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**Regulatory Oversight  
Report for Canadian  
Nuclear Power  
Generating Sites for 2019  
and Darlington  
Refurbishment Update**

**Rapport de surveillance  
réglementaire des sites  
de centrales nucléaires  
au Canada pour 2019 et  
mise à jour sur la  
réfection de Darlington**

Public Meeting

Réunion publique

Scheduled for:  
9 December 2020

Prévue pour:  
9 décembre 2020

Submitted by:  
CNSC Staff

Soumise par:  
Le personnel de la CCSN

## Summary

This CMD presents the *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites for 2019 and Darlington Refurbishment Update*.

The following summarizes the regulatory oversight report:

- Through compliance verification activities, CNSC staff concluded that nuclear power plants (NPPs) and the waste management facilities (WMFs) on their sites in Canada operated safely during 2019. The evaluations of all findings for the safety and control areas show that, overall, NPP and WMF licensees made adequate provision 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 conclusions:
  - Radiation doses to members of the public were well below the regulatory limit.
  - Radiation doses to workers were below the regulatory limits.
  - The frequency and severity of non-radiological injuries to workers were low.
  - No radiological releases to the environment exceeded the regulatory limits.
  - Licensees met applicable requirements related to Canada's international obligations.

## Résumé

Ce CMD présente le Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada pour 2019 et mise à jour sur la réfection de Darlington.

Ce qui suit résume le rapport de surveillance réglementaire :

- En se basant sur des activités de vérification de la conformité, le personnel de la CCSN a conclu que les centrales nucléaires et les installations de gestion des déchets sur leurs sites ont été exploitées de manière sûre en 2019. Les évaluations de toutes les constatations relatives aux domaines de sûreté et de réglementation montrent que, dans l'ensemble, les titulaires de permis de centrale nucléaire et d'installation de gestion des déchets ont pris les mesures voulues pour préserver la santé, la sûreté et la sécurité des personnes, protéger l'environnement contre l'utilisation de l'énergie nucléaire et respecter les obligations internationales que le Canada a assumées.
- Les observations suivantes appuient les conclusions:
  - Les doses de rayonnement reçues par le public étaient bien en deçà de la limite réglementaire.
  - Les doses de rayonnement reçues par les travailleurs étaient bien en deçà des limites réglementaires.
  - La fréquence et la gravité des blessures non radiologiques subies par les travailleurs étaient faibles.
  - Il n'y a eu aucun rejet radiologique dans l'environnement qui a dépassé les limites réglementaires.
  - Les titulaires de permis se sont conformés aux exigences applicables

relatives aux obligations  
internationales du Canada.

The following summarizes the refurbishment update for Unit 2 of Darlington Nuclear Generating Station (DNFS):

- The licensee conducted the refurbishment of Unit 2 safely and took all reasonable precautions to ensure the safety of workers, the Canadian public and the environment
- CNSC staff conducted the required oversight to ensure a safe and timely return-to-service of Unit 2

There are no actions requested of the Commission. This CMD is for information only.

The following item is attached:

- *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites for 2019 and Darlington Refurbishment Update*

Ce qui suit résume la mise à jour sur la réparation de la tranche 2 de la centrale nucléaire de Darlington.

- Le titulaire de permis a effectué la réparation de la tranche 2 en toute sécurité et a pris toutes les précautions raisonnables pour assurer la sécurité des travailleurs, du public canadien et de l'environnement
- Le personnel de la CCSN a effectué la surveillance requise pour assurer un retour en service sécuritaire et opportun de la tranche 2

Aucune mesure n'est requise de la Commission. Ce CMD est fourni à titre d'information seulement.

La pièce suivante est jointe :

- *Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada pour 2019 et mise à jour sur la réparation de Darlington*

**Signed/signé le**

5 October 2020

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## EXECUTIVE SUMMARY

This Commission member document (CMD) is in two parts. The first part is the *Regulatory Oversight Report for Nuclear Power Generating Sites: 2019*; the second part is an update on the refurbishment of Unit 2 of the Darlington Nuclear Generating Station (DNFS). Referenced documents in both parts of this CMD are available to the public upon request.

The regulatory oversight report describes the regulatory oversight and safety performance of nuclear power generating sites, consisting of nuclear power plants (NPPs) and adjacent waste management facilities (WMFs) in Canada in 2019. For certain topics, updates on developments in 2020 are also described. This is the third CNSC regulatory oversight report to cover both NPPs and WMFs.

The following list identifies the facilities for each site covered by this report. Each line in the list identifies facilities that are located at the same site and, governed by a single CNSC licence; for this reason, they are assessed together in this report:

- Darlington Nuclear Generating Station (DNFS), which includes the Tritium Removal Facility and Retube Waste Processing Building
- Darlington Waste Management Facility (DWMF), which includes the Retube Waste Storage Building
- Pickering Nuclear Generating Station (PNGS)
- Pickering Waste Management Facility (PWMF)
- Bruce A Nuclear Generating Station and Bruce B Nuclear Generating Station
- Western Waste Management Facility (WWMF) and Radioactive Waste Operations Site-1
- Point Lepreau Nuclear Generating Station (PLNGS) and Solid Radioactive Waste Management Facility (SRWMF)
- Gentilly-2 Facilities

CNSC staff concluded that the NPPs and WMFs operated safely in 2019. This conclusion was based on detailed staff assessments of findings from compliance verification activities for each facility in the context of the 14 CNSC safety and control areas. The conclusion was supported by safety performance measures and other observations.

Important performance measures and observations include the following:

- The NPP and WMF licensees followed approved procedures and took appropriate corrective action for all events reported to the CNSC.
- NPPs and WMFs operated within the bounds of their operating policies and principles.
- No serious process failures occurred at the NPPs. The number of unplanned transients and trips in the reactors was low and acceptable to CNSC staff. All unplanned transients in the reactors were properly controlled and adequately managed.

- Radiation doses to the public were well below the regulatory limits.
- Radiation doses to workers at the NPPs and WMFs were also below the regulatory limits.
- The frequency and severity of non-radiological injuries to workers were low.
- No radiological releases to the environment from the NPPs and WMFs exceeded the regulatory limits.
- Licensees met the applicable requirements related to Canada's international obligations; safeguards inspection results were acceptable to the IAEA.

CNSC staff's assessments for 2019 concluded that the licensees complied with the applicable requirements and also met CNSC staff's expectations for all SCAs at all the NPPs and WMFs.

The update on the refurbishment of the DNGS covers CNSC staff's oversight of the refurbishment of Unit 2, from October 2016 to July 2020. CNSC staff concluded that the licensee conducted the refurbishment safely and took all reasonable precautions to ensure the safety of workers, the Canadian public and the environment. Despite several challenges associated with the COVID-19 pandemic, CNSC staff provided the required oversight to ensure a safe and timely return to service of Unit 2.

## INTRODUCTION TO CMD

This CMD is in two parts. Part 1 consists of the main body of the regulatory oversight report for Canadian nuclear power generating sites for 2019. Part 2 is an update on the refurbishment of the Darlington nuclear generating station. The appendices for the regulatory oversight report follow Part 2.

# PART 1: REGULATORY OVERSIGHT REPORT FOR NUCLEAR POWER GENERATING SITES: 2019

## 1 INTRODUCTION

### 1.1 About the regulatory oversight report

The *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2019* provides Canadian Nuclear Safety Commission (CNSC) staff's assessment of the overall performance of Canadian nuclear power plants (NPPs) and their adjacent waste management facilities (WMFs) for 2019.

Section 1 of the report provides introductory material that explains this report, the licensed facilities that are covered, and the CNSC's regulatory framework and practices.

Section 2 provides background information that serves as context for the assessments. Although the assessments for each site are provided in section 3, section 2 contains some assessments of groups of licensees, where appropriate. For example, section 2 compares safety performance data for multiple licensees.

Section 3 contains highlights from the individual assessments for each facility. CNSC's approach to the safety assessments of the NPPs and WMFs is described in section 1.4.5.

Sections 2 and 3 are organized according to the CNSC safety and control area (SCA) framework, as it existed at the end of 2019.

Section 4 contains CNSC staff's conclusions based on the assessments presented in this report.

Some of the terms used in this document are defined in CNSC REGDOC-3.6, *Glossary of CNSC Terminology*.

This report includes information requested by the Commission from previous RORs and licensing hearings. These requests are tracked through the CNSC's Regulatory Information Bank (RIB) system. Table 1 provides the RIB tracking number, a description of the request, and where the request is addressed by CNSC staff in this report, as applicable.

**Table 1: Details on RIB Requests from the Commission**

RIB #	Request	Report section
17560	Include data for total recordable injury frequency for all workers, including contractors, if it is available	Minutes of Commission meeting on May 15, 2019 [6]

RIB #	Request	Report section
17557	Follow up to the licence renewal for Pickering Nuclear Generating Station (PNGS) <ul style="list-style-type: none"> <li>(i) provide update on the status of the integrated implementation plan (IIP)</li> <li>(ii) describe methodology and progress for whole site probabilistic safety assessment (PSA)</li> <li>(iii) provide update on the joint fuel machine reliability project</li> </ul>	3.3.0 2.4 2.6
17522	Provide update on emergency management and preparedness at PNGS <ul style="list-style-type: none"> <li>(i) 2017 Ontario Provincial Nuclear Emergency Response Plan (PNERP)</li> <li>(ii) implementation plan for PNGS for 2017 PNERP</li> <li>(iii) results from the technical study for 2017 PNERP</li> <li>(iv) Ontario's unified transport management plan</li> <li>(v) revision of public information and disclosure program for PNGS in regard to emergency preparedness and provision of information to populations beyond the detailed planning zone</li> </ul>	2.10 3.3.10 2.10 2.10 2.10
16516	Provide update on PNGS fish diversion system <ul style="list-style-type: none"> <li>(i) improvements and resulting fish impingement rate</li> <li>(ii) results of Ontario Power Generation's (OPG's) thermal plume monitoring</li> <li>(iii) a) OPG's compliance with its <i>Fisheries Act</i> authorization and b) involvement of Indigenous groups in activities related to the authorization</li> </ul>	3.3.0 3.3.0 a) 3.3.0 b) 3.3.0
14761	Describe enhancements at Bruce A to bring internal fire risk below the safety goal target	3.5.4
14760	Monitor Bruce Power's work to perform site-wide PSA for the next licence renewal	3.5.4
14759	Report on Bruce Power's progress on determining aggregate safety goals and targets for the next licence renewal	3.5.4

RIB #	Request	Report section
14757	Describe developments related to pressure tube fracture toughness for Bruce A and B, including: i) fracture toughness modelling ii) estimates of the maximum amount of equivalent hydrogen	3.5.6  Appendix C
14755	Provide update on the implementation of automated data transfer from Bruce A and B to the CNSC Emergency Operations Centre	3.5.10
14753	Provide update on status of major component replacement for Bruce A and B	3.5.0
8504	Provide update on the CNSC's regulatory position on risk aggregation	2.4

## 1.2 Scope of the regulatory oversight report

The scope of the *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2019* is similar to that of the *Regulatory Oversight Report for Canadian Nuclear Power Plants: 2018*. It covers the NPPs in Canada, including Gentilly-2. General statements in the report that refer to “NPPs” are intended to apply to Gentilly-2, while the phrase “operating NPPs” is used for statements that do not apply to Gentilly-2. The report also covers the WMFs located at the same sites, whether they are regulated under the same licence as the NPP or licensed separately.

Generally speaking, the information provided in this regulatory oversight report is pertinent to 2019, and the status that is described is valid as of December 2019. The word “UPDATE” is used to identify topics where more recent information (up to June 1, 2020) is included (for example, progress on corrective actions, descriptions of significant events and updates that the Commission specifically requested).

The detailed scope of the safety assessments in this regulatory oversight report is covered by the set of specific areas that constitute each SCA. They are described in more detail in *General Description of Regulatory Framework for Nuclear Power Generating Sites* [1]. As noted in *General Description of Regulatory Framework for Nuclear Power Generating Sites*, some specific areas do not apply to Gentilly-2 and the WMFs, in which case they were not considered in the safety assessments for those facilities.

## 1.3 Nuclear facilities covered by this regulatory oversight report

Figure 1 shows the geographic location in Canada of the NPPs and WMFs covered by this report. All sites are located on traditional territories of Indigenous peoples in Canada.

**Figure 1: Locations and facilities of nuclear power generating sites in Canada**



### 1.3.1 Nuclear power generating sites and associated waste management facilities in Canada

The Darlington site is located in Clarington, Ontario, and consists of the Darlington Nuclear Generating Station (DNGS) and the Darlington Waste Management Facility (DWMF). The DNGS and DWMF are licensed separately. See sections 3.1 and 3.2 for details. The site also includes the Darlington New Nuclear Project (DNNP).

The Pickering site is located in Pickering, Ontario, and consists of the Pickering Nuclear Generating Station (PNGS) and the Pickering Waste Management Facility (PWMF). The PNGS and PWMF are licensed separately. See sections 3.3 and 3.4 for details.

The Bruce site is located in Tiverton, Ontario, and consists of the Bruce A and B Nuclear Generating Stations; OPG's Western Waste Management Facility (WWMF) and Radioactive Waste Operations Site-1 (RWOS-1); and, Canadian Nuclear Laboratory's (CNL's) Douglas Point Waste Facility. Bruce A and B are licensed together. The WWMF, RWOS-1 and Douglas Point Waste Facility are all licensed separately. See sections 3.5 and 3.6 for details. Note that the Douglas Point Waste Facility is not covered in this report, but in the *Regulatory Oversight Report for Canadian Nuclear Laboratories Sites*.

The Point Lepreau site is located on the Lepreau Peninsula in New Brunswick and consists of the Point Lepreau Nuclear Generating Station (PLNGS) and the Solid Radioactive Waste Management Facility (SRWMF). The operation of the PLNGS and SRWMF are authorized under a single licence. See section 3.7 for details.

The Gentilly nuclear site is located in Bécancour, Quebec, and consists of CNL's Gentilly-1 Waste Facility and Hydro-Québec's Gentilly-2 facilities. The Gentilly-

1 and Gently-2 facilities are licensed separately. See section 3.8 for details. Note that the Gently-1 Waste Facility is not covered in this report, but in the *Progress Update for CNL's Prototype Waste Facilities, Whiteshell Laboratories and the Port Hope Area Initiative*.

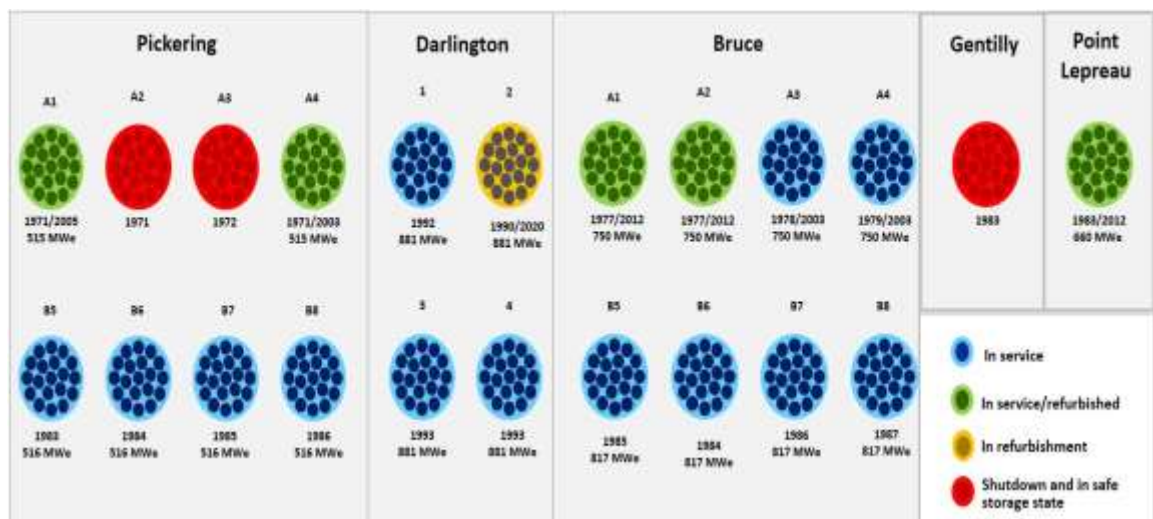
### 1.3.2 Nuclear power plants

#### Operating NPPs

Eighteen reactors continued to operate in Canada throughout 2019, unchanged from 2018. They are located at four NPP sites, each with a power reactor operating licence (PROL) issued by the CNSC. They are located in two provinces (Ontario and New Brunswick) and are operated by three distinct licensees (OPG, Bruce Power and NB Power). These NPPs range in size from one to eight power reactors, all of which are of the CANDU (CANada Deuterium Uranium) design.

Figure 2 provides data for each NPP, including the generating capacity of the reactor units, their initial start-up dates, and reactor status in 2019. Additional information on the NPPs and licences is provided in section 3.

**Figure 2: Basic information for operating NPPs**



#### Non-operating reactors and NPP

As noted in figure 2, the DNGS includes Unit 2, which was being refurbished in 2019 and did not operate. The PNGS also includes Units 2 and 3, which remained defuelled and in safe storage. They are also CANDU designs and are governed by the same PROL as the operating units.

In addition, the NPP at Gently-2 is shut down and is proceeding to decommissioning. It is also a CANDU design and is governed by a power reactor decommissioning licence.

#### New NPPs

In 2012, the Commission issued a nuclear power reactor site preparation licence (PRSL) to OPG for the DNNP at the Darlington site for a period of 10 years. The



PRSL requires OPG to continue follow-up work on the environmental assessment (EA) conducted in conjunction with the licence application.

UPDATE: OPG submitted its application to renew the PRSL in June 2020.

### 1.3.3 Waste management facilities

The WMFs that are assessed separately in this regulatory oversight report are the ones that are licensed independently from the adjacent NPP. They include the DWMF, PWMF, and WWMF, each of which is owned and operated by OPG under a waste facility operating licence (WFOL).

Table 2 provides data for each WMF, including the initial start-up date, the name of the licensee, the expiry date of the licence, and the type of waste managed at each facility (for example, low- and intermediate-level waste (L&ILW), intermediate-level waste (ILW) and high-level waste (HLW)). Additional information on the facilities and licences is provided in section 3.

As discussed in section 1.3.1, both the Point Lepreau and Gentilly-2 sites also have WMFs that are further discussed in sections 3.7 and 3.8, respectively.

**Table 2: Basic information for WMFs**

Facility	Licensee	Location	Operation start	WFOL expiry	Manages
DWMF	OPG	Clarington, ON	2008	Apr. 30, 2023	HLW from DNGS ILW from DNGS refurbishment
PWMF	OPG	Pickering, ON	1996	Aug. 31, 2028	HLW from PNGS. ILW from PNGS Units 1–4 refurbishment
WWMF	OPG	Tiverton, ON	1974	May 31, 2027	HLW from Bruce A and B NPPs. ILW from Bruce Units 1 and 2 refurbishment L&ILW from DNGS, PNGS, and Bruce A and B NPPs operations
RWOS-1	OPG	Tiverton, ON	Mid-1960	Indefinite	L&ILW from Douglas Point WMF and PNGS

## 1.4 Regulatory framework and oversight

The CNSC regulates the nuclear sector in Canada, including NPPs and WMFs, through licensing, reporting, compliance verification, and enforcement. The CNSC uses a risk-informed regulatory approach, applying resources and regulatory oversight commensurate with the risk associated with the regulated facility and activity. Additional information on the CNSC regulatory framework

and oversight is provided in this section, and in *General Description of Regulatory Framework for Nuclear Power Generating Sites* [1].

#### 1.4.1 CNSC requirements

All licensees are required to operate in accordance with the licensing basis. The licensing basis is defined in CNSC REGDOC-3.5.3, *Regulatory Fundamentals*, and is comprised of the following:

- (i) the regulatory requirements set out in the applicable laws and regulations
- (ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence
- (iii) the safety and control measures described in the licence application and the documents needed to support that licence application

The requirements in parts (ii) and (iii) of the licensing basis are unique to each licensed facility – they depend on the content of a given licence application and the applicant's supporting documentation. Regulations made under the *Nuclear Safety and Control Act* (NSCA), including the *Class I Nuclear Facilities Regulations*, provide requirements on the content of licence applications for NPPs and WMFs.

Licence applications for NPPs and WMFs cite CNSC regulatory documents, CSA Group standards, and other publications, as well as the applicant's own documentation. When a licence is issued, CNSC staff develop a licence conditions handbook (LCH) to identify the specific requirements that apply to that licence. All NPPs and WMFs covered by this report have LCHs.

Appendix B lists all CNSC regulatory documents and CSA Group standards that are identified as containing compliance verification criteria in the LCHs for the NPPs and WMFs covered by this regulatory oversight report. The appendix illustrates the large number of CNSC regulatory documents and CSA Group standards that provide requirements relevant to all SCAs.

Appendix B also indicates the significant number of newer CNSC regulatory documents and CSA Group standards that the licensees are implementing. Details about the implementation of these publications are provided under the relevant SCAs throughout this regulatory oversight report.

In this report, CNSC regulatory documents typically start with "REGDOC", followed by an identifying number. CSA Group standards are typically identified by "CSA N.xxx", where xxx is the number of the publication.

Each licensee implements new CNSC regulatory documents and CSA Group standards in a staged, risk-informed manner that takes into consideration the timing of licence renewals, operational needs, and other concurrent changes. Although differences exist in applicable requirements between similar facilities at

any given time, the requirements nevertheless are comprehensive, and improved requirements are implemented in a measured and systematic way.

#### 1.4.2 Licensing

Each of the operating NPPs and WMFs described in this report has been granted a licence by the Commission. The typical period for a WFOL and a PROL has been 10 years and 5 years, respectively, while Hydro-Québec has a 10-year licence to decommission its power reactor. In 2015, the Commission granted OPG a 10-year licence for DNGS, and in 2018, the Commission granted Bruce Power a 10-year licence for BNGS and OPG a 10-year licence for PNGS. For operating NPPs, this longer licence is issued in conjunction with the implementation of a periodic safety review (PSR) process in preparation for the licence renewal.

The PSR is a comprehensive evaluation of the design, condition and operation of an NPP. As outlined in CNSC REGDOC-2.3.3, *Periodic Safety Reviews*, a PSR involves an assessment of the current state of the NPP and plant performance to determine the extent to which the NPP conforms to modern codes, standards and practices, and to identify any factors that would limit safe, long-term operation. It provides the licensee a framework to systematically identify practicable safety enhancements, which are documented in an integrated implementation plan (IIP). For operating NPPs, licence conditions have been used to require the licensee to implement the IIP during the licence period and to conduct a PSR in support of the next licence renewal. A PSR is not a requirement for Gentilly-2 or the WMFs because the associated hazards are relatively smaller and the requirements change relatively slowly, such that the regular licensing process and implementation of CNSC regulatory documents and CSA Group standards are sufficient to assure safe, long-term operation.

The status of the PSR for each operating NPP is described in section 3.

#### ***Fisheries Act Authorization***

In addition to CNSC licences, this regulatory oversight report describes developments related to *Fisheries Act* authorizations. The *Fisheries Act* requires the establishment of offsets to compensate for any residual harm caused to fish and fish habitats after mitigation measures have been put in place. The CNSC has a memorandum of understanding with Fisheries and Oceans Canada whereby CNSC staff are responsible for monitoring activities and verifying compliance for *Fisheries Act* authorizations. The Minister of Fisheries and Oceans Canada is responsible for enforcing the authorizations in the event of non-compliance.

#### 1.4.3 Reporting

Licensees are required to provide various reports and notices to the CNSC in accordance with regulations made under the NSCA. LCHs clarify CNSC expectations for these requirements, if needed.

In addition to, and in conjunction with, the reporting requirements in the regulations, a licence condition requires NPP licensees to report to the CNSC in accordance with CNSC REGDOC-3.1.1, *Reporting Requirements for Nuclear*

*Power Plants.* REGDOC-3.1.1 requires licensees to submit quarterly and annual reports on various subjects; for example, quarterly reports on the safety performance indicators that are discussed in this report. REGDOC-3.1.1 also provides detailed requirements related to the submission of other important reports (such as updates to the final safety analysis report, proposed decommissioning plan and annual environmental protection report). REGDOC-3.1.1 also requires licensees to report any unplanned situations and events to the CNSC.

For Gentilly-2, the requirements in REGDOC-3.1.1 have been adjusted in accordance with its current state and the associated risks [5].

During 2019, NPP licensees reported to CNSC staff on 217 events, and submitted 90 scheduled reports. In accordance with the *General Nuclear Safety and Control Regulations*, WMF licensees also submitted 8 reports to CNSC staff for reportable events that occurred at the DWMF, PWF and WWMF.

The CNSC published REGDOC-3.1.2, *Reporting Requirements for Non-Power Reactor Class I Facilities and Uranium Mines and Mills*, in January 2018. Beginning in 2019, the WMFs reported to the CNSC in accordance with REGDOC-3.1.2.

#### **1.4.4 Compliance verification program**

The safety assessments presented in this report were based on the results of activities planned through the CNSC compliance verification program (CVP). In 2019, these activities included Type II inspections that evaluate the outputs and outcomes of licensee programs, field inspections that collect data on the outputs and outcomes of licensee programs, desktop inspections and reviews and surveillance and monitoring.

Additional reactive compliance verification activities for NPPs and WMFs are added as needed. These focus on site-specific matters and known or potential licensee challenges. CNSC staff then validate the annual plans by using a risk-informed approach that considers the status, performance history, and conditions and challenges of each facility to ensure appropriate regulatory oversight and safety performance evaluation. Additional compliance verification activities for NPPs and WMFs may also be added as necessary during the year in response to new or emerging licensee challenges. The goal is to ensure that the CVPs for NPPs and WMFs are always timely, risk-informed, performance-based and responsive to developments.

The CVPs for NPPs also include desktop reviews of safety performance indicators submitted quarterly to the CNSC in accordance with REGDOC-3.1.1. Data for some of these indicators are reproduced in this report. No regulatory limits or thresholds are associated with this data, but CNSC staff monitor them, watching for trends over time and deviations from the data typically provided by other licensees with similar operations or facilities. Any unfavourable trend or comparison is followed by increased regulatory scrutiny, which can range from increased surveillance and monitoring, to increased focus during field inspections,

adjustment of the timing or scope of a baseline inspection, focused desktop review or a reactive inspection, depending on the safety significance of the trend or deviation.

#### **1.4.5 Safety assessment ratings**

This report presents safety performance ratings for each SCA at each NPP and WMF based on findings generated during CVP activities. All findings are categorized into appropriate SCAs and specific areas and assessed against a set of high-level performance objectives for the SCAs, as well as the detailed regulatory requirements and CNSC staff's performance expectations. Since the CVP consists of a rolling (typically five-year) cycle of regulatory activities, not all specific areas are directly evaluated every year.

The SCAs and specific areas are described in more detail in *General Description of Regulatory Framework for Nuclear Power Generating Sites* [1]. See Appendix A.2 for a description of the rating methodology used for this regulatory oversight report.

In generating the ratings, CNSC staff considered 1,475 findings for NPPs and WMFs. All but two of these findings were assessed as being either compliant, negligible or of low safety significance. In other words, they had a positive, insignificant or small negative impact on safety within the specific area. There were two “medium” findings that had significant negative effects in the context of the assessment of their respective specific areas; they are discussed in Sections 3.2.10 and 3.6.14.

For the Bruce site<sup>1</sup>, Bruce A and B are rated separately from the WWMF because they are operated by different licensees. For the Darlington and Pickering sites, the NPP and WMF are rated separately because they are regulated under separate licences and have facility-specific licensing bases. The WMFs at Point Lepreau and Gentilly-2 are governed by the NPP licences and are subject to the same regulatory requirements, so they are assessed together with their respective NPPs (as was done in previous regulatory oversight reports).

#### **1.4.6 Update on CNSC Covid-19 Response and NPP Oversight**

On March 15, 2020, the CNSC activated the Business Continuity Plan (BCP) in response to the COVID-19 pandemic. Effective March 16, all CNSC staff in Ottawa and at regional and site offices were directed to work from home. CNSC management immediately suspended all regular NPP compliance activities and identified activities that were considered critical in order to support continued safe power reactor operation and regulatory decision making in relation. For example, oversight activities and reviews related to the release of regulatory hold points for Darlington Unit 2 were carried out remotely with no interruption, in adherence with measures put in place by CNSC management, OPG, and federal and provincial authorities.

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<sup>1</sup> Bruce A and B are operated by Bruce Power, while the WWMF is operated by OPG under a separate licence

In April 2020, a new procedure to plan and conduct compliance activities at NPPs during the COVID-19 pandemic was approved to ensure continued regulatory oversight. This procedure is to be utilized during and following the COVID-19 pandemic for fiscal year 2020-2021 until normal compliance processes resume. It provides direction for the conduct of oversight activities both remotely and on-site, as well as direction on revising the annual compliance plan for this fiscal year.

The procedure provides a framework for conducting remote oversight activities, and enhancing the number and capabilities of site inspectors to work remotely. CNSC staff have worked with licensees to provide comprehensive and remote access to site information systems, actual plant data and participation in all key plant management meetings.

In addition to this new procedure, a pandemic-related Pre-Job Brief was developed as additional instructions to be delivered by the site office supervisors to site inspectors prior to performing on-site oversight activities. Provision of personal protective equipment (PPE) to site inspectors prior to any on-site activities forms part of this Pre-Job Brief.

In May 2020, on-site oversight activities resumed at NPPs in a limited capacity. These activities focused on general health and safety issues (e.g., control of combustible material, housekeeping, contamination posting), as well as licensee adherence to their pandemic response plans and COVID-19 health protocols. The CNSC has taken precautions such as managing and limiting site inspector's access to the site offices, and providing additional PPE and sanitization products.

CNSC staff continue to conduct oversight activities during the COVID-19 pandemic to ensure the protection of the environment, and the health and safety of people. Oversight activities completed in 2020 during the pandemic will be further described in the 2020 regulatory oversight report.

## 2 GENERAL AND SUPPORTING INFORMATION

This section provides information, organized by SCA, which serves as background for the assessments in section 3. In some cases, it describes and assesses data and issues that are applicable to more than one facility. The sub-sections are organized according to the specific areas of each SCA, although some specific areas are omitted if there is no new information. General information about the SCAs and the applicability of the specific areas is provided in *General Description of Regulatory Framework for Nuclear Power Generating Sites* [1].

### 2.1 Management system

#### Safety culture

The CNSC published REGDOC-2.1.2, *Safety Culture*, in April 2018. This document sets out requirements and guidance for fostering a healthy safety culture and for conducting periodic safety culture assessments. NPP licensees provided implementation plans for REGDOC-2.1.2 in 2019. CNSC confirmed that Hydro-Québec complied with the REGDOC. As part of their implementation work, OPG, Bruce Power and NB Power committed to conduct their next self-assessments in accordance with REGDOC-2.1.2.

Additionally, most NPPs have implemented safety culture monitoring panels following the guidance provided by the Nuclear Energy Institute.

#### Management of contractors

In 2019, NPP licensees reported events related to the topic of counterfeit, fraudulent and suspect items (CFSIs) as discussed in Section 3.3.1 for the PNGS. For the most part, the licensee processes for detection of suspect or counterfeit items have been effective. The particular concern with these events was the misrepresentation of product or service quality early in the supply chain (i.e., fraudulence), which is difficult to detect. This has been more of a concern in the global context than in Canada. Nonetheless, noting that fraudulence can be detected with improved oversight of suppliers, CNSC staff continued to focus on the licensees' supply chains, with particular attention to fraudulence. CNSC staff were planning improved oversight activities in early 2021.

#### Business continuity

All licensees have business continuity plans that would be enacted if there were a labour disruption, major external event, or pandemic.

### 2.2 Human performance management

#### Human performance program

CNSC staff's inspection activities in 2019 indicated that the NPP and WMF licensees were developing and expanding their human performance programs to consider a systemic approach that included the interactions of humans, technology and the organization to support worker performance. The licensees were increasing their focus on accountability of workers and learning from events in order to improve human performance.

## Personnel certification

The NPP licences have a condition that requires the licensee to have certified staff in specific positions. All NPPs have certification requirements for responsible health physicists, and the operating NPPs are also required to have certified shift supervisors, shift managers and reactor operators. Due to the design of Bruce A, Bruce B and the DNGS, the CNSC requires those licensees to also employ certified Unit 0 operators.

Table 3 shows the number of certified personnel who were available in the certified positions at each NPP, as of December 31, 2019. The table also shows the minimum required number of personnel for each position, which is the minimum number of certified personnel that must be present at all times multiplied by the total number of crews.

**Table 3: Number of available certifications per NPP and certified positions for 2019**

Station	Reactor operator	Unit 0 operators <sup>a</sup>	Shift supervisor <sup>b</sup>	Health physicist	Total
<b>DNGS</b>					
Actual	64	18	32	5	119
Minimum	30	10	10	1	51
<b>PNGS Units 1, 4</b>					
Actual	42		21	2 <sup>c</sup>	66
Minimum	20		10	1	31
<b>PNGS Units 5–8</b>					
Actual	64		20	2 <sup>c</sup>	87
Minimum	30		10	1	41
<b>Bruce A</b>					
Actual	49	23	23	4 <sup>d</sup>	99
Minimum	30	10	10	1	51
<b>Bruce B</b>					
Actual	62	22	23	4 <sup>d</sup>	111
Minimum	30	10	10	1	51
<b>Point Lepreau</b>					
Actual	9		7	2	18
Minimum	6		6	1	13
<b>Gentilly-2 <sup>e</sup></b>					
Actual				2	2
Minimum				1	1

### Notes:

- There are no Unit 0 positions at PNGS Units 1 and 4 and Units 5–8, or Point Lepreau.
- At multi-unit NPPs, the shift supervisor number is the total of certified shift managers plus certified control room shift supervisors.
- There are two certified health physicists in all at Pickering, who cover both PNGS Units 1 and 4 and Units 5–8.
- There are four certified health physicists in all at Bruce, who cover both Bruce A and Bruce B.
- There are no reactor operators, Unit 0 operators or shift supervisors at Gentilly-2.



### **Initial certification examinations and requalification tests**

As noted above, health physicists are the only certified personnel employed at Gentilly-2. Since CNSC staff administer the initial examinations and requalification tests of the health physicists for Hydro-Québec, this specific area does not apply to Gentilly-2. There are no certified staff at the WMFs.

### **Work organization and job design**

All NPP licensees have a documented minimum shift complement (MSC), which forms part of its licensing basis. MSC is monitored each shift and is managed through face-to-face turnover, the use of electronic minimum complement monitoring systems, or the use of white boards that track staff in and out of the facility.

In 2019, licensees reported one MSC violation at the DNGS, two violations at the PNGS, one violation at Bruce A and B and three violations at Point Lepreau. All violations were of a short duration and the licensees took appropriate actions, e.g., calling in relief staff, holding over staff already present and operating in quiet mode.

### **Fitness for duty**

CNSC oversight of fitness for duty includes assessing licensee measures related to managing worker fatigue, managing alcohol and drug use, and minimum requirements for medical, physical and psychological certificates for nuclear security officers.

#### Managing worker fatigue

All NPP licensees have procedures to manage worker fatigue that include limits on hours of work.

CNSC REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* specifies requirements and guidance for managing worker fatigue at all high-security sites, with the aim of minimizing the potential for errors that could affect nuclear safety and security. OPG, Bruce Power and Hydro-Québec implemented this regulatory document in 2019, while NB Power planned to implement the document by 2020 for normal operations and 2022 for outages. NB Power's plan involved expanding its security and emergency response team staff (to a six crew format working on a 42-day shift cycle, which would match its operations staff).

Type I inspections to confirm compliance with REGDOC-2.2.4 were planned in 2020 for OPG and Bruce Power.

UPDATE: In May 2020, NB Power informed CNSC of a revision to its implementation plan, resulting in a planned implementation for operations by April 2021. CNSC staff reviewed the revised implementation plan and found it to be acceptable.

#### Managing alcohol and drug use

REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* sets out requirements and guidance for managing fitness for duty of workers occupying safety-sensitive and safety-critical positions in relation to alcohol and drug use at all high-security sites. All licensees of high-security sites provided implementation plans early in 2018, which were accepted by CNSC staff. In late 2018, OPG, Bruce Power and NB Power requested an amendment to include oral fluid testing to supplement the urinalysis

testing required by the regulatory document. OPG, Bruce Power and NB Power requested a change to their implementation dates, proposing to implement REGDOC-2.2.4 Volume II within a period following the date of its amendment (or from the date it is determined that it will not be amended). The licensees proposed, specifically, to implement the requirements other than random testing within 6 months of that date and to implement random testing within 12 months of that date. CNSC staff reviewed and accepted the request and began work in 2019 to revise REGDOC-2.2.4 Volume II.

Hydro-Québec implemented the current version of REGDOC-2.2.4 Volume II in July 2019.

CNSC staff anticipate the amended regulatory document to be submitted to the Commission for approval at the end of 2020.

#### Nuclear security officer medical, physical and psychological fitness

Licensees are required to ensure that all nuclear security officers have medical, physical and psychological certificates that meet CNSC's requirements. CNSC REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical and Psychological Fitness* sets out the expectations and minimum requirements for medical, physical and psychological certificates for nuclear security officers. All licensees have committed to fully implementing the document by December 31, 2020.

## 2.3 Operating performance

### **Conduct of licensed activity**

Eighteen reactors continued to operate in Canada throughout 2019, along with the WMFs at the same sites – unchanged from the previous year. Unit 2 at Darlington was shut down in 2019 while refurbishment continued.

The licensees' quarterly reports for operating NPPs include data on the performance indicator "Number of unplanned transients", which tracks unplanned transients (unexpected reactor power reductions) for each reactor that is not in a guaranteed shutdown state. Unplanned transients indicate problems within a plant and place unnecessary strain on its systems.

Table 4 summarizes the number of unplanned transients for the operating NPPs caused by setbacks, stepbacks and reactor trips<sup>2</sup>, where the trip resulted in a reactor shutdown. "Industry total" provides the data for the operating NPPs as a whole. In 2019, all unplanned transients were properly controlled and adequately initiated by the reactor control systems. CNSC staff also determined that no serious process failures occurred at any NPP in 2019.

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<sup>2</sup> Setbacks and stepbacks are automated power reductions (setbacks are slower; stepbacks are faster) intended to eliminate potential risks to plant operations. Trips are reductions initiated by any of a reactor's safety circuits to rapidly shut down the reactor.

**Table 4: Number of unplanned transients**

NPP	Number of operating reactors	Number of hours of operation	Un-planned reactor trips <sup>1</sup>	Step backs	Set backs	Total unplanned transients	Number of trips per 7,000 operating hours
DNGS	4	23,521	0	0	1	1	0.00
PNGS 1, 4	2	17,378	0	n/a <sup>2</sup>	0	0	0.00
PNGS 5–8	4	29,780	0	0	5	5	0.00
Bruce A	4	30,002	2	2	2	6	0.47
Bruce B	4	29,393	0	1	1	2	0.00
Point Lepreau	1	8,110	0	0	1	1	0.00
Industry total	19	138,184	2	3	10	15	0.10

**Notes:**

- 1 This includes automatic reactor trips only; it does not include manual reactor trips or trips during commissioning testing.
- 2 Stepbacks are not a design feature at PNGS Units 1 and 4.

Figure 3 shows the total number of unplanned transients from 2015 to 2019 for the operating NPPs.

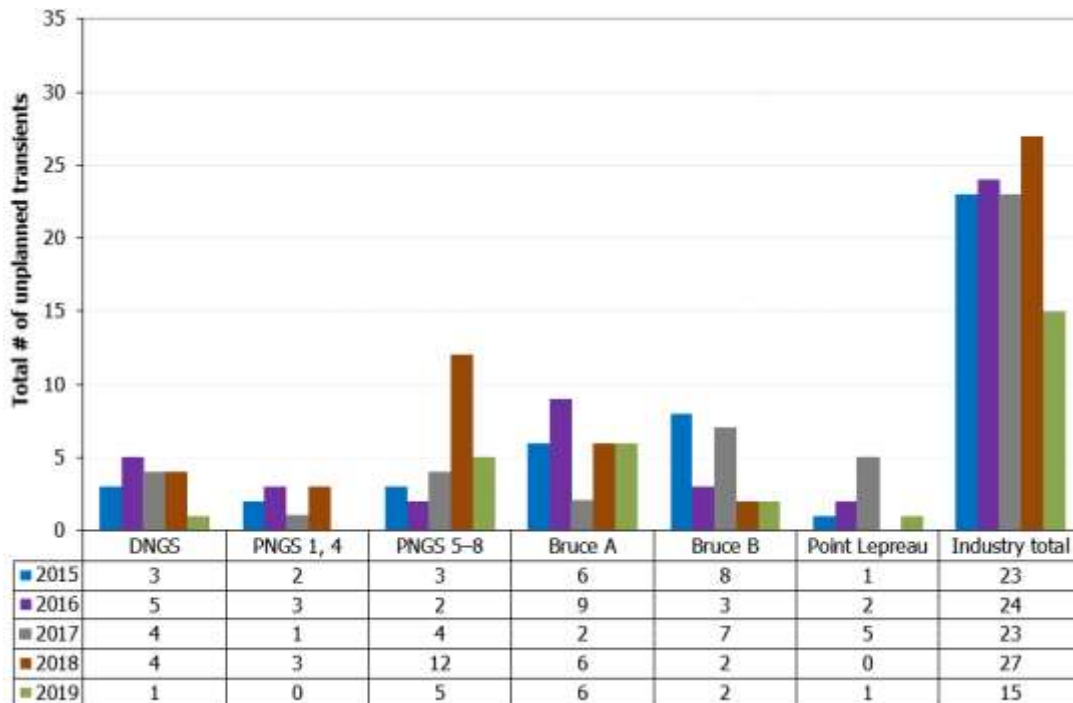
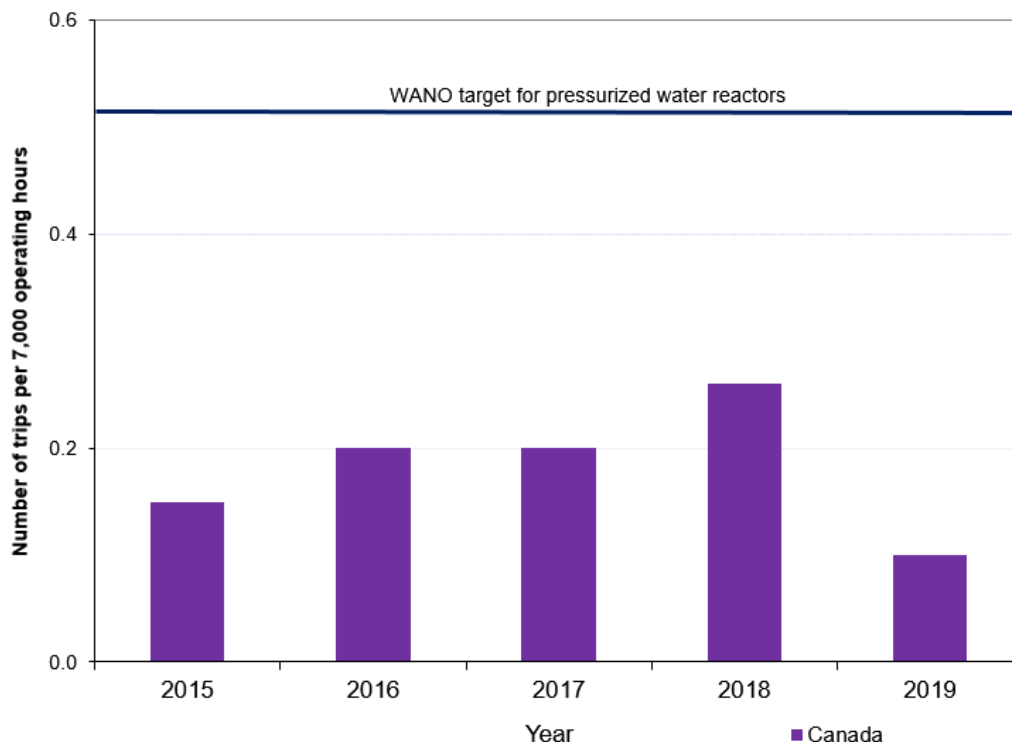
**Figure 3: Trend of unplanned transients for stations and industry**

Figure 4 compares the number of unplanned reactor trips for Canada’s operating NPPs per 7,000 hours of operation, which is a measure used by the World Association of Nuclear Operators (WANO). This WANO indicator is defined as the number of unplanned automatic scrams (reactor protection system logic actuations, which are comparable to ‘trips’ in the Canadian context) that occur per 7,000 hours of critical operation (which is approximately one year of operation). WANO establishes targets for this parameter for different types of reactor designs. The WANO target for individual pressurized heavy water reactors (PHWRs) is 1.5 scrams per 7,000 hours critical.

The WANO PHWR industry target (which is the equivalent industry total trips per 7,000 hour critical) is 1.0. CNSC staff derived from representative data in the 2019 WANO performance indicator publication that approximately 90% of reactor industries or groups worldwide met the WANO industry target (for the respective reactor type) of unplanned total scrams per 7,000 critical hours in 2019, and that approximately 70% of individual reactors worldwide met the individual target (for the respective reactor type).

According to the regulatory oversight report for 2018 [2], the WANO industry targets for PHWRs are the appropriate benchmark for the CANDU reactors. However, CNSC staff have used the more conservative targets for pressurized water reactors (PWRs) for comparison in figure 4. The WANO PWR targets for individual reactors and for the industry are 1.0 and 0.5 scrams per 7,000 hours critical, respectively. Thus, figure 4 superimposes a line at the challenging industry target (0.5) for pressurized water reactors. Figure 4 indicates that Canadian NPPs have been collectively well within that target since 2015. It is also clear that they would compare even more favourably against the WANO industry performance target for PHWRs.

**Figure 4: Trend of unplanned reactor trips per 7,000 operating hours**



### **Reporting and trending**

Besides requirements for NPP licensees to submit quarterly reports on operations and safety performance indicators, REGDOC-3.1.1 also expands on event reporting requirements in the regulations and specifies requirements for other quarterly and annual reports to the CNSC.

WMF licensees are required to submit annual reports on operations as described in REGDOC-3.1.2. In addition, OPG is required by conditions in the WFOLs to provide a quarterly operations report for all three WMFs. Similar to REGDOC-3.1.1, this regulatory document also expands on event reporting requirements for non-power reactor Class I nuclear facilities and uranium mines and mills.

The *General Nuclear Safety and Control Regulations* outlines specific scenarios under which licensees must file a report to the CNSC. For every reportable event, the licensees must file an event report that provides details regarding the event, including effects on the environment, the health and safety of persons and the maintenance of security that have resulted or may result from the situation. Corrective actions that the licensees have taken or propose to take with respect to the reportable event must also be included. In 2019, CNSC staff observed that licensees performed all required follow-up on all events with corrective actions and root cause analyses, when appropriate.

### **Outage management performance**

During the planned outages in 2019 for all units of operating NPPs, CNSC staff conducted inspections to confirm that regulatory requirements were met and outages were executed safely. All planned and unplanned (forced) outages were followed-up appropriately by licensees' staff. CNSC staff informed the Commission on all unplanned outages resulting from reactor trips and associated follow-up via regular status reports on NPPs in 2019.

### **Safe operating envelope**

CNSC staff determined that all licensees of operating NPPs had adequate safe operating envelope (SOE) programs in 2019. The licensees implemented a hierarchy of documents to support producing, updating and maintaining SOE-related documentation. CNSC staff also determined that all licensees operated within the SOE in 2019.

### **Severe accident management and recovery and Accident management and recovery**

REGDOC-2.3.2, *Accident Management*, Version 2 provides updated regulatory requirements for accident management at reactor facilities. All operating NPP licensees have implementation plans for REGDOC-2.3.2.

In 2019, licensees continued to update their severe accident management guidelines (SAMGs) to incorporate post-Fukushima lessons learned, including the addition of guidelines and strategies to deal with multi-unit events for multi-unit NPPs, events in irradiated fuel bays and events during shutdown states. In 2019, CNSC staff continued their review of the severe accident management programs for the DNGS and Bruce A and B.

## 2.4 Safety analysis

### Deterministic safety analysis

In 2019, the NPP licensees continued their safety analysis improvement programs, which include revisions to their facility descriptions and safety analysis reports, in support of the staged implementation of REGDOC-2.4.1, *Deterministic Safety Analysis*. CNSC staff were satisfied with the progress in 2019 and provided recommendations to the licensees on their ongoing safety analyses improvements. The existing deterministic safety analyses remained adequate during the continued implementation of REGDOC-2.4.1 throughout 2019.

Safety analysis updates in 2019 included those needed to reflect changing reactor conditions, including those associated with aging of components. The licensees of operating NPPs also submitted to the CNSC specific analyses that were associated with refurbishment projects and IIPs. Examples are provided in Section 3.

Large-break loss-of-coolant accident (LBLOCA) are analyzed to demonstrate sufficient safety analysis margin for the limiting break size. OPG, NB Power and Bruce Power had proposed the composite analytical approach (CAA) to demonstrate that safety analysis margins for LBLOCA were larger than those evaluated using the traditional safety analysis method that is based on a limit-of-operating-envelope approach. They also intended to use CAA to justify the reclassification of some LBLOCA events as beyond-design-basis accidents (BDBA) by demonstrating the very low frequency of those events. The proposed CAA methodology was deemed to be consistent with the requirements in REGDOC-2.4.1.

In 2019, CNSC staff accepted a CAA submission from Bruce Power that demonstrated the low frequency of pipe breaks above a threshold break size (TBS). See Section 3.5.4 for details.

UPDATE: In January 2020, Bruce Power submitted a revised LBLOCA analysis and requested that LBLOCA events involving breaks larger than the TBS be reclassified as BDBAs.

OPG continued to support the industry efforts in its resolution of safety analysis margins for LBLOCAs using the CAA as part of its long-term plan. Details on OPG's short-term approach are provided in Section 3.1.4.

NB Power continued to cooperate with Bruce Power in 2019 on the generic aspects of the CAA project and may consider a CAA-based analysis in the future.

### Probabilistic safety assessment

REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* introduces new requirements (such as considerations of multi-unit impacts; combinations of hazards, plant operational states other than the at-power and shutdown states, and other radioactive sources including the irradiated fuel bay). Point Lepreau has been compliant with REGDOC-2.4.2 since 2016.

In 2019, the DNGS, PNGS and Bruce A and B continued to comply with CNSC regulatory document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. The DNGS and PNGS were progressing their implementation plans to comply

with REGDOC-2.4.2 by 2020. Bruce Power submitted PSA reports in 2019 to demonstrate compliance with the requirements of REGDOC-2.4.2, which CNSC staff were reviewing at the end of 2019.

CNSC staff noted that OPG and Bruce Power were addressing the additional requirements outlined in REGDOC-2.4.2, through:

- PSA – for the consideration of multi-unit impacts
- Other alternative analyses methods, as allowed by REGDOC-2.4.2, such as the screening and bounding analyses – for the consideration of combinations of external hazards, other plant operational states, and other radioactive sources such as the irradiated fuel bays

The licensees were also participating in CANDU Owners Group projects to address REGDOC 2.4.2 requirements. Table 5 summarizes the status of PSAs at the operating NPPs in 2019.

**Table 5: Status of PSAs and reviews**

PSA submission	DNGS	PNGS 1, 4	PNGS 5–8	Bruce A	Bruce B	Point Lepreau
Last PSA report received	2015	2018	2017	2019	2019	2016
Review status	Completed	Completed	Completed	Ongoing*	Ongoing*	Completed
Next PSA report expected	2020	2023	2022	2024	2024	2021
Expected compliance REGDOC-2.4.2	2020	2020**	2020**	2019	2019	2016

\* CNSC staff planned to complete its review in 2020.

\*\* OPG committed to provide to the CNSC, by the end of 2020, updates for PNGS A and PNGS B; the updates would solely focus on the additional updated requirements of REGDOC-2.4.2 that go beyond S-294 requirements including, for example, risk assessments of the irradiated fuel bay and other less significant risk contributors.

In addition to addressing the new<sup>3</sup> requirements in REGDOC-2.4.2, NPP licensees have also worked collaboratively to address direction from the Commission to OPG (associated with the renewal of the operating licence for the PNGS in 2013) to develop an approach for whole-site PSA. Whole-site PSA involves estimating aggregate risk for sites with multiple reactors and other radioactive sources. OPG submitted the whole-site PSA for the PNGS in 2017 [RIB 17557 Part (ii)]. Bruce Power submitted its whole-site PSA methodology in 2018 [RIB 14760] and submitted the aggregated risk values for whole-site PSA for Bruce A and B in April 2019 [RIB 14759]. CNSC staff completed the review in 2019. Based on the information submitted, CNSC staff acknowledged that the submissions provided a good characterization of the whole-site risk.

<sup>3</sup> These are new requirements in REGDOC-2.4.2, compared to its predecessor S-294

OPG submitted a whole-site, aggregated risk value for the DNGS in 2015. As part of a whole site PSA for the DNGS, OPG was planning a risk aggregation calculation in 2020 based on the simplified aggregation method that was used for the PNGS and the available results from the DNGS PSA.

As part of the action [RIB 8504] on CNSC staff to provide an update to the Commission on the activities associated with the establishment of a proposed regulatory position on risk aggregation, staff provided the Commission with an update in December 2017 on whole-site PSA [3]. The update included a presentation on staff's active role in the international effort, especially with the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA), and on site-level PSA (including multi-unit PSA) developments including risk aggregation. The NEA work on the status of site-level PSA developments was completed in December 2018, and the NEA planned to issue the final report in 2020. The IAEA project on multi-unit PSA (MU-PSA) was completed, including its Phase 3 "Review of the MU-PSA methodology in light of the lessons learnt from the Phase 2 case study". The IAEA was proceeding to publish it as part of the IAEA Safety Report Series.

Both the NEA and IAEA projects reiterated that the scope of risk aggregation is highly dependent on the regulatory requirements, as well as on the intended uses and applications of the PSA. CNSC staff position with regard to risk aggregation is further elaborated in Section 4.2.2 guidance of REGDOC-2.5.2, *Design of Reactor Facilities: Nuclear Power Plants* and remains valid. Section 4.2.2 states the following:

"It is recognized that when the risk metrics for external events are conservatively estimated, their summation with the risk metrics for internal events can lead to misinterpretation. Should the aggregated total exceed the safety goals, conclusions should not be derived from the aggregated total until the scope of the conservative bias in the other hazards is investigated."

### **Severe accident analysis**

In 2019, the licensees of operating NPPs continued their severe accident analyses to support PSA Level 2 for the evaluation of plant safety goals, in order to demonstrate the effectiveness of their severe accident management programs and to support severe accident drills and exercises for emergency preparedness and response.

NB Power submitted an updated PSA Level 2 methodology and continued to work on the update of PSA Level 2 analysis. In this updated methodology, a large set of severe accident analyses (using the recently-updated severe accident computer code MAAP5-CANDU) were defined and planned to be performed to support safety goals evaluation for Point Lepreau. NB Power's methodology for MAAP5-CANDU simulations was acceptable to CNSC staff.

In 2019, CNSC staff were reviewing the severe accident analysis of the Bruce Power and OPG NPPs in support of their Level 2 PSAs. CNSC staff planned to complete the reviews in 2020.

### **Management of safety issues (including R&D programs)**

CNSC staff continued to monitor the management of CANDU Safety Issues (CSIs) by licensees of operating NPPs to ensure timely and effective implementation of plant-



specific safety improvement initiatives and risk control measures. In 2019, there were four remaining Category 3 CSI issues, three of which are related to LBLOCA:

- AA9 – analysis for void reactivity coefficient (Category 3)
- PF9 – fuel behavior in high temperature transients (Category 3)
- PF10 – fuel behavior in power pulse transients (Category 3)

As noted above, the licensees of operating NPPs continued to develop the CAA methodology in order to address the LBLOCA CSIs. Through an industry-wide agreement, Bruce Power was taking the lead in the regulatory application of the CAA methodology. In 2019, long-standing work on the reclassification of the CSIs related to LBLOCA progressed. For Bruce Power, CNSC staff reviewed the submission related to the CAA for LBLOCA, TBS assessment and additional information in support of the CAA. Subsequently, in November 2019, CNSC staff accepted Bruce Power's request for reclassification of the three large LOCA CSIs (AA9, PF9 and PF10) from Category 3 to Category 2.

For the other licensees, work in this area was ongoing and the licensees were expected to submit requests for the reclassification of these CSIs once their analyses were completed.

The fourth Category 3 issue, IH6, is related to the systematic assessment of the effects of high-energy pipeline breaks inside containment. At the beginning of 2019, it was only applicable as a Category-3 CSI to PNGS Units 1 to 4 and Point Lepreau. For PNGS Units 5 to 8, CNSC staff had re-categorized CSI IH6 from Category 3 to Category 2 in 2018. In November 2019, CNSC staff completed their review of OPG's request pertaining to re-categorization of CSI IH6 for PNGS Units 1 to 4. Based on OPG's response to CNSC staff's request for additional information and clarifications, OPG's re-categorization request for CSI IH6 for PNGS Units 1 to 4 from Category 3 to Category 2 was granted. However, this re-categorization was conditional on OPG providing further assurance of the actual condition of the non-nuclear, high-energy pipelines inside containment. For Point Lepreau, CNSC staff reviewed NB Power report's regarding CSI IH6 analysis and, in January 2019, re-categorized CSI IH6 from Category 3 to Category 2 for Point Lepreau.

CSI AA3, on computer code and plant model validation, had previously been reclassified from Category 3 to Category 2. As part of ongoing activities to address residual issues related to CSI AA3, the licensees of operating NPPs had contributed to the revision of the CANDU Owners Group (COG) guidelines on code validation and code accuracy assessment, as described in the regulatory oversight report for 2018 [2]. The licensees were also addressing other areas that needed further improvements to meet the objectives of the computer code and plant model validation program associated with CSI AA3. In 2019, the licensees provided a status update on the remaining work related to CSI AA3 and requested the closure of the associated action items. At the end of 2019, CNSC staff's review was in progress.

In 2019, CNSC staff continued to undertake systematic evaluations to confirm that the industry maintains or has access to a robust R&D capability to address emerging issues and enhance knowledge and confidence in safety provisions in key areas.

The licensees continued to participate in COG R&D and joint project programs, in collaboration with both national and international stakeholders, which included ongoing monitoring, review, and maintenance of R&D capability.

In 2019, all licensees submitted their 2018 COG R&D Annual Reports, which included:

- annual COG R&D program overview reports and operational plans
- multi-year strategic plans and capability maintenance reviews

The COG R&D program included the following five base program areas and the strategic R&D program:

- fuel channels
- safety and licensing
- health, safety and environment
- chemistry, materials and components
- Industry Standard Toolset

These programs aimed to support the safe, reliable and efficient operation of CANDU reactors in the short- and long-term. Their main objectives included the following:

- provide qualitative and quantitative experimental data to demonstrate key phenomena during the late phase of a postulated severe accident
- develop a consistent set of minimal requirements for the assessment of doses
- develop and demonstrate the effectiveness of various mitigation features in containment
- support the industry in increasing safety margins in CANDU stations in all operational states
- provide a database for use in industry tool set computer codes

## 2.5 Physical design

In 2019, each licensee carried out various modifications with no impact on its ability to operate within its safety case, while improving the overall performance of its facilities and improving safety in design and operations.

### Design governance

In 2019, CNSC staff reviewed the licensees' updates of their fire protection programs and fire protection assessments and confirmed that they complied with the applicable fire protection requirements.

### System design

In 2019, CNSC staff confirmed that the licensees' electrical power systems (EPSs) and instrumentation and control (I&C) functioned as expected.

## Components design

Licensees of operating NPPs have mature fuel design and inspection programs.

Over the past several years, operating NPPs have experienced challenges related to fuel performance (such as fuel defects or fuel bundle vibrations). However, licensee fuel programs and personnel have adequately managed these challenges. Regulatory limits for fuel bundle and fuel channel power were met throughout this period. Fuel performance has returned to historic norms, with the remaining challenges having mitigation strategies in place or in development. CNSC staff continued to monitor the status of the mitigation strategies and were satisfied with the licensees' management of these issues in 2019. Details on individual licensee challenges and performance are provided in section 3.

The licensees of operating NPPs have cable condition monitoring and surveillance programs that are verified through compliance activities to ensure their effectiveness in supporting safe and reliable operations. CNSC staff were satisfied with the licensees' management of these programs in 2019.

## 2.6 Fitness for service

### Equipment fitness for service / equipment performance

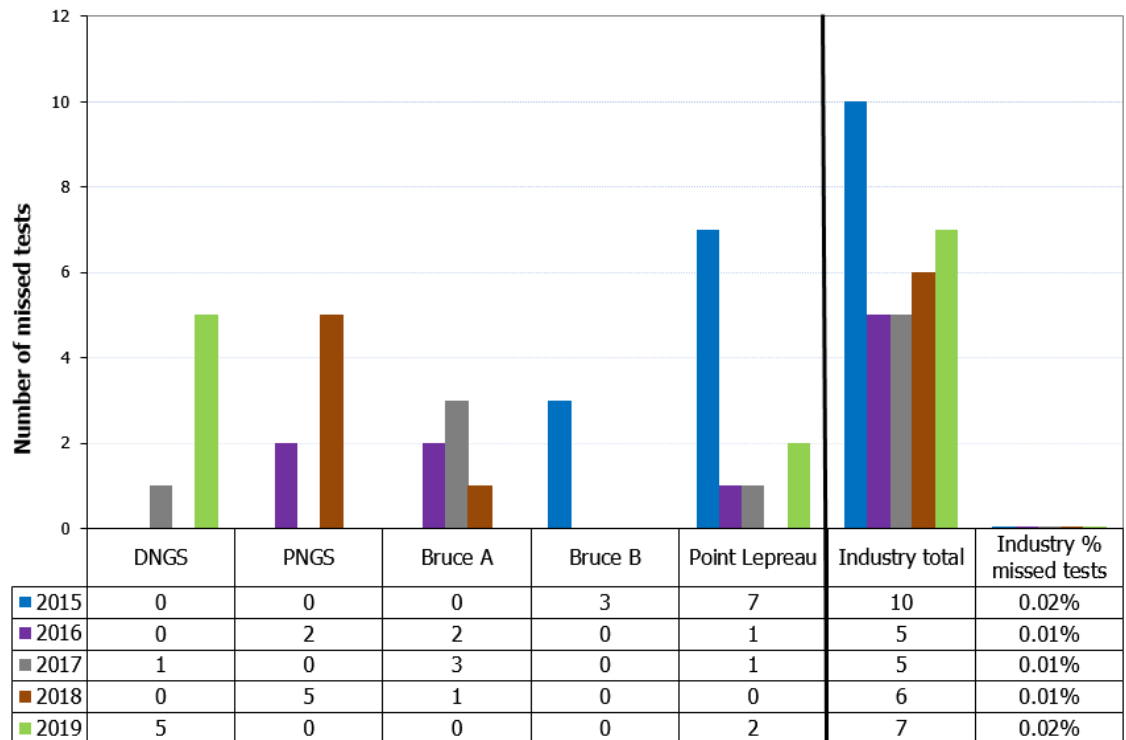
The licensees of operating NPPs monitor the performance or condition of the special safety systems (SSSs) against unavailability targets (no higher than 0.001) to ensure that these systems are capable of fulfilling their intended functions. Overall, the SSSs performed well in 2019 and met their unavailability targets, with some exceptions as outlined in section 3.

The licensees also monitored missed tests of systems important to safety. Data for the operating NPPs and "the industry" as a whole are shown in table 6 and figure 5.

The number of total missed safety system tests remained very low in 2019. In all, 49,281 tests were performed and the percentage of missed tests was 0.01 percent. The impact of missing a single test is negligible because the NPP designs have sufficiently high redundancy to ensure continuous availability of the safety systems. Table 6 indicates that there were five tests of SSSs that were not fully completed before the due date.

**Table 6: Safety system test performance for 2019**

Nuclear power plant	Number of annual planned tests	Safety system tests not completed				Percent not completed
		Special safety systems	Standby safety systems	Safety-related process systems	Total	
DNGS	10,381	3	1	1	5	0.05
PNGS	14,318	0	0	0	0	0.00
Bruce A	9,628	0	0	0	0	0.00
Bruce B	8,824	0	0	0	0	0.00
Point Lepreau	4,093	2	0	0	2	0.05
Industry total	47,244	5	1	1	7	0.01

**Figure 5: Trend of safety system test performance for NPPs and industry**

In 2016, OPG initiated a joint fuelling machine reliability project with NB Power through COG with the aim to prevent premature failures of the fuelling machine ram seals. Following engineering, testing and manufacturing, OPG received new (type IV) ram seals, housings and sleeves in 2019 for Pickering Units 5 to 8. OPG completed the initial installation (Unit 8 West) on December 27, 2019 [RIB 17557 (item iii)].

UPDATE: OPG completed the next installation (Pickering Unit 7 East) on April 30, 2020. The two fuelling machines with replaced seals had fuelled hundreds of fuel channels with no performance issues. OPG was proceeding with the installation of the new seals for the remaining fuelling machine rams for Units 5 to 8. OPG also expected to receive additional materials to service rams for Pickering Units 1 and 4 by the end of August 2020.

### Maintenance

The preventative maintenance completion ratio (PMCR) quantifies the effectiveness of the preventive maintenance program in minimizing the need for corrective maintenance activities for safety-related systems. The average PMCR value for operating NPPs was 94% in 2019. CNSC staff were satisfied with the effectiveness of the licensees' preventative maintenance.

The corrective maintenance backlog, deficient maintenance backlog and deferrals of preventive maintenance are used to monitor the effectiveness of the maintenance program at NPPs. The corrective and deficient maintenance backlogs reported in this regulatory oversight report are for critical components.

The maintenance backlogs and deferrals for the industry are provided in table 7. The industry average of these three performance indicators continuously decreased or were kept low in 2019. Overall, CNSC staff were satisfied with the progress in 2019. The current levels of the maintenance backlogs and deferrals for critical components for the NPPs represent a negligible risk to the safe operation of the NPPs.

**Table 7: Trend of industry maintenance backlogs and deferrals for critical components of NPPs**

Performance indicator	Average quarterly work orders per unit in 2017	Average quarterly work orders per unit in 2018	Average quarterly work orders per unit in 2019	Three-year trending
Corrective maintenance backlog	4	1	1	down
Deficient maintenance backlog	94	16	9	down
Deferrals of preventive maintenance	30	4	2	down

### **Aging management**

#### *Pressure tubes and fuel channels – Overall performance*

With respect to the pressure tubes in operating NPPs, overall, CNSC staff were satisfied that the lifecycle management plans (LCMPs) reflected sound aging management. CNSC staff also continued to review the results from fuel channel inspections that occurred routinely during planned inspection outages in 2019. They confirmed that no new flaw-initiation mechanisms were identified and that licensees appropriately evaluated any findings that required disposition, in accordance with CSA Group standards. CNSC staff concluded that fitness-for-service of inspected pressure tubes was effectively demonstrated.

CNSC staff were satisfied with the licensees' work to ensure that fuel channel spacers continued to perform their design function in 2019. A review of available information confirmed that the spacers were behaving predictably.

CNSC staff have enhanced regulatory oversight for licensees' activities to assess and manage the aging of fuel channels for units entering periods of extended operation. This increased focus on fuel channels is due to the fact that they are being operated beyond 210,000 effective full-power hours (EFPH) at some units. (Designers assumed 210,000 EFPH in order to establish the inspection requirements and acceptable levels of in-service degradation for CANDU pressure tubes.)

#### *Recent developments and research in aging management*

For in-service changes in pressure tube properties (such as fracture toughness), equivalent hydrogen (Heq) concentration is more important than EFPH. Fracture toughness is an important parameter that is modelled and used for assessments of leak-before-break and

fracture protection of pressure tubes. For temperatures below 250 °C, Heq content in the pressure tube is a critical input to the fracture toughness model. The analytical fracture toughness model that the CNSC currently accepts for use in this temperature range is valid only up to a Heq concentration of 120 ppm.

The licensees continued R&D related to the modelling of fracture toughness of pressure tube material in 2019 as some operating reactors may reach a Heq concentration of 120 ppm before their planned shutdown or refurbishment. In addition, improvements related to the model and its applicability were needed to maintain confidence in its use.

CNSC staff consider that the current regulatory process to monitor additional validation of the existing fracture toughness model up to Heq of 120 ppm is adequate to ensure that it will adequately support CSA-mandated assessments. In preparation for units approaching the validity limit of the existing toughness model (120 ppm Heq in any pressure tube), licensees must also develop a revised toughness model (capable of predicting toughness beyond 120 ppm Heq) and submit the technical basis for CNSC staff's approval well before any pressure tube reaches 120 ppm.

The licensees must seek CNSC staff concurrence (for the PNGS) or Commission approval (for Bruce A and B) to operate any pressure tube beyond 120 ppm Heq. Details on the current and anticipated future fuel channel conditions and validity of the fracture toughness model for the NPPs in Ontario are provided in Appendix C.

In 2019, CNSC staff actively monitored the industry's progress in research activities to ensure that licensees have sufficient understanding of degradation issues to safely operate pressure tubes, especially those planned for extended operation. Specifically, CNSC staff monitored the fuel channel life confirmation project, which included the following activities in 2019:

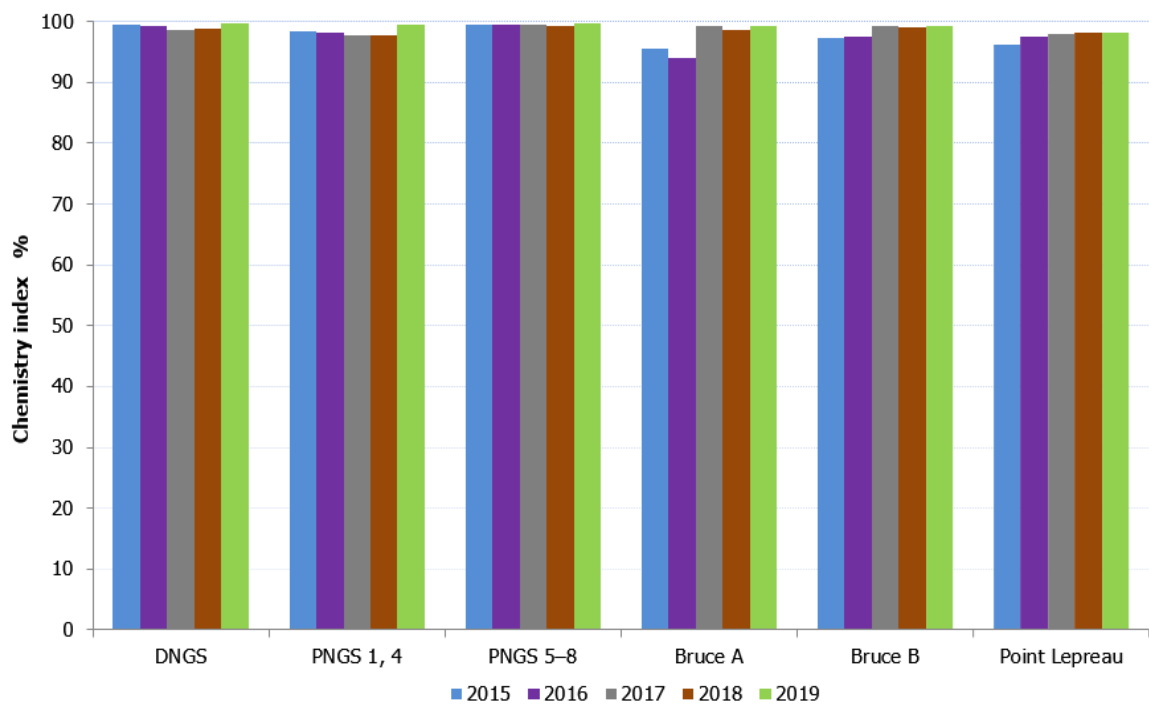
- research focusing on the fracture toughness of near-inlet areas of pressure tubes and changes in toughness occurring as Heq levels exceed 120 ppm [RIB 14757]
- collection of additional pressure tube burst-test data, supporting development of a revised version of the fracture toughness model [RIB 14757]
- continued development of assessment methodologies:
  - a probabilistic approach for demonstrating fracture protection (that is, confirmation that a pressure tube will continue to meet its design intent, if an undetected crack is subject to design-basis pressure/temperature transients)
  - a fully deterministic approach for assessing the risk of cracking due to hydrided region overload (that is, when a hydrided area is exposed to greater stress than existed when it was initially created)
- continued development of an industry-standard set of fitness-for-service guidelines for Inconel X-750 (a.k.a. "tight-fitting") annulus spacers

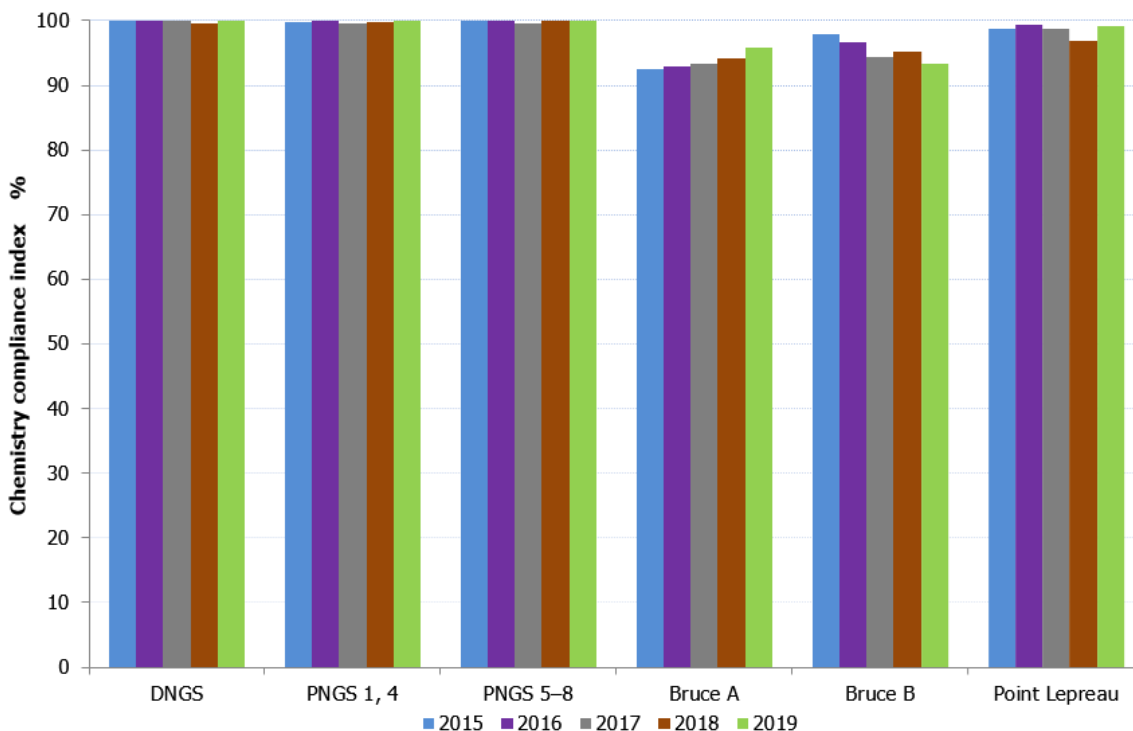
Overall, CNSC staff were satisfied with the licensees' work to demonstrate and support the safe operation of pressure tubes in the near- and medium-term.

### Chemistry control

Figures 6 and 7 show the values of the performance indicators “chemistry index” and “chemistry compliance index” for operating NPPs from 2015 to 2019. Based on these values, CNSC staff determined that chemistry control was acceptable for all licensees. The comparatively low results for the chemistry compliance index for Bruce A and B (figure 7) were due to a downward trend in moderator (heavy water [D<sub>2</sub>O]) isotopic purity for all units. However, there was no impact on the safe operation of Bruce A and B and safety system functions were not impaired.

**Figure 6: Trend of chemistry index for industry**



**Figure 7: Trend of chemistry compliance index for industry**

### Periodic inspections and testing

The licensees of operating NPPs are developing periodic inspection programs that comply with CSA N285.7, *Periodic Inspection and CANDU Nuclear Power Plant Balance of Plant Systems and Components*, which will be adopted as compliance verification criteria in the future for all operating NPPs except the PNGS. Implementation of a program for N285.7 was not practical for Pickering, given the planned shutdown in 2024. However, CNSC staff planned to apply experience gained from its implementation at other NPPs to the PNGS, in order to address potential safety concerns should the need arise.

## 2.7 Radiation protection

### Application of ALARA

In 2019, the total collective dose for monitored individuals at all Canadian NPPs and WMFs was 20.4 person-sieverts (p-Sv), approximately 21% lower than the industry-wide collective dose reported for 2018 (25.9 p-Sv). The number of persons who received a reportable dose in 2019 (9,857) was slightly higher than 2018 values (9,792). The decrease in total collective dose was mainly due to a reduction in high-dose refurbishment activities at the DNGS.

The vast majority of collective dose for the NPPs and WMFs occurs at the operating NPPs. The collective doses for the individual NPPs are shown in table 8. It illustrates that outages (including refurbishment activities) accounted for a much greater fraction of the collective dose than routine operations and that external dose was, collectively, much greater than internal dose.



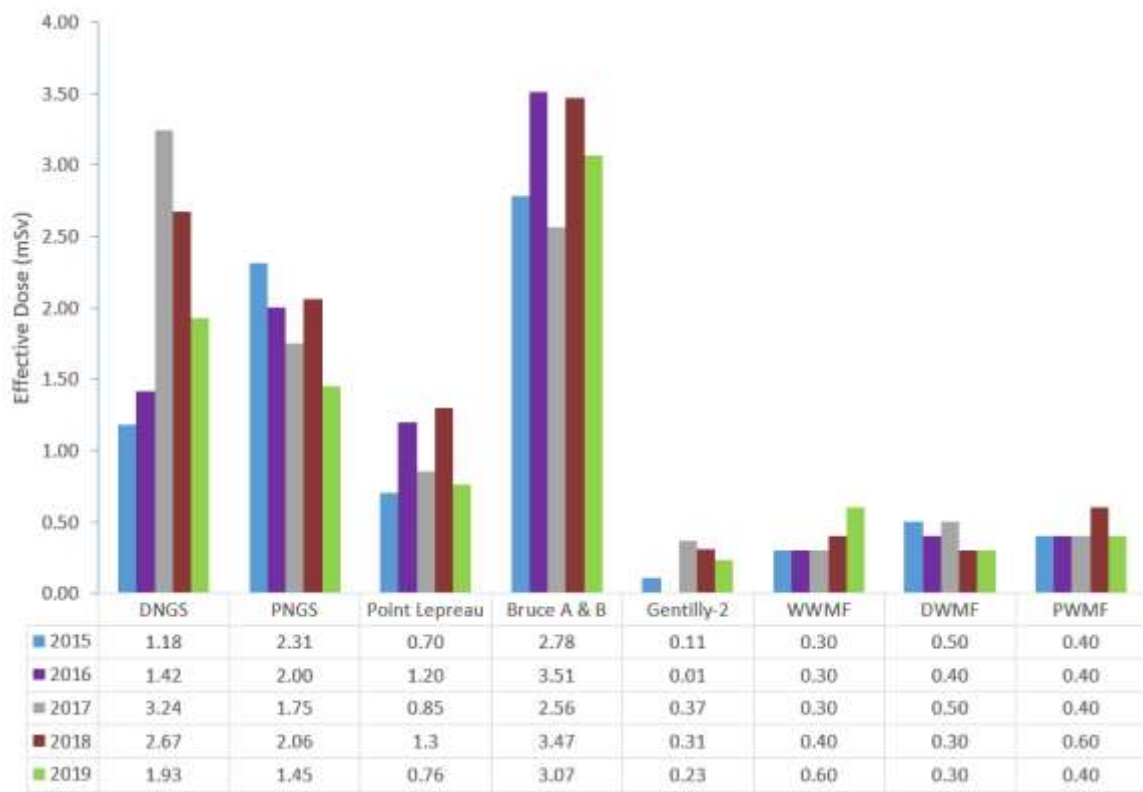
**Table 8: Breakdown of collective dose for operating NPPs in 2019 (person-mSv)**

NPP	Routine Operations	Outages	Internal	External	Total
Darlington	394	7,263*	469	7,188*	7,657*
Pickering	869	2,216	652	2,433	3,085
Point Lepreau	224	372	156	440	596
Bruce A	336	4,725	262	4,798	5,061
Bruce B	575	4,100	297	4,377	4,674

\* For 2019, only the DNGS had dose attributed to refurbishment activities.

Figures 8, 9, and 10 present the effective doses (average and maximum) and dose distributions to monitored persons, based on the dose records provided to the CNSC by the NPPs and WMFs for 2015 to 2019.

Figure 8 shows that, for 2019, the average effective dose at each NPP and WMF ranged from 0.23 to 3.07 mSv per year. In general, the fluctuations in average dose observed from year to year reflect the type and scope of work being performed at each facility. No negative trends were identified in 2019. The annual average effective dose in 2019 for all Canadian NPPs was 2.07 millisieverts (mSv), an approximate decrease of 21.5% from the 2018 value of 2.64 mSv.

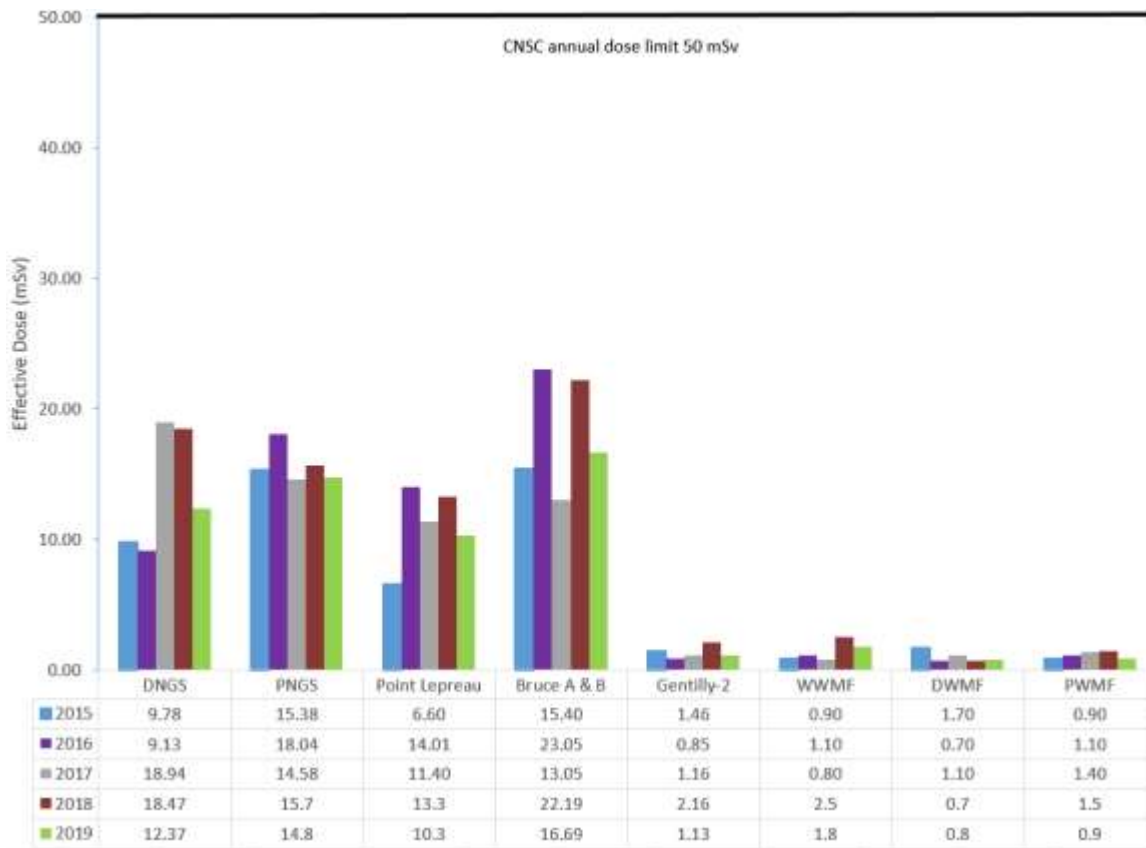
**Figure 8: Trend of average effective doses of monitored persons**

**Worker dose control**

The maximum annual individual effective doses, as reported by each NPP and WMF for 2015 to 2019, are presented in figure 9. In 2019, the maximum individual effective dose received at a single site was 16.69 mSv, received by a worker who performed duties at both Bruce A and B. In 2019. No radiation exposures received by persons at any NPP or WMF exceeded the regulatory dose limit of 50 mSv/year for nuclear energy workers, as established in the *Radiation Protection Regulations*.

Overall, CNSC staff were satisfied with the licensees’ control of worker doses in 2019.

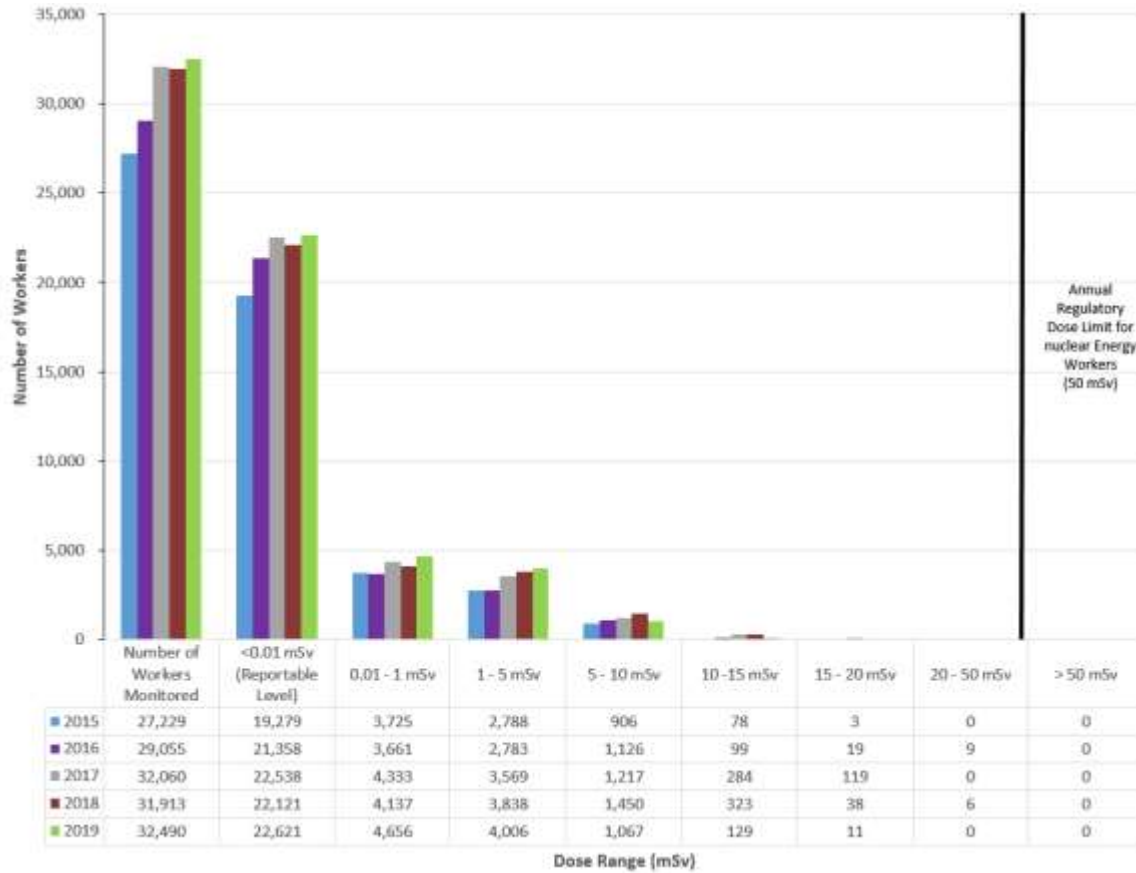
**Figure 9: Trend of maximum individual effective doses**



**Radiation protection program performance**

Figure 10 provides the distribution of annual effective doses to all monitored persons at all Canadian NPPs from 2015 to 2019. All doses reported over those years were below the annual regulatory dose limit of 50 mSv for nuclear energy workers. In fact, approximately 84% of the doses reported were at or below the much lower annual regulatory dose limit of 1 mSv for members of the public.

**Figure 10: Trend of distribution of annual effective doses received by all monitored persons at Canadian NPPs**



**Radiological hazard control**

In 2019, no contamination control action levels were exceeded and CNSC staff did not identify issues of safety significance at any NPP or WMF.

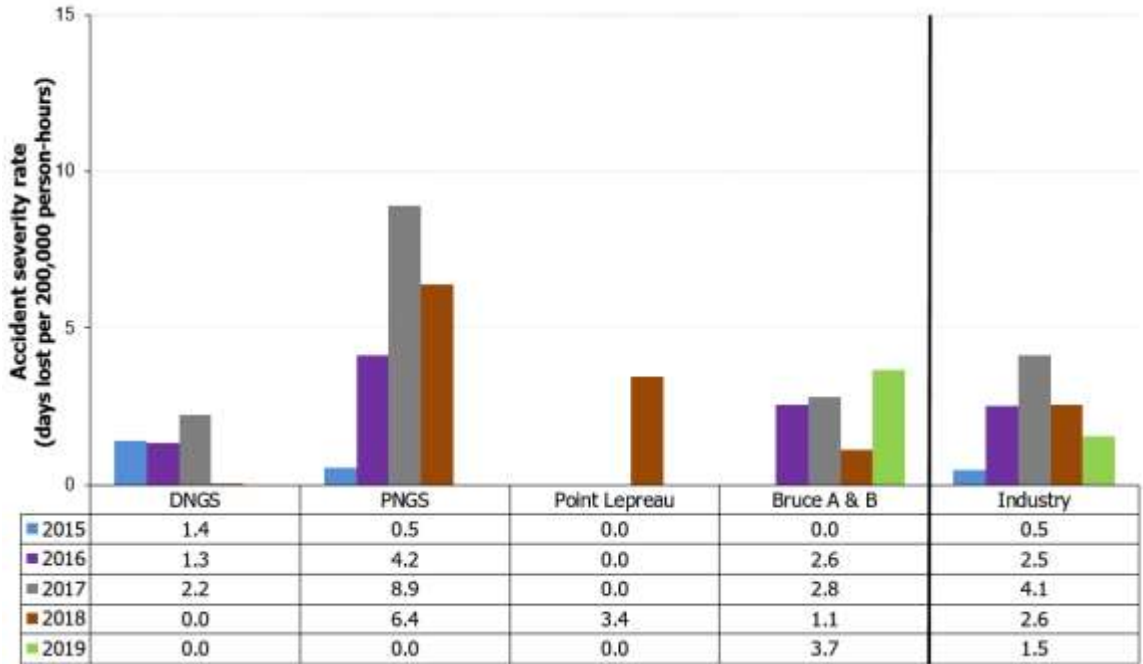
**2.8 Conventional health and safety**

**Performance**

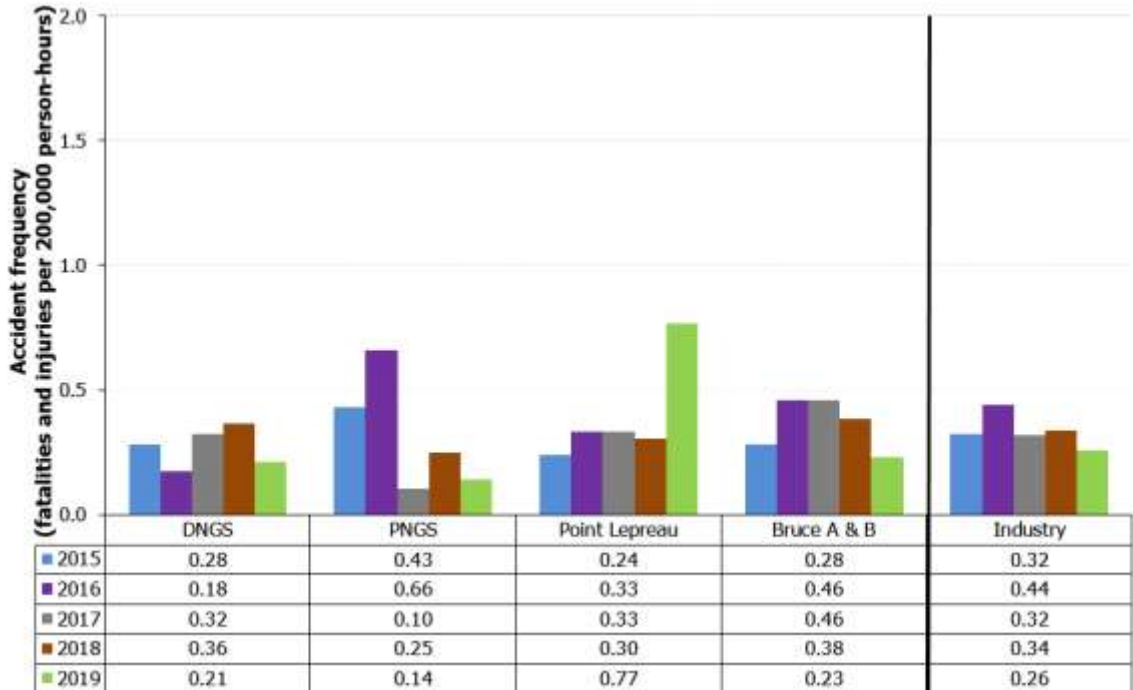
Data for the performance indicators “accident severity rate” (ASR), “accident frequency” (AF) and “industrial safety accident rate” (ISAR) are provided below. The ASR measures the total number of days lost due to work-related injuries for every 200,000 person-hours (approximately 100 person-years) worked 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 NPPs. The ISAR is a measure of the number of lost-time injuries for every 200,000 hours worked by NPP personnel.

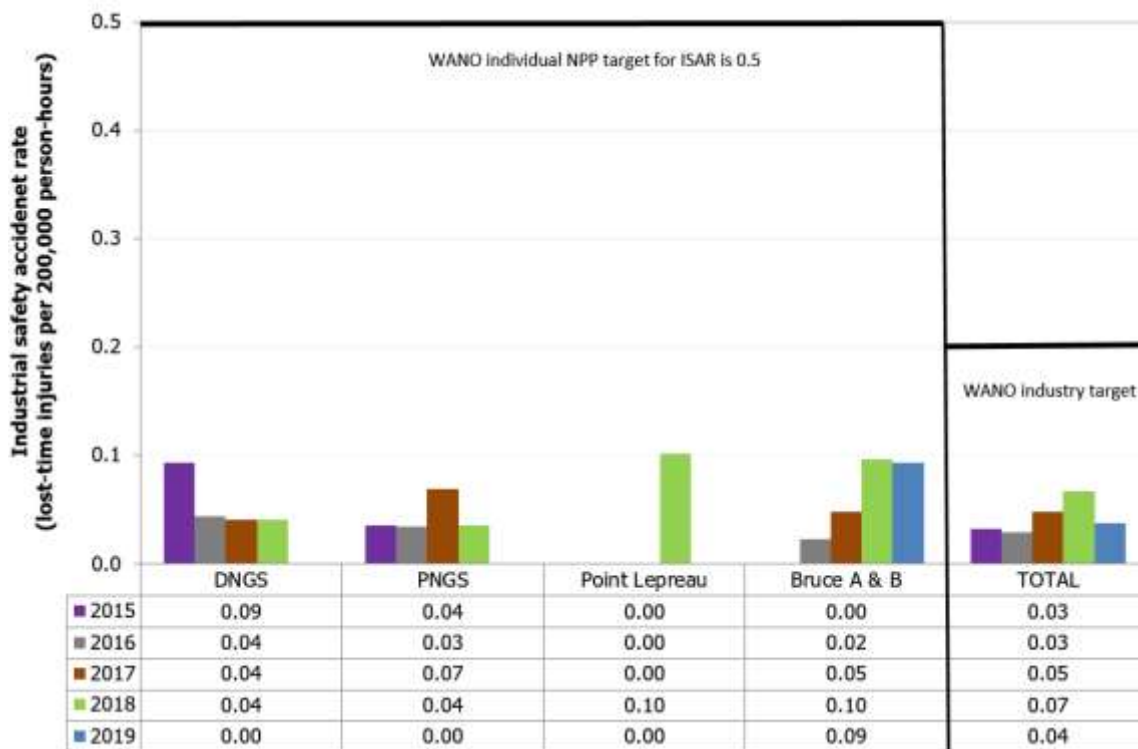
The ASR, AF and ISAR values for the NPPs and industry average are presented in figures 11, 12 and 13, respectively. The data in these figures indicate continuing low rates of accidents and lost time due to accidents. CNSC staff observed that no work-related fatalities occurred at Canadian NPPs and WMFs in 2019.

**Figure 11: Trend of accident severity rate for NPPs and Canadian industry**



**Figure 12: Trend of accident frequency for NPPs and Canadian industry**



**Figure 13: Trend of industrial safety accident rate for NPPs and Canadian industry**

## 2.9 Environmental protection

### Effluent and emissions control (releases)

Derived release limits (DRLs) are quantities of radionuclides (released as an airborne emission or waterborne effluent) that are calculated based on the regulatory dose limit for the public of 1 mSv per year. The DWMF and PWMF fall under the DRLs for the DNGS and the PNGS, respectively. The WWMF has its own facility-specific DRLs for airborne and liquid releases. The DRLs are provided in Appendix D.

Data on releases of radionuclides to the environment in 2019 are provided in Appendix D. The releases were well below the DRLs for each facility. Hence, no radiological releases to the environment from the facilities exceeded the regulatory limits. Further, only one environmental action level was exceeded in 2019 at the NPPs and WMFs (a monthly environmental action level; see section 3.3.9 for details). The environmental action levels are 10% of the DRL (or less, depending on the facility) for the release type. In fact, the releases were, in many cases, three or more orders of magnitude less than the applicable DRL.

### Environmental management system

All environmental management systems (EMSs) for operating NPPs and WMFs are registered with the International Standards Organization (ISO) 14001:2015 standard, *Environmental Management Systems – Requirements With Guidance for Use*. As a result of registration, the EMSs are subject to periodic, independent third-party audits and reviews to verify their sufficiency and identify potential improvements. CNSC staff

confirmed through inspections that annual management reviews of the EMS took place in 2019, and that corrective actions were documented.

### **Assessment and monitoring**

NPP and adjacent WMF licensees are required to submit annual environmental reports to the CNSC. Licensees also monitor groundwater around all sites and regularly submit the results to the CNSC. CNSC staff reviewed the 2019 monitoring results and concluded that the licensed operations had no adverse impact on the environment.

The CNSC's Independent Environmental Monitoring Program did not include monitoring activities in 2019 in the near vicinity of the facilities discussed in this regulatory oversight report. Program results from previous years had supported the conclusion that the public and the environment in the vicinity of all sites were protected.

### **Estimated dose to the public**

The estimated doses to the public for airborne emissions and liquid releases from 2015 to 2019 are provided in table 9. Note that the data for the DWMF, PWMF and WWMF are included in that of the Darlington, Pickering and Bruce sites, respectively. The table shows that the doses were well below the annual regulatory dose limit of 1 mSv for members of the public, as well as below 1.8 mSv, which is the average national annual background dose. A comparison of the 2019 data with that of previous years indicates that the values remained within the same general range (<0.01 mSv) as the values for 2015 to 2018.

The value for estimated dose in 2019 for Gentilly-2 (0.003 mSv) was lower than that of 2018 at Gentilly-2 but larger than the values for other NPPs. However 0.003 mSv is still a relatively small value (well below the regulatory limit of 1 mSv).

**Table 9: Trend of estimated dose to the public from Canadian nuclear power generating sites (mSv)**

	<b>Darlington Site</b>	<b>Pickering site</b>	<b>Point Lepreau</b>	<b>Bruce Site</b>	<b>Gentilly-2</b>
2015	0.0005	0.0012	0.0006	0.0029	0.0010
2016	0.0006	0.0015	0.0009	0.0016	0.0010
2017	0.0007	0.0018	0.0007	0.0021	0.0070
2018	0.0008	0.0021	0.0007	0.0017	0.0090
2019	0.0004	0.0017	0.0012	0.0015	0.0030

## **2.10 Emergency management and fire protection**

### **Nuclear emergency preparedness and response**

Note that OPG has a single, Consolidated Nuclear Emergency Plan that governs both the Darlington and Pickering sites and includes the Darlington and Pickering WMFs. The WWMF is under the nuclear emergency response plan and fire response plan for Bruce Power.

The licensees' nuclear emergency plans include measures to address on-site emergencies, as well as measures that support planning, preparedness and response for offsite emergencies. The following describes recent developments in 2019 related to off-site emergency planning and also provides, where needed, historical information from previous years related to the provincial nuclear emergency plans and related activities.

### Province of Ontario

#### *Provincial Nuclear Emergency Response Plan*

The Lieutenant Governor in Council of Ontario approved the updated Master Plan for the Provincial Nuclear Emergency Response Plan (PNERP) in December 2017. This approval triggered the development of site-specific implementing plans and subsequent incorporation of the relevant provisions in the Ontario licensees' emergency plans [RIB 17522 (item i)].

In 2018, the work focused on the Darlington, Pickering and Bruce Power PNERP implementing plans to ensure conformity with the Master Plan as well as updates to preparedness and response provisions since the last versions were issued in 2009. The Pickering and Bruce Power implementing plans received Order-in-Council approval in March 2018 [RIB 17522 (item ii)]. The Darlington implementing plan received final approval in March 2019. A technical study examining the planning basis for the Pickering, Darlington, Bruce Power and Fermi 2 areas through robust modelling was submitted in the spring of 2019 to the Solicitor General [RIB 17522 (item iii)]. Once released, the Ontario licensees plan to revise their training programs for new emergency response staff accordingly.

The Emergency Management Ontario (EMO) made progress in 2019 on a number of PNERP-related preparedness issues, including notification processes and agreements, participation in the CNSC-led working group on potassium iodide (KI) distribution and the revision of the emergency bulletins for alignment with the new PNERP.

Since June 2018, the Ontario Ministry of Transportation (MTO) was working to secure approval to procure a consultant to draft the transportation management methodology and five site-specific unified transportation management plans as required by the 2017 PNERP. In the fall of 2019, the approach shifted to consider options for the use of internal ministry resources. MTO staff were also involved in regular intra-ministry discussions to ensure that the unified transportation management plans integrate effective traffic control strategies and can be made operational in the field [RIB 17522 (item iv)].

OPG continued its work in 2019 to revise its public information and disclosure program for people living beyond the planning zone for Pickering [Item v) in RIB 17522]. OPG continued to collaborate with its key partners as members of the Pickering/Darlington Nuclear Public Education Sub-Committee (the next meeting of the sub-committee was planned for September 2020) and on the CNSC-led KI Pill Working Group. OPG also supported the Regional Municipality of Durham and the City of Toronto with the development of a local Public Education and Awareness strategy for the areas around the PNGS and DNGS, including those areas outside the detailed planning zone. That strategy and supporting tactics are targeted for completion by the end of 2020.

### *IAEA Emergency Preparedness Review Mission*

In 2018, the Office of the Fire Marshal and Emergency Management (OFMEM) continued to support Health Canada and the CNSC in the Ontario portion of the IAEA Emergency Preparedness Review (EPREV) which focused on the DNGS. In June 2019, OFMEM hosted the EPREV team in Toronto. See CMD 20-M14 [7] for details on the EPREV.

### *Environmental Radiation and Assurance Monitoring*

Environmental radiation and assurance monitoring is undertaken during a nuclear emergency to inform protective-action decision making as well as recovery planning. At the end of 2019, OFMEM finalized the Environmental Radiation and Assurance Monitoring Plan based on input from various stakeholders including federal departments and several Ontario ministries (Ministry of Health and Long-Term Care, Ministry of Labour, Training and Skills Development, Ministry of Agriculture and Food and Ministry of Environment, Conservation and Parks). Final approvals were expected in 2020, following which OFMEM planned to work with stakeholders to develop and implement the procedures needed to execute the plan, including necessary training. This effort was expected to take a number of years to complete.

### Province of New Brunswick

The New Brunswick Emergency Measures Organization (NBEMO) issued the new Point Lepreau Nuclear Off-Site Emergency Plan in August 2018 and made it available online. NBEMO aligned it with the applicable domestic and international requirements and made its interface more user-friendly. CNSC staff confirmed that Point Lepreau complied with the new plan.

In February 2019, the new Off-site Emergency Operations Centre located in St. George was declared operational.

NBEMO completed a demographic public safety survey between April and September 2019. It posed a variety of questions to all residents, which allowed NBEMO to produce detailed reports on residents living in the various zones surrounding Point Lepreau. NBEMO maintained the survey database and it also included data on distribution of iodide thyroid blocking tablets (e.g., who received them and when, as well as who refused them).

### Province of Quebec

The offsite nuclear emergency response plan for Quebec (“Plan des mesures d’urgence nucléaire externe à la centrale nucléaire Gentilly-2”, or PMUNE-G2) was abolished in 2016. However, Quebec’s broader emergency plan (“Plan national de sécurité civile” (PNSC)) remained in place to address emergencies in general. The PNSC involves the cooperation of various ministries and governmental organizations that have a defined role to play when responding to an emergency. The directorate for public health under Quebec’s Ministry of Health and Social Services will intervene for infectious, chemical, biological or radiological emergencies.



### Emergency exercises

Bruce Power held a full-scale exercise (Exercise Huron Resilience) at the Bruce site from October 20 to 23, 2019. This exercise tested and validated emergency preparedness, response capabilities and the collaborative and consultation processes of Bruce Power and its stakeholders. Bruce Power conducted a tabletop exercise of its business continuity procedures.

### **Fire emergency preparedness and response**

OPG conducted three fire drills at each OPG WMF in 2019.

## **2.11 Waste management**

### **Waste characterization, waste minimization and waste management practices and decommissioning plans**

The minimal low-level radioactive waste (LLW) generated at the DWMF and the PWF is typically restricted to floor sweepings that have a potential to contain contamination from preparing and welding dry storage containers (DSCs). The DWMF and PWF send their LLW – each totalling less than one drum per facility – to the DNGS and PNGS, respectively, for segregation as necessary. Eventually they are transported to the WWMF for processing and storage. LLW at the WWMF is processed and/or stored on-site. OPG does not generate intermediate-level radioactive waste (ILW) at the DWMF, PWF or WWMF.

OPG has a waste-sorting pilot project at the WWMF to further reduce the volume of waste stored at the facility through incineration, compaction, decontamination or free release.

All NPP and WMF licensees continued to employ effective programs for the characterization, minimization, handling, processing, transporting, storage and disposal of radioactive and hazardous wastes during 2019.

There were no changes to note for 2019 regarding the preliminary decommissioning plans (PDPs) for the nuclear facilities listed in this report. At the time of their review, CNSC staff found that the documents met and/or exceeded regulatory requirements and guidance. Note: The Bruce Power PDP is provided by OPG. Bruce Power and OPG have made their PDP's publically available.

The financial guarantees for decommissioning are discussed in section 2.15.

## **2.12 Security**

### **Facilities and equipment**

The licensees did not report any significant security equipment failures to CNSC staff in 2019.

### **Response arrangements**

All licensees provided well-trained and suitably equipped nuclear security officers and nuclear response force members for their facilities and have formal arrangements with offsite armed response services. The licensees contributed significant resources to the

CNSC performance testing program by providing expert staff and participants to the Canadian Adversary Testing Team, which is utilized to conduct force-on-force exercises at high-security sites.

### **Drills and exercises**

The licensees maintained drill and exercise programs in 2019 that met the applicable regulatory requirements and tested the effectiveness of the physical protection system at their facilities, consistent with their design basis threats.

### **Cyber Security**

Licensees were working through the COG cyber security peer group program to share lessons learned and develop best industry practices for implementing cyber security controls.

## **2.13 Safeguards and non-proliferation**

### **Nuclear material accountancy and control**

CNSC staff confirmed that the accountancy and control of nuclear material at all NPPs and WMFs complied with the applicable regulatory requirements in 2019. The licensees submitted their required monthly general ledgers on time.

The CNSC published REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy*, in February 2018. The regulatory document aims to establish a common understanding of the information, access and support that licensees are to provide to the CNSC and to the IAEA in order to facilitate Canada's compliance with its safeguards agreements.

The CNSC requested that the affected licensees provide an implementation plan for REGDOC-2.13.1 by July 2018. NB Power and Bruce Power implemented the new regulatory document by the end of 2019. OPG planned to fully implement the REGDOC by 2021, although it was already making significant progress towards implementation in 2019.

The CNSC determined that Hydro-Québec's Gentilly-2 facilities already met the new requirements. No additional action was required for Hydro-Québec.

### **Access and assistance to the IAEA**

In 2019, the IAEA conducted 19 announced, 5 short-notice and 30 unannounced inspections at the NPPs and WMFs. The numbers of activities conducted by the IAEA at each NPP and WMF in 2019 are provided in table 10.

**Table 10: IAEA safeguards activities for 2019**

Activity	DNGS	DWMF	PNGS	PWMF	Bruce A	Bruce B	WWMF	Point Lepreau	Gentilly -2	Totals
Physical inventory verifications	1	1	1	1	1	1	1	1	1	9
Design information verifications	1	1	2	1	1	1	1	1	1	10
Short-notice random inspections	1	N/A	1	N/A	1	1	N/A	1	0	5
Unannounced inspections	5	2	3	6	4	4	4	5	2	30
Complementary access	0	0	0	0	0	0	0	0	0	0

CNSC staff verified that the licensees met the applicable regulatory requirements for access and assistance at the NPPs and WMFs. Pursuant to the Canada/IAEA safeguards agreements and the facilities' licence conditions, the licensees granted timely access and provided adequate assistance to the IAEA for safeguards activities at the facilities. While the IAEA encountered minor implementation issues during a few inspections, it considered the overall results to be satisfactory.

### **Operational and design information**

CNSC staff confirmed that the licensees met the applicable regulatory requirements for operational and design information for the NPPs and WMFs in 2019. The licensees submitted their annual operational programs, with quarterly updates for their facilities, to the CNSC on time. The licensees also submitted their annual updates for the additional protocol to the CNSC on time, enabling CNSC staff to draft and submit Canada's additional protocol declarations to the IAEA. CNSC staff were satisfied with the information provided and concluded that it met the CNSC's submission requirements.

### **Safeguards equipment, containment and surveillance**

CNSC staff confirmed that the licensees met the applicable regulatory requirements for safeguards equipment, containment and surveillance for the NPPs and WMFs in 2019. The licensees supported IAEA equipment operation and maintenance activities, including maintenance and installation of surveillance equipment (such as IAEA cameras, seals and spent fuel monitors) to ensure the effective implementation of safeguards measures at each facility.

In January 2019, the single-unit CANDU NPPs (i.e., Point Lepreau and Gentilly-2) supported IAEA technical visits to discuss a revised safeguards approach for these facilities. This was a follow-up to the IAEA's site surveys in October 2017. Similar technical visits at the multi-unit NPPs and their associated WMFs took place in September 2018.

## **IAEA safeguards conclusion for Canada**

Based on the IAEA's comprehensive evaluation of all safeguards-relevant information available to it and an evaluation of the consistency of Canada's declared nuclear program with the results of the IAEA's verification activities, the IAEA was able to conclude that all nuclear material in Canada, including the nuclear material at the NPPs and WMFs, remained in peaceful activities.

## **2.14 Packaging and transport**

There were no packaging and transport events reported in 2019 that had any safety significance.

## **2.15 Other matters of regulatory interest**

### **Public information and disclosure programs**

CNSC REGDOC-3.2.1, *Public Information and Disclosure* sets out the requirements for public information and disclosure programs. The primary goal of the program is to ensure that information related to the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities, is shared with the public in a format relevant to the audience. The program includes a commitment and protocol for ongoing, timely dissemination of information related to the licensed facility.

CNSC staff determined that the public information and disclosure programs for the NPPs and WMFs complied with REGDOC-3.2.1 in 2019, and that the licensees provided information on the status of their facilities through various formats to multiple audiences. CNSC staff met with OPG, Bruce Power and NB Power to discuss the benefits of their communications programs, areas for improvement and plans for future initiatives.

Some highlights noted among licensees in 2019 included the following.

#### Ontario Power Generation

In addition to community and Indigenous engagement programs, OPG communicated to the public on the status of the DNGS refurbishment project and operations at PNGS through regular newsletter updates to local communities, municipal council updates, open houses and the information centre to engage and inform residents and stakeholders. OPG renewed their website, providing users with a refreshed look at their operations and increased their presence on social media, providing another avenue for public engagement and relevant two-way discussion.

#### Bruce Power

Bruce Power had an extensive community and Indigenous engagement program, which included telephone town hall meetings, an active online presence, an updated website and bus tours and participation in local community activities. In addition, Bruce Power implemented an online and traditional media campaign highlighting their contribution to the energy and medical communities. Bruce Power conducted extensive research to understand the effectiveness of its communication program with the general public and how to improve and refine messaging to have more impact with its target audiences.

### NB Power

NB Power continued to maintain an active role in its community. Through multiple venues, NB Power continued to foster relationships with Indigenous and local community members on various projects of mutual interest to share knowledge and experiences and develop greater common understanding with the Point Lepreau management team. NB Power continued to provide regular station updates and information on new technologies and upcoming projects to multiple audiences.

### Hydro-Québec

At the Gentilly-2 facilities, Hydro-Québec provided its target audiences with opportunities to observe the status of the decommissioning project through interviews and meetings. In 2019, Hydro-Québec hosted media access to the Gentilly-2 facilities as well as tours to key audiences with a specific interest in the decommissioning project. In addition, Hydro-Québec continued to update the project website for their multiple audiences, providing them with opportunities for public inquiries and general discussion as required.

## **Indigenous consultation and engagement**

### General overview

CNSC staff efforts in 2019 supported the CNSC's ongoing commitment to meeting its consultation obligations and building relationships with Indigenous peoples with interests in Canada's nuclear power generating sites. CNSC staff continued to work with Indigenous communities and organizations to identify opportunities for formalized and regular engagement throughout the lifecycle of these facilities, including meetings and facilitated workshops, aiming to discuss and address all topics of interest and concern to interested Indigenous communities.

In addition, CNSC staff provided interested communities with notices of the opportunity for funding through the CNSC's Participant Funding Program to review and comment on this report and the opportunity to submit a written intervention and/or appear before the Commission as part of the Commission meeting.

As part of upholding the Crown's duty to consult Indigenous communities, the CNSC also confirms that its licensees engage those communities in a meaningful way. In 2019, CNSC staff monitored the NPP and WMF licensees to ensure that they actively engaged and communicated with Indigenous groups who have interest in their facilities. CNSC staff confirmed that the licensees' dedicated Indigenous engagement programs continued to cover their operations at the NPPs and WMFs and were satisfied with the level and quality of Indigenous engagement conducted by the NPP and WMF licensees regarding their operations in 2019.

The following summarizes the engagement activities for each site conducted by CNSC staff and the licensees in 2019.

## Darlington and Pickering sites

### *CNSC staff engagement activities*

The DNGS, DWMF, PNGS and PWF lie within the Treaty territory of the Williams Treaties First Nations (WTFN)<sup>4</sup>. The Mohawks of the Bay of Quinte (MBQ) and the Métis Nation of Ontario (MNO), on behalf of the MNO Region 8 Consultation Committee, have also asked to be kept informed of any activities related to these sites. In 2019, CNSC staff continued to engage with these First Nation and Métis groups in recognition of their longstanding interest in the operation of the DNGS and PNGS. Regular discussions covered the ongoing DNGS refurbishment project and the operations and performance of the DNGS, DWMF, PNGS and PWF. Additional details are provided below.

In addition, in December 2019 the CNSC and the MNO signed a Terms of Reference to provide a forum through which to collaborate and address areas of interest or concern regarding CNSC-regulated facilities and activities. As the MNO is a province-wide organization, a specific engagement plan was being developed between CNSC and the MNO Region 8 consultation committee, whose region includes the Pickering and Darlington sites, to determine the appropriate frequency of regular engagement meetings to address their specific areas of interest.

### *Licensee engagement activities*

Throughout 2019, OPG met and shared information with interested Indigenous communities and organizations including the WTFN, the MNO and the MBQ. Topics of discussion included the ongoing DNGS refurbishment project, environmental monitoring activities, fish impingement and entrainment at the DNGS and PNGS [RIB 16516 item iii) b], OPG's intent to renew the licence to prepare the site for the Darlington New Nuclear Project, and the proposed DNGS isotope project.

In 2019, OPG continued its efforts to address concerns raised by Indigenous groups and conducted multiple site visits, provided regular briefings, and involved Indigenous communities in environmental monitoring activities.

## Bruce site

### *CNSC staff engagement activities*

The Bruce site lies within the traditional territory of the Chippewas of Nawash Unceded First Nation and Saugeen First Nation, who together form the Saugeen Ojibway Nation (SON), as well as the asserted traditional harvesting territory of the MNO and Historic Saugeen Métis (HSM). CNSC staff engages with all three communities on areas of interest to them. As committed to with each of the communities, the updates below were prepared in collaboration with their representatives.

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<sup>4</sup> Williams Treaties First Nations (WTFN) include the Mississaugas of Alderville First Nation (MAFN), Curve Lake First Nation (CLFN), Hiawatha First Nation (HFN), Mississaugas of Scugog Island First Nation (MSIFN), Chippewas of Beausoleil First Nation (CBFN), Chippewas of Georgina Island First Nation (CGIFN) and Chippewas of Rama First Nation (CRFN).

### Historic Saugeen Métis (HSM)

Following the licence renewal hearing for the BNGS, a Terms of Reference was agreed upon and signed April 12, 2019, between CNSC staff and the HSM, which formally documents the engagement with their community. CNSC staff met with HSM representatives in 2019 to discuss areas of interest such as the Douglas Point decommissioning licence application, and Bruce Power's *Fisheries Act* authorization, the mitigation measures study and the major component replacement project. HSM also participated with CNSC's IEMP by identifying local plant species important to the HSM community and assisting technical staff with collection in the field. While the HSM did not have any outstanding concerns related to the nuclear activities on the Bruce site, they continued to actively participate and make informed contributions to address any potential impacts on HSM rights and interests. CNSC staff planned to continue to engage and update HSM on regulatory activities on a semi-annual basis as agreed upon in the Terms of Reference.

### Métis Nation of Ontario (MNO)

Following the BNGS re-licensing Commission hearings in 2018, the CNSC has continued to work in the spirit of collaboration and partnership to formalize its relationship with the MNO. On December 17, 2019, the CNSC and the MNO signed a Terms of Reference to provide a forum through which both parties can collaborate and address areas of interest or concern raised by the MNO regarding CNSC-regulated facilities and activities within the MNO's regions and traditional territories. As the MNO is a province-wide organization, a specific engagement plan under the Terms of Reference was also signed in December 2019 with MNO Region 7, which is the consultation committee region that includes the Bruce site to address their areas of interest.

As per the engagement plan, in 2019 CNSC staff met with MNO Region 7 representatives to discuss topics such as the CNSC's IEMP, the Douglas Point decommissioning licence application, and Bruce Power's *Fisheries Act* authorization, the mitigation measures study and the major component replacement project.

As discussed at Bruce Power's re-licensing hearing in 2018, MNO Region 7 would like to be more involved in environmental monitoring activities around the Bruce site. MNO Region 7 participated in the CNSC's IEMP sampling campaign around the Bruce site in the fall of 2019 as observers to learn more about the program. MNO Region 7 and the CNSC committed to continue collaborating on future campaigns through identification of samples of interest and/or sample collection.

In addition, MNO Region 7 had been conducting surveys of their citizens in the Bruce area. One of the results of the surveys showed that a number of their citizens had concerns regarding perceived environmental impacts related to the Bruce site. As a result, CNSC staff collaborated with the MNO to share the results of environmental monitoring and information on the different risks posed by radiation, how these risks are managed, and answer any questions that MNO citizens may have. CNSC staff will continue to collaborate and engage with the MNO Region 7 on areas of interest with regards to the Bruce site.

### Saugeen Ojibway Nation (SON)

A Terms of Reference was signed on May 21, 2019 between the SON and CNSC staff, which documents the CNSC's commitment to formalize engagement and collaboration with their communities, as directed by the Commission in the Bruce Power licence renewal record of decision. Under the Terms of Reference, the SON and the CNSC collaborate on a number of areas including:

- joint review and analysis of licensee submissions, particularly around environmental protection
- participation in the CNSC's IEMP
- inclusion on the design and review of Bruce Power's study of available mitigation measures for environmental impacts
- SON community outreach
- sharing the results of CNSC's environmental oversight, such as inspection reports
- identifying federal, provincial and municipal decision-making agencies, as needed
- coordinating meetings with federal and provincial Crown agencies, as needed

A work plan was developed, which sets out detailed tasks and timelines for each of these items.

CNSC staff understood that the SON continued to have concerns regarding the environmental impacts resulting from the nuclear activities at the Bruce site, which were presented in their intervention in Bruce Power's licence renewal hearing on March 14, 2018. The focus of the activities in the work plan is to ensure SON oversight, inclusion, and a means to obtain additional information that will provide clarity, transparency and assurances for the communities and the SON leadership regarding the interactions between the Bruce facility and the environment.

In 2019, CNSC staff and the SON continued to meet and work collaboratively to complete a number of the agreed upon initiatives in the work plan. These activities included CNSC's funding support for a traditional land use and occupancy study to obtain a baseline inventory of mapped cultural sites in relation to the SON's Territory, including the Territory around the Bruce Power site, which should be completed by the SON in 2020.

They also included the expansion of the 2019 IEMP sampling program around the Bruce site to include areas within and around the SON communities and involvement of SON members in the sampling, including the procurement of fish species of interest from SON community members, as well as the SON's involvement in Bruce Power's environmental monitoring programs.



### *Licensee engagement activities*

Throughout 2019, both Bruce Power and OPG met and shared information with interested Indigenous communities and organizations, including the SON, the MNO and the HSM.

For Bruce Power, information and discussion topics included their operations at the Bruce site, their *Fisheries Act* authorization application, inclusion in the development of the mitigation measure study as well as information on environmental impacts, including impacts to fish. Bruce Power continued to engage the SON, the MNO and the HSM on the *Fisheries Act* authorization to adequately address their information requests and concerns raised throughout the process in its final application that was submitted to Fisheries and Oceans Canada in November 2019.

The SON completed the first year of the Coastal Waters Monitoring Program (CWMP), which is an initiative funded in cooperation with Bruce Power, but designed, led and implemented by the SON to monitor environmental conditions in the nearshore areas of the Saugeen Peninsula. CNSC staff are also interested in the results of the CWMP, as the data can be used in future environmental risk assessments in relation to the Bruce Site.

In 2019, OPG continued its regular updates and meetings with Indigenous groups who have an interest in their operations and projects at the Bruce site including the WWMF and the proposed Deep Geologic Repository (DGR). In 2019, OPG actively engaged with SON community members on the DGR project, both on and off reserve, to ensure that community members were able to get all of the information they needed to determine if the SON communities were supportive of moving forward with the project, or not, on their territory.

UPDATE: In January 2020, the SON held a community vote regarding OPG's proposed DGR project and a vast majority of the SON community members voted to not support the project. As a result, respecting their commitment to the SON to not go forward with the project without their support, OPG has indicated that it will no longer pursue the proposed DGR project at the Bruce site.

### Point Lepreau site

#### *CNSC staff engagement activities*

The Point Lepreau site lies within the traditional territory of nine Mi'gmaq communities of New Brunswick represented by Mi'gmawe'l Tplu'taqnn (MTI), six Maliseet communities of New Brunswick represented by the Wolastoqey Nation of New Brunswick (WNNB) and the Peskotomuhkati Nation, as well as the Sipekne'katik First Nation, which is situated in Nova-Scotia. CNSC staff regularly engages and communicates with the interested First Nations and their representative organizations on areas of interest to them.

In 2019, a major focus of CNSC's engagement activities was to formalize the relationship between the interested First Nations and CNSC staff. CNSC staff provided information and updates to MTI, WNNB and Peskotomuhkati leadership and met with them individually to discuss topics of interest, including the CNSC's Independent Environmental Monitoring Program, compliance activities at Point Lepreau, NB Power's application for a *Fisheries Act* authorization, the CNSC's independent laboratory in

Ottawa, potential construction of small modular reactors in Canada, as well as ongoing engagement relationships. In June 2019, MTI and WNNB representatives also participated in a tour of CNSC's independent laboratory in Ottawa. CNSC staff committed to continue meeting with these First Nations to provide key updates on nuclear activities and projects in their territory of interest.

#### *Licensee engagement activities*

In 2019, NB Power worked with several First Nation's communities and organizations, including the WNNB, MTI, the Peskotomuhkati Nation, Sipekne'katik First Nation, the Union of New Brunswick Indians and Mawiw Council. Information and discussion topics included NB Power's operations at Point Lepreau, its application for a *Fisheries Act* authorization, waste management, environmental monitoring, environmental and regulatory approval processes, education, cultural awareness and sensitivity.

NB Power also implemented a number of activities supporting Indigenous knowledge, and establishing more awareness and sensitivity among its workers. The efforts involve members of New Brunswick Indigenous communities to lead medicine walks, participate in regular activities at the site including collaborative environmental and safety monitoring and deliver presentations to leadership. Point Lepreau leadership and staff learned from the Indigenous involvement and integrated some of those lessons into its approach to station management, particularly with respect to environmental management. As well, NB Power worked with Indigenous groups to build capacity within their communities to better understand and self-direct learning on nuclear technology and its use in New Brunswick, waste management and new opportunities in nuclear development and its role in a clean electricity mix. It also attended several open houses in Mi'gmaq communities.

#### Gentilly-2 site

##### *CNSC staff engagement activities*

The Gentilly-2 site lies within the traditional territory of the Abénakis of Wôlinak and Odanak, represented by the Grand Conseil de la Nation Waban-Aki (GCNWA) as well as the Nation huronne-wendat. CNSC staff continued to keep interested First Nations informed throughout 2019 about the 2018 regulatory oversight report for Canadian NPGS, which the GCNWA participated in reviewing.

##### *Licensee engagement activities*

Throughout 2019, Hydro-Québec continued its commitment to engage and communicate with Indigenous groups with an interest in its operations and sites, and met and shared information with interested First Nations communities and organizations, particularly the GCNWA. As part of their engagement activities, Abenakis representatives have expressed to Hydro-Québec that there is a point of land located at the eastern portion of the Gentilly-2 property that may have potential for Indigenous archaeology. In November 2019, representatives of the GCNWA had access to the outdoor site of Gentilly-2 for possible archaeological excavations. The representatives considered the first visit to the field to be productive and it was agreed that the two parties would follow up on the request to carry out archaeological surveys during 2020, near the Gentilly river. Hydro-

Québec continued to engage the Abenakis regarding their interest in these lands - in particular their archaeological potential.

### **Nuclear liability insurance**

The *Nuclear Liability and Compensation Act* (NLCA) requires nuclear installations (nuclear facilities that have the potential to undergo a nuclear criticality event) to carry nuclear liability insurance. The NLCA is administered by Natural Resources Canada (NRCan). CNSC staff confirmed with NRCan that the licensees complied with the financial security obligations of the NLCA as of June 1, 2019 [RIB 14776].

### **Financial guarantees**

CNSC staff reviewed the annual reports for licensee's financial guarantees. CNSC staff were able to confirm that the financial guarantee cost estimates were still valid, and were able to confirm that the licensees had sufficient funds to meet decommissioning liabilities in 2019. Note: Bruce Power's financial guarantee is covered under OPG's financial guarantee.

OPG's financial guarantee was valued at \$18.992 billion in 2019, which exceeded the required value of \$17.133 billion. As of March 2017, the value of the financial guarantee for Point Lepreau was \$689.7 million, which exceeded the required value of \$567.8 million.

To cover its obligations, Hydro-Québec holds a trust fund and an irrevocable commitment from the Government of Quebec.

UPDATE: In March 2020, Hydro-Québec submitted its updated financial guarantee to CNSC. The trust fund was valued at \$158 million as of December 31, 2019; the commitment from the Government of Quebec amounted to \$685 million. The total exceeded the required financial guarantee value of \$776 million.

### 3 NUCLEAR POWER PLANT AND WASTE MANAGEMENT FACILITY SAFETY PERFORMANCE AND REGULATORY DEVELOPMENTS

#### 3.1 Darlington nuclear generating station

##### 3.1.0 Introduction

The DNGS is located on the north shore of Lake Ontario in Clarington, Ontario, 5 kilometres outside the town of Bowmanville and 10 kilometres southeast of Oshawa. The CNSC regulates the DNGS and Tritium Removal Facility (TRF) under a power reactor operating licence (PROL). The DNGS consists of four CANDU reactors that are rated at 881 MWe (megawatts electrical) each.



OPG developed a plan to refurbish the four reactors; the refurbishment of Unit 2 began in October 2016 and continued throughout 2019. In November 2017, OPG began operating the Retube Waste Processing Building in time for the processing of the removed reactor components from Unit 2 (fuel channel end-fittings, pressure tubes and calandria tubes).

The TRF, which is housed in the Heavy Water Wamagement Building, is used to remove tritium that builds up gradually in some plant systems as a result of day-to-day operations. Removing the tritium 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 stored safely in stainless steel containers as titanium tritide within a concrete vault.

##### Licensing

The Commission renewed the PROL for the DNGS, which also governs the TRF, in December 2015, with an expiry date of November 30, 2025.

On July 18, 2019, the Commission issued its Record of Decision [8] that approved OPG's request [4] to revise the DNGS Integrated Implementation Plan (IIP), in which OPG lays out the steps and timetable for the safety improvements associated with the refurbishment. In addition, on November 5, 2019, a CNSC staff member authorized by the Commission approved the removal of Regulatory Hold Point 1, allowing OPG to load fresh fuel in the refurbished Unit 2 reactor.

UPDATE: CNSC staff removed the other regulatory hold points associated with the restart of Unit 2 during the first half of 2020.

## Licence Conditions Handbook

CNSC staff revised the DNGS licence conditions handbook (LCH) on December 20, 2019. Details are provided in Appendix E.

## Fisheries Act Authorization

Fisheries and Oceans Canada issued a *Fisheries Act* authorization on June 24, 2015 to OPG for the DNGS. The authorization contains a condition for OPG to report to the staff of Fisheries and Oceans Canada and CNSC on the offset plan (compensation for residual harm to fish and fish habitats). In 2019, OPG submitted the reports.

## Refurbishment

CNSC staff actively monitor and conduct compliance verification inspections of the project to refurbish DNGS Unit 2, which started its refurbishment outage on October 14, 2016. The project has four phases:

1. Lead-in – preparation activities such as defuelling and dewatering the reactor
2. Component removal – removal of key components, in particular pressure tubes, calandria tubes and feeder pipes
3. Installation – installation of reactor components and the associated testing / quality control verifications to demonstrate fitness-for-service
4. Lead-out – transition from the end of the installation phase to full-power operation

By the end of 2019, OPG was completing the installation phase of the project. Following the removal of Regulatory Hold Point 1, OPG began loading fresh fuel into the Darlington Unit 2 reactor core in November of 2019.

CNSC staff focused their regulatory oversight on regulatory deliverables in the IIP. CNSC staff also focused efforts on verification activities associated with the completion of pre-requisites required for removal of regulatory hold points in the return to service of Unit 2. In addition, CNSC staff conducted compliance verification activities, as established in the Darlington Refurbishment Project Type II Compliance Plan for Unit 2.

The IIP was progressing according to schedule, with OPG completing 127 IIP tasks with IIP commitment due dates in 2019 [RIB 20544]. Table 11 summarizes the overall and 2019 IIP tasks that were planned, completed, under review and closed. OPG planned and completed all 2019 IIP tasks (127). At the end of 2019, CNSC staff were reviewing 37 of the 127 IIP tasks, while having closed 90 of the IIP tasks tied to 2019.

**Table 11: DNGS IIP (based on planned dates)**

Total commitments	Overall	2019
Planned by licensee	625 <sup>1</sup>	127
Completed by the licensee	369	127 <sup>2</sup>
Under review by CNSC	59	37
Closed	310	90

<sup>1</sup> This number was previously reported as 627. Two IIP tasks were eliminated as per the 2019 Record of Decision [4]

<sup>2</sup> Of these 127 IIP items, 79 IIPs were completed prior to 2019 and the remaining 48 IIP items were completed in 2019.

CNSC staff were satisfied with the progress on the IIP in 2019.

Of the 625 IIP items, there were 93 items specifically associated with Unit 2 refurbishment.

UPDATE: From 2016 through to 2020, OPG completed all 93 IIP items required for the return-to-service of Unit 2. CNSC staff reviewed and closed those items as prerequisites for the removal of additional regulatory hold points related to the return to service of Unit 2. As of May 2020, CNSC staff had closed 324 IIP items.

### **Safety Improvement Opportunities**

As part of its 2012 environmental assessment for the refurbishment project, OPG had made a commitment to address several safety improvement opportunities (SIOs). These commitments were later incorporated into the IIP to consolidate all the implementation activities. The SIOs involved features to improve safety of the plant for beyond-design-basis accidents. All but two SIOs had previously been addressed, as described in the regulatory oversight report for 2018. One of the remaining SIOs involves modifications to shield tank over-pressure (STOP) protection. Those modifications were completed for Units 1, 3 and 4 prior to 2018. As planned, OPG completed the modification for Unit 2 in 2019 prior to restart of the unit in accordance with the IIP schedule. The other remaining SIO concerned the provision of make-up water to the heat transport system using emergency service water and diesel-driven, fire-water pumps.

However, OPG's request to the Commission in early 2019 to allow a revision to the IIP involved changes to the means by which the SIO associated with the emergency service water system would be implemented. Based on the Commission's decision [8], the SIO will rely on existing Group 2 equipment and components to provide make-up water, as opposed to diesel driven, fire-water pumps as originally proposed. For Unit 2, completion of the modifications to address this SIO were scheduled before the restart of the unit.

UPDATE: OPG completed the required work to address the remaining SIO and declared the modification available for service in Unit 2 in March 2020. OPG plans to make similar modifications in the other units during their respective refurbishment outages.

### **Event initial reports**

No event initial reports pertaining to DNGS were submitted to the Commission for the period covering January 1, 2019 to June 1, 2020.

### **Compliance Program**

The inspections at the DNGS that were considered in the safety assessments in this regulatory oversight report are tabulated in table 12 (inspection reports were included if they were sent to OPG by January 31, 2020, with the exception of DRPD-2019-04955).

**Table 12: List of inspections at DNGS**

<b>Safety and control area</b>	<b>Inspection title</b>	<b>Inspection report sent date</b>
<b>Management system</b>	Records Management Program Report Number: DRPD-2019-01695	Aug 6, 2019
	Unit 3 Refurbishment Supply Chain Management Report Number: DRPD-2019-03585	Jan 6, 2020
<b>Human performance management</b>	Conduct of Simulator-based Initial Certification Examinations Report Number: DRPD-2019-01450	Mar 26, 2019
	Human performance program Report Number: DRPD-2019-01883	Apr 3, 2019
	Fleet Wide Desktop Inspection of the Leadership and Management Training Program Report Number: DRPD-2019-02877	Jun 11, 2019
	Evaluation of Refurbishment Training Programs Report Number: DRPD-2019-03468	Oct 2, 2019
	Health Physics Training program (desktop inspection) Report Number: DRPD-2019-03409	Dec 12, 2019
<b>Operating performance</b>	Quarterly Field Inspection Third Quarter FY 2018/19 Report Number: DRPD-2018-01823	Mar 15, 2019
	Quarterly Field Inspection Fourth Quarter FY 2018/19 Report Number: DRPD-2019-00275	Jun 3, 2019
	D1941 Outage Report Number: DRPD-2019-00277	Jun 26, 2019
	Quarterly Field Inspection First Quarter FY 2019/20 Report Number: DRPD-2019-03925	Oct 9, 2019
	Refurbishment Field Inspection Report First Quarter FY 2019/20 Report Number: DRPD-2019-04614	Oct 24, 2019

Safety and control area	Inspection title	Inspection report sent date
	Quarterly Field Inspection Second Quarter FY 2019/20 Report Number: DRPD-2019-04082	Sep 23, 2019
	Problem and Event Cause and Resolution Effectiveness and Trend Analysis Report Number: DRPD-2019-03434	Jan 13, 2020
	Quarterly Field Inspection Third Quarter FY 2019/20 Report Number: DRPD-2019-04955	Feb 21, 2020
<b>Physical design</b>	Darlington Refurbishment - Commissioning of SSC to Verify Technical Specifications Report Number: DRPD-2019-01158	Mar 1, 2019
	Commissioning of SSC to Verify Technical Specifications - RHP1 Report Number: DRPD-2019-03936	Dec 10, 2019
<b>Fitness for service</b>	SSC monitoring Report Number: DRPD-2019-02479	Apr 29, 2019
	Emergency Power Supply Systems and Associated Fuel Management System Report Number: DRPD-2019-00952	May 23, 2019
	Darlington NGS Instrument Calibration Report Number: DRPD-2019-02122	May 29, 2019
	Darlington Unit 2 Refurbishment Foreign Material Exclusion Report Number: DRPD-2019-04074	Sep 23, 2019
	Inter-Unit Feedwater Tie - System Inspection Report Number: DRPD-2019-02705	Oct 23, 2019
	Darlington NGS Maintenance Planning and Scheduling Report Number: DRPD-2019-04520	Oct 24, 2019
<b>Radiation protection</b>	Radiation Protection Program Implementation During Reconstruction of Unit 2 Reactor Report Number: DRPD-2019-01276	Apr 30, 2019



Safety and control area	Inspection title	Inspection report sent date
	RP2 Worker Dose Control - Dosimetry Report Number: DRPD-2019-FIR-04344	Nov 12, 2019
	Application of ALARA Report Number: DRPD-2019-03206	Dec 12, 2019
Security	Site Security - Response Arrangements Report Number: DRPD-2018-FIR-01555	Mar 8, 2019
	Nuclear security reactive inspection Report Number: DRPD-2019-03861	Jun 28, 2019
	Nuclear security reactive inspection Report Number: DRPD-2019-04445	Sep 10, 2019
	Site Security Report Number: DRPD-2019-04308	Jan 29, 2020

In addition to the inspections listed, CNSC staff considered various other sources of information in its assessment of the SCAs. CNSC staff assigned “satisfactory” ratings for all SCAs at the DNGS in 2019. Although CNSC staff did identify various examples of excellent safety performance, and instances of meeting and/or exceeding regulatory requirements in 2019, CNSC staff did not assign “fully satisfactory” ratings at the SCA level (this contrasts with the regulatory oversight for 2018, where the DNGS received multiple “fully satisfactory ratings”). This was strictly because of a lack of opportunity (due to the COVID-19 pandemic) for staff to assure the consistent applications of criteria for “fully satisfactory” ratings across all SCAs - it does not reflect, in itself, a decline in safety at the DNGS in 2019.

### 3.1.1 Management system

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff’s expectations, for the SCA Management system at the DNGS in 2019.

#### Management system

In 2019, CNSC staff conducted over 25 inspections to verify compliance of the management system to the applicable requirements and found the results to be acceptable. For example, CNSC staff noted that OPG complied with the applicable regulatory requirements for the following [DNGS DRPD-2019-01883]:

- clearly defining and communicating roles and responsibilities for the human performance program in the organizational structure
- controlling the preparation and distribution of documents

CNSC staff found several non-compliances of low and negligible safety significance in work control documents related to radiation protection [DRPD-2019-03206] and nuclear security [DRPD-2019-04308]. At the end of 2019, CNSC staff were satisfied with the progress OPG made on the implementation of corrective actions.

In 2019, CNSC staff were satisfied that the corrective actions taken by OPG had addressed the concerns regarding the completeness of implementing programs and interfaces in OPG's nuclear management system [2]. CNSC staff reviewed OPG's revised nuclear management system, which was submitted in late 2019, and confirmed its compliance with the applicable regulatory requirements. CNSC staff planned to review the implementation of the revised nuclear management system and its implementing programs in 2020 or 2021.

In 2019, CNSC staff noted multiple compliant findings regarding the roles and responsibilities of DNGS staff, including those involved in instrument calibration [DRPD-2019-02122] and nuclear refurbishment training [DRPD-2019-03468].

### **Performance assessment, improvement and management review**

CNSC staff also identified multiple compliant findings in 2019 related to OPG's measures for performance assessment, improvement and management review. For example, CNSC staff noted satisfactory self-assessments by OPG related to execution of work during the Unit 4 outage [DRPD-2019-00277] and hours of work [DRPD-2019-04082]. There were also two findings of low safety significance on the same topic. In one case, OPG had inadequate corrective action to address performance gaps and weaknesses identified by a self-assessment of emergency power supply systems and an associated self-assessment of the fuel management system [DRPD-2019-00952]. OPG committed to revise the self-assessment and to ensure proper documentation of actions to correct adverse conditions. At the end of 2019, CNSC staff were continuing to monitor OPG's progress to correct these deficiencies. Secondly, CNSC staff noted that OPG failed to conduct periodic self-assessments of the ALARA process. [DRPD-2019-03206]. OPG committed to completing a self-assessment of the radiation protection program, including the ALARA process. CNSC staff continued to monitor OPG's corrective action and expected the self-assessment to be completed in late 2020.

### **Change management**

CNSC staff found that OPG met the applicable regulatory requirements in the change management specific area based on multiple findings in 2019 that demonstrated OPG's effective implementation of the engineering change control program at the DNGS.

### **Safety culture**

The most recent safety culture self-assessment at the DNGS was in 2018. OPG presented the results to the CNSC during a meeting in July 2019. Through observations at the site, CNSC staff were satisfied that OPG continued to foster a healthy safety culture in 2019.

## **3.1.2 Human Performance Management**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Human performance management at the DNGS in 2019.

### **Human performance program**

CNSC inspections identified 16 compliant findings in 2019 directly applicable to the human performance program at the DNGS.

### **Personnel training**

DNGS had a well documented and robust training system based on a systematic approach to training (SAT), as indicated by 29 compliant findings that were documented in various compliance verification activities. CNSC staff also identified four non-compliant findings of negligible safety significance and three findings of low safety significance. None of the low safety significant findings represented, individually or collectively, a significant deficiency with respect to personnel training at the DNGS.

### **Personnel certification**

In 2019, CNSC developed and conducted five certification examinations for responsible health physicists (four initial certification examinations and one renewal of certification). All candidates passed the examinations and were certified by the CNSC. CNSC staff also confirmed that OPG was compliant with its program documentation during an inspection of simulator-based initial certification examinations [DRPD-2019-01450].

### **Fitness for duty**

There was one violation of the minimum shift compliment (MSC) at the DNGS in 2019. A nuclear operator for Unit 0 failed to register himself out of the electronic system and left the station without conducting a face-to-face turnover with a qualified relief worker. This resulted in an inaccurate count of Unit 0 operators between the day and evening shifts, and a 43-minute MSC violation. OPG subsequently called in a relief worker to fulfill the necessary duties in the emergency response organization.

OPG reported four hours-of-work violations for certified staff at the DNGS in 2019. In three instances, an authorized nuclear operator (ANO) exceeded the limit of 60 hours per week. In the other instance, an ANO had only 24 hours off (not the required 48 hours) between three day shifts and the next night shift. However, none of these violations, either individually or collectively, represented a significant deficiency with respect to OPG's fitness for duty program at DNGS.

CNSC staff continued to monitor and assess OPG's implementation of REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue*, and planned to conduct compliance verification activities in 2020.

### **3.1.3 Operating Performance**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Operating performance management at the DNGS in 2019.

### **Conduct of licensed activity**

CNSC staff identified 41 compliant findings from compliance activities related to the SCS Operating performance in 2019, as well as 4 non-compliances of low safety significance. One of the non-compliances was for not ensuring that all combustible materials safety (CMS) non-compliances identified outside of TAP reports were

evaluated as adverse conditions [DRPD-2019-03434]. A second non-compliance was related to the conduct of brake-holding tests of the fuel handling bridges that were necessary due to degraded equipment conditions [DRPD-2019-04082]. These two non-compliances were assessed as low risk because they did not pose a significant concern for plant safety.

### **Procedures**

The other two non-compliances of low safety significance were related to OPG procedures. In one field inspection, CNSC staff observed that OPG failed to consistently adhere to procedures. An inspection of problem and event cause and resolution effectiveness and trend analysis identified the second non-compliance. The issues revolved around the verification of instructions in an OPG procedure to ensure they were current and correct. OPG's corrective action plan for these two non-compliances was in progress at the end of 2019.

### **Reporting and trending**

In 2019, OPG submitted all scheduled quarterly and annual reports as required and in the appropriate timelines. Although there was one instance in which a reportable event was not reported within the required timeline, OPG's follow-up activities met CNSC staff expectations.

### **Safe operating envelope**

In 2019, CNSC staff conducted several compliance activities regarding the safe operating envelope for the DNGS. A few minor discrepancies were noted; however, CNSC staff determined that the findings are administrative in nature and would not negatively impact the safe operating envelope limits and conditions.

### **Severe accident management and recovery**

As part of regulatory oversight of IIP items related to severe accident management and recovery, CNSC staff reviewed the OPG completion declaration form and the inspection results for dampers in the containment atmosphere cooling system. OPG conducted intrusive inspections to determine which components in the reactor vault and fuelling duct dampers were failing and their associated failure modes. Following OPG's clarification of the assessment results, CNSC staff agreed with OPG's assessment and recommended that an internal follow-up review be conducted in five years to confirm the effectiveness of OPG's trending of damper failures and corrective action to reduce the number of failures.

## **3.1.4 Safety Analysis**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safety analysis at the DNGS in 2019.

### **Deterministic safety analysis**

OPG continued to carry out safety analyses in 2019 as part of its staged implementation of CNSC REGDOC-2.4.1, *Deterministic Safety Analysis*. CNSC staff reviewed OPG's revised implementation plan for REGDOC-2.4.1. OPG provided responses to CNSC

staff's recommendations and comments on the analysis plans for the loss of flow and loss of reactor power regulation scenarios. CNSC staff reviewed the responses and concluded that OPG adequately dispositioned the remaining issues. CNSC staff were satisfied with OPG's progress on the implementation of REGDOC-2.4.1 at the end of 2019.

In 2018, OPG submitted a revised analysis for the large-break loss of coolant accident (LBLOCA) that employed a more realistic implementation of the very conservative limit of envelope methodology. The analysis was intended to demonstrate that a sufficient safety analysis margin exists for the limiting break size. CNSC staff reviewed the LBLOCA analysis and concluded that more quantification and confirmatory work was needed – specifically related to computer code validation and uncertainties analysis – to support the analysis.

OPG submitted an analysis of neutron overpower (NOP) that reflected the impact of aging of the heat transport system of DNGS Units 1, 3 and 4 up until the anticipated aged configuration. CNSC staff were reviewing the submission at the end of 2019.

UPDATE: In April 2020, CNSC staff provided OPG with findings and recommendations related to the technical adequacy of the methodology, codes and the assumptions used for the NOP analysis.

In 2019, CNSC staff reviewed OPG's limited-scope LBLOCA analysis to support the return to service of DNGS Unit 2. CNSC staff informed OPG of its expectation for a full scope analysis to support the return to service of all future refurbished DNGS units.

### **Probabilistic safety assessment**

As part of its implementation of CNSC REGDOC 2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, OPG had submitted several new or revised PSA methodologies (including those for at-power and outage states (both Level 1 and Level 2), screening analyses for both internal and external hazards (which included a source identification and screening guide), seismic and high wind). CNSC staff finished their review and accepted the methodologies in 2019.

CNSC staff completed their review of the updated hazard screening analysis as part of the 2020 PSA update. The analysis systematically screened internal and external hazards (including potential combinations of external hazards) on reactor and non-reactor sources (irradiated fuel bay and used-fuel dry storage). CNSC staff determined that OPG's submission complied with REGDOC-2.4.2.

OPG took initiatives to lead international effort and break new ground in the PSA area by developing new methodologies to address the new REGDOC-2.4.2 requirements. For example, OPG developed new and revised methodologies to address the new requirements for consideration of non-reactor sources and operational states. OPG also continued to actively participate in CANDU Owners Group projects for the development of new methodologies to address REGDOC-2.4.2 requirements.

### **Severe accident analysis**

In 2019, CNSC staff completed their review of OPG's severe accident analysis to support the operation of the new emergency heat sink pipeline during in-core loss of coolant accidents. CNSC staff were, in general, satisfied by the quality of the analysis and provided recommendations for improvements to OPG.

#### **3.1.5 Physical Design**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Physical design at the DNGS in 2019.

##### **Design governance**

CNSC staff's review of the annual, third-party facility condition assessment, along with various field inspections, confirmed that OPG met the applicable regulatory requirements for plant condition inspections at the DNGS. The review of the third-party report also identified a number of recommendations to further align DNGS operations with the applicable regulatory requirements for fire protection. CNSC staff considered OPG's action plan to address the recommendations in the report acceptable.

During field inspections of seismic qualification in 2019, CNSC staff concluded that the seismic integrity of seismically-qualified areas and routes were maintained in accordance to the facility design. However, during one of the field inspections, CNSC staff observed that OPG failed to adequately maintain clearance between a scaffold tube and a seismically-qualified component in accordance with the applicable requirements. OPG's response to this non-compliance was acceptable to CNSC staff.

##### **System design**

In 2019, CNSC staff conducted a commissioning inspection of systems, structures and components to verify technical specifications prior to the release of Regulatory Hold Point 1 (loading of new fuel into Unit 2) [DRPD-2019-03936]. The inspection verified compliance with regulatory requirements for the commissioning of the containment filtered venting system and the continuing monitoring systems for beyond-design-basis events. However, CNSC staff observed some minor non-compliances related to the quality, accuracy and completeness of the commissioning reports.

UPDATE: In March 2020, OPG provided an update on its corrective action plan to address the above non-compliances, which CNSC staff found acceptable. OPG was expected to implement the corrective action plan by the end of 2020.

##### **Component design**

CNSC staff conducted several compliance verification activities in 2019 related to component design. CNSC staff's IIP reviews related to cables confirmed that OPG had a mature surveillance program for cable condition monitoring, surveillance and aging management at the DNGS. CNSC staff also reviewed the annual fuel monitoring and inspection report and noted that the DNGS continued to experience low defect rates and decreasing trends in observed fuel bundle wear. CNSC staff concluded that OPG operated within the design and operating limits, including iodine limits and power limits

for both individual fuel bundles and fuel channels. OPG effectively managed fuel performance issues while maintaining safe operations at the DNGS in 2019.

### **3.1.6 Fitness for Service**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Fitness for service at the DNGS in 2019.

#### **Equipment fitness for service / equipment performance**

CNSC inspections of equipment fitness for service in 2019 identified three compliant findings. However, one non-compliance of negligible safety significance and one non-compliance of low safety significance were observed. The first non-compliance was related to the approval process for the commissioning reports related to commissioning. CNSC staff were satisfied with the prompt response from OPG. The second non-compliance was related to the failure to perform routine field walk-downs as required. The licensee subsequently took corrective actions to comply with the field walk-down requirements.

CNSC staff reviewed the annual risk and reliability report for 2018 for the DNGS and confirmed that OPG met all the applicable regulatory requirements. CNSC staff also confirmed that all special safety systems for DNGS Units 1, 3 and 4 met their unavailability targets in 2019.

#### **Maintenance**

CNSC staff conducted several inspections in 2019 related to maintenance. These activities identified 23 compliant findings, 4 non-compliances of negligible safety significance, and 5 non-compliances of low-safety significance. The non-compliances were related to calibration deficiencies, justification of maintenance deferrals, deficiencies in system walk-downs, and foreign material exclusion during maintenance activities. CNSC staff were satisfied with OPG's response to the non-compliances identified.

The critical corrective maintenance backlog and the number of critical preventive maintenance deferrals were maintained at a very low level in 2019. The critical deficient maintenance backlog was reduced and was better than industry average. The preventive maintenance completion ratio improved to 96% in 2019. There were no safety significant findings in the maintenance area related to events. The corrective critical maintenance backlog, deficient critical maintenance backlog, and the number of deferrals of preventive maintenance critical components are given in table 13.

**Table 13: Trend of maintenance backlogs and deferrals for critical components for DNGS, 2017 to 2019**

Parameter	Average quarterly work orders per unit			Three year trending	Quarterly 2019 work orders				Industry average for 2019
	2017	2018	2019		Q1	Q2	Q3	Q4	
Corrective maintenance backlog	1	0	1	Steady	1	0	0	1	1
Deficient maintenance backlog	37	11	5	Down	8	7	3	3	9
Deferrals of preventive maintenance	7	0	2	Down	3	2	1	0	2

**Chemistry control**

The information from technical reviews and quarterly and annual reports related to chemistry control exceeded CNSC staff's expectations. OPG resolved any minor non-compliances promptly and there were no chemistry-related incidents in 2019. The safety performance indicators Chemistry Index and Chemistry Compliance Index were close to 100%, with only a few parameters in the low 90s.

**Periodic inspections and testing**

In 2019, OPG continued to transition its periodic inspection plans from compliance with the 2005 edition of CSA N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components*, towards full compliance with the 2014 edition. In 2019, CNSC staff accepted the revised DNGS Periodic Inspection Program (PIP) plans to comply with the 2014 edition of CSA N285.4.

**3.1.7 Radiation Protection**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Radiation protection at the DNGS in 2019.

**Application of ALARA**

In 2019, CNSC staff inspected the application of ALARA at the DNGS [DRPD-2019-03206] and identified seven compliant findings. During the inspection, OPG demonstrated a significant number of tools that were used to probe, analyze and understand radiation protection performance. For Unit 2, OPG's total collective radiation exposure (CRE) was 5179 p-mSv, which exceeded its target of 4300 p-mSv. OPG attributed the target exceedance to the additional time to complete the installation of fuel channels and upper and lower feeders.



CNSC staff continued to have quarterly information exchange meetings with OPG throughout 2019. The information received during these meetings, in addition to that gathered during the inspection of the application of ALARA and the outage inspection of Unit 4 [DRPD-2019-00277] demonstrated to CNSC that OPG continued to implement several initiatives to maintain worker dose ALARA. For example, OPG had implemented improved shielding capabilities in high dose rate areas, in addition to improving existing shielding on installed equipment.

CNSC staff noted that OPG did meet its collective internal dose target (CIRE) for its outage activities; however, OPG exceeded the CRE covering outage activities. OPG reported that its outage CRE was 1920 p-mSv compared to its established target of 1790 p-mSv. Post-outage reviews attributed this target exceedance to several factors; some of them were within OPG's control, including:

- higher than anticipated dose rates
- additional work due to the discovery of unplanned hotspots
- post-execution decontamination of transport flasks

Overall, CNSC staff found that there was sufficient evidence that OPG was making considerable effort to maintain worker doses ALARA, and that it was implementing several tools to allow for improved monitoring and control of those doses. The operating station was within 3% of its year-end CRE and, although OPG exceeded the year-end CRE for Unit 2, the factors that contributed to the exceedance were well-understood. CNSC staff noted that failure to achieve a target is not an adverse condition, since targets are established in advance of work without knowledge of the actual conditions that will be encountered, or the challenges that may ensue during work execution. Further, there was sufficient evidence to demonstrate that OPG continued to make progress on longer-term improvements to lower working radiation fields across the station. CNSC staff continue to monitor OPG's implementation of these initiatives, but note that due to the nature of these improvements, the benefits will take time to materialize.

CNSC staff concluded that OPG's performance exceeded CNSC staff's expectation with respect to the application of ALARA.

### **Worker dose control**

CNSC staff identified five non-compliances that were relevant to worker dose control. These non-compliances were associated with the following:

- inadequate planning of radioactive work
- improper selection and use of radiation personal protective equipment
- inadequate protection of a contractor work group
- a failure to provide workers with accurate radiological hazard information prior to conducting work
- inadequate contamination control while performing work

Individually, these non-compliances were found to be of low safety significance; however, considering them as a whole, CNSC staff determined that OPG failed to ensure compliance with its procedures, and noted that such a failure poses an avoidable increase in risk to workers if left uncorrected.

UPDATE: In February 2020, CNSC staff completed their review of OPG's corrective actions for each of these non-compliances and were satisfied with its response. CNSC staff continued to monitor OPG's implementation of the corrective measures in 2020.

Further, during a review of an event report, CNSC staff identified that some workers in the DNGS fuel handling group were placed on an incorrect bioassay schedule. CNSC staff followed up with a field inspection [DRPD-2019-FIR-04344] and found that 69 workers in the fuel handling group were similarly placed on an incorrect bioassay schedule, and that this problem persisted since 2011. The inspection did not identify any worker that was likely to have received an exposure of regulatory concern; however, the compounding factors led CNSC staff to determine that OPG had failed to ensure compliance with its radiation protection program. The cause of this non-compliance was OPG staff's use of outdated and unapproved procedures and guidelines, as well as OPG supervisors' failure to perform adequate oversight that would have identified these errors. CNSC staff agreed with OPG's corrective action plan, and continued to monitor its implementation.

As committed in its response to the requests pursuant to subsection 12(2) of the *General Nuclear Safety and Control Regulations* (discussed in 2018 regulatory oversight report), OPG implemented a confirmatory bioassay monitoring program for alpha nuclides in September 2019. In October 2019, OPG informed CNSC staff that it identified three workers subject to this program that received alpha uptakes. In its analysis of the information provided by OPG, CNSC staff confirmed that the magnitude of their individual exposures were well below 1.0 mSv and thus did not present an exposure of regulatory concern. Additionally, OPG collected 33 other samples in the last quarter of 2019 that did not have detectable alpha-emitting radionuclides. This information demonstrated that OPG had effective methods for monitoring radiological exposures to its workers.

In the 2018 regulatory oversight report [2], CNSC staff had concluded OPG's worker dose control exhibited a notable downward trend. Similarly, in 2019, CNSC staff noted that while no worker had received an unplanned dose of regulatory concern, there were a number of areas identified where OPG's performance failed to meet both its program requirements, and CNSC's regulatory expectations. However, CNSC staff determined that OPG met overall expectations with respect to worker dose control, based on the fact that there were no workers at DNGS that exceeded their exposure control level or regulatory dose limits. CNSC staff continued its oversight over OPG's performance and corrective actions in 2019.

### **Radiological hazard control**

CNSC staff identified 10 compliant findings from compliance verification activities specific to radiological hazard control, in 2019. CNSC staff also identified three non-compliances of negligible safety significance and four non-compliances of low safety

significance. The following low safety significant findings were associated with procedural non-compliances:

- inconsistent approach to performing, reviewing, and approving radiological surveys [DRPD-2019-01276]
- inadequate assessment of the storage of radioactive combustible materials [DRPD-2019-00275]
- a failure to provide direct protection to a contractor work group [DRPD-2019-04614]
- a failure to perform contamination surveys to assess changing radiological conditions [DRPD-2019-04614]

In addition, OPG reported ten events related to radiological hazard control. Seven of those events occurred in the operating part of the station and were associated with improper posting and labelling of hazards, inadequate calibration of fixed-area ambient gamma monitors, improper storage of radioactive material, and contamination control. The remaining three occurred at Unit 2 and were associated with improper posting and labelling of hazards and inadequate contamination control. CNSC staff noted that, although this was a high number of events, there were no exceedances of either environmental or personnel action levels due to inadequate contamination control.

For the seven non-compliances identified during inspections, and each of the ten event reports, OPG implemented acceptable remedial and corrective actions. CNSC staff also noted that the operating part of the station was below its year-end target of 130 total personal contamination events (PCE) and that Unit 2 was below its year-end target of 457 PCEs.

In the 2018 regulatory oversight report, CNSC staff had also identified a downward trend in OPG's radiological hazard control. In 2019, CNSC staff conclude that OPG had implemented measures to reverse this trend and that OPG showed clear improvement.

### **3.1.8 Conventional Health & Safety**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Conventional health and safety at the DNGS in 2019.

In 2019, CNSC staff noted multiple compliant findings related to conventional health and safety. However, during the field inspections, two non-compliances of low significance were noted. In one instance, OPG failed to properly inspect and clean fume-hood ventilation systems [DRPD-2019-04082]. In a separate field inspection, OPG did not fully comply with the applicable regulations for protecting against exposure to hydrazine [DRPD-2019-00275]. CNSC staff concluded that OPG promptly and adequately addressed the minor non-compliances.

CNSC staff observed that the accident severity rate (ASR) and the industrial safety accident rate (ISAR) for DNGS were 0 in 2019, as no lost time injuries were reported. The accident frequency (AF) decreased to 0.17 in 2019. CNSC staff found the ASR,

ISAR and AF values at DNGS to be acceptable. Additional ASR, ISAR and AF data are provided in section 2.8.

### **3.1.9 Environmental Protection**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Environmental protection at the DNGS in 2019.

CNSC staff observed that all airborne and waterborne radiological releases from DNGS remained below the regulatory limits and action levels. The absolute values for releases and DRLs for DNGS are provided in Appendix D.

During field inspections, CNSC staff concluded that OPG took all reasonable precautions to protect the environment and the health and safety of persons.

During an effluent monitoring program field inspection, CNSC staff identified a non-compliance with scheduling requirements for annual calibration of measuring equipment [DRPD-2018-01823]. OPG provided a corrective action plan that CNSC staff found acceptable.

Based on the review of 2019 environmental monitoring data, CNSC staff concluded that the public and the environment in the vicinity of the site were protected and that no health impacts were expected to result from the operations of the Darlington site in 2019.

The reported estimated dose to members of the public from DNGS for 2019 was at 0.4  $\mu\text{Sv}$ . This is a decrease from the estimated combined dose of 0.8  $\mu\text{Sv}$  in 2018, and well below the annual dose limit of 1 mSv (1,000  $\mu\text{Sv}$ ). See section 2.9 for additional information.

### **3.1.10 Emergency Management and Fire Protection**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Emergency management and fire protection at the DNGS in 2019.

CNSC staff conducted several field inspections in 2019 regarding nuclear emergency preparedness and identified compliant findings. However, there were three non-compliances of negligible safety significance regarding the use of daily inspection forms and maintenance of equipment. CNSC staff were satisfied by OPG's response to address the non-compliances.

During a field inspection of fire emergency preparedness and response [DRPD-2019-04082], CNSC staff identified five compliant findings, and two non-compliances of negligible safety significance. CNSC staff observed fire hoses that were past their testing dates and a fire brigade member not wearing bunker gear in a warm zone during a station fire drill [DRPD-2019-04082]. CNSC staff were satisfied by OPG's response to address the non-compliances.

In 2019, OPG reported three events to CNSC related to fire emergency preparedness and response. The events included a fire door incorrectly propped open and two incidents in which hot work caused a minor ignition. OPG took corrective actions that met the expectations of CNSC staff.

### 3.1.11 Waste Management

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Waste management at the DNGS in 2019.

CNSC field inspections in 2019 confirmed that OPG complied with the applicable regulatory requirements for the collection of radioactive waste and the minimization and segregation of conventional waste.

OPG's reporting on safety performance indicator SPI 25 (Low- and intermediate-level radioactive solid waste generated) and the data for 2019 met the expectations of CNSC staff.

### 3.1.12 Security

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Security at the DNGS in 2019.

CNSC staff inspected security facilities and equipment in 2019 and identified five compliant findings [DRPD-2019-04308]. OPG reported one event related to facilities and equipment, but CNSC staff deemed that it had no safety significance. CNSC staff's review of the quarterly reports for the DNGS revealed only minor non-compliances, and CNSC staff is satisfied with OPG's corrective actions.

CNSC staff inspected security response arrangements in 2019 and identified only compliant findings [DRPD-2018-FIR-01555].

OPG conducted a force-on-force exercise at the DNGS as part of its performance testing program in 2019. CNSC staff reviewed OPG's self-assessment report and were satisfied by corrective measures proposed by OPG. CNSC staff concluded that OPG deployed authorized, suitably equipped and trained nuclear security officers at the DNGS and provided an effective intervention against the design basis threat.

CNSC staff conducted two field inspections and a Type II inspection in 2019 and identified compliant findings related to security practices. Relevant performance information from desktop reviews and quarterly reports also met expectations.

CNSC staff concluded that OPG fully implemented CSA N290.7-14, *Cyber Security* as of November 2019.

### 3.1.13 Safeguards & Non-proliferation

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safeguards and non-proliferation at the DNGS in 2019.

OPG committed to full implementation of CNSC regulatory document REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy* by March 31, 2021. The CNSC reviewed OPG's implementation plan and discussed the identified gaps with OPG in February 2019. CNSC staff noted that OPG continued to progress in 2019 towards the full implementation of REGDOC-2.13.1. The CNSC agreed with the implementation plan proposed by OPG.

CNSC staff noted two compliant findings for assisting the IAEA inspectors during their inspections. Similarly, CNSC staff noted that OPG assisted the IAEA during their maintenance on safeguard equipment.

OPG submitted the required annual operational programme with quarterly updates and the annual update to the Additional Protocol to the CNSC in a timely manner. The CNSC reviewed these documents and determined that they met the applicable regulatory requirements and staff's expectations. In support of Unit 2 restart activities, OPG also submitted a proposed safeguards plan for new fuel load. In consultation with the IAEA, CNSC staff reviewed the plan and found it to be acceptable.

On October 31, 2019, the overhead lights in the truck bay of the east fuelling facilities auxiliary area (FFAA) blacked out for an unknown duration. This event violated OPG's operation manual, which requires a minimum of 25% of overhead lighting to be on continuously in areas where IAEA cameras are mounted, such as the south truck bays of the east and west FFAAs. The apparent cause of the event was the inadequate documentation on the impact of loss of lighting panels on IAEA cameras during the breaker and relay maintenance.

#### **3.1.14 Packaging & Transport**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Packaging & transport at the DNGS in 2019.

In 2019, CNSC staff conducted a field inspection of packaging and transport at the DNGS [DRPD-2019-04955] and identified only compliant findings.

## 3.2 Darlington waste management facility

### 3.2.0 Introduction

The CNSC regulates the DWMF under a waste facility operating licence (WFOL). At the DWMF, OPG processes and stores dry storage containers (DSCs) containing used nuclear fuel (high-level radioactive waste) generated solely at the DNGS. OPG also manages the intermediate-level radioactive waste generated from the refurbishment of the DNGS in Darlington storage overpacks (DSOs) at the Retube Waste Storage Building (RWSB) at the DWMF.



The DWMF consists of an amenities building, one DSC processing building, two DSC storage buildings (Storage Buildings #1 and #2), and the RWSB. The DWMF has the capacity to store 983 DSCs and 490 DSOs. Loaded DSCs are transferred from the DNGS to the DWMF on OPG property with a security escort. Loaded DSOs are also transferred from the DNGS to the RWSB on OPG property.

With the exception of the RWSB, the DWMF is contained within its own protected area, which is separate from the protected area of the DNGS but within the boundary of the Darlington site. The RWSB is also located within the boundary of the Darlington site but not within a protected area.

The WFOL for the DWMF authorizes OPG to construct two additional DSC storage buildings (Storage Buildings #3 and #4), which would allow for an additional storage capacity of 1,000 DSCs.

#### **Licensing**

The Commission renewed the WFOL for the DWMF in March 2013, with an expiry date of April 30, 2023. It was not amended in 2019.

#### **Licence Conditions Handbook**

CNSC staff did not revise the DWMF LCH in 2019. However, OPG implemented several CNSC regulatory documents (new publications or new versions of existing publications) in 2019. Future revisions of the LCH will reflect them as sources of compliance verification criteria for the DWMF.

#### **Event Initial Reports**

No event initial reports pertaining to DWMF were submitted to the Commission for the period covering January 1, 2019 to June 1, 2020.

## Compliance Program

The inspection conducted at the DWMF that were considered in CNSC staff assessments in this regulatory oversight report are included in table 14 (inspection reports were included if they were sent to OPG by January 31, 2020).

**Table 14: List of inspections at DWMF**

Safety and control area	Inspection title	Inspection report sent date
<b>Emergency management and fire protection</b>	Emergency Management - Fire Brigade Drill Report Number: OPG-DWMF-2019-01	November 19, 2019

In addition to the inspection listed, CNSC staff considered various other sources of information in its assessment of the SCAs. Those activities identified numerous examples of compliance with regulatory requirements and excellent safety performance, as well instances of non-compliance and opportunities for improved performance. For 2019, CNSC staff assigned “satisfactory” ratings for all SCAs at the DWMF in 2019.

### 3.2.1 Management system

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff’s expectations, for the SCA Management system at the DWMF in 2019.

In 2019, CNSC staff did not identify findings directly linked to the management system. Based on indirect observations in 2019, reviews of the quarterly and annual operational reports for the DWMF, and findings and observations from inspections prior to 2019, CNSC staff concluded that OPG continued to effectively implement the existing OPG management system framework at the DWMF in 2019.

### 3.2.2 Human Performance Management

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff’s expectations, for the SCA Human performance management at the DWMF in 2019.

CNSC staff’s reviews of the quarterly and annual operational reports for the DWMF in 2019 did not identify any issues or concerns related to training or other specific areas under human performance.

CNSC staff continued to monitor and assess OPG’s implementation of CNSC REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue*, and planned to perform compliance verification activities in 2020.

### 3.2.3 Operating Performance

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff’s expectations, for the SCA Operating performance at the DWMF in 2019.



In total, OPG processed 59 DSCs at the DWMF in 2019. CNSC staff's review of OPG's operational reports did not identify any issues or situations that suggested that licensed activities at the DWMF were unsafe. The reviews also confirmed that OPG's reporting and trending, and its responses to comments and requests for follow-up information/clarification met CNSC staff's expectations.

In 2019, OPG notified CNSC staff of a DSC that was not processed within a year - a non-compliance with the DWMF safety report. OPG indicated that there were no safety impacts or risks in exceeding the one year limit. OPG also executed corrective actions to prevent recurrence. CNSC staff were satisfied with the response.

#### **3.2.4 Safety Analysis**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safety analysis at the DWMF in 2019.

In 2019, CNSC staff reviewed OPG's fire hazard assessments for the DWMF and confirmed that they demonstrated compliance with the applicable regulatory requirements. OPG did not submit any significant updates to the safety analysis report for the DWMF in 2019; the next revision is expected in 2022.

#### **3.2.5 Physical Design**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Physical design at the DWMF in 2019.

CNSC staff did not identify any non-compliant findings related to design during their compliance verification activities for the DWMF in 2019.

#### **3.2.6 Fitness for Service**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Fitness for service at the DWMF in 2019.

As part of the aging management activities for DSCs, OPG submitted the aging management report for the OPG WMFs. CNSC staff reviewed the submission and found that it complied with OPG's aging management program.

During their reviews of the quarterly operations reports, CNSC staff did not identify any maintenance-related issues at the DWMF in 2019.

#### **3.2.7 Radiation Protection**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Radiation protection at the DWMF in 2019.

CNSC staff did not conduct any inspections at the DWMF in 2019 that focused on radiation protection. However, CNSC staff's reviews of quarterly reports submitted by OPG confirmed that:

- The DWMF achieved its year-end collective dose target.

- OPG did not exceed any action levels for dose to workers. The annual effective doses for all DWMF workers were well below the regulatory limit of 50 mSv.
- OPG did not exceed any action levels for contamination control.
- The perimeter dose rates at the DWMF were within OPG's targets and consistent with the results of the previous years.

### **3.2.8 Conventional Health & Safety**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Conventional health & safety at the DWMF in 2019.

OPG did not report any lost-time accidents at the DWMF in 2019 or any other events related to conventional health and safety. Also, CNSC staff's compliance verification activities did not identify any non-compliant findings relevant to conventional health and safety in 2019.

### **3.2.9 Environmental Protection**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Environmental protection at the DWMF in 2019.

CNSC staff reviewed the quarterly reports and databases for the DWMF in 2019 and confirmed that the results met staff's expectations. CNSC staff also confirmed that there were no exceedances of the derived release limits (DRLs) and no exceedances of environmental action levels.

CNSC staff concluded that the operation of the DWMF did not pose an unacceptable risk to human health and the environment in 2019. OPG planned to submit an updated environmental risk assessment for the DWMF in 2021.

### **3.2.10 Emergency Management and Fire Protection**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Emergency management and fire protection at the DWMF in 2019.

In 2018, CNSC staff had determined that OPG was not performing an annual fire response drill per the applicable regulatory requirements. This was described in the regulatory oversight report for 2018. In September 2019, CNSC inspected OPG's fire response drill at the DWMF [OPG-DWMF-2019-01] and identified a finding of medium safety significance. It was an accounting issue during the fire drill, when one DWMF OPG staff member did not assemble outside at one of the two assembly areas. The worker exited the facility and was accounted for 30 minutes after the fire alarm had sounded. The missing worker was unaware of correct OPG emergency procedures.

CNSC staff requested OPG to provide a list and timeline for corrective actions to address the deficiency and a description of any compensatory measures taken before the implementation of the corrective actions.

UPDATE: OPG provided the requested information to CNSC staff in January 2020. CNSC staff were satisfied with OPG's immediate and long-term corrective actions, specifically, the reinforcement of accounting training for all OPG DWMF staff.

### **3.2.11 Waste Management**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Waste management at the DWMF in 2019.

In 2019, CNSC staff reviewed the latest revision of OPG's decommissioning program and also reviewed its standard for the management of waste and other environmentally-regulated materials. The documents met the applicable regulatory requirements and CNSC staff's expectations.

### **3.2.12 Security**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Security at the DWMF in 2019.

CNSC staff did not identify any major non-compliant findings with regards to security at the DWMF in 2019.

CNSC staff confirmed that performance information from quarterly reports and the inspection met their expectations with respect to security. OPG reported minor failures related to security facilities and equipment, which were addressed to the expectations of CNSC staff.

### **3.2.13 Safeguards & Non-proliferation**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safeguards & non-proliferation at the DWMF in 2019.

CNSC staff confirmed that OPG submitted its required monthly general ledgers on time, except in one instance (for July 2019). OPG notified CNSC staff that the report was one day late. CNSC staff were satisfied with OPG's response and determined that there was no significant impact on safeguards implementation.

CNSC staff participated in the 2019 physical inventory verifications and design information verifications by the IAEA. The verifications generated satisfactory results.

OPG submitted the required annual operational programme with quarterly updates, and the annual update to the Additional Protocol, to the CNSC in a timely manner. CNSC staff determined that they met the applicable regulatory requirements and staff's expectations.

### **3.2.14 Packaging & Transport**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Packaging & transport at the DWMF in 2019.

### 3.3 Pickering nuclear generating station

#### 3.3.0 Introduction

The Pickering site is located on the north shore of Lake Ontario in Pickering, Ontario, 32 kilometers northeast of Toronto and 21 kilometers southwest of Oshawa. The Pickering site consists of the PNGS and the PWMF, both owned and operated by OPG. The CNSC regulates the PNGS and PWMF under two separate, independent licences – a power reactor operating licence (PROL) for the PNGS and a waste facility operating licence (WFOL) for the PWMF.



The PNGS consists of eight CANDU reactors. Units 1, 2, 3 and 4 (formerly known as PNGS A) went into service starting in 1971. Units 2 and 3 were defueled in 2008 and remain in a safe shutdown state; there are no plans to put them back into operation. Units 5, 6, 7 and 8 (formerly known as PNGS B) continue to operate safely since they were brought into service in 1983.

Each operating reactor for Units 1 and 4 has a gross electrical output of 542 MWe (megawatts electrical). Each operating reactor for Units 5–8 has a gross electrical output of 540 MWe.

The PNGS will end commercial operation by December 31, 2024. Following permanent shutdown, each unit will undergo stabilization activities in preparation for an extended phase of safe storage with surveillance. This phase will begin in 2028.

#### Licensing

In 2018, the Commission renewed the PROL for a 10-year period covering September 1, 2018 to August 31, 2028. This licence period includes three phases of operational activities:

- continued commercial operation until December 31, 2024
- stabilization phase (post-shutdown de-fuelling and de-watering), which lasts approximately three to four years
- beginning of safe storage for Units 1 and 4 and Units 5–8

#### Licence Conditions Handbook

One revision was made to the licence conditions handbook (LCH) in 2019. See Appendix E for details.

### ***Fisheries Act Authorization***

In January 2018, Fisheries and Oceans Canada issued a *Fisheries Act* authorization to OPG for operations at the PNGS; it is valid until December 2028. Among its provisions is a requirement for OPG to engage Fisheries and Oceans Canada if fish impingement exceeds 3,619 kg (annual average weight of fish) in two consecutive years.

In 2018, 5,616 kg of fish were impinged at the PNGS. CNSC staff reviewed OPG's impingement monitoring report for 2018 and made several recommendations to OPG in October 2019, which included the following:

- promptly engage Fisheries and Oceans Canada to determine potential follow-up requirements
- install the planned mid-water float additions to the fish diversion system (FDS), if feasible, to combat the effects of algae loading
- consider further increasing FDS maintenance should its performance continue to be impacted by algae loading
- consider the current science regarding increased algae loading in Lake Ontario and other options to combat its effects
- consider other impingement mitigation measures
- provide updates on installation timelines, locations, and effectiveness of mid-water float additions in future fish impingement monitoring reports

Fisheries and Oceans Canada concurred with these recommendations.

In 2019, 15,114 kg of fish were impinged [RIB 16516 item i) and item iii) a)]. The increase in fish impingement did not appear to be caused by spills or waterborne releases from PNGS operations. OPG attributed the exceedances to rapid water temperature changes related to lake conditions. OPG asserted that high winds caused the upwelling of colder water from lower depths, resulting in either direct mortality or a significant reduction in swimming performance that prevented the fish from avoiding the cooling water intake. The fish impinged were largely alewife, which are particularly sensitive to sudden temperature changes. In addition, some of the exceedances were likely related to the weighing down of the Fish Diversion System (FDS) barrier net during algae intrusion (algae loading), allowing fish to pass over the FDS.

OPG engaged Fisheries and Oceans Canada to determine potential follow-up requirements, as required by its *Fisheries Act* authorization. OPG's engagement with Indigenous groups on the topic of fish impingement and compliance with its *Fisheries Act* authorization at the PNGS is described in section 2.15 [RIB 16516 item iii) b)].

UPDATE: In March 2020, OPG submitted an analysis of the impingement exceedances to Fisheries and Oceans Canada and CNSC. CNSC staff reviewed the report and provided comments and recommendations to Fisheries and Oceans Canada.

In April 2020, OPG submitted its impingement monitoring report for 2019. CNSC staff were reviewing it, as of June 1, 2020.

### **Integrated Implementation Plan (IIP) [RIB 17557 (item i)]**

OPG developed an integrated implementation plan (IIP) that defines Resolution Actions to address issues identified through the periodic safety review conducted in support of the 2018 licence renewal. Each IIP Resolution Action is completed through the execution of one or more IIP actions. OPG has established a schedule to manage the completion of the 35 IIP Resolution Actions and the 63 supporting IIP actions; according to this schedule all actions must be completed by December 31, 2020. Table 15 summarizes the status of the IIP as of December 31, 2019.

**Table 15. Status of the IIP at PNGS**

<b>Total commitments</b>	<b>Overall</b>	<b>2019</b>
Planned by licensee	98 <sup>1</sup>	28
Completed by the licensee	78	36
Under review by CNSC	36	28
Closed by CNSC	42	8

<sup>1</sup> Includes 63 IIP actions and 35 IIP Resolution Actions

In 2019, OPG completed 24 IIP actions (including 3 postponed from 2018 and 4 from 2020) and 12 Resolution Actions (including 1 from 2020). CNSC staff is satisfied with OPG progress, as there are only 20 commitments remaining for completion in 2020 (10 IIP actions and 10 IIP Resolution Actions).

Overall, CNSC staff have closed 42 IIP commitments (30 IIP actions and 12 IIP Resolution Actions) and have 36 IIP commitments under review (23 IIP actions and 13 Resolution Actions).

OPG did not submit any notification of changes related to the IIP to the CNSC in 2019.

### **Event Initial Reports**

There was one (classified) event initial report pertaining to the PNGS submitted to the Commission for the period January 1, 2019 to June 1, 2020.

### **Compliance Program**

The compliance program included numerous activities in 2019 to confirm OPG's compliance with the licensing basis for PNGS. The publications that provided compliance verification criteria for those activities for PNGS are provided in Appendix B.

The inspections at the PNGS that were considered in preparation of this regulatory oversight report are tabulated in table 16 (inspection reports were included if they were sent to OPG by January 31, 2020, with one exception \*).

**Table 16. List of PNGS inspections**

<b>Safety and control area</b>	<b>Inspection title</b>	<b>Inspection report sent date</b>
<b>Management system</b>	Records Management Program - Management of Documents and Records Report Number: PRPD-2019-00606	Aug 6, 2019
<b>Human performance management</b>	Human Performance Program Report Number: PRPD-2019-00607	Apr 3, 2019
	Leadership and Management Training Program Report Number: PRPD-2019-02754	Jun 11, 2019
	Pickering Units 1 & 4 Conduct of a reactor Operator Simulator-based Certification Examination Report Number: PRPD-2019-01721	Jun 28, 2019
	Review of PNGS Q4 2018 Report on NPP Personnel Report Number: PRPD-2019-03976	Aug 12, 2019
	Design, Development and Grading of a Pickering 1-4 Reactor Operator Simulator-based Certification Examination Report Number: PRPD-2019-01784	Oct 18, 2019
	Certified Training Program Report Number: PRPD-2019-03870	Dec 12, 2019
<b>Operating performance</b>	Quarterly Field Inspection Third Quarter FY 2018/19 Report Number: PRPD-2018-01509	Mar 14, 2019
	P1881 Unit 8 Planned Outage Inspection Report Number: PRPD-2018-00840	Mar 21, 2019
	Quarterly Field Inspection Fourth Quarter FY 2018/19 Report Number: PRPD-2019-02116	Jun 10, 2019

<b>Safety and control area</b>	<b>Inspection title</b>	<b>Inspection report sent date</b>
	Quarterly Field Inspection First Quarter FY 2019/20 Report Number: PRPD-2019-03480	Sep 20, 2019
	Quarterly Field Inspection Second Quarter FY 2019/20 Report Number: PRPD-2019-03882	Dec 16, 2019
<b>Fitness for service</b>	P1971 Unit 7 Planned Maintenance Outage Report Number: PRPD-2019-00608	Aug 27, 2019
	System Inspection- Auxiliary Boiler Feedwater System Report Number: PRPD-2019-03901	Dec 3, 2019
<b>Radiation protection</b>	Radiological Hazard Control Report Number: PRPD-2019-04793	Feb 12, 2020*
<b>Environmental protection</b>	Effluent Control and Monitoring Program Report Number: PRPD-2019-03373	Nov 21, 2019
<b>Security</b>	Nuclear security reactive inspection Report Number: PRPD-2019-03860	Jun 28, 2019
	Nuclear security reactive inspection Report Number: PRPD-2019-04446	Sep 10, 2019
	(classified) Report Number: PRPD-2019-FIR -05572	
	(classified) Report Number: PRPD-2019-FIR-05647	
	(classified) Report Number: PRPD-2019-FIR-05646	
	(classified) Report Number: PRPD-2020-FIR-06001	



In addition to the inspections listed, CNSC staff considered various other sources of information in their assessment of the SCAs. CNSC staff assigned “satisfactory” ratings for all SCAs at the PNGS in 2019. Although CNSC staff did identify various examples of excellent safety performance, and instances of meeting and/or exceeding regulatory requirements in 2019, CNSC staff did not assign “fully satisfactory” ratings at the SCA level (this contrasts with the regulatory oversight for 2018, where the PNGS received multiple “fully satisfactory ratings”). This was strictly because of a lack of opportunity (due to the COVID-19 pandemic) for staff to assure the consistent applications of criteria for “fully satisfactory” ratings across all SCAs - it does not reflect, in itself, a decline in safety at the PNGS in 2019.

### 3.3.1 Management system

OPG met the applicable regulatory requirements, and its performance met CNSC staff’s expectations, for the SCA Management system at the PNGS in 2019.

#### Management system

In 2019, CNSC staff were satisfied that the corrective actions taken by OPG had addressed the concerns regarding the completeness of implementing programs and interfaces in OPG’s nuclear management system [2]. CNSC staff reviewed OPG’s revised nuclear management system, which was submitted in late 2019, and confirmed its compliance with the applicable regulatory requirements. CNSC staff planned to review the implementation of the revised nuclear management system and its implementing programs in 2020 or 2021.

#### Change management

In 2018, CNSC staff inspected OPG’s event investigation process and found deficiencies related to documentation and change control, event categorization and investigation, and assurance that all causes of events are addressed and independently verified. OPG developed and implemented a corrective action plan in 2019 and all deficiencies were resolved to CNSC staff’s satisfaction by early 2020.

Also in 2018, CNSC staff inspected software maintenance [PRPD-2018-01219] with a focus on change management, maintaining the integrity of software for instrumentation and control systems important to safety and ensuring that the software will reliably perform its design functions. CNSC staff raised three enforcement actions for deficiencies in document control, identification of discrepancies related to firmware and procedural use and adherence. OPG implemented a corrective action plan in 2019 and all deficiencies were addressed to the satisfaction of CNSC staff.

UPDATE: OPG resolved all issues to the CNSC’s satisfaction by mid-2020.

#### Safety culture

In 2019, OPG implemented REGDOC-2.1.2, *Safety Culture* with the exception of nuclear security culture. OPG has committed to revise its governance to include nuclear security culture by November 26, 2020. OPG conducted its most recent safety culture self-assessment in 2018; OPG planned to conduct its next self-assessment within five years of that date.

### **Records management**

In 2019, CNSC staff inspected the records management program at the PNGS [PRPD-2019-00606]. CNSC staff concluded that OPG complied with the applicable regulatory requirements and effectively demonstrated that:

- Documents and information were being used for the performance of activities.
- Records were retrievable and were stored and retained in a manner to prevent loss, deterioration, or damage.

Two enforcement actions were raised to ensure that OPG issued administrative governance documents with approved formats and templates, as well as to ensure that the Pickering quality assurance vaults comply with 2-hour separation fire ratings and that actions are taken to mitigate fire damage to records. OPG developed and implemented a corrective action plan in 2019.

UPDATE: OPG resolved all deficiencies to the satisfaction of CNSC staff by mid-2020.

### **Management of contractors**

In 2019, OPG reported that a vendor's sub-supplier had modified test results for PNGS bleed condenser tubing that had not yet been installed. The sub-supplier fraudulently modified chemical analysis results that were obtained from the ingots when the ingots did not meet the vendor's technical specification. CNSC staff conducted a full investigation to identify causes and corrective actions. Another sub-supplier independently confirmed that the chemical analysis for each lot of tubing conformed to the vendor's requirements. The vendor modified its approved supplier list and initiated a "counterfeit, fraudulent and suspect items" investigation in accordance with its quality assurance program and determined the extent of condition.

OPG conducted its own extent of condition determination and requested its vendors to also determine the extent of condition. No affected products were found. CNSC staff was continuing to monitor OPG's follow-up actions at the end of 2019.

## **3.3.2 Human Performance Management**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Human performance management at the PNGS in 2019.

### **Human performance program**

In 2019, CNSC staff inspected the human performance program [PRPD-2019-00607] and concluded that it met the applicable regulatory requirements. No enforcement actions were raised.

### **Personnel training**

In 2019, CNSC staff conducted a desktop inspection of OPG's leadership and management training program [PRPD-2019-02754] and a Type II inspection of OPG's certified training program [PRPD-2019-03870]. These activities combined with other compliance activities, identified 25 findings related to personnel training, the vast majority of which were compliant or of negligible safety significance. They supported the conclusion that the PNGS had a well-documented and robust training system based on a systematic approach

to training (SAT). CNSC staff were satisfied with OPG's progress in correcting the minor deviations.

### **Personnel certification**

In August 2019, the Commission approved a one-time exemption to section 26.1 of RD-204, *Certification of Persons working at Nuclear Power Plants* that allowed one person to progress through the last training program for control room shift supervisor.

In late 2018, OPG asked CNSC staff to decertify a certified individual. CNSC staff agreed to decertify the individual based on the justification provided and discussions with OPG in 2019. An opportunity to be heard was given to the individual, but none was requested within the prescribed timeframe. The decertification did not indicate any deficiencies in the health of the certification program at the PNGS.

CNSC staff's reviews of PNGS' quarterly reports on NPP personnel in 2019 confirmed that OPG complied with the applicable certification requirements. General compliance with requirements for certification activities was also noted during a Type II inspection of OPG's conduct of a simulator-based certification examination for a reactor operator [PRPD-2019-01721] and a field inspection of the retention of records that support initial certifications and their renewals [PRPD-2019-03480]. A desktop inspection of the design, development and grading of simulator-based certification examinations for operators of PNGS Units 1-4 [PRPD-2019-01784] identified three non-compliances of low safety significance. For example, CNSC staff found that one of the comprehensive test scenarios did not meet the requirements for clarity and uniqueness in the response of a primary malfunction. CNSC staff issued three enforcement actions and continued to monitor OPG's corrective actions.

### **Fitness for duty**

The minimum shift complement at the PNGS met the applicable regulatory requirements in 2019 based on three inspections. However, there were two minor minimum shift complement violations reported in 2019. In both events, the required qualifications for minimum shift complement personnel were not met for brief periods of less than two hours each. CNSC staff reviewed both events and were satisfied with the corrective actions taken by OPG.

CNSC staff verified the fitness for duty of workers at the PNGS in 2019 through a field inspection [PRPD-2018-01509]. CNSC staff confirmed that OPG had restorative sleep provisions to support workers in exceptional circumstances related to managing worker fatigue. There were no violations of limits of hours of work at the PNGS in 2019.

CNSC staff also reviewed OPG's implementation of REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* (which was completed in 2019) and were satisfied with the results.

### **3.3.3 Operating Performance**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Operating performance at the PNGS in 2019.

### **Conduct of licensed activity**

CNSC staff concluded that OPG met the applicable regulatory requirements for the conduct of licensed activities at the PNGS in 2019 based on five Type II inspections. OPG operated PNGS safely and securely in accordance with the regulatory requirements for the conduct of operations, including plant status control, surveillance, infrequently performed operations and independent verification of work.

In 2019, the PNGS experienced one manual reactor trip, zero stepbacks, three automatic setbacks and two manual setbacks. CNSC staff determined that the trips and setbacks were properly controlled and that power reductions were adequately initiated by the reactor control systems. There were no impacts on reactor safety. CNSC staff verified that OPG staff followed approved procedures and took appropriate corrective actions for all transients.

### **Outage management performance**

CNSC staff concluded that OPG's management of outages at the PNGS met the applicable regulatory requirements and expectations in 2019 and met the requirements in REGDOC-3.1.1 for the completion of regulatory undertakings. CNSC staff observed that OPG demonstrated satisfactory levels of performance and achievement of objectives during planned outages. In 2019, CNSC staff inspected planned outages for Unit 7 and Unit 8. For example, CNSC staff confirmed that OPG used an approved reactor shutdown guarantee state, continuously monitored heat sinks and components, kept equipment in the correct configuration to maintain reactor safety, and operated the main control room in accordance with its operations program. Further, the planned outage inspections noted compliance in the areas of reactivity management, containment envelope and regulatory undertakings and did not result in any CNSC enforcement actions.

### **Procedures**

In 2019, CNSC staff continued to follow-up on issues related to procedures including procedure use and adherence that were identified during an inspection in 2018 of an emergency response exercise. For example, CNSC staff directed OPG to ensure that all personnel and equipment surveys were performed at inter-zonal radiation monitoring locations and that OPG personnel provide accurate technical information to stakeholders. CNSC staff were satisfied with OPG's progress to address these and other remaining issues in 2019. CNSC staff also followed up on issues identified during a 2016 inspection of the electrical distribution system. CNSC staff closed the enforcement action in 2019 following its review of OPG's corrective action related to its testing program of the standby and emergency power generators at the PNGS.

CNSC staff inspected software maintenance [PRPD-2018-01219] and found deficiencies related to the control and adequacy of documentation and the need to revise several documents in order to align with OPG governance for procedure use and adherence. CNSC staff were satisfied with OPG's corrective actions, which were completed in mid-2019.

### **Reporting and trending**

CNSC staff noted OPG's overall compliance with requirements for quarterly and annual scheduled reports as required by REGDOC-3.1.1, including those related to report timing, content and the completion of regulatory undertakings during outages. OPG also responded to CNSC's informal requests for follow-up information/clarification in a timely manner.

OPG submitted reportable events that required a detailed event report in 2019. OPG took action to address CNSC staff concerns with the quality of OPG's event reports for the PNGS. CNSC site staff noted continual improvements related to event reporting in 2019. For example, there was only one occasion in 2019 when a supplementary information report was necessary (three were necessary in 2018).

### **Safe operating envelope**

In 2019, CNSC staff identified issues of low safety significance related to the safe operating envelope (SOE) program at the PNGS, although they did not negatively impact the SOE limits and conditions. For example, there were some delays in the update of SOE program-related documents (e.g. instrumentation uncertainty calculations). A CNSC field inspection [PRPD-2019-03882] identified some instances, administrative in nature, where the OPG compliance framework was inconsistent with SOE documents for the emergency coolant injection system. OPG addressed the concerns to CNSC staff's satisfaction prior to the issuance of the inspection report and no enforcement actions were necessary.

### **Severe accident management and recovery**

In 2019, CNSC staff completed its review of the revision of OPG's definition of requirements and measures to manage beyond-design-basis accidents at the PNGS. CNSC staff confirmed that the revised measures provided an appropriate framework (EMEGs and SAMGs) for identifying appropriate mitigating actions for an event that is, or has the potential to progress to, a severe accident.

#### **3.3.4 Safety Analysis**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safety analysis at the PNGS in 2019.

##### **Deterministic safety analysis**

The PNGS IIP included actions related to safety analyses that account for aging of the heat transport system up to December 31, 2024. Aging of the heat transport system affects reactor trip setpoints that are very important parameters for safe operation; margins associated with setpoints can become smaller as the NPP ages. Therefore, in 2019, OPG submitted an update of the safety analysis models and analyses of loss-of-flow, small-break loss of coolant accident and neutron overpower protection to demonstrate that the shutdown system will remain effective. CNSC staff reviewed the submissions and provided comments, which OPG is expected to address by the end of September 2020.

### **Probabilistic safety assessment**

CNSC staff determined that OPG's performance exceeded their expectations for probabilistic safety assessment (PSA) in 2019. OPG submitted full-scope PSA updates for PNGS Units 5–8 and for PNGS Units 1 and 4 in 2017 and 2018, respectively. CNSC staff completed their reviews of the updates in 2018 and 2019, respectively, and concluded that they complied with the applicable regulatory requirements (CNSC regulatory document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*).

As part of its transition to compliance with REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, OPG continued to submit revised PSA methodologies, to meet the requirements of REGDOC-2.4.2. In 2019, OPG submitted the following PSA methodologies: Level 1 and Level 2 PSAs for at-power and outage states, internal and external hazard screening analysis, seismic, and high wind. CNSC staff reviewed and accepted these methodologies. OPG planned to transition to REGDOC-2.4.2 at the PNGS by the end of 2020. The implementation strategy included submitting PSA updates to address new requirements including, for example:

- irradiated fuel bay risk assessment by the end of 2020
- full PSA updates for PNGS B by the end of 2020
- full PSA updates for PNGS A by the end of 2023

CNSC staff were satisfied with OPG's progress in the development of the whole-site PSA for the PNGS. OPG was actively participating in COG and international projects on whole-site PSA. In 2019, CNSC staff concluded its follow-up review of whole-site PSA for the PNGS, noting that OPG had adequately responded to CNSC comments on the relevant submissions.

### **Severe accident analysis**

CNSC staff determined that OPG maintained a severe accident analysis program that met or exceeded the applicable regulatory requirements and expectations. OPG continued to support industry R&D in the area of severe accident analysis.

In 2019, OPG developed software to estimate the source term and doses to members of the public following a reactor accident. CNSC staff is reviewing the software and the related methodology to calculate filtered venting flow rate from the reactor vacuum building (if venting is deemed necessary). Specifically, CNSC staff was assessing the adequacy of assumptions in the calculations and the appropriateness of the input data to ensure that these tools meet the applicable regulatory requirements for safety software quality assurance. CNSC staff plan to complete their review in 2020.

In 2019, CNSC staff completed their review of the assessment of containment integrity for beyond-design-basis accidents (BDBA), which was submitted in 2018. CNSC were satisfied with the assessment and with OPG's responses to the review comments.

### **3.3.5 Physical Design**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Physical design at the PNGS in 2019.

### **System design**

CNSC staff concluded that OPG met the applicable regulatory requirements for system design in 2019 for the PNGS. Overall, the design of the plant and its systems has been stable and underwent only minor changes in 2019.

CNSC staff concluded that the electrical power system at the PNGS met the applicable regulatory requirements. In 2019, the PNGS experienced three transients due to total or partial losses of Class IV power. After reviewing the event reports and following up with OPG staff, CNSC staff concluded that there were no safety concerns and the station performed as per design. CNSC staff were satisfied with OPG's response to these events and confirmed that adequate corrective actions were in place.

### **Component design**

CNSC staff concluded that OPG met the applicable regulatory requirements for component design in 2019 for the PNGS.

CNSC staff were satisfied with fuel performance at the PNGS in 2019. OPG operated within the applicable design and operating limits, iodine limits and maximum bundle power and channel power limits. The inspection rate met the minimum expectation of 20 bundles per unit per year and similarly, the defect rate per unit did not exceed the CNSC expectation of one defect per unit per year. Overall, CNSC staff determined that OPG adequately managed fuel performance issues while maintaining safe operations at the PNGS in 2019.

### **3.3.6 Fitness for Service**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Fitness for service at the PNGS in 2019.

#### **Equipment fitness for service / equipment performance**

In 2019, CNSC staff reviewed the annual risk and reliability report for 2018 for the PNGS and noted that it met all the applicable regulatory requirements. CNSC staff also confirmed that all special safety systems for PNGS Units 1 and 4 and Units 5–8 met their unavailability targets in 2019.

#### **Maintenance**

The performance of OPG's maintenance program met CNSC expectations in 2019. In 2019, OPG maintained the critical corrective maintenance backlog very low. Also, OPG reduced the critical deficient maintenance backlog to below industry average. The number of critical preventive maintenance deferrals was above industry average but it was trending down. OPG improved the preventive maintenance completion ratio (PMCR) in 2019 to 98%. CNSC staff did not identify any safety significant issues related to maintenance associated with events reported for the PNGS in 2019. The corrective critical maintenance backlog, deficient critical maintenance backlog, and the number of deferrals of preventive maintenance critical components are given in table 17.

**Table 17: Trend of maintenance backlogs and deferrals for critical components for PNGS, 2017 to 2019**

Parameter	Average quarterly work orders per unit			Three year trending	Quarterly 2019 work orders				Industry average for 2019
	2017	2018	2019		Q1	Q2	Q3	Q4	
Corrective maintenance backlog	7	2	1	Down	2	0	0	0	1
Deficient maintenance backlog	104	16	7	Down	17	5	3	4	9
Deferrals of preventive maintenance	81	11	5	Down	9	4	5	2	2

CNSC staff conducted numerous inspections in 2019 that confirmed that OPG's maintenance program consistently met the applicable regulatory requirements for the PNGS.

### **Aging management**

CNSC staff confirmed that the major component life-cycle management plans (LCMPs) at the PNGS continued to meet the applicable regulatory requirements in 2019.

The LCMPs for the PNGS include specific mitigating strategies should fitness-for-service assessments identify degradation mechanisms for which the acceptance criteria cannot be met up to the end of the evaluation period. The scope of OPG's in-service inspections of major components at the PNGS exceeded the minimum inspection requirements in 2019. Updates to the steam generator LCMP included additional inspections of Units 1 and 4 to support extension of the end of commercial operation to 2024.

In 2019, OPG submitted engineering assessments of degradation mechanisms that spanned the near-term operation and met all applicable CSA Group standard acceptance criteria. CNSC staff continued to monitor the implementation of the fuel channel life management project to further develop the analytical tools necessary to demonstrate pressure tube fitness-for-service for continued operation.

The PNGS is licensed to operate up to 295,000 effective full-power hours (EFPH) for its pressure tubes. At the end of 2019, the longest operating pressure tubes had approximately 250,000 EFPH of service. OPG predicted that the pressure tubes would not reach the current licensing limit prior to 2024.

Following the 2018 renewal of the PROL in 2018, CNSC staff included several new compliance verification criteria in the LCH related to pressure tube fracture toughness. These criteria involved confirmation of the ongoing use of the current model for fracture toughness, the assessment of the time available until the current model cannot be used, and the development of a new model. In 2018, OPG submitted an uncertainty analysis of the results of the current fracture toughness model. In 2019, CNSC staff reviewed the submission and provided comments to OPG.



OPG also updated CNSC staff on pressure tube burst tests and confirmed the validity of the model for the specific test conditions used. OPG confirmed that no Pickering pressure tube was expected to reach the validity limit for the current model (120 ppm Heq; see Appendix C) prior to the end of operation.

OPG also continued to work with industry partners on the development of the technical basis for a new fracture toughness model for pressure tube material. As required by the LCH, in late 2018, OPG submitted its first semi-annual update on industry R&D related to model development.

OPG demonstrated good progress in 2019 towards the implementation of probabilistic fracture protection assessments.

### Chemistry control

In 2019, CNSC staff inspected the auxiliary boiler feed system [PRPD-2019-03901] and confirmed that OPG system chemistry met the applicable regulatory requirements. CNSC staff verified that the chemistry parameters were within specification 100% of the time. The PNGS remained within its chemistry specifications, as demonstrated by the performance indicators “chemistry index” and “chemistry compliance index”, which are reported to the CNSC in accordance with REGDOC-3.1.1. (See section 2.6).

In 2018, CNSC staff had accepted OPG’s request to defer the Unit 7 reactor building leakage rate test by six months. In 2019, CNSC staff confirmed that OPG completed the test as required and met all the applicable regulatory requirements [PRPD-2019-00608].

### 3.3.7 Radiation Protection

OPG met the applicable regulatory requirements, and its performance met CNSC staff’s expectations, for the SCA Radiation protection at the PNGS in 2019.

#### Application of ALARA

OPG improved its management of collective doses (collective radiation exposure (CRE)) to workers in 2019 through station specific ALARA initiatives that exceeded CNSC staff expectations. In 2019, the CRE at the PNGS was 3102 person-mSv, which averaged to 517 person-mSv/unit. This was better than OPG’s target of 923 person-mSv/unit.

The largest contributor to CRE at the PNGS was the outage-related work. In 2019, the Unit 5 and Unit 7 outages performed better than outage targets for collective external EPD (electronic personnel dosimeter) doses and collective internal doses. Table 18 shows the collective dose actuals and targets for external and internal dose.

**Table 18: Collective dose actuals and targets for external and internal dose**

Unit Outage	Collective Dose (person-mSv)			
	External		Internal	
	Actual	Target	Actual	Target
5	1099	1200	160	230
7	795	1045	167	220

OPG was also credited for incorporating a number of ALARA initiatives into the outages to improve performance.

### **Worker dose control**

CNSC staff determined that OPG exceeded CNSC staff expectations for worker dose control at the PNGS in 2019 and noted numerous compliant findings related to worker dose control during inspections. Data for doses to workers at the Pickering site is provided in section 2.7. Radiation doses to workers at the PNGS were below the regulatory dose limits, as well as the action levels in OPG's radiation protection program. CNSC staff did not observe any adverse trends or safety significant unplanned exposures at the PNGS in 2019. Additionally, there were no event reports related to worker dose control in 2019.

### **Radiological hazard control**

In 2019, OPG addressed, to the satisfaction of CNSC staff, the outstanding actions related to fixed-area gamma monitoring and the Type I semi-portable alarming gamma monitoring system.

CNSC staff conducted various Type II inspections in 2019 that identified 13 findings and confirmed that OPG met the applicable regulatory requirements at the PNGS for radiological hazard control. No enforcement actions were raised.

## **3.3.8 Conventional Health & Safety**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Conventional health & safety at the PNGS in 2019.

CNSC's oversight of OPG worker practices and awareness in the area of conventional health and safety included various inspections in 2019. CNSC staff noted compliance with the applicable labour codes (e.g., with respect to scaffolding, work protection (such as barriers and danger signs), and health and safety). For example, CNSC staff observed good housekeeping and that OPG provided personal protective equipment that was worn by personnel in the field. CNSC staff identified a number of non-compliant findings of low safety significance, although staff did not deem it necessary to take enforcement action since corrective actions were taken by OPG immediately.

The Accident Severity Rate (ASR) for Pickering in 2019 was 0.0. This was lower than the 2018 ASR (6.4) and also lower than the industry average, which was 2.0 in 2019. The Accident Frequency (AF) for Pickering in 2019 was 0.11. This was lower than the AF for 2018, which was 0.21 and lower than the industry average, which was 0.23. Although AF is defined to include fatalities, there were no work-related fatalities at Pickering in 2019. The Industrial Safety Accident Rate (ISAR) for Pickering in 2019 was 0.00 (WANO target is 0.5).

## **3.3.9 Environmental Protection**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Environmental protection at the PNGS in 2019.

In 2019, all airborne and waterborne releases were less than the environmental derived release limits (DRLs) for the respective types of releases. OPG's environmental action levels are approximately 10% of the DRL for the release type. In 2019, there was a single environmental action level exceedance at the PNGS. The waterborne emissions of gross beta/gamma for November 2019 was 1.4 Ci, which exceeded the corresponding action level (0.403 Ci/month).

As a follow-up to the licence renewal for PNGS, OPG commenced a two-year thermal plume monitoring study in Lake Ontario in 2019. OPG planned to submit a thermal plume report that covers two consecutive years of sampling by March 31, 2021 [RIB 16516 item ii)].

The maximum dose to the public from operations at the PNGS, as estimated by OPG, remained low (1.7  $\mu\text{Sv}$ , versus the limit of 1000  $\mu\text{Sv}$ ). OPG continued satisfactory progress towards implementation of CSA N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, at the PNGS, with a scheduled completion date of December 31, 2020. Overall, CNSC staff observed that operations at the PNGS did not pose an unacceptable risk to human health and the environment.

### 3.3.10 Emergency Management and Fire Protection

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Emergency management and fire protection at the PNGS in 2019.

In 2019, CNSC inspections to assess OPG's conventional and nuclear emergency preparedness observed a small number of non-compliances of low safety significance in the area of drill conduct, management of combustibles, and maintenance and storage of emergency mitigating equipment (EME). In one example, OPG had not ensured that the EME generator fuel levels were maintained above OPG's requirement of 75% capacity. OPG subsequently changed its procedure to include checking and filling the tank following generator tests. Overall, those findings did not affect the operational readiness of the equipment in the event of an emergency.

In 2019, CNSC staff reviewed the fire hazard assessment and fire safe shutdown analysis for the PNGS and confirmed that they met the applicable regulatory requirements. OPG provided acceptable responses to CNSC's review comments on the fire hazard assessment.

OPG's new program for combustible material safety increased accountability, education, and simplification with respect to fire safety and led to significant improvement in the control of combustibles within the PNGS.

### 3.3.11 Waste Management

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Waste management at the PNGS in 2019.

CNSC inspections in 2019 confirmed that OPG complied with the applicable regulatory requirements for the management of low- and intermediate-level radioactive waste and the minimization and segregation of conventional waste.

CNSC staff were also satisfied with the values of the safety performance indicator SPI 25 (Low- and Intermediate-Level Radioactive Solid Waste Generated) for the PNGS in 2019.

### 3.3.12 Security

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Security at the PNGS in 2019.

CNSC staff conducted a field inspection in 2019 that identified two minor non-compliances related to security facilities and equipment [PRPD-2019-FIR-05572]. At the end of 2019, OPG committed to address the findings.

CNSC staff also conducted a field inspection in 2019 that identified a minor non-compliance related to response arrangements [PRPD-2019-FIR-05647]. OPG addressed the non-compliance to the satisfaction of CNSC staff.

Three other field inspections identified non-compliances of negligible safety significance related to security practices. At the end of 2019, OPG was working to address the findings.

### 3.3.13 Safeguards & Non-proliferation

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safeguards & non-proliferation at the PNGS in 2019.

Pursuant to the Canada/IAEA safeguards agreements and the facilities' licence conditions, OPG granted adequate access and assistance to the IAEA for safeguards activities, including inspections and the maintenance of equipment at the PNGS. See section 2.13 for additional details and a description of the verification activities conducted.

In 2019, CNSC, OPG and the IAEA continued to work to resolve an issue related to nuclear material accountancy and control. This issue was first raised during a physical inventory verification (PIV) in November 2016, when IAEA inspectors found that some of the spent fuel in the irradiated fuel bays could not be adequately verified because of accessibility issues. By the end of 2019, CNSC staff were satisfied with OPG's corrective actions and were continuing discussions on the resolution of the issue with the IAEA. While the IAEA acknowledged OPG's and CNSC's efforts and the progress on improving accessibility of nuclear material, a small number of stacks of irradiated fuel bundles in two out of the three bays remained inaccessible for verification to the PIV standard. The IAEA's annual statement of the conclusions of inspections for the PNGS may continue to reflect the inaccessibility of this fuel until the material in question is verified.

UPDATE: The issue was closed in 2020 when the IAEA applied safeguards seals to ensure the remaining inaccessible material in question remained frozen until it is available for verification in the future (e.g., during decommissioning activities).

CNSC staff conducted inspections at the PNGS during the November PIV [PRPD-2018-01509] and during the short notice random inspection in April 2019 [PRPD-2019-03480]. CNSC staff concluded that OPG complied with its own standard for ensuring that access and assistance was provided to the IAEA. CNSC staff conducted a field inspection of the

November PIV and concluded that OPG complied with the same standard for implementing measures to ensure that safeguards equipment seals remain intact.

#### **3.3.14 Packaging & Transport**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Packaging & transport at the PNGS in 2019.

CNSC staff confirmed that the transport of nuclear substances to and from the PNGS was conducted safely in 2019. For on-site movements of nuclear substances, OPG ensured an equivalent level of safety as was required for offsite transportation to protect the health and safety of workers, the public and the environment.

CNSC staff conducted an inspection of packaging and transport in 2019 and did not identify any non-compliances [PRPD-2019-02116].

## 3.4 Pickering waste management facility

### 3.4.0 Introduction

The CNSC regulates the PWMF under a waste facility operating licence (WFOL). At the PWMF, OPG processes and stores dry storage containers (DSCs) containing used nuclear fuel (high-level radioactive waste) generated solely at the PNGS. OPG also manages the intermediate-level radioactive waste generated from the refurbishment of the PNGS Units 1-4 in 34 above-ground dry storage modules (DSMs) located at the Retube Component Storage Area (RCSA) at the PWMF. With the exception of periodic inspection, monitoring, and maintenance of DSMs and the RCSA, there have been no operational activities for RCSA since 1993.



The PWMF spans over two separate areas - Phase I and Phase II - within the overall boundary of the Pickering site. Phase I is located within the protected area of the PNGS and consists of the DSC Processing Building, two DSC storage buildings (Storage Buildings #1 and #2) and the RCSA. Phase II of the PWMF is located northeast of Phase I and is contained within its own protected area, separate from the protected area of the PNGS, but within the boundary of the Pickering site. Phase II contains Storage Building #3. The PWMF currently has the capacity to store 1,154 DSCs. The transfer of loaded DSCs from the PWMF Phase I to the PWMF Phase II is conducted on OPG property with a security escort.

The PWMF spans over two separate areas - Phase I and Phase II - within the overall boundary of the Pickering site. Phase I is located within the protected area of the PNGS and consists of the DSC Processing Building, two DSC storage buildings (Storage Buildings #1 and #2) and the RCSA. Phase II of the PWMF is located northeast of Phase I and is contained within its own protected area, separate from the protected area of the PNGS, but within the boundary of the Pickering site. Phase II contains Storage Building #3. The PWMF currently has the capacity to store 1,154 DSCs. The transfer of loaded DSCs from the PWMF Phase I to the PWMF Phase II is conducted on OPG property with a security escort.

Under the WFOL for the PWMF, OPG is authorized to construct three additional DSC storage buildings in Phase II (Storage Buildings #4, #5, and #6) and one DSC processing building to replace the current DSC Processing Building. The additional storage buildings would allow OPG to store all of the used fuel generated at the PNGS to the end of its commercial operational life, and the new DSC processing building would increase OPG's processing capabilities at the PWMF from 50 DSCs per year to approximately 100 DSCs per year.

### Licensing

In April 2017, the Commission renewed the WFOL for the period April 1, 2018 to August 31, 2028.

### Licence Conditions Handbook

CNSC staff issued a LCH for the PWMF in June 2018 in conjunction with its WFOL renewal. CNSC staff did not revise the PWMF LCH in 2019. However, OPG implemented several CNSC regulatory documents (new publications or new versions of existing publications) in 2019. Future revisions of the LCH will reflect them as sources of compliance verification criteria for the PWMF.

### Event Initial Reports

No event initial reports pertaining to the PWMF were submitted to the Commission for the period January 1, 2019 to June 1, 2020.

### Compliance Program

The inspections conducted at the PWMF that were considered in CNSC staff assessments in this regulatory oversight report are included in table 19 (inspection reports were included if they were sent to OPG by January 31, 2020).

**Table 19: List of inspections at PWMF**

Safety and control area	Inspection title	Inspection report sent date
<b>Human Performance Management</b>	Compliance Inspection Report Number: OPG-PWMF-2019-03&04	November 6, 2019
<b>Operating Performance</b>	Type II Compliance Inspection Report Number: OPG-PWMF-2019-01	June 6, 2019
	Compliance Inspection Report Number: OPG-PWMF-2019-03&04	November 6, 2019
<b>Emergency Management and Fire Protection</b>	Compliance Inspection Report Number: OPG-PWMF-2019-02	November 6, 2019

In addition to the inspections listed, CNSC staff considered various other sources of information in its assessment of the SCAs. Those activities identified numerous examples of compliance with regulatory requirements and excellent safety performance, as well instances of non-compliance and opportunities for improved performance. For 2019, CNSC staff assigned “satisfactory” ratings for all SCAs at the PWMF in 2019.

#### 3.4.1 Management system

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff’s expectations, for the SCA Management system at the PWMF in 2019.

CNSC inspections confirmed the overall compliance and effectiveness of OPG’s management system framework at the PWMF in 2019 [OPG-PWMF-2019-03&04]. For example, CNSC staff confirmed that OPG met the applicable requirements to:

- document its human performance program and apply the graded approach
- define responsibilities and roles in the organizational structure
- provide the necessary resources to the organization
- continually improve, and apply operational experience into planning and execution of, its programs (in this case, the human performance program)
- identify, document and resolve adverse conditions

- maintain records
- control documents
- appropriately label DSCs
- maintain training records

In terms of business continuity, on-site observations by CNSC staff in 2019 confirmed that the PWMF had adequate contingency plans to maintain or restore critical safety and business functions in the events of disabling circumstances, such as a pandemic, severe weather, or labour actions.

### 3.4.2 Human Performance Management

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Human performance management at the PWMF in 2019.

CNSC inspections in 2019 confirmed that the PWMF complied with the applicable regulatory requirements for its human performance program [OPG-PWMF-2019-03&04]. However, CNSC staff found that OPG did not comply with its place-keeping requirements for procedures. At the end of 2019, OPG was working on corrective actions to ensure that its staff adhere to the place-keeping requirements.

Update: In 2020, OPG completed the corrective actions and CNSC staff concluded that they found them acceptable.

The same inspection also identified three compliant findings relevant to personnel training. In addition, CNSC staff did not identify any issues or concerns related to training through its reviews of the quarterly and annual 2019 operational reports for the PWMF in 2019 or OPG's notification package for the construction of Storage Building #4 (SB4).

CNSC staff continued to monitor and assess OPG's implementation of CNSC REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue*, and planned to perform compliance verification activities in 2020.

### 3.4.3 Operating Performance

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Operating performance at the PWMF in 2019,

In total, OPG processed 60 DSCs at the PWMF in 2019. CNSC staff's reviews of OPG's operational reports did not identify any issues or situations that suggested that licensed activities at the PWMF were unsafe. The reviews also confirmed that OPG's reporting and trending, and its responses to comments and requests for follow-up information/clarification, met CNSC staff's expectations.

CNSC staff's compliance verification activities identified six compliant findings related to reporting and trending and no non-compliances.



#### **3.4.4 Safety Analysis**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safety analysis at the PWMF in 2019.

In 2018, CNSC staff had reviewed OPG's update of the PWMF safety analysis report. As of 2019, there were still some outstanding items that required further review by CNSC staff. For example, CNSC staff identified issues with regards to the heat decay model used to model the used fuel in the DSCs.

Update: In June 2020, OPG submitted a revised safety report, which included changes to the heat decay model used for the used fuel. CNSC staff found the submission acceptable.

#### **3.4.5 Physical Design**

OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Physical design at the PWMF in 2019.

In 2019, OPG submitted its construction notification package for SB4. CNSC staff reviewed the package and found that it met their expectations for site characterization design.

#### **3.4.6 Fitness for Service**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Fitness for service at the PWMF in 2019.

In 2019, OPG submitted its aging management inspection reports, which documented OPG's aging management activities for DSCs at all WMFs. CNSC staff reviewed the submission and found that it complied with OPG's aging management program. CNSC staff noted that follow-up "underside" inspections of the base plates of two DSCs were deferred until 2020. CNSC staff identified no issues with the deferral.

During their reviews of the quarterly operations reports, CNSC staff did not identify any maintenance-related issues at the PWMF in 2019.

#### **3.4.7 Radiation Protection**

CNSC staff conclude that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Radiation protection at the PWMF in 2019.

CNSC staff's review of the construction notification package for SB4 included comments related to radiation protection. Examples include questions around changes to dose rates for workers through the addition of SB4. OPG addressed the comments in a timely manner.

CNSC staff's reviews of quarterly reports submitted by OPG confirmed that:

- The PWMF achieved its year-end collective dose target
- OPG did not exceed any action levels for contamination control
- The perimeter dose rates at the PWMF were within OPG's targets

- The results for loose contamination were consistent with the results of previous years
- OPG did not exceed any action levels for dose to workers. The annual effective doses for all PWMF workers were well below the regulatory limit of 50 mSv

CNSC staff conducted a Type II inspection in 2019 and identified two compliant findings related to radiation protection [OPG-PWMF-2019-01]. CNSC staff noted that their measurements of radiation fields were consistent with the measurements posted on the radiation signs. Additionally, all portable monitors checked by CNSC staff were in good working condition and calibrated within the required period.

### **3.4.8 Conventional Health & Safety**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Conventional health & safety at the PWMF in 2019.

During the Type II inspection in 2019, CNSC staff identified five compliant findings related to conventional health and safety [OPG-PWMF-2019-01]. These included the following observations:

- eye wash stations were accessible
- housekeeping was generally acceptable
- OPG staff wore appropriate PPE and dosimeters
- Material Safety Data Sheets (MSDS) were available and up to date for the heavy-duty degreaser, and the like-acid cleaner
- cabinets containing corrosives had appropriate signage

OPG did not report any lost-time accidents at the PWMF in 2019 or any other events related to conventional health and safety.

### **3.4.9 Environmental Protection**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Environmental protection at the PWMF in 2019.

CNSC staff reviewed the quarterly reports and databases for the PWMF in 2019 and confirmed that the results met staff's expectations. CNSC staff also confirmed that there were no exceedances of the derived release limits (DRLs) and no exceedances of environmental action levels. CNSC staff concluded that the operation of the PWMF did not pose an unacceptable risk to human health and the environment in 2019.

The Type II inspection identified one compliant finding related to environmental protection in 2019 [OPG-PWMF-2019-01]. During the inspection, CNSC staff reviewed the environmental gamma monitoring quarterly results for 2017 and 2018 at the Retube Components Storage Facility (RCSF) and Used Fuel Dry Storage Facility (UFDSF) and found them to be complete.

OPG planned to submit an updated ERA for Pickering site (including the PWMF) in 2022-2023.

#### **3.4.10 Emergency Management and Fire Protection**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Emergency management and fire protection at the PWMF in 2019.

In 2018, CNSC staff had determined that OPG was not performing an annual fire response drill per the applicable regulatory requirements. In September 2019, CNSC inspected OPG's fire response drill at the PWMF held in August 2019 [OPG-PWMF-2019-02]. Overall, CNSC staff were satisfied with the results of the drill and provided a recommendation to OPG.

OPG notified CNSC staff of a fire system impairment at Storage Building #3 in September 2019 that was due to a card failure in a booster panel. OPG ordered a new card and initiated its fire impairment plan. CNSC staff were satisfied with OPG's preventative measures and noted that OPG corrected the failure.

#### **3.4.11 Waste Management**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Waste management at the PWMF in 2019.

CNSC inspection findings in 2019 confirmed that OPG continued to comply with the applicable regulatory requirements for waste management. During a PWMF inspection, CNSC staff observed that DSCs were properly labelled with information including the DSC number, contents, where it was loaded, date loaded, date stored, the number of fuel bundles and the radiation trefoil sign [OPG-PWMF-03&04]. CNSC staff observed different colours of waste bins throughout the facility. These bins are to help with identification and segregation of contaminated and non-contaminated waste (contaminated vs likely clean waste).

In 2019, CNSC staff reviewed the latest revision of OPG's decommissioning program and also reviewed its standard for the management of waste and other environmentally-regulated materials. The documents met the applicable regulatory requirements and CNSC staff's expectations.

#### **3.4.12 Security**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Security at the PWMF in 2019.

CNSC staff did not identify any major non-compliant findings with regards to security at the PWMF in 2019. There was one security related event at the PWMF in 2019, and CNSC staff were satisfied with the actions taken by OPG to address the issue.

CNSC staff confirmed that performance information from desktop reviews, quarterly reports and the field inspection met their expectations.

### **3.4.13 Safeguards & Non-proliferation**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safeguards & non-proliferation at the PWMF in 2019.

CNSC staff confirmed that OPG submitted its required monthly general ledgers on time, except in one instance (for July 2019). OPG notified CNSC staff that the report was one day late. CNSC staff were satisfied with OPG's response and determined that there was no significant impact on safeguards implementation.

CNSC staff participated in the 2019 physical inventory verifications and design information verifications by the IAEA. The verifications generated satisfactory results.

OPG submitted the required annual operational programme with quarterly updates and the annual update to the Additional Protocol to the CNSC in a timely manner. CNSC staff determined that they met the applicable regulatory requirements and staff's expectations.

### **3.4.14 Packaging & Transport**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Packaging & transport at the PWMF in 2019

## 3.5 Bruce nuclear generating station

### 3.5.0 Introduction

Bruce A and Bruce B nuclear generating stations are located on the shores of Lake Huron, in the Municipality of Kincardine, ON. The facilities are operated by Bruce Power under a lease agreement with the owner, Ontario Power Generation (OPG). Bruce A has four CANDU reactors with a gross power of 831 MWe (megawatts electrical) each (Units 1-4). Bruce B has four CANDU reactors with a gross power of 872 MWe each (Units 5-8). All eight units were operational throughout 2019.



This report groups the two stations together because Bruce A and B have one power reactor operating licence (PROL) and Bruce Power uses common programs at both stations. However, the performance of each station was assessed separately due to the differences in implementation of some programs at Bruce A and Bruce B. The Western Waste Management Facility (WWMF) is also located at the same site. However, since it is operated by OPG under a different licence, it is assessed separately in section 3.6 of this regulatory oversight report.



#### Licensing

The PROL for Bruce A and B was renewed by the Commission in 2018 for a period of ten years from October 1, 2018 to September 30, 2028. The ten-year licence period will encompass Bruce Power's operation, as well as activities related to the major component replacement (MCR) of Units 3 to 8, which started in January 2020. The PROL for Bruce A and B was not amended in 2019.

#### Licence Conditions Handbook

CNSC staff revised the LCH for Bruce A and B on April 1, 2019. The changes are described in Appendix E.

#### Fisheries Act Authorization

In December 2019, Fisheries and Oceans Canada issued a *Fisheries Act* authorization for the ongoing operation of Bruce A and B. The authorization covers the death of fish through impingement and entrainment due to the water intakes that draw water from Lake Huron for the cooling water systems.

The conditions of the authorization include monitoring and inspections, as well as maintaining structures (velocity cap/chain rope barrier) to reduce fish impingement. Bruce Power was also required to submit a final impingement and entrainment monitoring plan by March 2023 after engaging with Indigenous groups. The offsetting plan included the removal of the Truax Dam (Saugeen River, Walkerton) in August 2019 and contributing funds to Ontario Ministry of Natural Resources and Forestry's lake trout rehabilitation program in Lake Huron.

### Periodic Safety Review

Bruce Power conducted a periodic safety review in support of its PROL renewal and the planned refurbishment of Units 3 to 8. Bruce Power also developed and began implementing its integrated implementation plan (IIP), which proposed various safety improvements.

Table 20 summarizes the IIP tasks that were planned, completed, under review and closed, both in 2019 and overall since the beginning of the project. The work in the IIP was progressing according to schedule, with Bruce Power completing 18 IIP tasks in 2019; these included the ten tasks that were planned for completion in 2019 as well as eight others that were planned for completion in either 2018 or 2020. At the end of 2019, CNSC staff were reviewing four IIP tasks, having closed all of the other IIP tasks that Bruce Power completed in 2019.

**Table 20: Status of BNGS IIP (based on planned dates as of the end of 2019)**

IIP Task Status	Overall	2019
Planned by Licensee	191	10
Completed by Licensee	40	18
Closed by CNSC	36	14
Under Review by CNSC as of Dec 2019	4	

UPDATE: Bruce Power submitted the annual IIP update for 2019 in March 2020. CNSC staff reviewed the update and confirmed that Bruce Power made acceptable progress on all IIP items. CNSC staff also determined that Bruce Power's revisions to the scope or schedule of three IIP items were acceptable (within the licensing basis).

### Refurbishment (MCR project)

The MCR project involves Units 3 to 8 and includes the replacement of major components such as the steam generators, fuel channels and feeders. The MCR outages started in January 2020 with Unit 6.

CNSC oversight prerequisite activities for Unit 6 began in January 2019, one year prior to the start of the project. CNSC staff conducted three Type II inspections and two desktop inspections in 2019 that covered the processes for contractor management and supply chain. CNSC staff did not identify any major issues.

UPDATE: The MCR outage began on January 17, 2020 with preparatory work activities.

### Event Initial Reports

There were no event initial reports (EIRs) pertaining to Bruce A and B submitted to the Commission for the period January 1, 2019 to June 1, 2020.

### Compliance Program

The compliance program included numerous activities in 2019 to confirm Bruce Power's compliance with the licensing basis for Bruce A and B. The publications that provided compliance verification criteria for those activities for Bruce A and B are provided in Appendix B.

The inspections at Bruce A and B that were considered in the safety assessments in this regulatory oversight report are tabulated in table 21 (inspection reports were included if they were sent to Bruce Power by January 31, 2020).

**Table 21: List of Bruce A and B inspections**

Safety and control area	Inspection title	Inspection report sent date
<b>Management System</b>	Bruce B, MCR inspection - Project and Contractor Management. Report Number: BRPD-MCR-2019-1971	April 17 2019
	Bruce B, MCR inspection - MCR Supply Management Unit 6. Report Number: BRPD-MCR-2019-2098	May 16, 2019
	Bruce A and B, Field Inspection - Configuration Management. Report Number: BRPD-A-2019-FIR-4174	August 23, 2019
	Bruce B, Unit 6, MCR inspection - Engineering Change Control. Report Number: BRPD-MCR-2019-04078	December 11, 2019
	Observation of Safety Culture Monitoring Panel Report Number: BRPD-AB-2019-FIR-05668	December 16, 2019
<b>Human performance management</b>	Bruce A, Desktop Inspection - Design, Development and Grading of a Bruce A UO CRO Simulator-based Certification Examination. Report Number: BRPD-A-2019-02183	March 11, 2019
	Bruce A and B, Security Personnel Training Program. Report Number: BRPD-AB-2019-0789	May 27, 2019
	Bruce A and B, Desktop Inspection - Development and Marking of a Bruce Power Supplementary Station Specific Certification Examination. Report Number: BRPD-AB-2019-03077	October 9, 2019
	Bruce A and B, Bruce Power Authorized Nuclear Operator Training Program. Report Number: BRPD-AB-2019-04830	December 18, 2019

Safety and control area	Inspection title	Inspection report sent date
<b>Operating performance</b>	Bruce A and B, Bruce A and B, Quarterly Field Inspection Report for Quarter 3, FY 2018-2019. Report Number: BRPD-AB-2018-1370	March 8, 2019
	Bruce B Unit 8 Planned Outage. Report Number: BRPD-B-2019-1548	March 15, 2019
	Bruce A and B, Quarterly Field Inspection Report for Quarter 4, FY 2018-2019 Report Number: BRPD-AB-2019-2214	June 5, 2019
	Bruce A Unit 3 2019 Planned Outage. Report Number: BRPD-A-2019-02216	June, 28, 2019
	Bruce B Unit 7 Planned Maintenance Outage. Report Number: BRPD-B-2019-02530	July 26, 2019
	Bruce A and B, Quarterly Field Inspection Report for Quarter 1, FY 2019-2020. Report Number: BRPD-AB-2019-03635	September 3, 2019
	Bruce A and B, Quarterly Field Inspection Report for Quarter 2, FY 2019-2020. Report Number: BRPD-AB-2019-03968	November 18, 2019
	Bruce A and B, Quarterly Field Inspection Report for Quarter 3, FY 2019-2020. Report Number: BRPD-AB-2019-05184	January 29, 2020
	Bruce B Unit 5 Planned Maintenance Outage. Report Number: BRPD-B-2019-04429	January 29, 2020
	Bruce A Unit 2 2019 Planned Outage. Report Number: BRPD-A-2019-05312	January 31, 2020
<b>Fitness for service</b>	Bruce A, System Inspection - Low Pressure Service Water. Report Number: BRPD-A-2019-04073	September 9, 2019
	Bruce A, System Inspection - Vacuum Building & Emergency Filtered Air Discharge System. Report Number: BRPD-A-2019-04423	October 1, 2019
	Bruce A, System Inspection - Negative Pressure Containment. Report Number: BRPD-A-2019-04725	December 18, 2019
	Bruce A and B, Field Inspection - Structure Systems and Components Monitoring. Report Number: BRPD-A-2019-FIR-04292	September 24, 2019
<b>Radiation protection</b>	Bruce B, MCR Desktop Inspection - Bruce B, Unit 6, DTI-07-01, Radiation Protection Program to protect health and safety of workers and to monitor and control	November 6, 2019



Safety and control area	Inspection title	Inspection report sent date
	radiation hazards (including alpha) during refurbishment. Report Number: BRPD-MCR-2019-04984	
	Bruce B, MCR Desktop Inspection - Bruce B, Unit 6, DTI-07-02, Radiation Protection Source Term and ALARA Program. Report Number: BRPD-MCR-2019-05407	December 11, 2019
<b>Environmental protection</b>	Bruce A and B, Effluent Control and Monitoring Inspection. Report Number: BRPD-AB-2019-04792	December 9, 2019
<b>Emergency management and fire protection</b>	Bruce A and B, Huron Resilience Corporate Drill. Report Number: BRPD-AB-2019-03799	January 14, 2020
<b>Security</b>	Bruce A and B Field Inspection - Security FI # 9 NSO Qualifications. Report Number: BRPD-AB-2019-FIR-01933	March 5, 2019
	Bruce A and B Field Inspection - Security FI # 15 NSO Minimum Required Training. Report Number: BRPD-AB-2019-FIR-01934	March 5, 2019

In addition to the inspections listed, CNSC staff considered various other sources of information in its assessment of the SCAs. CNSC staff assigned “satisfactory” ratings for all SCAs at Bruce A and B in 2019. Although CNSC staff did identify various examples of excellent safety performance, and instances of meeting and/or exceeding regulatory requirements in 2019, CNSC staff did not assign “fully satisfactory” ratings at the SCA level (this contrasts with the regulatory oversight for 2018, where Bruce A and B received multiple “fully satisfactory ratings”). This was strictly because of a lack of opportunity (due to the COVID-19 pandemic) for staff to assure the consistent applications of criteria for “fully satisfactory” ratings across all SCAs - it does not reflect, in itself, a decline in safety at Bruce A and B in 2019.

### 3.5.1 Management system

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff’s expectations, for the SCA Management system at Bruce A and B in 2019.

#### Management system

CNSC staff identified numerous findings from several compliance inspections in 2019 at Bruce A and B that confirmed the overall compliance of Bruce Power’s management system with the applicable regulatory requirements.

## **Organization**

CNSC inspections and compliance assessments in 2019 confirmed that Bruce Power had adequately defined organizational structure, roles and responsibilities in its governance. In 2019, Bruce Power adequately addressed CNSC staff's comments on changes to its organization chart.

## **Performance assessment, improvement and management review**

Based on findings from three inspections in 2019, CNSC staff confirmed that Bruce Power continued to meet the applicable regulatory requirements for performance assessment, improvement, and management review.

## **Operating experience**

In 2019, CNSC staff conducted several inspections that touched on Bruce Power's OPEX program and confirmed its overall compliance with the applicable regulatory requirements. As an example, CNSC staff noted during an MCR inspection of supply management that Bruce Power appropriately managed the OPEX associated with a CNSC recommendation for Bruce Power to implement good reviewing practices of all MCR suppliers [BRPD-MCR-2019-2098]. The same inspection also identified areas for improvement in the quality of some of the records produced by suppliers. CNSC staff requested Bruce Power to ensure that records issued by the suppliers are reviewed by inspectors to verify the quality of the records.

## **Change control**

An MCR inspection of engineering change control in 2019 [BRPD-MCR-2019-04078] identified minor areas for improvement related to the documentation of temporary changes related to the MCR. CNSC staff recommended that Bruce Power provide clearer guidance for MCR monitoring. Bruce Power took into consideration CNSC staff recommendations and implemented corrective actions.

In 2019, Bruce Power started to significantly change and simplify its management system documentation. CNSC staff planned to review the changes in 2020, including the effectiveness of the change management process.

## **Configuration management**

In 2019, CNSC staff inspected temporary configuration changes (TCCs) at Bruce A [BRPD-A-2019-FIR-4174]. CNSC staff requested Bruce Power to develop and implement a corrective action plan with target implementation dates to ensure that TCCs are always identified on its master flow sheets and that the configuration of TCCs processes are effective. CNSC staff were satisfied with the corrective actions for Bruce A. In response to CNSC staff's request, Bruce Power was taking similar corrective actions for Bruce B at the end of 2019.

## **Safety culture**

CNSC staff continued to monitor safety culture at Bruce A and B in 2019. Field inspections, which were used to oversee Bruce Power's activities, confirmed that Bruce Power met the applicable regulatory requirements related to safety culture. Specifically, CNSC staff conducted a field inspection on Bruce Power's safety culture monitoring. CNSC staff identified various compliant findings and there were no non-compliances.

### **Management of contractors**

CNSC staff identified some findings in 2019 related to elements of contractor/supply management processes. For example, an MCR inspection of project and contractor management at Bruce B [BRPD-MCR-2019-1971] identified the need to ensure that contracts are updated, based on the most recent requirements, and that quality assurance plans and verification plans are documented per a graded approach. CNSC staff were satisfied with Bruce Power's corrective actions by the end of 2019 to address the issues.

UPDATE: In April 2020, Bruce Power sent additional information to address the issue, which satisfied CNSC staff.

In all, CNSC staff observed that Bruce Power continued to improve its oversight of contractors in 2019. Issues were resolved as they were identified, with many being resolved before the MCR activities began. In 2020, CNSC staff plan to further their review of Bruce Power's management of MCR contractors.

### **Business continuity**

On-site observations in 2019 confirmed that Bruce Power had adequate contingency plans to maintain or restore critical safety and business functions in the events of disabling circumstances, such as a pandemic, severe weather, or labour actions at Bruce A and B. On-site staff also observed how these measures also supported the minimum shift complements for Bruce A and B.

## **3.5.2 Human Performance Management**

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Human performance management at Bruce A and B in 2019.

### **Human performance program**

In 2019, Bruce Power continued the development of the initiative "You Can Count on Me. Every Step. Every Time. Every Day" to improve human performance programs at Bruce A and B.

### **Personnel training**

CNSC compliance activities identified 43 findings relevant to training at Bruce A and B in 2019, many of which were compliant or of negligible safety significance. In 2019, CNSC staff inspected Bruce Power's authorized nuclear operator training program for Bruce A and B [BRPD-AB-2019-04830] and identified minor procedural issues of negligible safety significance. CNSC staff were satisfied with Bruce Power's progress in correcting all minor deviations in 2019.

### **Personnel certification**

CNSC staff reviewed the staffing reports for certified personnel and the applications for initial certification and renewal of certification and confirmed that Bruce Power had a sufficient number of personnel at both Bruce A and B in 2019 for all certified positions.

### **Initial certification examinations and requalification tests**

In 2019, CNSC staff performed a desktop inspection of the design, development and grading of a simulator-based certification examination for a control room operator at Bruce A [BRPD-A-2019-02183]. CNSC staff identified a non-compliance with the grading assessment documentation. All CNSC staff's recommendations from the inspection targeted continuous improvement of the grading of simulator-based certification examinations and marking of written certification examinations. Bruce Power submitted a corrective action plan to address the recommendation, which was found to be satisfactory by CNSC staff. CNSC staff also performed a desktop inspection of the development and marking of a supplementary station-specific certification examination for a control room shift supervisor, which identified only compliant findings [BRPD-AB-2019-03077].

### **Fitness for duty**

CNSC staff determined, through field inspections and other observations, that Bruce Power met the applicable regulatory requirements for minimum shift complement at Bruce A and B in 2019. In 2019, Bruce A and B promptly reported one violation of minimum shift complement. CNSC staff confirmed that the violation had minimal to no impact on safe operation of the stations.

In 2019, Bruce Power had to exceed the hours-of-work (HOW) limits at Bruce A and B for certified staff in order to maintain the minimum shift complement. Bruce A had six exceedances of the HOW limit of 16 hours worked in a 24-hour period. Bruce B had three exceedances of the 16 hour limit. CNSC staff observed that there was a general decreasing trend in the number of exceedances of the 16 hour limit during 2019. This was the result of Bruce Power's improvements to the management of worker fatigue in the second half of the year, including the implementation of an application to send bulk text messages to certified workers when replacements were needed due to illness.

Bruce Power completed the implementation of CNSC REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* in 2019. Bruce Power had also committed to fully implementing CNSC REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness* in 2020.

Bruce Power's implementation of the new regulatory document on managing alcohol and drug use was pending the development and publication of version 3 of REGDOC-2.2.4, *Fitness for Duty, Volume II, Managing Alcohol and Drug Use*. Bruce Power planned to implement all REGDOC-2.2.4 Volume II requirements, other than random alcohol and drug testing, six months from the publication of REGDOC-2.2.4 Volume II, version 3. Bruce Power planned to implement random alcohol and drug testing 12 months from the publication of REGDOC-2.2.4 Volume II, version 3.

### **3.5.3 Operating Performance**

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Operating performance at Bruce A and B in 2019.

### **Conduct of licensed activities**

In 2019, CNSC staff noted that Bruce Power's operating practices were adequate and, in several cases, were highly effective and carried out with a high regard for safety. Bruce Power achieved a high level of compliance with the applicable operational requirements and adequately addressed operational situations that were identified. For example, all issues identified in CNSC's field inspections were promptly and adequately addressed before CNSC staff issued the quarterly inspection report.

### **Procedures**

Various CNSC inspection findings and on-site observations confirmed that Bruce Power complied with the applicable regulatory requirements related to procedural use and adherence, and procedural adequacy.

### **Reporting and trending**

CNSC staff determined that Bruce Power complied with the applicable regulatory reporting requirements in 2019. All scheduled reports required by REGDOC-3.1.1 were submitted in a timely manner. The information provided in Bruce Power's scheduled quarterly reports exceeded CNSC staff's expectations. Bruce Power submitted 87 event reports in 2019. CNSC's on-site monitoring confirmed that Bruce Power reported events in a timely manner. However, there was one late submission of an event report at Bruce A that was related to a change of status of certified personnel in 2019. CNSC staff confirmed that Bruce Power promptly addressed the issue. There were also two late submissions of event reports at Bruce B. One was related to a damaged transportation package and the other to unavailability of the emergency water system. CNSC staff confirmed that Bruce Power promptly addressed the reporting issues.

Bruce Power followed up all reported events and supported them by adequate root cause analysis, when appropriate.

### **Outage management performance**

In 2019, there were two planned outages at Bruce A and two at Bruce B. Bruce Power submitted all its final outage reports in a timely manner. CNSC inspections of all planned outages confirmed that Bruce Power performed all outage-related undertakings safely. Bruce A and B complied with the applicable requirements related to the management of heat sinks and reactor shutdown guarantees. Bruce Power also promptly and adequately addressed CNSC staff recommendations and requests stemming from the inspections.

In 2019, Bruce A experienced five forced outages (three at Unit 2 and two at Unit 4). Bruce B experienced four forced outages (two at Unit 5 and two at Unit 6). All forced outages were manual and they were mainly caused by events related to service equipment (for example, an issue with the main output transformer resulted in a turbine trip; in another case, a switchyard bracket trip during maintenance activities resulted in a logic actuation that tripped the reactor). There were fewer forced outages than in 2018 and CNSC staff observed that Bruce Power followed up all forced outages appropriately in 2019. There were no process failures at Bruce A or Bruce B in 2019, including during the outages.

### **Safe operating envelope**

During 2019, CNSC staff reviewed a sample of Bruce Power's updated operating safety requirements documents and were satisfied with the progress of SOE implementation at Bruce A and B in 2019. SOE documents were found to be more closely aligned with station design, operations, and maintenance practices. Bruce Power planned to complete its updates of SOE documents (SOE governing documents, operational safety requirements, instrument uncertainty calculations and compliance table) in 2020.

### **Severe accident management and recovery**

In 2019, CNSC staff began a review of Bruce Power's integrated accident management program. At the end of 2019, CNSC staff were reviewing the severe accident management guidelines (SAMGs) and emergency mitigating equipment guidelines (EMEGs). CNSC staff planned to issue a report of its findings by the end of 2020. CNSC staff also inspected the Huron Resilience Corporate Drill in 2019 and identified a number of positive observations. CNSC staff determined that Bruce Power complied with the applicable regulatory requirements for adequacy of procedures [BRPD-AB-2019-03799].

## **3.5.4 Safety Analysis**

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safety analysis at Bruce A and B in 2019.

### **Deterministic safety analysis**

CNSC staff determined that Bruce Power had a well-managed program on conducting deterministic safety analysis and that the existing deterministic safety analysis remained adequate during the continued implementation of REGDOC-2.4.1, *Deterministic Safety Analysis*. In the process of REGDOC-2.4.1 implementation, Bruce Power submitted updates of part 1 and part 2 of its safety report for both Bruce A and B in February 2019. CNSC staff determined that the updates met the applicable regulatory requirements and that the safety analyses for both Bruce A and B predicted adequate margins and that Bruce Power met CNSC's acceptance criteria for safe operation.

In 2019, CNSC staff completed their review of Bruce Power's threshold break-size assessment in support of the composite analytical approach (CAA) for LBLOCAs. CNSC staff found that there was sufficient justification to accept the predicted low frequency for a break size larger than the threshold break size (TBS), which is a critical premise in the assessment. Bruce Power's work on the CAA, including the incorporation of the results of the threshold break-size assessment, was ongoing at the end of 2019. Background information on the CAA is provided in section 2.4.

Overall, Bruce Power's submissions in 2019 related to deterministic safety analysis exceeded CNSC staff's expectations.

UPDATE: In January 2020, Bruce Power submitted a revised LBLOCA analysis and requested that LBLOCA events above the TBS be reclassified as BDBA events. The January 2020 submission analyzes LBLOCA events above the TBS under more realistic operating conditions.

### **Probabilistic safety assessment**

CNSC staff determined that Bruce Power complied with CNSC regulatory document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* and was in transition to implementation of CNSC REGDOC-2.4.2, *Probabilistic Safety Analysis (PSA) for Nuclear Power Plants* by 2020. Bruce Power completed its PSA submissions in April 2019 for REGDOC-2.4.2 compliance. CNSC staff completed reviews for Bruce Power's external hazard assessment and external flood assessment, and determined that they complied with REGDOC-2.4.2. CNSC staff plan to review the remaining submissions by the end of 2020. One of these submissions is the update on the internal fire PSA [RIB14761].

UPDATE: As of June 1, 2020, Bruce Power was addressing CNSC staff comments on the internal fire PSA and applying its policy for the treatment of PSA results that are between its safety goals and administrative safety goals. Bruce Power identified the main contributors from the fire PSA to the large release frequency for Bruce A. The policy then entails an identification of proposed mitigation strategies, which would be evaluated per Bruce Power's process for business risk management.

CNSC staff completed its review of the Bruce whole-site PSA and acknowledged that the submission provided a good characterization of the whole-site risk [RIB 14760]. See Section 2.4 for additional discussion. Bruce Power also submitted the aggregated risk values for whole-site PSA for Bruce A and B [RIB 14759]. CNSC staff were continuing to review Bruce Power's other PSA submission at the end of 2019, including the degree to which they supported the results of the whole-site PSA.

Bruce Power's work on PSA exceeded CNSC staff's expectations in 2019 because of their proactive approach in addressing REGDOC-2.4.2 requirements and due to their contributions to advancements in whole-site PSA and site risk aggregation.

### **Criticality safety**

With respect to Bruce Power's criticality safety program, both the booster fuel assemblies and demonstration fuel bundles for low-void reactivity fuel remained in safe storage. There were no events or issues related to criticality safety at Bruce A and B during 2019.

### **Severe accident analysis**

In 2019, CNSC staff started reviewing the severe accident analysis for Bruce A and B that supported the PSA.

## **3.5.5 Physical Design**

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Physical design at Bruce A and B in 2019.

### **Design governance**

In 2019, CNSC inspections confirmed compliance with the applicable requirements for environmental qualification at Bruce A and B, such as those related to maintaining the integrity of environmental qualification barriers.

## **System design**

Bruce Power introduced a new safety measure in 2019 by revising its operating principles and policies to include testing of remaining available standby generators, when they are at the minimum allowed availability, to confirm that they are functional and capable of supporting safe operation.

In 2019, CNSC staff reviewed Bruce Power's revised fire protection assessment reports for Bruce A and B. CNSC staff were satisfied with the results in the reports and with Bruce Power's responses to review comments. CNSC staff concluded that Bruce Power's fire protection program met the applicable regulatory requirements.

## **Component design**

CNSC staff confirmed that Bruce Power operated its units within the applicable fuel power limits and managed fuel performance satisfactorily in 2019. The frequency of debris fretting at Bruce A remained high in 2019 but did not pose a significant risk to safety. The frequency of endplate cracks (EPC) at Bruce B increased in 2019 as compared to 2018. CNSC staff noted the developments in Bruce Power's long-term strategy to resolve the long-standing EPC issue and continued to monitor progress.

### **3.5.6 Fitness for Service**

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Fitness for service at Bruce A and B in 2019.

#### **Equipment fitness for service / equipment performance**

All special safety systems at Bruce A met their unavailability targets in 2019.

For Bruce B, all special safety systems met their unavailability targets in 2019, except for emergency cooling injection (ECI) for Units 5-8. The ECI system for Units 5-8 exceeded the unavailability target due to two separate events. In one case, it was discovered that the number of aluminum tubes and planks stored in the central service area duct was larger than allowed. In the event of a LOCA, the reaction of aluminum with water at a high pH and temperature can produce aluminum hydroxide precipitate, which has the potential to plug the ECI strainers. Bruce Power declared the ECI to be unavailable when this field condition existed. Bruce Power prevented re-occurrence by relocating the scaffolding in the three affected units and created a training change request (TCR) to include aluminum hydroxide awareness in certification training for operations. Bruce Power also planned to embed the TCR in the ECI course material.

The second event occurred in September 2019. While inspecting an instrument room, Bruce Power staff found unrestrained equipment that did not comply with the requirements in Bruce Power's procedure for equipment in seismically-qualified areas. Any impingement on the free area for passive ventilation of the instrumentation could impact the environmental qualification of the room that is being protected.

If a seismic event caused a secondary-side line break and also caused significant damage to ductwork in the instrument rooms due to unsecured material, it could have potentially impacted the environmental conditions inside the affected rooms and the ability of the equipment in those rooms to perform its intended safety function. Bruce Power declared the ECI unavailable while the condition persisted. CNSC staff concluded that Bruce



Power's response to maintain proper housekeeping in seismic-qualified areas was acceptable. Bruce Power removed the unrestrained equipment promptly and initiated corrective actions to improve operational awareness of seismic requirements and reduce the likelihood of recurrence. CNSC staff conducted several field inspections since the preliminary report was released to confirm that the corrective actions were effective.

There was no significant impact on nuclear safety as a result of these instances of unavailability. CNSC staff continued to monitor all Bruce Power's corrective actions.

CNSC staff inspected the low-pressure service-water system at Bruce A [BRPD-A-2019-04073] and determined that Bruce Power complied with the applicable regulatory requirements for system monitoring.

### **Maintenance**

The performance of Bruce Power's maintenance program met CNSC expectations in 2019. The preventive maintenance completion ratios were improved to approximately 90% for Bruce A and Bruce B. The maintenance backlog results for Bruce A and B were acceptable and are provided in tables 22 and 23, respectively. For Bruce A, Bruce Power reduced its corrective critical maintenance backlogs and reached the range of industry best practices. For Bruce B, Bruce Power continued to reduce its corrective maintenance backlog and also reduced the deficient critical maintenance backlog in 2019.

### **Bruce A**

**Table 22: Trend of maintenance backlogs and deferrals for critical components for Bruce A, 2017 to 2019**

Parameter	Average quarterly work orders per unit			Three year trending	Quarterly 2019 work orders				Industry average for 2019
	2017	2018	2019		Q1	Q2	Q3	Q4	
Corrective maintenance backlog	3	0	1	Steady	1	0	0	0	1
Deficient maintenance backlog	100	13	10	Down	14	9	8	7	9
Deferrals of preventive maintenance	6	1	0	Down	0	0	0	0	2

**Bruce B****Table 23: Trend of maintenance backlogs and deferrals for critical components for Bruce B, 2017 to 2019**

Parameter	Average quarterly work orders per unit			Three year trending	Quarterly 2019 work orders				Industry average for 2019
	2017	2018	2019		Q1	Q2	Q3	Q4	
Corrective maintenance backlog	2	0	0	Steady	1	0	0	0	1
Deficient maintenance backlog	127	19	11	Down	21	11	8	4	9
Deferrals of preventive maintenance	7	0	0	Down	0	0	0	0	2

CNSC staff inspected the negative pressure containment system at Bruce A in 2019 [BRPD-A-2019-04725] and confirmed that Bruce Power complied with the applicable regulatory requirements for preventive and corrective maintenance for the system. That inspection, and the inspection of the vacuum building and emergency filtered air discharge system [BRPD-A-2019-04073] at Bruce A, confirmed that Bruce Power complied with the applicable regulatory requirements for surveillance testing for those systems.

**Periodic inspections and testing**

CNSC reviewed Bruce Power's inspection program results, quarterly operations reports, pressure boundary reports, and event reports in 2019 and concluded that SSCs had the required structural integrity at Bruce A and B. In 2019, pressure boundary inspection results indicated that all inspected elements of the primary heat transport and auxiliary systems, steam generators, feeders and pressure tubes were fit for continued operation. Bruce Power evaluated all inspection findings to confirm that structural integrity margins were maintained. CNSC staff determined that appropriate corrective actions (such as repairs or replacement of components) were implemented to restore margins as required.

The results of CNSC's assessments of Bruce Power's final outage inspection reports and component dispositions confirmed that the pressure tubes at Bruce A and B remained fit for service in 2019.

In 2019, CNSC staff reviewed Bruce Power's updated deterministic fracture protection assessment for fueled and de-fueled pressure tubes in Unit 3 (up to a limit of 230,000 EFPH) and Unit 5 (up to a limit of 255,000 EFPH). CNSC staff found that Bruce Power's updated assessments were acceptable for both units.

Bruce Power had predicted that some pressure tubes will reach the Heq validity limit (associated with key fracture toughness models) of 120 ppm before reaching the licensing limit of 300,000 EFPH of operation. Bruce Power committed to submit a technical basis document for a new fracture toughness model in 2020 [RIB 14757]. In the meantime, CNSC staff considered that the existing regulatory process used to monitor the additional validation of the existing fracture toughness model was adequate and ensured that the pressure tubes would continue to meet CSA acceptance criteria.

In 2019, CNSC staff continued to monitor issues related to the assessment of the potential for pressure tube to calandria tube (PT-CT) contact in Bruce B fuel channels. During the outages of Unit 6 and Unit 8, Bruce Power detected a small PT-CT gap in two channels - it was lower than the validity limit of the inspection tool. The erosion of margins for PT-CT contact prompted Bruce Power to develop novel approaches to meet fitness-for-service and disposition requirements, which CNSC staff recognized as challenging for small gaps. However, CNSC staff concluded that fuel channels were fit for service at Bruce A and B in 2019 and continued to monitor the PT-CT contact issue.

### **Aging management**

In the area of aging management, Bruce Power demonstrated that the integrity of the steam generator tubes and support structures was adequate in 2019 and that no active degradation mechanisms would challenge integrity of the steam generator and preheater tubes over the requested operating period.

In 2019, Bruce Power implemented a relief-valve testing program to confirm that overpressure protection devices on pressure boundary systems would perform their intended function in the event of operating pressure transients. The number of relief valve test failures reported for balance-of-plant pressure boundary systems trended downward in 2019.

### **Chemistry control**

CNSC staff determined that Bruce Power's chemistry control met the applicable regulatory requirements during the planned outages of Units 2, 3, 5 and 7 in 2019. CNSC staff continued to monitor the low values for SPI 20 (chemistry compliance index) in 2019 due to lower moderator isotopic purity. Bruce Power has taken appropriate actions to maintain the chemistry control parameters within acceptable limits.

## **3.5.7 Radiation Protection**

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Radiation protection at Bruce A and B in 2019.

### **Application of ALARA**

In 2019, CNSC field inspections [BRPD-AB-20219-05202] confirmed that Bruce A and B implemented ALARA through post-job ALARA reviews, ALARA initiatives and oversight, and the use of engineering controls and specialized tooling to reduce worker exposures.

Bruce Power achieved its collective dose targets for planned outages in 2019 for Bruce A and B. Similarly, online collective doses were lower than the dose targets for both stations.

In 2019, CNSC staff performed an MCR desktop inspection of the program for radiation protection source-term and ALARA at Unit 6 [BRPD-MCR-2019-05407] and concluded that Bruce Power complied with the regulatory requirements for the development, monitoring, trending, assessment and reporting of dose goals and targets to drive continual improvement in performance. CNSC staff also confirmed that Bruce Power had processes to manage all radiological hazards during refurbishment activities in order to optimize occupational exposures.

CNSC staff conclude that Bruce Power's performance met or exceeded applicable regulatory requirements in the Application of ALARA specific area.

### **Worker dose control**

In 2019, Bruce Power maintained worker dose ALARA, in particular during the execution of outages. CNSC staff observed there were no adverse trends or safety significant unplanned exposures at Bruce A and B. CNSC staff also noted that the number of workers in higher dose categories was decreasing. There were no action level exceedances at Bruce A and B due to unplanned exposures and there were no exposures that resulted in a worker dose over the annual regulatory effective dose limit (50 mSv).

### **Radiation protection program performance**

In 2019, CNSC staff performed an MCR desktop inspection [BRPD-MCR-2019-04984] of the radiation protection program to protect health and safety of workers and to monitor and control radiation hazards (including alpha) during refurbishment at Unit 6. CNSC staff concluded that Bruce Power complied with the regulatory requirements for worker dose control (for example, related to the tracking and trending of dose targets to ensure management oversight). CNSC staff also confirmed that Bruce Power had an effective process to control facility layout and the classification of areas with respect to radiation protection.

CNSC staff confirmed that Bruce Power continually measured the performance of its radiation protection program against industry-established objectives, goals and targets. In 2019, Bruce Power's self-assessments identified improvements to its radiation protection program to protect health and safety of workers and to monitor and control radiation hazards (including alpha) during refurbishment.

### **Radiological hazard control**

CNSC staff determined that Bruce Power implemented effective controls for radiological hazards. There were no action level exceedances for surface contamination or contamination control at Bruce A and B in 2019. In addition, the total number of personal contamination events was less than Bruce Power's target for Bruce A and B.

## **3.5.8 Conventional Health & Safety**

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Conventional health & safety at Bruce A and B in 2019.

CNSC inspections in 2019 identified numerous compliant findings related to conventional health and safety at Bruce A and B. Additionally, all non-compliances identified were of negligible safety significance and were promptly and adequately addressed.

CNSC staff's on-site surveillance and monitoring also resulted in many positive observations related to awareness and practices associated with conventional health and safety. CNSC staff noted that Bruce Power had appropriate procedures to ensure the safety of workers from hazardous materials and that workers adequately identified workplace hazards in 2019.

In 2019, Bruce Power achieved more than 7 million hours without a lost time accident (LTA). The SPI Accident Frequency for Bruce A and B continued to be low in 2019 (data provided in Section 2.8). However, a lost-time injury, resulting in a significant number of lost days, occurred at the fire training facility (not in the main station area) when a worker slipped on ice and fell to the same level. The potential for ice on the roof had been identified in advance and the employee was wearing appropriate footwear. The employee needed five months off work to recover. Subsequently, the SPI Accident Severity Rate increased in 2019, but was still comparable to the industry average and data for previous years at Bruce A and B (see Section 2.8). CNSC staff concluded that Bruce Power's pre-work preparations, post-event response and corrective actions to prevent event re-occurrence were adequate.

### 3.5.9 Environmental Protection

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Environmental protection at Bruce A and B in 2019.

In 2019, radiological releases to the environment from Bruce A and B were well below regulatory limits; Bruce Power did not exceed any DRLs or environmental action levels for airborne and waterborne emissions. The actual values of the releases and DRLs are provided in Appendix D. Based on the review of the 2019 environmental monitoring data, CNSC staff concluded that Bruce Power's control, monitoring, analysis and reporting of environmental data and associated processes were consistently implemented and complied with the applicable regulatory requirements.

In 2019, CNSC staff inspected effluent control and monitoring at Bruce A and B [BRPD-AB-2019-04792] and confirmed that Bruce Power complied with the applicable regulatory requirements for effluent and emissions monitoring.

CNSC staff noted that there were no significant releases of hazardous substances at the Bruce site in 2019 that posed an unacceptable risk to the environment or the general public. The estimated maximum annual radiation dose to the public from the Bruce site remained very low at 0.15 percent of the public dose limit.

Bruce Power had submitted a revised Environmental Risk Assessment (ERA) in December 2018 and continued to implement CSA N288.6-12, *Environmental risk assessments at class I nuclear facilities and uranium mines and mills* in 2019. In 2019, CNSC and Environment and Climate Change Canada (ECCC) staff reviewed the revised ERA and concluded that it complied with CSA N288.6-12 and that the majority of CNSC and ECCC comments had been adequately addressed. Bruce Power, CNSC and ECCC met regularly in 2019 to discuss expectations for additional analysis and uncertainty assessment for the next revision of the ERA.

### 3.5.10 Emergency Management and Fire Protection

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Emergency management and fire protection at Bruce A and B in 2019.

Bruce Power's capital project for radio system replacement, which will enhance radio communication reliability for emergency response team members, continued in 2019. It included the replacement of all handheld radios and hardware infrastructure (antennas, cabling, repeaters, networking, etc.); refurbishment of the distributed antenna system; and construction of a replacement radio tower and associated equipment. CNSC staff were satisfied with the project's progress in 2019, which entailed completion of the design and work control packages for the whole site. The next steps were to move the necessary equipment on-site and begin construction. Bruce Power was on track to finish the project in 2022.

Bruce Power conducted the Huron Resilience corporate emergency exercise in 2019. It lasted three days and involved municipal, provincial and federal agencies. CNSC staff inspected the exercise [BRPD-AB-2019-03799] and concluded that Bruce Power demonstrated the ability to adequately respond to an emergency while ensuring the safety and protection of on-site personnel, the public and the environment.

In response to a CNSC staff request per subsection 12(2) of the *General Nuclear Safety and Control Regulations*, Bruce Power performed a feasibility assessment to investigate options for automatic connectivity between its plant data systems and its disaster LAN (DLAN) electronic data management system in 2019. CNSC staff concluded that the DLAN system was consistent with their data transfer expectations. CNSC staff participated in a test trial of the system as part of the development phase during the Huron Resilience exercise and confirmed its workability. CNSC staff requested Bruce Power to provide quarterly updates on system implementation starting in April 2020.

CNSC staff determined that Bruce Power maintained a comprehensive fire response capability and fire protection program in 2019. Bruce Power had an extensive fire drill and training program, which included the Emergency and Protective Services Training Facility on the Bruce site, where live fire training was conducted.

### 3.5.11 Waste Management

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Waste management at Bruce A and B in 2019.

In 2019, CNSC staff confirmed through a field inspection that Bruce Power complied with the applicable regulatory requirements for waste management practices associated with waste transfer documents. CNSC staff were satisfied with the values of the safety performance indicator SPI 25 (Low and Intermediate level Radioactive Solid Waste Generated) for Bruce A and B in 2019. CNSC staff also identified non-compliances of negligible safety significance that Bruce Power adequately addressed. For example, in the area of radioactive waste control, CNSC staff noted instances when Bruce Power staff had left containers of radioactive waste in areas that were not sanctioned by procedures.

### 3.5.12 Security

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Security at Bruce A and B in 2019.

CNSC staff conducted two field inspections in late in December of 2018 that identified minor non-compliances related to facilities and equipment. Due to discussions of the findings with Bruce Power, inspection reports were formally sent to Bruce Power in March 2019. Bruce Power addressed inspections findings promptly. As part of the MCR, Bruce Power added facilities and equipment to handle the increased contractor foot and vehicle traffic in and out of the protected area.

In 2019, Bruce Power implemented the corrective actions needed to address issues identified during the force-on-force exercise in 2018. Bruce Power planned to validate the corrective actions during the force-on-force exercise that is part of its 2020 performance-testing program.

Bruce Power continued to update its cyber security program at Bruce A and B to be in full compliance with CSA N290.7-14, *Cyber security for nuclear power plants and small reactor facilities* by December 31, 2020. CNSC staff were satisfied with the implementation progress.

### 3.5.13 Safeguards & Non-proliferation

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safeguards & non-proliferation at Bruce A and B in 2019.

With respect to nuclear material accountancy and control and safeguards equipment, Bruce Power adequately addressed a minor procedural issue identified during a safeguards field inspection that found a discrepancy with Bruce Power's fuel accounting system [BRPD-AB-2019-03968].

CNSC staff concluded that all nuclear material at Bruce A and B remained available for International Atomic Energy Agency (IAEA) verification in 2019.

In 2019, Bruce Power submitted its required monthly general ledgers on time.

CNSC staff confirmed that Bruce Power granted adequate access and assistance to the IAEA for safeguards activities, including inspections and the maintenance of equipment at both Bruce A and B. During the 2019 IAEA inspections, the nuclear material inventory was verified and the absence of undeclared nuclear material and activities was assured.

In 2019, the IAEA reviewed Bruce Power's revised draft design information questionnaire and provided additional comments that were also reviewed by CNSC staff. Bruce Power's response on these comments was expected in May 2020.

Bruce Power submitted its annual operational program with quarterly updates for both Bruce A and B in a timely manner. Bruce Power submitted the annual update to the information pursuant to the IAEA Additional Protocol as required. All information submitted to the CNSC met the applicable regulatory requirements.

CNSC staff confirmed that Bruce Power adequately supported IAEA equipment operation and maintenance activities on IAEA equipment at Bruce A and B in 2019, including routine maintenance of surveillance equipment (cameras, seals, and spent fuel monitors).

#### **3.5.14 Packaging & Transport**

CNSC staff concluded that Bruce Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Packaging & transport at Bruce A and B in 2019.

CNSC staff confirmed that the transport of nuclear substances to and from Bruce A and B was performed safely in 2019.

There were four transport and packaging events reported at Bruce A and B. Two of those events were incoming shipments, and upon arrival, Bruce Power noticed that packages had sustained minor damage while in transport. The third event related to a package damaged prior to shipping and was caused by jack bolt damage on the lid during package tightening. The last event was caused by improper draining prior to shipping. This event was evaluated by Bruce Power as not reportable; however, Bruce Power submitted the event report as a precautionary measure and for consistency with OPG and CNL reporting. None of these events were safety significant and there were no radioactive materials released to the environment.



## 3.6 Western waste management facility

### 3.6.0 Introduction

The CNSC regulates the WWMF under a waste facility operating licence (WFOL) and the RWOS-1 under a waste nuclear substance licence (WNSL). The WWMF and RWOS-1 are owned and operated by OPG.

At the WWMF, OPG processes and stores dry storage containers (DSCs) containing used nuclear fuel (high-level radioactive waste) generated solely at Bruce A and B. At this facility, OPG also manages the low- and intermediate-level radioactive wastes (L&ILW) generated from the operation of OPG-owned facilities. OPG also manages the L&ILW generated from the refurbishment of Bruce A at the WWMF.



The WFOL for the WWMF allows limited activities of import and export of nuclear substances, which occur primarily as contaminants in laundry, packaging, shielding or equipment.

The WFOL spans two separate areas - the L&ILW Storage Facility and the Western Used Fuel Dry Storage Facility (WUFDSF) - within the overall boundary of the Bruce site. The L&ILW Storage Facility consists of the Waste Volume Reduction Building; the Transportation Package Maintenance Building; 14 above-ground, low-level storage buildings (LLSBs), two above-ground, refurbishment waste storage buildings; and, various in-ground containers, trenches, and tile holes for the storage of ILW. The WUFDSF is located within its own protected area, separate from the protected area of Bruce A and B, but within the boundary of the Bruce site. The WUFDSF contains one DSC processing building and four DSC storage buildings (Storage Buildings #1, #2, #3, and #4). The WWMF currently has the capacity to store 2,000 DSCs. The transfer of loaded DSCs from Bruce A and B to the WWMF is conducted on property controlled by Bruce Power and OPG.

Under the WFOL for the WWMF, OPG is authorized to construct four additional DSC storage buildings (Storage Buildings #5, #6, #7 and #8), 11 additional LLSBs, 270 additional in-ground containers, 30 in-ground containers for heat exchangers, one large-object processing building, and one waste sorting building. The new structures will provide additional storage for used nuclear fuel and additional storage and processing facilities to manage L&ILW.

At RWOS-1, OPG stores L&ILW generated at the Douglas Point Nuclear Generating Station and PNGS Units 1-4. The RWOS-1 site comprises a number of in-ground waste storage structures, including concrete-lined trenches and steel-lined concrete holes.

### Licensing

The Commission renewed the WFOL for the WWMF in May 2017 for a period of 10 years until May 31, 2027. It was not amended in 2019. The WNSL for RWOS-1 was amended by the Designated Officer (DO) in 2019. The WNSL is valid for 10 years and expires on October 31, 2029.

### Licence Conditions Handbook

CNSC staff did not revise the WWMF LCH in 2019. However, OPG implemented several CNSC regulatory documents (new publications or new versions of existing publications) in 2019. Future revisions of the LCH will reflect them as sources of compliance verification criteria for the WWMF.

CNSC staff were drafting an LCH for RWOS-1 in 2019.

### Event initial reports

No event initial reports pertaining to the WWMF or RWOS-1 were submitted to the Commission for the period of January 1, 2019 to June 1, 2020.

### Compliance Program

The inspections conducted at the WWMF that were considered in CNSC staff's assessments in this regulatory oversight report are included in table 24.

**Table 24: List of Inspections at WWMF**

Safety and control area	Inspection title	Inspection report sent date
<b>Operating Performance</b>	Type II Compliance Inspection – General Report Number: OPG-WWMF-2019-02	November 26, 2019
<b>Environmental Protection</b>	Type II Environmental Protection Focused Compliance Inspection Report Number: OPG-WWMF-2019-03	December 19, 2019
<b>Packaging and Transport</b>	Type II Compliance Inspection Report Number: OPG-PWMF-2019-01	July 18, 2019

In addition to the inspections listed, CNSC staff considered various other sources of information in its assessment of the SCAs. Those activities identified numerous examples of compliance with regulatory requirements and excellent safety performance, as well instances of non-compliance and opportunities for improved performance. For 2019, CNSC staff assigned “satisfactory” ratings for all SCAs at the WWMF in 2019.

### 3.6.1 Management System

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Management system at the WWMF in 2019.

CNSC staff inspections in 2019 identified numerous complaint findings that confirmed the effectiveness of the management system framework at the WWMF, including the following:

- work-related documentation/checklists were properly filled out and complete (i.e., transfer dossiers of DSCs, maintenance inspection check sheets, etc.) [OPG-WWMF-2019-01]
- waste inventory records were maintained [OPG-WWMF-2019-02, OPG-WWMF-2019-03]

CNSC staff identified a finding of low safety significance whereby an OPG testing and sampling operator did not have the proper training records [OPG-WWMF-2019-03]. CNSC staff were satisfied with OPG's corrective actions.

### 3.6.2 Human Performance Management

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Human performance management at the WWMF in 2019.

Overall, CNSC staff did not identify any major non-compliant findings with regards to human performance in 2019. CNSC staff's reviews of the quarterly and annual operational reports for the WWMF in 2019 did not identify any issues or concerns related to training or other specific areas under human performance management.

CNSC staff continued to monitor and assess OPG's implementation of REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue*, and planned to perform compliance verification activities in 2020.

### 3.6.3 Operating Performance

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Operating performance at the WWMF in 2019.

In 2019, OPG:

- processed 102 DSCs
- received 982 m<sup>3</sup> of L&ILW
- operated the WWMF incinerator for 103 days on solids and 121 days on liquids
- conducted caretaking activities at the RWOS-1

In 2019, CNSC staff identified non-compliances related to procedures involving inconsistency of work forms for material transportation at the WWMF [OPG-WWMF-2019-01]. CNSC staff were satisfied with OPG's corrective measures.

CNSC staff's review of OPG's operational reports did not identify any issues or situations that suggested that licensed activities at the WWMF were unsafe. The reviews also confirmed that OPG's reporting and trending, and its responses to comments and requests for follow-up information/clarification met CNSC staff's expectations.

### 3.6.4 Safety Analysis

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safety analysis at the WWMF in 2019.

OPG did not submit any significant updates to the safety analysis report in 2019; the next revision was expected in 2022.

### 3.6.5 Physical Design

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Physical design at the WWMF in 2019.

In 2019, OPG submitted its construction notification package for future storage buildings (Storage Building #5 and #6) at the WWMF site. CNSC staff reviewed the package and found that it met their expectations for site characterization.

### 3.6.6 Fitness for Service

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Fitness for service at the WWMF in 2019.

As part of the aging management activities for DSCs, OPG submitted the aging management report for the OPG WMFs. CNSC staff reviewed the submission and found that it complied with OPG's aging management program.

### 3.6.7 Radiation Protection

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Radiation protection at the WWMF in 2019.

CNSC staff noted the following positive trends for radiation protection at the WWMF in 2019:

- OPG met the overall ALARA performance objectives in terms of collective dose targets.
- No action levels for worker dose control were exceeded and annual effective doses for all workers were well below the regulatory limit of 50 mSv.
- OPG's quarterly dose rate measurements at the RWOS 1 and WWMF perimeter fences confirmed that the average gamma dose rates at all locations remained within target.
- There were no recordable radiological exposures for OPG staff performing caretaking duties at RWOS-1.
- There was no reportable dose from work completed in the construction island around the Spent Solvent Treatment Facility.
- OPG did not exceed any action levels for loose surface contamination.
- There were no reported events related to radiological hazard control.

CNSC staff identified a non-compliance of low safety significance related to a legacy issue where the majority of the LLW and ILW containers in storage do not comply with the labelling requirements of the *Radiation Protection Regulations* [OPG-WWMF-2019-02]. CNSC staff directed OPG to submit a plan to achieve compliance for all remaining LLW and ILW containers.

UPDATE: In March 2020, OPG provided a corrective action plan regarding this directive that CNSC staff found acceptable.

### 3.6.8 Conventional Health & Safety

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Conventional health & safety at the WWMF in 2019.

CNSC inspections identified multiple compliant findings in 2019 [OPG-WWMF-2019-02/03]. These involved observations of:

- workers wearing appropriate PPE
- PPE readily available
- comprehensive safety briefings
- first aid kits and eyewash stations readily available

However, CNSC staff also identified non-compliances. For example, CNSC staff noted the use of an extension cord and coat hanger to keep an entrance hatch on the wall open at the WUFDSF. CNSC staff confirmed that OPG adequately addressed the non-compliances.

### 3.6.9 Environmental Protection

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Environmental protection at the WWMF in 2019.

CNSC staff noted the following positive trends for environmental protection at the WWMF in 2019:

- There were no documented exceedances of release limits for hazardous substances
- The WWMF and RWOS-1 did not exceed and DRLs or environmental action levels
- There were no environmental-related events

The estimated maximum dose to the public (as per Bruce Power's annual environmental reports) have been very low (<10uSv for the past decade, compared to the regulatory limit of 1 mSv), for which the WWMF represents a small fraction of the total dose calculation for the Bruce site.

However, CNSC staff also identified a finding of low safety significance involving an absence of samples from sample station (SS) #2 for waterborne effluents [OPG-WWMF-2019-03].

UPDATE: In May 2020, OPG provided a satisfactory corrective action plan to CNSC staff.

### **3.6.10 Emergency Management and Fire Protection**

CNSC staff confirmed that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Emergency management & fire protection at the WWMF in 2019.

In 2018, CNSC staff had determined that OPG was not performing an annual fire response drill per the applicable regulatory requirements. In May 2019, CNSC staff observed OPG's fire response drill at the WWMF and did not note any non-compliances.

However, CNSC staff identified a finding of low safety significance at the WWMF in 2019 involving the exceedance of a replacement date for fire hoses. While performing the annual inspection of fire hose cabinets in the Waste Volume Reduction Building, OPG found that all 13 fire hoses exceeded the replacement date of five years. OPG implemented appropriate corrective actions and immediately procured and installed new fire hoses. OPG immediately implemented a fire impairment plan that remained in place until the hoses were replaced. In addition, OPG updated and simplified its procedural requirements as part of the corrective actions. CNSC staff were satisfied with OPG corrective actions.

### **3.6.11 Waste Management**

CNSC staff confirmed that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Waste management at the WWMF in 2019.

CNSC staff noted multiple compliant findings and good practices at the WWMF in 2019 [OPG-WWMF-2019-02], including the following:

- segregation of radioactive waste at its point of generation; segregation bins in strategic locations throughout the facility for active incinerable, active compactable, active non-processible and likely-clean waste
- equipment that allows for the safe placement and removal of the storage containers
- good waste minimization in the LLSBs
- package labels on waste containers in accordance with requirements
- comprehensive waste acceptance criteria for the facility

In 2019, CNSC staff reviewed the latest revision of OPG's decommissioning program and also reviewed its standard for the management of waste and other environmentally-regulated materials. The documents met the applicable regulatory requirements and CNSC staff's expectations.

### **3.6.12 Security**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Security at the WWMF in 2019.

Bruce Power maintains an on-site nuclear response force and a drill and exercise program that serves the WWMF.

CNSC staff did not identify any major non-compliant findings with regards to security at the WWMF in 2019. CNSC staff confirmed that performance information from quarterly reports and the inspection met their expectations with respect to security.

### **3.6.13 Safeguards & Non-proliferation**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safeguards & non-proliferation at the WWMF in 2019.

CNSC staff confirmed that OPG submitted its required monthly general ledgers on time and that the site met the requirements of the IAEA's physical inventory verifications and design information verifications.

OPG submitted the required annual operational programme with quarterly updates, and the annual update to the Additional Protocol, to the CNSC in a timely manner. CNSC staff determined that they met the applicable regulatory requirements and staff's expectations.

### **3.6.14 Packaging & Transport**

CNSC staff concluded that OPG met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Packaging & transport at the WWMF in 2019.

CNSC staff conducted a focused inspection of packaging and transport at the WWMF in 2019 and identified 11 compliant findings [OPG-WWMF-2019-01]. During the same inspection, CNSC staff also identified a finding of medium safety significance. The finding was regarding a label that was covered and non-visible on a package containing residual material. The package was on-site awaiting for annual maintenance and the covering was an indication not to use that package. OPG addressed the situation to the satisfaction of CNSC staff.

## 3.7 Point Lepreau nuclear generating station

### 3.7.0 Introduction

The Point Lepreau site is located on the Lepreau Peninsula, 40 kilometres southwest of Saint John, New Brunswick. The facilities are owned and operated by New Brunswick Power Corporation (NB Power) and include a single CANDU reactor with a rated capacity of 705 megawatts electrical (MWe). The Point Lepreau site also includes the Solid Radioactive Waste Management Facility (SRWMF), which is a short distance from the power reactor and within the exclusion zone. The CNSC regulates the PLNGS and the SRWMF under a single power reactor operating licence (PROL).



Radioactive waste storage includes short-term storage in the service building prior to transfer of the waste to the SRWMF for long-term storage. The SRWMF is used for the storage of solid radioactive waste, including used nuclear fuel that is produced solely at PLNGS.

The SRWMF is comprised of the following Phase I, II and III sites:

- Phase I of the facility is used to store operational waste.
- Phase II is a dry storage facility for used fuel.
- Phase II Extension is an additional area prepared in 2006 to allow for dry storage of used fuel. Approval is required in accordance with the PROL prior to commissioning and use.
- Phase III of the facility stores waste from fuel channel replacement and other operations completed during the refurbishment outage.

### Licensing

In 2017, the Commission renewed the PROL for a period of five years, authorizing NB Power to operate the PLNGS and the SRWMF until June 2022. The PROL was not amended in 2019.

### Licence Conditions Handbook

CNSC staff issued a new licence conditions handbook (LCH) when the PROL was issued on June 30, 2017. The first revision of the LCH came into effect on December 20, 2019 to update the compliance verification criteria in various sections of the LCH, and to include new or revised CNSC regulatory documents, CSA Group standards (these developments are described in Appendix E of this report) and licensee documents.



### ***Fisheries Act Authorization***

According to the provisions of the *Fisheries Act*, NB Power submitted, for CNSC staff review, a preliminary self-assessment of serious harm to fish from cooling-water intake. In April 2016, CNSC staff reviewed the assessment and met with NB Power to discuss the need for additional information.

NB Power submitted a revised *Fisheries Act* self-assessment to the CNSC in January 2017. CNSC staff completed their technical review of the self-assessment and concluded that an authorization was required in accordance with subsection 35(1) of the *Fisheries Act*. Fisheries and Oceans Canada concurred with the CNSC's recommendation. NB Power submitted a partial draft *Fisheries Act* application to the CNSC on March 27, 2018, followed by another draft application in December 2018.

CNSC staff sent their comments to NB Power in February 2019. CNSC staff, Fisheries and Oceans Canada, and NB Power met in April 2019 to discuss these comments. In June 2019, NB Power informed the CNSC that it will proceed with a new offsetting strategy in the form of a dam removal. Since this strategy will serve as offset for three other NB Power facilities, it was agreed that Fisheries and Oceans Canada would take the lead as the primary regulatory agency. NB Power submitted a revised FAA application to DFO in June 2019. In August 2019, Fisheries and Oceans Canada deemed the *Fisheries Act* authorization application incomplete. In October 2019, NB Power submitted an updated application to Fisheries and Oceans Canada. In December 2019, Fisheries and Oceans Canada deemed the *Fisheries Act* authorization to be complete; however, the 90-day time limit within which a decision with respect to the application has ceased due to Indigenous consultation requirements.

### **Periodic safety review**

The PROL requires NB Power to perform a PSR in accordance with REGDOC-2.3.3, *Periodic Safety Reviews*. NB Power submitted a high-level project execution plan and a PSR basis document in support of a 10-year licensing period from 2022 to 2032. In December 2018, NB Power submitted an updated PSR basis document which was accepted by CNSC staff. NB Power submitted safety factor reports 4, 5, 6, 7, 9, 11, 12, 13 and 14 in December 2018. The safety factor reports 1, 2, 3, 8, 10 and 15 were submitted to CNSC in March 2019. CNSC staff completed the review of all 15 Safety Factor Reports in October 2019.

UPDATE: NB Power submitted the Global Assessment Report in February 2020, which was under review by CNSC staff as of June 1, 2020.

### **Event initial reports**

No event initial reports pertaining to Point Lepreau were submitted to the Commission for the period covering January 1, 2019 to June 1, 2020.

### **Compliance Program**

The compliance program included numerous activities in 2019 to confirm NB Power's compliance with the licensing basis for PLNGS. The publications that provided compliance verification criteria for those activities for PLNGS are provided in Appendix B.

The inspections at the Point Lepreau site that were considered in the safety assessments in this regulatory oversight report are listed in table 25 (inspection reports were included if they were sent to NB Power by January 31, 2020).

**Table 25: List of inspections at Point Lepreau**

<b>Safety and control area</b>	<b>Inspection title</b>	<b>Inspection report sent date</b>
<b>Management system</b>	Supply Management Report Number: GPLRPD-2019-05229	Dec 23, 2019
	Retention of Records Supporting Initial and Renewal of Certification (field inspection) Report Number: GPLRPD-2018-FIR-01245	Dec 21, 2018
<b>Human performance management</b>	Human Performance Program Report Number: GPLRPD-2019-02486	May 22, 2019
	Health Physics Training Program (desktop inspection) Report Number: GPLRPD-2019-04203	Aug 19, 2019
<b>Operating performance</b>	Quarterly Field Inspection Third Quarter FY 2018/19 Report Number: GPLRPD-2019-001	Mar 11, 2019
	Quarterly Field Inspection Fourth Quarter FY 2018/19 Report Number: GPLRPD-2019-004	Jun 7, 2019
	Planned Outage Report Number: GPLRPD-2019-03014	Jul 19, 2019
	Quarterly Field Inspection First Quarter FY 2019/20 Report Number: GPLRPD-2019-03257	Aug 23, 2019
	Operations, Testing and Maintenance Procedures Report Number: GPLRPD-2019-04221	Oct 11, 2019
	Quarterly Field Inspection Second Quarter FY 2019/20 Report Number: GPLRPD-2019-04104	Nov 4, 2019
	Quarterly Field Inspection Third Quarter FY 2019/20 Report Number: GPLRPD-2019-05144	Feb 13, 2019
<b>Physical design</b>	Human Factors in Design (desktop inspection) Report Number: GPLRPD-2019-04452	Oct 16, 2019
<b>Fitness for service</b>	System Inspection - Containment Report Number: GPLRPD-2019-04225	Aug 23, 2019
	System Inspection – Emergency Core Cooling Report Number: GPLRPD-2019-04018	Oct 21, 2019

<b>Safety and control area</b>	<b>Inspection title</b>	<b>Inspection report sent date</b>
	Chemistry Control Report Number: GPLRPD-2019-05301	Jan 28, 2020
<b>Radiation protection</b>	Worker Dose Control and Worker Hazard Control Field Inspection Report Number: GPLRPD-2019-FIR-03039	Apr 26, 2019
	Application of ALARA Report Number: GPLRPD-2019-04312	Dec 13, 2019
<b>Environmental protection</b>	Environmental Monitoring Report Number: GPLRPD-2019-04383	Nov 28, 2019
<b>Emergency management and fire protection</b>	Emergency Management and Fire Protection Field Inspection Report Number: GPLRPD-2019-FIR-03015	Apr 16, 2019
<b>Waste management</b>	Solid Radioactive Waste Management Facility Report Number: GPLRPD-2019-003	Jun 14, 2019

In addition to the inspections listed, CNSC staff considered various other sources of information in its assessment of the SCAs. CNSC staff assigned “satisfactory” ratings for all SCAs at Point Lepreau in 2019. Although CNSC staff did identify various examples of excellent safety performance, and instances of meeting and/or exceeding regulatory requirements in 2019, CNSC staff did not assign “fully satisfactory” ratings at the SCA level (this contrasts with the regulatory oversight for 2018, where Point Lepreau received multiple “fully satisfactory ratings”). This was strictly because of a lack of opportunity (due to the COVID-19 pandemic) for staff to assure the consistent applications of criteria for “fully satisfactory” ratings across all SCAs - it does not reflect, in itself, a decline in safety at Point Lepreau in 2019.

### 3.7.1 Management system

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff’s expectations, for the SCA Management system at Point Lepreau in 2019.

#### Management system

In 2019, CNSC staff conducted five inspections that verified compliance of NB Power’s management systems with various applicable regulatory requirements. An inspection of the human performance program indicated that NB Power adhered to its management system governance in processes such as controlling program documents [GPLRPD-2019-02486]. However, it was also found that NB Power did not adequately adhere to information requirements in five documents related to the human performance program. CNSC staff was satisfied with NB Power’s corrective actions taken to address the finding.

During an inspection of the human performance program, CNSC staff concluded that NB Power's practices that contribute to excellence in human performance began integrating with aspects of the management system. Further, CNSC staff noted that NB Power went beyond the expected implementation of human performance tools, and observation and coaching in the field. Efforts for continual improvement included trend analysis, self-assessments, consideration of a range of performance metrics, and benchmarking with other NPPs.

### **Organization**

Several inspections in the area of organization confirmed that NB Power properly defined various roles and responsibilities. However, during these inspections there were three instances where the responsibilities were either not clearly defined or not clearly communicated. Following the conclusion of NB Power's corrective action plans, CNSC staff confirmed that the documented roles and responsibilities had been clarified.

### **Change management**

In 2019, CNSC staff identified some minor non-compliances regarding change management within the health physics training program [GPLRPD-2019-04203]. CNSC requested NB Power to ensure that all change management documents for health physics training are accurate, complete and in accordance with its governance documents. CNSC staff were satisfied with NB Power's corrective actions taken to address the finding.

### **Safety culture**

CNSC staff continued to monitor safety culture at Point Lepreau in 2019. NB Power provided an implementation plan for REGDOC-2.1.2, *Safety Culture* in May 2019. NB Power updated its process documents for conducting nuclear safety culture assessments, as well as for nuclear safety culture monitoring panels, to close gaps with REGDOC-2.1.2 prior to its planned self assessment of safety culture in 2021.

### **Configuration management**

Five CNSC inspections in 2019 confirmed that NB Power complied with the applicable regulatory requirements for configuration management. In one inspection, not all fire equipment was easily identifiable [GPLRPD-2019-004]. CNSC staff directed NB Power to identify all fire response equipment placed in the field appropriately so that control and traceability of each item could be maintained.

UPDATE: CNSC staff were reviewing NB Power's plan to address the above non-compliance, as of May 1, 2020.

### **Records Management**

All CNSC inspections in 2019 verified compliance of some elements of records management, and the overall conclusion was general compliance with the applicable regulatory requirements. Inspections involving records related to initial certifications for shift supervisors and control room operators renewals of examinations, as well as review/update of pre-fire plans, identified four non-compliances of negligible safety significance and two non-compliances of low safety significance. For the two non-compliances of low safety significance, CNSC staff concluded the NB Power was addressing the issues adequately by the end of 2019.

In 2019, CNSC staff concluded a field inspection of fitness for duty and concluded that NB Power's process to manage fatigue met the applicable requirements for records management.

### **3.7.2 Human Performance Management**

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Human performance management at Point Lepreau in 2019.

#### **Human performance program**

CNSC staff identified more than 20 findings in 2019 that confirmed compliance with the applicable regulatory requirements for NB Power's human performance program - these findings covered both the definition of the program and the assessment of its effectiveness. Most findings were related to the appropriate use of human performance tools, including procedure use and adherence, while other topics included communications, resource planning and worker support. For example the inspection of the human performance program identified four compliant findings [GPLRPD-2019-02486].

#### **Personnel training**

CNSC staff concluded that Point Lepreau had a well-documented and robust training system based on a systematic approach to training in 2019, based on numerous compliant findings from various compliance verification activities. However, there were a few minor non-compliances (one of negligible safety significance and two of low safety significance) for the training programs at Point Lepreau [GPLRPD-2019-04203].

#### **Personnel Certification**

During a field inspection in 2018, CNSC staff identified several non-compliant findings in the area of personnel certification records. CNSC staff was satisfied with the corrective action plan proposed by NB Power in January 2019. NB Power was continuing the implementation of the plan at the end of 2019.

#### **Fitness for duty**

In 2019, there were three minimum shift complement (MSC) violations at Point Lepreau. All three events involved emergency response team (ERT) members calling in as 'unavailable' for their scheduled shift while replacements could not be found. Two ERT members worked 16 hours shifts, and thus allowed two 4 hours periods below MSC. Quiet mode was enacted for these two 4 hour periods. NB Power proposed adding ERT members to their MSC LCH table. This addition is an improvement and adds clarity. The numbers proposed by NB Power (i.e., 8 ERT Members and 1 ERT Leader) are in-line with NB Power's procedure and reflect the number of ERT members that were validated. Thus, the change met CNSC staff's expectations.

CNSC field inspections related to managing worker fatigue identified two compliant findings in 2019. NB Power committed to the implementation of REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* by March 1, 2021 (except during outages) and to fully implement it by June 30, 2022. In December 2019, NB Power re-affirmed that its implementation is on track.

NB Power had planned to implement CNSC REGDOC-2.2.4, *Fitness for Duty Volume II: Managing Alcohol and Drug Use* by December 2019. In the meantime, CNSC staff accepted several of NB Power's requests for amendments to REGDOC-2.2.4, *Volume II: Managing Alcohol and Drug Use*, Version 2. NB Power committed to implement the new Version 3 of the REGDOC-2.2.4, Volume II six months after its publication (other than random testing) and to implement the requirements for random testing twelve months after the publication.

NB Power became fully compliant with CNSC REGDOC-2.2.4, *Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness* as of November 2019.

### 3.7.3 Operating Performance

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Operating performance at Point Lepreau in 2019.

#### **Conduct of licensed activities**

CNSC staff identified over 30 findings through Type II system and outage inspections and field inspections in 2019 that confirmed NB Power's compliance with requirements for the general conduct of licensed activities. For example, CNSC staff confirmed that NB Power verified that activities such as operator surveillance, surveillance testing and performance of work were completed in accordance with the applicable requirements.

#### **Procedures**

CNSC staff identified seven compliant findings in 2019 related to NB Power's procedures during numerous verification activities. For example, during a planned outage inspection, CNSC staff confirmed that aspects of procedural adequacy and adherence complied with the applicable regulatory requirements [GLRPD-2019-03014]. .

#### **Reporting and trending**

NB Power submitted all scheduled reports in 2019 as required and in appropriate timelines. Although there were no significant issues related to NB Power's reporting and trending, there was one instance where NB Power did not submit a required notice of document change to CNSC. It involved a change related to the frequency of water lancing in the steam generator management plan, which is a "prior notification document" that is listed in the LCH.

#### **Outage management performance**

During its planned outage inspection in 2019, CNSC staff identified 18 compliant findings [GPLRPD-2019-03014]. CNSC staff noted that there were no process or equipment failures during the outage and that NB Power

- met all of the regulatory undertakings and commitments for the outage
- appropriately met the scope of the outage
- effectively planned the work

CNSC staff also noted the actions taken by NB Power during the three forced outages in 2019 were appropriate and in the conservative direction. In all cases, NB Power manually shut down the reactor and completed the repairs systematically. There were no concerns identified by site inspectors during their monitoring of the forced outages.

#### **Severe accident management and recovery**

In 2019, CNSC site staff conducted two field inspections of the emergency mitigating equipment [GPLRPD-2019-05144]. CNSC staff confirmed that the equipment was properly maintained and that it was poised and ready for use if needed to manage a severe accident.

### **3.7.4 Safety Analysis**

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safety analysis at Point Lepreau in 2019.

#### **Deterministic safety analysis**

In 2019, CNSC staff completed its review of NB Power's basis document for the analysis of loss-of-flow accidents. The purpose of the basis document was to align the expectations of NB Power and CNSC staff regarding the analysis to follow. While CNSC staff found the basis document to be well structured and well written, they made some recommendations related to the approach of the analysis and to a code validation issue.

In 2019, CNSC staff reviewed NB Power's safety analysis update for fast loss of reactivity control and found that it was generally consistent with the expectations and requirements outlined in CNSC REGDOC-2.4.1, *Deterministic Safety Analysis*. There were some sections where CNSC staff determined that additional information was needed.

In 2019, CNSC staff provided comments on NB Power's revised implementation plan for REGDOC-2.4.1. CNSC staff found NB Power's dispositions of comments on the graded approach to analysis of anticipated operational occurrences to be acceptable. NB Power continued to carry out safety analyses as part of REGDOC-2.4.1 implementation in a staged manner. CNSC staff was satisfied with NB Power's progress on REGDOC-2.4.1 implementation at the end of 2019.

During a system inspection [GPLRPD-2019-04018], CNSC staff observed that the technical operability evaluations for the system reviewed during the inspection compliant with the requirements for deterministic safety analysis.

#### **Probabilistic safety assessment**

NB Power submitted new and revised methodologies in 2018 for performing the next periodic PSA update in 2021. CNSC staff concluded that the new methodologies met the applicable regulatory requirements and found them acceptable. However, CNSC staff made some recommendations for improvements in areas such as documentation of changes, and sensitivity and uncertainty analyses.

### 3.7.5 Physical Design

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Physical design at Point Lepreau in 2019.

#### **Design governance**

In 2019, CNSC staff accepted NB Power's plan for compliance with CSA N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances* by 2022.

In 2019, CNSC staff completed field inspections that verified various aspects of design governance, and identified five compliant findings that confirmed NB Power met the applicable requirements for seismically-qualified component design. CNSC staff also identified that NB Power met the requirements for seismic component design under the broader category of structure design in 2019 [GPLRPD-2019-001].

CNSC staff identified three non-compliances of low safety significance during a desktop inspection of human factors in design [GPLRPD-2019-04452]. In the first case, NB Power did not meet all of the applicable requirements concerning the criteria and process used for grading. The grading criteria used in the human factors engineering activities was incomplete - two of the four modifications examined could not be graded using the documented process. In the second case, NB Power met the applicable regulatory requirements but NB Power did not comply with its own process - the requirements for human factors engineering were incompletely specified in all the engineering packages that CNSC staff examined. Lastly, the evaluation of the designs was not performed systematically in a way that demonstrated that the recommendations of the design reviewers were addressed.

UPDATE: In February 2020, NB Power provided, to the satisfaction of CNSC staff, a detailed corrective action plan with target completion dates in response to the non-compliances identified during the desktop inspection of human factors in design.

As follow-up to NB Power's revision of its battery-testing program, to test the batteries in the "as found" condition, CNSC staff reviewed and found acceptable the revised procedure for conducting the performance test. The first use of the revised procedure was planned for the 2020 outage.

#### **System design**

In September 2018, CNSC staff had conducted an inspection of electrical power systems that identified some non-compliances in the cable aging management program. CNSC staff found that NB power's detailed corrective action plan to establish a cable aging management program was acceptable. In 2019, NB Power developed the qualification stream for the role of cable program specialist, which addressed one of CNSC staff's concerns. CNSC staff was satisfied with the progress made in 2019 and expected that the remaining documentation-related items would be addressed in 2020.

While reviewing a station event, CNSC staff noted that an electrical fault on the secondary cable of the station service transformer (SST) was due to a degraded splice and termination, and subsequent failure of the cable. NB Power submitted an apparent-cause evaluation report that identified a lack of an effective cable aging management program as a contributing cause. NB Power staff repaired the cable and inspected all SST cables.



Furthermore, NB Power conducted additional maintenance and testing of SST cables during the 2019 outage.

### **Component design**

CNSC staff found NB Power's 2019 annual report on fuel monitoring and inspection to comply with the applicable regulatory requirements. However, CNSC staff noted a negative trend in the fuel defect rate for Point Lepreau, which has remained elevated for multiple years and continued to be above the expected rate of one defect per unit per year. The fuel defects were caused by foreign material introduced by outage work on the primary heat transport system. CNSC staff were satisfied that the elevated defects stemmed from an isolated event for which NB Power took effective corrective action. CNSC staff concluded that overall fuel performance remained safe at Point Lepreau but continued to monitor the defect rate trends.

### **3.7.6 Fitness for Service**

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Fitness for service at Point Lepreau in 2019.

#### **Equipment fitness for service / equipment performance**

CNSC staff identified five compliant findings during Type II and field inspections in 2019 related to fitness for service and performance of equipment at Point Lepreau in 2019. To address the findings of the CNSC inspection of the service water system in 2018, NB Power updated several documents, developed a preventive maintenance strategy for flow meters and updated the testing strategy for load-shedding valves. CNSC staff was satisfied with NB Power's corrective actions in 2019.

CNSC staff reviewed the 2018 annual reliability report for Point Lepreau and confirmed that it met the applicable regulatory requirements.

For 2019, CNSC staff noted that all the special safety systems at Point Lepreau met their unavailability targets, except for the negative pressure containment (NPC). The NPC system exceeded the unavailability target because two of the isolation valves were found to be passing. Upon discovery, NB Power repaired the valves. Containment isolation was unavailable for 1083 hours. There was no significant impact on nuclear safety as a result of these instances of unavailability. CNSC staff continued to monitor NB Power's corrective action in 2019.

### **Maintenance**

NB Power maintained both the critical corrective maintenance backlog and the number of critical PM deferrals very low in 2019. The critical deficient maintenance backlog was trending down but still above industry average (noting that the industry average also improved in 2019). The preventative maintenance completion ratio was around 92%. There were no safety significant findings identified in the maintenance area during CNSC inspections and event reviews in 2019. The corrective critical maintenance backlog, deficient critical maintenance backlog, and the number of deferrals of preventive maintenance critical components are given in table 26.

**Table 26: Trend of maintenance backlogs and deferrals for critical components for PLNGS, 2017 to 2019**

Parameter	Average quarterly work orders per unit			Three year trending	Quarterly 2019 work orders				Industry average for 2019
	2017	2018	2019		Q1	Q2	Q3	Q4	
Corrective maintenance backlog	2	1	1	Steady	1	1	3	0	1
Deficient maintenance backlog	71	27	15	Down	13	16	15	15	9
Deferrals of preventive maintenance	1	0	1	Down	1	1	0	1	2

### Periodic inspections and testing

As part of its periodic inspection program, NB Power removed a steam generator tube to perform a metallurgical examination. NB Power's technical service provider concluded that no additional degradation had occurred since the last surveillance examination in 2010 during the Point Lepreau refurbishment outage. In 2019, CNSC staff reviewed the submission from NB Power and concluded that the analysis satisfied the applicable regulatory requirements. Overall, the results of visual and metallurgical examinations indicated that the life cycle management strategies for Point Lepreau steam generators were effective and no changes were required. Noting that the technical service provider planned to continue examining the removed tube using focused ion beam and transmission Kikuchi diffraction analyses, CNSC staff requested NB Power to submit the final report after the additional analysis.

### Aging management

In 2018, CNSC staff had inspected the aging management program at Point Lepreau. Non-compliances included discrepancies in the aging management process implementation compared to the governance documents. The inspection also revealed minor non-compliances in the obsolescence program and in the conduct of condition assessments. In 2019, NB Power provided five submissions to address the non-compliances. CNSC staff concluded that the responses were acceptable and that there were no fundamental gaps.

### Chemistry control

A CNSC inspection of chemistry control identified three compliant findings and verified various aspects, such as maintaining chemistry in accordance to specifications, monitoring of chemistry parameters and data trending [GPLRPD-2019-05301]. Several other field inspections in the area of chemistry control recorded multiple compliant findings; the quarterly data for the chemistry index performance indicators were also satisfactory.

### 3.7.7 Radiation Protection

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Radiation protection at Point Lepreau in 2019.

#### Application of ALARA

In 2019, CNSC staff conducted a Type II inspection and multiple field inspections on the application of ALARA. The inspections identified six compliant findings in the application of ALARA. CNSC staff verified that NB Power used ALARA initiatives, work planning, and dose monitoring and control to work towards the ALARA targets established by NB Power.

Inspection activities verified that NB Power is implementing several long-term station ALARA initiatives to further reduce station collective dose, including a tritium mitigation strategy.

In 2019, NB Power performed better than its collective radiation exposure (CRE) target with a collective dose of 596 p-mSv versus the planned target of 783 p-mSv. The largest contributor to the CRE was due to outage activities.

CNSC staff conclude that NB Power's performance met or exceeded all applicable regulatory requirements in the application of ALARA specific area.

#### Worker dose control

CNSC staff identified 15 compliant findings during inspections in 2019 related to worker dose control.

CNSC staff determined that NB Power met or exceeded the applicable regulatory requirements to ascertain and record doses received by workers at the PLNGS in 2019.

Radiation doses to workers at the PLNGS were below the regulatory dose limits (50 mSv) and no action level exceedances were reported. CNSC staff observed that there were no adverse trends or safety significant unplanned exposures at PLNGS in 2019.

#### Radiological hazard control

During the outage inspection in April 2019 [GPLRPD-2019-03014], CNSC staff found that NB Power complied with the *Radiation Protection Regulations* for radiological hazard control, worker dose control and application of ALARA.

The inspections conducted in 2019 in the area of radiological hazard control identified seven compliant findings and one non-compliant finding. The non-compliant finding was associated with radiological hazard posting, specifically alpha classification, which did not always follow the applicable procedures. NB Power's corrective actions were determined to be satisfactory to CNSC staff.

CNSC staff determined that PLNGS implemented effective controls for radiological hazards. There were no action level exceedances for surface contamination or contamination control at PLNGS in 2019.

### 3.7.8 Conventional Health and Safety

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Conventional health & safety at Point Lepreau in 2019.

In 2019, CNSC identified 30 compliant findings related to conventional health and safety during Type II and field inspections.

CNSC staff observed that the accident severity rate (ASR) and the industrial safety accident rate (ISAR) for Point Lepreau were 0 in 2019 - no lost time injuries were reported. The accident frequency (AF) increased to 0.77 in 2019, from 0.3 in 2018 due to the higher number of medically treated injuries (eight) that did not result in lost time. CNSC staff found the ASR, ISAR and AF values at Point Lepreau to be acceptable. Additional ASR, ISAR and AF data are provided in section 2.8.

### 3.7.9 Environmental Protection

CNSC staff concluded that CNSC staff observed that all airborne and waterborne radiological releases from Point Lepreau remained below the regulatory limits and environmental action levels. The absolute values for releases and Derived Release Limits (DRLs) for Point Lepreau are provided in Appendix D.

In addition, NB Power's environmental monitoring data for 2019 showed that the public and the environment in the vicinity of Point Lepreau were protected.

In 2018, NB Power revised its DRLs document in order to comply with updated requirements. CNSC staff assessed the revised DRLs in 2019 and noted that they were, in general, more restrictive (95.6% of airborne DRLs and 89.1% of waterborne) than the previous DRLs. CNSC staff concluded that the implementation of DRLs at Point Lepreau indicated that the environment and the public are protected from the radiological impacts of radionuclides.

The estimated dose to the public from Point Lepreau for 2019 was 1.12  $\mu\text{Sv}$  for airborne releases and 0.8  $\mu\text{Sv}$  for liquid releases. This is an increase from the estimated combined dose of 0.72  $\mu\text{Sv}$  in 2018, but still well below the annual dose limit of 1 mSv (1,000  $\mu\text{Sv}$ ). See section 2.9 for additional information.

CNSC staff reviewed the 2019 annual environmental report on industrial waste treatment systems at Point Lepreau and noted that there were no exceedances of discharge limits for those systems.

CNSC field inspections confirmed that NB Power took all reasonable precautions to protect the environment, and the health and safety of persons. One of the field inspections also confirmed that NB Power complied with the hazardous waste management requirements for the areas inspected.

CNSC staff also inspected the operation of waste management facilities in 2019 and concluded that NB Power complied with the applicable regulatory requirements for effluent and emissions control (releases) [GPLRPD-2019-003].

NB Power reported a few spill events in 2019 at Point Lepreau, but they were insignificant spills and the public and environment remained protected.

During an inspection of environmental monitoring in 2019, CNSC staff concluded that NB Power complied with the applicable regulatory requirements for environmental assessment and monitoring [GPLRPD-2019-04383].

In 2017, NB Power submitted a revised environmental risk assessment (ERA). CNSC staff completed a detailed technical review of the ERA in 2019 and found the methodology to be generally consistent with the applicable regulatory requirements. However, CNSC staff recommended that future revisions to the ERA include an assessment of the magnitude and extent of the thermal plume from discharged cooling water and a broad risk assessment for the inter-tidal and near-surface zones that could be affected by the thermal plume.

To address this recommendation, in 2019, NB Power submitted the thermal plume monitoring report for Point Lepreau for which CNSC staff and ECCC provided initial comments. NB Power is expected to submit a revised ERA in June 2020 that also includes an updated thermal risk assessment.

### **3.7.10 Emergency Management and Fire Protection**

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Emergency management & fire protection at Point Lepreau in 2019.

In January 2019, NB Power completed its work to establish the capacity for direct plant data transfer from Point Lepreau to the CNSC's Emergency Operating Centre (EOC) during nuclear emergencies.

CNSC staff conducted field inspections and an outage inspection [GPLRPD-2019-03014] related to nuclear emergency preparedness and response in 2019, identifying five compliant findings and three non-compliances of low safety significance. In one case, non-compliances concerning the offsite emergency operations centre, equipment, and procedures were identified. Two other minor non-compliances were related to the emergency drills. CNSC staff were satisfied with how NB Power addressed these non-compliances.

CNSC staff also identified 19 compliant findings related to fire emergency preparedness and response. The areas verified included the availability of fire protection equipment, emergency notification, fire doors and exits, and the performance of fire drills. However, in one instance, CNSC staff could not fully verify the availability of fire equipment because the pre-fire plan document was not up-to-date [GPLRPD-2019-004].

UPDATE: In February 2020, NB Power updated its document. CNSC staff was satisfied with the update.

### **3.7.11 Waste Management**

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Waste management at Point Lepreau in 2019.

In 2019, CNSC staff conducted one inspection of waste management facility operations [GPLRPD-2019-003] and three field inspections related to waste management. CNSC staff identified six compliant findings in the areas of practices, waste characterization, segregation and minimization.

The PROL for Point Lepreau requires NB Power to submit a quarterly report on the SRWMF. CNSC staff were satisfied with all reports and additional information submitted by NB Power for the SRWMF in 2019.

### 3.7.12 Security

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Security at Point Lepreau in 2019.

In 2019, CNSC staff conducted two field inspections related to security facilities and equipment and concluded that NB Power met the applicable regulatory requirements and continued to sustain the equipment through lifecycle management. However, some minor equipment failures were observed. CNSC staff was satisfied with NB Power's response.

NB Power conducted a force-on-force security exercise in 2019 as part of its performance testing program and submitted its self-assessment report to the CNSC. The corrective measures proposed by NB Power to address identified issues met CNSC staff's expectations. CNSC staff concluded that the format of the drills and exercises significantly improved at Point Lepreau. Overall, CNSC staff concluded that NB Power deployed authorized, suitably equipped and trained nuclear security officers and maintained an on-site nuclear response force and drill and exercise program that meets regulatory requirements, in the context of the design basis threat.

CNSC staff identified minor non-compliances related to security practices during three field inspections in 2019. CNSC staff confirmed that NB Power effectively addressed the non-compliances. Overall, CNSC staff concluded that NB Power had procedures to provide guidance to security personnel at Point Lepreau.

### 3.7.13 Safeguards and Non-proliferation

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Safeguards & non-proliferation at Point Lepreau in 2019.

Pursuant to the Canada/IAEA safeguards agreements, NB Power granted adequate access and assistance to the IAEA for safeguards activities, including inspections and the maintenance of equipment at Point Lepreau. In 2019, the IAEA conducted two announced, one short-notice and five unannounced inspections at Point Lepreau. The results from IAEA inspections were all satisfactory. Details on other IAEA activities are provided in section 2.13.

NB Power implemented CNSC REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy* by the end of 2019.

During field inspections in 2019, CNSC confirmed that NB Power complied with the applicable safeguards requirements for the safeguards electrical panels that were observed, and also for access and assistance to the IAEA.

### **3.7.14 Packaging and Transport**

CNSC staff concluded that NB Power met the applicable regulatory requirements, and its performance met CNSC staff's expectations, for the SCA Packaging & transport at Point Lepreau in 2019.

There were no reportable events at Point Lepreau in 2019 related to packaging and transport of nuclear substances.

## 3.8 Gentilly-2

### 3.8.0 Introduction

Gentilly-2 est située sur la rive sud du fleuve Saint-Laurent à Bécancour (Québec), environ 15 km à l'est de la ville de Trois-Rivières. Elle appartient à Hydro-Québec et est gérée par celle-ci.

Le réacteur CANDU de Gentilly-2 présentait une capacité nominale de 675 mégawatts électriques (MWé). Il est entré en exploitation commerciale en 1983, a été mis à l'arrêt définitif le 28 décembre 2012 et a été complètement déchargé de son combustible le 3 septembre 2013. En décembre 2014, Gentilly-2 a complété la transition vers l'état de stockage sûr, c'est-à-dire que son combustible stocké se trouve dans les piscines de combustible usé (stockage en piscine) ou dans des modules de stockage CANSTOR (stockage à sec).



#### Autorisation

En 2016, la Commission a délivré à Hydro-Québec un permis de déclassement d'un réacteur de puissance pour les installations de Gentilly-2. Le permis est en vigueur du 1er juillet 2016 au 30 juin 2026.

#### Manuel des conditions de permis

Le Manuel des conditions de permis pour les installations de Gentilly-2 a été émis en même temps que le permis en 2016.

Le Manuel des conditions de permis a été révisé en février 2019 afin de refléter les changements survenus aux installations de Gentilly-2. Voir annexe E pour plus de détails.

#### Autorisation en vertu de la Loi sur les pêches

Hydro-Québec a réalisé une autoévaluation en vertu de la Loi sur les pêches avant la délivrance de son permis en 2016. Le personnel de la CCSN a examiné cette autoévaluation et a conclu qu'une autorisation en vertu de la *Loi sur les pêches* n'était pas requise.

#### Rapports initiaux d'événements

Aucun rapport initial d'événement mettant en cause Gentilly-2 n'a été présenté à la Commission entre le 1er janvier 2019 et le 1er juin 2020.

#### Programme de vérification de la conformité

Les inspections réalisées aux installations de Gentilly-2 qui ont été prises en compte dans les évaluations de la sûreté servant au présent rapport de surveillance réglementaire sont incluses au tableau 27.



**Tableau 27: Liste des inspections aux installations de Gentilly-2**

<b>Domaine de sûreté et de réglementation</b>	<b>Titre de l'inspection</b>	<b>Envoi du rapport d'inspection</b>
<b>Sécurité</b>	Programme de formation du personnel de sécurité aux Installations de Gentilly-2 Numéro de rapport : DPRGPL-2019-01	07 juin 2019
<b>Protection de l'environnement</b>	Programme de surveillance des effluents aux installations de Gentilly-2 Numéro de rapport : GPLRPD-2019-FIR-05297	20 novembre 2019
	Programme de surveillance de l'environnement aux installations de Gentilly-2 Numéro de rapport : GPLRPD-2019-FIR-05298	20 novembre 2019
<b>Gestion des déchets</b>	Gestion des déchets – Observation des activités de transfert du combustible irradié Numéro de rapport : GPLRPD-2019-FIR-03496	14 mai 2019
	Programme de surveillance des déchets dangereux aux installations de Gentilly-2 Numéro de rapport : GPLRPD-2019-FIR-05299	20 novembre 2019
<b>Gestion des urgences et protection-incendie</b>	Exercice Incendie aux Installations de Gentilly-2 Numéro de rapport : GPLRPD-2019-FIR-03215	14 mai 2019

En plus des inspections présentées dans la liste, le personnel de la CCSN a considéré d'autres sources d'information variées lors de son examen des DSR. Ces activités ont identifié dans bien des cas des exemples de conformité aux exigences réglementaires et d'excellente performance en matière de sûreté ainsi que certains cas de non-conformité et d'opportunités d'amélioration de la performance. Pour 2019, le personnel de la CCSN a attribué la cote « SATISFAISANT » pour tous les DSR à l'installation de Gentilly-2.

### 3.8.1 Système de gestion

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Système de gestion à Gentilly-2 en 2019.

En février 2019, le personnel de la CCSN a fait la revue d'une nouvelle révision du manuel de gestion de la qualité (MGQ) d'Hydro-Québec. Les commentaires du personnel de la CCSN portaient sur l'indépendance de la fonction assurance qualité (AQ) puisque l'organigramme de la révision de MGQ n'illustre pas comment la fonction AQ pouvait

être indépendante des autres fonction (telles qu'ingénierie, radioprotection, etc.). Ainsi, en juillet 2019, Hydro-Québec a présenté une nouvelle version du MGQ. Le personnel de la CCSN a révisé cette version et a conclu que le nouvel organigramme démontrait bien l'indépendance de la fonction AQ aux installations de Gentilly-2 puisque les fonctions audit et inspection se rapportent dorénavant directement au Directeur des installations.

Le personnel de la CCSN a fait la revue des Rapports pour Correctif ou Amélioration émis au cours de 2019 et a remarqué que les problèmes étaient identifiés par Hydro-Québec, que les correctifs étaient apportés, et que le suivi était fait [DPRGPL-2019-FIR-05299].

En janvier 2019, la CCSN a envoyé à Hydro-Québec une requête pour un plan de mise en œuvre le document REGDOC-2.1.2, *Culture de sûreté*. Hydro-Québec a fourni leur plan de mise en œuvre en septembre 2019 et des révisions de leur Programme d'amélioration continue. Le personnel de la CCSN était satisfait qu'Hydro-Québec répond aux exigences applicables du REGDOC-2.1.2. Gentilly- 2 a satisfait les attentes de la CCSN dans le domaine de la Culture de sûreté.

Les enregistrements vérifiés à Gentilly-2 au cours des inspections effectuées en 2019 étaient lisibles, retraçables et contrôlés, ce qui est conforme aux exigences [DPRGPL-2019-FIR-05298, DPRGPL-2019-FIR-05299, DPRGPL-2019-FIR-05297].

### 3.8.2 Gestion de la performance humaine

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Gestion de la performance humaine à Gentilly-2 en 2019.

En 2019, le personnel de la CCSN a complété une inspection du programme de formation des agents de sécurité nucléaire [DPRGPL-2019-001].

Trois inspections supplémentaires sur la formation du personnel ont été effectuées par la CCSN démontrant que la formation des travailleurs se conforme à la réglementation. Spécifiquement :

- Les travailleurs d'Hydro-Québec satisfaisaient aux exigences de qualifications précisées dans le programme. Les dossiers de formation des employés consultés étaient à jour. Les travailleurs rencontrés ont démontré qu'ils avaient les compétences requises pour effectuer leurs tâches dans le cadre du programme de surveillance des déchets dangereux [DPRGPL-2019-FIR-05299].
- Les travailleurs d'Hydro-Québec rencontraient les exigences de formation dans le plan de surveillance de l'environnement. Les travailleurs rencontrés lors des inspections ont démontré qu'ils avaient les connaissances nécessaires pour réaliser leur travail [DPRGPL-2019-FIR-05298].
- Pour le programme de surveillance de l'environnement, les travailleurs rencontrés satisfaisaient aux exigences de qualification, leur dossier de formation était à jour et ils étaient compétent pour effectuer les tâches reliées à leur travail [DPRGPL-2019-FIR-05297].

En se basant les résultats des inspections, le personnel de la CCSN a conclu que Hydro-Québec a implanté un programme de formation basé sur une approche systématique conforme aux exigences réglementaires.

Les personnes agissantes comme Responsable technique de la radioprotection (RTR) sont les seules personnes encore accréditées à Gentilly-2. Aucune demande d'accréditation ou de renouvellement d'une accréditation en tant que RTR n'a été soumise à la CCSN en 2019. Gentilly-2 ne maintient plus de programmes d'examens initiaux et de tests de requalification du personnel accrédité puisque les RTRs sont évaluées directement par le personnel de la CCSN.

Dans le domaine d'aptitude au travail, Hydro-Québec s'est engagé à mettre en œuvre les documents suivants:

- REGDOC-2.2.4, *Aptitude au travail, Tome II: Gérer la consommation d'alcool et de drogues* avant le 1er janvier 2019
- REGDOC-2.2.4, *Aptitude au travail: Gérer la fatigue des travailleurs* avant le 1er juillet 2019

En 2019, le personnel de la CCSN a analysé les clarifications et informations additionnelles soumises par Hydro-Québec relatifs au plan de mise en œuvre. Le personnel de la CCSN a confirmé qu'Hydro-Québec a complété et implanté toutes les actions incluses dans son plan de transition.

Hydro-Québec a transmis à la CCSN en novembre 2019 une correspondance afin de confirmer sa conformité au REGDOC-2.2.4, *Aptitude au travail, tome III: Aptitudes psychologiques, médicales et physiques des agents de sécurité nucléaire*. La CCSN a revu cette correspondance et confirmé en décembre 2019 qu'Hydro-Québec était conforme au REGDOC-2.2.4, tome III.

Le personnel de la CCSN a déterminé que la mise en œuvre des nouvelles exigences dans le domaine d'aptitude au travail a rencontré les attentes du personnel de la CCSN en 2019.

### **3.8.3 Conduite de l'exploitation**

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Conduite de l'exploitation à Gentilly-2 en 2019.

Les Rapports trimestriels/semestriels/annuels soumis par Hydro-Québec en 2019 qui documentent les activités réalisées ont montré une conformité aux exigences du permis. Lors de la revue de ces rapports par le personnel de la CCSN, aucune lacune ou situation qui aurait pu indiquer que les activités menées aux installations de Gentilly-2 étaient non sécuritaires ou en deçà des attentes du personnel n'a été remarquée. Hydro-Québec a fourni au personnel de la CCSN des réponses satisfaisantes et dans un délai acceptable au personnel de la CCSN qui a réalisé la revue de ces rapports. De plus, Hydro-Québec a rapporté à la CCSN les événements aux installations de Gentilly-2 en 2019 et a effectué la mise en application des correctifs à la satisfaction du personnel de la CCSN.

### 3.8.4 Analyse de la sûreté

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Analyse de la sûreté à Gentilly-2 en 2019.

Au niveau du rapport de sûreté de l'installation nucléaire de Gentilly-2, après avoir reçu la mise à jour d'Hydro-Québec en août 2019, le personnel de la CCSN en a fait la revue. Le personnel de la CCSN s'est déclaré satisfait de la mise à jour. Hydro-Québec a utilisé une approche conforme au REGDOC-2.4.1, *Analyse déterministe de la sûreté*.

Effectivement, les renseignements et l'analyse soumises par Hydro-Québec démontraient que les changements survenus depuis 2014 aux installations de Gentilly-2 n'augmentaient pas le risque et que le rapport de sûreté actuel couvrait adéquatement les risques qui seront présents jusqu'à l'atteinte de l'état de stockage sûr à sec. Toutefois, Hydro-Québec devra soumettre en 2021 la mise à jour complète du rapport de sûreté des installations nucléaires de Gentilly-2 afin de refléter le risque associés au nouvel état (état de stockage sûr à sec).

### 3.8.5 Conception matérielle

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Conception matérielle à Gentilly-2 en 2019.

Les informations sur le rendement des examens techniques, des rapports trimestriels et annuels ont répondu aux attentes du personnel de la CCSN dans le sujet des systèmes électriques. Par exemple, il n'y avait aucune préoccupation majeure à noter en ce qui concerne les revues suivantes:

- Analyse d'événement significatif - indisponibilité fortuite d'une turbine à gaz de la Centrale de Bécancour
- Travaux sur les équipements d'une ligne reliant Gentilly-2 au réseau d'électricité

### 3.8.6 Aptitude fonctionnelle

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Aptitude fonctionnelle à Gentilly-2 en 2019.

Le personnel de la CCSN a fait une inspection en chantier du programme de surveillance de l'environnement en 2019 [GPLRPD-2019-FIR-05298]. Tout l'équipement vérifié était étiqueté et identifié correctement et avait été étalonné selon les exigences. Le personnel de la CCSN s'est déclaré satisfait du coefficient d'exécution de l'entretien préventif, qui était de 90% en 2019.

### 3.8.7 Radioprotection

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Radioprotection à Gentilly-2 en 2019.

En 2019, le personnel de la CCSN a complété une inspection en chantier portant sur le transfert du combustible irradié [GPLRPD-2019-FIR-03496] qui a identifié des constats relatifs à la radioprotection. Voir la discussion sous Gestion des déchets pour plus de détails.

La revue par le personnel de la CCSN des indicateurs de performance et de rendement en sûreté en 2019 n'a révélé aucun problèmes. En effet, l'indicateur relatif à la dose collective (SPI #1) n'a rien signalé d'anormal. De plus, au cours de l'année 2019 à Gentilly-2, il n'y a eu aucun dépassement de doses reçues par les travailleurs au-dessus des limites réglementaires. Également, il n'y a eu aucun dépassement de seuils d'intervention réglementaire rapporté.

L'indicateur pour les événements de contamination personnel (SPI#2) a rapporté quelques événements mineurs mais aucun événement significatif n'est rapporté en 2019. Les indicateurs se rapportant aux doses non planifiées (SPI#3) ainsi qu'aux événements de contamination non-fixée (SPI# 4) ont indiqués tous deux "0" pour tous les trimestres de 2019. Ceci tend à indiquer qu'il n'y a eu aucun problème lié à ces aspects en 2019 chez Hydro-Québec.

### 3.8.8 Santé et sécurité classiques

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Santé et sécurité classiques à Gentilly-2 en 2019.

Lors des inspections chantier qui ont été menées par le personnel de la CCSN en 2019, bien que la santé et sécurité classiques n'ont pas été couverts formellement dans les rapports d'inspections, les inspecteurs en tiennent toujours compte. Le personnel de la CCSN en général, a observé pendant ces inspections que les pratiques en matière de santé et sécurité étaient adéquates. De plus, le personnel de la CCSN a noté qu'il n'y a eu aucun rapport déposé faisant état d'événements étant survenus dans ce domaine en 2019.

L'information soumise pour le SPI#21 santé et sécurité classiques par Hydro-Québec pour 2019 indiquait que le taux de fréquence des accidents calculé et le taux des accidents de travail calculé étaient de zéro en 2019.

### 3.8.9 Protection de l'environnement

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Protection de l'environnement à Gentilly-2 en 2019.

En 2018, Hydro-Québec a complété la transition au REGDOC-2.9.1, *Protection de l'environnement : Principes, évaluations environnementales et mesures de protection de l'environnement* (version 2013) et confirmé le respect de ce document réglementaire. En janvier 2019 également, Hydro-Québec a procédé à une révision de son MGQ, qui comprenait la documentation sur le système de gestion de l'environnement.

Lors de l'inspection de chantier effectuée en novembre 2019 [DPRGPL-2019-FIR-05299], deux constats ont été faits sur le système de gestion de l'environnement. Le constat sur le programme de surveillance de l'environnement était "négligeable" et le constat sur le programme de surveillance des déchets dangereux était un constat de

conformité. Le constat “négligeable” était dû au fait que les formulaires pour enregistrer les données de lectures des dosimètres thermo-luminescents (DTL) au laboratoire ne portaient pas la même appellation que les DTL qui sont en chantier. Toutefois, Hydro-Québec a corrigé rapidement et adéquatement cet écart.

En 2018, Hydro-Québec avait prolongé la ligne de rejet des effluents liquides sur une distance d'environ 800 mètres du début du canal de rejet jusqu'à plus loin dans le fleuve Saint-Laurent. Cette modification a nécessité une révision des limites opérationnelles dérivées (LOD) liquides à la baisse. Ces nouvelles LOD sont donc plus restrictives.

Durant l'année 2019, toutes les émissions radiologiques étaient bien inférieures aux limites réglementaires et ne représentaient que de petites fractions de leurs LOD. Un seul déversement a été enregistré au 4<sup>ème</sup> trimestre de 2019 - ce déversement n'a pas atteint l'environnement.

En 2019, la dose estimée de rayonnement annuelle chez les personnes représentatives était de 3 µSv. Cette dose était très inférieure à la limite de dose réglementaire du public (1 mSv) et inférieure à la dose de 2018.

Lors d'une inspection de chantier effectuée en 2019 portant sur les déchets dangereux [DPRGPL-2019-FIR-05299], il y a eu un constat selon lequel l'inventaire physique de certaines matières dangereuses résiduelles entreposées sur le site des installations de Gentilly-2 ne concordait pas avec les enregistrements contenus dans la base de données relativement à l'inventaire. Cependant, l'impact de cette lacune sur la protection du public était jugé très faible. Par ailleurs, Hydro-Québec a pris des mesures jugées adéquates par le personnel de la CCSN pour corriger la situation.

### **3.8.10 Gestion des urgences et protection-incendie**

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Gestion des urgences et protection-incendie à Gentilly-2 en 2019.

En mai 2019, le personnel de la CCSN a réalisé une observation [GPLRPD-2019-FIR-03215] d'un exercice incendie conjoint entre Hydro-Québec et le service de sécurité incendie de Bécancour (SSIB). L'entente entre Hydro-Québec et le SSIB stipule qu'Hydro-Québec doit tenir deux exercices incendie conjoint par année avec le SSIB. Cet exercice était surtout axé sur la réponse incendie mais comportait quand même un volet radiologique (sauvetage d'un blessé dans une zone radiologique). Le personnel de la CCSN s'est déclaré satisfait de la performance d'Hydro-Québec au niveau de réponse incendie ainsi que pour la réponse radiologique lors de l'exercice.

Le personnel de la CCSN a fait la revue des indicateurs de performance en matière de sûreté (indicateur SPI 23 Indice de la participation de l'organisation d'intervention d'urgence et indicateur SPI 24 Indice de vérification des ressources d'intervention d'urgence) et s'est déclaré satisfait des résultats communiqués par Hydro-Québec en 2019. De plus, il a été validé qu'en 2019, Hydro-Québec a organisé les deux visites de formation et de familiarisation requis pour les membres du SSIB et que les agents de sécurité nucléaire ont été formés sur le maniement des extincteurs.

### 3.8.11 Gestion des déchets

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Gestion des déchets à Gentilly-2 en 2019.

En 2019, le personnel de la CCSN a fait une inspection en chantier portant sur le transfert du combustible irradié [GPLRPD-2019-FIR-03496]. Lors de l'inspection, trois constats de conformités ont été relevés. Par exemple, la vérification des prérequis pour l'exécution des travaux a été effectuée par les travailleurs. Cependant, deux constats de non-conformités ont été relevés. Par exemple, bien que le personnel rencontré portait tous les appareils de dosimétrie appropriée, des travailleurs ont été vus portant ceux-ci à l'intérieur de leur vêtement de travail. Hydro-Québec a fourni une réponse à la suite du rapport d'inspection et le personnel de la CCSN était satisfait des mesures prises par Hydro-Québec.

Le personnel de la CCSN a examiné les deux rapports semestriels de 2019 pour la gestion des installations de déchets radioactifs solides et du combustible irradié de Gentilly-2. Les deux rapports répondaient aux exigences réglementaires et le personnel de la CCSN n'avait pas de commentaires.

En 2019, le personnel de la CCSN a examiné des plans et devis pour le projet d'encapsulation du combustible défectueux. Le personnel de la CCSN s'est dit satisfait de cette nouvelle méthode qui n'aura aucun impact sur la sûreté des installations et qui est en conformité avec les exigences du permis d'Hydro-Québec.

### 3.8.12 Sécurité

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Sécurité à Gentilly-2 en 2019.

### 3.8.13 Garanties et non-prolifération

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Garanties et non-prolifération à Gentilly-2 en 2019.

Hydro-Québec a soumis ses grands livres généraux mensuels dans les délais.

La plupart des titulaires de permis devaient fournir un plan de mise en œuvre afin de satisfaire aux exigences du REGDOC-2.13.1, Garanties et comptabilité des matières nucléaires. Il a été déterminé que Gentilly-2 était conforme au nouveau REGDOC et aucune autre mesure n'était requise.

En 2019, l'AIEA a complété une vérification du stock physique, une vérification des renseignements descriptifs, et deux inspections inopinées à Gentilly-2, qui ont donné les résultats satisfaisants pour l'AIEA. Le personnel de la CCSN n'a pas participé à ces vérifications et inspections.

Hydro-Québec a soumis le programme opérationnel annuel requis avec des mises à jour trimestrielles et la mise à jour annuelle du Protocole additionnel à la CCSN en temps opportun. Le personnel de la CCSN a examiné ces documents et a déterminé qu'ils

répondaient aux exigences et aux attentes. Hydro-Québec a soumis un questionnaire relatif aux renseignements descriptifs à jour en 2019. Le personnel de la CCSN a examiné le document et a déterminé qu'il répondait aux exigences et aux attentes. La CCSN a transmis le document révisé à l'AIEA en 2019.

Hydro-Québec a répondu aux demandes de l'AIEA (cinq instances) pour la réparation de l'équipement de l'AIEA.

#### **3.8.14 Emballage et transport**

Hydro-Québec a satisfait aux exigences réglementaires applicables, et son rendement a rencontré les attentes du personnel de la CCSN, pour le DSR Emballage et transport à Gentilly-2 en 2019.



#### **4 CONCLUSIONS FOR THE REGULATORY OVERSIGHT OF NUCLEAR POWER GENERATING SITES IN 2019**

CNSC staff concluded that the NPPs and the WMFs on their sites operated safely in 2019. This conclusion was based on detailed staff assessments of findings from compliance verification activities for each facility in the context of the 14 CNSC safety and control areas. The conclusion was supported by safety performance measures and other observations.

Important performance measures and observations include the following:

- The NPP and WMF licensees followed approved procedures and took appropriate corrective action for all events reported to the CNSC.
- NPPs and WMFs operated within the bounds of their operating policies and principles.
- There were no serious process failures at the NPPs. The number of unplanned transients and trips in the reactors was low and acceptable to CNSC staff. All unplanned transients in the reactors were properly controlled and adequately managed.
- Radiation doses to the public were well below the regulatory limits.
- Radiation doses to workers at the NPPs and WMFs were also below the regulatory limits.
- The frequency and severity of non-radiological injuries to workers were low.
- No radiological releases to the environment from the NPPs and WMFs exceeded the regulatory limits.
- Licensees met the applicable requirements related to Canada's international obligations; safeguards inspection results were acceptable to the IAEA.

CNSC staff's assessments for 2019 concluded that the licensees complied with the applicable requirements and also met CNSC staff's expectations for all SCAs at all the NPPs and WMFs.

**REFERENCES**

- [1] CNSC Management System document “General Description of Regulatory Framework for Nuclear Power Generating Sites”, e-doc 6069485.
- [2] CMD 19-M30, *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018*.
- [3] CMD 17-M64, *Presentation from CNSC Staff on Whole Site Probabilistic Safety Assessment (PSA)*
- [4] CMD 19-H104, *Ontario Power Generation request to revise the Darlington NGS Integrated Implementation Plan*
- [5] CMD 15-H111, *Modification au permis de Gentilly-2 pour inclure REGDOC 3 1 1*
- [6] Minutes of May 15, 2019 Commission Meeting, e-doc 5910107.
- [7] CMD 20-M14, *IAEA EPREV Mission to Canada 2019 Mission Findings and Canada’s Response*, e-doc 6253417.
- [8] 19-H104, *Record of Decision - OPG - Request to Revise the Integrated Implementation Plan for the Darlington NGS*, e-doc 5948260.

## PART 2: DNGS REFURBISHMENT UPDATE

### 1. OVERVIEW

In contrast to Part 1, this update provides some historical background and highlights the refurbishment of Unit 2, covering the period between October 2016 and July 2020. It provides an update on the status of the Darlington Refurbishment Project, as requested in the 2015 relicensing Record of Proceeding for the Darlington Nuclear Generating Station.

#### 1.1 Background

In 2007, OPG began planning for the refurbishment of the four Darlington NGS reactors to extend the life of the station for an additional 30 years. As required by RD-360, *Life Extension of Nuclear Power Plants*, which contained refurbishment related regulatory requirements at the time, OPG produced an Integrated Implementation Plan (IIP). The Commission approved the IIP during the 2015 License Renewal hearing. With its license renewal decision, the Commission authorized OPG to undertake the refurbishment of all four Darlington units and to begin implementing the IIP.

The refurbishment of Darlington's first unit (Unit 2) began on October 14, 2016. The Unit 2 refurbishment outage lasted 3.5 years and commercial operation of the unit resumed on June 4, 2020.

#### 1.2 Highlights

CNSC staff have provided oversight of the refurbishment at Darlington from the early initiation stages of the project. Most recently, CNSC staff were involved in the return to service of Unit 2 by verifying completion of all pre-requisites required for the removal of the four regulatory hold points (RHPs). CNSC staff's commitment to the safety of the public, workers and the environment, as well as the flexibility in the approaches taken to complete their tasks, ensured that the Executive Vice President and Chief Regulatory Operations Officer (EVP-CROO) of the CNSC provided his consent to remove all four RHPs without delay. The EVP-CROO provided his consent to remove the RHPs on the following dates:

- RHP-1 Consent provided on November 5, 2019
- RHP-2 Consent provided on April 5, 2020
- RHP-3 Consent provided on May 2, 2020
- RHP-4 Consent provided on May 13, 2020

#### 1.3 Conclusion for Unit 2

CNSC staff conclude that OPG conducted the refurbishment of Unit 2 safely, in accordance with Darlington PROL and Canada's international obligations, and took all reasonable precautions to ensure the safety of workers, the Canadian public and the environment. In addition, staff confirm that OPG successfully completed all pre-requisites required for the safe and effective return to service (RTS) of Unit 2, in accordance with the licensing basis, as established by the Commission.

Even with the presence of COVID-19 pandemic and the established modified work measures, CNSC staff maintained regulatory oversight required to remove the RHPs and EVP-CROO was able to grant consent to remove the RHPs without delay.

## 2. Refurbishment and Return to Service of Unit 2 at Darlington NGS

The refurbishment of Unit 2 began in October 2016. CNSC oversight of the project was led by the Darlington Regulatory Program Division with dedicated team of representatives from both the Ottawa head office and the Darlington Site office. All four Technical Support Branch (TSB) directorates provided the required support with specialist representation from every division.

### 2.1 Regulatory Basis

In order to provide assurance that return to service activities met regulatory requirements and were performed in a manner that did not compromise safety, the Darlington Power Reactor Operating Licence (PROL) includes licence conditions (LC) that the licensee must satisfy as part of the return to service program.

LC 15.2 of the Darlington PROL states:

The licensee shall implement a return to service plan for refurbishment.

OPG's Return to Service Program Management Plan is referenced in the LCH and describes the processes, procedures, and organization that was used during the Darlington Refurbishment Project to manage the modification and restart activities.

This plan identifies OPG's Completion Assurance Document (CAD) which provides confirmation that all pre-requisites, modification commissioning, testing, system restart activities and commitments have been addressed to the allow OPG's release of the regulatory hold point (RHP).

LC 15.3 of the Darlington PROL states:

The licensee shall implement the Integrated Implementation Plan

The IIP contains commitments, including the timeframes for implementation, resulting from the Environmental Assessment (EA) for Darlington Refurbishment and Continued Operations as well as the Darlington Integrated Safety Review (ISR).

LC 15.4 of the Darlington PROL states:

The licensee shall obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points.

The authority to provide consent to remove RHPs was delegated to the EVP-CROO in the 2015 Record of Proceeding (ROP) [1]. Consistent with past Canadian refurbishments and in accordance with RD-360, the following four RHPs were established:

1. Prior to fuel load
2. Prior to removal of Guaranteed Shutdown State (GSS)
3. Prior to exceeding 1% full power
4. Prior to exceeding 35% full power

Section 15.4 of the Darlington Licence Conditions Handbook (LCH) also established the following pre-requisites for removal of RHPs:

1. All IIP commitments required prior to removal of each RHP are complete;
2. All SSCs required for safe operation are available for service;
3. Staffing levels to safely operate the unit are adequate<sup>5</sup>;
4. Specified operating procedures have been formally validated;
5. Specified training is complete and staff qualified;
6. All non-conformances and open items identified leading up to reactor power increases are addressed;
7. Specified SSCs meet the quality and completion requirements of CSA N286; and
8. Verification by CNSC staff that all construction, commissioning, re-start, and available for service activities required prior to increasing reactor power have been successfully completed.

## 2.2 Oversight of the Refurbishment Project

CNSC staff maintained regulatory oversight of the Darlington refurbishment outage throughout its conduct. CNSC staff focused its regulatory oversight on the following regulatory objectives:

- Confirm that improvements identified in the OPG's Integrated Implementation Plan have been completed in accordance with LC 15.3
- Confirm that the systems, equipment, procedures, and qualified staff are available and ready for the unit RTS.
- Confirm that all pre-requisites required for the removal of RHPs were met
- Confirm that the refurbishment and regulatory requirements were met

In 2016, OPG and CNSC staff established a protocol that clarified specific requirements for RTS of Unit 2 and the removal of RHPs [2]. In addition, CNSC staff developed a Unit 2 compliance plan [3] based on the Generic Refurbishment Regulatory Oversight Project plan to establish and document all necessary CNSC regulatory oversight activities associated with the refurbishment project.

Outlined below is an overview of how CNSC staff completed the regulatory objectives associated to the oversight of the Darlington Refurbishment.

### 2.2.1. Integrated Implementation Plan (IIP)

As described in Section 1 of this update, RD-360, *Life Extension of Nuclear Power Plants* contained the CNSC requirements applicable to the Darlington Refurbishment Project. In preparation for a life extension or refurbishment project, RD-360 required that a licensee wishing to extend the life of a reactor conduct an ISR to address the Safety Factors from the International Atomic Energy Agency Safety Standards Series, as well as the CNSC safety areas and programs. RD-360 also required the licensee to participate in

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<sup>5</sup> The regulatory hold point for fuel load (RHP-1) had a pre-requisite for OPG to demonstrate that staffing levels to safely operate the unit are adequate. The pre-requisite encompassed ensuring all activities from loading fuel to operating the unit and therefore, was not a pre-requisite for the remaining hold points.

an EA, and that the results of the ISR and EA be compiled into a Global Assessment Report (GAR) and an IIP.

As required, OPG planned and is currently executing the Darlington Refurbishment project in accordance with RD-360. The Darlington ISR [4] consisted of an assessment of the plant design; systems, structures and component (SSCs) condition; and plant performance, to determine the extent to which the Darlington NGS conforms to modern standards and practices. From the ISR, OPG identified reasonable and practical modifications to SSCs and to the management of the station to enhance the safety of the plant to a level approaching that of modern nuclear power plants and to allow for long-term operation. The results of the EA [4], and ISR assessments were incorporated into the Darlington IIP [6]. In 2015, the IIP was presented to the Commission and, as described in the previous section, implementation of the IIP became a requirement of the Darlington PROL 13.00/2025.

The Darlington IIP consists of 625 items<sup>6</sup> encompassing all four units; and ninety-three (93) were specifically associated with Unit 2 Refurbishment. In accordance with LC 15.3, OPG has completed all IIP items associated to the restart of Unit 2. CNSC staff reviewed all completed IIPs, and confirmed closure of each item upon verification that all required actions and associated work were completed.

As described in Section 3.1.0 in the ROR, OPG has completed 369 IIP items, including those associated to Unit 2, and are progressing according to schedule. CNSC staff are satisfied with the progress on the IIP to date.

Overall, CNSC staff confirm that improvements identified in the OPG's Integrated Implementation Plan are being completed as planned and the IIP is being implemented in accordance with LC 15.3. Further, all IIP items associated to Unit 2 RTS were completed Pre-Requisite 1 was met in accordance with LC 15.4.

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<sup>6</sup> Based on Record of Decision for CMD 19-H104 [7], 2 IIP items were eliminated.

### 2.2.2. Unit 2 Return to Service

For the removal of each RHP, OPG was required to demonstrate that the people and the plant were ready for return to service of the unit by demonstrating that:

- Adequate number of trained and qualified staff are available
- All required training, has been delivered to safely execute the planned activities and start-up of the unit
- Procedures have been prepared/reviewed and have been validated
- And that systems, structures and components required for the removal of each regulatory hold point are confirmed to be available for service through commissioning and testing

As required by LC 15.2, OPG produced Completion Assurance Documents (CAD) for each RHP. OPG's completion assurance documentation provided confirmation of the above listed criteria by demonstrating that the commissioning test results met pre-defined acceptance criteria and provided evidence that all of the necessary systems, equipment, procedures, and qualified staff were available and ready in order to proceed with the next commissioning phase.

Following submission of the CAD, CNSC staff conducted reviews prior to each RHP that confirmed that all staffing, training, construction, commissioning, re-start, and available for service activities required prior to the hold point had been successfully completed and that there were no impediments to RHP removal.

CNSC staff assessments confirmed that:

- System Available for Service (SAFS) Packages and Summary Test Reports (STRs) demonstrated and assured that systems, structures and components required for the removal of each RHP could be credited to safely and reliably perform their design functions for continued unit operation during RTS and following refurbishment (Pre-Requisite 2)
- The individual and aggregate modifications installed during the Unit 2 refurbishment do not affect the present Darlington Nuclear Power Plant minimum shift complement. (Pre-Requisite 3)
- All procedures specified for use for removal of the RHPs underwent sufficient validation to ensure the safe operation during the return to service of Unit 2. (Pre-Requisite 4)
- OPG had demonstrated that the RTS specific training had been developed and delivered in accordance processes and procedures that constitute OPG's training system (Pre-requisite 5)
- Specified Structures, Systems and Components met the quality and completion requirement of N286 (Pre-requisite 6)

- Non-Conformances and Open Items were addressed (Pre-requisite 7). All open items and non-conformances were dispositioned and verified by CNSC staff prior to the recommendation to the EVP-CROO that consent be given to remove the RHP.

Overall, CNSC staff confirm that the systems, equipment, procedures, and qualified staff were available and ready for the unit return to service and formed the basis for the recommendation to remove the RHP in accordance with L.C. 15.2 and 15.4 of the Darlington LCH.



### 2.2.3. Pre-requisites for removal of Regulatory Hold Point

CNSC staff completed their verification that that all construction, commissioning, re-start, and available for service activities required prior to removal of each RHP had been successfully completed, as required by pre-requisite 8. CNSC staff provided detailed reports, as referenced in **Table 1: CNSC RHP documents**; these documents formed the basis for the recommendation to the EVP-CROO to provide his consent to remove each RHP

**Table 1: CNSC RHP documents**

RHP	CNSC RHP Document	CNSC Memorandum	Record of Consent
1	“Request by Ontario Power Generation Inc. to Remove Regulatory Hold Point for Prior To Fuel Load for Unit 2”, October 21, 2019 [8]	“Removal of Regulatory Hold Point 1 – Prior to Fuel Load for Darlington NGS Unit 2”, November 5, 2019 [12]	Record of Consent: Request by Ontario Power Generation for Consent to Remove the Regulatory Hold Point for Loading Fuel in Darlington Nuclear Generating Station – Unit 2, November 5, 2019 [16]
2	“Request by Ontario Power Generation Inc. to Remove Regulatory Hold Point for Prior to Guaranteed Shutdown State for Unit 2”, March 26, 2020 [9]	“Removal of Regulatory Hold Point 2 – Prior to GSS Removal for Darlington NGS Unit 2”, April 5, 2020 [13]	Record of Consent: Request by Ontario Power Generation for Consent to Remove the Regulatory Hold Point for Guaranteed Shutdown State for the Darlington Nuclear Generating Station – Unit 2, April 5, 2020 [17]
3	“Request by Ontario Power Generation Inc. to Remove Regulatory Hold Point for Prior to Exceeding 1% Full Power for Unit 2”, April 28, 2020 [10]	“Removal of Regulatory Hold Point 3 – Prior to Exceeding 1% Full Power for Darlington NGS Unit 2”, May 2, 2020 [14]	Record of Consent: Request by Ontario Power Generation for Consent to Remove the Regulatory Hold Point for Reactor Power Increases prior to exceeding 1% Full Power in Darlington Nuclear Generating Station – Unit 2, May 2, 2020 [18]
4	“Request by Ontario Power Generation Inc. to Remove Regulatory Hold Point for Reactor Power Increases Prior to Exceeding 35% Full Power for Unit 2”, May 7, 2020 [11]	“Removal of Regulatory Hold Point (RHP-4) for Reactor Power Increases Prior to Exceeding 35% Full Power for Darlington NGS Unit 2”, dated May 13, 2020 [15]	Record of Consent: Request by Ontario Power Generation for Consent to Remove the Regulatory Hold Point for Reactor Power Increases prior to exceeding 35% Full Power in Darlington Nuclear Generating Station – Unit 2, May 13, 2020 [19]

Overall, CNSC staff confirm that all pre-requisites required for the removal of RHPs were met in accordance with L.C. 15.2 and 15.4 of the Darlington LCH.

#### 2.2.4. Darlington Refurbishment Compliance Activities

In 2016, CNSC staff developed the Darlington Refurbishment Project Type II Compliance Plan based on the Generic Refurbishment Regulatory Oversight Project Plan. The Darlington Refurbishment Project Type II Compliance Plan aligned compliance verification activities with OPG's implementation schedule during the corresponding phases of refurbishment.

CNSC staff actively monitored and conducted compliance verification inspections including prior to the start of refurbishment for Unit 2. The compliance activities associated with Unit 2 consisted of Type II inspections and Field Inspections, which verified compliance with the PROL, *Nuclear Safety and Control Act* (NSCA), and other applicable regulatory requirements covering all Safety and Control Areas (SCAs) as described Darlington Refurbishment Project Type II Compliance Plan [3].

The Darlington Refurbishment Project Type II Compliance Plan reflected OPG's implementation schedule and activities during the corresponding phases of refurbishment and was modified to correspond with any changes to OPG's refurbishment schedule. Additional inspections were also added in response to emergent refurbishment issues of regulatory interest.

CNSC staff have completed 31 Type II Inspections and 35 Field inspections to date focused on Unit 2 refurbishment. As a result of the inspections, CNSC staff had placed enforcement actions on OPG to address deficiencies found. CNSC staff have completed the entirety of Darlington Refurbishment Project Type II Compliance Plan as planned; with one Type II inspection remaining to be conducted during the 2020-2021 fiscal year. The remaining Type II inspection is tied to post refurbishment and verifies OPG's configuration management for Unit 2.

As described in Section 3.1.10 of the ROR, Based on the scope of the inspections conducted, CNSC staff concluded that the licensee was in compliance with the regulatory requirements. No medium or high findings were identified in the inspections conducted for refurbishment. OPG provided acceptable CAP for all enforcement actions that resulted from the Unit 2 CNSC compliance activities. OPG has implemented all of the CAPs to staff's satisfaction and as a result, all enforcement actions previously raised for the refurbishment of Unit 2 have now been closed.

Total effort spent for refurbishment activities was approximately 6435 days.

Overall, CNSC staff confirm that the refurbishment and return to service activities were performed safely and in compliance with regulatory requirements.

### 3. Subsequent Units

Unit 2 resumed commercial operation on June 4, 2020, and subsequently the U2 RTS protocol was officially closed [20].

OPG proceeded with pre-refurbishment outage work on Unit 3 starting in 2019. Breaker open on Unit 3 occurred on July 31, 2020, which paved the way for defueling activities to commence for the purposes of a Single Fuel Channel Replacement. OPG is executing the SFCR activities to gather inspection and surveillance data to support Fuel Channel Fitness for Service work. Following the SFCR, OPG will begin defueling the remainder of the Unit 3 core as that unit's refurbishment outage is expected to begin in early September.

CNSC staff have been engaged in the planning of this unit's refurbishment and have approved the project plan for the regulatory oversight of Unit 3 [21]. The project plan serves as a comprehensive Regulatory Activity Plan (RAP) that integrates the processes, resources, planning, key activities, and schedule to meet the refurbishment project requirements.

A new protocol has been established between the CNSC and OPG to clarify requirements for RTS of Unit 3 [22] and the removal of RHPs; incorporating lessons learned and operational experience (OPEX) from the oversight of Unit 2. The Unit 2 protocol was successful in outlining the outputs surrounding each pre-requisite and ensuring timelines were met. The lessons learned utilized for the Unit 3 protocol included addition of CNSC witness points for items and evolutions of regulatory interest; addition of details surrounding the completion of certain IIP items, and a new process in place to manage refurbishment schedule changes.

Similarly, based on feedback from both TSB and Regulatory Operations Branch staff, CNSC staff have implemented lessons learned and OPEX in developing the Unit 3 compliance plan. Introduced changes include both the addition of compliance activities as well as modifications to the scope and type of planned verification activities. The Darlington Refurbishment Project Type II Compliance Plan for Unit 3 was approved in 2019 [23] and is currently being implemented.

Subsequent units are expected to enter their refurbishment outages as illustrated in the following diagram. CNSC will continue to ensure that an able and adaptable refurbishment oversight team is in a place and is equipped with appropriate oversight planning and executions tool, including unit specific project plans, RTS protocols, and compliance plans. Lessons learned will continue to be incorporated to plan RTS and compliance verification activities during the future refurbishment overlap of Units 3, 1 and 4 as shown in *Figure 1: Overlap of Refurbishment Units*.



*Figure 1: Overlap of Refurbishment Units*

#### **4. Conclusions for Darlington refurbishment**

CNSC staff conclude that OPG executed the RTS of Unit 2 in accordance with the Licensing Basis, as established by the Commission. Further to this, CNSC confirm that all regulatory requirements and pre-requisites required for the removal of each RHP were met, in accordance with the Darlington PROL and LCH. Thus far, OPG has executed refurbishment activities at Darlington effectively, with the outmost attention to the safety of the worker, the public and the environment, while ensuring that Canada's international obligations have been respected. Through the oversight provided since the onset of the Darlington Refurbishment Project, and as reported to the Commission in previous RORs and licence renewal CMDs, CNSC staff also conclude that OPG has the appropriate people, programs and processes in place to ensure continued safe execution of refurbishment activities at DNGS, including Unit 3 and the subsequent units.

Despite several challenges associated to the COVID-19 pandemic, CNSC staff provided the required oversight to ensure a timely RTS of Unit 2. Based on the Unit 2 experience, CNSC staff are ready to provide the same level of regulatory oversight for subsequent units beginning with Unit 3 and are already planning and looking to implement efficiencies to manage future periods of refurbishment overlap.

**REFERENCES FOR DARLINGTON REFURBISHMENT UPDATE**

1. Record of Proceedings, Including Reasons for Decision, “Application to Renew the Nuclear Power Reactor Operating Licence for the Darlington Nuclear Generating Station” March 2, 2016, e-Doc 4920689
2. Protocol, Ontario Power Generation Protocol with the Canadian Nuclear Safety Commission for Darlington Nuclear Generating Station Unit 2 Return to Service, Revision 2, March 2020, e-Doc 5388249
3. CNSC document, “Darlington Refurbishment Project Type II Compliance Plan Unit 2”, November 1, 2016, e-Doc 5112113
4. OPG Letter, D. Reiner to F. Rinfret, “Darlington NGS Integrated Safety Review (ISR) Submission – Final ISR Report Addendum 002 - NK38-REP-03680-10104-ADD-002-R000”, NK38-CORR-00531-16588, December 2, 2013, e-Doc 4244897
5. CNSC Report, Final Environmental Assessment Screening Report: The Refurbishment and Continued Operation of the Darlington Nuclear Generating Station, Municipality of Clarington, Ontario, March 2013, CEAR # 11-01-62516, e-Doc 3917932
6. Darlington NGS Integrated Implementation Plan, NK38-REP-03680-10185-R002, April 30, 2015, e-Doc 4743237
7. CMD 19- H104 Record of Decision - OPG - Request to Revise the Integrated Implementation Plan for the Darlington NGS, July 18, 2019, e-Doc 5948260
8. CNSC document, “Request by Ontario Power Generation Inc. to Remove Regulatory Hold Point for Prior To Fuel Load for Unit 2”, October 21, 2019, e-Doc 5910627
9. CNSC document “Request by Ontario Power Generation Inc. to Remove Regulatory Hold Point for Prior to Guaranteed Shutdown State for Unit 2”, March 26, 2020, e-Doc 6089062
10. CNSC document, “Request by Ontario Power Generation Inc. to Remove Regulatory Hold Point for Prior to Exceeding 1% Full Power for Unit 2”, April 28, 2020, e-Doc 6240155
11. CNSC document, “Request by Ontario Power Generation Inc. to Remove Regulatory Hold Point for Reactor Power Increases Prior to Exceeding 35% Full Power for Unit 2”, May 7, 2020, e-Doc 6275738
12. CNSC document, “Removal of Regulatory Hold Point 1 – Prior to Fuel Load for Darlington NGS Unit 2”, November 5, 2019, e-Doc 6025638
13. CNSC document, “Removal of Regulatory Hold Point 2 – Prior to GSS Removal for Darlington NGS Unit 2”, April 5, 2020, e-Doc 6269607
14. CNSC document, “Removal of Regulatory Hold Point 3 – Prior to Exceeding 1% Full Power for Darlington NGS Unit 2”, May 2, 2020, e-Doc 6250040
15. CNSC document, “Removal of Regulatory Hold Point (RHP-4) for Reactor Power Increases Prior to Exceeding 35% Full Power for Darlington NGS Unit 2”, dated May 13, 2020, e-Doc 6284298

16. Record of Consent: Request by Ontario Power Generation for Consent to Remove the Regulatory Hold Point for Loading Fuel in Darlington Nuclear Generating Station – Unit 2, November 5, 2019, e-Doc 6011522
17. Record of Consent: Request by Ontario Power Generation for Consent to Remove the Regulatory Hold Point for Guaranteed Shutdown State for the Darlington Nuclear Generating Station – Unit 2, April 5, 2020, e-Doc 6239009
18. Record of Consent: Request by Ontario Power Generation for Consent to Remove the Regulatory Hold Point for Reactor Power Increases prior to exceeding 1% Full Power in Darlington Nuclear Generating Station – Unit 2, May 2, 2020, e-Doc 6240299
19. Record of Consent: Request by Ontario Power Generation for Consent to Remove the Regulatory Hold Point for Reactor Power Increases prior to exceeding 35% Full Power in Darlington Nuclear Generating Station – Unit 2, May 13, 2020, e-Doc 6284341
20. CNSC letter, G. Frappier to S. Gregoris and D. Reiner, “Darlington NGS: Completion of the Ontario Power Generation Protocol with the Canadian Nuclear Safety Commission for Darlington Nuclear Generating Station Unit 2 Return to Service”, September 3, 2020, e-Doc 6368907.
21. CNSC document, “Project Plan – Darlington Refurbishment”, October 3, 2019, e-Doc 6368907
22. Protocol, “Ontario Power Generation Protocol with the Canadian Nuclear Safety Commission for Darlington Nuclear Generating Station Unit 3 Return to Service”, June 9, 2020, e-Doc 6105538
23. CNSC document, “Ontario Power Generation Protocol with the Canadian Nuclear Safety Commission for Darlington Nuclear Generating Station Unit 3 Return to Service”, June 9, 2020, e-Doc 6036639

## APPENDICES

## A. RATING DEFINITIONS AND METHODOLOGY

### A.1 Definitions

The assessments of SCAs provided in this regulatory oversight report were developed by applying the following definitions to assess the specific areas that comprise the SCAs. While the category Fully Satisfactory was assigned to certain specific areas for certain facilities in 2019, due to the additional workload caused by the COVID-19 pandemic, CNSC staff did not assign Fully Satisfactory ratings at the SCA level in 2019 because of the limited opportunity to ensure the consistent applications of criteria for Fully Satisfactory ratings across all SCAs

#### **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 safety and control area (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 SCA 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 SCA 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 SCA 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 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.

### A.2 Rating methodology – general approach

The methodology for rating licensees relies on multiple sources of input and involves the judgment of CNSC staff. The methodology involves ratings for both specific areas and SCAs. At the level of specific area, CNSC staff apply the above definitions by assessing both:



- the licensee's level of compliance with the requirements associated with the specific area and
- the degree to which the licensee's performance met CNSC staff's expectations associated with the specific area

In order to obtain a certain rating category (e.g., Satisfactory) for a specific area, the licensee must meet the criteria in the definition for both level of compliance and degree of performance.

After rating all the specific areas applicable to the licensee, CNSC staff combine them into composite ratings for the SCAs.

### **A.3 Detailed Description of Steps in Rating methodology**

#### **Step 1: Identifying the findings**

Findings are comparisons of observed facts with the applicable regulatory requirements. Findings are identified from including CNSC staff inspections and other assessments. Each finding is assigned to the most applicable specific area under an SCA.

#### **Step 2: Assessing the findings**

CNSC staff evaluate the significance of each finding and assign it to the appropriate category: high, medium, low, negligible or compliant. The significance is determined in the context of the verification criteria for the activity that generated the finding and depends on the degree to which a specific area's effectiveness is negatively affected. The five categories of safety significance for findings are:

- High** Licensee's measures are absent, completely inadequate or ineffective in meeting expectations or the intent of CNSC requirements and compliance expectations.
- Medium** Performance significantly deviates from expectations or from the intent or objectives of CNSC requirements and compliance expectations
- Low** Performance deviates from expectations or from the intent or objectives of CNSC requirements and compliance expectations
- Negligible** Performance insignificantly deviates from expectations or objectives of CNSC requirements and compliance expectations.
- Compliant** Performance meets applicable CNSC requirements and compliance expectations.

#### **Step 3: Assess the level of compliance of the specific area**

CNSC staff consider the safety significance of all relevant findings and assess the overall level of compliance with the applicable regulatory requirements for that specific area. In the absence of findings from regulatory activities in the year in question, CNSC staff may rely on findings from previous years if they are believed to be still applicable. CNSC staff choose one of the following statements, which are aligned with the definitions of the rating categories, to summarize the level of compliance for the specific area:

- effectively meets or exceeds all requirements
- meets requirements
- significant non-compliance
- unacceptable state of compliance

#### **Step 4: Identifying additional performance information**

CNSC staff identify additional information that, while not necessarily an indicator of compliance, does indicate the degree to which the licensee’s performance met CNSC staff’s expectations for the specific area. Examples of regulatory activities that yield performance information include surveillance and monitoring and CNSC staff reviews of events, data (e.g., performance indicators), licensee quarterly and annual reports, licensee corrective actions and document changes, and various other licensee submissions, such as those related to design, analysis, and many other areas.

#### **Step 5: Assess the level of performance of the specific area**

CNSC staff consider all the performance-related information available and choose one of the following statements, which are aligned with the definitions of the rating categories, to summarize the level of compliance for the specific area:

- exceeds expectations
- meets expectations
- does not meet expectations
- unreasonable risk

#### **Step 6: Rate the specific area**

CNSC staff combine the two summary statements – for compliance and performance – and determine the specific area rating, using table A.1.

**Table A.1: Minimum compliance and performance criteria for each rating category**

<b>Two Criteria Necessary</b>		<b>SpA Rating</b>
<b>Compliance</b>	<b>Performance</b>	
effectively meets or exceeds all requirements	exceeds expectations	<b>FS</b>
meets requirements	meets expectations	<b>SA</b>
significant non-compliance	does not meet expectations	<b>BE</b>
unacceptable state of compliance	unreasonable risk, high probability of hazards	<b>UA</b>

The criteria in both columns (for compliance and performance) must be met in order to receive the rating indicated in the right-hand column. CNSC staff then “fine-tune” the SpA rating (high medium and low, for the assigned category) to allow finer delineation of how well the licensee met the requirements and/or expectations, within the category, for that specific area.

CNSC staff then convert the performance rating to a numerical value between 0 and 10, using the grid in table A.2. No values are identified for Unacceptable ratings, since that rating has not

occurred in practice for NPPs and WMFs and would warrant special CNSC attention if it did occur.

**Table A.2: Numerical values for rating categories for specific areas**

Rating	Specific area values
High FS	9.6
Medium FS	9.0
Low FS	8.3
High SA	7.6
Medium SA	7.0
Low SA	6.3
High BE	5.6
Medium BE	5.0
Low BE	4.3

### Step 7: Rating the SCA

CNSC staff average the ratings of the applicable specific areas as a guide for determining the rating of the SCA.

**Table A.3: Numerical ranges (guidance) for SCA rating categories**

Average of Specific Area Values	Suggested Rating
8-10	FS
6-8	SA
4-6	BE

In the final decision for the SCA rating, CNSC staff use judgement in conjunction with the category suggested by the arithmetic average of the specific area ratings.

As mentioned, CNSC staff did not assign Fully Satisfactory ratings at the SCA level in 2019, so Satisfactory was the suggested rating when the average of the specific area ratings was above 6.

## **B. LIST OF REGULATORY REQUIREMENTS AT THE END OF 2019**

The following table lists published CNSC regulatory documents and CSA Group standards that contain compliance verification criteria used by CNSC staff for the SCAs covered in this regulatory oversight report. The information was compiled from the various facility LCHs as they existed in December 2019. Also, the main body of this report may include additional information related to the implementation of some of these documents, as well as more-recently published documents, which were not used for compliance verification purposes in 2019.

In the table, a check mark indicates that the publication was included as compliance verification criteria for the facility at the end of 2019, a dash indicates that the publication was not included as compliance verification criteria, and a date indicates the year when the licensee indicated it plans to fully implement the requirements in the publication.

Regulatory documents and industry standards to be applied as requirements for all applicants (currently as CVC in LCH) Legend: V = implemented ; WYY = to be implemented by year WYY ; - = no implementation date

Source	Number	Title	Year	SCA	Bruc	DMGS	DWMF	PNGS	PVMF	PLMGS	Gentilly2	WWMF
CSA	N 286	Management system requirements for nuclear power plants, Update 1, 2007	2005	1	V	-	-	-	-	-	-	-
CSA	N 286	Management system requirements for nuclear power plants, Update 1, 2007	2012	1	V	V	V	V	V	V	V	V
CNSC	REGDOC-2.2	Personnel Training	2014	2	V	V	V	V	V	V	V	V
CNSC	REGDOC-2.2	Personnel Training, version 2	2015	2	V	-	-	-	-	-	-	-
CNSC	RD-204	Certification of Persons Working at Nuclear Power Plants Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants	2008	2	V	V	V	V	V	V	V	V
CNSC	EG1 *	Requirements and Guidelines for Simulator-based Certification Examinations for Shift Personnel at Nuclear Power Plants	2005	2	V	V	-	V	-	V	-	-
CNSC	EG2 *	Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants	2004	2	V	V	-	V	-	V	-	-
CNSC	RD-363	Nuclear Security Officer Medical, Physical and Psychological Fitness	2009	2	V	V	-	V	-	V	-	-
CNSC	REGDOC-2.1.2	Safety Culture	2008	2	V	V	V	V	V	V	V	V
CNSC	REGDOC-2.2.4	Fitness for Duty Volume I: Managing Worker Fatigue	2018	2	V	V <sup>1</sup>	V <sup>1</sup>	V <sup>1</sup>	V <sup>1</sup>	-	-	V <sup>1</sup>
CNSC	REGDOC-2.2.4	Fitness for Duty Volume II: Managing Alcohol and Drug	2017	2	V	V	V	V	V	2022	2019	V
CNSC	REGDOC-2.2.4	Fitness for Duty Volume III: Periodic Safety Reviews	2017	2	TBD <sup>2</sup>	TBD <sup>2</sup>	TBD <sup>2</sup>	TBD <sup>2</sup>	TBD <sup>2</sup>	TBD <sup>2</sup>	TBD <sup>2</sup>	2019
CNSC	REGDOC-2.4	Fitness for Duty Volume III: Periodic Safety Reviews	2018	2	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
CNSC	REGDOC-3.3	Reporting Requirements for Nuclear Power Plants	2015	3	V	V	-	V	-	V	-	-
CNSC	REGDOC-3.1.1	Reporting Requirements for Nuclear Power Plants, Version 2	2014	3	-	-	-	-	-	-	-	-
CNSC	REGDOC-3.1.1	Reporting Requirements for Nuclear Power Plants, Version 2	2016	3	V	-	-	V	-	V	-	-
CNSC	REGDOC-3.1.2	Reporting Requirements, Volume 1: Non-Power Reactor Class / Nuclear Facilities and Uranium Mines and Mills	2018	3	-	-	-	V	-	V	-	-
CSA	N 290.15	Requirements for the safe operating envelope of nuclear power plants	2010	3	V	V	-	V	-	V	-	-
CNSC	REGDOC-3.2	Accident Management: Severe Accident Management Programs for Nuclear Reactors	2013	3	V	V	-	V	-	V	-	-
CSA	N 290.11	Requirements for reactor heat removal capability during outage of nuclear power plants	2013	3	-	-	-	-	-	-	-	-
CSA	N 286.7	Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants	1999	4	-	-	-	-	-	-	-	-
CSA	N 286.7	Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants	2016	4	V	-	-	V	-	-	-	-
CNSC	REGDOC-2.4.1	Deterministic Safety Analysis	2014	4	V	V	-	V	-	V	-	-
CNSC	REGDOC-2.4.2	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	2014	4	V	2020	-	2020	-	V	-	-
CNSC	RD-327	Nuclear Criticality Safety	2010	4	V	-	-	-	-	-	-	-
CSA	N 289.1	General requirements for seismic design and qualification of CANDU nuclear power plants	2008	5	V	V	-	V	-	-	-	-
CSA	N 289.2	Ground motion determination for seismic qualification of CANDU nuclear power plants	2010	5	V	-	-	-	-	-	-	-
CSA	N 289.3	Design procedures for seismic qualification of CANDU nuclear power plants	2010	5	V	-	-	-	-	-	-	-
CSA	N 289.4	Testing procedures for seismic qualification of nuclear power plants structures, systems, and components	2012	5	V	-	-	-	-	-	-	-
CSA	N 289.5	Seismic instrumentation requirements for nuclear power plants and nuclear facilities	2012	5	V	-	-	-	-	-	-	-
CSA	N 290.13	Environmental Qualification of Equipment for CANDU Nuclear Power Plants (2005/R 2015)	2005	5	V	V	-	V	-	V	-	-
CSA	N 285.0	General requirements for pressure-retaining systems and components in CANDU nuclear power plants	2008	5	-	V	V	V	V	-	-	V
CSA	N 285.0	General requirements for pressure-retaining systems and components in CANDU nuclear power plants (including updates 1 and 2)	2012	5	V	-	-	V	V	V	V	V
CSA	N 290.12	Human factors in design for nuclear power plants	2014	5	V	-	-	V	-	V	-	-
CSA	N 290.0	General requirements for safety systems of nuclear power plants	2011	5	V	V	-	V	-	-	-	-
CSA	N 291	Requirements for safety related structures for CANDU nuclear power plants	2008	5	-	V	-	V	-	V	-	-
CSA	N 291	Requirements for safety related structures for CANDU nuclear power plants	2015	5	V	-	-	-	-	-	-	-
CNSC	RD/GD-98	Reliability Programs for Nuclear Power Plants	2012	6	-	-	-	V	-	-	-	-
CNSC	REGDOC-2.6.1	Reliability Programs for Nuclear Power Plants	2017	6	V	V	-	-	-	-	-	-
CNSC	RD/GD-210	Maintenance Programs for Nuclear Power Plants	2012	6	-	V	-	V	-	-	-	-
CNSC	REGDOC-2.6.2	Maintenance Programs for Nuclear Power Plants	2017	6	V	V	-	-	-	-	-	-
CSA	N 285.4	Periodic inspection of CANDU nuclear power plant components	2005	6	V	-	-	V	-	-	-	-
CSA	N 285.4	Periodic inspection of CANDU nuclear power plant components	2009	6	V	-	-	-	-	-	-	-

Source	Number	Title	Year	SCA	Bruce	DNGS	DWMF	PNGS	PMMF	PLMGS	Genially2	WWMF
N 285.4		Periodic inspection of CANDU nuclear power plant components	2014	6	-	V	-	-	-	-	-	-
CSA	N 285.5	Periodic inspection of CANDU nuclear power plant containment components	2008	6	V	V	-	V	-	V	-	-
CSA	N 287.7	in-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants	2008	6	V	V	-	V	-	V	-	-
CSA	N 285.8	Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors	2010	6	V	-	-	V	-	-	-	-
CSA	N 285.8	Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors	2015	6	V	-	-	-	-	-	-	-
CSA	N 285.8	Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors	2005	6	-	-	-	-	-	-	-	-
CNSC	RD-334	Aging Management for Nuclear Power Plants	2010	6	-	-	-	-	-	-	-	-
CNSC	REGDOC-2.6.3	Aging Management	2014	6	V	V	V	V	V	V	V	V
CSA	N 288.1	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities (include update 1)	2008	9	V	V	V	V	V	V	-	V
CSA	N 288.1	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	2014	9	2021	V	-	V	-	V	-	V
CSA	N 288.3.4	Performance testing of nuclear air-cleaning systems at nuclear facilities	2013	9	-	V	V	V	V	V	-	V
CNSC	S-296	Environmental Protection, Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills	2006	9	-	-	-	-	-	-	-	-
CNSC	REGDOC-2.9.1	Environmental Policies, Programs and Procedures	2013	9	V	V	V	V	-	V	-	V
CNSC	REGDOC-2.9.1	Environmental Policies, Programs and Procedures, section 4.6	2016	9	-	-	-	-	-	V	-	V
CNSC	REGDOC-2.9.1	Environmental Principles, Assessments and Protection Measures, version 1.1	2017	9	2020	-	2022	-	2020	-	-	2021
CSA	N 288.4	Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills	2010	9	V	V	V	V	V	V	-	V
CSA	N 288.5	Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills	2011	9	V	V	V	V	V	V	-	V
CSA	N 288.6	Environmental risk assessments at Class I nuclear facilities and uranium mines and mills	2012	9	V	V	V	V	V	V	-	V
CSA	N 288.7	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	2015	9	2020	2022	2022	2020	2020	2020	-	2021
CNSC	RD-353	Testing and implementation of Emergency Measures	2008	10	-	-	-	-	-	-	-	-
CNSC	REGDOC-2.10.1	Nuclear Emergency Preparedness and Response	2014	10	V	V	V	V	V	V	V	V
CSA	N 293	Fire protection for nuclear power plants	2007	10	-	-	-	-	-	-	-	-
CSA	N 293	Fire protection for nuclear power plants	2012	10	V	V	-	V	-	V	-	V
CSA	N 293	Fire protection for facilities that process, handle, or store nuclear substances	2013	10	-	-	V	V	V	2022	-	V
CSA	N 292.0	General principles for the management of radioactive waste and irradiated fuel	2014	11	-	-	-	-	-	-	-	-
CSA	N 292.2	Interim dry storage of irradiated fuel	2007	11	-	-	-	-	-	-	-	-
CSA	N 292.2	Interim dry storage of irradiated fuel	2013	11	-	-	V	V	V	-	-	V
CSA	N 292.3	Management of low- and intermediate-level radioactive waste	2008	11	V	V	-	V	-	V	-	-
CSA	N 292.3	Management of low- and intermediate-level radioactive waste	2014	11	-	-	-	-	-	-	-	-
CSA	N 294	Decommissioning of facilities containing nuclear substances	2009	11	-	V	V	V	V	V	upd1	V
CSA	N 290.7	Cyber Security	2014	12	2020	V	-	V	V	V	2019	V
CNSC	RD-321	Criteria for Physical Protection Systems and Devices at High-Security Sites	2010	12	V	V	V	V	V	V	V	V
CNSC	RD-361	Criteria for Explosive Substance Detection, X-ray Imaging and Metal Detection at High Security Sites	2010	12	V	V	V	V	V	V	V	V
CNSC	REGDOC-2.12.1	High-Security Sites: Nuclear Response Force	2013	12	V	V	-	V	-	V	-	-
CNSC	REGDOC-2.12.2	Site Access Security Clearance	2013	12	V	V	V	V	V	V	-	-
CNSC	REGDOC-2.12.3	Security of Nuclear Substances – Sealed Sources	2013	12	V	-	-	V	-	V	-	-
CNSC	RD-336	Accounting and Reporting of Nuclear Material	2010	13	V	V	V	V	V	V	V	V
CNSC	REGDOC-2.13.1	Safeguards and Nuclear Material Accountancy	2018	13	V	2021	2021	2021	2021	2021	V	2021
CNSC	RD/GD-99.3	Public Information and Disclosure	2012	15	V	V	V	V	V	V	V	V

\* CNSC staff documents (not published as regulatory documents)

<sup>1</sup>OPG has implemented REGDOC-2.1.2, with the exception of nuclear security culture. OPG has committed to revise its governance to include nuclear security culture by November 26, 2020

<sup>2</sup>With the exception of random alcohol and drug testing requirements, implementation of REGDOC-2.2.4, Fitness for Duty, Volume II: Managing Alcohol and Drug Use will be six months from the date of Commission approval and subsequent publication of REGDOC-2.2.4 Volume II, version 3. Implementation of random alcohol and drug testing component will be 12 months from the date of Commission approval and subsequent publication of REGDOC-2.2.4 Volume II, version 3. [Reference e-Doc 5865465]

**C. CURRENT AND PREDICTED STATUS OF KEY PARAMETERS  
AND MODELS FOR PRESSURE TUBES IN CANADIAN POWER  
REACTOR**

UNIT	Status as of January 1 <sup>st</sup> 2020			Future situation			
	EFPH	Peak Heq concentration, ppm	Existing fracture toughness model valid?	Key date	Anticipated EFPH	Predicted maximum Heq conc., ppm	Existing fracture toughness model valid?
Darlington Unit 1	212,718	114	Yes	Refurbishment (February 2022)	229,000	~120	No <sup>2</sup>
Darlington Unit 2	<i>Refurbishment in-progress (started October 2016)</i>			<i>n/a – fuel channels replaced during Refurbishment</i>			
Darlington Unit 3	207,632	112	Yes	Refurbishment (September 2020)	213,000	114	Yes
Darlington Unit 4	202,458	102	Yes	Refurbishment (September 2023)	233,000	115	No <sup>2</sup>
Pickering Unit 1	151,116	67.4	Yes	Dec 2024	192,100	88.2	No <sup>1</sup>
Pickering Unit 4	122,911	55.7	Yes	Dec 2024	167,500	68.3	Yes
Pickering Unit 5	243,485	84.3	Yes	Dec 2024	287,500	97.4	Yes
Pickering Unit 6	250,731	77.6	Yes	Dec 2024	295,000	90.7	Yes
Pickering Unit 7	242,546	81.1	Yes	Dec 2024	287,000	94.2	Yes
Pickering Unit 8	229,586	74.2	Yes	Dec 2024	274,500	87.3	Yes
Bruce Unit 1	49,964	46.5	Yes	Time to reach 120 ppm Heq (beyond EOL)	>231,200	< 120	Yes



<b>Bruce Unit 2</b>	49,280	46.6	Yes	Time to reach 120 ppm Heq (beyond EOL)	>231,600	< 120	Yes
<b>Bruce Unit 3</b>	222,280	97.5	Yes	MCR (2023)	247,400	< 120	Yes
<b>Bruce Unit 4</b>	217,067	94.8	Yes	MCR (2025)	256,100	< 120	Yes
<b>Bruce Unit 5</b>	245,906	106.8	Yes	December 2023 – first pressure tube reaches 120 ppm	275,000	120 ppm	Yes – until December 2023 <sup>2</sup>
<b>Bruce Unit 6</b>	243,411	110.5	Yes	N/A	N/A	N/A	N/A
<b>Bruce Unit 7</b>	237,946	104.8	Yes	August 2024 – first pressure tube reaches 120 ppm	272,100	120 ppm	Yes – until August 2024 <sup>2</sup>
<b>Bruce Unit 8</b>	225,388	88.0	Yes	January 2027 – first pressure tube reaches 120 ppm	275,400	120 ppm	Yes – until January 2027 <sup>2</sup>
<b>Point Lepreau</b>	51108	54.3	Yes	March 2045	235000	99 ppm	Yes

1: The current fracture toughness model has been restricted to 80 ppm [H]eq for front end pressure tube material per CSA N285.8-15 Update #1. Pickering Unit 1 contains 50% of tubes oriented with front end material at the outlet location.

2: industry anticipates issuing a revised fracture toughness model by end of 2020.

Unit	Status as of January 1 <sup>st</sup> 2020			Future situation			
	EFPH	Peak Heq concentration, ppm	Existing fracture toughness model valid?	Key date	Anticipated EFPH	Predicted maximum Heq conc., ppm	Existing fracture toughness model valid?
Darlington Unit 1	212,718	114	Yes	Refurbishment (February 2022)	229,000	~120	No <sup>2</sup>
Darlington Unit 2	<i>Refurbishment in-progress (started October 2016)</i>			<i>n/a – fuel channels replaced during Refurbishment</i>			
Darlington Unit 3	207,632	112	Yes	Refurbishment (September 2020)	213,000	114	Yes
Darlington Unit 4	202,458	102	Yes	Refurbishment (September 2023)	233,000	115	No <sup>2</sup>
Pickering Unit 1	151,116	67.4	Yes	Dec 2024	192,100	88.2	No <sup>1</sup>
Pickering Unit 4	122,911	55.7	Yes	Dec 2024	167,500	68.3	Yes
Pickering Unit 5	243,485	84.3	Yes	Dec 2024	287,500	97.4	Yes
Pickering Unit 6	250,731	77.6	Yes	Dec 2024	295,000	90.7	Yes
Pickering Unit 7	242,546	81.1	Yes	Dec 2024	287,000	94.2	Yes
Pickering Unit 8	229,586	74.2	Yes	Dec 2024	274,500	87.3	Yes
Bruce Unit 1	49,964	46.5	Yes	Time to reach 120 ppm Heq (beyond EOL)	>231,200	< 120	Yes
Bruce Unit 2	49,280	46.6	Yes	Time to reach 120 ppm Heq (beyond EOL)	>231,600	< 120	Yes
Bruce Unit 3	222,280	97.5	Yes	MCR (2023)	247,400	< 120	Yes

Unit	Status as of January 1 <sup>st</sup> 2020			Future situation			
	EFPH	Peak Heq concentration, ppm	Existing fracture toughness model valid?	Key date	Anticipated EFPH	Predicted maximum Heq conc., ppm	Existing fracture toughness model valid?
Bruce Unit 4	217,067	94.8	Yes	MCR (2025)	256,100	< 120	Yes
Bruce Unit 5	245,906	106.8	Yes	December 2023 – first pressure tube reaches 120 ppm	275,000	120 ppm	Yes – until December 2023 <sup>2</sup>
Bruce Unit 6	243,411	110.5	Yes	N/A	N/A	N/A	N/A
Bruce Unit 7	237,946	104.8	Yes	August 2024 – first pressure tube reaches 120 ppm	272,100	120 ppm	Yes – until August 2024 <sup>2</sup>
Bruce Unit 8	225,388	88.0	Yes	January 2027– first pressure tube reaches 120 ppm	275,400	120 ppm	Yes – until January 2027 <sup>2</sup>
Point Lepreau	51108	54.3	Yes	March 2045	235000	99 ppm	Yes

1: The current fracture toughness model has been restricted to 80 ppm [H]eq for front end pressure tube material per CSA N285.8-15 Update #1. Pickering Unit 1 contains 50% of tubes oriented with front end material at the outlet location.

2: industry anticipates issuing a revised fracture toughness model by end of 2020.

## D. DERIVED RELEASE LIMITS AND RADIOLOGICAL RELEASES TO THE ENVIRONMENT

### Derived Release Limits

Licence release limits known as derived release limits or DRLs are site-specifically calculated rates of release that could, if exceeded, expose an individual of the most highly exposed group to a committed dose equal to the regulatory annual dose limit of 1 mSv/year. DRLs are calculated using CSA standard N288.1-14, Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities.

While it is possible to calculate a specific DRL for each radionuclide, it may not be practical nor necessary to monitor each of these separately. In such cases, emitted radionuclides may be organized into groups that are selected based on factors such as physicochemical properties and method of monitoring. DRLs can then be established for the radionuclide group applying a number of simplifying and conservative (i.e., protective) assumptions such as assuming that the group is composed entirely of the most restrictive radionuclide representative of the group. The most restrictive radionuclide can differ for different nuclear facilities depending on releases, local conditions and the choice of the representative person. Emission monitoring may then be carried out by a non-radionuclide-specific method for the group rather than for specific radionuclides. The most common DRL groupings for airborne releases are noble gases, radio-iodines, particulate beta/gamma, and particulate alpha with those for liquids release being beta/gamma emitters and alpha.

Licenses are required to demonstrate that their releases are not only below their respective DRLs but that the sum of their release are below 1 mSv/year, the public regulatory dose limit. To ensure these limits are respected, licensees also are required to develop action levels significantly below their DRLs as a means of detecting elevated releases meriting follow-up investigations and actions to ensure releases are adequately controlled. For nuclear power plants, the action levels are applied to weekly and monthly monitoring results for emissions to atmosphere and for effluent to surface waters, respectively.

Note that the DRLs shown in the tables of this appendix are applicable for 2019 and may not be applicable for previous years.

### Total Annual Release of Relevant Radionuclides to the Environment

CNSC staff have commenced publishing annual releases of radionuclides to the environment from nuclear facilities on the CNSC Open Government Portal: <https://open.canada.ca/data/en/dataset/6ed50cd9-0d8c-471b-a5f6-26088298870e>.

The following tables provide the annual load of key radionuclides directly released to atmosphere or to surface waters from licensed facilities along with the relevant DRL for the reporting period of 2011 to 2019. The CNSC published a report in 2012<sup>7</sup>, which reported the radionuclide release data from Canadian nuclear generating stations from

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<sup>7</sup> <http://publications.gc.ca/site/eng/9.506803/publication.html>

the years 2001 – 2010. Over this current reporting period (2011 – 2019), there have been no exceedances of licence derived release limits.

As facilities differ with respect to their on-site nuclear activities (e.g., presence of a tritium processing facility) or life-stage activities (e.g., safe shut-down), or operations (e.g., maintenance, rates of power productions), the relevant radionuclides specifically monitored and reported on as well as the actual quantities released will vary. Nuclear facilities monitor and report on a wide range of radionuclides with the standardized reporting provided here being based on the key radionuclides associated with public dose and the facilities derived releases limits. Therefore, direct comparisons between facilities are not possible, since one facility may have different release quantities of radioactive materials than another.

For the facilities associated with this ROR, the most common radionuclides or radionuclide groupings of interest are tritium (HTO), iodine-131, noble gases, particulates (beta/gamma) and carbon-14 for atmospheric releases and tritium (HTO), gross beta-gamma and carbon-14 for liquid releases to surface waters. Since particulate and gross beta-gamma consists of mixtures of radionuclides, the most dose-restrictive (based on potential dose to the public) radionuclide is often chosen to represent the mixture as the basis for comparison with the DRL.

Releases are reported in the following table as total becquerels (Bq) per year or in the case of noble gasses, becquerels-million electron volts (Bq-MeV). A becquerel is an SI (International System of Units) unit of radioactivity defined as the activity of a quantity of radioactive material in which one nucleus decays per second. Since the Bq is a very small unit, releases are reported here in scientific notation. In most cases, numbers are rounded to two or three significant figures. For example:

$$\begin{array}{rcl}
 100 & = & 1.0 \times 10^2 \\
 & & 1,260,000 = 1.2 \times 10^6 \\
 & & 4,445,758,748 = 4.4 \times 10^9
 \end{array}$$

## D.1 Darlington site

In addition to the standard suite of radionuclides reported for nuclear power plant releases, the Darlington facility also reports on atmospheric elemental tritium releases associated with the tritium removal facility that is on-site.

### Releases to atmosphere

The applicable DRLs for 2019 are also presented (Note: elemental tritium DRL is applicable to tritium removal facility).

**Table D.1: Darlington annual radionuclide releases to atmosphere for 2011–2019**

Year	Elemental Tritium (HT: Bq)	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
<b>2019 DRL</b>	<b>8.2 X 10<sup>17</sup></b>	<b>4.9 X 10<sup>16</sup></b>	<b>1.2 X 10<sup>15</sup></b>	<b>3.8 X 10<sup>16</sup></b>	<b>1.7 X 10<sup>12</sup></b>	<b>6.1 X 10<sup>11</sup></b>	<b>1.1 X 10<sup>11</sup></b>
2019	2.3 X 10 <sup>13</sup>	2.0 X 10 <sup>14</sup>	9.7 X 10 <sup>11</sup>	5.0 X 10 <sup>13</sup>	1.4 X 10 <sup>8</sup>	2.6 X 10 <sup>7</sup>	1.3 X 10 <sup>6</sup>
2018	4.7 X 10 <sup>13</sup>	2.1 X 10 <sup>14</sup>	8.4 X 10 <sup>11</sup>	4.7 X 10 <sup>13</sup>	1.4 X 10 <sup>8</sup>	2.5 X 10 <sup>7</sup>	1.0 X 10 <sup>6</sup>
2017	1.4 X 10 <sup>14</sup>	2.4 X 10 <sup>14</sup>	1.4 X 10 <sup>12</sup>	1.5 X 10 <sup>13</sup>	<1.5 X 10 <sup>8</sup>	2.6 X 10 <sup>7</sup>	1.8 X 10 <sup>6</sup>
2016	1.7 X 10 <sup>13</sup>	1.8 X 10 <sup>14</sup>	1.6 X 10 <sup>12</sup>	1.6 X 10 <sup>13</sup>	1.4 X 10 <sup>8</sup>	3.2 X 10 <sup>7</sup>	<5.0 X 10 <sup>6</sup>
2015	1.7 X 10 <sup>13</sup>	2.5 X 10 <sup>14</sup>	1.3 X 10 <sup>12</sup>	2.2 X 10 <sup>13</sup>	1.4 X 10 <sup>8</sup>	3.5 X 10 <sup>7</sup>	<6.4 X 10 <sup>6</sup>
2014	5.2 X 10 <sup>13</sup>	2.7 X 10 <sup>14</sup>	1.3 X 10 <sup>12</sup>	4.6 X 10 <sup>13</sup>	1.6 X 10 <sup>8</sup>	3.1 X 10 <sup>7</sup>	<6.4 X 10 <sup>6</sup>
2013	1.8 X 10 <sup>13</sup>	2.1 X 10 <sup>14</sup>	1.0 X 10 <sup>12</sup>	3.2 X 10 <sup>13</sup>	1.4 X 10 <sup>8</sup>	2.9 X 10 <sup>7</sup>	<6.2 X 10 <sup>6</sup>
2012	2.6 X 10 <sup>13</sup>	1.3 X 10 <sup>14</sup>	1.0 X 10 <sup>12</sup>	1.9 X 10 <sup>13</sup>	1.4 X 10 <sup>8</sup>	3.4 X 10 <sup>7</sup>	---
2011	8.8 X 10 <sup>13</sup>	1.4 X 10 <sup>14</sup>	1.0 X 10 <sup>12</sup>	2.2 X 10 <sup>13</sup>	1.5 X 10 <sup>8</sup>	4.0 X 10 <sup>7</sup>	---

**Releases to surface waters**

The applicable DRLs for 2019 are also presented.

**Table D.2: Darlington annual radionuclide releases to surface waters for 2011–2019**

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
<b>2019 DRL</b>	<b>6.4 X 10<sup>18</sup></b>	<b>3.5 X 10<sup>13</sup></b>	<b>7.0 X 10<sup>14</sup></b>	<b>4.4 X 10<sup>14</sup></b>
2019	1.0 X 10 <sup>14</sup>	2.3 X 10 <sup>10</sup>	3.8 X 10 <sup>8</sup>	5.4 X 10 <sup>5</sup>
2018	2.2 X 10 <sup>14</sup>	2.6 X 10 <sup>10</sup>	1.2 X 10 <sup>9</sup>	<3.5 X 10 <sup>5</sup>
2017	5.6 X 10 <sup>14</sup>	2.6 X 10 <sup>10</sup>	1.7 X 10 <sup>9</sup>	<1 X 10 <sup>6</sup>
2016	3.5 X 10 <sup>14</sup>	4.9 X 10 <sup>10</sup>	2.2 X 10 <sup>9</sup>	1.2 X 10 <sup>6</sup>
2015	2.4 X 10 <sup>14</sup>	4.9 X 10 <sup>10</sup>	7.3 X 10 <sup>9</sup>	2.3 X 10 <sup>6</sup>
2014	1.7 X 10 <sup>14</sup>	3.0 X 10 <sup>10</sup>	5.5 X 10 <sup>9</sup>	1.8 X 10 <sup>6</sup>
2013	1.1 X 10 <sup>14</sup>	2.8 X 10 <sup>10</sup>	3.2 X 10 <sup>9</sup>	8.5 X 10 <sup>5</sup>
2012	1.3 X 10 <sup>14</sup>	3.0 X 10 <sup>10</sup>	6.3 X 10 <sup>9</sup>	9.0 X 10 <sup>5</sup>
2011	1.1 X 10 <sup>14</sup>	3.1 X 10 <sup>10</sup>	1.9 X 10 <sup>9</sup>	1.1 X 10 <sup>6</sup>

## D.2 Pickering site

Releases at the Pickering Nuclear Power Plant are monitored and reported on separately for Pickering units 1 & 4 and Pickering units 5 – 8.

### Releases to atmosphere

**Table D.3: Pickering units 1 & 4 and Pickering units 5–8 combined total annual radionuclide releases to atmosphere for 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
<b>2019 DRL</b>	<b>1.0 X 10<sup>17</sup></b>	<b>2.7 X 10<sup>15</sup></b>	<b>2.7 X 10<sup>16</sup></b>	<b>2.8 X 10<sup>12</sup></b>	<b>4.3 X 10<sup>11</sup></b>	<b>7.5 X 10<sup>10</sup></b>
2019	5.6 X 10 <sup>14</sup>	2.6 X 10 <sup>12</sup>	1.3 X 10 <sup>14</sup>	1.4 X 10 <sup>7</sup>	5.7 X 10 <sup>6</sup>	1.1 X 10 <sup>6</sup>

**Table D.4: Pickering units 1 & 4 annual radionuclide releases to atmosphere for 2011–2018. The applicable DRLs for 2018 are also presented.**

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
<b>2018 DRL</b>	<b>1.2 X 10<sup>17</sup></b>	<b>2.2 X 10<sup>15</sup></b>	<b>3.2 X 10<sup>16</sup></b>	<b>9.8 X 10<sup>12</sup></b>	<b>4.9 X 10<sup>11</sup></b>	<b>8.7 X 10<sup>10</sup></b>
2018	3.0 X 10 <sup>14</sup>	2.3 X 10 <sup>12</sup>	1.2 X 10 <sup>14</sup>	7.0 X 10 <sup>6</sup>	4.2 X 10 <sup>6</sup>	4.3 X 10 <sup>5</sup>
2017	3.1 X 10 <sup>14</sup>	1.3 X 10 <sup>12</sup>	1.5 X 10 <sup>14</sup>	9.6 X 10 <sup>6</sup>	6.9 X 10 <sup>6</sup>	4.7 X 10 <sup>5</sup>
2016	2.2 X 10 <sup>14</sup>	1.2 X 10 <sup>12</sup>	1.1 X 10 <sup>14</sup>	9.9 X 10 <sup>6</sup>	5.5 X 10 <sup>6</sup>	3.7 X 10 <sup>5</sup>
2015	2.4 X 10 <sup>14</sup>	1.0 X 10 <sup>12</sup>	9.3 X 10 <sup>13</sup>	1.4 X 10 <sup>7</sup>	5.3 X 10 <sup>6</sup>	4.5 X 10 <sup>5</sup>
2014	2.5 X 10 <sup>14</sup>	9.1 X 10 <sup>11</sup>	1.1 X 10 <sup>14</sup>	1.0 X 10 <sup>7</sup>	4.1 X 10 <sup>6</sup>	3.4 X 10 <sup>5</sup>
2013	1.7 X 10 <sup>14</sup>	7.8 X 10 <sup>11</sup>	1.1 X 10 <sup>14</sup>	8.4 X 10 <sup>6</sup>	3.7 X 10 <sup>6</sup>	4.4 X 10 <sup>5</sup>
2012	2.6 X 10 <sup>14</sup>	8.8 X 10 <sup>11</sup>	1.1 X 10 <sup>14</sup>	1.1 X 10 <sup>7</sup>	4.5 X 10 <sup>6</sup>	---
2011	2.1 X 10 <sup>14</sup>	1.0 X 10 <sup>12</sup>	9.9 X 10 <sup>13</sup>	1.5 X 10 <sup>7</sup>	8.2 X 10 <sup>6</sup>	---

**Table D.5: Pickering units 5–8 annual radionuclide releases to atmosphere for 2011–2018. The applicable DRLs for 2018 are also presented.**

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
<b>2018 DRL</b>	<b>1.9 X 10<sup>17</sup></b>	<b>2.0 X 10<sup>15</sup></b>	<b>4.7 X 10<sup>16</sup></b>	<b>8.9 X 10<sup>12</sup></b>	<b>7.2 X 10<sup>11</sup></b>	<b>1.2 X 10<sup>11</sup></b>
2018	3.2 X 10 <sup>14</sup>	1.4 X 10 <sup>12</sup>	5.0 X 10 <sup>12</sup>	4.7 X 10 <sup>6</sup>	3.5 X 10 <sup>6</sup>	7.5 X 10 <sup>5</sup>

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
2017	$3.8 \times 10^{14}$	$1.3 \times 10^{12}$	$3.5 \times 10^{12}$	$4.3 \times 10^6$	$2.0 \times 10^8$	$3.7 \times 10^5$
2016	$4.6 \times 10^{14}$	$1.2 \times 10^{12}$	$5.8 \times 10^{12}$	$4.1 \times 10^6$	$2.4 \times 10^7$	$6.2 \times 10^5$
2015	$3.0 \times 10^{14}$	$1.0 \times 10^{12}$	$1.6 \times 10^{13}$	$4.6 \times 10^6$	$1.5 \times 10^7$	$6.1 \times 10^5$
2014	$2.8 \times 10^{14}$	$9.1 \times 10^{11}$	$1.1 \times 10^{13}$	$5.2 \times 10^6$	$3.8 \times 10^6$	$5.2 \times 10^5$
2013	$2.4 \times 10^{14}$	$9.1 \times 10^{11}$	$6.5 \times 10^{12}$	$4.4 \times 10^6$	$5.0 \times 10^6$	$5.8 \times 10^5$
2012	$2.8 \times 10^{14}$	$9.4 \times 10^{11}$	$1.9 \times 10^{13}$	$6.6 \times 10^6$	$3.6 \times 10^6$	---
2011	$3.4 \times 10^{14}$	$7.7 \times 10^{11}$	$8.4 \times 10^{13}$	$8.8 \times 10^6$	$3.6 \times 10^6$	---

### **Releases to surface waters:**

Note that carbon-14 and gross alpha releases associated with units 1 – 4 are included in the unit 5 – 8 reporting as the radioactive liquid waste management system is discharged through the outfall for units associated with units 5 – 8.

**Table I12: Pickering - A (units 1 - 4) and Pickering B (units 5 - 8) combined total annual radionuclide releases to surface water for 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	C-14 (Bq)	Gross Alpha (Bq)
<b>2019 DRL</b>	$7.9 \times 10^{17}$	$3.8 \times 10^{13}$	$3.8 \times 10^{13}$	$2.4 \times 10^{10}$
2019	$4.3 \times 10^{14}$	$7.8 \times 10^{10}$	$3.4 \times 10^9$	$2.3 \times 10^6$

**Table I13: Pickering annual radionuclide releases to surface waters for 2011 – 2018. The applicable DRLs for 2018 are also presented.**

Year	Units 1 - 4		Units 5 - 8			
	Tritium: (HTO: Bq)	Gross beta/ gamma (Bq)	Tritium: (HTO: Bq)	Gross beta/ gamma (Bq)	C-14 (Bq)	Gross Alpha (Bq)
<b>2018 DRL</b>	$3.7 \times 10^{17}$	$1.7 \times 10^{12}$	$7.0 \times 10^{17}$	$3.2 \times 10^{12}$	$6.0 \times 10^{13}$	$2.6 \times 10^{13}$
2018	$1.4 \times 10^{14}$	$9.3 \times 10^9$	$2.8 \times 10^{14}$	$3.4 \times 10^{10}$	$1.1 \times 10^9$	$1.8 \times 10^6$



Year	Units 1 - 4		Units 5 - 8			
	Tritium: (HTO: Bq)	Gross beta/ gamma (Bq)	Tritium: (HTO: Bq)	Gross beta/ gamma (Bq)	C-14 (Bq)	Gross Alpha (Bq)
2017	1.1 X 10 <sup>14</sup>	6.6 X 10 <sup>9</sup>	2.7 X 10 <sup>14</sup>	2.0 X 10 <sup>10</sup>	1.9 X 10 <sup>9</sup>	<2.5 X 10 <sup>6</sup>
2016	1.1 X 10 <sup>14</sup>	6.8 X 10 <sup>9</sup>	2.1 X 10 <sup>14</sup>	5.1 X 10 <sup>10</sup>	4.7 X 10 <sup>9</sup>	<3.7 X 10 <sup>6</sup>
2015	9.9 X 10 <sup>13</sup>	4.9 X 10 <sup>9</sup>	2.7 X 10 <sup>14</sup>	1.7 X 10 <sup>10</sup>	2.8 X 10 <sup>9</sup>	5.4 X 10 <sup>6</sup>
2014	1.0 X 10 <sup>14</sup>	9.0 X 10 <sup>9</sup>	2.4 X 10 <sup>14</sup>	2.3 X 10 <sup>10</sup>	1.5 X 10 <sup>9</sup>	3.2 X 10 <sup>6</sup>
2013	1.2 X 10 <sup>14</sup>	6.7 X 10 <sup>9</sup>	1.9 X 10 <sup>14</sup>	2.6 X 10 <sup>10</sup>	1.7 X 10 <sup>9</sup>	1.3 X 10 <sup>6</sup>
2012	1.1 X 10 <sup>14</sup>	1.1 X 10 <sup>10</sup>	1.8 X 10 <sup>14</sup>	1.9 X 10 <sup>10</sup>	1.1 X 10 <sup>9</sup>	7.7 X 10 <sup>6</sup>
2011	1.2 X 10 <sup>14</sup>	5.1 X 10 <sup>9</sup>	2.0 X 10 <sup>14</sup>	1.4 X 10 <sup>10</sup>	2.2 X 10 <sup>9</sup>	4.8 X 10 <sup>7</sup>

### D.3 Bruce A and B

The Bruce Power nuclear power plant reports releases from Bruce-A and Bruce-B.

#### Releases to atmosphere:

**Table I.1: Bruce-A annual radionuclide releases to atmosphere for 2011 – 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (beta/gamma) (Bq)	Gross alpha (Bq)
<b>2019 DRL</b>	<b>1.98 X 10<sup>17</sup></b>	<b>6.34 X 10<sup>14</sup></b>	<b>1.12 X 10<sup>17</sup></b>	<b>1.14 X 10<sup>12</sup></b>	<b>1.73 X 10<sup>12</sup></b>	<b>2.96 X 10<sup>11</sup></b>
2019	4.63 X 10 <sup>14</sup>	1.34 X 10 <sup>12</sup>	7.07 X 10 <sup>13</sup>	4.17 X 10 <sup>7</sup>	1.97 X 10 <sup>6</sup>	2.43 X 10 <sup>4</sup>
2018	6.08 X 10 <sup>14</sup>	1.14 X 10 <sup>12</sup>	8.46 X 10 <sup>13</sup>	6.57 X 10 <sup>6</sup>	1.28 X 10 <sup>6</sup>	1.10 X 10 <sup>4</sup>
2017	7.32 X 10 <sup>14</sup>	1.89 X 10 <sup>12</sup>	9.48 X 10 <sup>13</sup>	2.06 X 10 <sup>7</sup>	4.39 X 10 <sup>5</sup>	4.08 X 10 <sup>3</sup>
2016	5.66 X 10 <sup>14</sup>	1.69 X 10 <sup>12</sup>	5.63 X 10 <sup>13</sup>	4.40 X 10 <sup>6</sup>	3.14 X 10 <sup>5</sup>	2.46 X 10 <sup>3</sup>
2015	7.05 X 10 <sup>14</sup>	3.15 X 10 <sup>12</sup>	5.62 X 10 <sup>13</sup>	5.15 X 10 <sup>7</sup>	1.06 X 10 <sup>7</sup>	1.23 X 10 <sup>6</sup>
2014	7.51 X 10 <sup>14</sup>	1.64 X 10 <sup>12</sup>	5.30 X 10 <sup>13</sup>	3.94 X 10 <sup>8</sup>	3.13 X 10 <sup>6</sup>	8.02 X 10 <sup>5</sup>
2013	5.04 X 10 <sup>14</sup>	2.53 X 10 <sup>12</sup>	6.66 X 10 <sup>13</sup>	<4.94 X 10 <sup>7</sup>	<4.84 X 10 <sup>6</sup>	<6.67 X 10 <sup>5</sup>
2012	4.50 X 10 <sup>14</sup>	2.30 X 10 <sup>12</sup>	6.82 X 10 <sup>13</sup>	2.18 X 10 <sup>8</sup>	<7.45 X 10 <sup>6</sup>	<6.40 X 10 <sup>5</sup>
2011	6.00 X 10 <sup>14</sup>	1.36 X 10 <sup>12</sup>	6.68 X 10 <sup>13</sup>	3.58 X 10 <sup>7</sup>	<7.06 X 10 <sup>6</sup>	<5.99 X 10 <sup>5</sup>

**Table I.2: Bruce - B annual radionuclide releases to atmosphere for 2011 – 2019 with weekly releases provided for 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Carbon -14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/ gamma) (Bq)	Gross alpha (Bq)
<b>2019 DRL</b>	<b>3.16 X 10<sup>17</sup></b>	<b>7.56 X 10<sup>14</sup></b>	<b>2.17 X 10<sup>17</sup></b>	<b>1.35 X 10<sup>12</sup></b>	<b>3.61 X 10<sup>12</sup></b>	<b>5.77 X 10<sup>11</sup></b>
2019	3.30 X 10 <sup>14</sup>	1.08 X 10 <sup>12</sup>	3.39 X 10 <sup>13</sup>	4.40 X 10 <sup>5</sup>	4.76 X 10 <sup>6</sup>	2.63 X 10 <sup>4</sup>
2018	3.86 X 10 <sup>14</sup>	1.13 X 10 <sup>12</sup>	4.24 X 10 <sup>13</sup>	3.43 X 10 <sup>6</sup>	2.21 X 10 <sup>6</sup>	2.37 X 10 <sup>4</sup>
2017	7.14 X 10 <sup>14</sup>	1.23 X 10 <sup>12</sup>	4.82 X 10 <sup>13</sup>	1.41 X 10 <sup>6</sup>	2.34 X 10 <sup>6</sup>	3.70 X 10 <sup>3</sup>
2016	5.70 X 10 <sup>14</sup>	1.13 X 10 <sup>12</sup>	5.25 X 10 <sup>13</sup>	<LD <sup>a</sup>	1.13 X 10 <sup>6</sup>	1.85 X 10 <sup>3</sup>
2015	3.74 X 10 <sup>14</sup>	1.16 X 10 <sup>12</sup>	5.25 X 10 <sup>13</sup>	4.01 X 10 <sup>7</sup>	1.63 X 10 <sup>7</sup>	2.34 X 10 <sup>6</sup>
2014	4.13 X 10 <sup>14</sup>	1.26 X 10 <sup>12</sup>	5.25 X 10 <sup>13</sup>	4.02 X 10 <sup>7</sup>	1.53 X 10 <sup>7</sup>	2.26 X 10 <sup>6</sup>
2013	2.63 X 10 <sup>14</sup>	1.10 X 10 <sup>12</sup>	3.71 X 10 <sup>12</sup>	<4.04 X 10 <sup>7</sup>	<1.86 X 10 <sup>7</sup>	<2.51 X 10 <sup>6</sup>
2012	3.26 X 10 <sup>14</sup>	1.16 X 10 <sup>12</sup>	3.64 X 10 <sup>12</sup>	4.13 X 10 <sup>7</sup>	1.80 X 10 <sup>7</sup>	<4.38 X 10 <sup>5</sup>
2011	7.17 X 10 <sup>14</sup>	1.44 X 10 <sup>12</sup>	3.64 X 10 <sup>12</sup>	4.19 X 10 <sup>7</sup>	5.07 X 10 <sup>7</sup>	1.78 X 10 <sup>7</sup>

a = less than analytical detection limit

#### Releases to surface waters:

**Table I.3: Bruce-A annual radionuclide releases to surface waters for 2011 – 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
<b>2019 DRL</b>	<b>2.30 X 10<sup>18</sup></b>	<b>4.58 X 10<sup>13</sup></b>	<b>1.03 X 10<sup>15</sup></b>	<b>1.12 X 10<sup>14</sup></b>
2019	2.12 X 10 <sup>14</sup>	2.13 X 10 <sup>9</sup>	8.17 X 10 <sup>8</sup>	<LD <sup>a</sup>
2018	1.96 X 10 <sup>14</sup>	1.20 X 10 <sup>9</sup>	9.73 X 10 <sup>8</sup>	<LD <sup>a</sup>
2017	2.26 X 10 <sup>14</sup>	1.08 X 10 <sup>9</sup>	9.13 X 10 <sup>8</sup>	<LD <sup>a</sup>
2016	2.36 X 10 <sup>14</sup>	9.96 X 10 <sup>8</sup>	1.66 X 10 <sup>9</sup>	6.96 X 10 <sup>4</sup>
2015	2.20 X 10 <sup>14</sup>	9.17 X 10 <sup>8</sup>	2.45 X 10 <sup>9</sup>	1.31 X 10 <sup>6</sup>
2014	1.94 X 10 <sup>14</sup>	1.02 X 10 <sup>9</sup>	1.13 X 10 <sup>9</sup>	1.77 X 10 <sup>6</sup>
2013	1.96 X 10 <sup>14</sup>	9.08 X 10 <sup>8</sup>	9.95 X 10 <sup>8</sup>	2.12 X 10 <sup>6</sup>
2012	1.40 X 10 <sup>14</sup>	5.79 X 10 <sup>8</sup>	5.37 X 10 <sup>8</sup>	1.60 X 10 <sup>6</sup>
2011	2.95 X 10 <sup>14</sup>	6.29 X 10 <sup>8</sup>	1.70 X 10 <sup>9</sup>	1.09 X 10 <sup>6</sup>

a = less than analytical detection limit

**Table I.4: Bruce-B annual radionuclide releases to surface waters for 2011 – 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
<b>2019 DRL</b>	<b>1.84 X 10<sup>18</sup></b>	<b>5.17 X 10<sup>13</sup></b>	<b>1.16 X 10<sup>15</sup></b>	<b>1.21 X 10<sup>14</sup></b>
2019	8.82 X 10 <sup>14</sup>	2.26 X 10 <sup>9</sup>	4.68 X 10 <sup>9</sup>	<LD <sup>a</sup>

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
2018	5.60 X 10 <sup>14</sup>	2.55 X 10 <sup>9</sup>	1.38 X 10 <sup>9</sup>	<LD <sup>a</sup>
2017	7.15 X 10 <sup>14</sup>	2.04 X 10 <sup>9</sup>	2.39 X 10 <sup>9</sup>	<LD <sup>a</sup>
2016	5.07 X 10 <sup>14</sup>	1.42 X 10 <sup>9</sup>	1.76 X 10 <sup>9</sup>	<LD <sup>a</sup>
2015	6.72 X 10 <sup>14</sup>	1.53 X 10 <sup>9</sup>	9.07 X 10 <sup>9</sup>	1.40 X 10 <sup>6</sup>
2014	6.42 X 10 <sup>14</sup>	1.99 X 10 <sup>9</sup>	8.06 X 10 <sup>9</sup>	1.49 X 10 <sup>6</sup>
2013	4.19 X 10 <sup>14</sup>	3.95 X 10 <sup>9</sup>	4.90 X 10 <sup>9</sup>	8.91 X 10 <sup>6</sup>
2012	1.14 X 10 <sup>15</sup>	3.35 X 10 <sup>9</sup>	4.63 X 10 <sup>9</sup>	1.11 X 10 <sup>6</sup>
2011	5.10 X 10 <sup>14</sup>	2.38 X 10 <sup>9</sup>	2.82 X 10 <sup>9</sup>	1.48 X 10 <sup>6</sup>

a = less than analytical detection limit

## Western waste management facility

Western Waste Management Facility at the Bruce Operation

### Releases to atmosphere:

**Table I.5: Western waste management facility annual radionuclide releases to atmosphere for 2011 – 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Carbon -14 (Bq)	Iodine-131 (Bq)	Particulate (Gross gamma) (Bq)
<b>2019 DRL</b>	<b>2.96 X 10<sup>17</sup></b>	<b>1.09 X 10<sup>15</sup></b>	<b>1.90 X 10<sup>12</sup></b>	<b>2.34 X 10<sup>12</sup></b>
2019	1.03 X 10 <sup>13</sup>	2.62 X 10 <sup>9</sup>	0	6.52 X 10 <sup>2</sup>
2018	3.25 X 10 <sup>12</sup>	1.57 X 10 <sup>9</sup>	7.23 X 10 <sup>4</sup>	2.41 X 10 <sup>4</sup>
2017	1.72 X 10 <sup>13</sup>	4.09 X 10 <sup>9</sup>	1.38 X 10 <sup>5</sup>	4.52 X 10 <sup>3</sup>
2016	2.06 X 10 <sup>13</sup>	3.94 X 10 <sup>9</sup>	1.71 X 10 <sup>5</sup>	5.42 X 10 <sup>3</sup>
2015	4.14 X 10 <sup>12</sup>	1.41 X 10 <sup>9</sup>	1.21 X 10 <sup>5</sup>	4.89 X 10 <sup>5</sup>
2014	7.17 X 10 <sup>12</sup>	1.57 X 10 <sup>9</sup>	1.22 X 10 <sup>5</sup>	5.12 X 10 <sup>4</sup>
2013	1.43 X 10 <sup>13</sup>	1.96 X 10 <sup>9</sup>	6.38 X 10 <sup>4</sup>	3.78 X 10 <sup>5</sup>
2012	1.04 X 10 <sup>13</sup>	1.88 X 10 <sup>9</sup>	6.06 X 10 <sup>4</sup>	1.26 X 10 <sup>5</sup>
2011	1.99 X 10 <sup>13</sup>	3.45 X 10 <sup>9</sup>	8.95 X 10 <sup>4</sup>	1.34 X 10 <sup>5</sup>

### Releases to surface waters:

**Table I.6: Western waste management facility annual radionuclide releases to surface waters for 2011 – 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Gross Beta (Bq)
<b>2019 DRL</b>	<b>7.70 X 10<sup>15</sup></b>	<b>4.46 X 10<sup>11</sup></b>
2019	1.60 X 10 <sup>11</sup>	7.08 X 10 <sup>7</sup>
2018	3.64 X 10 <sup>11</sup>	1.69 X 10 <sup>8</sup>
2017	2.59 X 10 <sup>11</sup>	2.84 X 10 <sup>8</sup>
2016	6.12 X 10 <sup>11</sup>	4.62 X 10 <sup>8</sup>

Year	Tritium: (HTO: Bq)	Gross Beta (Bq)
2015	$4.29 \times 10^{11}$	$1.56 \times 10^8$
2014	$2.44 \times 10^{11}$	$1.26 \times 10^8$
2013	$1.42 \times 10^{11}$	$1.26 \times 10^8$
2012	$1.00 \times 10^{11}$	$6.80 \times 10^7$
2011	$1.20 \times 10^{11}$	$9.02 \times 10^7$

#### D.4 Point Lepreau

The Point Lepreau nuclear power plant consisting of a single reactor unit has DRLs for each individual noble gas and particulate categories and therefore monitors and reports on wide range of specific radionuclides. For consistency in reporting within this appendix, these have been combined as total noble gases and total particulate in the tables below.

#### Releases to atmosphere:

**Table I.14: Point Lepreau annual radionuclide releases to atmosphere for 2011 – 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Carbon- 14 (Bq)	Noble Gas (Bq- MeV)	Iodine- 131 (Bq)	Particulate (Gross beta/gamma) (Bq)
<b>2019 DRL</b>	<b><math>2.4 \times 10^{17}</math></b>	<b><math>1.2 \times 10^{16}</math></b>	<b>a</b>	<b><math>6.3 \times 10^{13}</math></b>	<b>a</b>
2019	$2.5 \times 10^{14}$	$2.8 \times 10^{11}$	$2.9 \times 10^{13}$	$2.7 \times 10^7$	$<1.1 \times 10^8$
2018	$1.4 \times 10^{14}$	$3.3 \times 10^{11}$	$2.5 \times 10^{13}$	$1.3 \times 10^6$	$<2.2 \times 10^6$
2017	$1.5 \times 10^{14}$	$3.1 \times 10^{11}$	$4.6 \times 10^{13}$	$<5.2 \times 10^5$	$<2.2 \times 10^6$
2016	$1.5 \times 10^{14}$	$1.1 \times 10^{11}$	$9.5 \times 10^{13}$	$5.2 \times 10^5$	$<2.2 \times 10^6$
Year	Tritium: (HTO: Bq)	Carbon- 14 (Bq)	Noble Gas (Bq- MeV)	Iodine- 131 (Bq)	Particulate (Gross beta/gamma) (Bq)
2015	$1.4 \times 10^{13}$	$7.1 \times 10^{10}$	$5.9 \times 10^{12}$	$<5.0 \times 10^5$	$<8.1 \times 10^5$
2014	$6.6 \times 10^{13}$	$8.4 \times 10^{10}$	$3.8 \times 10^{12}$	---	---
2013	$9.1 \times 10^{13}$	$8.0 \times 10^{10}$	$4.6 \times 10^{12}$	---	---
2012	$1.4 \times 10^{14}$	$3.7 \times 10^{10}$	$8.0 \times 10^{11}$	---	---
2011	$4.3 \times 10^{11}$	$3.3 \times 10^{15}$	---	---	---

**a:** Specific DRLs are calculated for a range of noble gas and particulate categories. None of these individuals DRLS were exceeded.

**Releases to surface waters:****Table I.15: Point Lepreau annual radionuclide releases to surface waters for 2011 – 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Gross beta (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
<b>2019 DRL</b>	<b>4.5 x 10<sup>19</sup></b>	<b>a</b>	<b>3.7 x 10<sup>14</sup></b>	<b>a</b>
2019	3.4 X 10 <sup>14</sup>	8.4 X 10 <sup>7</sup>	7.6 X 10 <sup>9</sup>	1.3 X 10 <sup>7</sup>
2018	2.4 X 10 <sup>14</sup>	9.7 X 10 <sup>7</sup>	4.9 X 10 <sup>9</sup>	1.7 X 10 <sup>7</sup>
2017	1.2 X 10 <sup>14</sup>	7.8 X 10 <sup>7</sup>	1.8 X 10 <sup>9</sup>	7.9 X 10 <sup>6</sup>
2016	1.8 X 10 <sup>14</sup>	7.8 X 10 <sup>7</sup>	2.9 X 10 <sup>9</sup>	7.9 X 10 <sup>6</sup>
2015	1.4 X 10 <sup>14</sup>	5.5 X 10 <sup>7</sup>	1.0 X 10 <sup>10</sup>	6.7 X 10 <sup>6</sup>
2014	3.2 X 10 <sup>14</sup>	1.5 X 10 <sup>8</sup>	6.6 X 10 <sup>9</sup>	8.6 X 10 <sup>6</sup>
2013	2.9 X 10 <sup>14</sup>	1.5 X 10 <sup>8</sup>	4.3 X 10 <sup>9</sup>	8.6 X 10 <sup>6</sup>
2012	7.8 X 10 <sup>14</sup>	7.2 X 10 <sup>7</sup>	3.8 X 10 <sup>10</sup>	6.5 X 10 <sup>6</sup>
2011	3.4 X 10 <sup>13</sup>	8.2 X 10 <sup>7</sup>	1.4 X 10 <sup>7</sup>	5.8 X 10 <sup>6</sup>

a: Specific DRLs are calculated for a range of noble gas and particulate categories

**D.5 Gentilly-2**

The G-2 facility was permanently shut down in December 2012. Since then, activities conducted by Hydro-Québec have been to stabilize and transition the G-2 facility to safe storage.

**Releases to atmosphere:****Table I.16: Gentilly-2 annual radionuclide releases to atmosphere for 2011 – 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/ gamma) (Bq)
<b>2019 DRL</b>	<b>1.7 x 10<sup>17</sup></b>	<b>1.2 x 10<sup>15</sup></b>	<b>NA<sup>1</sup></b>	<b>NA<sup>1</sup></b>	<b>8.0 x 10<sup>11</sup></b>
2019	7.21 X 10 <sup>13</sup>	2.70 X 10 <sup>10</sup>	<LD <sup>a</sup>	<LD <sup>a</sup>	9.49 X 10 <sup>5</sup>
2018	9.17 X 10 <sup>13</sup>	4.63 X 10 <sup>10</sup>	<LD <sup>a</sup>	<LD <sup>a</sup>	2.15 X 10 <sup>6</sup>
2017	7.31 X 10 <sup>13</sup>	4.47 X 10 <sup>11</sup>	<LD <sup>a</sup>	<LD <sup>a</sup>	8.32 X 10 <sup>6</sup>
2016	7.31 X 10 <sup>13</sup>	3.79 X 10 <sup>11</sup>	<LD <sup>a</sup>	<LD <sup>a</sup>	5.17 X 10 <sup>5</sup>
2015	1.12 X 10 <sup>14</sup>	4.10 X 10 <sup>11</sup>	<LD <sup>a</sup>	<LD <sup>a</sup>	1.35 X 10 <sup>6</sup>

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/ gamma) (Bq)
2014	$1.19 \times 10^{14}$	$4.83 \times 10^{11}$	$3.15 \times 10^9$	<LD <sup>a</sup>	$2.92 \times 10^5$
2013	$1.14 \times 10^{14}$	$7.49 \times 10^{11}$	$6.96 \times 10^8$	<LD <sup>a</sup>	$8.65 \times 10^5$
2012	$2.13 \times 10^{14}$	$4.41 \times 10^{11}$	$3.87 \times 10^{11}$	$8.31 \times 10^6$	$1.79 \times 10^6$
2011	$1.90 \times 10^{14}$	$2.71 \times 10^{11}$	$1.16 \times 10^{11}$	<LD <sup>a</sup>	$9.13 \times 10^5$

<sup>1</sup> Not applicable as facility is in safe shut-down.

<sup>a</sup> = less than analytical detection limit

### Releases to surface waters:

**Table I.17 Gentilly-2 annual radionuclide releases to surface waters for 2011 – 2019. The applicable DRLs for 2019 are also presented.**

Year	Tritium: (HTO: Bq)	Gross beta (Bq)	Carbon-14 (Bq)
<b>2019 DRL</b>	<b><math>1.1 \times 10^{19}</math></b>	<b><math>5.3 \times 10^{13}</math></b>	<b><math>7.3 \times 10^{14}</math></b>
2019	$8.22 \times 10^{13}$	$3.47 \times 10^7$	$1.90 \times 10^8$
2018	$5.46 \times 10^{13}$	$2.51 \times 10^7$	$1.71 \times 10^8$
2017	$2.17 \times 10^{14}$	$3.28 \times 10^8$	$2.79 \times 10^{11}$
2016	$3.83 \times 10^{13}$	$1.33 \times 10^8$	$5.64 \times 10^{10}$
2015	$1.51 \times 10^{14}$	$5.28 \times 10^8$	$3.00 \times 10^{11}$
2014	$3.56 \times 10^{14}$	$2.86 \times 10^8$	$5.28 \times 10^{10}$
2013	$2.14 \times 10^{14}$	$1.84 \times 10^9$	$1.15 \times 10^{10}$
2012	$3.51 \times 10^{14}$	$1.09 \times 10^9$	$2.88 \times 10^{10}$
2011	$2.44 \times 10^{14}$	$5.35 \times 10^9$	$1.89 \times 10^{10}$

## E. LIST OF LICENCE CONDITIONS HANDBOOKS CHANGES

The following table lists the LCHs for each facility covered by the regulatory oversight report and indicates the changes made to LCHs in 2019. For those that were revised in 2019, the details are provided below.

Facility	LCH #	Revision # as of December 31, 2019	Revised in 2019?
DNGS	LCH-PR-13.00/2025	R003	Issued R003 on December 20, 2019
DWMF	LCH-W4-355.01/2023	R000	No
PNGS	LCH-PR-48.00/2028	R001	Issued R002 on December 20, 2019
PWMF	LCH-W4-350.00/2028	R000	No
Bruce A and B	LCH-PR-18.00/2028	R001	Issued R001 on April 1, 2019
WWMF	LCH-W4-314.00/2027	R000	No
Point Lepreau	LCH-PR-17.00/2022	R000	Issued R001 on December 20, 2019
Gentilly-2	MCP-GENTILLY-2	R000	Issued R001 on February 25, 2019

### Revisions to LCH for Darlington Nuclear Generating Station

On December 20, 2019, CNSC staff published revision R003 of the DNGS LCH to clarify recommendations, guidance and the compliance verification criteria in various sections to include a reference to the Commission's decision regarding a revision to the Darlington IIP, new or revised CNSC regulatory documents and CSA Group standards (these developments are described in this report and are aligned with the Commission decisions) and licensee documents.

The table below summarizes the changes made in revision R003:

LC(s)	Sub-section	Change
G.1	Guidance	Replaced reference to INFO-0795, Licensing Basis Objective and Definition with REGDOC-3.5.3, <i>Regulatory Fundamentals</i>
1.1	Guidance	Added implementation plan submission date of November 26, 2020 for section 1.4.1 of REGDOC-2.1.2, <i>Safety Culture</i> , on security culture. The rest of REGDOC-2.1.2 has been implemented.

LC(s)	Sub-section	Change
2.1	CVC	P-119 <i>Policy on Human Factors</i> , was superseded by REGDOC-2.2.1 <i>Human Factors</i> , in March 2019. Replaced reference to P-119 in preamble to section 2.1 and appendix E.2.
2.1	CVC	Updated the licensee document number for Limit of Hours of Work and the title for N-PROC-OP-0005.
2.1	CVC	<p>Modified the effective date for REGDOC-2.2.4, <i>Vol I: Fitness for duty: managing worker fatigue</i>, to Jan 1, 2019, to reflect that this document was implemented.</p> <p>Noted that OPG updated the implementation of REGDOC-2.2.4, <i>Vol. II: Managing alcohol and drugs</i> to 6 months after the approval of version 3 of the REGDOC-2.2.4, Vol II, with the exception of the requirements for random alcohol and drug testing. The requirements for random alcohol and drug testing will be implemented 12 months after the approval of version 3 of the REGDOC-2.2.4, Vol II.</p> <p>Added reference to REGDOC-2.2.4 Vol III to Guidance. OPG has been requested to provide an implementation plan by November 30, 2019. This REGDOC supersedes RD-363.</p>
2.2	Guidance	<p>Replaced reference to G-323 <i>Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement</i>, with REGDOC-2.2.5 <i>Minimum Staff Complement</i>. REGDOC-2.2.5 published April 2019, and it superseded G-323.</p> <p>Added REGDOC-2.5.1, <i>General Design Considerations: Human Factors</i>, which was published April 2019, to guidance. It supersedes G-276 and G-278.</p>
2.3	Guidance	Added CNSC regulatory document REGDOC-2.3.3 <i>Personnel Certification Volume III: Certification of Persons Working at Nuclear Power Plants</i> as guidance. CNSC regulatory document REGDOC-2.3.3 was published in September 2019, superseding RD-204.
3.1	CVC	Modified the conditions for Rod-based Guaranteed Shutdown State. CNSC staff provided concurrence to OPG to extend the applicability of RBGSS for outages up to 375 days in length, without the need to notify CNSC staff.
5.1	Guidance	Added REGDOC-2.5.1 <i>General Design Considerations: Human Factors</i> , which was published April 2019, to the guidance section. It supersedes G-276 and G-278.
5.1	CVC	Modified the title of the licensee document N-PROC-MP-0090.
5.2	CVC	Made modifications to integrate changes regarding the registration of fittings for fire protection systems.



LC(s)	Sub-section	Change
5.2	Guidance	Added the white paper N-REF-01913.11-00001 <i>Temporary Leak Maintenance by Leak Mitigation Process</i> , as guidance on performing the leak mitigation.
6.1	CVC	REGDOC-2.6.2, <i>Maintenance Programs for Nuclear Power Plants</i> , published 2017, replaced the superseded document RD/GD-210, <i>Maintenance Programs for Nuclear Power Plants</i> . REGDOC-2.6.1, <i>Reliability Programs for Nuclear Power Plants</i> published 2017, replaced the superseded document RD/GD-98, <i>Reliability Programs for Nuclear Power Plants</i> . Additional clarity was provided on reconciling the use on the new documents in the licensee governing documents.
6.1	CVC	The new editions of CSA N285.4 Periodic Inspection Program (2014- for specific clauses & 2019) were added to replace the 2005 version of the standard.
6.1	CVC	The updated fuel channel periodic inspection plan, with regards to CSA 285.4 clause 12.2.5.1.3 replaced the previous plan.
6.1	CVC	More clarifications were added with respect to Fuel Channel Annulus spacers' inspections.
6.1	CVC	The fitness for service guidelines for steam generators and preheater tubes were updated to include the new release of the COG guidelines.
6.1	CVC	Added OPGs commitment to adopt 2018 version of CSA 285.5 by May 2022. Some of the clauses of the 2018 version of CSA 285.5 have been already adopted and are now part of the CVC.
7.1	CVC	The action levels for surface contamination levels were updated, while some additional licensees documents were added to the list of documents requiring notifications.
8.1	Guidance	REGDOC-2.8.1, <i>Conventional Health and Safety</i> , was added to the guidance section.
9.1	Preamble	Added REGDOC-2.9.1, <i>Environmental Protection: Environmental Principles, Assessments and Protection Measures</i> as an additional source describing the principles and factors guiding CNSC in regulating the environmental protection.
9.1	CVC	Added CSA N288.3.4, <i>Performance testing of nuclear air-cleaning systems at nuclear facilities</i> , 2013 version and N288.1, <i>Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operations of nuclear facilities</i> , 2014 to the list of controlled documents.

LC(s)	Sub-section	Change
9.1	CVC	Added a requirement to implement N288.7, <i>Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills</i> , by Dec 31, 2022.
9.1	CVC	Updated derived release limits and environmental action levels to reflect changes to Darlington NGS governance.
9.1	CVC	Additional text was added to the sections on Environmental Risk Assessment, Environmental Management System and Assessment and Monitoring to more clearly explain the requirements.
9.1	Guidance	Added two new CSA standards to Guidance: CSA N288.8-17, <i>Establishing and implementing action levels for releases to the environment from nuclear facilities</i> ; and CSA N288.2-14, <i>Guidelines for Calculating the Radiological Consequences to the Public of a Release of Airborne Radioactive Material for Nuclear Reactor Accidents</i> .  Added REGDOC-2.9.1, <i>Environmental Protection: Environmental Principles, Assessments and Protection Measures</i> as guidance.
12.1	CVC	Updated the licensee's documents requiring notification of change with three Cyber security related documents.
12.1	Guidance	Added REGDOC-2.12.1, <i>High Security Facilities, Volume I: Nuclear Response Force, Version 2</i> as guidance until implementation plan to replace the 2013 version is accepted.
13.1	CVC	Added a new document REGDOC-2.13.1, <i>Safeguards and Nuclear Material Accountancy</i> , as a requirement, with full implementation expected by March 2021.
15.3	CVC	Updated the text to reflect the July 18, 2019 Commission's decision regarding the revised IIP commitments.
Appendix C		The list of All Version-Controlled Documents was updated as per above-mentioned changes.
Appendix D		The list of Licensee Documents Requiring Written Notification was updated as per above-mentioned changes.

### Revisions to LCH for Pickering Nuclear Generating Station

On December 20, 2019, CNSC staff made a number of changes to clarify recommendations, guidance and the compliance verification criteria in various sections to include a new or revised CNSC regulatory documents and CSA Group standards (these developments are described in this report and are aligned with the Commission decisions) and licensee documents.

The table below summarizes the changes made in revision R001:

LC(s)	Sub-section	Change
G.1	Guidance	Replaced reference to INFO-0795, <i>Licensing Basis Objective and Definition</i> with REGDOC-3.5.3, <i>Regulatory Fundamentals</i>
1.1	CVC	Added REGDOC-2.1.2 <i>Safety Culture</i> to Licensing Basis Publication table with effective date of 2019-05-24; implementation plan submission date of November 26, 2020 for section 1.4.1 of REGDOC-2.1.2, <i>Safety Culture</i> , on security culture. The rest of REGDOC-2.1.2 has been implemented.
1.1	Guidance	Additional guidance from REGDOC-2.1.2 is provided.
2.1	Preamble	P-119 <i>Policy on Human Factors</i> , was superseded by REGDOC-2.2.1 <i>Human Factors</i> , in March 2019. Replaced reference to P-119 in preamble to section 2.1. Also, added REGDOC-2.2.1 to guidance.
2.1	Guidance	Added REGDOC-2.2.4 <i>Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical and Psychological Fitness</i> , to guidance until implementation plan is accepted, replacing the superseded RD-363.
2.1	CVC	Modified the effective date for REGDOC-2.2.4, <i>Vol I: Fitness for duty: managing worker fatigue</i> , to Jan 1, 2019, to reflect that this document was implemented.  Noted that OPG updated the implementation of REGDOC-2.2.4, <i>Vol. II: Managing alcohol and drugs</i> to 6 months after the approval of version 3 of the REGDOC-2.2.4, Vol II, with the exception of the requirements for random alcohol and drug testing. The requirements for random alcohol and drug testing will be implemented 12 months after the approval of version 3 of the REGDOC-2.2.4, Vol II.  Added reference to REGDOC-2.2.4 Vol III to Guidance. OPG has been requested to provide an implementation plan by November 30, 2019. This REGDOC supersedes RD-363.
2.1	Guidance	Replaced reference to G-323 <i>Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement</i> , with REGDOC-2.2.5 <i>Minimum Staff Complement</i> .  Other administrative changes to Preamble and guidance text.
2.2, 3.1, 5.1	Guidance	REGDOC-2.5.1, <i>General Design Considerations: Human Factors</i> , was added as guidance. It supersedes G-276 and G-278.
3.1	CVC	Several licensee's documents that require notification were modified.
4.1	CVC	Removed reference to AECB 1059.

LC(s)	Sub-section	Change
		<p>This is change is to address Commission direction in the Record of Decision from the Pickering licence renewal, to remove references to old AECB documents from the LCH.</p> <p>AECB 1059 was the siting guide for Pickering NGS and is the source of the LCH table listing the reference dose limits for single and dual failures. The table will remain in the LCH.</p>
5.1 , 6.1	CVC	More clarification were provided at OPGs' request, in relation to compliance with CSA N291-08.
5.2	Guidance	Added the white paper N-REF-01913.11-00001 <i>Temporary Leak Maintenance by Leak Mitigation Process</i> , as guidance on performing the leak mitigation.
6.1	CVC	The new edition of CSA N285.4 Periodic Inspection Program (2014) was added to replace the 2005 version of the standard, for certain clauses. Further clarifications were made in relation to CSA 285.4 clauses.
6.1	CVC	Modified implementation strategy to adopt 2018 version of CSA N285.5. Some of the clauses of the 2018 version of CSA 285.5 have been already adopted and are now part of the CVC.
6.1	CVC	CNSC staff provided its consent for OPG to modify the testing interval for the vacuum building, the dousing system and the pressure relief duct from 10 to 12 years.
6.1	CVC	Updated CVC for Probabilistic Leak-Before-Break (PLBB) assessments to reflect extension of acceptance criterion until Feb 28, 2021.
6.1	CVC	Update CVC under "Validation of the Cohesive Zone-based Fracture Toughness Model" Management to reflect current status of model.
7.1	CVC	Several licensee's documents related to radiation dosimetry program and radioactive work planning that require notification were modified.
7.1	CVC	Updated "Action Levels for Dose to Workers" and "Action Level for Surface Contamination Levels" tables to reflect changes to AL where applicable.
9.1	Preamble	Added general statement about regulating the release of hazardous substances.
9.1	CVC	Editorial changes and other information reorganization changes made.
9.1	Guidance	Two new CSA standards added to Guidance: CSA N288.8-17 <i>Establishing and implementing action levels for releases to the environment from nuclear facilities</i> ; and CSA N288.9-18

LC(s)	Sub-section	Change
		<i>Guideline for design of fish impingement and entrainment programs at nuclear facilities.</i>
12.1	Guidance	REGDOC-2.12.1, <i>High Security Facilities</i> , Volume I: <i>Nuclear Response Force</i> , Version 2, published Sept 2018, supersedes REGDOC-2.12.1, <i>High-Security Sites: Nuclear Response Force</i> (2013).  Add to Guidance until implementation plan is received (due November 2019). Will be moved to CVC once implementation date is determined.
13.1	CVC	Moved REGDOC-2.13.1 <i>Safeguards and Nuclear Material Accountancy</i> , from Guidance to CVC.  OPG's implementation plan was under review during the last LCH revision. After follow-up discussions with OPG, CNSC staff concur with implementation dates
15.1	CVC	Clarification made to CVC for annual status report on IIP implementation.

### Revisions to LCH for Bruce Nuclear Generating Station

On April 1, 2019, CNSC staff made a number of changes to clarify recommendations, guidance and the compliance verification criteria in various sections to include a new or revised CNSC regulatory documents and CSA Group standards (these developments are described in this report and are aligned with the Commission decisions) and licensee documents.

The table below summarizes the changes made in revision R001:

LC(s)	Sub-section	Change
G.1	Guidance	Replaced reference to INFO-0795, <i>Licensing Basis Objective and Definition</i> with REGDOC-3.5.3, <i>Regulatory Fundamentals</i>
G.5	Guidance	Added a new guidance document REGDOC-3.2.2, <i>Aboriginal Engagement</i> , 2016 version
1.1	CVC	Removed N286, <i>Management system requirements for nuclear power plants</i> , 2005 revision including update No 1(2007). The transition to N286 2012 revision was completed.
1.1	Guidance	Added implementation plan submission date of June 1, 2019 for REGDOC-2.1.2, <i>Safety Culture</i> .
2.1	CVC	Modified the effective date for REGDOC-2.2.4, <i>Vol I: Fitness for duty: managing worker fatigue</i> , to Dec. 31, 2018 to reflect that this document was implemented.

LC(s)	Sub-section	Change
		Noted that Bruce Power submitted its October 15, 2018 update on the implementation of REGDOC-2.2.4, <i>Vol. II: Managing alcohol and drugs</i> .
2.4	CVC	Added a note to clarify that one of the licensee documents is under revision to address CNSC comments related to the authorities and responsibilities of an authorized health physicist.
3.3	CVC	Modified the revision of the interpretation of REGDOC-3.1.1, <i>Reporting Requirements for Nuclear Power Plants</i> , from rev. 0 to the updated Rev. 1.
4.1	CVC	Added a requirement for the licensee to provide the methodology and aggregate values for whole site PSA.
4.1	CVC	Editorial change to add the title for the CSA standard N286.7.
4.1	CVC	Removed the guidance on the development of a method for determining aggregate values for safety goals.
5.1	CVC	Removed the note on the licensee's implementation of the new enterprise management system.
5.2	CVC	Added a note to indicate that Annex L of N285.0, General requirements for pressure-retaining systems and components in CANDU nuclear power plants was accepted as a "Normative" Annex. In addition, more clarifications were provided on how to implement and maintain a pressure boundary program.
6.1	CVC	A clarification was included in the aging management section to indicate that Bruce Power submitted its quantitative assessment of uncertainties in Revision 1 of the Cohesive Zone Model, and it is under review by CNSC staff. Some minor editorial changes were done. More clarifications were also provided in relation to the certification of personnel for Steam Generator inspections.
6.1	CVC	Update to the Pressure tube fracture toughness assessments sub-section to indicate that Bruce Power submitted a quantitative assessment of the uncertainties (due by Dec. 31, 2018) and that CNSC staff are reviewing it.
7.1	CVC	More clarifications were provided in relation to the authorities and responsibilities for an authorized health physicist, a certified position.
9.1	CVC	The implementation strategy details for CSA N288.4, N288.5 and N288.6 were removed, as the standards are implemented.
9.1	Guidance	Added CSA N288.3.4, <i>Performance testing of nuclear air-cleaning systems at nuclear facilities</i> , 2013 version as guidance.
10.1	CVC	Modified effective date for the REGDOC-2.10.1, <i>Nuclear Emergency Preparedness and Response</i> , to a later date. Also

LC(s)	Sub-section	Change
		removed the implementation strategy details as the regulatory document is now implemented.
10.2	CVC	Small editorial correction was made to the title of N293 standard.
11.1	CVC	Updated one of the document titles that require notification of change. The Waste Management Program is no longer described and given in BP-PROG-12.03, <i>Nuclear Fuel Management</i> but in BP-PROG-12.05, <i>Radiation Protection Program</i> . Further clarified that Bruce Power audits its waste management program per the governance given in BP-PROG-15.01, <i>Independent Oversight Management</i> .
11.1	CVC	Added a new document CSA N292.3, <i>Management of low- and intermediate-level radioactive waste</i> , to the licensing basis publications, which describes the requirement to implement and maintain a program for waste management. Previously this CSA standard was considered guidance.
13.1	CVC	Added a new document REGDOC-2.13.1, <i>Safeguards and Nuclear Material Accountancy</i> , to the licensing basis publications, which describes the requirement for the accounting and reporting of nuclear material instead of RD-336, <i>Accounting and reporting of nuclear material</i> . Previously this regulatory document standard was considered as guidance.
14,1	CVC	A new licensee document, BP-PROC-00188, describing the process for radioactive material transportation was added to the licensee documents that require notification of change.
15.1	CVC	Added as CVC “Initial Renewal Notice for the first renewal period of one year under the Amended and Restated Lease Agreement...” (for the year 2019) and as CVC “Renewal Notice for a renewal period of two years under the Second Amended and Restated Lease Agreement ...” (for the years 2020 and 2021).
15.3, 15.6, 15.11	Guidance	Small editorial changes to the titles of two documents
15.9	Guidance	Added REGDOC-2.4.3, <i>Nuclear Criticality Safety</i> , as guidance.
15.12	CVC	<p>More details were provided on how to conduct licensed activities with the nuclear substances and the prescribed equipment listed:</p> <ul style="list-style-type: none"> <li>- Several devices were removed</li> <li>- Included the use of the nuclear substances and prescribed equipment to support dosimetry services under the licensed activities, as a result of the consolidation of the NSRD licence and PROL</li> </ul>



LC(s)	Sub-section	Change
		<p>- Added additional substances to the list of approved substances</p> <p>More details are now included to describe Import and Export of Nuclear Substances as Contamination on Equipment.</p>
Appendix B		The list of All Version-Controlled Documents was updated as per above-mentioned changes.
Appendix D		The list of Licensee Documents Requiring Written Notification was updated as per above-mentioned changes.



### Revisions to LCH for Point Lepreau Nuclear Generating Station

On December 20, 2019, CNSC staff published revision R001 of the PLNGS LCH to clarify recommendations, guidance and the compliance verification criteria in various sections, to include a reference to a new or revised CNSC regulatory documents and CSA Group standards (these developments are described in this report and are aligned with the Commission decisions) and licensee documents.

The table below summarizes the changes made in revision R001:

LC(s)	Sub-section	Change
Intro		Provided additional clarifications in the introductory statement on meeting the standards and regulatory documents.
G.1	Preamble	Removed INFO 0795, <i>Licensing Basis Objective and Definition</i> , 2010 which has been superseded by the newly added REGDOC-3.5.3, <i>Regulatory Fundamentals</i> .
G.5	Guidance	Guidance Document GU-206 version was listed as 2010 but was changed to 2000.
G.6	Guidance	REGDOC 3.2.2 <i>Aboriginal Engagement</i> has now been implemented and added as guidance.
1.1	CVC	CSA N286-12 has been implemented by NBP and it now replaces previous CVC of CSA N286 Version 2005 with 2007 Update 1. All text related to CSA N286-05 has been updated to reflect the clauses found in CSA N286-12 throughout the LCH document.
1.1 & 5.2	CVC	Updated the references to NMM-00660, <i>Nuclear Management Manual</i> , for consistency and clarity purposes.
1.1	CVC	Added three NBP documents as written notification documents in Management System.
1.1	Guidance	Added REGDOC-2.1.2, <i>Safety Culture</i> , as guidance for licensee self-assessments of Safety Culture.
2.1	Pre	Added reference to REGDOC-2.2.1, <i>Human Factors</i> (published March 2019) which supersedes P-119, <i>Policy on Human Factors</i> .
2.1	CVC	Controlling Hours of Work for Regular Day Workers was changed to a prior notification document to align with Appendix F which correctly indicated the prior notification status.
2.1	Guidance	Removed reference to G-323 which has been superseded by REGDOC 2.2.5, published April 2019.
2.1	Guidance	Added REGDOC-2.2.1, <i>Human Factors</i> (published March 2019). And removed reference to P-119, <i>Policy on Human Factors</i> which is superseded. Added REGDOC-2.5.1, <i>General Design Considerations: Human Factors</i> (published March 2019) and removed reference to G-276,

LC(s)	Sub-section	Change
		<i>Human Factors Engineering Program Plans</i> , and G-278, <i>Human Factors Verification and Validation Plans</i> which are superseded. Added REGDOC-2.2.5, <i>Minimum Staff Complement</i> , as guidance.
2.1	Guidance	Added REGDOC 2.2.4 <i>Fitness for Duty: Managing Worker Fatigue</i> , with implementation date, to Guidance section.
2.2	CVC	Updated the minimum shift complement table: <ul style="list-style-type: none"> <li>- The total number of mechanical maintainers to 0 and</li> <li>- The total number of EI&amp;C to 2.</li> <li>- ERT leader emergency response to 1 and</li> <li>- ERT member ERT qualification to 8</li> </ul>
2.2	CVC	Changed the Meeting Minimum Operational Staffing Requirements to a prior notification document.
2.2	Guidance	Moved G-276 <i>Human Factors Engineering Plans</i> and G-278 <i>Human Factors Verification and Validation Plans</i> to Section 5.1 Design Program, as these relate solely to human factors in design (now REGDOC 2.5.1).  Replaced G-323 with REGDOC-2.2.5, <i>Minimum Staff Complement</i> .
2.3	CVC	Provided additional clarifications on the licensee's main core processes that describe the training program is PRR-00660-SU-3, <i>Provide Training</i> . Further supporting the operations certification training is PRR-00660-OP-1, <i>Control and Monitor Station Equipment</i> . The senior health physicist certified training PRR-00660-OP3, <i>Controlling Effluents</i> , PRR-00660-SU-4, <i>Providing Personnel Safety Services</i> and PRR-0060-SU-2, <i>Provide Environmental Services</i> were also mentioned in this section, while being listed as written notification documents under the management system in LCH Section 1.1
2.4	Preamble	Corrected minor syntax errors and added missing words to add clarity.
2.4	CVC	The section title was changed to Personnel Certification Requirements to be consistent with standard terminology and be more representative of the content that follows.  Additional editorial changes were made by adopting "personnel" when referencing a group of certified workers, and using "certified worker" wherever possible.  Additional clarifications were made to indicate that CNSC-EG1, EG2 and the requirements for the Requalification Testing supplement the RD-204 by setting detailed requirements.

LC(s)	Sub-section	Change
2.4	CVC	Added PRR-00660-OP-3, <i>Controlling Effluents</i> , PRR-00660-SU-4, <i>Providing Personnel Safety Services</i> and PRR-00660-SU-2, <i>Provide Environmental Services</i> to the licensee's main core processes that describe the certification training and examination programs.
2.4	CVC	Replaced SI-01365-A108, <i>Radiation Protection Directives</i> with STD-03400-04 " <i>Radiation Protection Directives</i> ".
2.4	CVC	Additional clarifications were provided to indicate that the entire CNSC document RD-204 remains applicable, while only paragraph 13.1.6 is superseded by an amended criterion. The criterion itself remains equivalent.
3.1	CVC	Some additional clarifications around heat sinks were provided in Outage management performance.
3.1	CVC	The description under Accident management and recovery section was moved here from the section under Severe Accident Management and Recovery.
3.1	CVC	Added "reactor" to the title CSA N290.11, <i>Requirements for Reactor Heat Removal Capability During Outage of Nuclear Power Plants</i> . This will align with the CSA Standards title.
3.1	CVC	Since Rod Based Guaranteed Shutdown State (RBGSS) is not for emergency situations, the requirement to provide prior written notification for changes to operations or procedures for RBGSS was removed.
3.1	CVC	Written and Prior Notification documents have been rebranded with new document numbers. The corrections were made in the documents requiring notification table.
3.1	Guidance	Update to include REGDOC-2.3.2, <i>Accident management</i> , version 2, implementation date of 2020-11-30 as committed in the NBP correspondence.
3.2 & 3.3	CVC	Corrected the title of REGDOC-3.1.1 to <i>Reporting Requirements: Nuclear Power Plants</i> .
3.3	Guidance	Updated the guidance section to indicate that the REGDOC-3.1.1's interpretation document was issued.
3.4	Preamble	REGDOC 2.3.3, <i>Periodic Safety Reviews</i> , wording indicated that safety factor reports and the global assessment report are submitted to CNSC for review and comment only, not acceptance. For consistency and accuracy with the REGDOC the text has been changed.
4.1	CVC	Editorial changes to better clarify the requirements under the Deterministic Safety Analysis.
4.1	CVC	The text under the Probabilistic Safety Analysis was updated to better align with the requirements in REGDOC-2.4.2, <i>Probabilistic Safety Assessment (PSA) for Nuclear Power Plants</i> .
4.1	CVC	Added a sub-section Beyond Design Basis Accidents / Severe Accidents, along with the description on where the requirements are described in REGDOC-2.4.1.

LC(s)	Sub-section	Change
4.1	CVC	Updated the written notification table with the current relevant licensee's documents.
4.1	Guidance	The Deterministic Safety Analyses sections have been revised to remove the reference to COG documents.
4.1	Guidance	CSA N290.17, <i>Probabilistic Safety Assessment for Nuclear Power Plants</i> was added as guidance. Removed the IAEA, USNRC, EPRI and ASME documents from the guidance list.
5.1	CVC	Editorial changes were made to indicate that fire protection design is generally covered under the design program, but is more specifically addressed as compliance criteria for CSA N293 in LCH section 10.2 and CSA N393 section 15.3.
5.1	CVC	Moved the reference to CSA N287.1 and N287.5 to the guidance section.
5.1	CVC	Minor editorial change was made in the instrumentation and control section.
5.1	CVC	Removed references to the results of the High Wind Assessment, and the site-specific Probabilistic Tsunami Hazard Assessment.
5.1	Guidance	Remove text referring to G-276, <i>Human Factors Engineering Program Plans</i> , and G-278, <i>Human Factors Verification and Validation Plans</i> , and added reference to REGDOC-2.5.1, <i>General Design Considerations: Human Factors</i> .  Updated the versions of N290.0 to the 2017 edition, N290.3 to the 2016 edition and the implementation date for N290.14 to April 2022.
5.2	Preamble	Removed the description of Authorized Inspection Agency.
5.2	CVC	Updated the list of certain types of pressure boundary fittings that are exempt from requiring a Canadian Registration Number (CRN) provided they are certified with Underwriter Laboratories of Canada (ULC) or they are listed by Underwriter Laboratories based on a Canadian standard (cUL). After further review and code comparison, it was determined that the cUL/ULC testing and certification requirements are equivalent to, or exceed, the requirements for a CRN. Therefore, it was agreed that the CRN exemption can be extended to all cUL/ULC certified fittings in fire protection systems.
5.2	CVC	Removed the requirement for the Authorized Inspection Agency to be accredited by ASME.
5.2	CVC	Updated the written notification table with the current relevant licensee's documents.
5.3	CVC	Change title of CSA N290.13 Environmental qualification of equipment for CANDU nuclear power plants as the word CANDU has been removed from title.

LC(s)	Sub-section	Change
5.3	CVC	Removed statement on Environmentally qualified (EQ) equipment and process, since any EQ modification is performed following the ECC process like any other modification.
5.3	CVC	Renamed one of the written notification document.
5.3	Guidance	Text modified with minor structure program for clarity.
6.1	CVC	<p>Removed CNSC RD/GD-98 <i>Reliability Programs for Nuclear Power Plants 2012 Implemented</i> – superseded. REGDOC 2.6.1, <i>Reliability Programs for Nuclear Power Plants</i>, 2017 version replaced RD/GD-98.</p> <p>Removed CNSC RD/GD-210 <i>Maintenance Programs for Nuclear Power Plants 2012 Implemented</i> – superseded. REGDOC 2.6.2, <i>Maintenance Programs for Nuclear Power Plants</i>, version 2017 replaced RD/GD-210.</p> <p>NBP has now implemented aging management REGDOC-2.6.3. The implementation plan related text was removed. The word CANDU has been removed from the title of N290.13.</p> <p>CSA N285.8 2010 Update 2 has been implemented and replaced 2005 with Update 1 and 2.</p>
6.1	CVC	Removed unclear statement about the notifications for new aging management documents.
6.1	CVC	Included the version referenced for N287.7 to avoid misinterpretation.
6.1	CVC	The Fuel Channels PIP has been accepted by CNSC in January 2019. Updated text to reflect the new date.
6.1	CVC	Updated the frequency of leakage rate tests for the Reactor Building (RBLRT) from every 3 years to every 4 years. Changed text to reflect new frequency, and to remove text related to previous tests.
6.1	CVC	Updated the written notification table with the current relevant licensee's documents.
6.1	Guidance	Removed RD/GD-98 and RD/DG-210 from Guidance as this was a duplicate, found in CVC and guidance. Remains in CVC.
6.1	Guidance	Removed N285.4, N285.5 Implementation Plan table and updated with Implementation dates, as per NBP implementation plan. Implementation date committed to 2020-06-30. Update the table to note that N287.7 is now implemented.
6.1	Guidance	Changed the implementation plan for CSA N285.8 version 2015 date to 2019-12-30.

LC(s)	Sub-section	Change
7.1	CVC	<p>The note "***" stated that for skin contamination events, the action level shall be applied to the calculated exposure based on the highest level of activity measured over an area of not more than 100 cm<sup>2</sup>.</p> <p>The Radiation Protection Regulations requires to use an area of 1 cm<sup>2</sup> when skin is unevenly irradiated. Therefore, the statement was modified as follows: for skin contamination events, the action level shall be applied to the calculated exposure based on the highest level of activity measured over an area of not more than 1 cm<sup>2</sup>.</p>
7.1	CVC	<p>Corrected the total surface contamination level value for beta-gamma contamination cited in the observations column of the table entitled "Action Levels: Surface Contamination Levels". 370 kBq/100 cm<sup>2</sup> (beta-gamma) to be changed for 370 Bq/100 cm<sup>2</sup>. Also added the word and to the first note as it was an error and should have been included in the previous revision.</p>
7.1	CVC	<p>In the Licence Application Documents that Require Notification of Change IR-03541-04, <i>ALARA Program</i> is listed. This IR has been obsoleted. It was replaced by SDP-01368-A046, <i>Controlling Radiation Exposures As Low As Reasonably Achievable (ALARA)</i>.</p>
9.1	CVC	<p>Replaced N288.1 2008 Update 1 with N288.1 2014.</p> <p>Updated CVC to indicate that PLNGS implemented CSA N288.4-10.</p> <p>Changed CSA N288.5 to implemented and moved to CVC from guidance.</p>
9.1	CVC	<p>Removed the first paragraph as this is a duplicate with the paragraph found directly below. Wording changed for clarity.</p>
9.1	CVC	<p>Document changed from SI-01365-L20, <i>Online Monitoring and Control of Liquid and Airborne Effluents</i> to SDP-01368-P077, <i>Monitor and Control Effluents</i>. No prior notification is required in this document.</p>
9.1	CVC	<p>Updated values in Attachment 3: LCH Section 9.1 Table: Derived Release Limits. This Table was reviewed and accepted by CNSC. Removed the text stating the next review of the DRLs as this has occurred and was completed.</p>



LC(s)	Sub-section	Change
9.1	Guidance	<p>Remove N288.1 from Guidance and moved to CVC.</p> <p>Removed 288.2 and 288.3.4 from Guidance.</p> <p>Changed N288.5 from 2017-09-30 to implemented and moved to CVC from guidance.</p> <p>N288.6 and N288.7 implementation plans received by dates which were included in the LCH. The plan has now been received and the dates changed to reflect implementation date of the plan.</p>
10.1	Preamble	Removed paragraph about Pandemic Response Plan and Business Continuity. The pandemic response plan does not belong in this section, however remains in Section 1.1.
10.1	CVC	NBP has now implemented REGDOC 2.10.1. Moved REGDOC to CVC and removed RD-353 and G-225 as these were superseded by REGDOC 2.10.1. Wording changed to reflect the new document.
10.1	CVC	Referenced document PRR-00660-SU12 should be SU5.
10.1	CVC	Modified the requirement on conducting Emergency Exercises and Drills, on there is no requirement to conduct drills/exercises <u>annually</u> with these facilities.
10.1	Guidance	REGDOC 2.10.1 version 2 (2016) added in the table for guidance. REGDOC 2.10.1 Version 2014 has been implemented and therefore has been moved from Guidance to CVC.
10.2	CVC	Added a reference which outlines the three year cycle for the fire protection program audit.
10.2	CVC	<p>Remove superseded documents 0087-71400-FIRE-001-FHA-A-01, <i>Fire Hazard Assessment</i> and 0087-71400-FIRE-001-FSSA-A-01, <i>Fire Safe Shutdown Analysis</i> and replace with 0087-714-3000-001-FHA-A-00, <i>Fire Hazard Assessment for Point Lepreau Generating Station</i> and 0087-71400-3000-001-FSSA-A-00, <i>Fire Safe Shutdown Analysis for the Point Lepreau Nuclear Generating Station</i> in the Licence Application Documents that Require Notification of Change table.</p> <p>Also, CCR removed reference to the revision number as the link is more accurate and is updated as required.</p>
11.1	CVC	CSA N292.0 and N292.3-18 have been implemented. Changed from Guidance to CVC.
11.1	Guidance	Updated the guidance documents to indicate that PLGS is compliant with N292.2 (2013 Update 1).
11.2	CVC	Update to indicate that the implementation of N294-09 & Update 1 is complete. Changed from Guidance to CVC.
12.1	CVC	Updated the current title of N290.7, and its implementation date from 2019-12-31 to 2020-03-31.

LC(s)	Sub-section	Change
12.1	CVC	Updated the cyber security program text to ensure that all elements proposed in the new statement are well defined in cyber security. The proposed text better identifies the cyber security requirements. Furthermore, the cyber security text should not be referring to NBP's cyber security program elements.
12.1	CVC	Updated licensee's document titles to the revised document names.
12.1	Guidance	Updated document title to the revised document name for the CSA N290.7 listed in the CVC table.  Added IAEA Nuclear Security Series No. 33.  Changed REGDOC 2.12.3 to implemented.
13.1	CVC	REGDOC 2.13.1 included in CVC, as it replaces RD 336/GD 336. Also all text referring to RD 336 is replaced by REGDOC 2.13.1 reference. Full implementation completed by NBP.
13.1	CVC	The text regarding CNSC's NMAR system becoming available was added to the CVC section to clarify what to do in such instances.
13.1	CVC	REGDOC 2.13.1 replaces RD 336/GD 336 therefore all text referring to RD 336/GD 336 is replaced by REGDOC 2.13.1 reference.
13.1	Guidance	As REGDOC 2.13.2 has been placed as CVC and replaced RD 336/GD 336.
14.1	Preamble	Added clarification text to the Preamble in order to be consistent with other NPP LCHs.
14.1	CVC	Added text to the CVC in order to be consistent with other NPP LCHs.
15.1	CVC	Updated the written notification table with the current relevant licensee's documents.
15.2	Preamble	Removed unnecessary text related to refurbishment, as refurbishment was completed in 2012, as this statement is no longer necessary.
15.2	CVC	Added the Safety Report for the Solid Radioactive Waste Management Facility, as prior written notification document listed in Section 15.1 of the LCH.
15.3	CVC	For clarity purposes, rewording as the design requirements are not retroactive except where specific hazards exist. Design requirements already approved prior to CSA N393-13 do not have to be retroactive except where specific hazards exist. However, every modification or changes to design or existing buildings is required to meet the requirements of the CSA.
15.3	Guidance	As the implementation plan has been received, table modified to include the implementation date, in accordance with NBP plan.
16.4	CVC	Reference to section 16.1 was corrected.
Appendix B		Updated definitions in Appendix for additional clarity.



LC(s)	Sub-section	Change
Appendix B		Appendix B has been completely updated to refer to REGDOC 3.6 for all definitions of terms which can be found in it. The remaining definitions in this section have been updated for clarification purposes.
Appendices C to F		Appendices C, D, E and F update to reflect all changes proposed in the above CVC, Guidance, Licensee, Regulatory Documents, Standards and Other.

### Revisions to LCH for Gentilly-2

On February 25, 2019, CNSC staff made a number of changes to clarify recommendations, guidance and the compliance verification criteria in various sections to include a new or revised CNSC regulatory documents and CSA Group standards (these developments are described in this report and are aligned with the Commission decisions) and licensee documents.

The table below summarizes the changes made in revision R001:

LC(s)	Sub-section	Change
G.4	Preamble	At the time of the licence renewal, discussions were still ongoing with Hydro-Québec regarding the Financial Guarantee. Since then Hydro-Québec has opted for a deferred decommissioning (dormancy of several years). Changes to the Financial Guarantee have been made to reflect the context of the plant's closure and to clarify that the costs of disposal of the spent fuel are included in the Financial Guarantee. These changes were approved by the Commission in the summer of 2017.
G.4	Preamble	Added reference to decision report - CMD 17-H107 - Financial guarantee for future decommissioning of Gentilly-2 located in Bécancour, Quebec
3.1.1	Guidance	THE REGDOC 2.1.2 - <i>Safety Culture</i> was published by the CNSC in April 2018. Added to the Recommendations and Guidance section that REGDOC 2.1.2 sets out the rules for a healthy safety culture and the guidelines for conducting those assessments. Hydro-Québec Will Have to Submit a Implementation Plan for REGDOC 2.1.2 for September 30, 2019
3.2.1	Preamble	Specify in the preamble additional standards criteria that include requirements for human performance. CSA Standard N286-12 Section 4.2 - Safety Culture also includes human performance requirements.
3.2.1	CVC	Introduction of REGDOC 2.2.4 <i>Work ability: Managing Worker Fatigue and Work Ability ( Vol. II): Managing Alcohol and Drug Use, Version 2</i> Also, Added a date (July 1, 2019) at which Hydro-Québec should comply with REGDOC's Vol. II 2.2.4

LC(s)	Sub-section	Change
3.2.1	CVC	Added CVC for REGDOC-2.2.4. <i>Vol. I, Managing Worker Fatigue</i> , so that Hydro-Québec submits annual information to the CNSC regarding discrepancies in REGDOC 2.2.4 Vol. 1 "Managing Worker Fatigue" and occurrences of these discrepancies. And added a date (July 1, 2019) to which Hydro-Québec should comply with REGDOC's Vol. I 2.2.4
3.2.2	CVC	Change to the text made to reflect that there is no longer an Industrial Fire Brigade (BII) present on the site continuously. Hydro-Québec has now signed an agreement with the Safety and Fire Department of the Municipality of Becancour
3.2.2	CVC	Added text to indicate that the transition plan to maintenance autonomy has been completed and that the recall process has been validated and is satisfactory to the CNSC
3.2.3	CVC	Training Program: Added "A worker is defined by the same Regulations as a person who performs a job mentioned in a permit. This includes the licensee's employees, contractors and temporary employees. »
3.2.3	CVC	Added the requirement to implement and maintain training programs for workers according to REGDOC 2.2.2, Staff Training, which sets out requirements and guidelines for the development and implementation of a training system.
3.2.3	CVC	Withdrawal of the requirement to conduct a gap analysis and transition plan for REGDOC 2.2.2 this has been verified and confirmed
3.4.1	CVC	Added a subsection on severe accidents as required by REGDOC 2.4.1 to the compliance verification criteria. For accidents HORS DIMENSIONMENT. The aim is to demonstrate that the available preventive measures are able to mitigate the consequences of the severe accident. This recommendation applies primarily to the Fuel Pool.  Hydro-Québec and the Quebec government abandoned PMUNE in 2016. This plan covered the distribution of Iodine tablets and also the management of the evacuation of the surrounding population in the event of a serious accident at the plant. The PMUNE has been abandoned because from now on, the consequences of the most severe accident will not be exceeded the exclusion zone of the site. In addition, the amount of fuel in the pool is greatly reduced and constantly decreases as well as its thermal load. In this context accidents that would be out of sizing at the pool are unlikely.
3.5.1	CVC	CSA N290.12-14, Human factors in the design of nuclear power plants was published in 2015 and included in the compliance verification criteria.
3.9.1	CVC	To better reflect: the current state of the facilities, recent changes to the liquid effluent system and the activities that are now being

LC(s)	Sub-section	Change
		conducted The "Derived Operational Limits" (LOD) have been changed. The table on Page 66 (LOD) and page 67 reflect what was reviewed by CNSC staff.
3.9.1	CVC	For the control and release of hazardous materials the small table of materials to be brought back has been modified to remove SO <sub>2</sub> , SO <sub>2</sub> SO <sub>2</sub> ammonia, Hydrazine and Chlorine. These substances are almost no longer produced or are no longer used at Gentilly-2 facilities.
3.9.1	CVC	The table describing the thresholds for intervention has been modified because the values come directly from the new LOD values.
3.10.2	CVC	A mention is made to explain that since January 1, 2018 there is no more industrial fire brigade (BII) on the site but that an agreement with the Municipality of Becancour is in place to avail itself of the services of the BII of the Becancour Fire and Safety Service (SSIB)
3.10.2	CVC	Added text to indicate that the plant condition inspection and fire protection program audit must be submitted to the CNSC for review. The condition inspection of the plant is carried out by a qualified third party and the audit of the fire protection program must be submitted to the CNSC for review.
3.10.2	CVC	Additional Compliance Audit Criteria have been incorporated so that CNSC staff can verify Hydro-Québec's compliance as a new agreement with the Municipality of Bécancour regarding the (BII) Hydro-Québec must: - Organize two joint annual exercises with the SSIB - Organize at least two familiarization visits
3.11.1	CVC	Withdrawal of requirements to produce the transition plan to N292.0-14 are withdrawn. The transition plan to CSA N292.0-14 was accepted. HQ meets CSA N292.0-14 General Principles for the Management of Radioactive Waste and Spent Fuel.
3.11.2	CVC	Added reference to decision report - CMD 17-H107 - Guarantee
3.12.1	CVC	Withdrawal of RD-321 and RD-361 documents as they are replaced by REGDOC 2.12.1 Volume II.
3.13.1	Preamble	Reference additions and a redesign of the "Preamble" section to the C.P. Guarantee Programs.
3.13.1	CVC	Some minor editorial changes. The titles of the personnel authorized to give consent were refused because the organization at Hydro-Québec will be much smaller and there is a risk that regulatory knowledge will be diluted. We prefer to be more precise
3.14.1	Preamble & CVC	A redesign of the preamble section and Compliance Verification Criteria