electrical cabinets and systems.	Licensees need to consider practicable measures to reduce the probability of consequential failures of support systems to control, cool, and contain (e.g., instrument air; electrical; heating, ventilation, and air conditioning; emergency forced air discharge system; and air cooling units).	October 2014
AA 3	Computer code and plant model validation	Specific validation programs have been established for industry standard computer codes that provide the necessary confidence in the safety analyses being performed.	Further work is required by industry to demonstrate that the existing code validation, in general, complies with the requirements that would allow a full qualification of these codes.	December 2014

Table C.3: Details of the Category 3 LLOCA CSIs

CSI	Title	Brief description	Notes	Target date
AA 9	Analysis for void reactivity coefficient	The LLOCA design-basis event is one of the most difficult accidents to analyze for a CANDU reactor because many aspects of the reactor behaviour under accident conditions are subject to some uncertainties.	The CNSC has developed an interim regulatory position, which is consistent with the risk control measures for CSIs and will remain in effect until the recommendations of the COG LLOCA working group are accepted by the CNSC and are fully implemented by the industry.	Continue to be developed by industry and under review by CNSC staff
PF 9	Fuel behaviour in high temperature transients			
PF 10	Fuel behaviour in power pulse transients			

Table C.4: Details of the Category 3 non-LLOCA CSIs

CSI	Title	Brief description	Notes	Target date
GL 3	Aging of equipment and structures	Safety-related functions in NPPs must remain effective throughout the life of the plant. Licensees are expected to have a program in place to prevent, detect and correct significant degradation, due to aging.	Licensees have aging management programs, as well as fitness for service guidelines for life limiting components (e.g., feeders, pressure tubes, steam generator tubes). However, licensee programs for management of aging of other systems and components have not been systematically implemented.	December 2015 (remains for Point Lepreau)
IH 6	Systematic assessment of high energy line break effects	Dynamic effects at high energy line breaks (e.g., pipe whip, jet impingement) can cause consequential failure of structures, systems and components and impair defence in depth.	The industry has to provide systematic analysis for protecting structures, systems and components from the effects of postulated pipe rupture.	December 2016 (remains for Pickering and Point Lepreau)
PF 18	Fuel bundle/ element behaviour under post dryout conditions	Specific models, such as fuel bundle deformation, require improvements to increase the confidence in the prediction of fuel element or fuel channel failure.	Licensees need to present experimental or analytical evidence to clarify the conditions for fuel deformation and for fuel sheath failure (e.g., dryout, fuel temperature, timing of failure), and for the consequential failure of fuel channels.	September 2015

Appendix D: Nuclear power plant collective effective doses

The following figures provide a five-year trend (from 2010 to 2014) of the annual collective effective doses (hereafter referred to as collective doses) to workers at each station. This information has been broken down to illustrate the operational state of the reactor when the dose was received (i.e., during operation or during outages/refurbishment), and the pathways of exposure (i.e., internal or external). Note that the figures provide the doses received by the same group of workers.

For each NPP:

- The first figure provides collective doses received during routine operations (day-to-day) versus doses received during outages/refurbishment. The collective dose shown for routine operations and outages/refurbishment includes both external and internal doses.
- The second figure provides the collective doses received from internal and external exposures for all radiological activities performed during the year.

The annual collective dose is the sum of the effective doses received by all the workers at that NPP in a year. It is measured in person-sievert (p-Sv). There is no regulatory dose limit for the annual collective dose; however, it is used internationally as a benchmark for assessing the reactor dose optimization performance.

For routine operations, variations between years are attributed, in part, to how long the plant operated during each year, as well as typical dose rates associated with the operation of the station.

The outage dose (planned and forced) includes the dose to all personnel, including contractors. Parameters affecting the dose include the number of outages for the year, the scope and duration of the work, the number of workers involved, and the dose rates associated with the outage work.

The external dose is the portion of the dose that was received from radiation sources outside the body, while the internal dose is the portion received from radioactive material taken into the body.

In 2014, approximately 89 percent of the collective dose was due to outage activities, and most of the radiation dose received by the workers came from external exposure. Approximately 11 percent of the dose received was from internal exposure, with tritium being the main contributor to the internal dose of exposed workers.

Note: Caution should be used when comparing the collective dose data between NPPs; such a comparison is not entirely appropriate, due to the differences between individual stations (such as design, age, operation and maintenance).

D.1 Annual collective doses at Bruce A and B

In 2014, Bruce Power was effective in controlling worker radiological exposures at Bruce A and B.

Bruce A

Figures D.1 to D.2 present the collective doses at Bruce A Units 1 to 4.

At Bruce A, all four units were operational with a total of 268 outage days. Outage activities at Bruce A accounted for approximately 90 percent of the total collective dose. Outage work included planned vault inspections, maintenance activities and repairs to a graylock leak on Unit 4.

Routine operations accounted for approximately 10 percent of the total Bruce A collective dose. Internal dose was approximately 7 percent of the total Bruce A collective dose. This is a slight increase from 2013 and was attributed to the leak rate in the Unit 4 primary heat transport system.

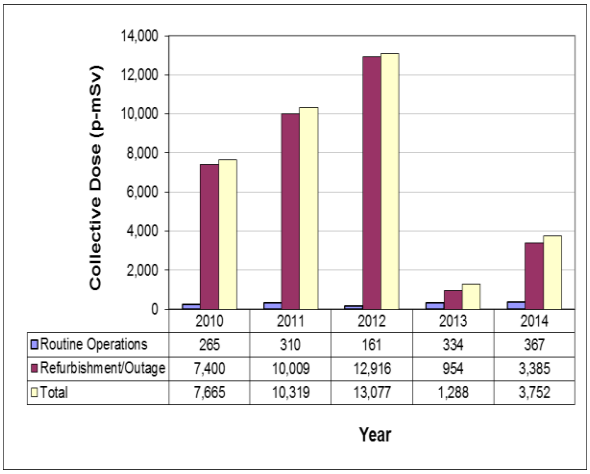
Bruce B

Figures D.3 and D.4 reflect the collective doses at Bruce B Units 5 to 8.

At Bruce B, all four units were operational with a total of 133 outage days. Outage activities at Bruce B accounted for approximately 89 percent of the total collective dose. Outage work included planned vault inspections and maintenance activities.

Routine operations accounted for 11 percent of the total station collective dose. Internal dose was approximately 4 percent of the total Bruce B collective dose, which the lowest in 6 years and largely attributed to a continued focus on reducing tritium exposures.

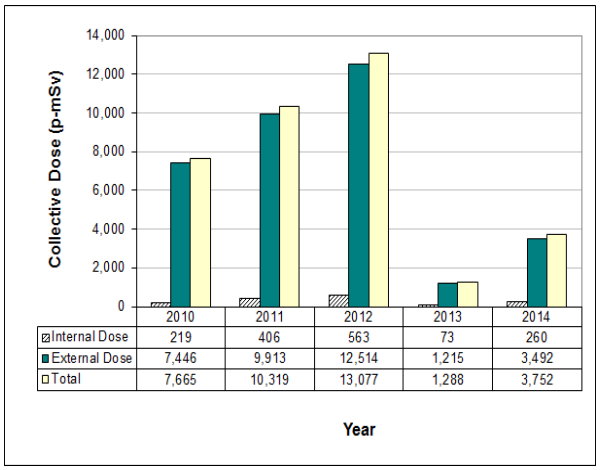
Figure D.1: Collective dose by operational state for Bruce A – Units 1 to 4*



	2010	2011	2012	2013	2014
Routine Operations	265	310	161	334	367
Refurbishment/Outage	7,400	10,009	12,916	954	3,385
Total	7,665	10,319	13,077	1,288	3,752

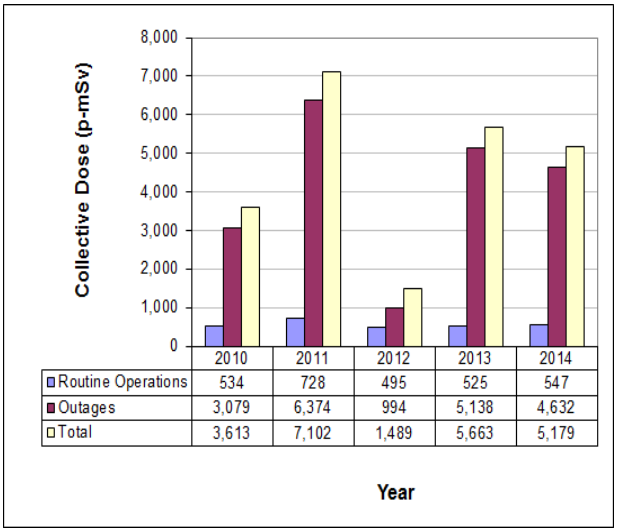
* Refurbishment was in progress 2010 to 2012.

Figure D.2: Collective dose from internal and external exposures for Bruce A – Units 1 to 4*



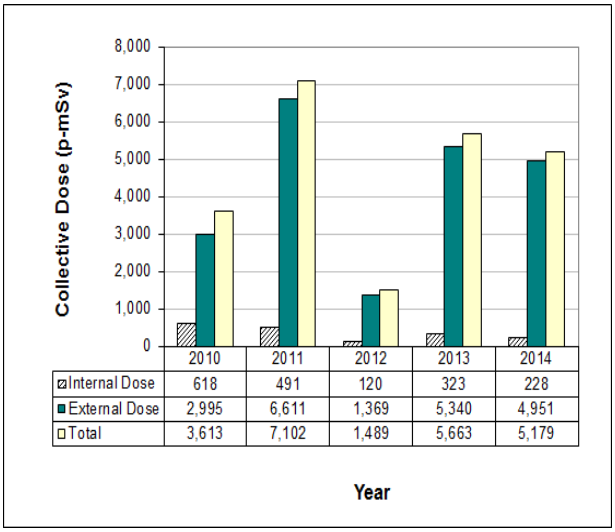
	2010	2011	2012	2013	2014
Internal Dose	219	406	563	73	260
External Dose	7,446	9,913	12,514	1,215	3,492
Total	7,665	10,319	13,077	1,288	3,752

Figure D.3: Collective dose by operational state for Bruce B – Units 5 to 8



	2010	2011	2012	2013	2014
Routine Operations	534	728	495	525	547
Outages	3,079	6,374	994	5,138	4,632
Total	3,613	7,102	1,489	5,663	5,179

Figure D.4: Collective dose from internal and external exposures for Bruce B – Units 5 to 8



	2010	2011	2012	2013	2014
Internal Dose	618	491	120	323	228
External Dose	2,995	6,611	1,369	5,340	4,951
Total	3,613	7,102	1,489	5,663	5,179

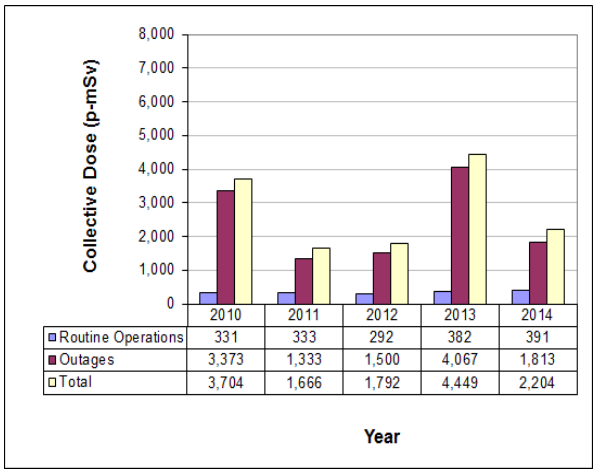
D.2 Annual collective doses at Darlington

In 2014, OPG was effective in controlling worker radiological exposures at Darlington. Figures D.5 and D.6 present the collective doses at Darlington Units 1 to 4.

At Darlington, all four units were operational with a total of 104 outage days. Outage activities at Darlington accounted for approximately 82 percent of the total collective dose. This was a decrease from 2013 and primarily due to fewer planned and forced outages resulting from Darlington's three year unit outage cycle.

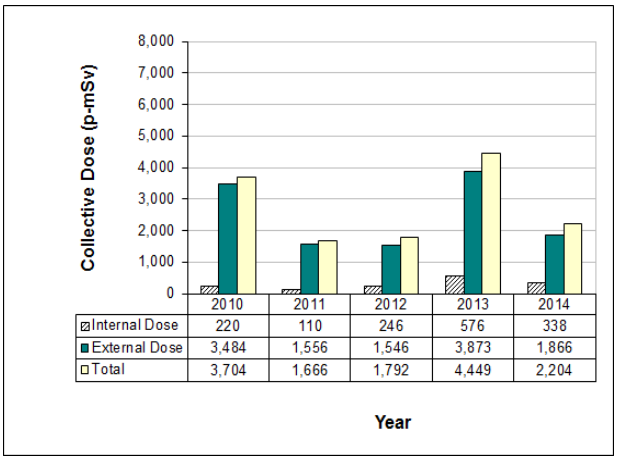
Routine operations accounted for approximately 18 percent of the total collective dose. Internal dose was approximately 15 percent of the total collective dose, a slight increase from 2013 and attributed to airborne tritium levels in containment.

Figure D.5: Collective dose by operational state for Darlington – Units 1 to 4



	2010	2011	2012	2013	2014
Routine Operations	331	333	292	382	391
Outages	3,373	1,333	1,500	4,067	1,813
Total	3,704	1,666	1,792	4,449	2,204

Figure D.6: Collective dose from internal and external exposures for Darlington – Units 1 to 4



	2010	2011	2012	2013	2014
Internal Dose	220	110	246	576	338
External Dose	3,484	1,556	1,546	3,873	1,866
Total	3,704	1,666	1,792	4,449	2,204

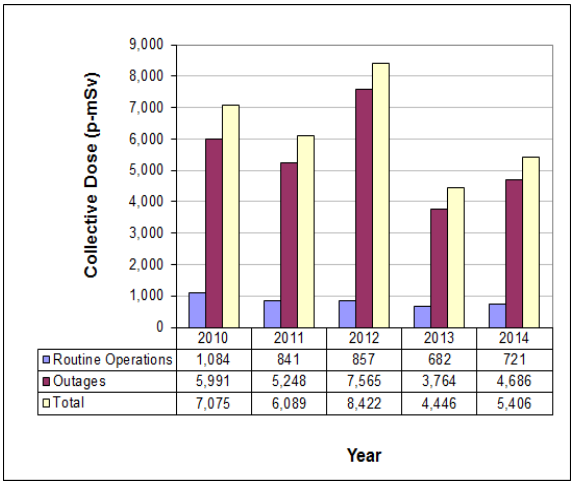
D.3 Annual collective doses at Pickering

In 2014, OPG was effective in controlling worker radiological exposures at Pickering. Figures D.7 and D.8 present the collective doses at Pickering Units 1 to 8

Pickering Units 1 and 4 and Units 5 to 8 were operational with a total of 405 outage days. Units 2 and 3 continued to remain in a safe storage state. Outage activities to perform maintenance and inspection activities accounted for approximately 87 percent of the total station collective dose.

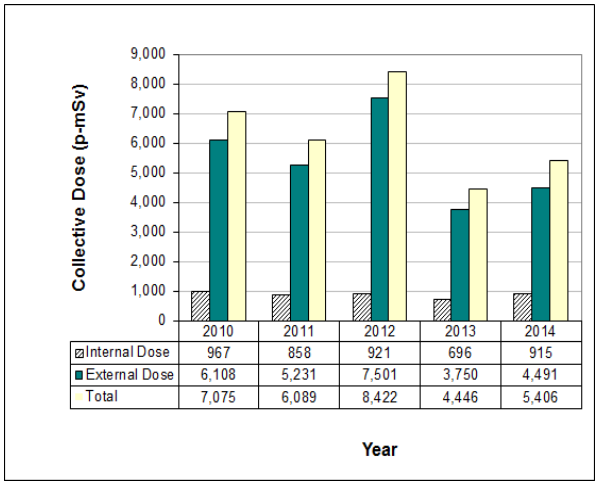
Routine operations accounted for approximately 13 percent of the total collective dose. Internal dose was approximately 17 percent of the total collective dose, a slight increase from 2013 and is partially attributed to outage extensions in Units 4 and 8 as well as airborne tritium levels in reactor buildings.

Figure D.7: Collective dose by operational state for Pickering – Units 1 to 8



	2010	2011	2012	2013	2014
Routine Operations	1,084	841	857	682	721
Outages	5,991	5,248	7,565	3,764	4,686
Total	7,075	6,089	8,422	4,446	5,406

Figure D.8: Collective dose from internal and external exposures for Pickering – Units 1 to 8



	2010	2011	2012	2013	2014
Internal Dose	967	858	921	696	915
External Dose	6,108	5,231	7,501	3,750	4,491
Total	7,075	6,089	8,422	4,446	5,406

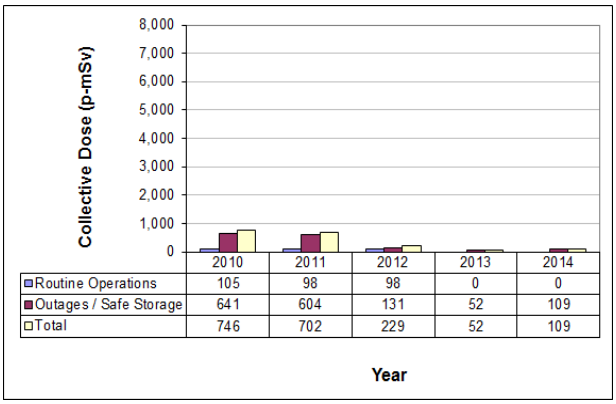
D.4 Annual collective doses at Gentilly-2

In 2014, Hydro-Québec was effective in controlling worker radiological exposures at Gentilly-2. Figures D.9 and D.10 present the collective doses at Gentilly-2.

At Gentilly-2, there was an increase in the collective doses due to radiological work activities associated with the transition from an operational unit to a safe storage state, which included draining and drying of the moderator and heat transport systems, installation of a liner in the irradiated fuel bay and transfer of purification resins and used fuel.

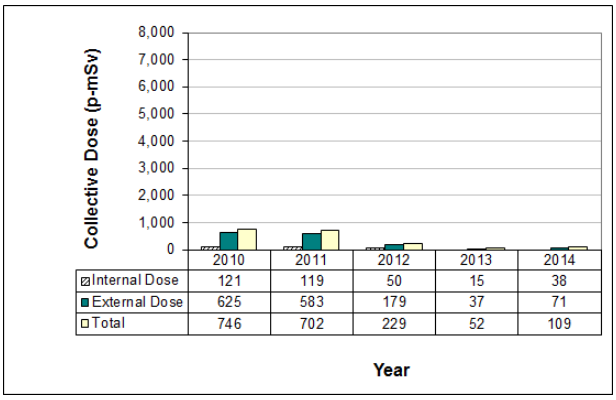
The entire station collective dose total is attributed to safe storage transition activities. Internal dose was approximately 35 percent of the total station collective dose, which is an increase from 2013 and attributable to the draining and drying of the moderator and heat transport systems.

Figure D.9: Collective dose by operational state for Gentilly-2



	2010	2011	2012	2013	2014
Routine Operations	105	98	98	0	0
Outages / Safe Storage	641	604	131	52	109
Total	746	702	229	52	109

Figure D.10: Collective dose from internal and external exposures for Gentilly-2



	2010	2011	2012	2013	2014
Internal Dose	121	119	50	15	38
External Dose	625	583	179	37	71
Total	746	702	229	52	109

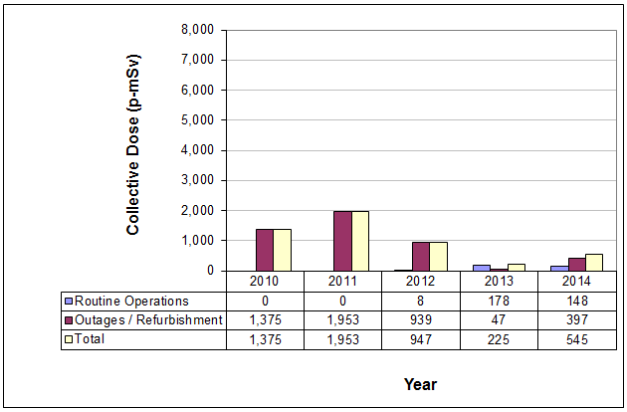
D.5 Annual collective doses at Point Lepreau

In 2014, NB Power was effective in controlling worker radiological exposures at Point Lepreau. Figures D.11 and D.12 present the collective doses at Point Lepreau.

Point Lepreau was operational with 66 outage days. Outage activities at Point Lepreau accounted for approximately 73 percent of the total station collective dose versus 21 percent in 2013 due to an increased number of outage days. Outage work included one planned outage and one forced outage.

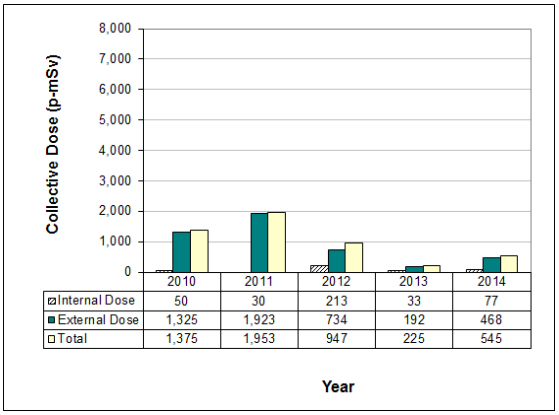
Routine operations accounted for approximately 27 percent of the total station collective dose. Internal dose was approximately 15 percent of the total station collective dose, which is the same as in 2013.

Figure D.11: Collective dose by operational state for Point Lepreau*



	2010	2011	2012	2013	2014
Routine Operations	0	0	8	178	148
Outages / Refurbishment	1,375	1,953	939	47	397
Total	1,375	1,953	947	225	545

Figure D.12: Collective dose from internal and external exposures for Point Lepreau*



	2010	2011	2012	2013	2014
Internal Dose	50	30	213	33	77
External Dose	1,325	1,923	734	192	468
Total	1,375	1,953	947	225	545

* Refurbishment was in progress 2010 to 2012.

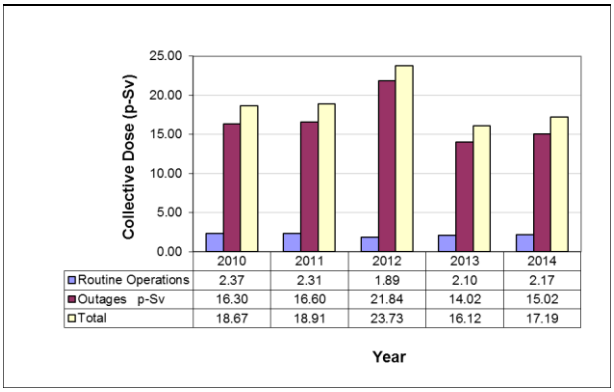
D.6 Average collective doses for all Canadian NPPs in operation

Nineteen reactor units were operational in 2014.

As shown in figures D.13 and D.14, the total collective doses and the average collective dose per unit at operating Canadian NPPs increased slightly (approximately 6 percent) from 2013 however trends remain steady since 2010. This increase reflects the type and scope of work being performed at each facility.

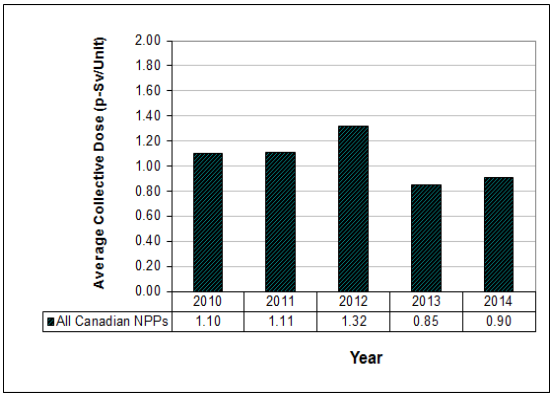
As was the case in 2013, the 2014 annual collective dose per unit of 0.90 p-Sv is below the historical low values of approximately 1 p-Sv per unit observed from 2010 to 2013. The implementation of as low as reasonably achievable (ALARA) initiatives such as improved shielding, source term reduction activities and improved work planning have contributed to an overall reduction in collective dose per unit across the Canadian industry.

Figure D.13: Collective dose by operational state for operating Canadian NPPs, from 2010 to 2014



	2010	2011	2012	2013	2014
Routine Operations	2.37	2.31	1.89	2.10	2.17
Outages p-Sv	16.30	16.60	21.84	14.02	15.02
Total	18.67	18.91	23.73	16.12	17.19

Figure D.14: Average collective dose for operating Canadian NPPs, from 2010 to 2014



	2010	2011	2012	2013	2014
All Canadian NPPs	1.10	1.11	1.32	0.85	0.90

Appendix E: Derived release limits for Canadian nuclear power plants

For the calculation of radiation doses received by members of the public from routine releases at nuclear power plants (NPPs), a quantity known as a derived release limit (DRL) is used; this value is based on the regulatory dose limit of 1 millisievert per year (1 mSv/y).

DRLs are required because nuclear materials released into the environment (through gaseous and liquid effluents from NPPs) can expose members of the public to low radiation doses via external and internal pathways. External exposure occurs from direct contact with radionuclide-contaminated ground surfaces, or by immersion into contaminated water and air clouds; internal exposure occurs through the intake of radionuclides by inhalation (breathing) and/or intake of contaminated foods. Such radiation doses to members of the public are subject to statutory limits, which are set out in sections 13 and 14 of the *Radiation Protection Regulations*.

DRL calculations are based on a method recommended by the Canadian Standards Association (CSA) in the standard published as CSA-N288.1-08, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities* [57].

The DRLs for gaseous and liquid effluents from Canadian NPPs can be found in tables E.1 and E.2. The units of measurement for noble gases are either terabecquerel for individual radionuclides or terabecquerel-million electron volts for mixtures of radionuclides.

Table E.1: DRLs for gaseous effluents

Nuclear power plant	Tritium [a] (TBq)	Iodine-131 (TBq)	Noble gases (TBq)	Particulates (TBq)	Carbon-14 (TBq)
Bruce A[i]	1.98×10^5	1.14	1.12×10^5 [c]	1.73[d]	6.34×10^2
Bruce B[ii]	3.16×10^5	1.35	2.17×10^5 [c]	3.61[d]	7.56×10^2
Darlington[iii]	5.9×10^4 (HTO) 8.5×10^5 (HT) [b]	1.4	4.5×10^4 [c]	0.67	3.5×10^2
Pickering 1, 4[iv]	1.2×10^5	9.8	3.2×10^4 [c]	0.49	2.2×10^3
Pickering 5–8[v]	1.9×10^5	8.9	4.7×10^4 [c]	0.72	2.0×10^3
Gentilly-2[vi]	8.6×10^4	0.3	7.7×10^4 [c]	1.2	2.0×10^2
Point Lepreau[vii]	$2.8x\ 10^5$	6.0×10^1	1.2×10^5	1.8	6.8×10^3

a. Tritium oxide (HTO)
b. For elemental tritium (HT) resulting from operations at the tritium removal facility at Darlington
c. Terabecquerel-million electron volts
d. Particulate (beta/gamma)

Table E.2: DRLs for liquid effluents

Nuclear power plant	Tritium [a] (TBq)	Gross beta-gamma activity (TBq)	Carbon-14 (TBq)
Bruce A[i]	2.3×10^{6}	4.58×10^{1}	1.03×10^{3}
Bruce B[ii]	1.84×10^{6}	5.17×10^{1}	1.16×10^{3}
Darlington[iii]	5.3×10^{6}	7.1×10^{1}	9.7×10^{2}
Pickering 1, 4[iv]	3.7×10^{5}	1.7	3.2×10^{1}
Pickering 5–8[v]	7.0×10^{5}	3.2	6.0×10^{1}
Gentilly-2[vi]	1.44×10^{7}	2.23×10^{1}	3.06×10^{2}
Point Lepreau[vii]	4.6×10^{7}	3.9×10^{1}	3.3×10^{2}

a. Tritium oxide (HTO)

i Canadian Nuclear Safety Commission, *Nuclear Power Reactor Operating Licence Bruce Nuclear Generating Station A* (PROL 15.00/2015), Appendix C: Derived Release Limits, May 2014.

ii Canadian Nuclear Safety Commission, *Nuclear Power Reactor Operating Licence Bruce Nuclear Generating Station B* (PROL 16.00/2015), Appendix C: Derived Release Limits, May 2014.

iii Ontario Power Generation, *Derived Release Limits for Darlington Nuclear Generating Station*, NK38-REP-03482-10001-R01 (as referenced in LCH-DNGS-R000 for PROL 13.00/2014), September 2011.

iv Canadian Nuclear Safety Commission, *Licence Conditions Handbook* (LCH-PNGS-R000 for PROL 48.00/2018), September 2013.

v Canadian Nuclear Safety Commission, *Licence Conditions Handbook* (LCH-PNGS-R000 for PROL 48.00/2018), September 2013.

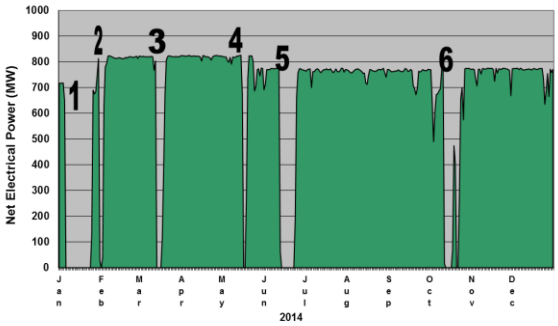
vi Canadian Nuclear Safety Commission, *Licence Conditions Handbook* (MCP-GENTILLY-2-R003 for PERP 10.02/2016), July 2014.

vii Canadian Nuclear Safety Commission, *Nuclear Power Reactor Operating Licence Point Lepreau Nuclear Generating Station* (PROL 17.02/2017), Appendix A.3: Derived Release Limits, September 2013.

Appendix F: 2014 power history graphs for Canadian reactor units

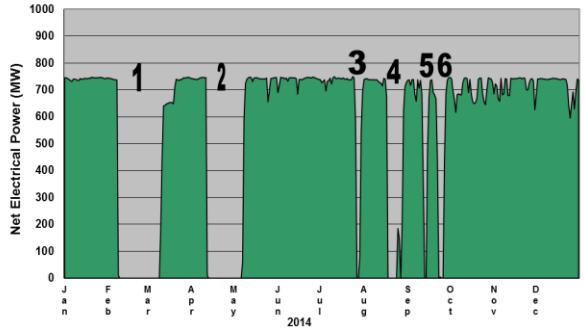
The 2014 power history graphs for licensed Canadian nuclear power reactor units are shown below in figures F.1 to F.20. The graphs show the occurrences of outages (forced or planned) and the associated power reductions during the year. A brief explanation of the power reductions is given for each graph.

Figure F.1: Power history for Bruce A, Unit 1



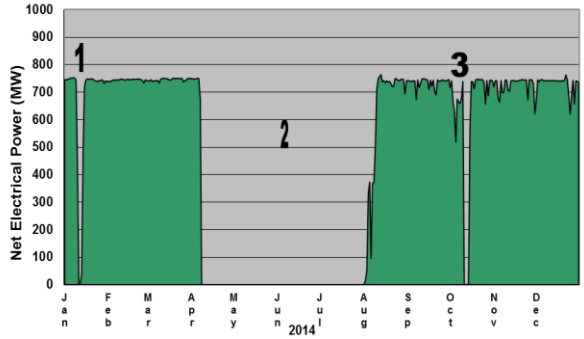
1 Forced outage to repair a shutdown system poison injection valve
2 Forced outage due to fault in the electrical supply transformer
3 Forced outage due to turbine fault
4 Outage to reconnect the electrical supply transformer
5 Forced outage due to problem with generator hydrogen purity
6 Forced outage to repair a shutdown system poison injection valve followed by a fault in a turbine governor system

Figure F.2: Power history for Bruce A, Unit 2



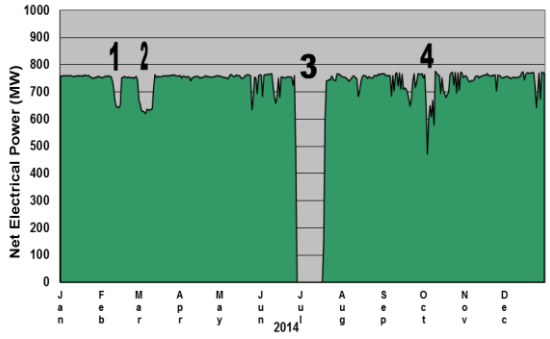
1 Forced outage to repair a generator hydrogen leak
2 Forced outage to repair a generator hydrogen leak
3 Forced outage due to a problem in the switchyard
4 Forced outage due to a pump fault in the heat transport system
5 Forced outage due to a problem in the electrical switchyard
6 Forced outage due to a problem in the electrical switchyard

Figure F.3: Power history for Bruce A, Unit 3



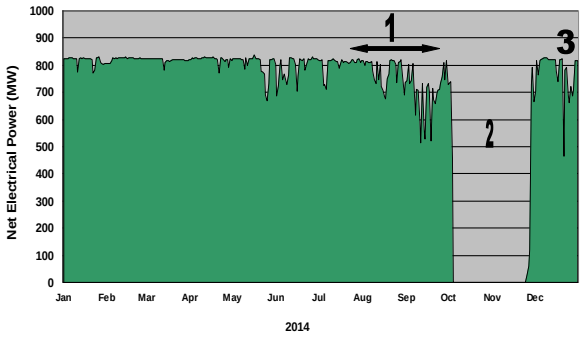
1 Forced outage to repair a steam leak
2 Planned outage for routine maintenance, component inspections and turbine rotor replacement
3 Forced outage to repair a service water leak

Figure F.4: Power history for Bruce A, Unit 4



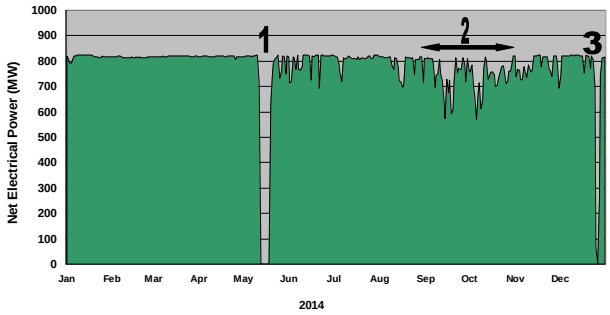
1 Reduction to repair a condenser tube leak
2 Reduction to repair a condenser tube leak
3 Forced outage due to a problem in the electrical switchyard
4 Reductions due to external electrical grid events

Figure F.5: Power history for Bruce B, Unit 5



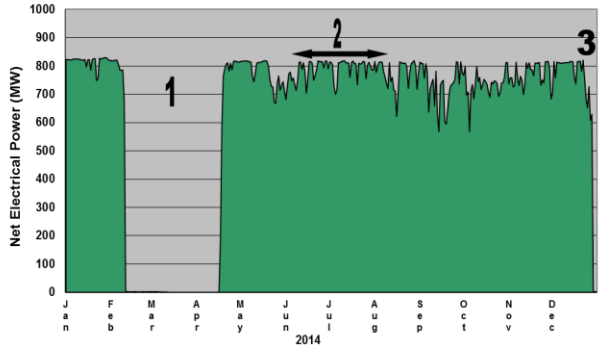
1 Reductions due to external electrical grid events
2 Planned outage for routine maintenance, cobalt harvest and component inspections
3 Reductions due to external electrical grid events

Figure F.6: Power history for Bruce B, Unit 6



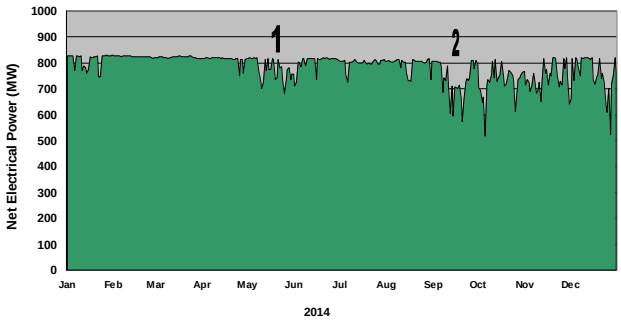
1 Forced outage to repair a maintenance cooling valve
2 Reductions due to external electrical grid events
3 Outage due to external electrical grid event

Figure F.7: Power history for Bruce B, Unit 7



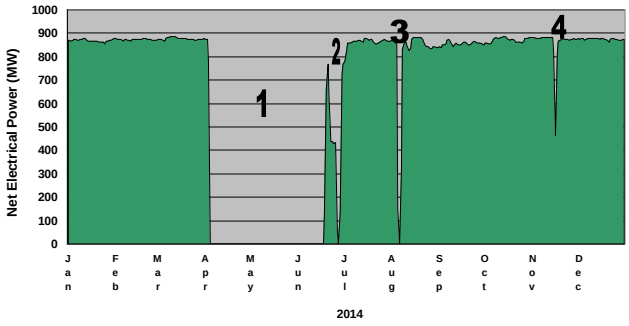
1 Planned outage for routine maintenance, cobalt harvest and component inspections
2 Reductions due to external electrical grid events
3 Outage due to failed pressure release device in the moderator system

Figure F.8: Power history for Bruce B, Unit 8



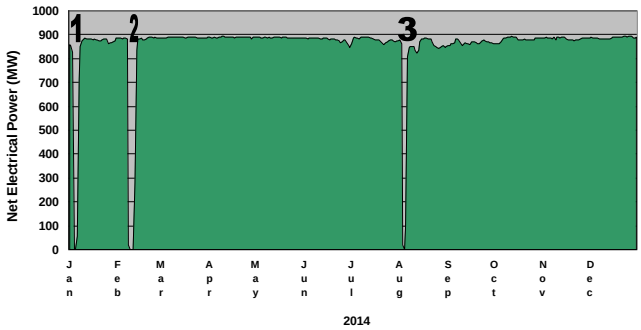
1 Reductions due to external electrical grid events
2 Reductions due to external electrical grid events

Figure F.9: Power history for Darlington, Unit 1



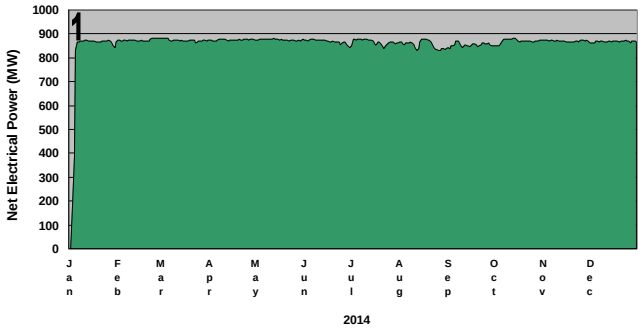
1 Planned outage for routine maintenance and component inspections
2 Forced outage due to a problem with turbine output
3 Forced outage to repair a heavy water leak in the reactor vault
4 Reduction for maintenance of reactor power monitoring computers

Figure F.10: Power history for Darlington, Unit 2



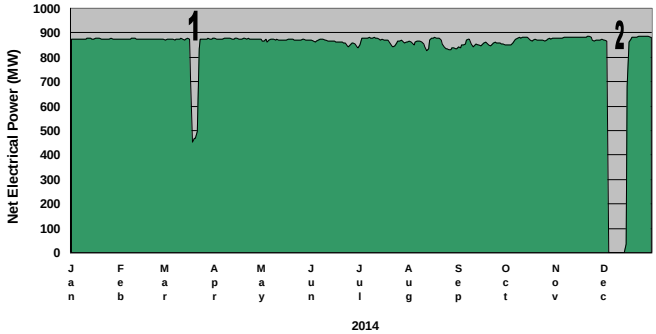
1 Forced outage for testing of reactor shutdown system
2 Forced outage due to a problem with air temperature in reactor vault
3 Forced outage to repair the station electrical output transformer

Figure F.11: Power history for Darlington, Unit 3



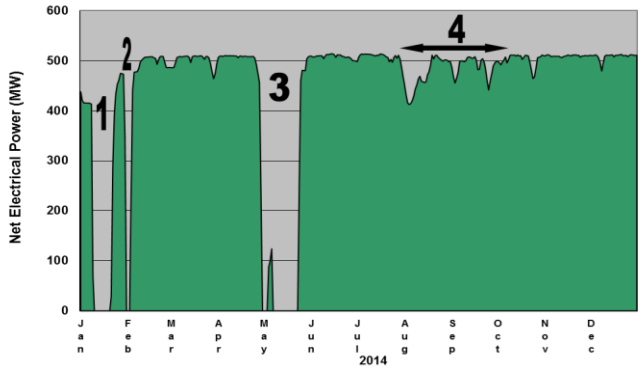
1 Forced outage (started in Dec. 2013) to repair feedwater line

Figure F.12: Power history for Darlington, Unit 4



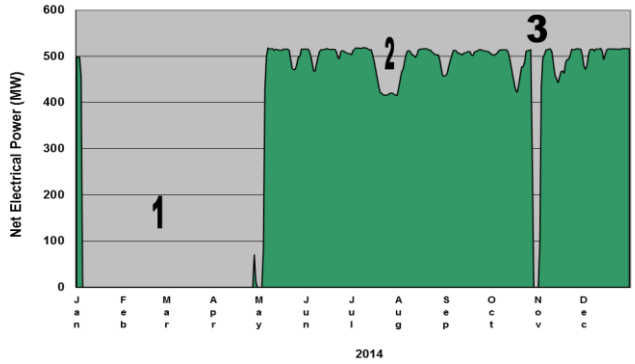
1 Reduction due to a problem with availability of fuelling machine
2 Forced outage to repair a heavy water leak in the reactor vault

Figure F.13: Power history for Pickering, Unit 1



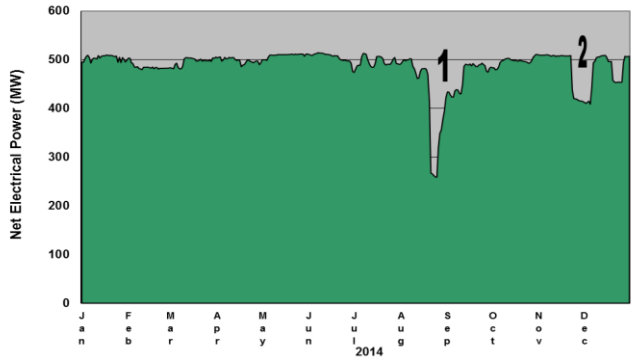
1 Forced outage to repair fuelling machine conveyor cable
2 Forced outage due to a problem with freezing in the lake water intake
3 Two forced outages (April 29 and May 6, 2014) to repair helium supply and reactor power control equipment
4 Reduction due to a problem with fuelling machine availability

Figure F.14: Power history for Pickering, Unit 4



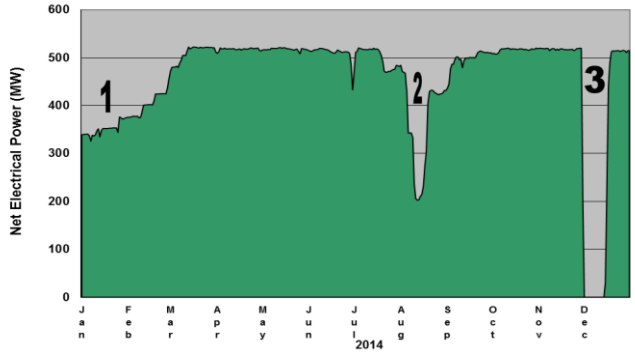
1 Planned outage for routine maintenance and component inspections
2 Reduction due to a problem with fuelling machine availability
3 Forced outage due to unnecessary trip on the shutdown system

Figure F.15: Power history for Pickering, Unit 5



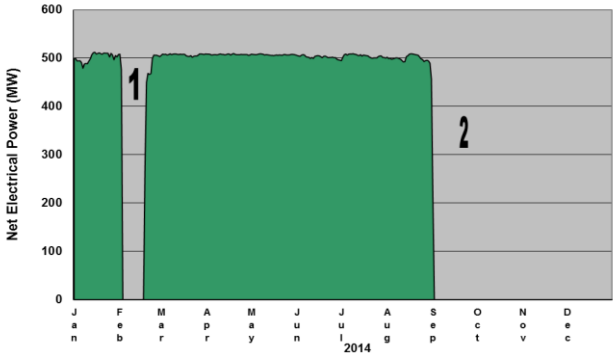
1 Reduction due to a problem with fuelling machine availability
2 Reduction to repair a leak in a reheat pump

Figure F.16: Power history for Pickering, Unit 6



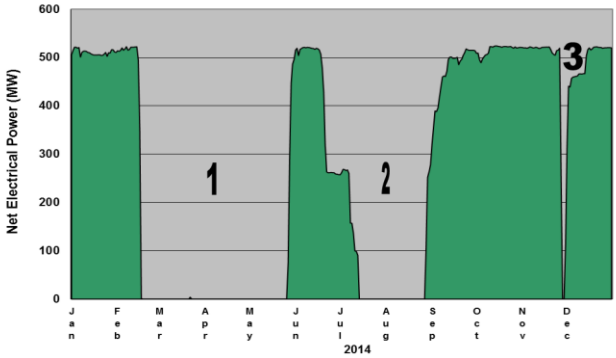
1 Continued return to service following shutdown in previous calendar year
2 Reduction due to a problem with fuelling machine availability
3 Forced outage for maintenance of shutdown cooling system

Figure F.17: Power history for Pickering, Unit 7



1 Forced outage to repair a heat transport pump leak
2 Planned outage for routine maintenance and component inspections

Figure F.18: Power history for Pickering, Unit 8



1 Planned outage for routine maintenance and component inspections
2 Reduction extended to a forced outage for maintenance of fuelling machine
3 Forced outage due to a problem with reactor power monitoring computers

Figure F.19: Power history for Gentilly-2

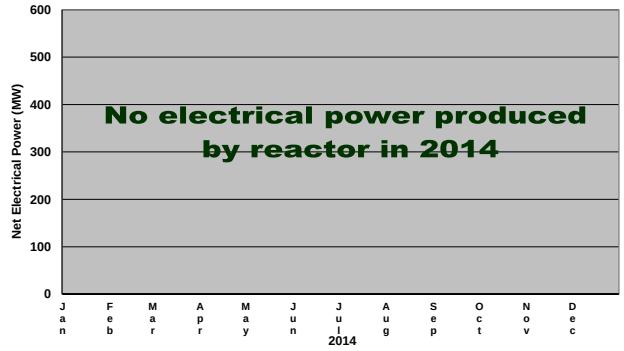
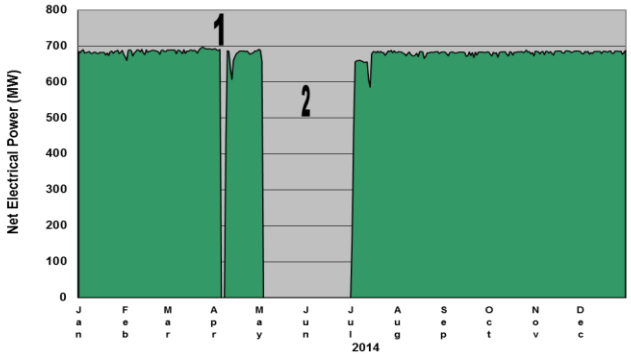


Figure F.20: Power history for Point Lepreau



1 Forced outage due to a problem with the turbine control oil system
2 Planned outage for routine maintenance, component inspections and maintenance of station transformers

Appendix G: Status of Fukushima action items applicable to nuclear power plants

Table G.1 provides the status of the Fukushima action items (FAIs) that apply to each station as of May 1, 2015, followed by a description of each FAI. Each nuclear power plant (NPP) FAI will be closed only once all the stations have produced the required deliverable and it has been accepted by the CNSC. In some cases, station-specific FAIs may then be opened to track the performance of further deliverables.

A complete description of these NPP FAIs can be found in the *CNSC Integrated Action Plan* [2].

Table G.1: Status of Fukushima action items (FAIs) applicable to NPPs (as of May 1, 2015)

	Darlington				Pickering 1, 4				Pickering 5-8				Bruce A				Bruce B				Point Lepreau				Gentilly-2			
FAI*	'12	'13	'14	'15	'12	'13	'14	'15	'12	'13	'14	'15	'12	'13	'14	'15	'12	'13	'14	'15	'12	'13	'14	'15	'12	'13	'14	'15
AI 1.1.1	√				√				√				√				√				√				√			
AI 1.1.2	√				√				√				√				√				√				√			
AI 1.2.1		√				NA				√				√				√				√				√		
AI 1.2.2		√				NA				√				√				√				√				√		
AI 1.2.3		√				NA				√				√				√				√				√		
AI 1.3.1				√				√				√				√				√				√				S
AI 1.3.2				√				√				√				A				A				√				S
AI 1.4.1	√				√				√				√				√				√				√			
AI 1.5.1		√				√				√				√				√				√				√		
AI 1.6.1		√				√				√				√				√				√				√		
AI 1.6.2		NA				√				√				√				√				√				√		
AI 1.7.1		√				√				√				√				√				√				√		
AI 1.8.1		√				√				√				√				√				√				S		
AI 1.9.1			√				√				√				√				√				√				√	
AI 1.10.1	√				√				√				√				√				√				S			
AI 1.10.2	√				√				√				√				√				√				S			
AI 1.11.1	√				√				√				√				√				√				S			
AI 2.1.1		√				√				√				√				√					A			√		
AI 2.1.2		√				√				√				√				√					A			√		
AI 2.2.1		√				√				√				√				√				√				S		
AI 3.1.1		√				√				√				√				√				√				S		
AI 3.1.2		√				√				√				√				√				NA				NA		
AI 3.1.3		√				√				√				√				√				√				√		
AI 3.1.4		√				√				√				√				√				√				S		
AI 3.2.1	√				√				√				√				√				NA				NA			
AI 3.2.2	√				√				√				√				√				NA				NA			
AI 4.1.1	√				√				√				√				√				√				√			
AI 4.1.2	√				√				√				√				√				√				√			
AI 4.2.1	√				√				√				√				√				√				√			
AI 5.1.1	√				√				√				√				√				√				S			
AI 5.1.2	√				√				√				√				√				√				S			
AI 5.2.1	√				√				√				√				√				NA				√			
AI 5.2.2	√				√				√				√				√				NA				S			
AI 5.2.3	√				√				√				√				√				NA				√			
AI 5.3.1	√				√				√				√				√				√				S			
AI 5.4.1	NA				NA				NA				NA				NA				√				S			
Total	18	15	1	2	18	15	1	2	18	15	1	2	18	15	1	2	18	15	1	2	18	13	3	2	18	15	1	2
Closed/NA	18	15	1	2	18	15	1	2	18	15	1	2	18	15	1	1	18	15	1	1	18	13	1	2	18	15	1	2
Active	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2	0	0	0	0	0

* A description of each FAI follows on the next page

S – Suspended for Gentilly-2

NA – Not applicable

√ Closed

A Active submissions under CNSC review

Table G.2: Description of Fukushima action items and target completion dates

FAI #	Fukushima action item description
1.1.1	An updated evaluation of the capability of bleed condenser/degasser condenser relief valves providing additional evidence that the valves have sufficient capacity. December 2012.
1.1.2	If required, a plan and schedule either for confirmatory testing of installation or provision for additional relief capacity. December 2012.
1.2.1	An assessment of the capability of shield tank/calandria vault relief. December 2013.
1.2.2	If relief capacity is inadequate, an assessment of the benefit available from adequate relief capacity and the practicability of providing additional relief. December 2013.
1.2.3	If additional relief is beneficial and practicable, a plan and schedule for provision of additional relief. December 2013.
1.3.1	Assessments of the adequacy of existing means to protect containment integrity and prevent uncontrolled releases in beyond-design-basis accidents, including severe accidents. December 2015.
1.3.2	Where the existing means to protect containment integrity and prevent uncontrolled releases of radioactive products in beyond-design-basis accidents, including severe accidents, are found inadequate, a plan and schedule for design enhancements to control long-term radiological releases and, to the extent practicable, unfiltered releases. December 2015.
1.4.1	A plan and schedule for the installation of passive autocatalytic recombiners as quickly as possible. December 2012.
1.5.1	An evaluation of the potential for hydrogen generation in the irradiated fuel bay (IFB) area and the need for hydrogen mitigation. December 2013.
1.6.1	An evaluation of the structural response of the IFB structure to temperatures in excess of the design temperature, including an assessment of the maximum credible leak rate following any predicted structural damage. December 2013.
1.6.2	A plan and schedule for deployment of any additional mitigating measures shown to be necessary by the evaluation of structural integrity. December 2013.
1.7.1	A plan and schedule for optimizing existing provisions (to provide coolant makeup to primary heat transport system, steam generators, moderator, etc.) and putting in place additional coolant makeup provisions, and supporting analyses. December 2013.
1.8.1	A detailed plan and schedule for performing assessments of equipment survivability, and a plan and schedule for equipment upgrades, where appropriate, based on the assessment. December 2013.
1.9.1	An evaluation of the habitability of control facilities under conditions arising from beyond-design-basis and severe accidents. Where applicable, detailed plan and schedule for control facilities upgrades. December 2014.
1.10.1	An evaluation of the requirements and capabilities for electrical power for key instrumentation and control. The evaluation should identify practicable upgrades that would extend the availability of key instrumentation and control, if needed. December 2012.
1.10.2	A plan and schedule for deployment of identified upgrades. A target of eight hours without the need for offsite support should be used. December 2012.
1.11.1	A plan and schedule for procurement (of emergency equipment and other resources that could be stored offsite). December 2012.
2.1.1	Re-evaluation, using modern calculations and state-of-the-art methods, of the site-specific

FAI #	Fukushima action item description
	magnitudes of each external event to which the plant may be susceptible. December 2013.
2.1.2	Evaluate if the current, site-specific design protection for each external event assessed in 2.1.1, above, is sufficient. If gaps are identified, a corrective plan should be proposed. December 2013.
2.2.1	Site-specific implementation plans for regulatory document RD-310 *Safety Analysis for Nuclear Power Plants*. December 2013.
3.1.1	Where severe accident management guidelines (SAMGs) have not been developed/finalized or fully implemented, provide plans and schedules for completion. December 2013.
3.1.2	For multi-unit stations, provide plans and schedules for the inclusion of multi-unit events in SAMGs. December 2013.
3.1.3	For all stations, plans and schedules for the inclusion of IFB events in station operating documentation where appropriate. December 2013.
3.1.4	Demonstration of effectiveness of SAMGs via table-top exercise and drills. December 2013.
3.2.1	An evaluation of the adequacy of existing modelling of severe accidents in multi-unit stations. The evaluation should provide a functional specification of any necessary improved models. December 2012.
3.2.2	A plan and schedule for the development of improved modelling, including any necessary experimental support. December 2012.
4.1.1	An evaluation of the adequacy of existing emergency plans and programs. December 2012.
4.1.2	A plan and schedule to address any gaps identified in the evaluation. December 2012.
4.2.1	A plan and schedule for the development of an improved exercise program. December 2012.
5.1.1	An evaluation of the adequacy of backup power for emergency facilities and equipment. December 2012.
5.1.2	A plan and schedule to address any gaps identified. December 2012.
5.2.1	Identify the external support and resources that may be required during an emergency. December 2012.
5.2.2	Identify the external support and resource agreements that have been formalized and documented. December 2012.
5.2.3	Confirm if any undocumented arrangements can be formalized. December 2012.
5.3.1	Provide a project plan and installation schedule. December 2012.
5.4.1	Develop source term and dose modelling tools specific to each NPP. December 2012.

Appendix H: Licence amendments and licence conditions handbook revisions

The tables given in this appendix give the details of the licence amendments and licence conditions handbook (LCH) revisions for NPP licensees during the period of January 1, 2014 to April 30, 2015.

1. Bruce A and B

Table H.1: Amendments to the Bruce A and Bruce B power reactor operating licences

Power reactor operating licence # - Effective date	Amendment applications
15.01/2014, January 23, 2014, Bruce A	• Added RD/GD-99.3, *Public Information and Disclosure* [3], and updated Bruce Power's derived release limits (DRLs).
16.01/2014, January 23, 2014, Bruce B	• Added RD/GD-99.3, *Public Information and Disclosure* [3], and updated Bruce Power's derived release limits (DRLs).
15.00/2015 May 1, 2014 Bruce A	• Changed licence number to PROL 15.00/2015 with an effective date of May 1, 2014. • Amended Licence period with validity from November 1, 2009 to May 31, 2015.
16.00/2015 May 1, 2014 Bruce B	• Changed licence number to PROL 16.00/2015 with an effective date of May 1, 2014. • Amended Licence period with validity from November 1, 2009 to May 31, 2015.
15.01/2015 January 1, 2015 Bruce A	• Changed licence condition 1.7 text to set new reporting requirements in accordance with CNSC REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* [6], and implementation and maintenance a public information and disclosure program in accordance with CNSC RD/GD-99.3, *Public Information and Disclosure* [3].
16.01/2015 January 1, 2015 Bruce B	• Changed licence condition 1.7 text to set new reporting requirements in accordance with CNSC REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* [6], and implementation and maintenance a public information and disclosure program in accordance with CNSC RD/GD-99.3, *Public Information and Disclosure* [3].

Table H.2: Significant changes to the LCHs for Bruce A and Bruce B

Section	Description of change	Revision type	LCH
4.3	Modified the compliance verification criteria (CVC) text of section 4.3 to the revised dates for the station containment outage and vacuum building outage for Bruce A and Bruce B.	Administrative	Bruce A and B
4.3	Changed the CVC text of section 4.3 regarding fuel channel operation beyond 210,000 equivalent full power hours (EFPH) in the Bruce A and B LCHs. Operation of any unit beyond 210,000 EFPH is not permitted unless approved by the Commission.	Administrative	Bruce A and B
7.1	Added the CVC text of section 7.1 regarding pre-distribution of potassium iodide (KI) pills	Administrative	Bruce A and B

2. Darlington

Table H.3: Amendments to the Darlington power reactor operating licence

Power reactor operating licence # - Effective date	Amendment applications
PROL 13.00/2015 – March 1, 2013	Amended the licence period with validity from March 1, 2013 to December 31, 2015.
PROL 13.01/2015 – January 1, 2015	Amended the licence as follows: • Incorporated references to REGDOC-3.1.1 [6], REGDOC-2.4.1 [16], REGDOC-2.4.2 [18] and RD-336 [39]. • Withdrew reference to S-99 [7] and Licence Condition 1.3.

Table H.4: Significant changes to the LCH for Darlington

Section	Description of change	Revision type
All	Updated the LCH to refer to the current power reactor operating licence (PROL 13.00/2015).	Administrative
3.2	Changed the minimum shift complement table in section 3.2 to align with revision R013 of OPG document D-PROC-OP-009.	Technical
5.1	Updated the LCH to include REGDOC-2.4.1 [16] and REGDOC-2.4.2 [18].	Technical
7.1	Inclusion of clause regarding demonstration of fitness for service of pressure tubes beyond 210,000 EFPH.	Technical
11.1	Added text to compliance verification criteria (CVC) and Recommendations and Guidance related to iodine thyroid blocking agents.	Technical
14.1	Updated LCH to include RD-336 [39].	Technical
Several	Updated LCH to replace reference to S-99 [7] with REGDOC-3.1.1 [6].	Technical

3. Pickering

Table H.5: Amendments to the Pickering power reactor operating licence

Power reactor operating licence # - Effective date	Amendment applications
48.01/2018 – January 1, 2015	Amended the licence as follows: • Replaced references to S-99, *Reporting Requirements for Operating Nuclear Power Plants* [7], with REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* [6]. • Added RD-336, *Accounting and Reporting of Nuclear Material* [39]. • Cancelled non-applicable licence conditions.

Table H.6: Significant changes to the LCH for Pickering

Section	Description of change	Revision type
11.1	Added new CVC for iodine thyroid blocking agents.	Administrative
4.1, 5.1, Appendix D	Changed title for a licensee document.	Administrative
1.2, 1.3, 2.1, 3.1, 4.2, 4.3, 5.1, 6.2, 7.1, 10.1, 12.2, 14.1, Appendices A, B and C	• Licence amendment to replace S-99 [7] with REGDOC-3.1.1 [6]. • Updated numerous sections of LCH to reflect the change described above. • Changed to reflect cancellation of unnecessary licence condition. • Added of RD-336 [39].	Administrative
3.3	Removed transitional provisions for initial implementation of RD-204 [10] as these are now expired.	Administrative
4.1	Removed implementation strategy for SOE as deadline for compliance with N290.15 [11] has passed.	Administrative
5.1	• Updated text to reflect latest submission of Pickering B Safety Report. • New text added to *Recommendations and Guidance* for deterministic and probabilistic safety analysis.	Administrative
7.1	Updated CVC for N285.4 [24] and N287.7 [26] to reflect recent CNSC correspondence.	Administrative
10.1	• Correction made to units for noble gases DRL. • Implementation strategy for N288.5-11 [58] added under CVC.	Administrative
11.2	Updated text for N293-07 [50].	Administrative
16.2	Update text to remove references to the closed action items 2010-8-05 and 2012-48-3459.	Administrative
16.3	Updated CVC to reflect removal of hold point.	Administrative

4. Gentilly-2

Table H.7: Amendments to the Gentilly-2 power reactor operating licence

Power reactor operating licence # - Effective date	Amendment applications
10.02/2016 – July 22, 2014	Given the shutdown state of the facility and the transition to safe storage, this amendment was made to delete licence conditions no longer required and to modify licence conditions for transition activities. Modifications were made to the application of S-99 [7] reporting through removing the need for the submission of unnecessary reports for a shutdown reactor.

Table H.8: Significant changes to the LCH for Gentilly-2

Section	Description of change	Revision type
Throughout	Removal of references to deleted licence conditions.	Administrative
Throughout	Updates to the LCH due to the modifications made in the application of S-99 [7] reporting.	Administrative

5. Point Lepreau

Table H.9: Amendments to Point Lepreau power reactor operating licence

Power reactor operating licence # - Effective date	Amendment applications
17.03/2017 – October 3, 2014	On May 16, 2014, NB Power submitted a request to the CNSC for a licence amendment to the Point Lepreau licence. This licence amendment request was to update the table of nuclear substances and prescribed equipment found in Appendix B.2 of the licence. This appendix contains the current inventory of nuclear substances approved for use at Point Lepreau. NB Power requested the revision of the unsealed source maximum quantity numbers for two items (items 1 and 2 of Appendix B.2). The CNSC approved this licence amendment request on October 3, 2014.
17.04/2017 – January 1, 2015	On October 24, 2014, NB Power submitted a request to the CNSC for a licence amendment to the Point Lepreau licence. This licence amendment request was to replace references to S-99 [7] with REGDOC-3.1.1 [6] and to include associated changes to two licence conditions. To maintain continuity of reporting requirements, CNSC staff recommended, and the applicant agreed, that the Commission include in the licence a reference to RD-336 [39] under licence condition 14.1. The CNSC approved this licence amendment request on December 23, 2014 and it became effective on January 1, 2015.

Table H.10: Significant changes to the LCH for Point Lepreau

Section	Description of change	Revision type
Multiple sections of the LCH	Edited text to reflect modifications to the LCH template.	Administrative
1.1	Made administrative changes due to Commission approval of Licence Amendment Number for Point Lepreau.	Administrative
5.2	Added currently accepted NB Power probabilistic safety assessment (PSA) documents, including schedule for resubmission of the PSA updates	Administrative
7.3	Added text clarifying that operation beyond 210,000 equivalent full power hours (EFPH) requires the presentation of a fitness for service assessment to the Commission. LCH text regarding N287.7 [26] modified to reflect that the NB Power inspection and testing program documents (*Reactor Building Management Plan*, *Equipment Program Plan* and *the Standard Leak-Rate Test Technical Specification*) were accepted by CNSC staff.	Administrative
7.3 Appendix C Appendix D	Modified LCH text regarding N285.5 [25] to reflect that the NB Power *Equipment Program for Periodic Inspection Program* (PIP) (0087-03642-PIP2-001-A-02) was up-to-date with N285.5-08 [25].	Administrative
8.1	Updated information related to alpha monitoring and control.	Administrative
11.1	Added text regarding the pre-distribution of iodine thyroid blocking agents (potassium iodide pills). Updated NB Power Fire Protection documentation.	Administrative
16.1	Added revised Schedule A of the CNSC Financial Security and Access Agreement.	Administrative
16.4	Revised submission dates for the Fire Hazard Assessment and Fire Safe Shutdown Analysis from NB Power.	Administrative

Acronyms and abbreviations

ACU	air conditioning unit
AECL	Atomic Energy of Canada Limited
AF	accident frequency
AI	action item
ALARA	as low as reasonably achievable
ANO	authorized nuclear operator
ASR	accident severity rate
BEAU	best estimate and uncertainty
BOP	balance-of-plant
BOT	body of tube
BRL	below reportable level
BTI	business transformation initiatives
CAA	composite analytical approach
CANDU	Canada Deuterium Uranium
CANSTOR	CANDU storage (for used fuel)
CEA	Canadian Electricity Association
CMD	Commission member document
CNL	Canadian Nuclear Laboratories Ltd.
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group (Inc.)
COP	continued operations plan
CSA	Canadian Standards Association (as referenced in titles of standards; the association itself is now known as “CSA Group”)
CSI	CANDU safety issue
CVC	compliance verification criteria
CVP	compliance verification program
DFO	Fisheries and Oceans Canada
DNNP	Darlington new nuclear project
DRL	derived release limit
E-NOP	enhanced neutron overpower protection
EA	environmental assessment
EC	Environment Canada
ECIS	emergency coolant injection system
EFPH	equivalent full power hour(s)
EIR	event initial report
EME	emergency mitigating equipment
EMS	environmental management system
EPRI	Electric Power Research Institute
EQ	environmental qualification
FAI	Fukushima action item
FCLMP	Fuel Channel Life Management Project
FoF	force-on-force
HSM	Historic Saugeen Métis
HT	elemental tritium
HTO	tritium oxide
I&C	instrumentation and control

IAEA	International Atomic Energy Agency
IFB	irradiated fuel bay
IIP	integrated implementation plan
INES	International Nuclear and Radiological Event Scale
IPR	integrated plant rating
IRRS	Integrated Regulatory Review Service
IST	industry standard toolset
JRP	Joint Review Panel
KI	potassium iodide
LBLOCA	large-break loss-of-coolant accident
LCH	licence conditions handbook
Le	low enrichment (see NESTLE)
LLOCA	large loss-of-coolant accident
LOCA	loss-of-coolant accident
LRF	large-release frequency
LTI	lost-time injury
MOL	Ministry of Labour
MoU	memorandum of understanding
MTI	medically treated injury
MUPSA	multi-unit probabilistic safety assessment
MWe	megawatts electrical (that is, megawatts of electrical power)
NB Power	New Brunswick Power Corporation
NEA	Nuclear Energy Agency
NESTLE	Nodal Eigenvalue, Steady-state Le core Evaluator (where Le means low enrichment)
NEW	nuclear energy worker
NOP	neutron overpower protection
NPCS	negative pressure containment system
NPP	nuclear power plant
NRF	nuclear response force
NSCA	*Nuclear Safety and Control Act*
OECD	Organization for Economic Co-operation and Development
OMNRF	Ontario Ministry of Natural Resources and Forestry
OPEX	operating experience
OPG	Ontario Power Generation Inc.
PHT	primary heat transport
PHTS	primary heat transport system
PI	performance indicator
PIP	periodic inspection program
PIV	physical inventory verification
PLBB	probabilistic leak before break
PNERP	Provincial Nuclear Emergency Response Plan
PPS	Provincial Policy Statement
PRAISE	Piping Reliability Analysis Including Seismic Events
PROL	power reactor operating licence
PRSL	power reactor site preparation licence
PSA	probabilistic safety assessment
PTNSR	*Packaging and Transport of Nuclear Substances Regulations*
QHO	quantitative health objective
R&D	research and development
RCM	risk control measures
RD	regulatory document

RD/GD	regulatory document/guidance document
REGDOC	regulatory document
RIDM	risk-informed decision making
RP	radiation protection
RSGs	reactor shutdown guarantees
RWAP	Round Whitefish Action Plan
SAMG	severe accident management guideline
SAT	systematic approach to training
SCA	safety and control area
SDS	shutdown system
SDS1	shutdown system number 1
SDS2	shutdown system number 2
SG	standby generator
SLOR	slow-loss-of-regulation
SMART	Simple Model for Activity Removal and Transport
SOE	safe operating envelope
SON	Saugeen Ojibway Nations
SOP	sustainable operations plan
SRWMF	Solid Radioactive Waste Management Facility
SSCs	structures, systems and components
TCD	target completion date
TDGR	*Transportation of Dangerous Goods Regulations*
TRF	tritium removal facility
TSP	trip setpoint
U0O	Unit 0 operator
UCLF	unplanned capability loss factor
WANO	World Association of Nuclear Operators
WGRISK	Working Group on Risk
WGSG	Working Group on Safety Goals

Glossary

accident frequency (AF)
A measure of the number of fatalities and injuries (lost-time and medically treated) due to accidents for every 200,000 person-hours (approximately 100 person-years) worked.

accident severity rate (ASR)
A measure of the total number of days lost due to a work-related injury for every 200,000 person-hours.

becquerel (Bq)
The unit of measure for the quantity of radioactive material. One Bq is equal to the decay of one atom per second.

beyond-design-basis accident (BDBA)
Accident conditions less frequent and more severe than a design-basis accident. A beyond-design-basis accident may or may not involve core degradation.

calandria tubes
Tubes that span the calandria and separate the pressure tubes from the moderator. Each calandria tube contains one pressure tube.

Commission
The Canadian Nuclear Safety Commission established by section 8 of the NSCA. It is a corporate body of not more than seven members, appointed by the Governor in Council. The objects of the Commission are:

a) to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in order to:
   - prevent unreasonable risk, to the environment and to the health and safety of persons, associated with that development, production, possession or use
   - prevent unreasonable risk to national security associated with that development, production, possession or use
   - achieve conformity with measures of control and international obligations to which Canada has agreed

b) to disseminate objective scientific, technical and regulatory information to the public concerning the activities of the CNSC and the effects, on the environment and on the health and safety of persons, of the development, production, possession and use referred to in paragraph a)

Commission member document (CMD)
A document prepared for Commission hearings and meetings by CNSC staff, proponents and intervenors.

derived release limit (DRL)
A limit imposed by the CNSC on the release of a radioactive substance from a licensed nuclear facility such that compliance with the derived release limit gives reasonable assurance that the regulatory dose limit is not exceeded.

design basis
The range of conditions and events taken explicitly into account in the design of the facility, according to established criteria, such that the facility can withstand them without exceeding authorized limits by the planned operation of safety systems.

design-basis accident (DBA)
Accident conditions against which a nuclear power plant is designed according to established design criteria and for which the damage to the fuel and the release of radioactive material are kept within authorized limits.

design life
The period specified for the safe operation of the facility, systems, structures and components.

equivalent full power hour (EFPH)
The period over which a component sees service that equals the amount of full service the component would have experienced if it had been operated continuously over a full hour.

feeder
One of several hundred channels in a CANDU reactor that contain fuel. The feeders are pipes attached to each end of the channels and are used to circulate heavy water coolant from the fuel channels to the steam generators.

forced outage
A reactor shutdown that results in an outage that had not been identified in the licensee's long-term plan or that is not due to a surplus baseload generation request.

guaranteed shutdown state (GSS)
The reactor shall be considered to be in a guaranteed shutdown state if the following is in place:
- There is sufficient negative reactivity to ensure subcriticality in the event of any process failure.
- Approved administrative safeguards (i.e., reactor shutdown guarantees) – approved by the senior operations authority and concurred with by the CNSC – are in place to prevent net removal of negative reactivity.

International Atomic Energy Agency (IAEA)
An independent international organization related to the United Nations system. The IAEA, located in Vienna, works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies. The IAEA reports annually to the UN General Assembly and, when appropriate, to the UN Security Council regarding non-compliance by states with respect to their safeguards obligations, as well as on matters relating to international peace and security.

licensing basis
A set of requirements and documents for a regulated facility or activity comprising:
- the regulatory requirements set out in the applicable laws and regulations
- the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence
- the safety and control measures described in the licence application and the documents needed to support that licence application

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

mSv
Millisievert, one-thousandth of a sievert. See also sievert.

MWe
Megawatts electrical; that is, megawatts of electrical power.

pressure tubes
Tubes that pass through the calandria and contain 12 or 13 fuel bundles. Pressurized heavy water flows through the tubes, cooling the fuel.

probabilistic safety assessment (PSA)
For a nuclear power plant or nuclear fission reactor, a comprehensive and integrated assessment of the safety of the plant or reactor. The safety assessment considers the probability, progression and consequences of equipment failures or transient conditions to derive numerical estimates that provide a consistent measure of the safety of the plant or reactor, as follows:

- A Level 1 PSA identifies and quantifies the sequences of events that may lead to the loss of core structural integrity and massive fuel failures.
- A Level 2 PSA starts from the Level 1 results and analyzes the containment behaviour, evaluates the radionuclides released from the failed fuel and quantifies the releases to the environment.
- A Level 3 PSA starts from the Level 2 results and analyzes the distribution of radionuclides in the environment and evaluates the resulting effect on public health.

A PSA may also be referred to as a probabilistic risk assessment (PRA).

risk
The chance of injury or loss, defined as a measure of the probability and severity of an adverse effect (consequence) to health, property, the environment or other things of value; mathematically, it is the probability of occurrence (likelihood) of an event multiplied by its magnitude (severity).

risk-informed approach
A modern approach to the classification of accidents – one that considers a full spectrum of possible events, including the events of greatest consequence to the public.

root cause analysis
An objective, structured, systematic and comprehensive analysis designed to determine the underlying reason(s) for a situation or event. Such an analysis is conducted with a level of effort consistent with the safety significance of the event.

safety-related system
As defined in the CSA Group publication CSA-N285.0-08, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, and that is referenced in the nuclear power plant licence, safety related systems are "those systems and their related components and supports that, by failing to perform in accordance with the design intent, have the potential to impact the radiological safety of the public or nuclear power plant personnel. Those systems and their components involve:

- "the regulation (including controlled start-up and shutdown) and cooling of the reactor core under normal conditions (including all normal operating and shutdown conditions)

- "the regulation, shutdown and cooling of the reactor core under anticipated transient conditions and accident conditions, and the maintenance of the reactor core in a safe shutdown state for an extended period following such conditions
- "limiting the release of radioactive material and the exposure of plant personnel and/or the public to meet the criteria established by the licensing authority with respect to radiation exposure during and following normal, anticipated transient conditions and accident conditions

"Notes:

1) "The term "safety-related system" covers a broad range of systems, from those having very important safety functions to those with a less direct effect on safety. The larger the potential radiological safety effect due to system failure, the stronger the 'safety-related' connotation.
2) "'Safety-related' also applies to certain activities associated with the design, manufacture, construction, commissioning, and operation of safety-related systems and to other activities that can similarly affect the radiological safety of the public or plant personnel, such as environmental and effluent monitoring, radiation protection and dosimetry, and radioactive material handling (including waste management). The larger the potential radiological safety effect associated with the performance of the activity, the stronger the 'safety-related' connotation.
3) "Certain failures of other systems can adversely affect a safety-related system (e.g., through flooding or mechanical damage)."

safety report
A report, as described in regulatory document S-99, *Reporting Requirements for Operating Nuclear Power Plants*, which provides descriptions of the structures, systems and components of a facility, including their design and operating conditions. This includes a final safety analysis report demonstrating the adequacy of the design of the nuclear facility.

safety system
A system provided to ensure the safe shutdown of a reactor or the residual heat removal from the core, or to limit the consequences of anticipated operational occurrences and design-basis accidents.

serious process failure
A failure of a process structure, system or component:

- that leads to a systematic fuel failure or a significant release from the nuclear power plant
- that could lead to a systematic fuel failure or a significant release in the absence of action by any special safety system

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

sievert (Sv)
Unit of dose, corresponding to the rem, another unit of dose (1 Sv = 100 rem). One sievert is defined as one joule of energy absorbed per kilogram of tissue (1 Sv = 1 J/kg) multiplied by an appropriate, dimensionless weighting factor.

special safety system
One of the following systems of an NPP: shutdown system no. 1, shutdown system no. 2, the containment system or the emergency core cooling system.

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

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

structures, systems and components (SSCs)
A general term encompassing all of the elements (items) of a facility or activity that contribute to protection and safety. Structures are the passive elements: buildings, vessels, shielding, etc. A system comprises several components, assembled in such a way as to perform a specific (active) function. A component is a discrete element of a system. Examples are wires, transistors, integrated circuits, motors, relays, solenoids, pipes, fittings, pumps, tanks and valves.

systematic approach to training (SAT)
A logical approach to training that consists of the following phases:

- the analysis phase, during which the competencies with respect to knowledge and skills required to work in a position are identified
- the design phase, during which the competency requirements for a position are converted into training objectives and a training plan is produced
- the development phase, during which the training material needed to meet the training objectives is prepared
- the implementation phase, during which the training is conducted using the material developed
- the evaluation phase, during which data regarding each of the above phases are collected and reviewed to determine the effectiveness of training, and appropriate actions are taken to improve training effectiveness

systems important to safety (SIS)
Structures, systems and components of the nuclear power plant associated with the initiation, prevention, detection or mitigation of any failure sequence that have the most significant impact in reducing the possibility of damage to fuel, associated release of radionuclides or both. Note: Not all systems important to safety are safety systems.

TBq
Terabecquerel, a trillion becquerels. See becquerel.

unavailability target
Unavailability targets are compared against actual plant performance to identify deviations from expected performance. Availability is the fraction of time for which the system can be demonstrated to meet all of the minimum allowable performance standards. Licensees are expected to not exceed the unavailability targets.

World Association of Nuclear Operators (WANO)
A non-profit organization whose stated mission is to maximize the safety and reliability of nuclear power plants worldwide by working together to assess, benchmark and improve performance through mutual support, exchange of information and emulation of best practice.

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