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Annual Report

Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2017

Public Meeting

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Rapport annuel

Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada : 2017

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Summary

This CMD presents the report, *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2017*

- Through compliance verification inspections, reviews and assessments, CNSC staff concluded that the NPPs and WMFs operated safely during 2017. 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 conclusion of safe operation:
  - 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 very low
  - No radiological releases to the environment exceeded the regulatory limits
  - Licensees met applicable requirements related to Canada's international obligations
  - No events above level 0 on the International Nuclear and Radiological Event Scale (INES) reported to the International Atomic Energy Agency

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

Résumé

Ce CMD présente *Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada : 2017*

- En se basant sur des inspections de vérification de la conformité, des examens et des évaluations, le personnel de la CCSN a conclu que les centrales nucléaires et les installations de gestion des déchets ont été exploitées de manière sûre en 2017. 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 la conclusion d'exploitation sûre :
  - 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 sont demeurées très 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
  - Aucun événement de niveau supérieur à 0 sur l'échelle internationale des événements nucléaires (INES) n'a été signalé à l'Agence internationale de l'énergie atomique

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

The following items are attached:

- *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2017*

Les pièces suivantes sont jointes :

- *Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada : 2017*

Signed/signé le

6 September 2018

Gerry Frappier, P. Eng.

Director General

Directorate of Power Reactor Regulation

Directeur général

Direction de la réglementation des centrales nucléaires

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Director General

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Executive summary

This report describes the regulatory oversight and safety performance of nuclear power plants (NPPs) and adjacent waste management facilities (WMFs) in Canada in 2017. For certain topics, updates on developments in 2018 are also described. This is the first CNSC regulatory oversight report to cover both NPPs and WMFs. The WMFs and the NPP at Gentilly-2 were not covered by a regulatory oversight report for 2016.

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

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

The CNSC's substantial regulatory effort for NPPs and WMFs in 2017 included activities related to licence renewals for NPPs and WMFs and compliance verification activities such as inspections, desktop reviews, and surveillance and monitoring. The licensing decisions and compliance activities identified follow-up activities, findings, and corrective actions that CNSC staff monitored during 2017. CNSC staff continues to follow up on those developments and corrective actions that were not concluded by the end of 2017.

The licensing and compliance activities were conducted in the context of robust regulatory requirements. The requirements include those found in CNSC regulatory documents and CSA Group standards, which continued to evolve in 2017 as both organizations published new and revised documents. NPP and WMF licensees were in the process of implementing various new requirements in 2017, and CNSC staff were satisfied with the overall progress.

CNSC staff concluded that the NPPs and WMFs operated safely in 2017. 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. No events

above Level 0 on the International Nuclear and Radiological Event Scale were reported to the International Atomic Energy Agency.

- 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 below the regulatory limits. The annual average effective radiation dose to workers at NPPs and WMFs remained low in 2017.
- The frequency and severity of non-radiological injuries to workers were very 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 of the SCAs for the NPPs and WMFs are summarized in the ratings in the following tables. Separate ratings are provided for Bruce A and Bruce B – although they are governed by the same licence and share programs, there are differences in the implementation of those programs between the two stations that warrant separate assessments. The rating categories used by CNSC staff in these assessments are:

FS fully satisfactory

SA satisfactory

BE below expectations

UA unacceptable

Canadian NPP safety performance ratings for 2017

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

Canadian WMF safety performance ratings for 2017

Safety and control area	DWMF	PWMF	WWMF
Management system	**SA**	**SA**	**SA**
Human performance management	**SA**	**SA**	**SA**
Operating performance	**FS**	**FS**	**FS**
Safety analysis	**FS**	**FS**	**FS**
Physical design	**SA**	**SA**	**SA**
Fitness for service	**SA**	**SA**	**SA**
Radiation protection	**SA**	**SA**	**SA**
Conventional health and safety	**FS**	**FS**	**FS**
Environmental protection	**SA**	**SA**	**SA**
Emergency management and fire protection	**SA**	**SA**	**SA**
Waste management	**SA**	**SA**	**SA**
Security	**SA**	**SA**	**SA**
Safeguards and non-proliferation	**SA**	**SA**	**SA**
Packaging and transport	**SA**	**SA**	**SA**
Overall rating	**SA**	**SA**	**SA**

Regulatory Oversight Report for Nuclear Power Generating Sites: 2017

1 Introduction

1.1 About this regulatory oversight report

The *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2017* provides Canadian Nuclear Safety Commission (CNSC) staff's assessment of the overall safety performance of Canadian nuclear power plants (NPPs) and the adjacent waste management facilities (WMFs) for 2017.

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

Section 2 of the report 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. It also contains general assessments of all licensees as a whole in the area of security, since the information presented in Section 3 for individual sites is limited.

Section 3 contains the individual assessments for each facility or site. In some cases, the NPP and WMF on the same site are licensed separately and those subsections contain separate assessments of the NPP and WMF. This report uses headers to distinguish the information and assessments related to the two facilities. In other cases, the NPP and WMF on the same site are licensed together and so are assessed together. The safety assessments of the NPPs and WMFs are described in more detail in Section 1.4.6.

Sections 2 and 3 are organized according to the CNSC safety and control area (SCA) framework. The SCA framework includes 14 SCAs, which are grouped into three functional areas, and one additional area, as shown in Table 1.

Table 1: List of SCAs

Functional Area	SCA	#
Management	Management system	1
	Human performance management	2
	Operating performance	3
Facilities and equipment	Safety analysis	4
	Physical design	5
	Fitness for service	6
Core control processes	Radiation protection	7
	Conventional health and safety	8
	Environmental protection	9
	Emergency management and fire protection	10
	Waste management	11
	Security	12
	Safeguards and non-proliferation	13
	Packaging and transport	14
Other matters of regulatory interest		15

The safety assessments in this regulatory oversight report are in the context of the licensing basis for each facility. The licensing basis is unique for each licensed facility, so statements related to compliance are in terms of "the applicable regulatory requirements" for the specific facility. The licensing basis is described in Section 1.4.1.

The conclusions of this report are provided in Section 4.

This report includes a list of references, a glossary, and a list of the CNSC inspection reports that form the basis of many of the observations and conclusions in this report. In addition to the terms that are explained in the glossary, the reader should note the use of the terms "Indigenous peoples", "public," and "general public." "Indigenous peoples" include First Nation, Métis and Inuit communities. "General public" is meant to include all people and comprises two groups - "Indigenous peoples" and the "public" – each having distinct rights and interests.

1.2 Scope

The scope of the *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2017* is significantly different than that of the *Regulatory Oversight Report for Canadian Nuclear Power Plants: 2016 [1]*. That report only covered NPPs that were operating in Canada in 2016; information on Gentilly-2 was not included as it had been permanently shut-down in 2012. Safety assessments of Gentilly-2 are included in this regulatory oversight report, since its status and regulatory oversight is similar to that of the WMFs covered in the report. General statements in

the report that refer to "NPPs" are intended to apply to Gentilly-2, whereas the phrase "operating NPPs" is used for statements that do not apply to Gentilly-2.

As above, safety assessments of WMFs licensed separately from the NPPs but located at the same sites are also included in this regulatory oversight report. Although those WMFs had been covered in separate regulatory oversight reports in the past, there was no regulatory oversight report for WMFs in 2016. However, the 2016 safety assessment of the PWMF and the WWMF were presented to the Commission at public hearings in April 2017.

Generally speaking, the information provided in this regulatory oversight report is pertinent to 2017, and the status that is described is valid as of December 2017. Since Gentilly-2 and the WMFs were not covered by a regulatory oversight report for 2016, the descriptions for those facilities may contain more background information than those for the operating NPPs.

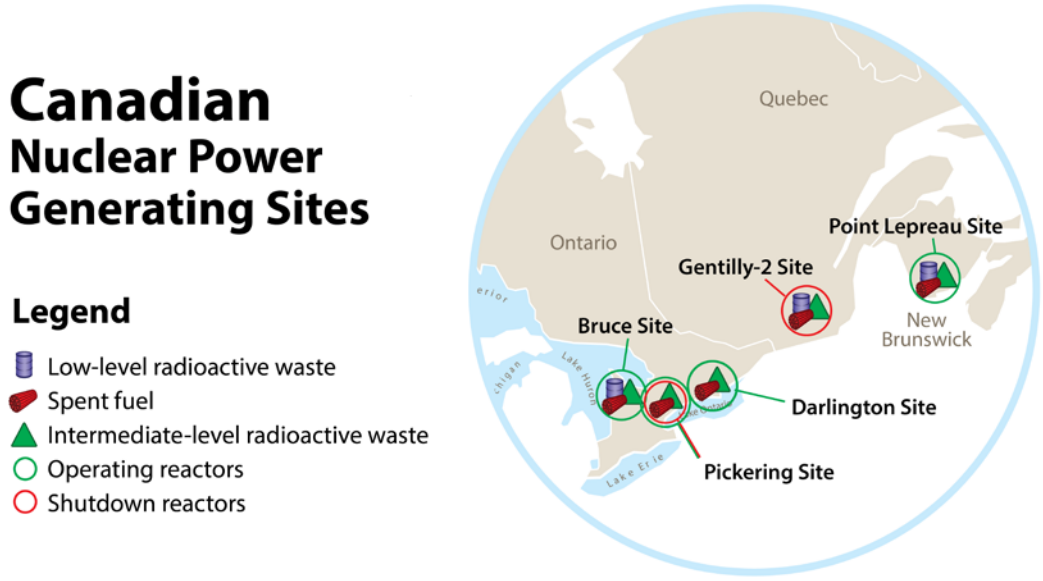
The word "UPDATE" is used in the report to identify topics where more recent information (up to June 1, 2018) is included (e.g., descriptions of significant events or updates that were specifically requested by the Commission).

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 listed at the beginning of each SCA section in Section 2 as well as Appendix A:. 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

NPPs and WMFs are considered Class I facilities and are subject to the *Class I Nuclear Facilities Regulations*. 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 for Nuclear Power Generating Sites in Canada



1.3.1 Nuclear power generating Sites in Canada

The Darlington site is located in Clarington, ON and consists of the Darlington Nuclear Generating Station (DNGS) and the Darlington Waste Management Facility (DWMF). The DNGS and DWMF are licenced separately. See Section 3.1 for details.

The Pickering site is located in Pickering, ON and consists of the Pickering Nuclear Generating Station (PNGS) and the Pickering Waste Management Facility (PWMF). The PNGS and PWMF are licenced separately. See Section 3.2 for details.

The Point Lepreau site is located on the Lepreau Peninsula, NB and consists of the Point Lepreau Nuclear Generating Station (NGS) and the Solid Radioactive Waste Management Facility (SRWMF). The Point Lepreau NGS and SRWMF are licenced together. See Section 3.3 for details.

The Bruce site is located in Tiverton, ON and consists of the Bruce A and B NPPs, OPG's Western Waste Management Facility (WWMF) and Radioactive Waste Operations Site-1 (RWOS-1), the Central Laundry and Maintenance Facility (CLMF), and Canadian Nuclear Laboratory's (CNL) Douglas Point Waste Facility (WF). The Bruce A and B NPPs and the CLMF are licenced together. The WWMF, RWOS-1, and Douglas Point WF are all licenced separately. See Sections 3.4 and 3.5 for details. Note that the Douglas Point WF is not covered in this report, but rather in the *Progress Update for CNL's Prototype Waste Facilities, Whiteshell Laboratories and the Port Hope Area Initiative* (CMD 18-M30 [2] for the 2017 update).

The Gentilly nuclear site is located in Bécancour, QC and consists of CNL's Gentilly-1 WF and Hydro-Québec's Gentilly-2 Facilities. The Gentilly-1 and Gentilly-2 Facilities are licenced separately. See Section 3.6 for details. Note that the Gentilly-1 WF is not covered in this report, but rather in the *Progress Update for CNL's Prototype Waste Facilities, Whiteshell Laboratories and the Port Hope Area Initiative* (CMD 18-M30 [2] for the 2017 update).

1.3.2 NPPs

NPPs are considered Class IA nuclear facilities, as defined in the *Class I Nuclear Facilities Regulations*.

Operating NPPs

Nineteen reactors continued to operate in Canada throughout 2017, unchanged from the previous year's end. They are located in four NPPs, 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.

Table 2 provides data for each operating NPP, including the generating capacity of the reactor units, their initial start-up dates, the name of the licensee, and the expiry date of the power reactor operating licence. Additional information on the NPPs and licences is provided in Section 3.

Table 2: Basic information for operating NPPs

NPP	Licensee	Location	State of reactor units	Gross capacity per unit (MWe)	Startup[1]	Licence expiry
Bruce A[2]	Bruce Power Inc.	Tiverton, ON	Four operating	831	1977	May 31, 2020
Bruce B[2]	Bruce Power Inc.	Tiverton, ON	Four operating	872	1984	May 31, 2020
DNGS	Ontario Power Generation Inc.	Clarington, ON	Four operating (including one undergoing refurbishment)	935	1990	November 30, 2025
PNGS	Ontario Power Generation Inc.	Pickering, ON	Six operating, two defueled and in safe storage	Units 1, 4: 542 Units 5–8: 540	Units 1, 4: 1971 Units 5–8: 1982	August 31, 2018
Point Lepreau	New Brunswick Power Corp.	Lepreau, NB	One operating	705	1982	June 30, 2022

[1] For the multi-unit NPPs, this indicates the startup of the first reactor unit.

[2] Bruce A and Bruce B are licenced as one multi-unit NPP consisting of eight operating reactor units.

Non-operating reactor and NPP

PNGS also includes Units 2 and 3, which remain defueled and in safe storage. They are governed by the same power reactor operating licence as the six operating units.

In addition, the NPP at Gentilly-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 build

In 2012, the Commission issued a nuclear power reactor site preparation licence (PRSL) to OPG for the new nuclear project at the Darlington site for a period of 10 years. The PRSL requires OPG to continue follow-up work on the environmental assessments (EA) conducted in conjunction with the licence application. OPG carried out work in 2017 in the following areas:

- bank swallow monitoring and mitigation;
- support for CNSC activities to engage stakeholders in developing policy for land use around nuclear generating stations; and,
- development of a methodology that will help with siting of intake and diffuser structures in Lake Ontario.

See Appendix D: for a description of progress on these activities, as well as a description of anticipated work for 2018.

1.3.3 WMFs

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 Darlington, Pickering and

Western WMFs (DWMF, PWMF, and WWMF), which are considered Class IB nuclear facilities, as defined in the Class I Nuclear Facilities Regulations. They are owned and operated by OPG.

Table 3 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 (e.g., low-level waste (LLW), intermediate-level waste (ILW), 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 3.3 and 3.6, respectively.

Table 3: Basic information for WMFs

Facility	Licensee	Location	Operation start	Licence expiry	Manages
DWMF	OPG	Clarington, ON	2008	April 30, 2023	HLW from DNGS. ILW from DNGS refurbishment.
PWMF	OPG	Pickering, ON	1996	August 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 is the federal government body that regulates the use of nuclear energy and materials to protect health, safety, security and the environment; implements Canada's international commitments on the peaceful use of nuclear energy, and disseminates objective scientific, technical and regulatory information related to the above to the general public. The CNSC consults Indigenous peoples and ensures that all its licensing decisions uphold the honour of the Crown and considers potential or established Aboriginal or treaty rights. Licensees are responsible for operating their facilities safely and are required to implement programs that make adequate provisions for meeting legislative and regulatory requirements.

The CNSC regulates the nuclear sector in Canada, including NPPs and WMFs, through licensing, reporting, compliance verification, and enforcement. For each NPP and WMF, CNSC staff perform inspections, surveillances and monitoring, and desktop reviews.

The CNSC uses a risk-informed regulatory approach, applying resources and regulatory oversight commensurate with the risk associated with the regulated facility and activity.

The CNSC's regulatory programs for NPPs and WMFs involve the direct efforts of approximately 400 CNSC staff, which includes support from other members of the organization; approximately 44% of the CNSC workforce. CNSC inspectors and other subject matter experts travel to NPPs and WMFs to conduct inspections and other regulatory activities (described further in section 1.4.4). At operating NPPs, the regulatory program also includes approximately 37 CNSC inspectors permanently located at those sites, who also monitor safety performance and provide regulatory oversight from site offices.

1.4.1 CNSC Requirements

The licensing basis is defined in the CNSC information document titled *Licensing Basis Objective and Definition* [3]. It comprises 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 licences for NPPs and WMFs have a requirement for the licensee to operate in accordance with the licensing basis. The requirements in parts (ii) and (iii) of the licensing basis are unique to each licensed facility – they depend on the content of licence applications and the applicant's supporting documentation. CNSC regulations, including the *Class I Nuclear Facilities Regulations,* provide requirements on the content of licence applications for NPPs and WMFs. In 2017, the CNSC published REGDOC-1.1.3, *Licence Application Guide: Licence to operate a Nuclear Power Plant* to elaborate on the application requirements for operating NPPs. CNSC staff also provide additional, tailored guidance for licensees intending to renew their licences for NPPs and WMFs.

Licence applications for NPPs and WMFs cite CNSC REGDOCs, 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, described further in section 1.4.2) to identify the specific requirements that apply to that licence. Appendix E: lists all CNSC REGDOCs 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.

Appendix E: illustrates the large number of CNSC REGDOCs and CSA Group standards that provide requirements relevant to all SCAs. The table indicates the similarities and differences in the CNSC REGDOCs and CSA Group standards that apply to NPPs and WMFs, and it indicates certain differences in publications that apply to operating NPPs versus Gentilly-2. It also indicates the significant number of newer CNSC REGDOCs and CSA Group standards that are being implemented by the licensees. Details about the implementation of these publications are provided under the relevant SCAs throughout this regulatory oversight report. Each licensee implements new CNSC REGDOCs 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 there are differences that exist in applicable requirements between similar facilities at any given time, the requirements nevertheless are robust and comprehensive, and improved requirements are implemented in a measured and systematic way.

1.4.2 Licensing

The CNSC licensing process for NPPs and WMFs is comprehensive and covers all the SCA.

The CNSC assesses licence applications to ensure that the proposed safety measures are technically and scientifically sound, that all application requirements are met, and that the appropriate safety systems will be in place to protect people and the environment. The CNSC assesses the adequacy of the proposed measures against the requirements in the regulations and any guidance that has been provided to the applicant and which would be expected to become part of the licensing basis if the licence is granted.

The licensing process offers significant opportunities for participation of the public and Indigenous peoples, including in Commission hearings, which are often held in the community, and Commission meetings. All Commission proceedings are open to the general public and webcast live.

Each of the operating NPPs and WMFs described in this report has been granted a licence by the Commission. The typical period for a waste facility operating licence and a power reactor operating licence has been 10 years and 5 years, respectively. The CNSC is transitioning to longer licence periods for power reactor operating licences. For operating NPPs, this longer licence is issued in conjunction with the implementation of a comprehensive 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. CNSC regulatory document REGDOC-2.3.3, Periodic Safety Reviews sets out the regulatory requirements for PSR implementation. As outlined in REGDOC-2.3.3, a PSR involves an assessment of the current state of the plant and plant performance to determine the extent to which the plant 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). PSR is not a requirement for Gentilly-2 or the WMFs because the associated hazards and requirements change relatively slowly, such that the regular licensing process and implementation of REGDOCs 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.

In 2016, the Commission granted Gentilly-2 a licence to decommission a power reactor for a period of ten years.

Amendments to the licences covered by this regulatory oversight report are described in Appendix F:.

The NPP and WMF licences are relatively similar and contain standardized licence conditions that are organized according to the SCAs. For example, under the radiation protection SCA, the licences have a condition that requires the licensee to implement and maintain a radiation protection program. The detailed compliance verification criteria for the radiation protection program are found in the licence conditions handbook (LCH) for the facility, which is written by CNSC staff. The LCHs are consistent with the licensing basis (described above) for the facility and establish the basis for the compliance verification program during the licence period.

All NPPs and WMFs covered by this report had LCHs by the end of 2017, with the exception of the PWMF (which was issued its first LCH in June 2018.)

When licensees implement new CNSC REGDOCs and CSA Group standards, the implementation plans are typically recorded in the LCH (e.g., the LCH will indicate the date when CNSC staff will begin assessing compliance with the new or revised requirements).

In 2017, CNSC staff continued to standardize LCHs for NPPs and WMFs. This involves the gradual adoption or adaption of templates, generic text, and common guidance for writing and revising LCHs that apply to all CNSC licences that have LCHs. Revisions to the LCHs relevant to this report are summarized in Appendix F:.

Fisheries Act Authorizations

In addition to CNSC licences, this regulatory oversight report also describes developments related to *Fisheries Act* authorizations, such as the preparation of applications and resulting decisions by Fisheries and Oceans Canada. 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 CNSC regulations. LCHs clarify CNSC expectations for these requirements, if needed.

In addition to, and in conjunction with, the reporting requirements in the regulations, NPP licensees are required by a condition in their licences to report to the CNSC in accordance with 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, e.g., quarterly reports on the safety performance indicators that are illustrated in various parts of this report. REGDOC-3.1.1 also provides detailed requirements related to the submission of other important reports (e.g., updates to the final safety analysis report, proposed decommissioning plan, annual environmental protection report, and many others). REGDOC-3.1.1 also requires licensees to submit to the CNSC reports on any unplanned situations and events. These reports are posted by the licensees on their respective websites.

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

During 2017, NPP licensees reported to CNSC staff on 256 events, and submitted 90 scheduled reports. Three of these events were also presented to the Commission as event initial reports in 2017 –they are described in the relevant parts of Section 3 (along with two other event initial reports that were presented to the Commission in 2018). WMF licensees also submitted 13 reports to CNSC staff for reportable events under the *General Nuclear Safety and Control Regulations* that occurred at the DWMF, PWMF and WWMF. There were no event initial reports related to WMFs presented to the Commission in 2017. The NPP EIRs and WMF reportable events are discussed in Section 3. None of these events were above level 0 on the International Nuclear and Radiological Event Scale.

Note that 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, WMF licensees will report to the CNSC in accordance with REGDOC-3.1.2.

1.4.4 Compliance Program

The safety assessments presented in this report were based on the results of activities planned through the CNSC compliance verification program (CVP). In 2017, these activities included inspections supported by subject matter experts, desktop reviews by a wide range of technical specialists, and surveillance and monitoring conducted by CNSC inspectors. These activities were performed through an effective combination of document reviews, workplace observations, and worker interviews. All compliance verification activities were fully documented.

Tables 4, 5 and 6 show the CVP effort by CNSC staff for each NPP and WMF. There were approximately 16,000 person-days of effort by CNSC staff in conducting inspections, event reviews, and other compliance activities in 2017. This effort was comparable to 2016.

Table 4: Compliance activities for NPPs for 2017, person days

Compliance activities effort	Bruce A and B	DNGS	PNGS	Point Lepreau	Gentilly-2	Industry total
Inspections	1,716	1,422	1,764	981	98	5,981
Event reviews	184	120	130	70	8	512
Other activities*	2,970	2,160	2,602	1,466	139	9,339
Total effort	4,871	3,702	4,497	2517	245	15,832

Table 5: Number of Inspections for WMFs for 2017

	DWMF	PWMF	WWMF	Industry total
Inspections	3	3	3	9

Table 6: Compliance activities for WMFs for 2017, person days

Compliance activities effort	DWMF	PWMF	WWMF	Industry total
Event reviews	75	209	258	542
Other activities*	161	94	227	482
Total effort	236	303	485	1024

* Includes verification activities such as surveillance and monitoring and desktop reviews of licensee-submitted documents and reports (other than event reports)

The five-year trend in compliance activities is given in Appendix G:.

At its foundation, the CVP consists of a collection of compliance verification activities covering the 14 SCAs conducted with varying frequency over a rolling five-year period. This baseline is the minimum set of activities needed to systematically and comprehensively verify whether licensees are complying with the safety and control measures in their licensing bases. Inspections typically verify compliance with requirements across multiple specific areas and SCAs.

For each NPP, between 80 and 100 applicable compliance verification activities are selected from the baseline for the year's compliance plan.

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. The annual plans are then validated by CNSC technical specialists and licensing staff 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 CVP for NPPs includes reviews of safety performance indicators submitted quarterly to the CNSC in accordance with regulatory requirements. Data for some of the safety performance indicators that are submitted are

reproduced in this report. There are no regulatory limits or thresholds associated with these 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. Trends over time are relatively slow to develop, and the differences between licensees are relatively small, since licensees tend to have mature programs for the SCAs that are based on similar or identical requirements. Any unfavourable trend or comparison is followed by increased regulatory scrutiny, which can range from increased surveillance and monitoring, 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.

The goal is to ensure that the CVP for NPPs and WMFs are always timely, risk-informed, performance-based and responsive to developments.

During 2015–2016, the Commissioner of the Environment and Sustainable Development completed a performance audit of the CNSC's oversight of the nuclear sector looking at the April 2013 to March 2015 period. Details were provided in the *Regulatory Oversight Report for Canadian Nuclear Power Plants: 2016 [1]*. The CNSC implemented four of the audit's five recommendations by September 30, 2016. Work to address the final recommendation – to improve the documentation of the site inspection planning process on inspection planning – was completed by March 31, 2017 (hence its inclusion in this report).

1.4.5 Enforcement

The CNSC uses a graduated approach to enforcement to encourage and compel compliance, and deter future non-compliances.

When a non-compliance is identified, CNSC staff determine the appropriate enforcement action based on the safety significance and other factors such as whether the non-compliance is systemic or repeated. Each enforcement action is a discrete and independent response to a non-compliance.

Regulatory responses to non-compliances and enforcement measures include:

- informing licensees
- issuing written notices
- increasing regulatory scrutiny
- making requests under subsection 12(2) the *General Nuclear Safety and Control Regulations*
- issuing administrative monetary penalties
- issuing orders
- taking licensing actions
- decertifying persons or equipment
- prosecution

Enforcement actions may be applied independently or in combination with other actions.

Regulatory judgment is applied, and multiple factors are taken into account to determine the most appropriate enforcement strategy for any given situation. If the initial enforcement action does not result in timely compliance, other enforcement actions are used.

1.4.6 Safety assessment ratings

This report presents safety performance ratings for each SCA at each NPP and WMF. The ratings are based on findings generated during CVP activities. The findings are categorized into appropriate SCAs and specific areas and assessed against a set of CNSC-developed performance objectives and criteria for the SCAs.

Since the CVP consists of a rolling, typically five-year, cycle of regulatory activities, not all specific areas are directly evaluated through inspections or desktop reviews every year. In rating specific areas, CNSC staff relied on inspections conducted in previous years, supplemented by conclusions from other regulatory oversight conducted during 2017, such as review of actions stemming from previous inspections and other developments, monitoring and surveillance at site, and other interactions with the licensees.

The assessment presented in this report includes an overall rating for each NPP and WMF. It is a judgement of the overall safety performance at each facility. See B.2 for a comprehensive description of the CNSC NPP and WMF rating methodology.

In generating the performance ratings, CNSC staff considered 1547 findings for NPPs and WMFs. The vast majority of the findings (i.e., 99.9 percent) 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. The remainder (i.e., less than 0.1 percent) had a significant negative effect in the context of the assessment of a specific area. (These findings of medium safety significance are discussed in detail in Section 3 of this report.)

For the Bruce site, Bruce A and B are rated separately from 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 regulatory requirements. However, they are discussed together in the same site sub-section as they have commonalities (the same licensee). 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).

The SCA ratings for the NPPs and WMFs for 2016 are provided in B.3. There were no Gentilly-2 ratings from 2016 to compare with the 2017 ratings. The 2016 ratings for PWMF and WWMF were provided during their licence renewal proceedings in 2017. The 2016 ratings for DWMF were compiled “retroactively” as part of the preparation of this report. The 2017 SCA ratings for the NPPs and WMFs are provided in section 2 on an SCA basis and also in section 3 on a facility basis.

2 General and Supporting Information

This section provides general information, organized by SCA, that serves as background for the assessments in Section 3. It includes notes about the requirements for the assessments; detailed information about those requirements is provided in Appendix E:.

2.1 Management system

This SCA covers the framework that establishes the processes and programs required to ensure that an organization achieves its safety objectives, continuously monitors its performance against those objectives, and fosters a healthy safety culture.

Management system ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

Management system encompasses the following specific areas:

- management system
- organization
- change management
- safety culture
- configuration management
- records management
- management of contractors
- business continuity
- performance assessment, improvement and management review
- problem identification and operating experience

Management system

The following publications contain regulatory requirements that were relevant in 2017:

- CSA Group standard N286-05, *Management system requirements for nuclear power plants*
- CSA Group standard N286-12, *Management system requirements for nuclear facilities*

Details on their applicability and implementation are provided in Appendix E: and Section 3.

Licensee management systems encompass nuclear policy statements, descriptions of interfaces, and supporting documentation that control and maintain the programs and processes that comprise the management system. The CNSC's compliance verification activities gather objective evidence of the effectiveness of licensee management systems in accordance with regulatory requirements.

Organization

The organization of each licensee is defined in its management system documentation. Organizational structure, authorities, accountability, and responsibilities of positions are defined, including internal and external interfaces and how and by whom decisions are made. The CNSC's compliance verification activities verify that the organizational structures and roles and responsibilities are documented and current, in the context of the processes reviewed during inspections and other oversight.

Change management

Licensees have approved processes to control changes to their organization, documentation, processes, programs, designs, drawings, structures, systems, components, equipment, materials, and software. The processes ensure that changes are documented, justified, and reviewed by stakeholders to assess the potential impact on safety. The level of approval is commensurate to the impact and complexity of the change.

Safety culture

Licensees periodically conduct safety-culture self-assessments, which gather data through multiple methods; including surveys, interviews, and focus groups. Bruce Power, OPG, and NB Power have implemented safety-culture monitoring panels following the guidance provided by the Nuclear Energy Institute.

CNSC staff review licensee safety culture self-assessments and their results to confirm the adequacy of the licensees' follow-up actions to continually improve their safety culture.

Configuration management

Licensees' configuration management integrates management processes that ensure that the physical and operational configuration and documentation conform to the design and licensing basis requirements. These processes include the review of completion assurance prior to turnover of structures, systems and components (SSCs) to operation.

Records management

Records management systems ensure that only approved and current documents are issued and used; obsolete documents are withdrawn; records are produced and reviewed for acceptance; documents and records are available when they are needed; and, records are protected and retained in accordance with the applicable regulatory requirements. CNSC staff base their assessment of the licensees' implementation of the documents and records control processes through many regulatory activities involving a variety of SCAs.

Management of contractors

Licensees' management define, plan, and control the business in establishing safety objectives that achieve regulatory and licensee requirements. Achievement of those objectives is measured and monitored, and that extends to aspects of the business that are assigned to contractors.

CNSC staff assess licensees' implementation of the supply chain programs that qualify contractors, and manage contractual requirements and contractors' work.

Business Continuity

Licensees have measures to continue achieving their safety and business objectives in the event of disabling circumstances. Those measures include contingency plans to maintain or restore critical

safety and business functions in the event of disabling circumstances.

Performance assessment, improvement and management review

Licensees continually assess and improve their management system. Senior management confirms the effectiveness of the management system in controlling safe operation through annual reviews of performance monitoring. The inputs to these reviews include audit and self-assessment results; status of corrective actions; and key performance indicators used to maintain the control of their processes to operate safely. From these reviews, actions are taken to resolve identified weaknesses in the management system.

Problem identification and operating experience

Licensees have corrective action programs to identify and resolve problems and take into account operating experience. When problems arise, licensees take immediate action to limit the impact on their facilities. Problems are documented and reported to the appropriate levels of management to initiate the process of correcting their causes and to prevent recurrence of significant events. The timeframes for controlling deficiencies and completing corrective actions are established. For systemic or serious problems, licensees conduct root cause analyses. For lower safety significance problems, the direct and apparent causes are determined. Licensees perform analyses to identify trends.

Licensees also have an information gathering and review process to identify and evaluate relevant operating experience to improve and implement actions that prevent the occurrence of problems.

2.2 Human performance management

This SCA covers the activities that enable effective human performance through the development and implementation of processes that ensure licensees have sufficient personnel in all relevant job areas – and that these personnel have the necessary knowledge, skills, procedures and tools to safely carry out their duties.

Human performance management ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

Human performance management encompasses the following specific areas:

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

Human performance program

The human performance program is applied as a corporate requirement across the licensee organizations and implemented locally within the various departments, so it is applicable to both

the NPPs and WMFs. Licensees use a human performance program to minimize errors and to support workers in completing their tasks effectively and safely.

Personnel training

The licensees use training systems based on the principles of a systematic approach to training (SAT).

The following publication contains regulatory requirements for NPPs and WMFs that were relevant in 2017:

- CNSC REGDOC-2.2.2, *Personnel Training*

Details on its applicability and implementation are provided in Appendix E: and Section 3.

Personnel certification

This specific area applies to the NPPs but does not apply to the DWMF, PWMF, or WWMF because they have no certified personnel.

The following publication contains regulatory requirements that were relevant in 2017.

- CNSC RD-204, *Certification of Persons Working at Nuclear Power Plants*

Details on its applicability are provided in Appendix E: and Section 3.

To become a certified worker, a candidate must successfully complete the training program and certification examinations. The CNSC then certifies the candidates that meet the requirements of RD-204 and who have demonstrated their competence to safely perform the duties of the certified position. Once certified by the CNSC, certified workers undergo continuing training and requalification testing to ensure that they maintain the knowledge and skills to safely perform their duties.

CNSC requires NPP licensees to have certified shift supervisors, reactor operators and health physicists. Due to the design of Bruce A, Bruce B and DNGS, the CNSC requires these licensees to also have certified Unit 0 operators (U0O). The only certified persons working at Gentilly-2 are health physicists (in French called responsables techniques de radioprotection).

Table 7 shows the number of certified personnel that are available in the certified positions at each NPP, as of December 31, 2017. 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 7: Number of certifications per station and certified positions for 2017

Station	Reactor operator	Unit 0 operators[a]	Shift supervisor[b]	Health physicist	Total
Bruce A					
Actual	51	21	19	5[c]	96
Minimum	30	10	10	1	51
Bruce B					
Actual	58	26	17	5[c]	106
Minimum	30	10	10	1	51
DNGS					
Actual	58	18	30	3	109
Minimum	30	10	10	1	51
PNGS 1, 4					
Actual	36		16	4[d]	56
Minimum	20		10	1	31
PNGS 5–8					
Actual	60		19	4[d]	83
Minimum	30		10	1	41
Point Lepreau					
Actual	12		7	2	21
Minimum	6		6	1	13
Gentilly-2					
Actual [e]				3	3
Minimum [e]				1	1

Notes:

a. There are no Unit 0O positions at PNGS 1, 4, PNGS 5–8 or Point Lepreau.
b. At multi-unit stations, the shift supervisor number is the total of certified shift managers plus certified control room shift supervisors.
c. Five health physicists are certified for both Bruce A and Bruce B.
d. Four health physicists are certified for both PNGS 1, 4 and PNGS 5–8.
e. There are no Reactor Operator, U0O or Shift Supervisors at Gentilly-2. The corresponding cells are therefore left empty

Initial certification examinations and requalification tests

This specific area applies to the NPPs but does not apply to the DWMF, PWMF, or WWMF.

As part of the personnel certification program to become certified workers, candidates are required to complete initial certification examinations. Workers that are certified are required to complete requalification tests as part of the requirements to renew their certification. CNSC staff administer the initial certification examinations and requalification tests for health physicists while the licensees are responsible for the administration of the certification examinations and requalification tests for all other certified staff.

As noted above, health physicists are the only certified staff working at G-2. Since CNSC administers the initial examinations and requalification tests for them, this specific area does not apply to Gentilly-2.

The following publication contains regulatory requirements that were relevant in 2017.

- CNSC RD-204, *Certification of Persons Working at Nuclear Power Plants*

Details on its applicability are provided in Appendix E:.

Work organization and job design

Minimum shift complement

This specific area applies to the NPPs but does not apply to the DWMF, PWMF, or WWMF.

In accordance with the *General Nuclear Safety and Control Regulations*, licensees are required to ensure the presence of a sufficient number of qualified workers to safely carry out all licensed activities. Furthermore, NPP licensees must maintain a minimum shift complement (MSC) at all times in accordance with their PROLs. The MSC is specific to each NPP and is influenced by the design of the facility, operating and emergency procedures, and organizational functions. NPP licensees determine their respective MSC by systematic analysis, which CNSC staff reviews and accepts, and demonstrate their adequacy in integrated validation exercises. The analyses and validation reports become part of the licensing basis for each NPP.

CNSC requires NPP licensees to report minimum shift complement non-compliances to the CNSC in accordance with CNSC REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. A total of eight minimum shift complement non-compliances were reported by licensees in 2017. Of the eight events reported, four events were related to the availability and qualifications of full-time and voluntary fire fighters and emergency response personnel. Some of them are described in more detail in Section 3. The NPP licensees took appropriate actions to ensure safety was maintained including operation in "quiet mode" [1] and the call-in of additional personnel. CNSC staff did not identify any significant operations-related issues from the reports.

Fitness for duty

All NPP and WMF licensees have fitness for duty programs in place.

The following publications contain regulatory requirements that were relevant in 2017:

- CNSC RD-204, *Certification of Persons Working at Nuclear Power Plants*
- CNSC RD-363, *Nuclear Security Officer Medical, Physical, and Psychological Fitness*

Details on their applicability and implementation are provided in Appendix E: and Section 3.

CNSC REGDOC 2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use*, was published in November 2017. This document 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 were requested to provide implementation plans early in 2018. Details on its implementation are provided in section 3.

UPDATE: CNSC staff were reviewing the implementation plans in the first half of 2018.

[1] "Quiet mode" is a mode of operation that does not allow for any evolution that may disturb reactor operation.

Managing Worker Fatigue

All NPP licensees have procedures that specify facility requirements related to hours of work and processes for monitoring compliance with the hours of work limits. CNSC requires NPP licensees to report on a quarterly basis the non-compliances with hours of work limits for certified staff performing safety related tasks to the CNSC in accordance with REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. In the four quarterly reports submitted to the CNSC in 2017, NB Power reported no non-compliances with its hours of work procedure for certified staff, and OPG reported two for the DNGS and one for the PNGS. Bruce Power reported numerous instances when they did not comply with the station's hours of work procedure for certified staff. These non-compliances are addressed in Section 3.4.2.

There were no non-compliances to provincial hours of work limits at the OPG WMFs in 2017.

To ensure regulatory clarity and consistency in this area, the Commission approved REGDOC 2.2.4, *Fitness for Duty Volume I: Managing Worker Fatigue* for publication in March 2017. Implementation plans and timelines for the licensees of NPPs and WMFs have been submitted to the CNSC. Details on its implementation are provided in section 3.

2.3 Operating performance

This SCA includes an overall review of the conduct of licensed activities and the activities that enable effective operating performance.

CNSC staff evaluate licensees' operating performance by conducting various compliance verification activities, including: reviewing quarterly operational reports; reviewing the reports and follow-up actions associated with reportable events; conducting baseline and focused inspections; and, follow-up on licensee's responses to inspection findings.

Operating performance ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
FS	FS	FS	FS	SA	FS	FS	FS	SA

Operating performance encompasses the following specific areas:

- conduct of licensed activity
- procedures
- reporting and trending
- outage management performance
- safe operating envelope
- severe accident management and recovery
- accident management and recovery

Conduct of licensed activity

During onsite inspections, CNSC staff verify that safe work practices are being followed and review licensee record systems to confirm that corrective actions are identified and tracked.

Operating policies and principles for NPPs and WMFs set out specific requirements to meet the design basis of the facility for safe operation.

The CNSC requires operating NPP licensees to report serious process failures to the CNSC in accordance with CNSC REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. CNSC staff determined that there were no serious process failures at any of the NPPs. The CNSC also requires operating NPP licensees to report the performance indicator "number of unplanned transients" to the CNSC in accordance with REGDOC-3.1.1. This performance indicator shows the unplanned reactor power transients due to all sources, while the reactor was not in a Guaranteed Shutdown State (GSS). Unexpected reactor power reductions (or transients) can indicate problems within a plant and place unnecessary strain on its systems. Table 8 summarizes the number of unplanned reactor power transients at NPPs caused by stepbacks, setbacks, and reactor trips where the trip resulted in a reactor shutdown. Stepbacks and setbacks are gradual power changes intended to eliminate potential risks to plant operations.

In 2017, all unplanned transients were properly controlled and adequately managed by the reactor control systems. They are discussed further in Sections 3.1.3, 3.2.3, 3.3.3 and 3.4.3.

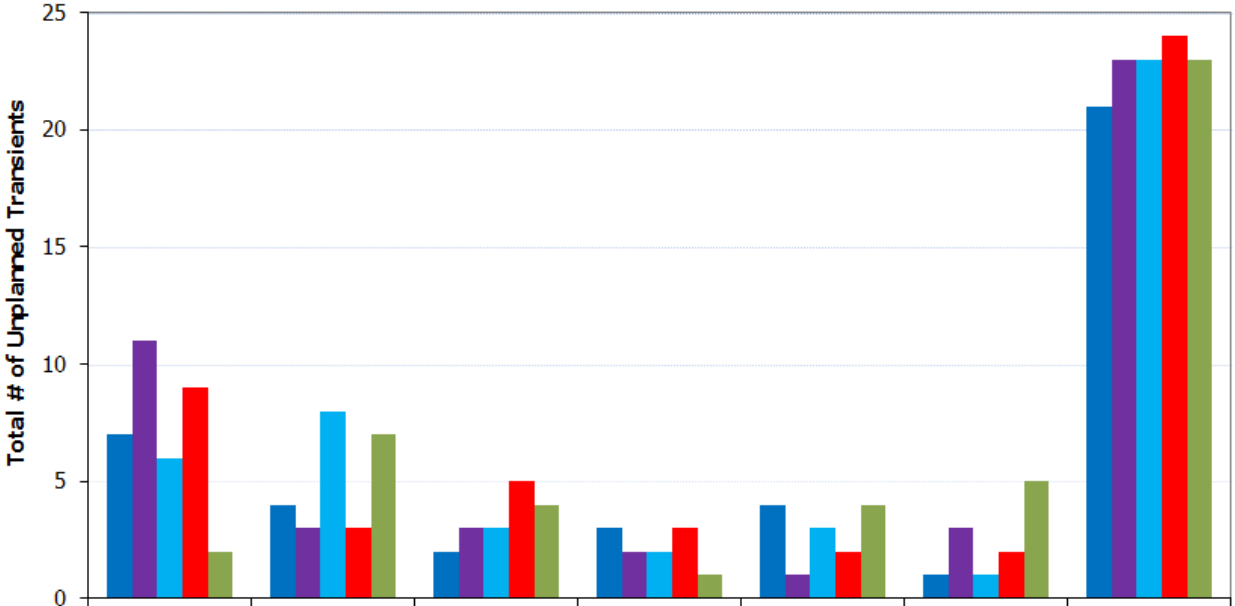
Table 8: Number of unplanned transients

NPP	Number of operating reactors	Number of hours of operation	Un-planned reactor trips[1]	Stepbacks	Setbacks	Total unplanned transients[2]	Number of trips per 7,000 operating hours[3]
Bruce A	4	32,965	2	0	0	2	0.42
Bruce B	4	30,871	0	1	6	7	0.00
DNGS	4	23,846	1	1	2	4	0.29
PNGS 1, 4	2	13,301	1	n/a [4]	0	1	0.53
PNGS 5–8	4	29,825	0	0	4	4	0.00
Point Lepreau	1	7,928	0	0	5	5 [5]	0.00
Industry total	19	138,736	4	2	17	23	0.20

Notes:
1 Automatic reactor trips only; does not include manual reactor trips or trips during commissioning testing.
2 Unplanned transients consist of unplanned reactor trips, stepbacks and setbacks.
3 Nuclear power industry performance target is less than 0.5 reactor trips per 7,000 operating hours.
4 Stepbacks are not implemented at PNGS 1, 4.
5 There were not five distinct events; see section 3.3.3.

Figure 2 shows the total number of unplanned transients from 2013 to 2017 for both individual operating NPPs and the operating NPPs as a whole. The number of unplanned transients in 2017 was comparable to previous years and was acceptable to CNSC staff.

Figure 2: Trend details for the number of unplanned transients for stations and industry, 2013–17



	Bruce A	Bruce B	DNGS	PNGS 1,4	PNGS 5-8	Point Lepreau	Industry Total
2013	7	4	2	3	4	1	21
2014	11	3	3	2	1	3	23
2015	6	8	3	2	3	1	23
2016	9	3	5	3	2	2	24
2017	2	7	4	1	4	5	23

Figure 3 compares the number of unplanned reactor trips for Canada's operating NPPs, per 7,000 hours of operation, to international nuclear power industry data published by the World Association of Nuclear Operators (WANO). Prior to 2016, WANO published actual data for the numbers of trips for all WANO members, shown in blue in Figure 3. The figure indicates that the Canadian NPPs consistently had fewer trips on average than WANO member reactors in that timeframe. In 2016, WANO discontinued the publication of actual numbers of unplanned trips. Instead, it began reporting the overall percentage of reactors that met the WANO targets. WANO targets for overall industry performance for specific reactor types include the following:

- 0.5 unplanned total scrams (equivalent to a CANDU reactor trip) per 7,000 hours critical for pressurized water reactors (also applies to boiling water reactors and light water cooled graphite-moderated reactors); and,
- 1.0 unplanned total scrams per 7,000 hours critical for pressurized heavy water reactors.

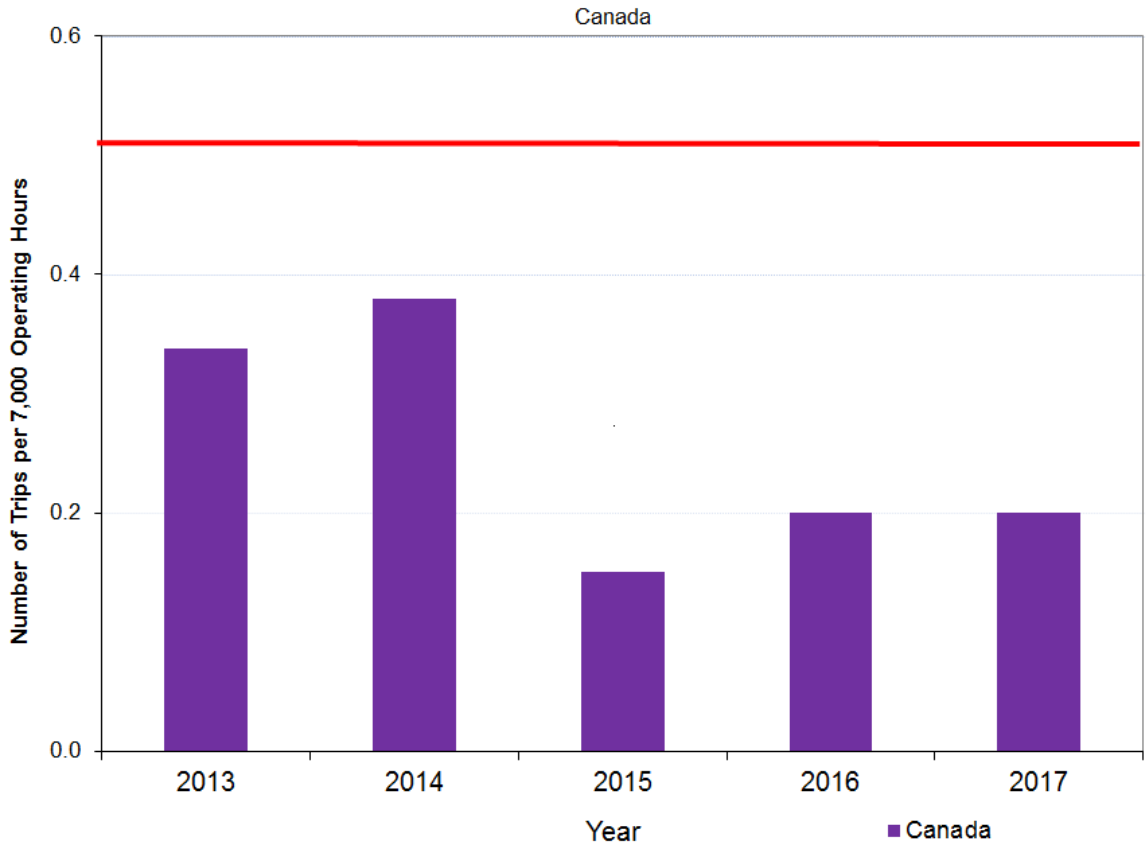
Although the WANO target for pressurized heavy water reactors is a more appropriate benchmark for the CANDU reactors at Canadian NPPs, Figure 3 superimposes a line at the more challenging target (0.5) for pressurized water reactors. To compare Canadian NPP performance with reactor performance world-wide, the following approximations were derived from representative data in the 2016 WANO performance indicator publication (the WANO data for 2017 is not yet available):

- Only 64% of pressurized water reactors worldwide met the WANO industry target of 0.5 unplanned total scrams per 7,000 critical hours; and,

- Only 58% of pressurized heavy water reactors worldwide met the WANO industry target of 1.0 unplanned total scrams per 7,000 critical hours.

Figure 3 indicates that Canadian NPPs collectively met those targets in both 2016 and 2017.

Figure 3: Trend details for the number of unplanned reactor trips per 7,000 operating hours, compared to WANO data, 2013–2017



Procedures

All NPPs and WMFs have defined processes in place to ensure that procedures are developed and changes are managed in a consistent manner to support the safe operation and maintenance of each facility.

Reporting and trending

Sections 29 and 30 of the *General Nuclear Safety and Control Regulations* outline specific scenarios under which a licensee must file a report to the CNSC. For every reportable event, the licensee must file a full 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, and actions that the licensee has taken or proposes to take with respect to the reportable event.

The following publications elaborate on the regulatory requirements for reporting for NPPs:

- CNSC REGDOC-3.1.1, *Reporting requirements for nuclear power plants*
- CNSC REGDOC-3.1.1, *Reporting requirements for nuclear power plants, Version 2*

Details on their applicability and implementation are provided in Appendix E: and Section 3.

REGDOC-3.1.1 expands on event reporting requirements and also specifies requirements for quarterly and annual reports to the CNSC. For example, it requires quarterly reports containing the safety performance indicator data that is provided in this regulatory oversight report. CNSC staff monitor safety performance indicators on a quarterly basis. CNSC staff found that licensees' reporting and trending met regulatory requirements in 2017.

Applicable regulations, such as the *General Nuclear Safety and Control Regulations*, and the WFOLs contain reporting requirements for the WMFs. For example, each WFOL contains a licence condition for reporting requirements that detail when the quarterly and annual reports shall be submitted to the CNSC and what shall be included in them.

CNSC staff follow up on all reportable events in a graded approach based on the risk significance of the event, including the corrective actions that are taken.

CNSC staff inform the Commission of significant reportable events through event initial reports or through regular status updates. The most significant events reported in 2017 related to the NPPs and WMFs are discussed in this report.

Outage management performance

This specific area applies to the operating NPPs but does not apply to the DWMF, PWMF, WWMF, or Gentilly-2.

CNSC staff conduct inspections during NPP outages to confirm regulatory requirements continue to be met and that work is executed safely. CNSC staff monitor the level of performance and achievement of objectives during planned maintenance outages. CNSC staff also confirm that forced outages and outage extensions are managed safely and in accordance with the applicable regulatory requirements. CNSC staff inform the Commission of unplanned outages resulting from reactor trips and their outcomes via Event Initial Reports (EIRs) and status reports on NPPs.

Safe operating envelope

This specific area applies to the operating NPPs but does not apply to the DWMF, PWMF, WWMF, or Gentilly-2.

The following publication contains regulatory requirements that were relevant to operating NPPs in 2017.

- CSA Group standard N290.15-10, *Requirements for the safe operating envelope of nuclear power plants*

The adherence of operating NPPs to their Safe Operating Envelopes (SOE) ensures that each reactor operates in an analyzed state, thereby ensuring adequate safety at all times.

Severe accident management and recovery

The licensees have established roles and responsibilities within their organizations to manage severe accidents at their sites, should they occur.

All NPP licensees have developed and implemented severe accident management guidelines (SAMG). SAMG include measures to prevent severe damage to the reactor core in the event of an accident, mitigate the consequences of an accident involving damage to the reactor core, and achieve stable conditions in the long term.

Licensees have also developed emergency mitigating equipment guidelines (EMEG) to provide instructions for use and deployment of emergency mitigating equipment (EME). The purpose of EME is to provide additional water make-up and power-supply capabilities to cool the fuel, arrest accident progression, and mitigate accident consequences for beyond design basis accidents, including severe accidents.

Licensees continued to update their existing SAMG to incorporate post-Fukushima lessons learned, including the addition of guidelines and strategies to deal with multi-unit events for multi-unit NPPs, and events in irradiated fuel bays and shutdown states.

The following publication contains regulatory requirements that were relevant in 2017:

- CNSC REGDOC 2.3.2, *Accident Management* (2013)

Details on its applicability and implementation are provided in Appendix E: and Section 3.

The CNSC also published version 2 of REGDOC-2.3.2 in 2015 to provide updated regulatory requirements for accident management at reactor facilities. The CNSC requested the licensees of operating NPPs to submit their implementation plans. NB Power submitted its plan; see section 3.3.3 for details.

Accident management and recovery

NPP and WMF licensees have adequate procedures in place (e.g., abnormal incident manuals and emergency operating procedures for NPPs) to manage abnormal incidents as well as design basis accidents. These procedures ensure that incidents are mitigated and the facility is returned to a safe and controlled state. They also prevent the further escalation of the abnormal incident into a serious accident, which is discussed above). CNSC compliance verification activities ensure that up-to-date procedures are available to the operators and that those operators are trained in their use.

2.4 Safety analysis

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

For NPPs, safety analysis is primarily deterministic in demonstrating the effectiveness of the fundamental safety functions of “control, cool, and contain.” Risk contributors are considered by using probabilistic safety assessments. Appropriate safety margins should be demonstrated to address uncertainties and limitations of safety analysis approaches.

Safety analysis ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
FS	FS	FS	FS	FS	FS	FS	FS	SA

Safety analysis encompasses the following specific areas:

- deterministic safety analysis
- probabilistic safety assessment

- criticality safety
- severe accident analysis
- management of safety issues (including R&D programs)

The following publication contains regulatory requirements that were relevant in 2017 to this SCA, as well as the Physical design SCA:

- CSA Group standard N286.7, *Quality assurance of analytical, scientific, and design computer programs for nuclear power plants*

Deterministic safety analysis

NPP and WMF licensees submit a safety analysis report for their facilities, at a minimum, every five years that effectively identifies facility hazards and items relied on for safety to control or mitigate these hazards.

The following publications contain regulatory requirements that were relevant in 2017:

- CNSC REGDOC-2.4.1, *Deterministic Safety Analysis*
- CSA Group standard N293, *Fire Protection for nuclear power plants* (2007)
- CSA Group standard N293, *Fire Protection for nuclear power plants* (2012)
- CSA Group standard N393, *Fire protection for facilities that process, handle, or store nuclear substances* (2013)

Details on their applicability and implementation are provided in Appendix E: and Section 3.

The NPP licensees are undertaking a safety analysis improvement program that is linked to the on-going, staged implementation of REGDOC-2.4.1. An area of focus in 2017 was the deterministic safety analysis for common-mode events (CMEs), which contains some new features for the analysis of multi-unit CANDU reactors.

CNSC staff provide feedback to the NPP licensees' on their ongoing safety analyses improvements. The existing licensees' deterministic safety analyses remained adequate during the continued implementation of REGDOC-2.4.1 throughout 2017.

Impact of aging on the safety analysis for NPPs

Aging of a reactor affects certain characteristics of the heat transport system, which can result in a gradual reduction of safety margins. Therefore, compensatory measures are implemented to mitigate the impact of aging when needed. Structures, system and components of a reactor are affected by aging simultaneously and to different degrees. As such, the overall safety case of an NPP needs to be periodically assessed and the existing safety margins quantified.

Important parameters related to the safety analysis of reactor aging are systematically monitored by an aging management program put in place by the licensee. The aging management program is supported by the licensee's assessments of the existing safety margins as reactor conditions change due to aging. The goal of the assessments and aging management programs is to monitor, assess and mitigate the impact of heat transport system aging on safety analysis and demonstrate safe operation of the plant.

CNSC staff is satisfied with the licensees' consideration of aging in their safety analyses.

Large-break loss-of-coolant accident: safety margin for NPPs

OPG, NB Power and Bruce Power have proposed the composite analytical approach (CAA) to demonstrate that safety margins for large-break loss-of-coolant accidents (LBLOCAs) are larger than those evaluated using the traditional safety analysis method that is based on a limit of operating envelope approach. (See the description of management of safety issues below for further details.)

At the conceptual level, the proposed CAA methodology is consistent with the requirements set out in REGDOC-2.4.1; however, CNSC has determined that the methodology requires further validation and refinement before it can be accepted for regulatory application. A number of key activities have been identified that would lead to CNSC staff acceptance of the CAA methodology. Overall, industry continues to progress well with all identified activities.

Bruce Power submitted a work plan for the CAA development in late 2016 intending to use the CAA methodology to quantitatively demonstrate that the LBLOCA safety margins are greater than predicted in the current analysis for the Bruce B reactors. The work plan was reviewed in 2017 by CNSC staff. CNSC staff concluded that, overall, the proposed work is acceptable, however, subject to further clarifications in some areas. While addressing CNSC staff's review comments, Bruce Power plans to submit the results in a regulatory application of the CAA for LBLOCA safety analysis of Bruce B reactors in mid 2019.

OPG continues to support the industry efforts in resolution of LBLOCA safety margins using the CAA as part of OPG's long term plan. Meanwhile, OPG had proposed an improvement to their current approach - a more realistic implementation of limit of operating envelope (LOE) methodology - to address the LBLOCA safety margin issue in the short term. In 2017, CNSC staff reviewed the proposed work and made certain recommendations in some areas. UPDATE: OPG has addressed some of the CNSC staff's comments, and plans to submit its updated LBLOCA safety analysis using the proposed more realistic implementation of LOE methodology for DNGS in March 2018 and for PNGS in a subsequent phase. As mentioned above, OPG also continues to work with Bruce Power to further develop CAA methodology for regulatory application.

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

While development of advanced analytical methods such as CAA continues, CNSC staff has confirmed that all operating NPPs have sufficient LBLOCA safety margins for the most probable operating states. As a risk control measure, CNSC has put in place a set of interim criteria for the safety margins (in case of discoveries that could decrease margins further) until CAA is implemented in regulatory applications.

Fire Safety Analysis

The CNSC requires NPP and WMF licensees to complete and maintain comprehensive fire protection assessment reviews (e.g., CCR and FHA). These reviews help ensure that each licensee is able to efficiently and effectively prevent, detect and mitigate the effects of a fire or to protect the ability to safely shutdown in the event of a fire.

Probabilistic safety assessment

This specific area applies to the operating NPPs but does not apply to Gentilly-2, DWMF, PWMF, or WWMF.

Table 9: Status of PSAs and reviews

PSA submission	Bruce A	Bruce B	DNGS	PNGS 1, 4	PNGS 5–8	Point Lepreau
Last PSA report received	2014	2014	2015	2013	2017	2016
Review status	Completed	Completed	Completed	Completed	Ongoing	Completed
Next PSA report expected	2019	2019	2020	2018	2022	2021
Expected compliance REGDOC-2.4.2	2019	2019	2020	2020	2020	2016

The following publication contains regulatory requirements that were relevant in 2017.

- CNSC REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*

Details on its applicability and implementation are provided in Appendix E: and Section 3.

REGDOC-2.4.2 introduces new requirements (i.e. considerations of other radioactive sources, including the irradiated fuel bay and multi-unit impacts).

Bruce Power, DNGS and PNGS are compliant with regulatory document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, and are progressing in their plans for compliance with REGDOC-2.4.2 by 2019, 2020 and 2020 respectively. Note that the additional requirements outlined in REGDOC 2.4.2 have already been addressed by OPG and Bruce Power either through the PSA, for the consideration of multi-unit impacts, or through the use of the deterministic safety analysis and/or alternative approaches for the consideration of combinations of external hazards, and the consideration of other radioactive sources such as the irradiated fuel bays.

In addition to addressing the new 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 PNGS PROL in 2013) to develop an approach for whole-site PSAs. Whole-site PSA involves estimating aggregate risk for sites with multiple reactors and other radioactive sources. OPG submitted the whole-site PSA for PNGS in 2017, which included the risk associated with different operating states, shutdown states, irradiated fuel bay and dry fuel storage. OPG and CNSC staff presented the preliminary results to the Commission meeting in December 2017. CNSC staff agreed with OPG's overall results – specifically, the methodology used to avoid the double counting of accident sequences (CMD 17-M64 [4]).

Bruce Power is expected to submit its whole-site PSA methodology in 2018. DNGS will study the lessons learned from the pilot whole-site PSA project prior to starting whole-site PSA work.

As part of the action 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 (CMD 17-M15.A [5]), CNSC staff provided the Commission with an update in December 2017 on whole-site PSA (CMD 17-M64 [4]). The update included a presentation on staff's active role in

the international effort, especially with the International Atomic Energy Agency (IAEA), 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 is targeted for completion in December 2018, while the IAEA project on multi-unit PSA is targeted for completion by October 2019.

Criticality safety

NPP and WMF licensees handle and store fuel bundles, containing irradiated natural or depleted uranium. Analyses of nuclear criticality safety of these types of bundles had been performed and included in the safety analysis reports. The OPG, Hydro-Québec, and NB Power fuel bundles have sufficiently low fissile content that they cannot become critical in air or in light water. Therefore, their respective facilities are not required to maintain nuclear criticality safety programs. However, due to the storage of booster fuel assemblies at Bruce A and the Low Void Reactivity Fuel (LVRF) demonstration irradiation at Bruce B during the 2006 -2007 period, Bruce Power is required to have a criticality safety program. The following publication contains regulatory requirements that were relevant for Bruce Power in 2017:

- CNSC RD-327, *Nuclear Criticality Safety*

Severe accident analysis

This specific area applies to the NPPs but does not apply to the DWMF, PWMF, or WWMF.

OPG and Bruce Power participated in the Severe Accident Software Simulator Solution project to improve their methods for probabilistic analysis of multi-unit severe accidents. They submitted the results to the CNSC in 2015. CNSC staff completed its review in 2017 and proposed some recommendations for improvements.

Additional information on supporting R&D related to certain aspects of severe accident analysis is provided below under Management of safety issues.

Management of safety issues

This specific area applies to the NPPs but does not apply to the DWMF, PWMF, or WWMF.

CANDU safety issues

In 2007, CNSC staff identified generic safety issues associated with CANDU reactors as a result of initiatives started by the IAEA to reassess the safety of operating NPPs. CANDU Safety Issues (CSI) were classified into three (3) broad categories according to the adequacy and effectiveness of the control measures implemented by the NPP licensees, namely:

- Category 1: Not an issue in Canada
- Category 2: Issue is a safety concern in Canada but appropriate measures are in place to maintain safety margin.
- Category 3: Issue is a concern in Canada; however, measures are in place to maintain safety margins, but the adequacy of these measures need to be confirmed.

A technical briefing on the generic safety issues were presented to the commission in August 2016 (CMD 16-M34 [24]). The CNSC continued to monitor the management of CSIs by licensees of operating NPPs to ensure timely and effective implementation of plant-specific safety improvement initiatives and risk control measures. None of the remaining category 3 CSIs are applicable to Gentilly-2.

At the end of 2017, there were four remaining category 3 CSI issues, three of which are related to large break loss-of-coolant accident (LOCA).

- 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)

The industry continues to develop the CAA methodology described above in order to address the LBLOCA CSIs. Through an industry-wide agreement, Bruce Power is taking the lead in the regulatory application of the CAA methodology. Bruce Power requested the re-classification of the LBLOCA CSIs to a lower category.

UPDATE: In 2018, CNSC staff concluded that additional information was needed to justify the re-classification of CSIs AA9, PF9, and PF10 for Bruce Power. (CMD 18-H4 [6])

The fourth Category 3 issue, IH6, is related to systematic assessment of the effects of high energy pipeline breaks inside containment. It is only applicable to PNGS and Point Lepreau.

For PNGS Units 5 to 8, OPG had requested re-categorization of this CSI to category 2 based on pipe-whip and jet-impingement assessments for various systems. CNSC expects to complete its review of the request by fall of 2018.

UPDATE: CNSC re-categorized CSI IH6 from category 3 to category 2 for PNGS Units 5 to 8 in June 2018.

OPG was also completing a leak before break analysis for various systems at PNGS Units 1 and 4. Following its anticipated completion in summer of 2018, OPG plans to request re-categorization of CSI IH6 for Units 1 and 4 to category 2. CNSC staff is satisfied with this timeline.

NB Power requested re-categorization of this CSI to category 2 based on pipe-whip and jet-impingement assessments for various systems. CNSC expects to complete its review of the request by fall of 2018.

Supporting R&D

In 2017, CNSC staff continued to undertake systematic evaluations to confirm that the industry maintains or has access to a robust R&D capability to address any emerging issues and enhance knowledge and confidence in safety provisions in key areas.

CNSC staff reviewed the 2017 COG R&D Annual Reports submitted by OPG, Bruce Power, and NB Power. These reports include:

- The annual COG R&D program overview reports and operational plans;
- The multi-year strategic plans and capability maintenance reviews at such intervals as they are produced.

CNSC staff determined that the licensees complied with the reporting requirements of REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. Some shortcomings were however identified, and recommendations are made for future COG reports to fully satisfy the reporting requirements.

Information on specific R&D projects executed by the licensees and CNSC is provided in Appendix C:.

NPP licensees had started a COG joint project to address questions raised by intervenors, during licence renewal hearings in 2015, related to postulated severe accidents at operating NPPs. Background information was provided in the *Regulatory Oversight Report for Canadian Nuclear Power Plants: 2016 [1]*. CNSC staff reviewed the results and presented their findings to the Commission (CMD 17-M14 [7]). CNSC staff agreed with the project's dispositions, and concluded that issues raised were of low safety significance. This conclusion was shared by external expert reviewers engaged by CNSC and COG. The commission was satisfied with the methodical approach, although CNSC staff identified a limited number of topics, deemed of low safety significance, where a more complete experimental or a documented technical basis for the arguments was needed. The main topics were:

- Hydrogen/deuterium Production and PARs Effectiveness
- MAAP-CANDU Modelling
- In-vessel Retention Strategy
- Hydrogen/Deuterium, Source term estimation
- Long-Term Monitoring Capability

CNSC staff requested that the licensees of operating NPPs document COG research and development (R&D) work performed to date, work in progress and planned to specifically address the topics described above. This overview document was provided by all licensees in December 2017. At the end of 2017, CNSC staff were preparing a detailed review for the formal response to the licensees

2.5 Physical design

This SCA relates to activities that affect the ability of structures, systems and components to meet and maintain their design basis as new information arises over time and changes take place in the external environment.

Physical design ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

Physical design encompasses the following specific areas:

- design governance
- site characterization
- facility design
- structure design
- system design
- components design

In addition to the extensive design requirements applicable to operating NPPs and WMFs detailed in this report, general guidance for design of NPPs is provided in CNSC REGDOC-2.5.2, *Design*

of Reactor Facilities: Nuclear Power Plants, which would apply to new-build as requirements and as guidance for existing NPPs.

In 2017, the licensees executed various modifications with no impact on their ability to operate within the safety case, improve the overall performance of their facilities, and improve safety in design and operations.

Design governance

Licensees have policies, processes and procedures that provide direction and support for physical design. Licensees' design management is supported by programs that govern the conduct of engineering, pressure boundaries, seismic qualification, environmental qualification, human factors in design, robustness, and fire protection, as well as change control mechanisms within their management systems.

Seismic qualification

Seismic qualification is the verification of the ability of a structure, system, or component to perform its intended function during and/or following the designated earthquake, through testing, analysis, or other methods. The following publication contains regulatory requirements that were relevant in 2017:

- CSA Group standard N289.1, *General requirements for seismic design and qualification*

Details on its applicability and implementation are provided in Appendix E:.

CNSC staff determined that all licensees have established seismic qualifications that meet the applicable regulatory requirements or guidance.

Environmental qualification

An environmental qualification program ensures that all required structures, systems and components are capable of performing their designated safety functions in a postulated harsh environment resulting from design-basis accidents. The following publications contain regulatory requirements that were relevant in 2017:

- CSA Group standard N290.13-05, *Environmental qualification of equipment for CANDU nuclear power plants*

Details on its applicability are provided in Appendix E:.

Although these programs are mature, CNSC staff monitor this area closely to confirm that the NPP licensees continue to maintain environmental qualification in the context of reactor aging and limited resources.

Pressure boundary design

The following publication contains regulatory requirements for that were relevant in 2017:

- CSA Group standard N285.0, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*

Details on its applicability and implementation are provided in Appendix E:.

NPP and WMF licensees implement comprehensive pressure boundary programs and maintain formal service agreements with an authorized inspection agency.

Human factors in design

The following publication contains regulatory requirements for that were relevant in 2017:

- CSA Group standard N290.12-14, *Human factors in design for nuclear power plants*

Details on its applicability and implementation are provided in section 3 and Appendix E:.

Robustness design

Robustness design and assessment covers the physical design of nuclear facilities for sufficient robustness against anticipated threats. CNSC's assessment of this specific area is based on licensee performance in meeting regulatory commitments for mitigating the potential consequences of these accidents.

Fire Protection - Governance

NPP and WMF licensees have fire protection programs to minimize the risk to health, safety and the environment due to fire by ensuring that each licensee is able to efficiently and effectively respond to emergency fire situations. The CNSC requires that fire protection provisions are applicable to all work related to the design, construction, operation and maintenance of nuclear facilities, including the structures, systems and components that directly support the facility and the protected area.

The following publications contain regulatory requirements for operating NPPs or WMFs that were relevant in 2017:

- CSA Group standard N293, *Fire Protection for nuclear power plants* (2007)
- CSA Group standard N293, *Fire Protection for nuclear power plants* (2012)
- CSA Group standard N393, *Fire protection for facilities that process, handle, or store nuclear substances* (2013)

Details on their applicability and implementation are provided in Appendix E:.

The CSA Group standards require licensees to submit third party reviews (TPR) to CNSC staff of proposed modifications with the potential to impact protection from fire. The TPRs confirm that the compliance criteria for modifications are being met. CNSC staff reviewed the TPRs and determined that the licensees met the applicable fire protection requirements for modifications.

Site characterization

There is no background information needed for this specific area.

Facility design

There is no background information needed for this specific area.

Structure design

The following publication contains regulatory requirements for NPPs that were relevant in 2017:

- CSA Group standard N291, *Requirements for Safety-related Structures for CANDU Nuclear Power Plants (2015).*

Details on its applicability are provided in Appendix E:.

Facility design and structure design pertains to the overall adequacy of the design of the facility and structures, which is governed by licensee design programs, including a number of codes and standards.

System design

CNSC staff activities in 2017 included the confirmation that licensees' service-water, electrical power, and fire protection systems functioned as expected.

Service water, including emergency service-water systems

Service-water systems in NPPs provide water to a large number of components and systems. From the nuclear safety perspective, however, the most important service-water loads are associated with:

- removing heat from the reactor core (such as moderator heat exchanger cooling and end-shield cooling)
- cooling functions to ensure proper functioning of structures, systems, and components important to safety (such as instrument air compressors and boiler room air cooling units)

Electrical power systems

Electrical power systems provide necessary support for the safety of an NPP and are important in the defence-in-depth concept. It is essential that NPPs have reliable electrical power supplies to control anticipated deviations from normal operations, and to power, control, and monitor the plants during events of all types. These electrical power systems include onsite and offsite power systems, which work together to provide necessary power in all conditions, so that the NPP can be maintained in a safe state.

Components design

Fuel 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 (e.g., fuel defects, end plate cracking, and deposits). However, these challenges have been adequately managed by licensee fuel programs and personnel. Regulatory limits for fuel bundle and fuel channel power were met throughout. Fuel performance has for the most part now returned to historic norms with the few remaining challenges having well-developed corrective action plans and mitigation strategies put in place. CNSC staff continue to monitor the success of the corrective action plans and presently are satisfied with the industry's management of these issues. Details regarding individual licensee challenges and performance are provided in Section 3.

Cables

Cables are critical to the safe and reliable operation of NPPs due to their widespread use as a connection medium for many systems important to safety. Canada's operating reactors are aging, and cables are affected by the aging process. The CNSC requires operating NPP licensees to implement cable condition monitoring and surveillance programs, and cable aging management programs to assess, over time, the degradation of cable insulation.

2.6 Fitness for service

This SCA covers activities affecting the physical condition of structures, systems and components to ensure that they remain effective over time. This includes programs that ensure that all equipment is available to perform its intended design function when needed.

Fitness for service ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

Fitness for service encompasses the following specific areas:

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

Equipment fitness for service/equipment performance

This specific area applies to the NPPs but does not apply to the DWMF, PWMF, or WWMF.

Reliability of systems important to safety

The following publication contains regulatory requirements for operating NPPs that were relevant in 2017:

- CNSC RD/GD-98, *Reliability Programs for Nuclear Power Plants*

Details on its applicability are provided in Appendix E:

Multiple special safety systems in CANDU reactors provide protection against process system failures. The special safety systems are required to be available and effective for continued operation. These special safety systems include two shutdown systems that are independent of each other. The first uses shutoff rods which drop into the reactor core by gravity, with an initial spring assist. The second uses the injection of a neutron-absorbing solution into the moderator. At least one shutdown system will operate, if required, following any process system failure.

In addition to the special safety systems, the CANDU design provides other safety-related systems and features that solely perform safety functions. If unavailability is detected, immediate actions are taken to ensure that safety is maintained at all times.

Operating NPP licensees' reliability programs trend system performance - e.g., by monitoring process parameters, station condition records, and test and inspection results - and initiate investigations or maintenance activities as needed.

REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* requires each operating NPP licensee to report the results of its reliability program to the CNSC annually. CNSC staff review these reports to confirm compliance with the regulatory requirements.

The annual reliability reports include information on the reliability of the special safety systems. Overall, the special safety systems performed well in 2017 to meet their unavailability targets (apart from those exceptions noted in section 3 of this report). Notwithstanding backup systems in place, licensees took appropriate actions to address the incidents leading to unavailability and put in place corrective actions.

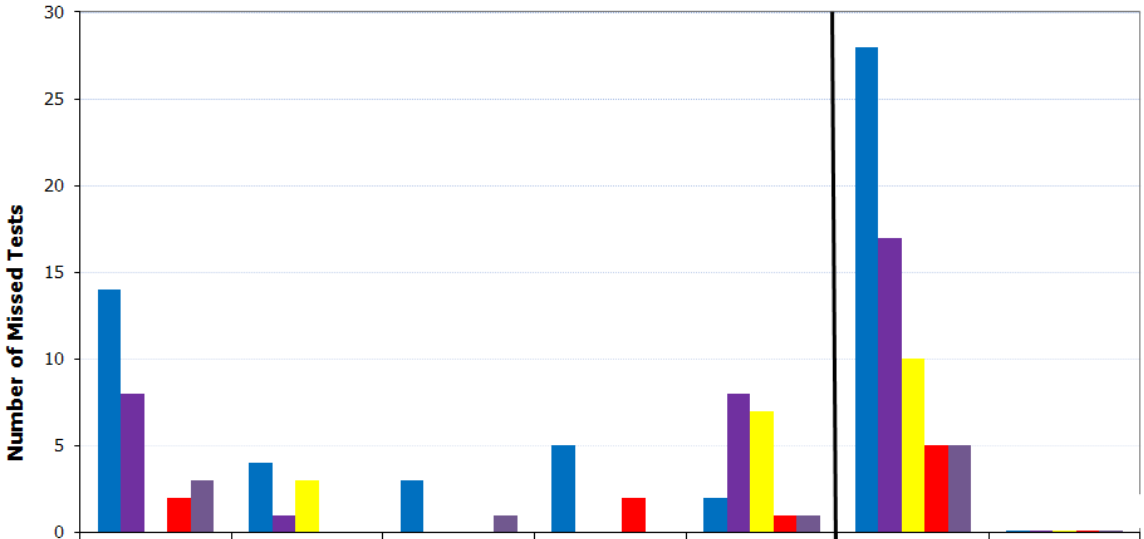
In addition, the reliability program requires that the availability of systems important to safety is confirmed through surveillance activities such as testing and inspections. Missed tests are tracked by licensees and reported to the CNSC per REGDOC-3.1.1. The numbers are a measure of a licensee's ability to successfully complete routine tests on safety-related systems and calculate the predicted availability of systems. Data for the stations and the industry as a whole are shown in table 10 and figure 4.

The number of total missed safety system tests remains very low. In all, 47,657 tests were performed over the course of 2017. The percentage of missed tests was 0.01 percent. The impact of missing a single test is negligible because the safety systems involved in the tests have sufficient high redundancy to ensure continuous safety system availability.

Table 10: Safety system test performance for 2017

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	
Bruce A	10,454	0	3	0	3	0.03
Bruce B	9,300	0	0	0	0	0.00
DNGS	10,093	0	1	0	1	0.01
PNGS	13,608	0	0	0	0	0.00
Point Lepreau	4,202	0	1	0	1	0.02
Industry total	47, 657	0	5	0	5	0.01

Figure 4: Trend details of safety system test performance for stations and industry, 2013–17



	Bruce A	Bruce B	DNGS	PNGS	Point Lepreau	Industry Total	Industry % Missed Tests
2013	14	4	3	5	2	28	0.04%
2014	8	1	0	0	8	17	0.03%
2015	0	3	0	0	7	10	0.02%
2016	2	0	0	2	1	5	0.01%
2017	3	0	1	0	1	5	0.01%

Maintenance

The following publication contains regulatory requirements that were relevant in 2017:

- CNSC RD/GD-210, *Maintenance Programs for Nuclear Power Plants*

Details on its applicability are provided in Appendix E:. REGDOC-2.6.2, *Maintenance Programs for Nuclear Power Plants* superseded RD/GD-210 in August 2017. The requirements and guidance remain unchanged. REGDOC-2.6.2 will replace RD/GD-210 in the upcoming licence renewal for each NPP or through the regular LCH revision process.

CNSC staff routinely monitor several maintenance safety performance indicators, including ones that are required to be reported according to REGDOC-3.1.1, *Reporting requirements for nuclear power plants*, i.e., the preventive maintenance completion ratio (PMCR), maintenance backlogs and the number of preventive maintenance deferrals.

There are no pre-determined limits for these indicators – CNSC staff track trends and compare the values of these indicators at individual NPPs with the industry average to help determine if closer regulatory scrutiny is warranted. Based on the values and trending, CNSC might, for example, increase the focus on maintenance during regular field inspections or adjust the frequency of the baseline compliance program inspection on maintenance planning and scheduling or conduct a reactive inspection to verify the causes and determine the actual safety significance of the exceedance.

The PMCR quantifies the effectiveness of the preventive maintenance program in minimizing the need for corrective maintenance activities. The average PMCR value for NPPs was 88 percent in 2017. CNSC staff were satisfied with this value.

Corrective maintenance backlogs, deficient maintenance backlogs and deferrals of preventive maintenance monitor the effectiveness of the maintenance program at NPPs. A certain level of backlog is always expected, due to normal work management processes and equipment aging. Although usually not safety significant, maintenance backlogs can be a useful indicator of overall maintenance effectiveness and plant operation. Corrective maintenance work is required when a structure, system or component has failed and can no longer perform its design function. As defined by REGDOC-3.1.1, corrective maintenance backlogs consist of all corrective work generated through work order requests and appearing in the work management system as uncompleted work.

Deficient maintenance is planned when structures, systems, or components of NPPs have been identified as degrading, but remain capable of performing their design functions. The deficient maintenance backlog consists of all deficient work generated through work requests and appearing in the work management system of uncompleted work.

The corrective and deficient maintenance backlogs reported in this regulatory oversight report are for critical, i.e., safety-significant components.

Deferred preventive maintenance is preventive maintenance at NPPs that has received an approved technical justification for extension prior to its late date. The industry maintenance backlogs are provided in table 11.

Table 11: 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 2016	Average quarterly work orders per unit in 2015	Three years trending
Corrective maintenance backlog	4	8	11	down
Deficient maintenance backlog	94	111	117	down
Deferrals of preventive maintenance	30	38	49	down

The industry average numbers of these three performance indicators continued to reduce in 2017. Overall, CNSC staff were satisfied with the progress in 2017. The current levels of the maintenance backlogs for the NPPs represent a negligible risk to the safe operation of the NPPs.

Structural integrity

The following publications contain regulatory requirements that were relevant to NPPs in 2017:

- CSA Group standard N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components* (2005)
- CSA Group standard N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components* (2009)
- CSA Group standard N287.7, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants*
- CSA Group standard N285.5, *Periodic inspection of CANDU nuclear power plant containment components*

- CSA Group standard N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors* (2005)
- CSA Group standard N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors* (2010)

Details on their applicability and implementation are provided in Appendix E:.

Licensees have processes to monitor and assess structural integrity, such as pressure boundary component and containment inspections for NPPs or the inspection and testing of dry storage containers (DSCs) and storage facility structures for WMFs. After DSCs are loaded with used fuel, they are required to undergo several inspections and tests to confirm their integrity before placing them into storage. These processes draw on results from aging management activities, which are described in the next section. Licensees also monitor and assess safety-significant balance-of-plant systems. Balance of plant pressure boundary systems consist of the systems and components that comprise a complete NPP, excluding the systems that are subject to inspection in accordance with CSA Group standard N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components*, which are typically considered non-nuclear systems.

CNSC compliance verification reviews related to the Structural Integrity specific area include desktop reviews of reports provided by the licensee (e.g., quarterly operations reports, pressure boundary reports, and event reports as required by REGDOC-3.1.1, *Reporting requirements for nuclear power plants*, and inspection reports and annual aging management reports for DSCs).

CNSC staff determined that all licensees continued to inspect and demonstrate the structural integrity of passive NPP components and structures, including those for pressure boundary systems, containment systems, and safety-significant balance-of-plant systems, in accordance with the stations' periodic inspection programs and applicable standards. No significant issues were reported to the CNSC.

Aging management

NPP and WMF licensees have implemented processes and programs to address aging-related factors that could affect the condition of structures, systems, and components important to safety. The licensees manage known and plausible aging-related degradation of structures, systems and components to prevent the erosion of design and safety margins.

The following publications contain regulatory requirements that were relevant to NPPs in 2017.

- CNSC RD-334, *Aging management for nuclear power plants*
- CNSC REGDOC-2.6.3, *Aging Management*

Details on their applicability and implementation are provided in Appendix E: and Section 3.

The CNSC requires NPP licensees to have component-specific aging management programs – licensees typically refer to them as lifecycle management plans (LCMPs) – for the major primary heat transport components of their reactors (i.e., feeders, pressure tubes, and steam generators) as well as for reactor internals, concrete containment structures, and balance-of-plant safety-related civil structures.

The LCMPs include structured, forward-looking inspection and maintenance schedule requirements to monitor and trend aging effects and any preventative actions necessary to minimize and control aging degradation.

The CNSC also requires the WMFs to have aging management plans for DSCs to address plausible aging mechanisms. OPG also has inspection programs in place at the WMFs to support aging management of civil structures.

Compliance monitoring activities conducted by CNSC staff included desktop reviews of licensee submissions related to integrated aging management programs and component and structure-specific LCMPs, as well as onsite inspections to assess licensees' implementation of these programs.

The LCMPs are updated to incorporate operating experience and research findings and are submitted to the CNSC for review to demonstrate compliance with the requirements of REGDOC-2.6.3.

Aging management programs for pressure tubes are important to the ongoing safe operation of the NPPs as operating conditions in CANDU fuel channels have significant effects on the material properties. Pressure tube aging management activities include inspections to verify the condition of the tubes and monitor material property changes (see the section on structural integrity, below).

The ability to safely operate pressure tubes is demonstrated through assessments of the current and expected conditions of the pressure tubes based on an understanding of relevant degradation mechanisms. Research activities as well as inspection and maintenance programs provide data to periodically validate the input parameters for these assessments. One important parameter is fracture toughness, which is modelled and used for assessments of leak-before-break for pressure tubes, which is a key assessment to demonstrate the continued safe operation of aging fuel channels. For temperatures below 250°C, a critical input to the fracture toughness model is the equivalent hydrogen content (Heq) in the pressure tube. The analytical fracture toughness model that CNSC currently accepts for use in this temperature range is only valid up to a Heq concentration of 120 ppm. Details on the current and anticipated future fuel channel conditions and validity of the fracture toughness model for the NPPs in Ontario[2] are provided in Appendix H:.

CNSC staff actively monitored the industry's progress in research activities to ensure 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 Management Project, which included the following activities in 2017:

- Research focusing on the fracture toughness of near-inlet areas of pressure tubes;
- Initiating the development of a revised version of the fracture toughness model, including collection of supporting burst-test data; and,
- Continued development of assessment methodologies: a probabilistic approach for demonstrating fracture protection (i.e., the ability to satisfy the design intent of a pressure tube when an undetected crack is postulated); and a deterministic approach for assessing risks posed by hydride region overload (i.e., when a hydride area is exposed to greater stress than existed when it was initially created, which could lead to crack initiation).

Overall, CNSC staff are satisfied that the LCMPs for pressure tubes provide a sound basis for licensee aging management activities. CNSC staff also continued to review the results from fuel

[2] Point Lepreau's pressure tubes began their service life in 2012 following refurbishment and are not expected to approach the Heq limit of 120 ppm for many years.

channel inspections that occurred routinely during planned inspection outages in 2017. CNSC staff confirmed that no new flaw degradation 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.

In addition to pressure tube aging, LCMPs address the aging and behaviour of fuel channel spacers, which maintain the gaps between pressure tubes and their corresponding calandria tubes. If contact were to occur between a pressure tube and the cooler calandria tube, pressure tube degradation could result. Licensees assess the possibility of spacer movement along the fuel channel (which could increase the likelihood of pressure tube to calandria tube contact) over time, and correct the positioning if necessary. The fuel channel life management project also continued, in 2017, research and development on annulus spacer degradation, and supporting development of a set of fitness-for-service guidelines. CNSC staff are satisfied with the licensees' work to ensure fuel channel spacers continue to perform their design function. A review of available information confirms that annulus spacers are behaving in a predictable manner.

Chemistry control

Licensee's programs establish processes, address overall requirements, and identify staff accountabilities to ensure effective control of chemistry. For NPPs, chemistry control covers operational and lay-up conditions, control of laboratory methods, sampling and analyses, process chemicals, chemistry control performance monitoring, and reporting. These programs maintain system chemistry at conditions necessary to minimize corrosion and performance degradation during all plant states, and contribute to safe and reliable plant operation. Proper chemistry control maximizes equipment life, reliability and long-term performance. Chemistry specifications identify parameters that must be controlled within specified limits.

The CNSC requires licensees of operating NPPs to report on the safety performance of their chemistry programs through the Chemistry Index and Chemistry Compliance Index in accordance with REGDOC 3.1.1, *Reporting requirements for nuclear power plants*. The Chemistry Index is the percentage of time that the selected chemical parameters are within specification. It quantifies the long-term control of important chemical parameters in accordance with licensee requirements. The Chemistry Compliance Index is the average percentage of time that selected, important chemical parameters are within the licensees' specifications for guaranteed shutdown state and non-guaranteed shutdown state conditions. Index values that are close to 100 indicate that measured parameters were maintained within specifications most of the time.

Figures 5 and 6 show the values of the Chemistry Index and the Chemistry Compliance Index for operating NPPs from 2013 to 2017. Based on these values, CNSC staff determined that chemistry control was acceptable for all licensees. The downward trend and comparatively low results for the Chemistry Compliance Index for Bruce A and B (figure 6) were due to a downward trend in moderator (D2O) isotopic purity for all units. However, there was no impact on the safe operation of Bruce A and B and safety systems functions were not impaired. Bruce Power has since applied corrective action to its use of D2O upgraders and its de-tritiation program.

Figure 5: Chemistry Index for industry, 2013–17

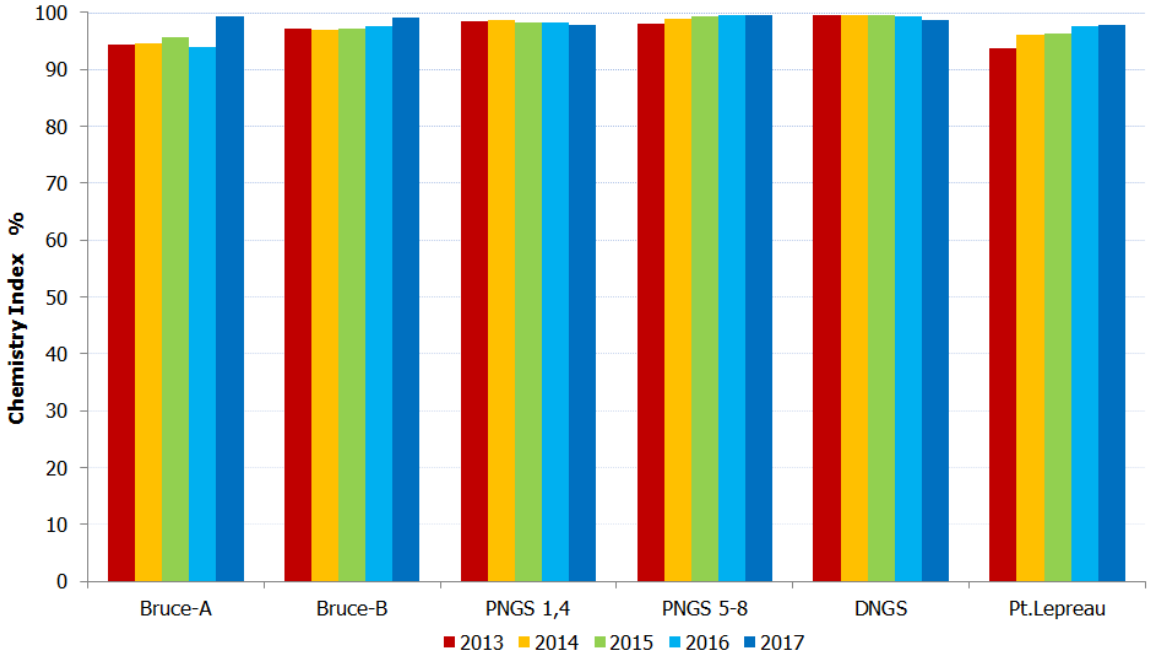
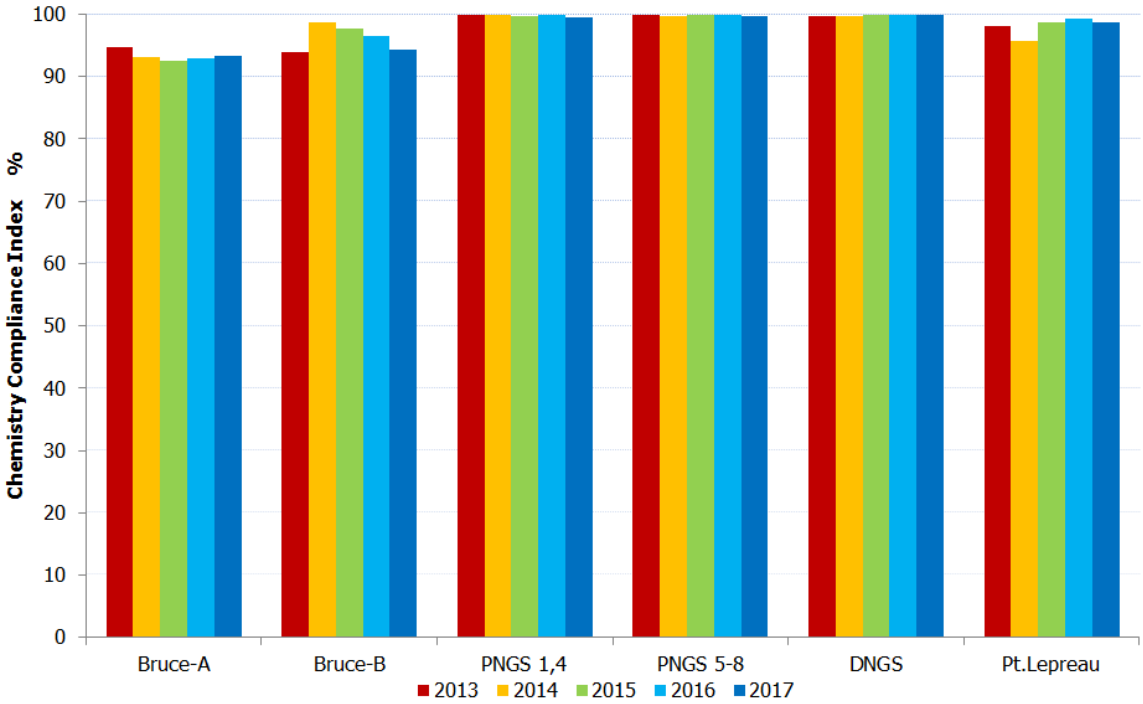


Figure 6: Chemistry Compliance Index for industry, 2013–17



Periodic inspection and testing

This specific area applies to the operating NPPs but does not apply to the DWMF, PWMF, WWMF, or Gentilly-2.

The following publications contain regulatory requirements that were relevant to operating NPPs in 2017.

- CSA Group standard N285.4, *Periodic inspection of CANDU nuclear power plant components* (2005)
- CSA Group standard N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components* (2009)
- CSA Group standard N285.5, *Periodic inspection of CANDU nuclear power plant containment components*
- CSA Group standard N287.7, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants*

Details on their applicability and implementation are provided in Appendix E: and section 3.

Licensees of operating NPPs have inspection and testing programs to provide ongoing monitoring of the fitness for service and structural integrity of safety-significant structures, systems and components. After every inspection campaign, the results of these inspections and tests are submitted to CNSC staff for review. CNSC staff perform desktop reviews of the submissions to verify licensee implementation of their inspection and testing programs.

2.7 Radiation protection

This SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure contamination levels and radiation doses received by individuals are monitored, controlled and maintained as low as reasonably achievable (ALARA).

The dose data presented in this report is based on the radiation exposure records for every individual monitored at a Canadian NPP or WMF. This report presents and analyzes these dose records in terms of annual collective dose[3], average effective dose[4], maximum individual effective dose, and the distribution of doses among the monitored individuals.

Figures 7, 8, and 9 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. The estimated dose to the public from Canadian NPPs and WMFs, 2013–17 is provided in Figure 10.

[3] The "annual collective dose" is the sum of the effective doses received by all the workers at that facility in a year. It is measured in person-Sieverts (p-Sv).
[4] The "average effective dose" or "average effective dose – non-zero results only" is obtained by dividing the total collective dose by the total number of individuals receiving a dose above the minimum reportable level of 0.01 mSv.

Radiation protection ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	FS	FS	SA	SA

Radiation protection encompasses the following specific areas:

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

Application of ALARA

NPP and WMF licensees implement radiation protection measures to keep the doses to persons ALARA, taking into account social and economic factors, as required by the *Radiation Protection Regulations*.

In 2017, the total collective dose for monitored individuals at all Canadian NPPs and WMFs was 23.33 person-sieverts (p-Sv), approximately 23 percent higher than the industry-wide collective dose reported for the previous year (18.94 p-Sv). The number of persons that received a dose in 2017 (9,273) was also significantly higher than 2016 values (7,697). The increase in total collective dose was mainly due to 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 operating NPPs are shown for the individual NPPs in the following table. It illustrates that outages account for a much greater fraction of the collective dose than routine operations, and that external dose is collectively, much greater than internal dose.

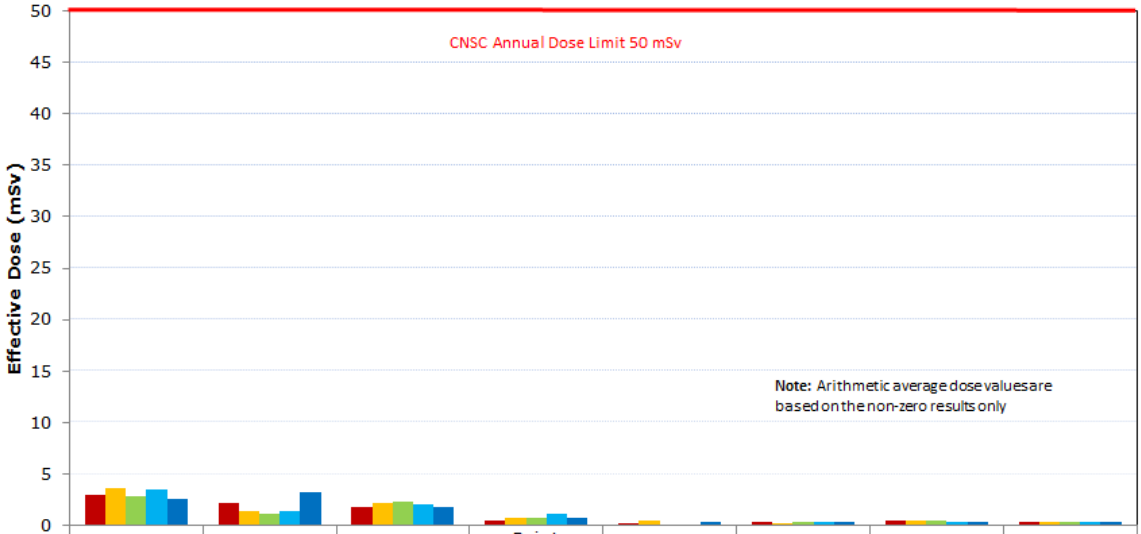
Table 12: Breakdown of collective dose for operating NPPs in 2017 (person-mSv)

NPP	Routine Operations	Outages	Internal	External	Total
Bruce A	389	884	132	1141	1273
Bruce B	504	4509	220	4792	5012
Pickering	719	3309	782	3246	4028
Darlington	429	12068	542	11955	12497
Point Lepreau	204	361	89	475	564

The annual average effective dose in 2017 for all operating Canadian NPPs and WMFs was 2.52 millisieverts (mSv), an approximate increase of three percent from the 2016 value of 2.46 mSv.

Figure 7 shows the average effective doses to monitored persons at each NPP and WMF for the period 2013 to 2017. This figure shows that, for 2017, the average effective dose at each facility ranged from 0.30 to 3.24 mSv per year. In general, the fluctuations in average dose observed from year to year are reflective of the type and scope of work being performed at each facility. No negative trends were identified in 2017.

Figure 7: Average effective doses of monitored persons, 2013–2017



	Bruce A&B	DNGS	PNGS	Point Lepreau	Gentilly-2	WWMF	DWMF	PWMF
2013	2.95	2.25	1.79	0.54	0.25	0.40	0.50	0.40
2014	3.68	1.35	2.21	0.70	0.52	0.20	0.50	0.40
2015	2.78	1.18	2.31	0.70	0.11	0.30	0.50	0.40
2016	3.51	1.42	2.00	1.20	0.01	0.30	0.40	0.40
2017	2.56	3.24	1.75	0.80	0.37	0.30	0.30	0.40

Worker dose control

The *Radiation Protection Regulations* require that all licensees implement a radiation protection programs to control the occupational doses received by persons.

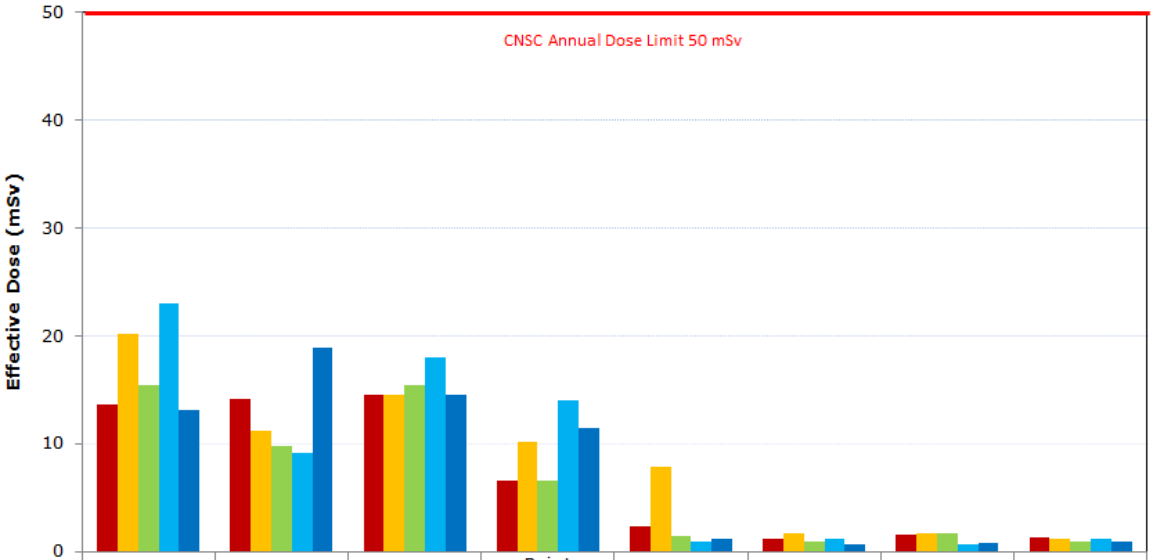
In addition to maintaining doses to persons below regulatory limits, NPP and WMF licensees have established action levels[5] for worker exposures. During 2017, no worker at any NPP or WMF received a radiation dose that exceeded the licensees' action levels or regulatory dose limits.

REGDOC-3.1.1, *Reporting Requirements for nuclear power plants* requires NPP licensees to report safety performance indicators related to worker dose control. They include tracking of occurrences involving doses received from unplanned exposures or uptakes. CNSC staff monitor licensee actions for workers that have been reported to have received unplanned exposures or uptakes.

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

The maximum annual individual effective doses as reported by each NPP and WMF for the period of 2013 to 2017 are presented in Figure 8. In 2017, the maximum individual effective dose received at a single site was 18.94 mSv, received by a worker at the DNGS. In 2017, there were no radiation exposures, received by persons at any NPP or WMF that exceeded the regulatory dose limit of 50 mSv/year, as established in the *Radiation Protection Regulations*.

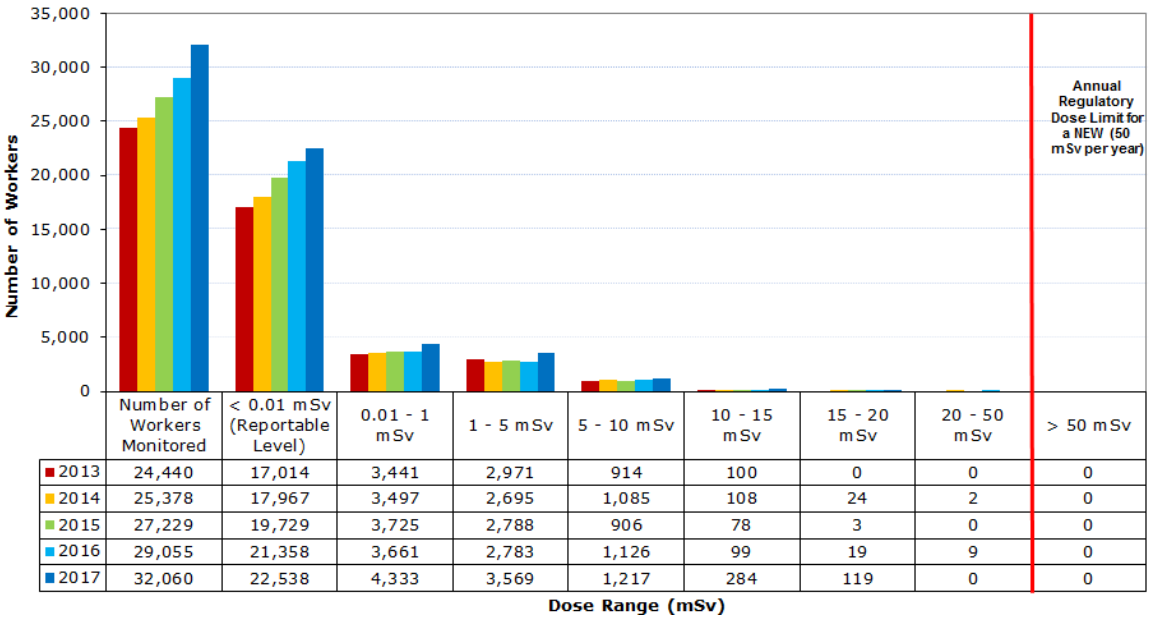
Figure 8: Maximum individual effective doses, 2013–17



	Bruce A&B	DNGS	PNGS	Point Lepreau	Gentilly-2	WWMF	DWMF	PWMF
2013	13.63	14.15	14.50	6.59	2.26	1.20	1.60	1.30
2014	20.17	11.13	14.50	10.20	7.85	1.70	1.70	1.20
2015	15.40	9.78	15.38	6.60	1.46	0.90	1.70	0.90
2016	23.05	9.13	18.04	14.01	0.85	1.10	0.70	1.10
2017	13.05	18.94	14.58	11.40	1.16	0.60	0.80	0.90

Figure 9 provides the distribution of annual effective doses to all monitored persons at all Canadian NPPs and WMFs from 2013 to 2017 according to dose information provided by each licensee. All doses reported were below the annual regulatory dose limit of 50 mSv for Nuclear Energy Workers. In fact, approximately 70 percent of the doses reported were at or below the much smaller annual regulatory dose limit of 1 mSv for members of the general public.

Figure 9: Distribution of annual effective doses received by all monitored persons at Canadian NPPs, 2013–2017



	Number of Workers Monitored	< 0.01 mSv (Reportable Level)	0.01 - 1 mSv	1 - 5 mSv	5 - 10 mSv	10 - 15 mSv	15 - 20 mSv	20 - 50 mSv	> 50 mSv
2013	24,440	17,014	3,441	2,971	914	100	0	0	0
2014	25,378	17,967	3,497	2,695	1,085	108	24	2	0
2015	27,229	19,729	3,725	2,788	906	78	3	0	0
2016	29,055	21,358	3,661	2,783	1,126	99	19	9	0
2017	32,060	22,538	4,333	3,569	1,217	284	119	0	0

Overall, CNSC staff were satisfied with the licensees' control of worker doses.

Radiation protection program performance

NPP and WMF licensees effectively implement their radiation protection programs and seek to improve program performance through assessment and benchmarking. The licensees maintain program documents and supporting procedures, taking into consideration operating experience and industry best practices. Licensee programs include safety performance indicators to monitor program performance.

Radiological hazard control

NPP and WMF licensees implement measures in their radiation protection programs to monitor, minimize, and control radiological hazards and the spread of radioactive contamination in their facilities. These measures include, but are not limited to, the use of radiological zoning systems, ventilation systems to control the direction of air flow, and ambient air monitoring and radiation monitoring equipment at zone boundaries. The licensees also set action levels for contamination control.

Workplace monitoring programs protect workers and ensure radioactive contamination is controlled within the site boundary. In 2017, no contamination control action levels were exceeded and no safety significant performance issues were identified at any NPP or WMF.

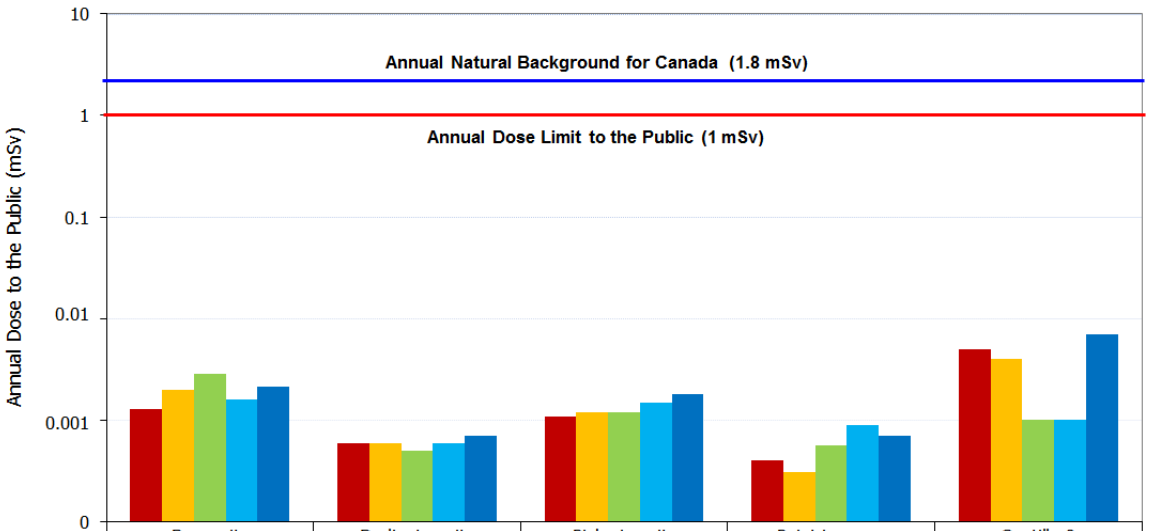
Estimated doses to the public

The estimated dose to the public for airborne emissions and liquid releases from 2013 to 2017 are provided in Figure 10. Note that the data for Bruce, Darlington, and Pickering include that of the WWMF, DWMF, and PWMF, respectively. Figure 10 shows that the doses to the public were well below the annual regulatory dose limit of 1 mSv for members of the general public.

A comparison of the 2017 data to previous years indicates that the values remained within the same general range as the 2013 to 2016 values

The Gentilly-2 value for 2017 was higher than the Gentilly-2 values of previous years, and the values for other NPPs, but still very small and well within regulatory limits. See section 3.6.7 for further details.

Figure 10: Comparison of estimated doses to the public from Canadian Nuclear Power Generating Sites, 2013–2017



	Bruce site	Darlington site	Pickering site	Point Lepreau	Gentilly-2
2013	0.0013	0.0006	0.0011	0.0004	0.0050
2014	0.0020	0.0006	0.0012	0.0003	0.0040
2015	0.0029	0.0005	0.0012	0.0006	0.0010
2016	0.0016	0.0006	0.0015	0.0009	0.0010
2017	0.0021	0.0007	0.0018	0.0007	0.0070

2.8 Conventional health and safety

This SCA covers the implementation of a program to manage workplace safety hazards and protect personnel and equipment.

Regulatory requirements for conventional health and safety are found in the relevant provisions of provincial and/or federal laws (*Occupational Health and Safety Act* (Ontario), the *Ontario Labour Relations Act*, *Occupational Health and Safety Act* (New Brunswick), Quebec's Loi sur la Santé et la Securité au Travail (Québec), and the *Canada Labour Code, Part II: Occupational Health and Safety*). The CNSC has memoranda of understanding with the Provinces of Ontario and New Brunswick to facilitate cooperation in the regulation of conventional health and safety at the nuclear sites. A similar MOU with Québec is not considered necessary. CSA Group standard N286-12, *Management system requirements for nuclear facilities* also contains regulatory requirements that are directly applicable to conventional health and safety.

Conventional health and safety ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
FS	FS	FS	FS	FS	FS	SA	FS	SA

Conventional health and safety encompasses the following specific areas:

- performance
- practices
- awareness

Performance

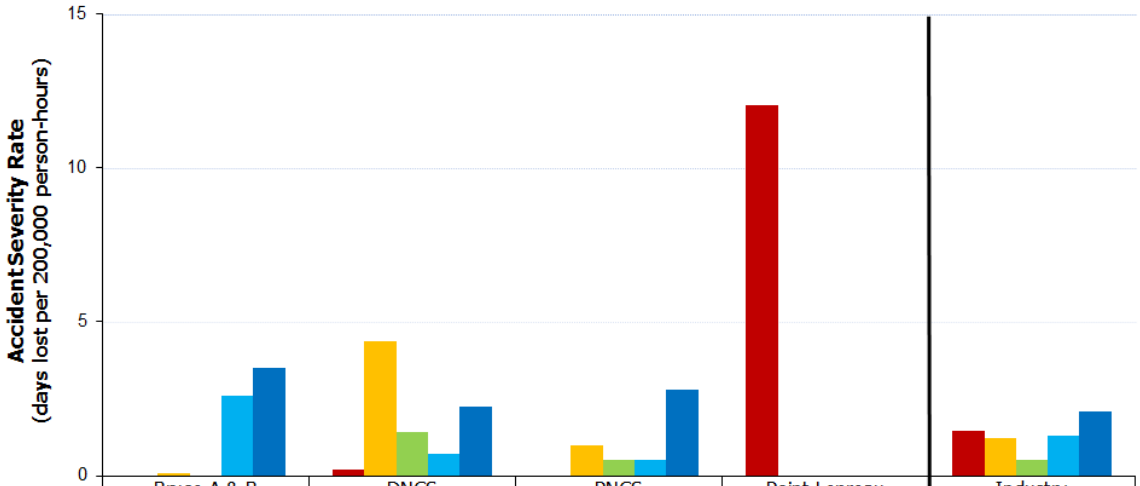
A key performance measure is the number of lost-time-injuries (LTIs) that occur per year. An LTI is an injury that takes place at work, and results in the worker being unable to return to work and carry out their duties for a period of time. The number of recordable LTIs reported by the WMFs was zero in 2017 (as it was in 2016).

NPP licensees are required to report additional safety performance indicators for conventional health and safety in accordance with REGDOC-3.1.1, *Reporting requirements for nuclear power plants*. These safety performance indicators are based on averages for 200,000 person hours worked (approximately 100 person-years). They are not appropriate indicators for Gentilly-2, which has far fewer person hours than the operating NPPs. Hydro-Québec reported one LTI in 2017 (it reported zero in 2016); the LTI in 2017 is discussed in Section 3.6.7. Data for Gentilly-2 has been excluded from the following graphs.

For operating NPPs, the performance indicators “accident severity rate” (ASR), “accident frequency” (AF) and “industrial safety accident rate” (ISAR) provide additional measures of the effectiveness of conventional health and safety programs with respect to worker safety. The ASR measures the total number of days lost due to injury for every 200,000 person-hours (approximately 100 person-years) worked at an NPP. This indicator reflects licensees’ performance to meet nuclear industry standards related to the area of worker health and safety. 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 nuclear power plant personnel.

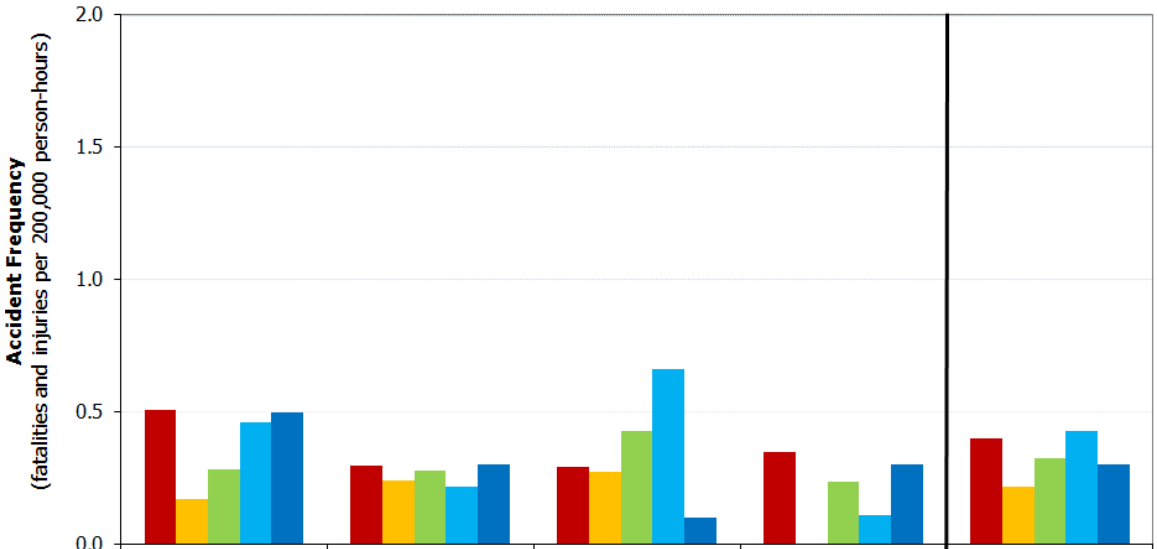
The ASR, AF and ISAR values for the NPPs and industry average are presented in Figures 11, 12, and 13, respectively. CNSC staff observed that the data in Figures 11, 12, and 13 indicate continuing low rates of accidents and lost time due to accidents. CNSC staff observed that there were no work-related fatalities at Canadian NPPs and WMFs in 2017. Figures 14 indicates that accident frequency at the Canadian NPPs continued to be very low in comparison to comparable industries.

Figure 11: Trend details of accident severity rate for NPPs and Canadian industry, 2013–2017



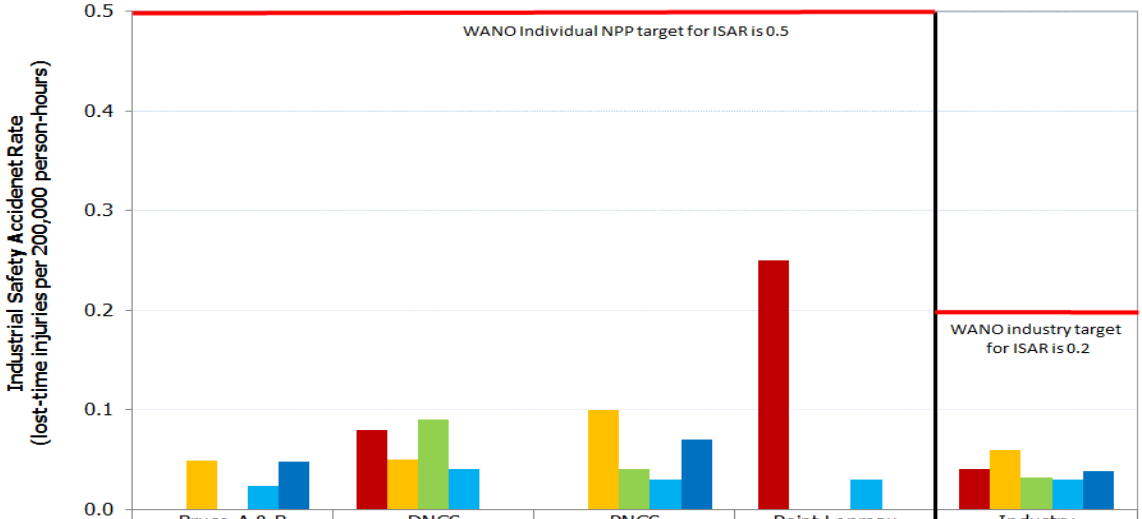
	Bruce A & B	DNGS	PNGS	Point Lepreau	Industry
2013	0.0	0.2	0.0	12.0	1.4
2014	0.1	4.4	1.0	0.0	1.2
2015	0.0	1.4	0.5	0.0	0.5
2016	2.6	0.7	0.5	0.0	1.3
2017	3.5	2.2	2.8	0.0	2.1

Figure 12: Trend details of accident frequency for NPPs and Canadian industry, 2013–2017



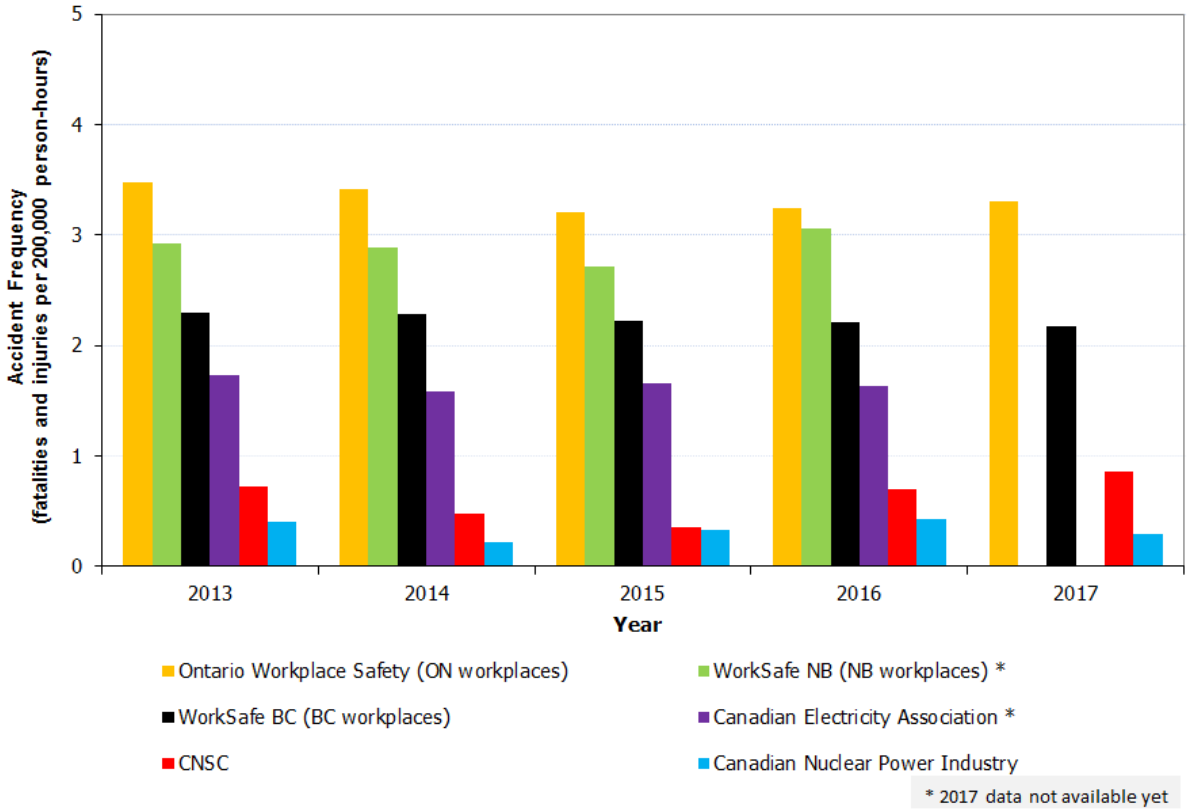
	Bruce A & B	DNGS	PNGS	Point Lepreau	Industry
2013	0.51	0.30	0.29	0.35	0.40
2014	0.17	0.24	0.27	0.00	0.22
2015	0.28	0.28	0.43	0.24	0.33
2016	0.46	0.22	0.66	0.11	0.43
2017	0.50	0.30	0.10	0.30	0.30

Figure 13: Trend details of industrial safety accident rate for NPPs and Canadian industry, 2013–2017



	Bruce A & B	DNGS	PNGS	Point Lepreau	Industry
2013	0.00	0.08	0.00	0.25	0.04
2014	0.05	0.05	0.10	0.00	0.06
2015	0.00	0.09	0.04	0.00	0.03
2016	0.02	0.04	0.03	0.03	0.03
2017	0.05	0.00	0.07	0.00	0.04

Figure 14: Trend details of accident frequency for Canadian workplaces, 2013–2017



Practices

NPP and WMF licensees establish practices through their conventional health and safety policies and programs to protect workers from physical, chemical and other hazards that may arise in their facilities. Licensees provide the CNSC with any reports made to other regulatory bodies (e.g., provincial regulatory body for occupational health and safety).

In addition to radiological hazards, workers at NPPs and WMFs could be exposed to other hazardous materials and industrial work hazards. Hazardous materials can include compressed gases such as gases used for welding activities or fire suppression, and for emission monitors. Other materials include lubricants, adhesives, abrasives, solvents, paints, fuel for incinerators, and other maintenance and cleaning supplies. In addition to hazardous materials, the risks from conventional hazards include, for example, hazards associated with the control and safe handling of large and heavy items, heavy equipment, conventional x-ray equipment for security-related purposes, etc.

Awareness

Licensees deliver safety-related training courses to their employees and contractors. These courses encompass the safety areas of general health and safety knowledge, radiation protection, fire protection, regulatory requirements and job/task-specific safety training, and the use of a Workplace Hazardous Materials Information System (WHMIS) which provides information on the safe use of hazardous materials. The training is supported by management oversight.

2.9 Environmental protection

This SCA covers programs that identify, control, and monitor all releases of radioactive and hazardous substances, and the effects on the environment from facilities or as a result of licensed activities.

Environmental protection ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

Environmental protection encompasses the following specific areas:

- effluent and emissions control (releases)
- environmental management system
- assessment and monitoring
- protection of the public
- environmental risk assessment

Effluent and emissions control (releases)

The following publications contain regulatory requirements that were relevant in 2017:

- CSA Group standard N288.1, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* (2008)

- CSA Group standard N288.1, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* (2014)
- CSA Group standard N288.3.4, *Performance testing of nuclear air cleaning systems at nuclear facilities*
- CSA Group standard N288.5, *Effluent monitoring programs at Class 1 nuclear facilities and uranium mines and mills*

Details on their applicability and implementation are provided in Appendix E: and Section 3.

As part of normal operations, NPPs release radioactive substances into both the atmosphere (as gaseous emissions) and bodies of water (as liquid effluents), and WMFs release radioactive substances into the atmosphere. Licensees are required to control radioactive releases into the environment to ensure they are compliant with and do not exceed the regulatory release limits. These limits are based on derived release limits (DRLs), which are quantities of radionuclides (released as an airborne emission or waterborne effluent) that are calculated based on the regulatory dose limit of 1 mSv per year (1 mSv/y). 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 given in Appendix I:. No radiological releases to the environment from the facilities exceeded the regulatory limits.

Licensees also establish and use environmental action levels that, in 2017, were set at approximately 10 percent of the DRLs with the exception of Point Lepreau (set at 1 percent of the DRLs). An action level is a specific quantity of radionuclide (released as an airborne emission or waterborne effluent) that, if reached, could indicate a loss of control of part of a licensee's environmental protection program and the need for specific actions to be taken and reported to the CNSC. In 2017, Hydro-Québec revised the calculation of its DRLs, which CNSC staff accepted in April 2011. In December 2017 OPG submitted new DRLs and ALs for the WWMF for CNSC staff review.

Data on releases of radionuclides to the environment in 2017 are provided in Appendix I:. The releases were well below the DRLs for each facility; comparisons of the releases with the respective DRLs are also provided in the site-specific discussions of effluent and emissions control in section 3. Further, no environmental action levels were exceeded in 2017 at any facility covered by this report.

Environmental management system

The following publications contain regulatory requirements that were relevant in 2017:

- CNSC regulatory document S-296, *Environmental Protection Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills*
- CNSC REGDOC-2.9.1, *Environmental Protection Policies, Programs, and Procedures* (2013)
- CNSC REGDOC-2.9.1, *Environmental Principles, Assessment and Protection Measures, version 1.1* (2017)

Details on their applicability and implementation are provided in Appendix E: and section 3.

Each licensee has an environmental management system (EMS) to assess environmental risks associated with its nuclear activities, and to ensure that these activities are conducted in a way

that prevents or mitigates adverse environmental effects. The EMS includes activities such as establishing annual objectives and targets and is verified through internal and external compliance audits.

All EMSs for operating NPPs are also registered to ISO 14001: 2015 standard, *Environmental Management Systems – Requirements with Guidance for Use [8]*. As a result of registration, the EMS' are subject to periodic independent third party audits and reviews to verify its sufficiency and also identify potential improvements. CNSC staff confirmed that annual management reviews of the EMS have taken place, and that corrective actions were documented, by reviewing the documentation of licensee management teams.

Assessment and monitoring

Under the NSCA, the licensee of each nuclear facility is required to develop, implement and maintain an environmental monitoring program to demonstrate that the general public and the environment are protected from emissions related to the facility's nuclear activities. The results of these monitoring programs are submitted to the CNSC to ensure compliance with applicable guidelines and limits, as set out in CNSC regulations. CNSC REGDOC-3.1.1, *Reporting requirements for nuclear power plants* requires NPP licensees to submit annual environmental reports to the CNSC. Similar requirements apply to WMFs.

The following publications contain regulatory requirements that were relevant in 2017:

- CSA Group standard N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*
- CSA Group standard N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*

Details on their applicability and implementation are provided in Appendix E: and Section 3.

Licensees monitor groundwater regularly around all sites and submit the results annually to the CNSC. CNSC staff reviewed the 2017 monitoring results and concluded that the licensed operations had no adverse impact on the groundwater environment.

Independent Environmental Monitoring Program

To complement ongoing compliance activities, the CNSC has implemented its own Independent Environmental Monitoring Program (IEMP). The IEMP involves taking samples from publically accessible areas around the facilities, and measuring and analyzing the amount of radiological and hazardous substances in those samples. Samples may be taken for air, water, soil, sediment, vegetation, and some food such as meat and produce.

CNSC staff conducted independent environmental monitoring around the Bruce site (which includes Bruce A, Bruce B, and the WWMF), as well as the Point Lepreau site and the G-2 facilities in 2016. Areas around the Pickering, Darlington, and Point Lepreau sites were sampled in 2017. The results are available on the CNSC website [http://nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/index-iemp.cfm#map].

The IEMP results indicate that the general public and the environment in the vicinity of all sites are protected. The IEMP results are in the same numerical range for the same media with the results submitted by licensees, independently confirming that the licensees' environmental protection programs protect the general people and the environment.

Additionally, regional monitoring is also carried out by other government organizations in the area around the NPPs, which the CNSC takes into account when assessing the protection of

public health and the environment. These include the Ministry of Ontario Environment and Climate Change Drinking Water Surveillance Program, the Ontario Ministry of Labour Ontario Reactor Surveillance Program, and the Health Canada Radiation Monitoring Network, along with a Fixed Point Surveillance system. These programs provide further confirmation that the environment around the sites is protected and that there are no expected health impacts.

Protection of the public

This specific area is related to ensuring that members of the general public are not exposed to unreasonable risk with respect to hazardous substances discharged from the facilities. Dose to the general public is discussed separately in Section 2.7.

Environmental risk assessment

An environmental risk assessment (ERA) is a systematic process used by licensees to identify, quantify and characterize the risk posed by contaminants and physical stressors in the environment to biological receptors, including humans. It is a practice or methodology that provides science-based information to support decision-making and to prioritize the implementation of mitigation measures. The applicant or licensee's ERA informs an environmental assessment (EA) under the Canadian Environmental Assessment act (CEAA 2012) and forms the basis of an EA under the Nuclear Safety and Control Act. The CNSC requires that the environmental effects of all nuclear facilities or activities be considered and evaluated when licensing decisions are made. All licence applications that demonstrate potential interactions with the environment are subject to an EA, commensurate with the scale and complexity of the environmental risks associated with the facility or activity.

The following publication contains regulatory requirements that were relevant to ERAs in 2017:

- CSA Group standard N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*

Details on its applicability and implementation are provided in Appendix E: and Section 3.

The CNSC reviews the ERAs of the operating NPPs on a five-year cycle or more frequently if major facility changes are proposed, or if the science upon which the conclusions are based changes. CNSC staff were satisfied with the status of the ERAs in 2017.

NPP licensees have developed and implemented programs to ensure that fish are being protected from the effects of thermal discharge of water as well as intake water withdrawal (i.e., impingement and entrainment), and to verify that measures are in place to make sure that risks to fish and fish populations remain acceptable. This work is conducted at the request of CNSC staff with advice from agencies including Fisheries and Oceans Canada, and Environment and Climate Change Canada, through respective memoranda of understanding.

2.10 Emergency management and fire protection

This SCA covers emergency response plans and emergency preparedness programs for managing radiological, nuclear, and conventional emergencies. It also includes the results of participation in emergency response exercises during the year. For the specific area of fire response, only the performance of the industrial fire brigade organization is addressed in this SCA. Design issues are described under Section 2.5.

Emergency management and fire protection ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

Emergency management and fire protection encompasses the following specific areas:

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

Conventional emergency preparedness and response

NPP and WMF licensees maintain conventional emergency preparedness and response capabilities to manage potential emergency situations, such as physical injuries, chemical releases, uncontrolled energy releases (such as steam, electrical, compressed gases, etc.), equipment malfunctions, extreme weather conditions, etc. Licensees have safety and emergency response programs to minimize both the probability of occurrence and the consequences from emergencies involving conventional hazards. These programs identify training, barriers, procedures, processes, and emergency response to demonstrate a planned, coordinated and controlled approach to conventional safety and response.

Nuclear emergency preparedness and response

The following publications contain regulatory requirements that were relevant in 2017:

- CNSC RD-353, *Testing and implementation of emergency measures (2016)*
- CNSC REGDOC 2.10.1, *Nuclear emergency preparedness and response (2014)*

Details on their applicability and implementation are provided in Appendix E: and Section 3.

NPP and WMF licensees have emergency preparedness programs that identify the concepts, structures, roles, and resources to implement and maintain an effective response capability. The programs establish how nuclear facilities and other concerned organizations prepare for and plan to respond to emergencies (including nuclear or radiological emergencies, both onsite and offsite), in order to protect workers, the general public and the environment. An effective emergency preparedness program ensures that arrangements are in place to ensure a timely, coordinated, and effective response to any emergency.

Each licensee's response capability is captured in its nuclear emergency plan, which encompasses both emergency preparedness and emergency response measures. It ensures that appropriate emergency response capabilities have been developed and are maintained for an effective response in the event of a nuclear emergency. The plan is based upon the licensee's planning basis for both design basis and beyond design basis events. Note that OPG has a single, Consolidated Nuclear Emergency Plan that governs both the Darlington and Pickering sites.

The licensees nuclear emergency plans include measures to address on-site emergencies, as well as measures that support planning, preparedness, and response for off-site emergencies. The response to offsite emergencies takes a hierarchical approach that involves the licensee, the local municipal government, the provincial/territorial government, and the federal government. Background information on the measures provided by each of these stakeholders is provided in

Appendix K:. The following describes development in 2017 related to the provincial nuclear emergency plans.

Province of Ontario

In 2017, the Province of Ontario revised the Provincial Nuclear Emergency Response Plan (PNERP). The PNERP had undergone a public review involving a formal public consultation, outreach to Indigenous communities and review by an advisory group. CNSC staff submitted proposed changes to the PNERP draft plan to the Advisory Group in August 2017. The updated PNERP Master Plan 2017 was approved by the Executive Council of Ontario in December 2017, which triggered the development of site-specific implementing plans and subsequent incorporation of those plans in the Ontario licensees' emergency plans.

UPDATE: The draft PNERP site-specific implementing plans became available for stakeholder comment in February 2018. These site-specific plans were approved at the end of March 2018. Now that the site-specific plans are approved and issued, the agreements in these plans will be formalized with the United States of America, the federal and provincial governments, and affected municipalities. These affected stakeholders will update their site-specific nuclear emergency plans for their nuclear emergency response.

UPDATE: In 2018, the NPP licensees in Ontario began updating their plans and procedures to align with the new PNERP and site specific implementing plans. The update is administrative and is expected to be operationally complete by March 2019. The licensees plan to complete the revision of training programs for new emergency response staff in 2019.

The Office of the Auditor General (OAG) of Ontario, in its 2017 Annual Report, reported on the status of emergency preparedness in Ontario. There were 14 recommendations regarding the Province's Emergency Management Program and nine that dealt with the nuclear emergency management program. Details can be found at www.auditor.on.ca. CNSC staff reviewed the OAG report and the responses provided by the Ministry of Community Safety and Correctional Services, which committed to correcting the deficiencies that were identified by the OAG.

UPDATE: The Office of the Fire Marshall and Emergency Management (OFMEM) developed a detailed management action plan to address the OAG recommendations. OFMEM staff presented this action plan and a PNERP update to the Commission at the April 4, 2018 Commission Meeting (CMD 18-M21 [9]).

In December 2017, the Commission also requested CNSC to review the OAG report and determine if any of the recommendations identified potential improvements to the CNSC's emergency management program.

In general, the OAG recommendations were intended to enhance compliance with Ontario's *Emergency Management and Civil Protection Act*. They were aimed specifically at the OFMEM, along with its off-site, key partner ministries and some of the affected communities in Ontario. The recommendations did not have a direct impact on the CNSC and its Nuclear Emergency Response Plan, which generally addresses onsite matters with licensees and ensures that the CNSC understands and validates the technical processes and procedures in place.

CNSC staff noted that the recommendations from the OAG report were consistent with the findings from several major exercises conducted at NPPs in Ontario in recent years.

The CNSC is a member of the Nuclear Emergency Management Coordinating Committee, involving all levels of government and the licensees, which openly discusses some of the more complex issues and determines how they will be addressed.

OFMEM began to address the issues and revised the PNERP and the site-specific implementing plans to take the OAG report into consideration. The modifications took into account CSA Group standard N1600, *General requirements for nuclear emergency management programs*, CNSC REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* and IAEA standards.

CNSC staff was satisfied with the progress to date and will continue to support OFMEM to improve the overall nuclear emergency response network in Ontario.

Province of New Brunswick

The New Brunswick Emergency Measures Organization (NBEMO) issued the new Point Lepreau Nuclear Off-Site Emergency Plan in August 2017 and made it available online. NBEMO aligned it with the applicable domestic and international requirements and made its interface more user-friendly. Point Lepreau is compliant with the new plan.

Province of Québec

The off-site nuclear emergency response plan for Québec ("Plan des mesures d'urgence nucléaire externe à la centrale nucléaire pour Gentilly-2", or PMUNE-G2) was abolished in 2016.

Emergency Exercises

As part of their emergency preparedness programs, the licensees conduct emergency preparedness training, drills and exercises annually to ensure their sites have adequate and robust emergency notification and response capability from their own staff and/or nearby emergency services with which they have memoranda of understanding or agreements.

On December 6 and 7, 2017, OPG conducted a full-scale exercise (Exercise Unified Control) at the PNGS, which tested the preparedness and response capabilities and capacities of more than 30 organizations including the CNSC and some non-government agencies. Additional details about the exercise itself are provided in section 3.2.10.

The CNSC participated at its Emergency Operations Centre (EOC) at Headquarters, the Site Management Centre (SMC) at OPG and the Provincial Operations Centre at OFMEM in Toronto. Health Canada had limited participation during this exercise and the majority of activities were simulated.

The CNSC contracted the services of an expert consultant to conduct an independent evaluation during the exercise. OPG also contracted an expert organization to plan all aspects of the exercise and to write a joint evaluation report of all participating organizations in the context of the "Tier one" objectives.

The lessons identified for the CNSC included the following.

- The CNSC EOC needs to refine its briefing methodology, consultation and process with the Emergency Executive Team
- The EOC Director should focus on tactical and strategic responses when briefing the President and the Emergency Executive Team
- Senior management at the CNSC should explore and promote mutual understanding with OPG and OFMEM to better resolve serious issues which could potentially arise
- To ensure a clear understanding, the CNSC should confirm and validate whether the International Nuclear Event Scale (INES) ratings are helpful when responding to a nuclear emergency in Canada

- CNSC should develop a long-term strategy to fully integrate and improve its WebEOC tool for sharing information
- For future exercises, the CNSC should clarify with the Operator early on in the planning process that the technical scenario must be sent to the regulator for review and approval at least six weeks in advance of the exercise start date.

The lessons identified for other organizations included the following.

- A clear understanding of the role and responsibilities of Liaison Officers at the PEOC is necessary, especially within the PEOC Science Group to ensure effective coordination and communication of response activities
- OFMEM should review its data validation process, especially when dealing with conflicting information
- OPG and Region of Durham staff should develop standard radiation guidelines as protective actions to be adhered to by its emergency workers (based on Health Canada's guidance)
- The province should update its decision making process on protective actions to take real-time radiation data into consideration
- Key organizations, such as OPG, CNSC, OFMEM and HC should collectively agree on a common platform to share technical data electronically

CNSC developed a management action plan to ensure all findings are captured and considered as part of the overall emergency management program.

Fire emergency preparedness and response

The following publications contain regulatory requirements that were relevant in 2017:

- CSA Group standard N293, *Fire Protection for nuclear power plants* (2007)
- CSA Group standard N293, *Fire Protection for nuclear power plants* (2012)
- CSA Group standard N393, *Fire protection for facilities that process, handle, or store nuclear substances* (2013)

Details on their applicability and implementation are provided in Appendix E: and Section 3.

The licensees have fire protection programs to minimize both the probability of occurrence and the consequences of fire at their facilities. The programs identify the procedures and processes to demonstrate a planned, coordinated, and controlled approach to fire protection. Fire response capability is maintained through a variety of arrangements.

2.11 Waste management

This SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility. This SCA also covers any planning for eventual decommissioning of the facility.

Waste management ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
FS	SA	FS	SA	SA	FS	FS	SA	SA

Waste management encompasses the following specific areas:

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

The licensees' waste management programs describe how waste is managed throughout its lifecycle to the point of disposal. This includes waste generation, storage, processing, recycling, and removal/transfer.

The licensees continued to provide safe interim storage for LLW, ILW and HLW in 2017, noting that Bruce Power transfers its LLW, ILW, and HLW to OPG's WWMF for management. OPG is moving forward with long-term solutions for the management of LLW and ILW, while Hydro-Québec and NB Power engaged in discussions for possible long-term solutions for their LLW and ILW. OPG, Hydro-Québec, and NB Power are also stakeholders in the Nuclear Waste Management Organization (NWMO), which is leading the development of a long-term-solution for HLW (described below).

Minimal radioactive waste is generated from the waste management activities conducted at the WMFs. Nonetheless, OPG has set a goal to minimize the generation of radioactive waste due to the operational activities of the WMFs.

The following publications contain regulatory requirements that were relevant to the waste management SCA in 2017:

- CSA Group standard N292.0, *General principles for the management of radioactive waste and irradiated fuel* (2014)
- CSA Group standard N292.2, *Interim dry storage of irradiated fuel* (2007 and revised in 2013)
- CSA Group standard N292.3, *Management of low and intermediate-level radioactive waste* (2008 and revised in 2014)

Details on their applicability and implementation are provided in Appendix E: and Section 3.

OPG intends to dispose of low- and intermediate-level waste generated during operations and from decommissioning activities in the deep geologic repository (DGR) proposed for the Bruce nuclear site in Tiverton, Ontario. The DGR will be owned and operated by OPG.

The Canadian Environmental Assessment Agency (CEA Agency) and the CNSC established a joint review panel (JRP) in January 2012 to review OPG's environmental impact statement in support of its application for a licence to prepare the site and construct the DGR. The JRP held public hearings in 2013 and 2014. On May 6, 2015 the JRP issued its environmental assessment report, which included 97 recommendations, to the Minister of Environment and Climate Change

for review and decision under the CEA Act, 2012. In this report, the JRP concluded that OPG's DGR project is not likely to cause significant adverse environmental effects, provided the mitigation measures proposed, the commitments made by OPG during the review, and the mitigation measures recommended by the JRP are implemented.

The Minister of Environment and Climate Change requested additional information from OPG in 2016 and 2017. The CEA Agency will review the additional information, which considers input from the federal review team, Indigenous peoples, and the public. Subject to the Minister's decision, the JRP under the NSCA would decide whether to issue a licence to OPG to prepare a site and construct the DGR.

Waste characterization, waste minimization, and waste management practices

All NPP and WMF licensees continue to employ effective programs for the characterization, minimization, segregation, handling, storage, monitoring, and processing (where applicable) of radioactive and hazardous wastes during 2017.

LLW generated at the DWMF and the PWMF is typically restricted to floor sweepings that have a potential to contain contamination from preparing and welding DSCs. Annual volumes amount to less than one drum that are sent to the DNGS or PNGS, respectively, for segregation as necessary and eventually transported to the WWMF for storage. LLW at the WWMF is processed and/or stored on site. "Likely clean" programs are in place at the DWMF, PWMF and WWMF that allows for the separation at the source of waste that is likely not radioactive, so as to minimize the generation of LLW at these facilities. OPG does not generate ILW at the DWMF, PWMF, or WWMF.

In 2014, OPG began 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. This program continued throughout 2017.

According to assessments of the hazard levels, all radioactive waste was disposed of appropriately using effective waste management practices that complied with the applicable regulatory requirements.

Decommissioning plans

The objective of decommissioning is to permanently retire a nuclear facility from service in a manner that ensures that the health, safety, and security of workers, the general public, and the environment are protected. Decommissioning involves removing radioactive and other hazardous materials from the site, and restoring the site to an agreed end state.

Planning for decommissioning is an ongoing process, taking place throughout each stage of the licensed facility lifecycle. In accordance with paragraph 3(k) of the *Class I Nuclear Facilities Regulations*, the licensees develop Preliminary Decommissioning Plans (PDP) for the facility lifecycle stages before decommissioning. The PDP is updated at minimum every five years, or when required by the Commission, and provides the basis for the cost estimate and financial guarantee, which gives the assurance that funds will be available when the facility is ready to be decommissioned. A Detailed Decommissioning Plan (DDP) is developed prior to decommissioning in support of an application for a licence to decommission.

The following publication contains regulatory requirements that were relevant in 2017:

- CSA N294-09, *Decommissioning of facilities containing nuclear substances*

Regulatory guidance is also found in CNSC document G-219, *Decommissioning Planning for Licensed Activities*.

Details on their applicability and implementation are provided in Appendix E: and Section 3.

The licensees are required to revise the PDPs and associated financial guarantees every five years or when requested by the Commission. For NPPs, the proposed decommissioning strategy allows for an extended period of storage with surveillance after the end of normal operations. This period would take place under a CNSC licence and would last for three or four decades prior to the onset of active dismantling, allowing for radioactive decay and safe storage of dismantling equipment. The decommissioning strategy for the WMFs, on the other hand, is immediate decommissioning with dismantling activities beginning once the waste is moved to a permanent repository.

OPG updated its PDPs for all of its nuclear facilities including the Bruce A and B, WWMF, DNGS, DWMF, PNGS, and PWMF in January 2017 and submitted it to the CNSC for acceptance. These plans covered the period of 2018 to 2022 (the next regular revision is due in 2022). CNSC staff concluded that the plans met the applicable regulatory requirements and guidance.

The PDPs for Point Lepreau and Gentilly-2 are separate and are discussed in sections 3.5.11 and 3.6.10, respectively.

The financial guarantees for decommissioning are discussed in section 2.15.

2.12 Security

This SCA covers the programs licensees are required to implement in support of the requirements stipulated in the *Nuclear Security Regulations* and associated regulatory documents, in their licences, in orders, or in expectations for their facilities or activities.

Security ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

Security encompasses the following specific areas:

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

While not represented as a specific area, cyber security has become an important topic; it is discussed under the facilities and equipment specific area, under the heading cyber security.

Facilities and equipment

The following publications contain regulatory requirements that were relevant in 2017:

- CSA Group standard N290.7-14, *Cyber security for nuclear power plants and small reactor facilities*

- CNSC RD-321, *Criteria for Physical Protection Systems and Devices at High-Security Sites*
- CNSC RD-361, *Criteria for Explosive Substance Detection, X-ray Imaging and Metal Detection at High-Security Sites*

Details on their applicability and implementation are provided in Appendix E: and Section 3.

OPG partnered in the Durham Regional NextGen public safety radio system. In 2017, it installed radio system infrastructure at the sites to support improved and interoperable communication links to offsite response services in Durham Region. The P25 safety-grade communications system for the general public was established as the primary communications system for OPG fire and security organizations.

UPDATE: The system became operational for the security exercise under the CNSC Performance Testing Program at the Pickering site in March 2018 and was evaluated as a performance objective with positive results.

Cyber Security

NPP licensees maintain cyber security programs to protect cyber-essential assets from cyber-attacks. Licensees are working through the CANDU Owners Group cyber security peer group program to share lessons learned and develop best industry practices for implementing cyber security controls.

Response arrangements

The following publication contains regulatory requirements for operating NPPs that were relevant in 2017:

- CNSC REGDOC-2.12.1, *High-Security Sites: Nuclear Response Force*

Details on its applicability and implementation are provided in Appendix E:.

All licensees provide well-trained and suitably equipped Nuclear Security Officers for their facilities.

High-Security Nuclear Facilities have formal arrangements with off-site armed response services and contributed significant resources to the CNSC performance testing program by providing expert staff and participants to the Canadian Adversary Testing Team.

Security practices

NPP and WMF licensees have programs and procedures in place to control access to facilities, nuclear materials, and prescribed information.

The following publications contain regulatory requirements that were relevant in 2017:

- CNSC REGDOC-2.12.2, *Site Access Security Clearance*
- CNSC REGDOC-2.12.3, *Security: Security of Nuclear Substances: Sealed Sources*

Details on their applicability and implementation are provided in Appendix E: and Section 3.

UPDATE: All licensees were compliant with the regulatory requirements in REGDOC-2.12.3 for categories 1, 2, 3, 4, and 5 sealed sources by May 31 2018.

The WMFs updated their security operating procedures and ensured that their contingency plans met the Design Basis Threat (DBT) in 2017.

As a result of the Treasury Board Secretariat (TBS) update to its Standard on Security Screening, CNSC staff requested the licensees to implement new screening practices as part of their Site Access Security Clearance (SASC) programs. These best practices will be identified as requirements in the revision of REGDOC 2.12.2, and will apply to NPPs and WMFs.

Each licensee has taken a different approach to adjust its screening practices to meet the TBS update.

Drills and exercises

Licensees have exercise and drill programs to validate security practices, ensure regulatory compliance and identify areas for improvement in security operations, including drills with the participation of offsite response.

2.13 Safeguards and non-proliferation

This SCA covers the programs and activities required for the successful implementation of Canada's obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements as well as other measures arising from the Treaty on the Non-Proliferation of Nuclear Weapons.

Safeguards and non-proliferation ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

The safeguards program encompasses the following specific areas:

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

This section also includes a statement of the IAEA's overall safeguards conclusion for Canada.

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

Nuclear material accountancy and control

The following publication contains regulatory requirements that were relevant in 2017:

- CNSC RD-336, *Accounting and Reporting of Nuclear Material* (2010)

Details on its applicability are provided in Appendix E:.

Access and assistance to the IAEA

NPP and WMF licensees are required to grant adequate access and assistance to the IAEA in order to perform safeguards activities at their respective facilities, including inspections and the

maintenance of equipment. The inspections may include an annual physical inventory verifications and a number of short notice and unannounced inspections that target certain groups of material or their transfer.

Operational and design information

NPP and WMF licensees are required to submit operational and design information, as well as necessary information pursuant to the IAEA Additional Protocol to the CNSC on time..

Safeguards equipment, containment and surveillance

NPP and WMF licensees support IAEA equipment operation and maintenance activities at the NPPs and WMFs, including maintenance and installation of surveillance equipment to ensure the effective implementation of safeguards measures at each facility.

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 Agency's verification activities, the IAEA was able to conclude that all nuclear material in Canada has remained in peaceful activities, including the nuclear material at the NPPs and WMFs.

2.14 Packaging and transport

This SCA pertains to programs that cover the safe packaging and transport of nuclear substances to and from the licensed facility.

Packaging and transport ratings

DNGS	DWMF	PNGS	PWMF	PLNGS	Bruce A	Bruce B	WWMF	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

Packaging and transport encompasses the following specific areas:

- package design and maintenance
- packaging and transport
- registration for use

While the *Packaging and Transport of Nuclear Substance Regulations, 2015* do not apply to on-site transfers of packages, the licensees have programs in place to provide an equivalent level of safety to workers, the general public, and the environment as is required for off-site transportation.

Package design and maintenance

Nuclear substances originating from NPPs and WMFs are required to be transported using packages that meet regulatory requirements. Common shipments include tritiated heavy water, contaminated tooling, laundry, resin and filters, and material samples for analysis.

Packaging and transport

NPP and WMF licensees have programs in place to ensure compliance with the requirements of both the *Packaging and Transport of Nuclear Substances Regulations*, 2015 and the

Transportation of Dangerous Goods Regulations for all shipments of nuclear substances to and from their facilities. All licensees are required to have appropriate training for personnel involved in the handling and transport of dangerous goods and to issue a training certificate to those workers in accordance with the *Transportation of Dangerous Goods Regulations*.

Registration for use

As required by the *Packaging and Transport of Nuclear Substances Regulations*, 2015, all licensees who use certified packages have registered their use with the CNSC.

2.15 Other matters of regulatory interest

Other matters of regulatory interest include public information and disclosure, Indigenous consultation, financial guarantees, nuclear liability insurance, and environmental assessment. Environmental assessment is discussed under the environmental protection SCA.

Public information programs

The following publication contains regulatory requirements that were relevant in 2017:

- CNSC RD/GD-99.3, *Public Information and Disclosure Program*

NPP and WMF licensees have public information and disclosure programs that are supported by disclosure protocols. The protocols outline the type of information that will be shared with the general public (e.g., incidents, major changes to operations, periodic environmental performance reports) and how that information will be shared. The objective is to ensure that timely information about the health, safety and security of persons and the environment and other issues associated with the lifecycle of nuclear facilities is effectively communicated.

The licensees provide information on the status of their facilities through a variety of communication activities, such as information sessions for the general public, facility tours, participation in community events, newsletters, ongoing website updates, and use of social media.

Indigenous relations

In addition to the licensees' work (described in Section 3) to build and sustain relationships with Indigenous peoples, the CNSC also works toward strengthening relationships with Indigenous peoples. CNSC staff efforts in 2017 supported the CNSC's commitment to reconciliation and building strong relationships with Indigenous peoples with interests in Canada's NPPs and WMFs. CNSC staff continued to work with Indigenous communities and organizations to identify opportunities for formalized and regular engagement throughout the lifecycle of those facilities.

Through this engagement, CNSC staff welcomed the opportunity to discuss all issues of interest and concern, including the licensees' scheduled reports to the CNSC. CNSC staff continued to work with the licensees to ensure that their scheduled reports were provided to interested Indigenous communities and organizations.

CNSC staff continued to have regular communications and meetings, including facilitated workshops with Indigenous communities and organizations to discuss their respective interests, issues, and concerns. Concerns raised or issues addressed during these meetings included: the CNSC's IEMP and possible opportunities for participation in the program; the operation of NPPs and WMFs in Canada; environmental impacts from nuclear power plants; *Fisheries Act* authorizations; environmental impacts – including to fish; major component replacement oversight; the CNSC's role as an agent of the Crown; and, the CNSC's approach to engagement

and consultation.

Copies of the *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites* are sent to all Indigenous communities and organizations who have requested to be kept informed of activities at NPPs and WMFs. These communities are notified of the availability of funding through the CNSC's Participant Funding Program to support their participation in the review of this report.

Nuclear liability insurance

On January 1, 2017 the *Nuclear Liability and Compensation Act* (NLCA) came into force, replacing the *Nuclear Liability Act* (NLA). The NLCA requires nuclear installations (nuclear facilities that have the potential to undergo a nuclear criticality event) to carry nuclear liability insurance.

Whereas the administration of the NLA was shared between the CNSC and Natural Resources Canada (NRCan), the role of administering the NLCA resides solely with NRCan.

Therefore, the CNSC will not require that licensees provide proof of compliance with the NLCA on an ongoing basis. Licensees will be expected to meet its (their) obligation(s) for nuclear liability coverage under the NLCA, consistent with the CNSC general licence conditions requiring licensees to be in compliance with all applicable laws. CNSC staff confirm with NRCan that the licensees comply with the financial security obligations of the NLCA.

Financial guarantees

The NPP and WMF licensees are required to revise their financial guarantees associated with the PDPs every five years or when requested by the Commission.

In January 2017, as part of its submission to the CNSC of its consolidated PDP, OPG submitted information related to its revised financial guarantee for the future decommissioning of its nuclear facilities in Ontario. Following a public hearing in October 2017, the Commission accepted OPG's revised financial guarantee, which was in the amount of $16,468 M in 2018 dollars – OPG's financial guarantee was valued at $21, 171 M as of December 31, 2017.

The financial guarantees for Point Lepreau and Gentilly-2 are discussed in Sections 3.3.15 and 3.6.15, respectively.

3 Nuclear power plant and waste management facility safety performance and regulatory developments

3.1 Darlington site

The safety assessment presented below for each SCA is facility-specific. General information relevant to the SCAs is provided in Section 2. The CNSC regulatory documents and CSA Group standards that were identified as regulatory requirements for the Darlington site, as of December 2017, are listed in Appendix E:.

Safety assessment

The Darlington site consists of the Darlington Nuclear Generating Station (DNGS), the Tritium Removal Facility (TRF), and the Darlington Waste Management Facility (DWMF). The CNSC staff safety assessment of the Darlington site for 2017 resulted in the performance ratings shown in Table 13. Based on the observations and assessments of the SCAs, CNSC staff concluded that the DNGS, TRF and DWMF operated safely. The overall rating for the DNGS (and TRF) was "fully satisfactory", unchanged from the integrated plant rating for 2016. The overall rating for the DWMF was "satisfactory", unchanged from 2016.

Table 13: Performance ratings for the Darlington site, 2017

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

Legend: FS – Fully Satisfactory SA – Satisfactory
BE – Below Expectations UA – Unacceptable

* Also applies to TRF

3.1.0 Introduction

Darlington Site

The Darlington Site is located on the north shore of Lake Ontario in Clarington, ON, five kilometers outside the town of Bowmanville and 10 kilometers southeast of Oshawa. The CNSC regulates the DNGS and the TRF under a power reactor operating licence (PROL); and the DWMF under a separate, independent waste facility operating licence (WFOL). General statements in this regulatory oversight report about DNGS can be considered to be applicable to the TRF, unless stated otherwise. The facilities are owned and operated by Ontario Power Generation Inc. (OPG).

Darlington Nuclear Generating Station

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

OPG intends to refurbish the four reactors; Unit 2 refurbishment began in October 2016 and continued in 2017. OPG constructed the Retube Waste Processing Building (RWPB) on the NPP site for the execution of refurbishment activities. The RWPB was placed in operation in November 2017, in time for the processing of the removed reactor components from Unit 2, namely end-fittings, pressure tubes and calandria tubes.

The TRF, which is housed in the heavy water management building (HWMB), 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.

Darlington Waste Management Facility

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, which was completed and placed into operation in 2017.

OPG's DWMF (Source: OPG)

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. The transfer of loaded DSCs from the DNGS to the DWMF is conducted on OPG property with a security escort and the transfer of loaded DSOs from the DNGS to the RWSB is also conducted on OPG property.

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

OPG is authorized under the current licence for the DWMF 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

Darlington Nuclear Generating Station

The PROL for DNGS, which also governs the TRF, was renewed in December 2015 [10] for a 10-year period, expiring November 30, 2025). The PROL was issued with an accompanying licence conditions handbook (LCH).

In March and April 2017, OPG requested the Commission to amend the PROL for the DNGS to allow the import and export of nuclear substances occurring primarily as contaminants in laundry, packaging, shielding or equipment. These activities were already authorized under a Nuclear Substance and Radiation Device Temporary Possession licence. CNSC staff determined that there were no safety impacts associated with the proposed licence amendment, and that it would not change the scope of the import and export activities already authorized under the existing temporary possession licence. On October 26, 2017, the Commission amended Part IV of the DNGS PROL to include the new licensed activity.

Darlington Waste Management Facility

The Commission renewed the WFOL for the DWMF in March 2013 [11], with an expiry date of April 30, 2023. No licensing actions occurred in 2017.

LCH

Darlington Nuclear Generating Station

There was one revision to the DNGS LCH in 2017. The revision to the LCH was to update the compliance verification criteria in various sections to include new or revised regulatory documents and standards and licensee documents. See Appendix F for details.

Darlington Waste Management Facility

The DWMF LCH was not revised in 2017.

Fisheries Act Authorization

The Department of Fisheries and Oceans (DFO) issued a *Fisheries Act* authorization on June 24, 2015 for the DNGS. The authorization contains a reporting condition on the offset plan (compensation for residual harm to fish and fish habitats) to both DFO and CNSC staff.

Refurbishment

Darlington Nuclear Generating Station

CNSC staff are actively monitoring and conducting compliance verification inspections of the refurbishment of Unit 2, which started its refurbishment outage on October 14, 2016.

CNSC staff are focusing their regulatory oversight on regulatory deliverables specified in the Integrated Implementation Plan (IIP), implemented in accordance with licence condition (LC) 15.3. The IIP was approved by the Commission during the licence renewal process, which delegated to staff the acceptance of scheduling changes per the change control and closeout process referenced in the LCH including those IIPs tied to return to service of Unit 2.

Work committed to in the IIP by OPG is progressing according to schedule; OPG submitted its annual report on completed IIP items for 2017 in March 2018. OPG planned and completed 37 IIP tasks in 2017. Table 14 summarizes the IIP tasks that have been planned and already completed for the duration of the project. The report is under review by CNSC staff. IIP items are closed only when CNSC staff confirm that each has met regulatory requirements.

Table 14: IIP progress

Year	Planned Tasks	Completed Tasks
2015	102	102
2016	38	38
2017	37	37
2018	52	15
2019	109	23
2020	18	2
2021	3	-
2022	105	5
2023	28	-
2024	46	2
2025	62	5
2026	14	0
2027	3	-
2028	12	1
Total	629	230

OPG made a commitment to address several station improvement opportunities as part of its 2012 environmental assessment for the refurbishment project. The station improvement opportunities are features to further improve safety of the plant under beyond-design-basis accidents. These commitments were later incorporated into the IIP to consolidate all the implementation activities. These station improvement opportunities are:

- shield tank over-pressure (STOP) modifications in all four units
- containment filtered venting system (CFVS)
- emergency power generator 3 (EPG 3)
- powerhouse steam venting system (PSVS)
- emergency service water and diesel driven fire water pumps

The PSVS improvements and the installation of the STOP modifications on Units 1, 3 and 4 are complete. The Unit 2 STOP modifications will be installed during the refurbishment outage prior to unit restart in accordance with the original IIP schedule, 2019.

EPG 3 installation and commissioning was complete. CNSC staff conducted an inspection of the EPG 3 installation and commissioning at the DNGS. The inspection confirmed compliance with IIP commitments for the installation and commissioning of EPG 3 and that OPG met the completion assurance, design, installation, commissioning and turnover requirements . Based on the scope of the inspection conducted, CNSC staff concluded that the licensee was compliant with the regulatory requirements.

The CFVS was commissioned and available for service in 2017. CNSC staff conducted an inspection on the CFVS. The inspection confirmed compliance with IIP commitments for the installation and commissioning of the CFVS and that OPG met the completion assurance, design, installation, commissioning and turnover requirements.

CNSC staff are satisfied with the progress to date.

A protocol has been established between the CNSC and OPG to clarify requirements for return to service of Unit 2 and the removal of regulatory hold points. There was one revision of this protocol in 2017. Regular meetings are required under the protocol to monitor progress on the refurbishment.

Event Initial Report

Darlington Nuclear Generating Station

CNSC staff submitted two event initial reports to the Commission pertaining to DNGS for the period January 1, 2017 to June 1, 2018. They are described in Table 15.

Table 15: Event initial reports for DNGS

Subject	Brief description
Contaminated motor shipped to an unlicensed vendor (as reported in CMD 17-M11 [12])	In February 2017, an event occurred where four electrical motors with undetected internal contamination were shipped from DNGS to an unlicensed facility for repair. All four motors had been surveyed for contamination at DNGS and approved for unconditional transfer prior to the shipment. Following the detection of contamination at the repair facility, all four motors and contaminated materials were packaged and shipped back to DNGS by qualified shippers and in accordance with OPG procedures and Packaging and Transport Nuclear Substances Regulations, 2015. There were no safety consequences as a result of the incident. The licensee has taken the necessary measures to ensure an incident such as the one reported does not re-occur.
CMD 18-M14 [13]	In February 2018, two workers were contaminated while working in the retube waste processing building. Investigation determined that a wrongly classified work site resulted in workers wearing ineffective protective gear for the radiological hazards they encountered. This event was presented to the Commission during a public meeting held on March 15, 2018. Dose assessments confirmed that the two workers received a committed effective dose of 0.28 mSv and 0.31 mSv, well below the licensee's action level and the regulatory dose limits. CNSC staff conducted a reactive inspection and identified several non-compliances with OPG's Radiation Protection program requirements. OPG is expected to provide a corrective action plan to address the findings in 2018. Any findings that are identified during the CNSC's review of this event will be considered in the assessments for the 2018 regulatory oversight report.

Darlington Waste Management Facility

No event initial reports pertaining to DWMF were submitted to the Commission for the period January 1, 2017 to June 1, 2018.

Compliance Program

The annual CNSC effort on the compliance program is tabulated in Appendix G: for the DNGS and the DWMF. The inspections at the Darlington site that were considered in the safety assessments in this regulatory oversight report are tabulated in Appendix J:.

3.1.1 Management system

CNSC staff concluded that the management system SCA at the Darlington site met the performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received "satisfactory" ratings, unchanged from the previous year.

Management system

CNSC staff determined that OPG's Nuclear Management System at the Darlington site met the applicable regulatory requirements in 2017. OPG has completed the transition to the 2012 version of CSA Group standard N286-12, *Management system requirements for nuclear facilities*.

Darlington Nuclear Generating Station
As a result of regulatory oversight, CNSC staff are satisfied with OPG performance for this specific area.

Darlington Waste Management Facility

CNSC staff conducted a desktop review of OPG's Nuclear Waste Management Program documentation for the DWMF and determined that it was adequate to meet the applicable regulatory requirements. In 2017, CNSC staff conducted a general inspection at DWMF, with a focus on OPG's Management system. As a result of the inspection, CNSC staff identified minor issues of low safety significance regarding clarity and consistent application of documentation. At the end of 2017, CNSC staff were monitoring the implementation of the corrective actions.

Organization

CNSC staff determined that OPG has adequately defined organizational structures and roles and responsibilities at the Darlington site.

Darlington Nuclear Generating Station
In 2017, CNSC staff inspected the implementation of the OPG organization, roles and responsibilities and interfaces at DNGS (and PNGS) related to the documentation and corporate business units.

CNSC staff identified low safety significance non compliances with respect to identifying all program interfaces and defining roles and accountabilities.

At the end of 2017, CNSC staff were reviewing OPG corrective action plan and will continue to monitor OPG's implementation.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

Change Management

CNSC staff determined that OPG has an adequate change management program at the Darlington site that complies with the applicable regulatory requirements.

Darlington Nuclear Generating Station
As a result of regulatory oversight, CNSC staff were satisfied with OPG performance for this specific area.

Darlington Waste Management Facility
In 2017, CNSC staff inspected the change management process at DWMF and found that its implementation was ineffective for the DSC inspection process and for other generic documentation that is used by all OPG WMFs, resulting in a finding of medium safety significance. As a result of the inspection, OPG implemented a change management committee to manage governance and process changes for nuclear waste at all the WMFs, and committed to applying the corrective actions. At the end of 2017, CNSC staff were monitoring the implementation of the corrective actions and overseeing the implementation of OPG's changes at the DWMF.

Safety culture

CNSC staff were satisfied that OPG continued to foster a healthy safety culture at the Darlington site in 2017. CNSC will monitor OPG's next safety culture self-assessment at the Darlington site, scheduled for 2018, and any improvement actions initiated.

Configuration management

CNSC staff determined that OPG maintained the configuration of its structures, systems and components (SSCs) at the Darlington site in compliance with its configuration management program and other applicable regulatory requirements.

Darlington Nuclear Generating Station
In 2017, CNSC staff inspected configuration management at DNGS and identified one deficiency of low safety significance with respect ensuring that the status of equipment and systems is known at all times during the outage.

OPG addressed this deficiency by re-enforcing the requirements of configuration control during outages. In addition, OPG has reviewed their instructions to become more robust and has committed to performing a self assessment during the Unit 3 and Unit 4 outages in 2018.

CNSC staff were satisfied with OPG's corrective action plan, which is targeted to be complete by September 2018.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

Records management

CNSC staff determined that OPG continued to maintain and implement a document control and records management system at the Darlington site that complied with the applicable regulatory requirements.

Darlington Nuclear Generating Station

During inspections in 2017, CNSC staff identified deficiencies of low safety significance in the control of documents and records at DNGS with respect to the traceability of documents. CNSC staff reviewed OPG's corrective action plans and were satisfied with the progress to the end of 2017. OPG is planning to have a new records repository by the end of 2020. In 2018, CNSC staff will review this upgrade to ensure it meets the applicable requirements.

Darlington Waste Management Facility

CNSC staff's inspection that focused on OPG's management system identified deficiencies of low safety significance in the control of documents and records at the DWMF. At the end of 2017, CNSC staff were reviewing OPG's corrective action plans and were satisfied with the progress.

Management of contractors

Darlington Nuclear Generating Station

CNSC staff confirmed in 2017 that the interfaces between OPG and its contractors at DNGS are planned, defined, controlled and understood in accordance with the applicable regulatory requirements. In 2016, CNSC staff identified deficiencies of low safety significance in the area of management of contractors at DNGS during a reactive inspection on quality management and project oversight, with respect to maintaining documentation and records of oversight activities. The corrective action plans were developed by OPG in 2017. OPG addressed the deficiencies to the satisfaction of CNSC staff.

Darlington Waste Management Facility

CNSC staff concluded that the interface between OPG and its contractors at the DWMF did not meet the applicable regulatory requirements in 2017. CNSC staff during an inspection that focused on OPG's management system observed that OPG was no longer performing the receiving inspection, including the verification of the DSC history docket received from the vendors, which effectively removed oversight of the vendors. OPG had cancelled the source surveillance inspection for DSCs at all three-waste facilities (the DWMF, PWMF and WWMF) in 2014, but had failed to reflect this change in its internal documentation. CNSC staff assessed this as a medium finding in the context of the management of contractors, but noted that the overall safety significance of the finding was low because there are several other subsequent verification steps in the loading and storage of DSCs.

As a result, CNSC staff directed OPG to conduct an extent of condition assessment of DSCs received after 2014; including the DSC history packages, and prohibited the transport of the affected DSCs until OPG completed the extent of condition assessment.

CNSC staff reviewed OPG's corrective action plan that includes conducting an extent of condition assessment of the affected DSCs, and found it to be acceptable. OPG committed to updating the CNSC on its progress to implement the corrective actions, expected to be complete by 2019. At the end of 2017, CNSC staff were monitoring the implementation of the corrective actions.

Business continuity

CNSC staff concluded that OPG met the applicable regulatory requirements for business continuity at DNGS and the DWMF. CNSC staff verified that OPG had adequate contingency plans in place to maintain or restore critical safety and business functions in the event of disabling circumstances, such as a pandemic, severe weather, or labour actions.

Problem identification and operating experience

CNSC staff determined that OPG met the applicable regulatory requirements for problem identification and OPEX at the Darlington site.

Darlington Nuclear Generating Station

In 2017, CNSC staff conducted an inspection at DNGS on the event investigation process. OPG was compliant with the regulatory requirements; however, CNSC staff found that for some event categories, OPG did not consistently conduct a root cause analysis as required in the OPG's corrective action program. For those events, CNSC staff found that OPG conducted a common cause evaluation, instead of a root cause analysis.

CNSC staff were satisfied with OPG's corrective action plans and will continue to monitor their implementation in 2018.

Darlington Waste Management Facility

CNSC staff has no significant observations at the DWMF to report in this specific area in 2017.

Performance assessment, improvement and management review

CNSC staff confirmed that OPG continued to meet the applicable regulatory requirements for performance assessment, improvement, and management at the DNGS and the DWMF.

CNSC staff has no significant observations at the DNGS or DWMF to report in this specific area for 2017.

3.1.2 Human performance management

CNSC staff concluded that the human performance management SCA at the Darlington site met performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received a "satisfactory" rating, unchanged from the previous year.

Human performance program

CNSC staff determined that OPG's human performance program for the DNGS and the DWMF met the applicable regulatory requirements.

CNSC staff had no significant observations at the DNGS or the DWMF to report in this specific area for 2017.

Personnel training

CNSC staff determined that OPG has a well-documented and robust fleet-wide training system based on a systematic approach to training (SAT). Implementation of this system for the training programs at the DNGS and the DWMF met the applicable regulatory requirements.

Darlington Nuclear Generating Station

In 2017, CNSC staff performed compliance verification inspections of the Authorized Nuclear Operator and Contract Management personnel training programs at DNGS. CNSC staff also

performed a desktop review of the Chemical Laboratory Staff training program in DNGS. In all cases, CNSC staff concluded that the training programs were defined and documented in accordance with the OPG SAT-based training system and that OPG met regulatory requirements. Minor procedural non-compliances of low safety significance were identified with respect to the documentation of training objectives and alignment of training qualification description documents with governance. CNSC staff were satisfied with OPG's progress to address non-compliances

Darlington Waste Management Facility

In 2017, CNSC staff verified that OPG completed the corrective actions that resulted from the training-focused compliance verification inspection conducted in 2016 to CNSC staff's satisfaction and the associated action item was closed.

Personnel certification

Darlington Nuclear Generating Station

CNSC staff determined that OPG's personnel certification program at DNGS met the applicable regulatory requirements. CNSC staff reviewed the staffing reports for certified personnel, the applications for initial certification and renewal of certification, and confirmed that certified personnel at DNGS possessed the knowledge and skills required to perform their duties safely and competently.

DarlingtonWaste Management Facility

This specific area does not apply to the DWMF because there are no CNSC certified positions at the facility.

Initial certification examinations and requalification tests

Darlington Nuclear Generating Station

CNSC staff concluded that the initial certification examination and requalification testing programs for the certified personnel at DNGS met the applicable regulatory requirements.

In 2017, CNSC staff conducted a compliance verification inspection of the conduct of the Simulator-Based initial Certification Examinations. A non-compliance of low safety significance was observed by CNSC staff, with respect to examination support team members not consistently performing their role playing duties in accordance with requirements during the conduct of certification examinations. CNSC staff were satisfied with OPG`s corrective actions that were developed and implemented to prevent recurrence.

DarlingtonWaste Management Facility

This specific area does not apply to the DWMF because there are no CNSC certified positions at the facility.

Work organization and job design

Minimum shift complement

Darlington Nuclear Generating Station

The minimum shift complement at DNGS met the applicable regulatory requirements.

In 2017 at DNGS, there were only two MSC violations by duty crew staff and they did not impact safety. One individual left due to a family emergency, and the other violation was due to a late sick call.

DarlingtonWaste Management Facility

This specific area does not apply to the DWMF.

Fitness for duty

CNSC staff determined that OPG met the applicable regulatory requirements for fitness for duty at the DNGS and the DWMF.

CNSC staff requested OPG to provide an implementation plan for REGDOC-2.2.4 *Fitness for Duty, Volume I: Managing Worker Fatigu*e by September 30, 2017. OPG committed to the full implementation of this REGDOC at the Darlington site by January 1, 2019. CNSC staff were satisfied with OPG's implementation plan and will monitor its progress.

OPG committed to the implementation of REGDOC -2.2.4 *Fitness for Duty, Volume II: Managing Alcohol and Drug Use,* except random testing, by July 2019. The implementation date for random testing is planned for December 2019. CNSC staff will monitor OPG's implementation progress.

UPDATE: CNSC staff found the plans to be acceptable, although notes that implementation could be impacted by legal challenges.

Darlington Nuclear Generating Station

In 2017, CNSC staff completed a desktop review to verify the accuracy of reporting of non-compliances with the limits of hours worked for certified staff for DNGS (and PNGS). CNSC staff identified non-compliances related to processes used to track, monitor and report hours of work non-compliances. By the end of 2017, OPG was developing a corrective action plan that covered both PNGS and DNGS.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

3.1.3 Operating performance

CNSC staff concluded that the operating performance SCA at the Darlington site met or exceeded performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received "fully satisfactory" ratings, unchanged from the previous year.

Conduct of licensed activities

CNSC staff concluded that OPG met or exceeded the applicable regulatory requirements for the conduct of licensed activities at the DNGS and the DWMF. CNSC staff observed that OPG continued to operate the DNGS and the DWMF in a safe and secure manner, with adequate regard for health, safety, security, radiation and environmental protection and international obligations.

In 2017, OPG operated the DNGS and the DWMF within the bounds of its operating policies and principles, and operational safety requirements.

Darlington Nuclear Generating Station

DNGS experienced one unplanned reactor trip, one stepback and two setbacks.

In 2017, CNSC staff determined that the stepback, setbacks and reactor trip were controlled properly and power reduction was adequately initiated by the reactor control systems. CNSC staff verified that for all events, Darlington staff followed approved procedures and took appropriate corrective actions.

Tritium Removal Facility

In 2017, CNSC staff conducted an inspection at the TRF and concluded that the TRF met the regulatory requirements applicable to the operation of the facility.

CNSC staff observed that the operation of the TRF did not exceed any environmental release limits, and was operated safely.

Darlington Waste Management Facility

During the reporting period, OPG processed 63 DSCs at the DWMF. Since the start of facility production to the end of 2017, OPG had processed and placed into storage 551 DSCs at the DWMF.

In 2017, OPG completed construction of the RWSB. Prior to the commencement of operations at the RWSB, CNSC staff reviewed and accepted the RWSB commissioning reports. A Record of Acceptance was issued to OPG in November 2017. As of December 31, 2017, 29 loaded Retube Waste Containers had been transferred from the DNGS to the DWMF.

Procedures

OPG has governance in place that ensures that procedures at the DNGS and the DWMF are written in a consistent and usable manner. OPG has clearly documented expectations for procedural use and adherence, and a process to manage procedural changes at the Darlington site. CNSC staff were satisfied with the quality of the OPG procedures and found that they met the applicable regulatory requirements at the DNGS and the DWMF.

Reporting and trending

CNSC staff determined that OPG's reporting and trending met or exceeded the applicable regulatory requirements and expectations in 2017 for the DNGS and the DWMF.

During the reporting year, all scheduled reports were submitted to CNSC in a timely manner and were adequate. In accordance with the LCHs, OPG provided notification of document changes to CNSC staff throughout the reporting period that were reviewed by staff, and comments were provided to OPG as applicable.

Darlington Nuclear Generating Station

OPG submitted 60 event reports to CNSC regarding the DNGS. CNSC staff found that OPG`s reporting and trending processes met or exceeded the applicable regulatory requirements and expectations in 2017 for DNGS and the DWMF. All reported events were followed up by OPG with corrective actions and root cause analysis, when appropriate.

Darlington Waste Management Facility

During 2017, CNSC staff received 2 event reports of low safety significance from OPG regarding the DWMF. The event reports are discussed in detail in their applicable SCA section(s) throughout this report.

Outage management performance

Darlington Nuclear Generating Station

CNSC staff observed that OPG continues to demonstrate high levels of performance and achievement of objectives during outages.

OPG performed three planned outages and experienced five forced outages at DNGS. OPG followed up appropriately on all planned and forced outages. CNSC staff determined that all outage-related undertakings, including heat sink management at DNGS, were performed safely by OPG staff.

CNSC staff found that OPG outage management performance at DNGS met or exceeded regulatory requirements and expectations in 2017.

Darlington Waste Management Facility

This specific area does not apply to the DWMF.

Safe operating envelope

Darlington Nuclear Generating Station

CNSC staff determined that OPG operated within the safe operating envelope (SOE) and met the applicable regulatory requirements for DNGS.

In 2017, CNSC staff conducted a compliance verification inspection for the defueling for Unit 2 refurbishment. CNSC staff observed one non-compliance of low safety significance with respect to the tools in place for monitoring the heat load of the Irradiated Fuel Bay. The tools used overly conservative methodology, which lead to an over-estimation of heat load. CNSC staff confirmed that the bay temperatures always remained within the design limits.

CNSC staff were satisfied with OPG's corrective action plans and implementation is targeted to be complete by June 2018.

Darlington Waste Management Facility

This specific area does not apply to the DWMF.

CNSC staff were satisfied that OPG had adequate measures in place.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

Severe accident management and recovery

CNSC staff determined that severe accident management and recovery met the applicable regulatory requirements for the DNGS and met or exceeded them for the DMWF. The program is implemented at the Darlington site with an organizational structure that clearly establishes the roles and responsibilities of all program participants.

Darlington Nuclear Generating Station

In 2017, CNSC commenced a desktop review for DNGS SAMG documentation including its recent updates, expected to be completed in 2018.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

Accident management and recovery

CNSC staff determined that OPG's accident management and recovery programs for DNGS and the DWMF met or exceeded the applicable regulatory requirements in 2017.

Darlington Nuclear Generating Station

OPG has a series of abnormal incident manual (AIMs) and emergency operating procedures (EOPs) at DNGS to detect abnormal conditions, mitigate causes of the incidents and accidents, return the plant to a safe and controlled state, and to prevent further escalation into a more serious accident. CNSC staff were satisfied that OPG had adequate measures in place.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

3.1.4 Safety analysis

CNSC staff concluded that the safety analysis SCA at the Darlington site met or exceeded performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received "fully satisfactory" ratings, unchanged from the previous year.

Deterministic safety analysis

CNSC staff concluded that OPG's deterministic safety analysis predicts adequate safety margins, and met or exceeded the applicable regulatory requirements at DNGS and the DWMF.

Darlington Nuclear Generating Station

CNSC staff have determined that OPG has a well-managed program on deterministic safety analysis. OPG continues to implement REGDOC-2.4.1, Deterministic Safety Analysis, and CNSC staff are satisfied with the progress to date. CNSC staff are currently reviewing the revised implementation plan submitted by OPG in 2017.

In 2017, OPG submitted an updated Fire hazard Assessment (FHA) and Fire Safe Shutdown Analysis (FSSA) for the DNGS, CNSC staff reviewed the FHA and FSSA determined that the approach and methodology used is consistent with the applicable regulatory requirements.

Darlington Waste Management Facility

OPG has established and maintains a safety analysis program which is effectively implemented at the DWMF and that fully satisfies regulatory requirements. OPG submits a safety analysis report for the DWMF every five years that effectively identifies facility hazards and the measures in place to control or mitigate these hazards. The most recent revision to the safety report for the DWMF and safety report annex for refurbishment waste were submitted to CNSC staff in 2017. CNSC staff reviewed the reports and were satisfied with the updated documents. CNSC staff expect the next revision of the safety report for the DWMF to be submitted in 2022.

In 2016, OPG submitted an updated Code Compliance Review (CCR) and FHA for the DWMF. In 2017, CNSC staff reviewed the updated documents and determined that the approach and methodology used was consistent with CSA Group standard N393-13, *Fire protection for facilities that process, handle, or store nuclear substances*.

Probabilistic safety assessment

Darlington Nuclear Generating Station

CNSC staff determined that DNGS is compliant with Regulatory Document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* and is in transition to implementing CNSC REGDOC-2.4.2, *Safety Analysis: Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. OPG plans to update the PSA models and demonstrate that DNGS continues to meet the safety goals throughout the life extension refurbishment project. The next update to the models will be submitted in 2020, and at this time DNGS is expected to be fully compliant with REGDOC-2.4.2.

CNSC staff found that OPG's performance in PSA at DNGS met or exceeded the applicable regulatory requirements in 2017.

Darlington Waste Management Facility

This specific area does not apply to the DWMF.

Criticality safety

This specific area does not apply to the DNGS and DWMF.

Severe accident analysis

Darlington Nuclear Generating Station

OPG continues to support industry research and development (R&D) program in the area of severe accident analysis.

OPG with other licensees have developed a project called Severe Accident Software Simulator Solution to improve their methods for deterministic analysis of multi-unit severe accidents. CNSC staff have reviewed the analysis and proposed some recommendations. See section 2 for more details.

Darlington Waste Management Facility

This specific area does not apply to the DWMF.

Management of safety issues (including R&D programs)

Darlington Nuclear Generating Station

The work by NPPs to address the remaining category 3 CANDU safety issues is described in section 2.4.

The following R&D project is currently ongoing:

Moderator subcooling requirements methodology

OPG submitted the conclusion of the review by a Safety Analysis Issue Review Panel of experimental results from the CNSC-sponsored Calandria-Tube Strain Contact Boiling project. CNSC staff issued an interim report summarizing the results of the experiments and an evaluation of the results. OPG plans to address the outstanding issues over the next licence period. This issue is considered to be of low safety significance as it only affects safety margins during postulated accidents of a low probability of occurrence.

Darlington Waste Management Facility

This specific area does not apply to the DWMF.

3.1.5 Physical design

CNSC staff concluded that OPG activities falling under the physical design SCA at the Darlington site met performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received a "satisfactory" rating, unchanged from the previous year.

Design governance

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements regarding design governance in 2017 for the DNGS and the DWMF.

Darlington Nuclear Generating Station

Environmental qualification

CNSC staff determined that the environmental qualification program is implemented in all DNGS units. OPG maintains program sustainability in accordance with applicable regulatory requirements.

Pressure boundary design

CNSC staff observed that OPG continued to implement a comprehensive pressure boundary program at DNGS. The program is compliant with regulatory requirements.

Human factors in design

OPG completed a gap analysis and developed an implementation plan to implement CSA Group standard N290.12-14, *Human factors in design for nuclear power plants* text by September 1, 2018.

Darlington Waste Management Facility

CNSC staff determined that OPG continues to implement a comprehensive pressure boundary program at the DWMF that is compliant with regulatory requirements.

Site characterization

CNSC staff had no significant observations at the DNGS or the DWMF to report in this specific area for 2017.

Facility design

CNSC staff had no significant observations at the DNGS or the DWMF to report in this specific area for 2017.

Structure design

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements regarding structure design for the DNGS and the DWMF.

Darlington Nuclear Generating Station

In 2017, CNSC staff continued to monitor and review documentation related to a follow-up action from an inspection on preservation of seismic design basis conducted in 2016. CNSC staff were satisfied with OPG's corrective action plan related submissions and the actions taken.

Darlington Waste Management Facility

In 2017, CNSC staff reviewed the commissioning reports for the RWSB. CNSC staff concluded that the commissioning reports were consistent with the requirements of the DWMF RWSB Modification Design Requirements, design objectives, applicable CSA Group standards requirements, commissioning test results and compliance verification criteria, where available. CNSC confirmed that the commissioning reports were acceptable and authorized OPG to begin operations at the RWSB as per licence condition 15.2.

System design

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements regarding system design in 2017 at the DNGS and the DWMF.

Darlington Nuclear Generating Station

Electrical power systems

CNSC staff concluded that DNGS's electrical power systems met applicable regulatory requirements.

In 2017, CNSC staff conducted desktop reviews and followed-up on the Integrated Safety Reviews (ISRs) and 2014 compliance verification inspection. Based on these compliance activities, no areas of non-compliance were found and CNSC staff concluded that the Electrical Power Systems (EPS) at DNGS met the applicable regulatory compliance requirements.

Fire protection design

Darlington's fire protection program met applicable regulatory requirements based on results of CNSC's ongoing compliance activity.

Independent third party reviews (TPR) for design modifications and facility site condition inspection were acceptable and yielded no major finding.

CNSC staff are satisfied with the level of compliance and the licensee continues to implement a comprehensive fire protection program at DNGS.

Instrumentation and Control

SDS1 and SDS2 trip computers and monitoring and test computers are planned to be replaced in 2019. New trip computer hardware and software have demonstrated to meet the design modification requirements. The target date of replacement is 2019; the review of submissions is on-going.

As a result of regulatory oversight, CNSC staff were satisfied with OPG performance for this specific area.

Darlington Waste Management Facility

Fire Protection System

CNSC staff determined that OPG continued to implement a comprehensive fire protection program at the DWMF in accordance with CSA Group standard N393-13, *Fire protection for facilities that process, handle, or store nuclear substances.*

Components design

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements regarding component design for the DNGS and the DWMF.

Darlington Nuclear Generating Station

CNSC staff conclude that OPG met applicable regulatory requirements for component design at DNGS.

Fuel design

CNSC staff determined that OPG has a mature reactor fuel inspection program. Fuel performance at Darlington was acceptable in 2017. OPG's defect rate and inspection findings were consistent with previous years. OPG is able to adequately manage fuel performance issues while maintaining safe operations.

Cables

In 2017, there were no issues found during compliance activities (i.e., desktop reviews). As a result, CNSC staff concluded that the cable management program at DNGS met the applicable regulatory requirements.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

3.1.6 Fitness for service

CNSC staff concluded that the fitness for service SCA at the Darlington site met performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received "satisfactory" ratings, unchanged from the previous year.

CNSC staff determined that OPG has established and maintains fitness for service programs which are effectively implemented at the DNGS and the DWMF, and that satisfy regulatory requirements. The implemented programs ensure the safe physical condition of systems, structures, and components.

Equipment fitness for service and equipment performance

Darlington Nuclear Generating Station

CNSC staff determined that the overall equipment fitness for service and performance at DNGS were satisfactory and met the applicable regulatory requirements.

Reliability of systems important to safety

Specifically, CNSC staff determined that the reliability program at DNGS met the applicable regulatory requirements.

All special safety systems for DNGS Units 1– 4 met their unavailability targets in 2017.

Darlington Waste Management Facility

This specific area does not apply to the DWMF.

Maintenance

CNSC staff determined that OPG's maintenance program met the applicable regulatory requirements for the DNGS and the DWMF in 2017.

OPG's nuclear power plants maintenance program also governs preventative and corrective maintenance activities for the waste management facilities.

Darlington Nuclear Generating Station

The average preventive maintenance completion ratio for the four units at DNGS was 94 percent, which compared favourably with the industry average (88%). The maintenance backlogs were acceptable and are provided in table 16.

Table 16: Maintenance backlogs and deferrals for critical components for DNGS, 2017

Parameter	Average quarterly work orders per unit in 2015	Average quarterly work orders per unit in 2016	Average quarterly work orders per unit in 2017	Three years trending	Industry average
Corrective maintenance backlog	5	6	1	down	4
Deficient maintenance backlog	75	48	37	down	98
Deferrals of preventive maintenance	9	22	7	stable	30

The corrective maintenance backlog, deficient maintenance backlog and number of deferrals of critical component preventive maintenance were all below the industry average and were being continuously reduced.

CNSC staff determined that the overall safety significance of maintenance backlogs and deferrals for critical components was negligible for DNGS.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

Structural integrity

CNSC staff concluded that the SSCs important for safe operation continued to meet the applicable structural integrity requirements established in the design basis or in CNSC accepted standards and guidelines for the DNGS and the DWMF in 2017.

Darlington Nuclear Generating Station

As part of OPG's Periodic Inspection Program (PIP), OPG inspected DNGS Unit 1 pressure boundary and Units 0, 3 and 4 containment components in 2017. The pressure boundary inspections covered elements of the primary heat transport and auxiliary systems, feeders and pressure tubes. CNSC staff reviewed OPG's inspection reports and were satisfied with the results, which indicated that all inspected elements met CSA acceptance criteria.

Darlington Waste Management Facility

In October 2016, OPG reported to CNSC staff that a DSC had failed its initial leak test and was subsequently repaired. CNSC staff reviewed OPG's follow-up actions and concluded in 2017

that this finding resulted in no impact on nuclear safety and that the licensee responded to the finding appropriately.

Aging management

CNSC staff concluded that OPG's integrated aging management program met the applicable regulatory requirements at the DNGS and the DWMF in 2017. OPG completed its transition from RD-334 to REGDOC-2.6.3, *Aging Management* in 2017 at the DNGS and the DWMF.

Darlington Nuclear Generating Station

CNSC staff confirmed that the major component Life Cycle Management Plans exceeded the basic requirements and provided a comprehensive in-service inspection plan. For example, OPG's fuel channel LCMP included 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.

CNSC staff determined that OPG had adequate programs in place to confirm that fuel channels were fit for service for near-term operation. OPG submitted engineering assessments of degradation mechanisms that spanned the near-term and met all applicable CSA acceptance criteria.CNSC staff continued to monitor the implementation of the fuel channel life management project to further the development of the analytical tools necessary to demonstrate pressure tube fitness for service for continued operation. CNSC staff were satisfied with the progress - see Section 2.6 for further details. Also, see Appendix H: for details on the current and anticipated future fuel channel conditions and validity of analytical models of pressure tube fracture toughness for fuel channels at Darlington (and the other NPPs in Ontario).

Darlington Waste Management Facility

There were no significant observations to report for this specific area at DWMF in 2017.

Chemistry control

CNSC staff determined that OPG's chemistry control program met or exceeded the applicable regulatory requirements for DNGS and the DWMF in 2017.

Darlington Nuclear Generating Station

DNGS remained compliant with their chemistry specifications in 2017. See Performance Indicators Chemistry Index and Chemistry Compliance Index. Moreover, DNGS has not experienced any Chemistry related reportable events over 2017.

Darlington Waste Management Facility

In 2017, CNSC staff reviewed the DWMF quarterly reports and concluded that the facility had maintained acceptable performance related to chemistry. There were no chemistry-related incidents at the DWMF in 2017.

Periodic inspections and testing

Darlington Nuclear Generating Station

CNSC staff have determined that OPG has adequate and well maintained periodic inspection programs in place at DNGS for the pressure boundary and containment components important to safety.

CNSC staff monitored compliance with the applicable regulatory requirements for periodic inspection programs during the year and concluded that their implementation met regulatory requirements.

OPG is in the process of updating its Periodic Inspection Plans to comply with the 2014 edition of CSA standard N285.4, Periodic inspection of CANDU nuclear power plant components. Full implementation of the updated program requirements is expected by July 2019. CNSC staff are satisfied with progress to date.

Darlington Waste Management Facility

This specific area does not apply to the DWMF because periodic inspection and testing requirements are addressed under the scope of Aging Management at the facility.

3.1.7 Radiation protection

CNSC staff concluded that the radiation protection SCA at the Darlington site met performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received "satisfactory" ratings, unchanged from the previous year.

Application of ALARA

CNSC staff determined that OPG continued to implement an effective and well-documented program, based on industry best practices, to keep doses to persons as low as reasonably achievable (ALARA) at the DNGS and the DWMF.

CNSC staff verified that OPG used ALARA initiatives, work planning, and dose monitoring and control to work towards the challenging ALARA targets established by OPG at the DNGS and the DWMF.

Darlington Nuclear Generating Station

In 2017, CNSC staff verified that OPG used ALARA initiatives in work planning, and dose monitoring and control to achieve the ALARA targets established by OPG. As well, it was confirmed that OPG approved a Five-Year ALARA Plan for DNGS that incorporated lessons-learned and OPEX to develop challenging dose targets for future years, with the goal of reducing worker doses. CNSC staff concluded that the application of ALARA at DNGS met or exceeded regulatory requirements and safety was not compromised.

Darlington Waste Management Facility

CNSC staff verified during 2017 that radiation exposures and doses to workers at the DWMF were below the regulatory dose limits and remained ALARA.

Worker dose control

CNSC staff determined that OPG continued to comply with the regulatory requirements to measure and record doses received by workers at the DNGS and the DWMF.

CNSC staff continues to apply additional vigilance and attention with respect to worker dose control while Darlington is conducting refurbishment activities. Additional oversight activities are in place during this period, including enhanced surveillance and inspections.

Routine compliance verification activities conducted in 2017 confirmed that performance in the area of worker dose control at the DNGS and the DWMF was effective. Radiation doses to workers at the DNGS and the DWMF were below the regulatory dose limits, as well as the action levels established in OPG's Radiation Protection Program.

CNSC staff observed that there were no adverse trends or safety-significant unplanned exposures that resulted from the licensed activities at DNGS and the DWMF in 2017.

The data for doses to workers at the Darlington site can be found in section 2.7.

Darlington Nuclear Generating Station

The maximum individual dose received at the Darlington site was 18.94 mSv received by a contractor performing bulkhead isolation, feeder cabinet removal and feeder coupling disconnect work as part of Unit 2 refurbishment. CNSC staff are satisfied that the dose to this worker was managed according to OPG processes, and processes and well below the annual dose limit of 50 mSv.

In 2017, CNSC staff identified two low significance non-compliances, one with respect to OPG adequately demonstrating that the Exposure Control Levels (ECL) increases for Unit 2 refurbishment workers are being maintained ALARA. The other, non-compliance was observed with respect to workers complying with program requirements for non-routine bioassay submissions. CNSC staff are satisfied with OPG's corrective action plans for the non-compliances and will continue to monitor the implementation in 2018.

Darlington Waste Management Facility

The maximum dose received by a worker in 2017 at the DWMF was 0.8 mSv, which is approximately 1.6 % of the regulatory dose limit.

Radiation protection program performance

CNSC staff determined that OPG's corporate Radiation Protection Program, which covers the DNGS and the DWMF, met the requirements of the *Radiation Protection Regulations*.

The oversight applied by OPG in implementing and improving this program was effective in protecting workers at the DNGS and the DWMF. OPG regularly measures the performance of its Radiation Protection Program against industry-established objectives, goals, and targets.

Darlington Nuclear Generating Station

In 2017, DNGS implemented changes to the radiation protection program that dealt with improvements to the selection and use of personal protective equipment, the use of portable instruments to measure radiation and the unconditional transfer of materials from radiological zones. CNSC staff noted that the change to material transfer procedures stemmed from a loss of contamination control event at DNGS described in Radiological Hazard Control specific area and Event Initial Report section. DNGS implemented enhancements to the RP program to prevent recurrence of similar events.

Darlington Waste Management Facility

OPG's action levels for the WMFs were revised in 2017 to ensure they were appropriate indicators of a possible loss of control of an element of OPG's Radiation Protection Program at the DWMF. CNSC staff reviewed the revised action levels and found them to be appropriate.

Radiological hazard control

CNSC staff determined that OPG implemented radiological hazard controls that met the applicable regulatory requirements. These measures protect workers and ensure radioactive contamination is controlled within site boundaries for the DNGS and the DWMF.

There were no contamination control action level exceedances for surface contamination as a result of licensed activities at DNGS and the DWMF in 2017.

CNSC staff confirmed that no safety-significant incidents were identified through reporting of safety performance indicators on personnel and loose contamination events.

OPG's contamination control action levels were revised in 2017 for the Darlington site to ensure they were appropriate indicators of a failure of the Radiation Protection Program. CNSC staff reviewed the revised action levels and found them to be appropriate.

Darlington Nuclear Generating Station

In 2017, CNSC staff identified non-compliances with radiation hazard labelling requirements, with contamination control during the execution of outage work, and with review and verification of radiological survey results. CNSC staff determined that the adverse conditions identified did not pose unreasonable risks to workers or the environment, and that suitable corrective action plans were implemented by OPG.

CNSC staff are monitoring OPGs progress in implementing a suitable corrective actions to effectively address the non-compliance related to supervisory review and verification of radiological survey results.

In February 2017, an event occurred where four electrical motors with undetected internal contamination were shipped from DNGS to an unlicensed facility for repair. All four motors had been surveyed for contamination at DNGS and approved for unconditional transfer prior to the shipment. Following the detection of contamination at the repair facility, all four motors and contaminated materials were packaged and shipped back to DNGS by qualified shippers and in accordance with OPG procedures and with the *Packaging and Transport Nuclear Substances Regulations, 2015*. This incident was reported to the Commission in March 2017 as an EIR (CMD 17-M11 [12]). There were no safety consequences as a result of the incident. The licensee has taken the necessary measures to ensure an incident such as the one reported does not re-occur.

Darlington Waste Management Facility

CNSC staff inspected the DWMF in November 2017 and issued two non-compliance actions in the area of radiation protection for OPG to review the routine survey locations and perform an extent of condition review of worker radiation monitoring results.

UPDATE: CNSC staff were reviewing the corrective actions and were satisfied with OPG's progress to date.

Estimated dose to the public

CNSC staff determined that OPG continued to ensure the protection of members of the general public in accordance with the Radiation Protection Regulations. The reported estimated dose to a member of the general public from the Darlington site was 0.0007 mSv, well below the annual dose limit of 1 mSv. See Section 2.7.

3.1.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at the Darlington site met or exceeded performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received "fully satisfactory" ratings, higher than the previous year.

Performance

CNSC staff determined that OPG met or exceeded requirements at the DNGS and the DWMF in regards to conventional health and safety performance.

OPG continues to demonstrate its ability to keep workers safe from occupational injuries while conducting its licensed activities at the DNGS and the DWMF. Health and safety related incidents are reported by OPG on an ongoing basis, as applicable.

CNSC staff conducted inspections at the DNGS and the DWMF and recorded findings on safety practices and the controls being employed by OPG to address conventional hazards. CNSC staff have not identified any areas of concern regarding conventional health and safety in 2017.

Darlington Nuclear Generating Station

CNSC staff observed that the accident severity rate (ASR)for DNGS increased from 0.7 in 2016 to 2.23 in 2017, while the accident frequency (AF) rate increased slightly from 0.22 in 2016 to 0.329 in 2017. DNGS's accident severity rate remains below the industry average. In 2017, there was one LTIs reported by OPG.

The ASR and AF safety performance indicators at DNGS were found to be acceptable by CNSC staff.

Health and safety related incidents are reported by OPG on an ongoing basis. CNSC staff have reviewed OPG's actions and conclude that they are appropriate.

Darlington Waste Management Facility

No health and safety related incidents or LTIs were reported by OPG to CNSC staff for the DWMF in 2017.

CNSC staff participated in pre-inspection health and safety briefings held with OPG staff and management while on-site for inspections. CNSC staff found that the health and safety briefings were satisfactory.

Practices

CNSC staff determined that conventional health and safety practices met or exceeded the applicable regulatory requirements at the DNGS and the DWMF in 2017.

The conventional health and safety work practices and conditions at the DNGS and the DWMF continued to achieve a high degree of personnel safety. OPG personnel at all levels exhibit proactive attitudes toward anticipating work related hazards and preventing unsafe conditions. There continues to be a working environment where safe work practices are encouraged. CNSC staff verified that OPG has appropriate procedures at the DNGS and the DWMF to ensure the protection of the environment and the health of persons against hazardous materials.

Darlington Nuclear Generating Station

As a result of regulatory oversight in 2017, CNSC staff were satisfied with OPG's performance for this specific area.

Darlington Waste Management Facility

CNSC staff observed safe work practices during site inspection at the DWMF. A positive indicator in this regard is the use of their job hazard analysis program which specifies OPG's commitment to conduct pre-inspection tours of jobs and job sites, listing emergency procedures

for such jobs, identifying the minimum level of personal protective equipment required, and listing the required permits or work authorizations before starting work.

Awareness

CNSC staff concluded that OPG met or exceeded the applicable regulatory requirements for awareness in 2017 at the DNGS and the DWMF. CNSC staff determined that OPG continued to maintain a safe working environment at the DNGS and the DWMF.

Darlington Nuclear Generating Station

Throughout 2017, CNSC staff observed the DNGS to be clean and tidy, although there were some instances of improperly stored equipment and transient material which were addressed by OPG.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

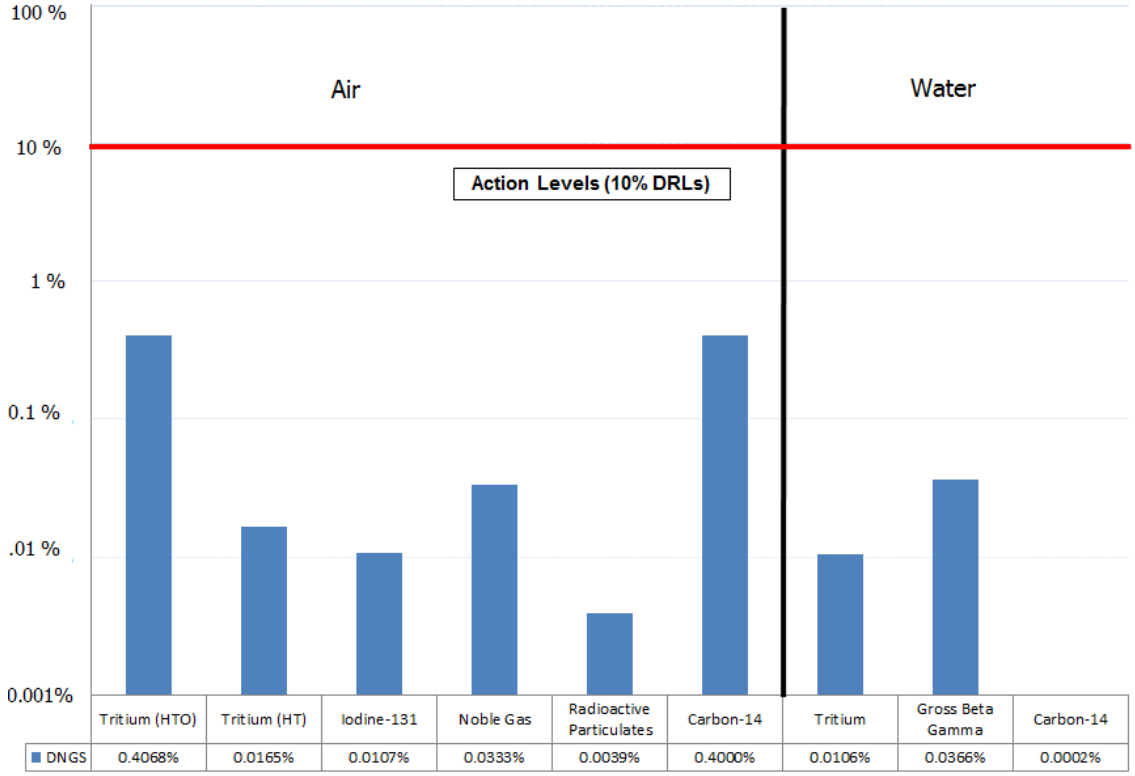
3.1.9 Environmental protection

CNSC staff concluded the environmental protection SCA at the Darlington site met performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received "satisfactory" ratings, unchanged from the previous year.

Effluent and emissions control (releases)

CNSC staff reviewed all reported airborne and waterborne radiological releases from the Darlington site and confirmed that they remained below regulatory limits and action levels. The releases For DNGS and DWMF are shown in figure 15 as fractions of the applicable DRLs. The actual values for the releases and DRLs for the Darlington site are provided in Appendix I:.

Figure 15: Effluent and emissions at Darlington as percentages of DRLs (includes data for DWMF)



In 2017, OPG fully implemented CSA Group standard N288.3.4-13, *Performance testing of nuclear air-cleaning systems at nuclear facilities* for DNGS and DWMF.

Environmental management system

CNSC staff concluded that OPG has established and implemented a corporate-wide Environmental Management System at the Darlington site in accordance with CNSC REGDOC- 2.9.1, *Environmental Protection: Environmental Protection Policies, Programs and Procedures* (2013) to assess environmental risks associated with its nuclear activities at the DNGS and the DWMF and to ensure these activities are conducted in a way that prevents or mitigates adverse environmental effects. The EMS is also registered to the ISO 14001: 2015 – *Environmental management systems – Requirements with guidance for use [8]* standard. As a result of registration, the EMS is subject to periodic independent third party audits and reviews to verify its sufficiency and also identify potential improvements.

Assessment and monitoring

CNSC staff reviewed and assessed the environmental monitoring data provided by OPG for the Darlington site and concluded that the general public and the environment in the vicinity of the site were protected. OPG met the applicable regulatory requirements for the DNGS and the DWMF.

CNSC staff conducted independent environmental monitoring around the Darlington site in 2017 (see Section 2.9 for a description of the IEMP). The results are available on the CNSC's

IEMP webpage [http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp]. The IEMP results indicated that the general public and the environment in the vicinity of Darlington site were protected, and that there were no expected health impacts.

OPG has a transition plan in place to implement the requirements of CSA Group standard N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* at the DNGS and DWMF by December 31, 2020. CNSC staff found the transition date to be acceptable.

Protection of the public

CNSC staff confirmed that the general public in the vicinity of the Darlington site are protected and that there are no expected health impacts. There were no reported hazardous substances released from the Darlington Site that exceeded regulatory limits in 2017.

Dose to the public is discussed in Section 3.1.7.

Environmental risk assessment

CNSC staff determined that OPG continued to implement and maintain an effective environmental risk assessment and management program at the Darlington site in accordance with the applicable regulatory requirements.

In 2017, CNSC staff reviewed the 2016 Darlington Nuclear Environmental Risk Assessment, which covers the DNGS and the DWMF. CNSC staff determined that OPG had taken adequate measures to protect human health and the environment, and that the ERA was in compliance with CSA Group standard N288.6, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*.

3.1.10 Emergency management and fire protection

CNSC staff concluded that the emergency management and fire protection SCA at the Darlington site met performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received "satisfactory" ratings, unchanged from the previous year.

CNSC staff determined that OPG continued to maintain comprehensive conventional, nuclear, and fire emergency response capabilities at all times for the Darlington site that met the applicable regulatory requirements. This includes personnel and equipment for medical, HAZMAT, search and rescue, and fire response.

The DNGS Emergency Response Team (ERT) will respond to events within the DNGS protected area at any time. The DNGS ERT will provide off-hours investigation and response to fire alarms within the DWMF protected area.

OPG has a written agreement with the Municipality of Clarington to provide emergency response services, with support from site personnel, within the site boundary of the Darlington site, but outside the DNGS protected area, for fire, medical, rescue, and HAZMAT events. The site support can include operations, security staff, or ERT personnel.

Conventional emergency preparedness and response

CNSC staff had no significant observations at the DNGS or the DWMF to report in this specific area for 2017.

Nuclear emergency preparedness and response

OPG continued to support offsite emergency management organizations and commitments throughout 2017.

OPG's nuclear emergency preparedness program is documented in the Consolidated Nuclear Emergency Plan (CNEP) which governs the Darlington site.

Training and exercises are conducted annually at the Darlington site to ensure all areas of the site have adequate emergency notification or response capability from either the DNGS or the Municipality of Clarington emergency services.

Darlington Nuclear Generating Station

OPG implemented version 1 of REGDOC-2.10.1 *Nuclear emergency preparedness and response* (2014) for DNGS by September 2017.

In 2017, OPG completed the implementation of a real-time automatic data transfer system for DNGS, which will provide prompt plant information to staff in the CNSC's Emergency Operations Centre (EOC) during nuclear emergencies.

In September 2017, CNSC staff inspected an emergency response exercise at DNGS. The inspection identified one low safety significance area of non-compliance related to ensuring that the transmittal of survey results to external stakeholders are completed as required. CNSC staff were satisfied with OPG's corrective action plan. OPG plans to provide updates on the implementation to CNSC staff in November 2018.

Darlington Waste Management Facility

The DWMF has a facility emergency program for the DWMF that includes radiation response emergency procedures. OPG also incorporates the CNEP as part of its on-site requirements for nuclear response.

OPG currently has a transition plan in place to implement the requirements of CNSC REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*, version 2 (2016) at the DWMF by December 31, 2018. CNSC staff found the transition date to be acceptable.

Fire emergency preparedness and response

DNGS has an extensive fire drill and training program which includes the Wesleyville Fire Training Academy located near Wesleyville Ontario where live fire training is conducted for Darlington ERT and with Clarington Municipal Fire Department.

Darlington Nuclear Generating Station

In 2017, CNSC staff conducted several inspections at DNGS that verified compliance with the Fire Protection Program. During the field verifications, CNSC staff observed a number of low safety significant non-compliances in the areas of radioactive material storage, Ignition Source Permits, and Space Allocation of Transient Combustible Material. CNSC staff are satisfied with OPG's corrective action plan and will monitor the implementation targeted for April 2018.

In addition to CNSC compliance activities DNGS is required to conduct expert Third Party Reviews (TPR) of an annual plant condition, bi-annual fire drill audit and tri-annual fire program audit.

By incorporating the results of the CNSC compliance findings and TPR observations and recommendations into the drill and training program, the emergency response team performance continues to improve.

Darlington Waste Management Facility

OPG has a facility emergency program for the DWMF that includes basic fire response for facility staff to respond to small fires with fire extinguishers.

On February 23, 2017, OPG reported an event that occurred at the DWMF to CNSC staff regarding a programmatic failure to inspect the exit signs at the facility. OPG stated that there were no immediate effects or impacts on the environment, the health and safety of persons, or the maintenance of security that resulted or may have resulted from the situation. CNSC staff were satisfied with the measures taken by OPG and subsequently closed the event.

On April 4, 2017, OPG reported an event that occurred at the DWMF to CNSC staff regarding a loss of fire water that occurred during routine maintenance of the fire suppression system. OPG stated that there were no immediate effects or impacts on the environment, the health and safety of persons, or the maintenance of security that resulted, or may have resulted from the situation. CNSC staff are satisfied with the corrective measures taken by OPG, and subsequently closed the event.

3.1.11 Waste management

CNSC staff concluded that the waste management SCA at the Darlington site met or exceeded performance objectives and applicable regulatory requirements. As a result, the DNGS received a “fully satisfactory” rating and the DWMF received a “satisfactory” rating, unchanged from the previous year.

Waste characterization

CNSC staff determined that OPG’s waste characterization met or exceeded the applicable regulatory requirements at the DNGS and the DWMF.

OPG continued to employ effective programs for the characterization of radioactive and hazardous wastes at the DNGS and the DWMF during 2017.CNSC staff had no significant observations at the DNGS or the DWMF to report in this specific area in2017.

Waste minimization

CNSC staff determined that OPG’s waste management programs for minimizing radioactive waste met or exceeded the applicable regulatory requirements at the DNGS and the DWMF.

Darlington Nuclear Generating Station

As a result of regulatory oversight, CNSC staff are satisfied with OPG performance for this specific area.

Darlington Waste Management Facility

Minimal radioactive waste is generated from the waste management activities conducted at the DWMF. Nonetheless, OPG has set a goal to minimize the generation of radioactive waste due to operational activities. Annual volumes amount to less than one drum that is sent to the DNGS for segregation, as necessary, and eventually transported to the WWMF for processing and storage.

Waste management practices

CNSC staff determined that OPG's waste management practices met or exceeded the applicable regulatory requirements at the DNGS and the DWMF. OPG continued to employ effective radioactive and hazardous waste management practices at Darlington during 2017. OPG uses waste management procedures to ensure that waste generated at the facility is separated properly.

Darlington Waste Management Facility

As of October 31, 2017 OPG was fully compliant with the requirements of CSA Group standards N292.0-14, *General principles for the management of radioactive waste and irradiated fuel*, N292.2-13, *Interim dry storage of irradiated fuel* and N292.3-14, *Management of low and intermediate-level radioactive waste* for the DWMF.

Decommissioning plans

The preliminary decommissioning plans (PDP) for the DNGS and the DWMF met or exceeded the applicable regulatory requirements in 2017.

In 2017, OPG revised the PDPs for all of its facilities for the period up to 2022. OPG selected a deferred decommissioning strategy for the decommissioning of the DNGS and an immediate decommissioning strategy for the DWMF, following the completion of the DNGS decommissioning. The associated financial guarantee is discussed in section 2.15.

3.1.12 Security

CNSC staff concluded that the security SCA at the Darlington site met performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received "satisfactory" ratings, unchanged from the previous year.

Facilities and equipment

CNSC staff determined that OPG met the applicable regulatory requirements for facilities and equipment at the DNGS and the DWMF. OPG continued to sustain its security equipment through lifecycle management at the Darlington site. No significant equipment failures were reported in 2017. OPG has processes in place to adequately prevent security events at the DNGS and the DWMF.

Darlington Nuclear Generating Station

OPG made improvements to the DNGS preventive maintenance program in 2017 to ensure that adequately trained personnel are available in order to effectively maintain security equipment.

Cyber Security

OPG maintains a cyber security program at the DNGS. CNSC staff concluded that the program is compliant with applicable regulatory requirements. There were no cyber security events reported in 2017.

OPG was updating its current cyber security program for the DNGS to achieve compliance with CSA Group standard N290.7-14, *Cyber security for nuclear power plants and small reactor facilities* by November 30, 2019. CNSC staff are satisfied with the progress to date.

Darlington Waste Management Facility

OPG has physical protection systems and a security program in place at the DWMF appropriate for a high-security nuclear facility.

CNSC staff inspected security at the DWMF in 2017 and issued one low risk compliance action to OPG. CNSC staff were satisfied with the resulting corrective actions and consider the inspection to be closed.

CNSC staff confirmed that the DWMF updated its security operating procedures and ensured that its contingency plans continued to meet the Design Basis Threat (DBT) as approved by CNSC.

Response arrangements

CNSC staff determined that OPG met the applicable regulatory requirements for response arrangements at the DNGS and the DWMF.

Darlington Nuclear Generating Station

OPG has nuclear security officers to respond to security incidents and perform routine patrols at DNGS.

CNSC staff conducted a type II compliance inspection which concluded that elements of the response force did not meet all performance objectives outlined in the licensee's exercise manual .Several low significant findings were made during the inspection/evaluation, where some individuals faced challenges in utilizing their training and subsequent decision-making. OPG is working towards implementing suitable corrective measures to effectively address the outstanding items.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

Security practices

CNSC staff determined that OPG implemented security practices at the DNGS and the DWMF that met the applicable regulatory requirements.

OPG has procedures in place at the DNGS and the DWMF to guide plant and security personnel in security practices.

Darlington Nuclear Generating Station

In 2017, this area was affected by reportable events related to non-adherence to security procedures. There are some challenges in the area of security awareness. However, CNSC staff concluded that there were no safety-significant issues for this specific area and corrective actions are being appropriately implemented.

OPG has submitted a detailed implementation plan to meet the new requirements for security screening, which CNSC staff have assessed as acceptable.

Darlington Waste Management Facility

CNSC staff had no significant observations at the DWMF to report in this specific area for 2017.

Drills and exercises

CNSC staff determined that OPG's exercise and drill program met the applicable regulatory requirements for the DNGS and the DWMF.

CNSC staff had no significant observations at the DNGS or the DWMF to report in this specific area for 2017.

3.1.13 Safeguards and non-proliferation

CNSC staff concluded that the Safeguards and Non-proliferation SCA at the Darlington site met performance objectives and all applicable regulatory requirements. As a result, the DNGS and the DWMF received "satisfactory" ratings, unchanged from the previous year.

Nuclear material accountancy and control

CNSC staff confirmed that OPG's accountancy and control of nuclear material at the DNGS and the DWMF complied with the applicable regulatory requirements in 2017.

Access and assistance to the IAEA

CNSC staff verified that OPG met the applicable regulatory requirements for access and assistance at the DNGS and the DWMF. OPG granted adequate access and assistance to the International Atomic Energy Agency (IAEA) for safeguards activities, including inspections and the maintenance of equipment at DNGS and the DWMF, pursuant to the Canada/IAEA safeguards agreements and the facilities licence conditions.

Darlington Nuclear Generating Station

The IAEA did not perform physical inventory verification at DNGS in 2017. CNSC staff performed an evaluation of DNGS's preparedness for an IAEA physical inventory verification. CNSC staff concluded that the DNGS is adequately prepared for an IAEA physical inventory verification should they have been selected.

In 2017, the IAEA performed one short notice random inspection and three unannounced inspection at DNGS to verify the nuclear material inventory and assure the absence of undeclared nuclear material and activities.

OPG granted access and provided assistance to the IAEA in October 2017 for a site survey to site potential locations of additional IAEA surveillance equipment in the spent fuel bay area, with the goal of optimizing the current safeguards approach at that facility.

Darlington Waste Management Facility

In 2017, the IAEA performed four unannounced inspections at the DWMF to verify the nuclear material inventory and assure the absence of undeclared nuclear material and activities. OPG provided access and support to these inspections and the CNSC was informed by the IAEA that the results of the inspections were satisfactory.

The IAEA did not perform a physical inventory verification at the DWMF in 2017. CNSC staff performed an evaluation of OPG's preparedness for a physical inventory verification at the DWMF. CNSC staff concluded that OPG was adequately prepared for an IAEA physical inventory verification at the DWMF in 2017 had it been selected.

Operational and design information

CNSC staff confirmed that OPG met the applicable regulatory requirements for operational and design information for the DNGS and the DWMF.

OPG submitted its annual operational program with quarterly updates for DNGS and the DWMF to the CNSC on time. OPG submitted the annual updates to the information pursuant to

the IAEA Additional Protocol to the CNSC on time. CNSC staff were satisfied with the information provided and concluded that it met CNSC's submission requirements.

Safeguards equipment, containment and surveillance

CNSC staff confirmed that OPG met the applicable regulatory requirements for safeguards equipment, containment and surveillance for the DNGS and the DWMF. OPG supported IAEA equipment operation and maintenance activities at the Darlington site, including routine maintenance of surveillance equipment, to ensure the effective implementation of safeguards measures at the DNGS and the DWMF.

3.1.14 Packaging and transport

CNSC staff concluded that the packaging and transport SCA at the Darlington site met performance objectives and applicable regulatory requirements. As a result, the DNGS and the DWMF received a "satisfactory" rating, unchanged from the previous year.

Package design and maintenance, packaging and transport, and registration for use

CNSC staff determined that OPG has a packaging and transport program for the DNGS and the DWMF that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the *Transportation of Dangerous Goods Regulations*.

There were no packaging and transport events reported in 2017.

For on-site movement of nuclear substances, OPG ensures an equivalent level of safety as is required for off-site transportation to protect the health and safety of workers, the public, and the environment.

CNSC staff had no significant observations at the DNGS or the DWMF to report in this specific area for 2017.

3.1.15 Other Matters of regulatory Interest

Public Information Program

OPG continued regular communications about the Darlington site to engage and inform residents and stakeholders about the facility, and, in particular, on the progress of the refurbishment project.

CNSC staff determined that OPG met the applicable regulatory requirements related to public information and disclosure and provided sufficient information on the status of the Darlington site through a variety of communication activities, including: participation in community events, facility tours, ongoing website updates, and the use of social media.

Indigenous Relations

CNSC staff observed that OPG has a dedicated Indigenous engagement program. Throughout 2017, it met and shared information with interested Indigenous communities and organizations, particularly the Williams Treaties First Nations, the Mohawks of the Bay of Quinte, and the Métis Nation of Ontario.

Information and discussion topics included OPG's current operations at DNGS and the progress of refurbishment activities, the DWMF, environmental protection and performance, monitoring program results and participation, and fish impingement and entrainment.

3.2 Pickering site

The safety assessment presented below for each SCA is facility-specific. General information relevant to the SCAs is provided in Section 2. The CNSC regulatory documents and CSA Group standards that were identified as regulatory requirements for the Pickering site, as of December 2017, are listed in Appendix E:.

Safety assessment

The Pickering site consists of the Pickering Nuclear Generating Station (PNGS) and the Pickering Waste Management Facility (PWMF). The CNSC staff safety assessment of the Pickering site for 2017 resulted in the performance ratings shown in Table 17. Based on the observations and assessments of the SCAs, CNSC staff concluded that both the PNGS and the PWMF operated safely. The overall rating for the PNGS was "fully satisfactory", unchanged from the integrated plant rating for 2016. The overall rating for the PWMF was "satisfactory".

Table 17: Performance ratings for the Pickering site, 2017

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

Legend: FS – Fully Satisfactory SA – Satisfactory
BE – Below Expectations UA – Unacceptable

3.2.0 Introduction

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

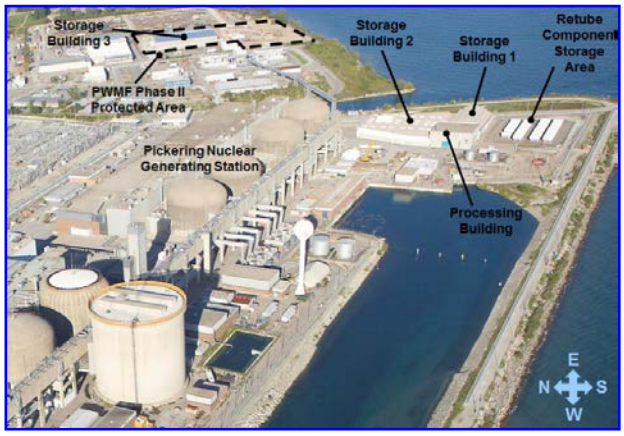
Pickering Nuclear Generating Station

The PNGS consists of eight CANDU reactors. Units 1, 2, 3, and 4 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 at the PNGS 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.

In 2010, OPG announced that PNGS would continue operation until shutdown in 2020. In January 2016, OPG was requested by the Province of Ontario to plan for continued operation beyond 2020. In 2017, OPG applied for a licence to continue commercial operation until December 2024.

Pickering Waste Management Facility



At the PWMF, OPG processes and stores 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 (formerly known as PNGS A) in 34 above-ground Dry Storage Modules (DSM) located at the Retube Component Storage Area (RCSA) at the PWMF. The RCSA is closed to the receipt of any new intermediate-level radioactive waste.

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 one 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 has the capacity to store 1,156 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.

OPG is authorized under the current licence for the PWMF 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 proposed end of its commercial operational life (2024), 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

Pickering Nuclear Generating Station

The PROL was set to expire on August 31, 2018. In August 2017, OPG submitted to the CNSC a licence application requesting the renewal of its PROL [14] for a period of 10 years, which would include the end of commercial operation on December 31, 2024. That licence period would cover three phases of operational activities: continued commercial operation until December 31, 2024; a stabilization phase (post-shutdown defueling and dewatering) lasting approximately 3-4 years; and the beginning of safe storage for Units 1, 4 and 5-8.

UPDATE: Part I of the public hearing was held on April 4, 2018. Part II of the public hearing was held from June 25 to 29, 2018. In August, the Commission announced its decision to renew OPG's licence for the PNGS, effective September 1, 2018 until August 31, 2028.

In a separate request, in April 2017, OPG requested that the Commission amend the PROL to allow the import and export of nuclear substances occurring primarily as contaminants in laundry, packaging, shielding or equipment. These activities had been authorized under a Temporary Possession Licence (TPL). CNSC staff determined that there were no safety impacts associated with the proposed licence amendment, and that it would not change the scope of the import and export activities already authorized under the TPL (CMD 17-H109 [15]). On October 26, 2017, the Commission amended Part IV of the PROL to include the import and export of nuclear substances licensed activity.

Pickering Waste Management Facility

In October, 2016, OPG submitted a request to the CNSC to have the PWMF licence renewed [16] for a period of approximately 11 years until August 31, 2028. A Public Hearing for the licence renewal was held in Ottawa on April 13, 2017.
UPDATE: On April 1, 2018, the Commission issued the renewed WFOL for the period April 1, 2018 to August 31, 2028.

LCH

Pickering Nuclear Generating Station

In 2017, there was one revision to the LCH. This revision incorporated details related to the PROL amendment authorizing import/export of contaminated laundry. This revision also included other Administrative and Technical changes (see Appendix F:)

CNSC staff has drafted a new LCH in conjunction with the preparation for the renewal of the PROL.

Pickering Waste Management Facility

The WFOL for the PWMF did not have an accompanying LCH in 2017.

UPDATE: CNSC staff issued an associated LCH for the PWMF licence in June, 2018 in conjunction with its WFOL renewal.

Fisheries Act Authorization

Pickering Nuclear Generating Station

In May 2015, OPG had an episodic fish impingement event at the PNGS that impinged an estimated biomass between 5,410 to 6,428 kg. Fisheries and Oceans Canada (formerly Department of Fisheries and Oceans) conducted an investigation and issued a letter to OPG that included a requirement for OPG to submit an application for an authorization under Paragraph 35(2)(b) of the *Fisheries Act.*

In July 2017, OPG submitted its application to Fisheries and Oceans Canada. Following Fisheries and Oceans Canada review of the application, OPG submitted a revised application in December 2017.

UPDATE: On January 11, 2018, Fisheries and Oceans issued the Authorization, valid until December 2028.

The authorization also requires OPG to annually install a Fish Diversion System (FDS) barrier net by May 1 and that it remain in place and functioning until November 1, in order to avoid and mitigate serious harm to fish. However, as Fisheries and Oceans Canada determined that there is likely to be serious harm to fish even after the installation of the FDS, the authorization also requires that OPG offset the residual impacts with the following compensatory measures:

- Big Island Wetland habitat creation project (use of approximately 7.6 ha drawn from the existing Big Island Wetland complex habitat bank)
- Simcoe Point Wetland habitat creation project (rehabilitation of Simcoe Point to create a 4.6 ha coastal wetland)
- Stocking contribution for Lake Ontario Atlantic Salmon Program. (stocking of approximately 1,500 kg of Age 1 equivalent of Atlantic Salmon into Duffins Creek)

Periodic Safety Review

CNSC requested OPG to conduct a Periodic Safety Review (PSR) to ensure that Pickering NGS operation, condition and programs conform, to the extent practicable, to modern codes and standards, and that arrangements exist to enhance the continued safe operation of the plant.

OPG performed the PSR in accordance with CNSC regulatory document REGDOC-2.3.3 *Periodic Safety Reviews*. In conducting the PSR, OPG built on the results of several earlier safety reviews such as the work performed in support of Units 1 and 4 return to service, the 2009 Integrated Safety Review (ISR) conducted for Pickering NGS B, and the Darlington ISR completed in 2015. The PSR findings are being addressed by safety enhancement actions in an Integrated Implementation Plan (IIP). CNSC staff have included a licence condition in the proposed PROL requiring OPG to implement the IIP. The PSR covered operational and stabilization phases as well as the beginning of the safe storage phase. Adequate provisions are in place to ensure fitness for service of the safety significant systems required for each phase; especially at the point of hand over from permanent shutdown to the stabilization phase and from the stabilization phase to the safe storage with surveillance phase.

OSART Mission at PNGS

In 2016, an IAEA Operational Safety Review Team (OSART) mission was conducted to evaluate the PNGS operational safety performance against IAEA safety standards. OSART missions provide IAEA member states with the opportunity to share best practices and to support continuous improvements to their operations. The international, multi-disciplinary review team evaluated the following areas:

- leadership and management for safety
- training and qualifications
- operations
- maintenance
- technical support
- OPEX feedback
- radiation protection
- chemistry
- emergency preparedness and response
- accident management
- human-technology and organization interactions
- long term operations and
- transition to decommissioning

The OSART team concluded that management at PNGS is committed to improving the operational safety and reliability of the plant. The team identified 8 good practices, 11 suggestions and 10 recommendations.

The final OSART report is available through the CNSC website at http://nuclearsafety.gc.ca/eng/resources/educational-resources/feature-articles/OSART-mission.cfm.

OPG developed improvement strategies and established action plans for all the suggestions and recommendations. All corrective actions to address safety-related findings were completed by the end of 2017, with the exception of the recommendations related to managing alcohol and drug use testing of key staff in safety important roles. The recommendation to include 'without cause' alcohol and drug tests as part of its existing fitness for duty program is being addressed through OPG's implementation of REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use*, which has requirements for random alcohol and drug testing. See Section 3.2.2 for information on the implementation of REGDOC-2.2.4.

CNSC staff reviewed the OSART report and confirmed that in the areas related to the suggestions and recommendations, PNGS remained compliant with the applicable regulatory requirements. A follow-up mission by the IAEA is planned for 2018 to assess the progress with OPG actions on suggestions and recommendations.

Event initial reports

No event initial reports pertaining to the Pickering site were submitted to the Commission for the period January 1, 2017 to June 1, 2018.

Compliance program

The annual CNSC effort on the compliance program is tabulated in Appendix G: for the PNGS and the PWMF. The inspections at the Pickering site that were considered in the safety assessments in this regulatory oversight report are tabulated in Appendix J:.

3.2.1 Management system

CNSC staff concluded that the management system SCA at the Pickering site met the performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "satisfactory" ratings, unchanged from the previous year.

Management system

CNSC staff determined that OPG's Nuclear Management System at the Pickering site met the applicable regulatory requirements in 2017. OPG has completed the transition to the 2012 version of CSA Group standard N286-12, *Management system requirements for nuclear facilities*.

Pickering Nuclear Generating Station
As a result of regulatory oversight, CNSC staff were satisfied with OPG performance for this specific area.

Pickering Waste Management Facility

CNSC staff conducted a desktop review of OPG's Nuclear Waste Management documentation for the PWMF and determined that it was adequate to meet the applicable regulatory requirements. However, during a 2017 inspection at the DWMF, CNSC staff identified minor issues of low safety significance regarding clarity and consistent application of documentation, that was also applicable at the PWMF. OPG committed to applying its corrective action plan at the PWMF as well. At the end of 2017,

CNSC staff were monitoring the implementation of the corrective actions and confirming the implementation of OPG's changes at PWMF.

Organization

CNSC staff determined that OPG has adequately defined organizational structures and roles and responsibilities at the Pickering site.

Pickering Nuclear Generating Station

In 2017, CNSC staff inspected the implementation of OPG's organization, roles and responsibilities and interfaces for PNGS (and DNGS). CNSC staff identified low safety significance non compliances with respect to identifying all program interfaces and defining roles and accountabilities. At the end of 2017, CNSC staff were reviewing OPG's corrective action plan and will continue to monitor OPG's implementation.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

Change Management

CNSC staff determined that OPG has an adequate change management program at the Pickering site that complies with the applicable regulatory requirements.

Pickering Nuclear Generating Station

As a result of regulatory oversight, CNSC staff were satisfied with OPG performance for this specific area. There were no significant observations to report for 2017.

Pickering Waste Management Facility

As a result of the 2017 inspection at the DWMF, CNSC staff identified that the OPG change management process was ineffective for the inspection of DSCs and for other generic documentation that is used by all OPG WMFs. OPG implemented a change management committee to manage governance and process changes for nuclear waste at all of its WMFs. OPG committed to applying the corrective action plan at PWMF with respect to change management. At the end of 2017, CNSC staff were monitoring the implementation of the corrective actions and overseeing the implementation of OPG's changes at the PWMF.

Safety culture

CNSC staff were satisfied that OPG continued to foster a healthy safety culture at the Pickering site in 2017. CNSC will monitor OPG's next safety culture self-assessment at the Pickering site, scheduled for 2018, and any improvement actions initiated.

Configuration management

CNSC staff determined that OPG maintained the configuration of its structures, systems and components (SSCs) at the Pickering site in compliance with its configuration management program and other applicable regulatory requirements.

Pickering Nuclear Generating Station

In 2016, CNSC staff inspected configuration management and identified low safety significant non-compliances with OPG's internal governance related to the documentation of temporary configuration change at PNGS. CNSC staff were satisfied with OPG`s proposed corrective action plan and were monitoring OPG`s implementation of the corrective actions at the PNGS, targeted to be complete by May, 2019.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

Records management

CNSC staff determined that OPG continued to maintain and implement a document control and records management system at the Pickering site that complied with the applicable regulatory requirements.

Pickering Nuclear Generating Station

In 2017, CNSC staff inspected the training of personnel involved in contract management and identified deficiencies of low safety significance in the area of records management at PNGS. CNSC staff were reviewing OPG's corrective action plans and were satisfied with the progress to the end of 2017.

OPG is planning to have a new records repository by the end of 2020. In 2018, CNSC staff will review this upgrade to ensure it meets the applicable requirements.

Pickering Waste Management Facility

As a result of the 2017 inspection at DWMF that focused on OPG's management system, CNSC staff identified minor issues of low safety significance regarding the control of documents and records that apply to the PWMF as well. OPG committed to applying the corrective action plan at the PWMF with respect to records management. At the end of 2017, CNSC staff were reviewing OPG's corrective action plans and were satisfied with the progress.

Management of contractors

Pickering Nuclear Generating Station

In 2017, CNSC staff inspected supply management at PNGS and confirmed compliance with applicable regulatory requirements. However, CNSC staff did identify deficiencies of low safety significance with respect to the identification of technical requirements in OPG documentation and with OPG`s review of the qualification of contractors and audits reports submitted by contractors. CNSC staff is satisfied with OPG`s proposed corrective action plan and is monitoring OPG`s implementation of one remaining corrective action at the PNGS.

Pickering Waste Management Facility

CNSC staff concluded that the interface between OPG and its contractors at the PWMF did not meet the applicable regulatory requirements in 2017. As a result of an inspection at DWMF, CNSC staff observed that OPG was no longer performing the receiving inspection, including the verification of the DSC history docket received from the vendors. The discontinuation of receiving inspections and failure to reflect the change in its internal documentation significantly reduced OPG's oversight of contractors. OPG committed to applying the corrective action plan at the PWMF regarding management of vendors. At the end of 2017, CNSC staff was monitoring the implementation of the corrective actions at PWMF. See Section 3.1.1 for further details.

Business continuity

CNSC staff concluded that OPG met the applicable regulatory requirements for business continuity at the PNGS and the PWMF. CNSC staff verified that OPG had adequate contingency plans in place to maintain or restore critical safety and business functions in the event of disabling circumstances, such as a pandemic, severe weather, or labour actions.

Problem identification and operating experience

CNSC staff determined that OPG met the applicable regulatory requirements for problem identification and OPEX at the Pickering site.

Pickering Nuclear Generating Station

In 2017, CNSC staff inspected problem identification and operating experience at PNGS and confirmed the overall compliance of the program with the applicable regulatory requirements. CNSC staff identified minor deficiencies with respect to the problem identification program. At the end of 2017, CNSC staff were reviewing OPG`s proposed corrective action plan.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

Performance assessment, improvement and management review

CNSC staff confirmed that OPG continued to meet the applicable regulatory requirements for performance assessment, improvement, and management at PNGS and PWMF.

Pickering Nuclear Generating Station

In 2017, CNSC staff inspected OPG's audit and self-assessments programs at PNGS. Both the audit and self-assessment programs were found to comply with the applicable regulatory requirements and CNSC staff were satisfied with the implementation of the programs. CNSC staff did identify one minor deficiency with respect to not ensuring that all programs and procedures are independently assessed periodically for effectiveness, specifically, Hours of Work and Fitness-for-Duty. At the end of 2017, CNSC staff were reviewing OPG`s proposed corrective action plan and will monitor OPG`s implementation of the corrective action at PNGS.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

3.2.2 Human performance management

CNSC staff concluded that the human performance management SCA at the Pickering site met performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "satisfactory" ratings, unchanged from the previous year.

Human performance program

CNSC staff determined that the OPG human performance program for the PNGS and the PWMF met the applicable regulatory requirements.

CNSC staff had no significant observations at the PNGS or the PWMF to report in this specific area for 2017.

Personnel training

CNSC staff determined that OPG has a well-documented and robust fleet-wide training system based on a systematic approach to training (SAT). Implementation of this system for the training programs at the PNGS and the PWMF met the applicable regulatory requirements.

Pickering Nuclear Generating Station

In 2017, CNSC staff performed compliance verification inspections of the Authorized Nuclear Operator and Contract Management personnel training programs. CNSC staff also performed desktop reviews of the Chemical Laboratory Staff and Radiation Protection Technician training programs. In all cases, CNSC staff concluded that the training programs were defined and documented in accordance with the OPG SAT-based training system and that OPG met regulatory requirements. Minor procedural non-compliances of low safety significance were identified with respect to the documentation of training objectives and alignment of training qualification description documents with governance. At the end of 2017, CNSC staff were satisfied with OPG's progress to address non-compliances.

Pickering Waste Management Facility

In 2017, CNSC staff verified that OPG completed the corrective actions that resulted from the training-focused compliance verification inspection conducted in 2016 to CNSC staff's satisfaction and the associated action item was closed.

Personnel certification

Pickering Nuclear Generating Station

CNSC staff determined that OPG's personnel certification program at PNGS met the applicable regulatory requirements. CNSC staff reviewed the staffing reports for certified personnel, the applications for initial certification and renewal of certification, and confirmed that certified personnel at PNGS possessed the knowledge and skills required to perform their duties safely and competently.

Pickering Waste Management Facility

This specific area does not apply to the PWMF because there are no CNSC certified positions at the facility.

Initial certification examinations and requalification tests

Pickering Nuclear Generating Station

Based on previous inspections and regular compliance verification activities, CNSC staff concluded that the initial certification examination and requalification testing programs at PNGS met regulatory requirements.

Pickering Waste Management Facility

This specific area does not apply to the PWMF because there are no CNSC certified positions at the facility.

Work organization and design

Minimum shift complement

Pickering Nuclear Generating Station

The minimum shift complement at PNGS met the applicable regulatory requirements.

In May 2017, CNSC staff conducted an inspection of the PNGS MSC program. The scope of the inspection encompassed all aspects of the MSC to verify availability of sufficient qualified staff at PNGS. CNSC staff confirmed that OPG was in compliance with licence requirements and has processes and procedures in place to ensure the availability of a sufficient number of qualified staff.

However, CNSC staff identified non-compliances of low safety significance in the areas of record keeping, training qualification records, and procedural adherence. OPG provided a corrective action plan to address the findings. CNSC staff is satisfied with OPG's proposed corrective actions and is monitoring OPG's implementation of the actions at PNGS. OPG has targeted completion of all the actions by Q1 2019.

Pickering Waste Management Facility

This specific area does not apply to the PWMF.

Fitness for duty

CNSC staff determined that OPG met the applicable regulatory requirements for fitness for duty at the PNGS and the PWMF.

CNSC staff requested OPG to provide an implementation plan for REGDOC-2.2.4 *Fitness for Duty, Volume I: Managing Worker Fatigue* by September 30, 2017. OPG committed to the full implementation of this REGDOC at the Pickering site by January 1, 2019. CNSC staff were satisfied with OPG's implementation plan and will monitor its progress.

OPG committed to the implementation of REGDOC -2.2.4 *Fitness for Duty Volume II: Managing Alcohol and Drug Use*, except random testing, by July 2019. The implementation date for random testing is planned for December 2019. CNSC staff will monitor OPG's implementation progress.

UPDATE: CNSC staff found the plans to be acceptable, although notes that implementation could be impacted by legal challenges.

Pickering Nuclear Generating Station

In 2017, CNSC staff completed a desktop review to verify the accuracy of reporting of non-compliances with the limits of hours worked for certified staff for PNGS (and DNGS). CNSC staff identified non-compliances with the OPG processes that are used to track, monitor, and report hours of work non-compliances. By the end of 2017, OPG was developing a corrective action plan that covered both PNGS and DNGS.

Overall, CNSC staff are satisfied with the fitness for duty of workers at PNGS.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

3.2.3 Operating performance

CNSC staff concluded that the operating performance SCA at the Pickering site met or exceeded performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "fully satisfactory" ratings, unchanged from the previous year.

Conduct of licensed activities

CNSC staff concluded that OPG met or exceeded the applicable regulatory requirements for the conduct of licensed activities at the PNGS and the PWMF. CNSC staff determined that OPG continued to operate the PNGS and the PWMF in a safe and secure manner, with adequate regard for health, safety, security, radiation and environmental protection, and international obligations.

In 2017, OPG operated the PNGS and the PWMF within the bounds of its operating policies and principles, and operational safety requirements.

Pickering Nuclear Generating Station

OPG operated the PNGS within the bounds of its operational safety requirements.

PNGS experienced 1 unplanned reactor trip, 0 stepbacks and 4 setbacks.

CNSC staff determined that the trip and setbacks were controlled properly, and power reduction was adequately initiated by the reactor control systems. CNSC staff verified that for all events, OPG staff followed approved procedures and took appropriate corrective actions.

Pickering Waste Management Facility

During the reporting period, OPG processed 54 DSCs at the PWMF, 4 DSCs above OPG's internal target. Since the start of facility production to the end of 2017, OPG had processed and placed into storage 901 DSCs at the PWMF.

Procedures

CNSC staff concluded that OPG has governance in place that ensures that procedures for the PNGS and the PWMF are written in a consistent and usable manner. OPG has clearly documented expectations for procedural use and adherence, and a process to manage procedural change at the Pickering site.

CNSC staff were satisfied with the quality of the OPG procedures reviewed and found that they met the applicable regulatory requirements at the PNGS and the PWMF.

Reporting and trending

CNSC staff determined that OPG's reporting and trending met or exceeded the applicable regulatory requirements and expectations in 2017 for the PNGS and the PWMF.

During the reporting year, all scheduled reports were submitted to the CNSC in a timely manner and were adequate.

Pickering Nuclear Generating Station

OPG submitted 33 reportable events that required a detailed event report in 2017. All reported events were followed up by OPG with corrective actions and root cause analysis, when appropriate.

Pickering Waste Management Facility

During 2017, CNSC staff received 5 low safety significance event reports from OPG regarding the PWMF. The event reports are discussed in detail in their applicable SCA throughout this report.

Outage management performance

Pickering Nuclear Generating Station

OPG demonstrated good levels of performance and achievement of objectives during maintenance outages.

In 2017, there were there four (4) planned PNGS outages (Units 1, 4, 5, and 8) and eight (8) forced outages (involving Units 1, 4, 6, and 7).

Overall, based on the CNSC staff oversight results, OPG executed planned outages safely and met regulatory requirements.

In addition to planned outages, OPG also undertook forced unplanned outages as required to fix or replace equipment.

OPG conducted these outages safely.

CNSC staff conducted two outage management inspections and found that PNGS's outage management performance met or exceeded regulatory requirements and expectations in 2017.

Pickering Waste Management Facility

This specific area does not apply to the PWMF.

Safe operating envelope

Pickering Nuclear Generating Station

CNSC staff determined that OPG operated within the safe operating envelop (SOE) and met the applicable regulatory requirements for PNGS.

Pickering Waste Management Facility

This specific area does not apply to the PWMF.

Severe accident management and recovery

Through regulatory oversight activities, CNSC staff determined that severe accident management and recovery met the applicable regulatory requirements for the PNGS and met or exceeded them for the PWMF. The program is implemented at the Pickering site with an organizational structure that clearly establishes the roles and responsibilities of all program participants.

Pickering Nuclear Generating Station

CNSC staff had no significant observations at PNGS to report in this specific area for 2017.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

Accident management and recovery

CNSC staff determined that OPG's accident management and recovery programs for the PNGS and the PWMF met or exceeded the applicable regulatory requirements in 2017.

Pickering Nuclear Generating Station

OPG has a series of abnormal incident manual (AIMs) and emergency operating procedures (EOPs) at PNGS to detect abnormal conditions, mitigate causes of the incidents and accidents, return the plant to a safe and controlled state, and to prevent further escalation into a more serious accident. CNSC staff were satisfied that OPG had adequate measures in place.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

3.2.4 Safety analysis

CNSC staff concluded that the Safety Analysis SCA at the Pickering site met or exceeded performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "fully satisfactory" ratings, unchanged from the previous year.

Deterministic safety analysis

CNSC staff concluded that OPG's deterministic safety analysis predicted adequate safety margins, and met or exceeded the applicable regulatory requirements at the PNGS and the PWMF.

Pickering Nuclear Generating Station

CNSC staff have determined that OPG has a well-managed program on deterministic safety analysis. OPG continued to implement CNSC REGDOC-2.4.1, *Deterministic Safety Analysis*. OPG submitted a revised implementation plan in November, 2017. As of December, 2017, CNSC staff were reviewing it and were satisfied with the progress to date.

As a key input for the implementation of REGDOC-2.4.1, OPG had submitted the identification and classification of Common Cause Events for Pickering and the technical basis document in August 2016. In December 2017, OPG submitted the analysis and results to CNSC.

UPDATE: Based on CNSC staff's review, OPG is expected to address CNSC staff comments on the analysis through the safety report update process; it is also one of the IIP actions to support continued operation until 2024.

In 2017, OPG submitted an updated fire hazard analysis (FHA) and fire safe shutdown analysis (FSSA) for PNGS. CNSC staff's review determined that the approach and methodology used is consistent with the applicable regulatory requirements.

There were no major concerns raised through the review of the findings that had an effect on the licensees' fire protection program or Fire Hazard Analysis. The level of compliance is satisfactory and the licensee continues to implement a comprehensive fire protection program at PNGS in accordance with the applicable requirements.

Pickering Waste Management Facility

OPG has established and maintains a safety analysis program which is effectively implemented at the PWMF and that fully satisfies regulatory requirements. OPG submits a safety analysis report for the PWMF every five years that effectively identifies facility hazards and the measures in place to control or mitigate these hazards. The most recent revision to this document was submitted to CNSC staff in 2013, which was reviewed by CNSC staff and found satisfactory. CNSC staff expect the next revision of the safety report for the PWMF to be submitted in 2018.

OPG continues to implement a comprehensive fire protection program at the PWMF in accordance with applicable requirements.

Probabilistic safety assessment

Pickering Nuclear Generating Station

As requested by the Commission after the Part 2 Hearing for the Pickering NGS licence renewal in 2013, OPG updated both the Pickering NGS 1, 4 and Pickering NGS 5-8 PSAs to account for the enhancements required under the Fukushima Action Plan. OPG has used the results and insights of the updated PSAs to identify and optimize risk improvement tasks.

OPG developed and implemented a Risk Improvement Plan to implement safety improvements for PSA values that were below the safety goal limit but above the administrative safety goal target, specifically for PNGS A Severe Core Damage Frequency (SCDF) and Large Release Frequency (LRF) for internal fires, and PNGS A LRF for Internal Events At-Power. The last update on the risk improvement plan was submitted in February 2018 (see Physical Design SCA for details).

In 2017, OPG submitted a full scope PSA update for PNGS Units 5-8 that was compliant with CNSC Regulatory Document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. OPG will submit a full scope PSA update for PNGS Units 1 and 4, that is compliant with S-294, by the end of 2018.

In 2015, OPG provided a plan for PSA updates to meet the requirements established by CNSC REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. OPG plans to fully implement REGDOC-2.4.2 at PNGS by the end of 2020. CNSC staff were satisfied with OPG's transition plan and will continue to monitor the implementation of REGDOC-2.4.2. This is also one of the IIP actions to support continued operation until 2024.

In addition, as per the Commission's direction associated with the renewal of the PNGS PROL, OPG submitted the pilot project report on whole-site PSA for PNGS in 2017. OPG and CNSC staff presented the preliminary results to the Commission in December 2017. CNSC staff agreed with OPG's overall results – specifically, the methodology used to avoid the double counting of accident sequences (CMD 17-M64 [4]). See Section 2.4 for additional background information on whole-site PSA.

CNSC found that OPG's performance in the PSA area at PNGS met or exceeded the applicable regulatory requirements in 2017.

Pickering Waste Management Facility

This specific area does not apply to the PWMF.

Criticality safety

This specific area does not apply to the PNGS and PWMF.

Severe accident analysis

Pickering Nuclear Generating Station

OPG continues to support industry research and development (R&D) program in the area of severe accident analysis.

OPG with other licensees have developed a project called Severe Accident Software Simulator Solution to improve their methods for deterministic analysis of multi-unit severe accidents. CNSC staff has completed the review of this document and proposed some recommendations.

OPG has scheduled implementation of some modifications and provisions to arrest progression of a beyond design-basis accident (BDBA) to a severe accident and to prevent challenge to containment integrity.

The emergency fire water cooling piping connection to PNGS Units 1 & 4 is expected to be completed during a planned 2020 outage, and the restoration of emergency power to one main volume vacuum pump is expected to be completed by 2019."

Pickering Waste Management Facility

This specific area does not apply to the PWMF.

Management of safety issues (including R&D programs)

Pickering Nuclear Generating Station

The work by NPPs to address the remaining category 3 CANDU safety issues is described in section 2.4.

The following are highlights of two R&D projects that are currently ongoing:

Moderator subcooling requirements methodology

OPG submitted the conclusion of the review by a Safety Analysis Issue Review Panel of experimental results from the CNSC-sponsored Calandria-Tube Strain Contact Boiling project. CNSC staff issued an interim report summarizing the results of the experiments and an evaluation of the results. OPG plans to address the outstanding issues over the next licence period. This issue is considered to be of low safety significance as it only affects safety margins during postulated accidents of a low probability of occurrence.

Moderator temperature predictions

The accurate prediction of the moderator temperature is important for several design basis accident analyses. The original work completed on moderator temperature predictions did not consider in detail the moderator nozzle configuration specific for PNGS Units 1, 4. OPG recently completed several initiatives to address CNSC staff's concerns including the conduct of analyses and experiments representing the specific geometries of the moderator inlet nozzles for PNGS Units 1, 4. Further experimental work is currently underway at McMaster University. CNSC staff will review the experimental results when they become available. This issue is considered to be of low safety significance as the issue deals with the uncertainties in analyses using the overall robust models.

CNSC staff continued to undertake systematic evaluations of the OPG R&D program activities, as submitted to CNSC staff through annual reporting in accordance with REGDOC-3.1.1 *Reporting Requirements for Nuclear Power Plants*. These evaluations confirm that OPG maintains or has access to a robust R&D capability to address any emerging issues.

Pickering Waste Management Facility

This specific area does not apply to the PWMF.

3.2.5 Physical design

CNSC staff concluded that OPG activities falling under the physical design SCA at the Pickering site met performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received a "satisfactory" rating, unchanged from the previous year.

Design governance

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements regarding design governance in 2017 for the PNGS and the PWMF.

Pickering Nuclear Generating Station

Environmental qualification

CNSC staff determined that OPG met the applicable regulatory requirements. In 2017, CNSC staff reviewed OPG's response to previous inspection findings on PNGS A and B

Environmental Qualification Program efficiency and effectiveness and concluded that OPG adequately addressed issues related to knowledge management and resourcing. Outstanding actions relating to the improvement of system performance monitoring plans and EQ documentation update are targeted to be completed in 2018.

OPG is conducting, under one action of the IIP, an evaluation of existing environmental qualification assessments for life-limiting components to support operation beyond 2020. Resulting actions will be documented and resolved in accordance with OPG environmental qualification program requirements, and supported documentation will be submitted to CNSC by December 2019.

Pressure boundary design

OPG continues to implement a comprehensive pressure boundary program at PNGS. The pressure boundary program is compliant with regulatory requirements.

Human factors in design

OPG completed a gap analysis and developed an implementation plan to implement CSA Group standard N290.12-14, *Human factors in design for nuclear power plants* text by September 1, 2018.

Pickering Waste Management Facility

Pressure boundary design

CNSC staff determined that OPG continues to implement a comprehensive pressure boundary program at the PWMF that is compliant with regulatory requirements.

Site characterization

CNSC staff had no significant observations at the PNGS or the PWMF to report in this specific area for 2017.

Facility design

CNSC staff had no significant observations at the PNGS or the PWMF to report in this specific area for 2017.

Structure design

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements regarding structure design in 2017 for the PNGS and the PWMF.

Pickering Nuclear Generating Station

In 2016, CNSC staff hadinspected the preservation of the seismic design basis at PNGS. CNSC staff had concluded that OPG met regulatory requirements with the exception of some minor deficiencies of low safety significance related to verification of documents and maintaining plant configuration consistent with design documents. OPG provided a long-term corrective action plan. CNSC staff found the plan acceptable and were monitoring its implementation at the end of 2017.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

System design

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements regarding system design in 2017 for the PNGS and the PWMF.

Pickering Nuclear Generating Station

Electrical power systems

In 2017, CNSC staff conducted desktop reviews, and followed-up on 2015 and 2016 compliance inspections. Based on these compliance activities, no major concerns were found and CNSC staff concluded that the Electrical Power Systems (EPS) met the applicable regulatory requirements at PNGS.

The PNGS PSR identified modifications to protect containment through the provision of emergency power and water to the reactor air cooling units, as well as emergency power to the hydrogen igniters and the Filtered Air Discharge System (FADS). In addition, modifications will be completed to make fire protection system water available to the steam generators, heat transport system and the moderator system. These and other specific activities are documented in the PSR IIP.

Fire Protection design

The licensee is in compliance with the regulatory requirements based on results of CNSC's ongoing compliance activity.

Independent third party reviews (TPR) for design modifications and facility site condition inspection were acceptable and yielded no major finding. The level of compliance is satisfactory and the licensee continues to implement a comprehensive fire protection program at PNGS.

Instrumentation and Control

CNSC staff had no significant observations at PNGS to report in this specific area for 2017. CNSC staff determined that OPG has improved the performance and reliability of instrumentation and control systems at the PNGS through the verification of compliance with code and standards, the corrective maintenance program, and ageing management of instrumentation and control systems.

Pickering Waste Management Facility

CNSC staff determined that OPG continued to implement a comprehensive fire protection program at the PWMF in accordance with CSA-N393-13, *Fire protection for facilities that process, handle, or store nuclear substances*.

Components design

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements regarding components design in 2017 for the PNGS and the PWMF.

Pickering Nuclear Generating Station

Fuel design

CNSC staff determined that OPG has a mature reactor fuel inspection and monitoring program. Fuel performance at PNGS was acceptable in 2017. As a result of the corrective actions, the severity and frequency of observed black deposits has continued to trend downwards. OPG is able to adequately manage fuel performance issues while maintaining safe operations.

Cables

In 2017, there were no issues found during compliance verification activities (i.e. desktop reviews and compliance verification inspection of the Electrical Power Systems (EPS) CNSC staff concluded that the cable management program at PNGS met the applicable regulatory requirements.

PSA Risk Improvement Plan

OPG developed and implemented a Risk Improvement Plan to implement safety improvements for PSA values that were below the safety goal limit but above the administrative safety goal target.

CNSC staff reviewed and accepted the plan which addressed physical changes to the station as well as changes to the PSA modeling. Improvements to plant design included:

- Emergency Mitigating Equipment (EME) modifications
- Installation of Passive Autocatalytic Recombiners (PARs)
- Tie-down of EME for high wind
- Installation of flood barriers

These improvements have resulted in a significant risk reduction to internal fires, SCDF and LRF results.

Since 2015, OPG has provided annual updates to CNSC on the progress and status of the Risk Improvement Plan. CNSC staff have verified and confirmed that OPG has completed the risk improvement tasks based on the plan.

CNSC staff are satisfied with the current status of the implementation of risk improvement tasks. OPG completed all the items in the risk improvement plan by the end of 2017.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

3.2.6 Fitness for service

CNSC staff concluded that the fitness for service SCA at the Pickering site met performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received “satisfactory” ratings, unchanged from the previous year.

CNSC staff determined that OPG has established and maintains fitness for service programs which are effectively implemented at the PNGS and the PWMF, and that satisfy regulatory requirements. The implemented programs ensure the safe physical condition of systems, structures, and components.

Equipment fitness for service/equipment performance

Pickering Nuclear Generating Station

CNSC staff determined that the overall equipment fitness for service and performance at PNGS was satisfactory and met the applicable regulatory requirements.

Reliability of systems important to safety

CNSC staff determined that the reliability program at PNGS met the applicable regulatory requirements.

CNSC staff reviewed OPG's maintenance strategy to improve the system availability/reliability and determined that the existing reliability (and maintenance, described below) programs meet regulatory requirements.

CNSC staff identified an area for improvement regarding an increasing unavailability trend of the EPGs, which primarily resulted from long outages. It was noted that there was no simultaneous loss of both EPGs, and in addition, when EPG1 or EPG2 was unavailable, EPG3 was put in standby state to maintain the reliability of the emergency power supply function. OPG has already implemented some corrective actions to address this issue and an action item has been raised for OPG to address issues identified by CNSC staff. CNSC staff have also recently noticed, based on the 2017 Annual Risk and Reliability Report, that the unavailability time of the EPGs has been reduced. CNSC staff continue to monitor the effectiveness of OPG's reliability improvement actions.

All special safety systems for PNGS Units 1, 4 and 5–8 met their unavailability targets in 2017.

Pickering Waste Management Facility

This specific area does not apply to the PWMF.

Maintenance

CNSC staff determined that OPG's maintenance program met the applicable regulatory requirements for the PNGS and the PWMF in 2017.

OPG's nuclear power plants maintenance program also governs preventative and corrective maintenance activities for the waste management facilities.

Pickering Nuclear Generating Station

The average preventive maintenance completion ratio for the six units at PNGS was 82 percent. This was slightly lower than the industry average, but acceptable to CNSC staff. The maintenance backlogs were also acceptable and are provided in table 18.

Table 18: Maintenance backlogs and deferrals for critical components for PNGS, 2016

Parameter	Average quarterly work orders per unit in 2017	Average quarterly work orders per unit in 2016	Average quarterly work orders per unit in 2015	Three years trending	Industry average
Corrective maintenance backlog	7	19	26	down	4
Deficient maintenance backlog	104	109	96	stable	94
Deferrals of preventive maintenance	81	110	120	down	30

The corrective maintenance backlog was reduced and is close to the industry average. The performance of managing the deficient maintenance work was below industry average. The number of preventive maintenance deferrals has been trending down but it was more than twice the industry average.

CNSC staff conducted a focused desktop review in 2017 to verify the causes of their relatively high number for the deficient maintenance backlog and the relatively high number of preventive maintenance deferrals. Among the causes revealed in the review, lack of maintenance resources was one of the major causes of the high number of preventive maintenance deferrals.

UPDATE: In January 2018, CNSC requested OPG to provide a self-assessment and the associated corrective actions to ensure adequate maintenance resources are in place to timely conduct the critical maintenance activities. OPG provided its first response in May 2018. CNSC staff reviewed the response and concluded that adequate resources were in place to complete the maintenance work per the required frequency. Overall, the significance of maintenance backlogs and deferrals for critical components was low because the deficient maintenance backlog has stabilized during the last four quarters and the system safety functions have always been maintained, which has been and will be continuously verified in the maintenance inspections and maintenance-related event reviews.

As part of the licence renewal, OPG confirmed it had implemented CNSC regulatory document RD/GD-210 *Maintenance Programs for Nuclear Power Plants*, which supersedes CNSC regulatory document S-210. This standard has been added as compliance verification criteria in the proposed LCH.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

Structural integrity

CNSC staff concluded that SSCs required for safe operation continued to meet the applicable structural integrity requirements established in the design basis or in CNSC-accepted standards and guidelines for the PNGS and the PWMF in 2017.

Pickering Nuclear Generating Station

In 2017, OPG's pressure boundary inspection results indicated that all inspected elements of the primary heat transport and auxiliary systems, steam generators, feeders and pressure tubes met CSA acceptance criteria. CNSC staff reviewed the results of the Unit 1 reactor building pressure test in November 2017 and found no significant issues.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

Aging management

CNSC staff concluded that OPG's integrated aging management program met the applicable regulatory requirements at the PNGS and the PWMF in 2017. OPG completed its transition to compliance with REGDOC-2.6.3, *Aging Management* in 2017 at the PNGS and the PWMF.

Pickering Nuclear Generating Station

CNSC staff confirmed that the in-service inspection scope included in the major component LCMPs exceeded the minimum inspection requirements. Further, the major component LCMPs also included 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.

CNSC staff determined that OPG had adequate programs in place to confirm that fuel channels were fit for service for near-term operation. OPG submitted engineering assessments of degradation mechanisms that spanned the near-term and met all applicable CSA 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. CNSC staff were satisfied with the progress - see Section 2.6 for further details. Also, see Appendix H: for details on the current and anticipated future fuel channel conditions and validity of analytical models of pressure tube fracture toughness for fuel channels at Pickering (and the other NPPs in Ontario).

Pickering Waste Management Facility

There were no significant observations to report for this specific area at PWMF in 2017.

Chemistry control

CNSC staff determined that OPG's chemistry control program met or exceeded the applicable regulatory requirements for the PNGS and the PWMF in 2017.

Pickering Nuclear Generating Station

PNGS maintained acceptable performance during the licence period as demonstrated from the Quarterly Safety Performance Indicators Chemistry Index and Chemistry Compliance Index.

In 2017, CNSC staff inspected the PNGS chemistry program and concluded that it complied with the applicable regulatory requirements and aligned with industry best practices.

Pickering Waste Management Facility

CNSC staff reviewed the 2017 quarterly reports for the PWMF and concluded that the facility has maintained acceptable performance related to chemistry. There were no chemistry-related incidents at the PWMF in 2017.

Periodic inspection and testing

Pickering Nuclear Generating Station

CNSC staff have determined that OPG has adequate and well maintained periodic inspection programs (PIPs) for pressure boundary systems, containment components and containment structures that comply with CSA Standards N285.4 *Periodic inspection of CANDU nuclear power plant components*, N285.5 *Periodic inspection of CANDU nuclear power plant containment components* and N287.7 *In-service examination and testing requirements for concrete containment structures*

Pickering Waste Management Facility

This specific area does not apply to the PWMF because periodic inspection and testing requirements are addressed under the scope of Aging Management at the facility.

3.2.7 Radiation protection

CNSC staff concluded that the radiation protection SCA at the Pickering site met performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "satisfactory" ratings, unchanged from the previous year.

Application of ALARA

CNSC staff determined that OPG continued to implement an effective and well-documented program, based on industry best practices, to keep doses to persons as low as reasonably achievable (ALARA) at the PNGS and the PWMF.

CNSC staff verified that OPG used ALARA initiatives, work planning, and dose monitoring and control to work towards the challenging ALARA targets established by OPG at the PNGS and the PWMF.

Pickering Nuclear Generating Station

In 2017, CNSC staff conducted a compliance inspection focused on the area of Application of ALARA. This inspection demonstrated that a mature ALARA program that meets CNSC expectations is in place to plan and control work activities. There were no regulatory non-compliances identified as a result of this inspection.

Pickering Waste Management Facility

CNSC staff verified during 2017 that radiation exposures and doses to workers at the PWMF were below the regulatory dose limits and remained ALARA.

Worker Dose Control

CNSC staff determined that OPG continued to comply with the regulatory requirements to measure and record doses received by workers at the PNGS and the PWMF.

Routine compliance verification activities conducted in 2017 indicated that performance in the area of worker dose control at the Pickering site was effective. Radiation doses to workers at the PNGS and the PWMF were below the regulatory dose limits, as well as the action levels established in OPG's Radiation Protection Program.

CNSC staff observed that there were no adverse trends or safety-significant unplanned exposures that resulted from the licensed activities at the Pickering site in 2017.

The data for doses to workers at the Pickering site can be found in section 2.7.

Pickering Nuclear Generating Station

The maximum dose received by a worker at the PNGS in 2017 was 14.58 mSv, which is approximately 29% of the regulatory dose limit.

Pickering Waste Management Facility

The maximum dose received by a worker at the PWMF in 2017 was 0.9 mSv, which is 1.8% of the regulatory dose limit.

Radiation protection program performance

CNSC staff determined that OPG's corporate Radiation Protection Program, which covers the PNGS and the PWMF, met the requirements of the *Radiation Protection Regulations*.

The oversight applied by OPG in implementing and improving this program was effective in

protecting workers at the PNGS and the PWMF. OPG regularly measures the performance of its Radiation Protection Program against industry-established objectives, goals, and targets.

Pickering Waste Management Facility

OPG's action levels for the WMFs were revised in 2017 to ensure they were appropriate indicators of a possible loss of control of an element of OPG's Radiation Protection Program at the PWMF. CNSC staff reviewed the revised action levels and found them to be appropriate.

Radiological hazard control

CNSC staff determined that OPG implemented radiological hazard controls that met the applicable regulatory requirements. These measures protect workers and ensure radioactive contamination is controlled within the site boundaries for the PNGS and the PWMF.

There were no contamination control action level exceedances for surface contamination as a result of licensed activities at the PNGS and the PWMF in 2017.

CNSC staff confirmed that no safety-significant incidents were identified through reporting of safety performance indicators on personnel and loose contamination events.

OPG's contamination control action levels were revised in 2017 for the Pickering site to ensure they were appropriate indicators of a failure of the Radiation Protection Program. CNSC staff reviewed the revised action levels and found them to be appropriate.

Estimated dose to the public

CNSC staff determined that OPG continued to ensure the protection of members of the general public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to members of the general public from the Pickering site was 0.0018 mSv, well below the annual dose limit of 1 mSv for members of the general public. See Section 2.7.

3.2.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at the Pickering site met or exceeded performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "fully satisfactory" ratings, unchanged from the previous year.

Performance

CNSC staff determined that OPG met or exceeded requirements at the PNGS and the PWMF in regards to conventional health and safety performance.

OPG continues to demonstrate its ability to keep workers safe from occupational injuries while conducting its licensed activities at the PNGS and the PWMF. Health and safety related incidents are reported by OPG on an ongoing basis, as applicable.

CNSC staff conducted inspections at the PNGS and the PWMF, and recorded findings on the safety practices and controls being employed by OPG to address conventional hazards. CNSC staff did not identify any areas of concern regarding conventional health and safety in 2017.

Pickering Nuclear Generating Station

CNSC staff observed that the accident severity rate (ASR) for PNGS was 2.8 and then indicate year over year comparison if applicable. The accident frequency (AF) for PNGS was 0.1 and then indicate year over year comparison if applicable. The number of lost-time injuries for

PNGS was 2 and then indicate year over year comparison if applicable. The ASR and AF safety performance indicators at PNGS were found to be acceptable by CNSC staff.

Pickering Waste Management Facility

No health and safety related incidents or LTIs at the PWMF were reported by OPG to CNSC staff for the PWMF in 2017.

CNSC staff also participated in pre-inspection health and safety briefings held with OPG staff and management while on-site for inspections. CNSC staff found that the health and safety briefing were satisfactory.

Practices

CNSC staff determined that conventional health and safety practices met or exceeded the applicable regulatory requirements at the PNGS and the PWMF in 2017.

The conventional health and safety work practices and conditions at the PNGS and the PWMF continued to achieve a high degree of personnel safety. OPG personnel at all levels exhibit proactive attitudes towards anticipating work related hazards and preventing unsafe conditions. There continues to be a working environment where safe work practices are encouraged. CNSC staff verified that OPG has appropriate procedures in place at the PNGS and the PWMF to ensure protection of the environment and the health of persons against hazardous materials.

Pickering Waste Management Facility

CNSC staff observed safe work practices during site inspections at the PWMF. A positive indicator in this regard is the use of their job hazard analysis program which specifies OPG's commitment to conduct pre-inspection tours of jobs and job sites, listing emergency procedures for such jobs, identifying the minimum level of personal protective equipment required, and listing the required permits or work authorizations before starting work.

Awareness

CNSC staff concluded that OPG met or exceeded the applicable regulatory requirements for awareness in 2017 at the PNGS and the PWMF. CNSC staff determined that OPG continued to maintain a safe working environment at the PNGS and PWMF. CNSC staff had no significant observations at the PNGS or the PWMF to report in this specific area for 2017.

3.2.9 Environmental protection

CNSC staff concluded that the environmental protection SCA at the Pickering site met performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "satisfactory" ratings, unchanged from the previous year.

Effluent and emissions control (releases)

CNSC staff observed that all airborne and waterborne radiological releases from the Pickering site remained below the regulatory limits and action levels The releases are shown in figures 16 and 17 for PNGS 1,4 and PNGS 5-8, respectively, as percentages of the applicable DRLs; the Pickering B releases include those for PWMF. The actual values for the releases and DRLs for the Pickering site are provided in Appendix I:.

Figure 16: Effluent and emissions at PNGS 1, 4 as percentages of DRLs (waterborne Carbon-14 discharged via PNGS 5-8)

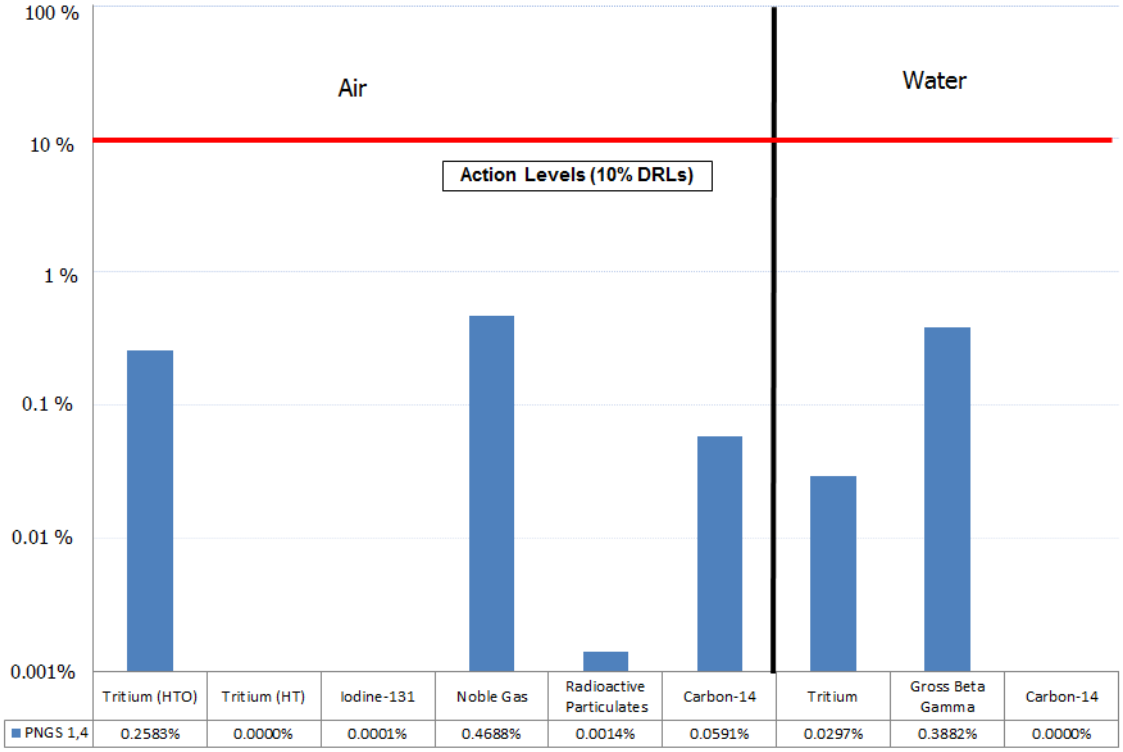
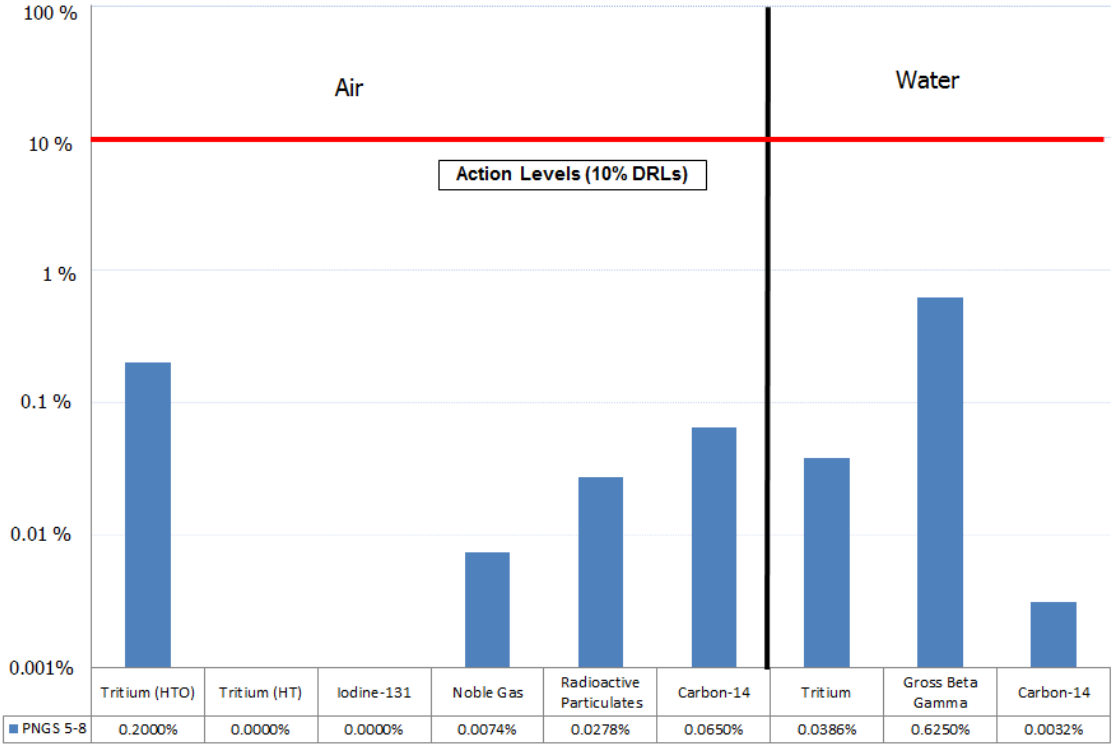


Figure 17: Effluent and emissions at PNGS 5-8 as percentages of DRLs (includes data for PWMF, and waterborne Carbon-14 discharges from PNGS 1, 4)



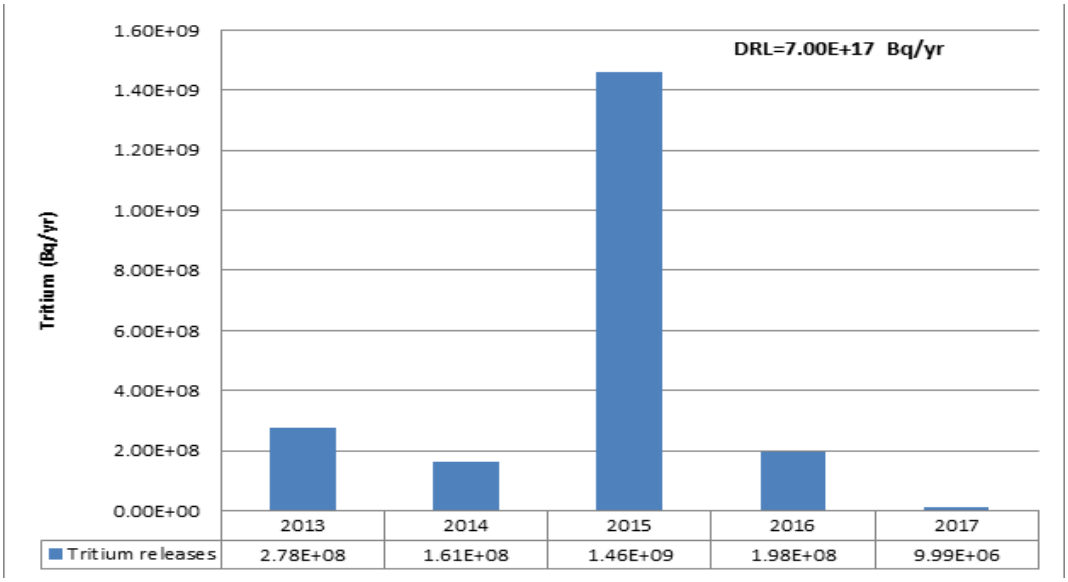
OPG plans to complete the implementation of CSA Group standard N288.3.4-13, *Performance testing of nuclear air-cleaning systems at nuclear facilities* by September 2018 for both the PNGS and the PWMF.

Pickering Waste Management Facility

As of December 14, 2017 OPG was fully compliant with the requirements of CSA Group standard N288.3.4-13, *Performance testing of nuclear air cleaning systems at nuclear facilities* for the PWMF.

In the Record of Decision issued for the licence renewal of the PWMF, the Commission requested that CNSC staff provide an updated and confirmatory analysis that tritium releases from the PWMF are not increasing. CNSC staff trended the release data provided by OPG and confirmed that the tritium releases at the PWMF show a decreasing trend since 2015, as shown in the figure 18.

Figure 18: Waterborne annual tritium releases (transfers) from PWMF



Environmental management system

CNSC staff concluded that OPG has established and implemented a corporate-wide EMS at the Pickering site in accordance with REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures* (2013) to assess environmental risks associated with its nuclear activities at the PNGS and the PWMF and to ensure these activities are conducted in a way that prevents or mitigates adverse environmental effects. The EMS is also registered to the ISO 14001: 2015 - *Environmental management systems – Requirements with guidance for use* **Error! Reference source not found.** standard. As a result of registration, the EMS is subject to periodic independent third party audits and reviews to verify its sufficiency and also identify potential improvements.

Assessment and monitoring

CNSC staff reviewed and assessed the environmental monitoring data provided by OPG for the Pickering site and concluded that the general public and the environment in the vicinity of the site were protected. OPG met the applicable regulatory requirements for the PNGS and the PWMF.

CNSC staff conducted independent environmental monitoring around the Pickering site in 2017 (see Section 2.9 for a description of the IEMP). The results are available on the CNSC's IEMP webpage [http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp]. The IEMP results indicated that the general public and the environment in the vicinity of the Pickering site were protected, and that there were no expected health impacts.

OPG has a transition plan in place to implement the requirements of CSA N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* at the PNGS and PWMF by December 31, 2020. CNSC staff found the transition date to be acceptable.

Pickering Nuclear Generating Station

Fish barrier net (monitoring)

In November 2017, approximately 24,000 kg of fish biomass, predominately larvae and young-of-the-year (age-0) Alewife, were impinged on the intake screen after the barrier net had been removed for the winter prior to lake ice formation. This quantity of Alewife is equivalent to approximately 1500 kg of one-year old adult (age-1) fish). OPG notified both CNSC staff and Fisheries and Oceans Canada of this event. OPG conducted an investigation and in June, 2017 OPG provided the results to both CNSC and Fisheries and Oceans Canada. OPG concluded that the event was attributable to rapid changes in the near shore lake environment, specifically sudden changes in lake temperature, current direction and speed. UPDATE: OPG submitted its detailed event investigation report to CNSC in April 2018 for review.

Protection of the public

CNSC staff confirmed that the general public in the vicinity of the Pickering site were protected, and that there were no expected health impacts. There were no reported hazardous substances released from the Pickering site that exceeded regulatory limits in 2017.

Dose to the public is discussed in Section 3.2.7.

Environmental risk assessment

CNSC staff determined that OPG continued to implement and maintain an effective environmental risk assessment and management program at the Pickering site in accordance with the applicable regulatory requirements.

OPG submitted a site-wide Environmental Risk Assessment (ERA) report (revision R000) for the Pickering site in April 2017, based on effluent and environmental monitoring data for the five-year period between 2011 and 2015. The ERA included an ecological risk assessment (EcoRA) and a human health risk assessment (HHRA) for radiological and non-radiological (hazardous) chemicals of potential concern and physical stressors.

UPDATE: In March, 2018, OPG submitted its revised ERA report (revision R001) for the Pickering site. CNSC staff's reviews drew the same conclusion for revisions R000 and R001; namely, that the ERA met the applicable regulatory requirements, and that meaningful adverse ecological and human health effects due to releases to air and water from the PNGS and the PWMF are unlikely. By the time of the PNGS licence renewal in 2018, OPG complied with the requirements of CSA Group standard N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* for the PNGS and PWMF.

Pickering Nuclear Generating Station

OPG also submitted a Predictive Effects Assessment (PEA) to support the licensing process for the continued operations of the reactor units and eventual Stabilization and Storage with Surveillance Phases and to demonstrate its provisions to protect the environment are adequate.

CNSC staff found that the 2017 PEA provided an adequate evaluation of all potential risks to human health and the environment associated with the continued operations of the reactor units and eventual Stabilization and Storage with Surveillance Phases if PNGS ceases commercial operation in the future. The results of the PEA review by CNSC staff indicate that meaningful human health or ecological effects attributable to the proposed Stabilization and Storage with Surveillance activities are unlikely.

3.2.10 Emergency management and fire protection

CNSC staff concluded that the emergency management and fire protection SCA at the Pickering site met performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "satisfactory" ratings, unchanged from the previous year.

CNSC staff determined that OPG continued to maintain comprehensive conventional, nuclear, and fire emergency response capabilities at all times for the Pickering site that met the applicable regulatory requirements. This includes personnel and equipment for medical, HAZMAT, search and rescue, and fire response.

The PNGS Emergency Response Team (ERT) will respond to events within the PNGS protected area (including the PWMF Phase I) 24/7.

Within the site boundary of the Pickering site (including the PWMF Phase II protected area), but outside the PNGS protected area, emergency response is provided by the City of Pickering Fire Department and Emergency Medical Services (EMS) with support from site personnel. Site support can include operations, security staff, or ERT personnel.

Conventional emergency preparedness and response

CNSC staff had no significant observations at the PNGS or the PWMF to report in this specific area for 2017.

Nuclear emergency preparedness and response

OPG continued to support offsite emergency management organizations and commitments throughout 2017.

OPG's nuclear emergency preparedness program is documented in the Consolidated Nuclear Emergency Plan (CNEP) which governs the Pickering site.

Training and exercises are conducted annually at the Pickering site to ensure all areas of the site have adequate emergency notification and response capability from either PNGS or the City of Pickering emergency services.

Pickering Nuclear Generating Station

OPG implemented version 1 of REGDOC-2.10.1 *Nuclear emergency preparedness and response* (2014) for PNGS by September 2017.

In 2017, OPG completed the implementation of a real-time automatic data transfer system for PNGS, which will provide prompt plant information to staff in the CNSC's Emergency Operations Centre (EOC) during nuclear emergencies.

In December 2017, OPG conducted a full-scale exercise (Exercise Unified Control) at the PNGS. The exercise was designed to test the preparedness and response capabilities and capacities of more than 30 organizations including the CNSC and some non-government agencies. The exercise progressed to a severe accident which allowed for the testing of OPG's ability to respond to extreme events.

CNSC staff inspected the exercise to assess OPG's compliance with the applicable regulatory requirements and, specifically, OPG's Consolidated Nuclear Emergency Plan.

UPDATE: CNSC staff identified a number of compliant and non-compliant findings during the inspection. The non-compliant findings were in the area of human performance related to

awareness and adherence to the procedures used during the emergency exercise. OPG has developed a corrective action plan and CNSC staff are monitoring its implementation.

Pickering Waste Management Facility

OPG has a facility emergency program for the PWMF that includes radiation response emergency procedures. OPG also incorporates the CNEP as part of its on-site requirements for nuclear response at the PWMF.

OPG currently has a transition plan in place to implement the requirements of version 2 of CNSC REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* (2016) at the PWMF by December 31, 2018. CNSC staff found the transition date to be acceptable.

Fire emergency preparedness and response

OPG has an extensive fire drill and training program which includes the Wesleyville Fire Training Academy located near Wesleyville, Ontario where live fire training is conducted for the Pickering ERT and the City of Pickering Municipal Fire Department.

Pickering Nuclear Generating Station

CNSC staff performed a compliance inspection of the Fire Protection program in 2017. Staff concluded that OPG was in compliance with regulatory requirements; however non-compliances with OPG's governance were observed for the effective management of transient and combustible material and for deficiencies with the fire protection surveillance process. OPG had provided a corrective action plan. CNSC staff will continue to monitor OPG's corrective actions through regular compliance oversight activities. CNSC staff also performed a reactive field inspection of fire protection equipment at PNGS. OPG was found non-compliant with the applicable National Fire Protection Association 1962 requirements for not maintaining the required records to support the conduct of maintenance and inspection of fire protection equipment. OPG provided a corrective action plan which CNSC staff found acceptable.

In addition to CNSC compliance activities, PNGS is required to conduct expert Third Party Reviews (TPR) of an annual plant condition, bi-annual fire drill audit and tri-annual fire program audit.

By incorporating the results of the CNSC compliance findings and TPR observations and recommendations into the drill and training program, the emergency response team performance continues to improve.

Pickering Waste Management Facility

OPG has a facility emergency program for the PWMF that includes basic fire response for facility staff to respond to small fires with fire extinguishers.

On January 23, 2017, OPG reported an event that occurred at Storage Building #3 of the PWMF to CNSC staff regarding the exceedance of the due date on the fire hydrant flush and drain maintenance. OPG stated that there were no environmental, health, safety or security implications for the facility or personnel as a result of this event. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

On June 22, 2017, OPG reported an event that occurred at Storage Building #3 of the PWMF to CNSC staff regarding a failure of the fire protection system booster panel, rendering three of five beam detectors unavailable. OPG stated that there were no environmental, health, safety or security implications for the facility or personnel as a result of this event. CNSC staff requested to be notified once the impairment was cleared. CNSC staff received correspondence on

September 30, 2016 noting that the impairment was cleared in August. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

On August 3, 2017, OPG reported an event that occurred at the PWMF Processing building to CNSC staff regarding an emergent fire impairment in which a panel module failed, rendering the fire detection panel impaired. OPG stated that there were no residual environmental, health, safety or security implications for the facility or personnel as a result of this event with the implementation of the impairment plan. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

3.2.11 Waste management

CNSC staff concluded that the waste management SCA at the Pickering site met or exceeded performance objectives and applicable regulatory requirements. As a result, the PNGS received a "fully satisfactory" rating, an improvement over the "satisfactory" rating from the previous year, and the PWMF received a "satisfactory" rating, unchanged from the previous year.

Waste characterization

CNSC staff determined that OPG's waste characterization met or exceeded the applicable regulatory requirements at the PNGS and the PWMF.

OPG continued to employ effective programs for the characterization of radioactive and hazardous wastes at the PNGS and the PWMF during 2017. CNSC staff had no significant observations at the PNGS or the PWMF to report in this specific area for 2017.

Waste minimization

CNSC staff determined that OPG's waste management programs for minimizing radioactive waste met or exceeded the applicable regulatory requirements at the PNGS and the PWMF.

Pickering Waste Management Facility

Minimal radioactive waste is generated from the waste management activities conducted at the PWMF. Nonetheless, OPG has set a goal to minimize the generation of radioactive waste due to operational activities. Annual volumes amount to less than one drum that is sent to the PNGS for segregation as necessary and eventually transported to the WWMF for processing and storage.

Waste management practices

CNSC staff determined that OPG's waste management practices met or exceeded the applicable regulatory requirements at the PNGS and the PWMF. OPG continued to employ effective radioactive and hazardous waste management practices at the Pickering site during 2017. OPG uses waste management procedures to ensure that waste generated at the facility is separated properly.

Pickering Waste Management Facility

As of October 31, 2017 OPG had fully implemented the requirements of CSA Group standards N292.0-14, *General principles for the management of radioactive waste and irradiated fuel,* N292.2-13, *Interim dry storage of irradiated fuel* and N292.3-14, *Management of low and intermediate-level radioactive waste* for the PWMF.

Decommissioning plans

The PDPs for the PNGS and the PWMF met or exceeded the applicable regulatory requirements in 2017.

In 2017, OPG revised the PDPs for all of its facilities for the period up to 2022. OPG selected a deferred decommissioning strategy for the decommissioning of the PNGS and an immediate decommissioning strategy for the PWMF, following the completion of the PNGS decommissioning. The associated financial guarantee is discussed in Section 2.15.

3.2.12 Security

CNSC staff concluded that the security SCA at the Pickering site met performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "satisfactory" ratings, unchanged from the previous year for the PNGS, and a downgrade from the previous year for the PWMF.

Facilities and equipment

CNSC staff determined that OPG met the applicable regulatory requirements for facilities and equipment at the PNGS and the PWMF. OPG continued to sustain its security equipment through lifecycle management at the Pickering site. No significant equipment failures were reported in 2017. OPG has processes in place to adequately prevent security events at the PNGS and the PWMF.

Pickering Nuclear Generating Station

OPG committed to improvements to the PNGS preventive maintenance program in 2017 to ensure that adequate qualified personnel are available to effectively maintain security equipment.

Cyber Security

OPG maintains a cyber security program for the PNGS. CNSC staff concluded that the program is compliant with applicable regulatory requirements. There were no cyber security events reported in 2017.

OPG was updating its current cyber security program for the PNGS to achieve compliance with CSA Group standard N290.7-14, *Cyber security for nuclear power plants and small reactor facilities* by November 30, 2019. CNSC staff were satisfied with the progress to date.

Pickering Waste Management Facility

OPG has physical protection systems and a security program in place at the PWMF appropriate for a high-security nuclear facility.

CNSC staff confirmed that OPG updated its security operating procedures and ensured that its contingency plans continued to meet the Design Basis Threat (DBT) as approved by the CNSC.

CNSC staff inspected security at the PWMF in 2017 and issued three low risk compliance actions to OPG. CNSC staff were satisfied with the resulting corrective actions and consider the inspection to be closed.

On October 24, 2017 OPG reported an event that occurred at the PWMF to CNSC staff regarding security. CNSC staff followed up with the event on site during a routine inspection. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

Response arrangements

CNSC staff determined that OPG met the applicable regulatory requirements for response arrangements at the PNGS and the PWMF.

Pickering Nuclear Generating Station

CNSC staff are monitoring the implementation of corrective actions in response to findings made during compliance verification activities at PNGS in 2016. These findings were in the areas of training and decision making. OPG implemented corrective actions to address these outstanding items by March 30, 2018. CNSC staff are meeting with the licensee and will conduct follow up activities in the coming year until the completion of the corrective actions.

OPG has also developed an Incident Command course, which provides valuable training and information for both the off-site response force and the PNGS on-site nuclear response force. Course material is updated based on outcomes and opportunities for improvement noted in previous security exercises.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

Security practices

CNSC staff determined that OPG implemented security practices at the PNGS and the PWMF that met the applicable regulatory requirements.

OPG has procedures in place at the PNGS and the PWMF to guide plant and security personnel in security practices.

Pickering Nuclear Generating Station

OPG has implemented a corrective action plan to reduce the frequency of number of reportable events related to employees not following procedures, and CNSC staff conducted a follow up inspection to verify corrective measures to mitigate the issues.

OPG has submitted a detailed implementation plan to meet the new requirements for security screening, which CNSC staff have assessed as acceptable.

Pickering Waste Management Facility

CNSC staff had no significant observations at the PWMF to report in this specific area for 2017.

Drills and exercises

CNSC staff determined that OPG's drill and exercise program met the applicable regulatory requirements for the PNGS and the PWMF.

CNSC staff had no significant observations at the PNGS or the PWMF to report in this specific area for 2017.

3.2.13 Safeguards and non-proliferation

CNSC staff concluded that the safeguards and non-proliferation SCA at the Pickering site met performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "satisfactory" ratings, unchanged from the previous year.

Nuclear material accountancy and control

CNSC staff confirmed that OPG's accountancy and control of nuclear material at the PNGS and the PWMF complied with the applicable regulatory requirements in 2017.

Access and assistance to the IAEA

CNSC staff verified that OPG met the applicable regulatory requirements for access and assistance at the PNGS and the PWMF. OPG granted adequate access and assistance to the International Atomic Energy Agency (IAEA) for safeguards activities, including inspections and the maintenance of equipment at the PNGS and the PWMF, pursuant to the Canada/IAEA safeguards agreements and the facilities licence conditions.

Pickering Nuclear Generating Station

In 2017, the IAEA performed one physical inventory verification, one design information verification and three unannounced inspections at PNGS to verify the nuclear material inventory and assure the absence of undeclared nuclear material and activities.

OPG granted access and provided assistance to the IAEA in October 2017 for a site survey to determine potential siting locations of additional IAEA surveillance equipment in the spent fuel bay area, with the goal of optimizing the current safeguards approach at that facility.

Pickering Waste Management Facility

In 2017, the IAEA performed one short notice random inspection and five unannounced inspections at the PWMF to verify the nuclear material inventory and assure the absence of undeclared nuclear material and activities.

The IAEA did not perform a physical inventory verification at the PWMF in 2017. CNSC staff performed an evaluation of OPG's preparedness for a physical inventory verification at the PWMF. CNSC staff concluded that OPG was adequately prepared for an IAEA physical inventory verification at the PWMF in 2017 had it been selected.

Operational and design information

CNSC staff confirmed that OPG met the applicable regulatory requirements for operational and design information for the PNGS and the PWMF. OPG submitted its annual operational program with quarterly updates for the PNGS and the PWMF to the CNSC on time. OPG submitted the annual update to the information pursuant to the IAEA Additional Protocol to the CNSC on time. CNSC staff were satisfied with the information provided and concluded that it met CNSC's submission requirements.

Pickering Waste Management Facility

In addition, OPG also submitted an updated Design Information Questionnaire for the PWMF, which was reviewed by CNSC staff and subsequently submitted to IAEA. CNSC staff were satisfied with the information provided and concluded that it met CNSC's submission requirements.

Safeguards equipment, containment and surveillance

CNSC staff confirmed that OPG met the applicable regulatory requirements for safeguards equipment, containment and surveillance for the PNGS and the PWMF. OPG supported IAEA equipment operation and maintenance activities at the Pickering site, including routine maintenance of surveillance equipment, to ensure the effective implementation of safeguards measures at the PNGS and the PWMF.

Pickering Nuclear Generating Station

In September 2017, OPG reported an event to the CNSC regarding an unexpected loss of external power to IAEA surveillance equipment overnight from September 19 to September 20, 2017. The event was immediately reported to the IAEA. The IAEA subsequently confirmed that continuity of knowledge was maintained, and therefore there was no impact on safeguards implementation at the facility. CNSC staff were satisfied with the corrective actions taken by the licensee for this event.

Pickering Waste Management Facility

On September 29, 2017 OPG reported an event that occurred at the PWMF to CNSC staff regarding the breakage of an IAEA COBRA seal on a DSC. CNSC staff later received confirmation from the IAEA that that continuity of knowledge was maintained since the metal seal was intact at all times. The IAEA replaced the seals on the DSC on October 30, 2017 and confirmed that there was no further follow-up action required. OPG stated that there were no environmental, health, safety or security implications for the facility or personnel as a result of this event. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

3.2.14 Packaging and transport

CNSC staff concluded that the packaging and transport SCA at the Pickering site met performance objectives and applicable regulatory requirements. As a result, the PNGS and the PWMF received "satisfactory" ratings, unchanged from the previous year.

Package design and maintenance, packaging and transport, and registration for use

CNSC staff determined that OPG has a packaging and transport program for the PNGS and the PWMF that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the *Transportation of Dangerous Goods Regulations*.

There were no packaging and transport events reported in 2017.

For on-site movements of nuclear substances, OPG ensures an equivalent level of safety as is required for off-site transportation to protect the health and safety of workers, the general public, and the environment.

CNSC staff had no significant observations at the PNGS or the PWMF to report in this specific area for 2017.

3.2.15 Other Matters of Regulatory Interest

Public Information Program

OPG continued regular communications about the Pickering site to engage and inform residents and stakeholders about the facilities. CNSC staff determined that OPG met the applicable regulatory requirements related to public information and disclosure and provided sufficient information on the status of the Pickering site through a variety of communication activities., including: participation in community events, facility tours, ongoing website updates, and the use of social media.

Pickering Nuclear Generating Station

In the fall of 2017, OPG hosted a series of open houses in advance of licence renewal to generate discussion about the future of PNGS and to gauge clarity of messaging and clarify any misconceptions about PNGS.

Pickering Waste Management Facility

In the Record of Decision for the 2017 licence renewal of the PWMF, the Commission encouraged OPG to make available to the general public data on contaminants of potential concern. CNSC staff confirmed that OPG has made that information available to the general public on its website, as per the direction of the Commission.

Indigenous Relations

CNSC staff observed that OPG has a dedicated Indigenous engagement program. Throughout 2017, OPG met and shared information with interested Indigenous communities and organizations, particularly the Williams Treaties First Nations, the Mohawks of the Bay of Quinte, and the Métis Nation of Ontario.

Information and discussion topics included OPG's current operations at the Pickering site, the PWMF licence renewal, the PNGS licence renewal application, fish impingement and entrainment, procurement, employment and training opportunities, environmental protection and performance, and monitoring program results.

3.3 Point Lepreau

The safety assessment for each safety and control area (SCA) is facility-specific. General information relevant to the SCAs is provided in section 2. The CNSC regulatory documents and CSA Group standards that were identified as regulatory requirements for Point Lepreau site, as of December 2017, are listed in Appendix E:.

Safety assessment

The CNSC staff safety assessment of the Point Lepreau site for 2017 resulted in the performance ratings as shown in table 19. Based on the observations and assessments of the SCAs, CNSC staff concluded that Point Lepreau operated safely. The overall rating was "satisfactory", unchanged from the integrated plant rating from the previous year.

Table 19: Performance ratings for Point Lepreau, 2017

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

Legend: FS – Fully Satisfactory SA – Satisfactory
BE – Below Expectations UA – Unacceptable

* Also applies to the Solid Radioactive Waste Management Facility

3.3.0 Introduction

The Point Lepreau Nuclear Generating Station (referred to as Point Lepreau or PLNGS) is located on the Lepreau Peninsula, 40 kilometres southwest of Saint John, NB. The facilities are owned and operated by New Brunwick Power Corporation (NB Power) and consists of a single CANDU reactor with a rated capacity of 705 megawatts electrical (MWe). The Point Lepreau site includes the Solid Radioactive Waste Management Facility (SRWMF) located a short distance from the power reactor within the exclusion zone. The waste storage process includes short-term storage in the reactor building prior to being transferred for long-term storage at the SRWMF. The SRWMF is used for the storage of solid radioactive waste, including nuclear spent fuel, produced solely at Point Lepreau. CNSC regulates the station and the SRWMF under a single power reactor operating licence (PROL).

The assessments in this section apply equally to the PLNGS and the SRWMF, unless noted otherwise. The information presented below for each SCA is station specific; general information is provided in section 2.

Licensing

In June 2016, NB Power had applied to have its PROL renewed [17] for a period of five years. Part 1 of the Commission hearing was held on January 26, 2017 and Part 2 was held on May 10 and 11, 2017. In June 2017, the Commission issued PROL 17.00/2022 for a period of five years, which authorizes NB Power to operate the PLNGS and the SRWMF to June 2022. The PROL has not been amended since it was granted.

Licence Conditions Handbook

CNSC staff issued a new LCH when the PROL was issued on June 30, 2017. It had not undergone any revisions as of the end of 2017.

Periodic Safety Review

With the introduction of PSRs to the CNSC regulatory framework, CNSC staff recommended a five-year operating licence to provide adequate time for NB Power to complete a PSR in accordance with REGDOC-2.3.3, Periodic Safety Reviews. Licence Condition 3.4 of the current licence and LCH require NB Power to perform a PSR in accordance with REGDOC-2.3.3. 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. Following a sufficiency check review of the PSR Basis Document which found a few missing elements, NB Power submitted a revised and updated version of the document on March 15, 2018. CNSC staff is currently reviewing the PSR Basis Document with a target completion date of July 31, 2018. NB Power will submit the Safety Factor Reports during 2018 and early 2019. CNSC staff will be reviewing PSR deliverables to gain confidence in the safety case for the continued operation of the NPP.

Fisheries Act authorization

In April 2016, NB Power submitted a preliminary self-assessment of serious harm to fish due to cooling water intake according to the provisions of the *Fisheries Act* for CNSC staff review. CNSC staff reviewed the assessment and met with NB Power to discuss the need for additional information.

NB Power provided a revised *Fisheries Act* self-assessment to the CNSC in January 2017. CNSC staff completed its technical review of the self-assessment and concluded that an authorization is required in accordance with subsection 35(1) of the *Fisheries Act*. The conclusions were shared with the Department of Fisheries and Oceans, which concurred with CNSC's recommendation. NB Power provided a partial draft *Fisheries Act* application to the CNSC March 27, 2018 prior to final submission.

UPDATE: CNSC staff reviewed the draft *Fisheries Act* application for technical completeness and provided comments to NB Power on April 26, 2018. NB Power is on target to submit a complete draft to CNSC for review by December 2018.

Event initial reports

No event initial reports pertaining to Point Lepreau were submitted to the Commission for the period January 1, 2017 to June 1, 2018.

Compliance Program

The annual CNSC effort on the compliance program is tabulated in Appendix G: for Point Lepreau. The inspections at the Point Lepreau site that were considered in the safety assessments in this regulatory oversight report are tabulated in Appendix J:.

3.3.1 Management system

CNSC staff concluded that the management system at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the station received a "satisfactory" rating, unchanged from the previous year.

Management system

CNSC staff determined that NB Power's management system at Point Lepreau met the applicable regulatory requirements in 2017. NB Power has successfully completed the implementation of the 2012 version of the CSA Group management system standard N286-12, *Management system requirements for nuclear facilities*. In 2017, CNSC staff verified the implemented actions, which resulted from the NB Power gap analysis conducted against the 2005 version of N286, and determined that NB Power's disposition of the gap was satisfactory.

Organization

CNSC staff determined that NB Power has an adequately defined organizational structure and roles and responsibilities at Point Lepreau. As a result of regulatory oversight, CNSC staff are satisfied with NB Power performance in this specific area

Change management

CNSC staff determined that NB Power has an adequate change management program that complies with the applicable regulatory requirements. As a result of regulatory oversight, CNSC staff are satisfied with NB Power performance in this specific area.

Safety culture

CNSC staff were satisfied that NB Power continued to foster a healthy safety culture at Point Lepreau in 2017. In 2016, a safety culture self-assessment was undertaken; CNSC will monitor OPG's next safety culture self-assessment at Point Lepreau, scheduled for 2019, and any improvement actions initiated.

Configuration management

NB Power has maintained the configuration of its structures, systems and components (SSCs) in compliance with its configuration management program and regulatory requirements.

This was demonstrated during the CNSC Plant Outage and Field Inspections conducted in 2017.

Records management

CNSC staff determined that NB Power continued to maintain and implement a document control and records management system that met the applicable requirements.

Following a CNSC Type II inspection on Chemistry Control conducted in September 2017, NB Power initiated a corrective action plan for the chemistry process documentation, and plans on having all corrective actions completed by the end of September 2018. CNSC staff are satisfied with the progress to date.

Management of Contractors

CNSC staff conducted an inspection in 2015 to verify that procedures and processes are in place for contractor management and are effectively implemented in accordance with CSA 286-05. As an outcome of this inspection, CNSC staff identified non-compliances related to the oversight of contractors and documentation of performance evaluations. CNSC staff continued to verify the implementation of the NB Power corrective action plan, and in 2017 all actions were completed and determined to be satisfactory.

Business continuity

CNSC staff concluded that NB Power met regulatory requirements for business continuity.

NB Power has adequate contingency plans (such as Emergency Response Plan, Pandemic Response Plan) to maintain or restore critical business functions in the event of disabling circumstances (such as a pandemic, severe weather or labour actions). (CMD 17-H2 [17])

Problem identification and operating experience

CNSC staff determined that NB Power continued to meet the applicable regulatory requirements for problem identification and OPEX. As a result of regulatory oversight, CNSC staff are satisfied with NB Power performance in this specific area.

Performance assessment, improvement and management review

CNSC staff confirmed that NB Power met the applicable regulatory requirements for performance assessment, improvement, and management review.

CNSC staff conducted a desktop review on the Independent Assessment Program in 2017. The Independent Assessment Program allows NB Power to independently evaluate the performance and effectiveness of activities, programs, processes and work to compare actual results against expected results. CNSC staff are satisfied with the implementation of this Independent Assessment Program and are currently monitoring NB Power's endeavor for continuous improvement in this area.

3.3.2 Human performance management

CNSC staff concluded that the human performance management SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the station received a "satisfactory" rating, unchanged from the previous year.

Human performance program

CNSC staff determined that the NB Power human performance program met applicable requirements.

In 2017, there were no deviations from regulatory requirements identified during compliance activities.

Personnel training

NB Power has a well-documented and robust training system based on a systematic approach to training (SAT). Implementation of this system for the training programs at Point Lepreau met the applicable regulatory requirements.

In 2017, CNSC staff performed a compliance verification inspection of the Non-Licenced Operator training program. CNSC staff found that the training program was defined and documented in accordance with the NB Power SAT-based training system. A minor procedural non-compliance of low safety significance was identified with respect to accessibility to continuing training records. CNSC staff are satisfied with NB Power's progress to address the non-compliance.

Personnel certification

CNSC staff determined that NB Power's personnel certification program met the applicable regulatory requirements. CNSC staff reviewed the staffing reports for certified personnel, the applications for initial certification and renewal of certification, and confirmed that certified personnel at Point Lepreau possessed the knowledge and skills required to perform their duties safely and competently.

Initial certification examinations and requalification tests

In 2017, CNSC staff conducted compliance verification inspections on the conduct of simulator-based initial certification examinations for shift supervisors and the conduct of written certification examinations. A non-compliance of low safety significance related to simulator modelling capabilities was observed by the CNSC staff during the conduct of the simulator-based initial certification examinations.

At the request of CNSC staff, NB Power provided a corrective action plan as well as short, medium and long-term strategies that are being implemented to improve the simulator modelling. CNSC staff are currently reviewing the submission.

With the exception of the deficiency mentioned above, CNSC staff concluded that the initial certification examination and requalification testing programs for the certified personnel at Point Lepreau met regulatory requirements.

Work organization and job design

Minimum shift complement

The minimum shift complement at Point Lepreau met the applicable regulatory requirements. In March 2018, CNSC staff approved a request by NB Power to modify the minimum shift

complement requirements. The change consisted of the replacement of the requirement for a mechanical maintainer with an increase by one of an electrical instrumentation and control maintainer. CNSC staff found the request to be acceptable.

In 2017, one violation of minimum shift complement was reported to the CNSC at Point Lepreau, with no impact to safety.

Fitness for duty

CNSC staff determined that NB Power met the applicable regulatory requirements for fitness for duty at Point Lepreau.

As part of its fitness-for-duty provisions, NB Power developed procedures that limit hours worked by staff. In quarterly reports submitted over the past year to CNSC, NB Power reported its certified staff to be fully compliant with the Point Lepreau limits on hours of work.

In 2017, CNSC staff completed a desktop review to verify the accuracy of reporting of non-compliances with the limits of hours of work for certified staff. The results of the desktop confirmed that NB Power's reporting is accurate, and two recommendations were identified.

CNSC staff are satisfied with NB Power's phased implementation plan of CNSC REGDOC 2.2.4 *Fitness for Duty Volume I: Managing Worker Fatigue*. NB Power has committed to fully implement the REGDOC by June 30, 2022.

In late 2017, CNSC staff requested that NB Power submit an implementation plan for REGDOC 2.2.4 *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* with supporting gap analysis.

UPDATE: NB Power submitted its implementation plan in early 2018, committing to fully implement the REGDOC by December 1, 2019. CNSC staff found the implementation date to be satisfactory.

3.3.3 Operating performance

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

Conduct of licensed activities

CNSC staff concluded that NB Power met the applicable regulatory requirements for the conduct of licensed activities at Point Lepreau. CNSC staff determined that NB Power continued to operate Point Lepreau in a safe and secure manner, with adequate regard for health, safety, security, radiation and environmental protection and international obligations. NB Power operated Point Lepreau within the bounds of its operating policies and principles and operational safety requirements.

In 2017, Point Lepreau experienced 0 unplanned reactor trips, 0 stepbacks and 5 setbacks (although the 5 setbacks were only associated with two distinct events).

CNSC staff determined that the setbacks were controlled properly, and power reduction was adequately initiated by the reactor control systems. CNSC staff verified and confirmed that for all events, NB Power staff followed approved procedures and took appropriate corrective actions.

Procedures

CNSC staff determined that the Point Lepreau procedures met the applicable regulatory requirements.

CNSC staff continue to monitor the implementation of the NB Power corrective action plan to address weaknesses, identified in previous reporting periods, in the areas of procedural adequacy and adherence. Although non-compliances had been identified during inspections in previous years, they do not present an immediate risk to the health and safety of persons, or the environment. Overall, NB Power continues to improve and has made progress in addressing these areas through training and process improvements.

CNSC staff are satisfied with NB Power's implementation of improvements which were completed in 2017.

Reporting and trending

During the reporting year, all scheduled reports were submitted to CNSC in a timely manner and were adequate. CNSC staff determined that reporting and trending at Point Lepreau met the applicable regulatory requirements and expectations in 2017. For instance, a CNSC desktop review identified that NB Power reports and trends hours of work to CNSC staff's satisfaction.

Outage management performance

NB Power demonstrated good levels of performance and achievement of objectives during maintenance outages.

NB Power completed a planned maintenance outage in 2017. CNSC staff performed a related inspection to verify NB Power's compliance with regulatory requirements associated with the outage, and concluded that NB Power was in compliance with the applicable regulatory requirements. In particular, CNSC staff determined that NB Power met the maintenance requirements in the inspected areas of sub-criticality as well as the heat sink requirements during this outage.

CNSC staff found that NB Power outage management performance of Point Lepreau met the applicable regulatory requirements.

Safe operating envelope

CNSC staff determined that NB Power operated within the safe operating envelope (SOE) and met the applicable regulatory requirements for Point Lepreau. There are minor SOE related non-compliances that are currently being addressed to the satisfaction of the CNSC staff. Namely, a finding concerning inconsistencies in SOE documentation, raised from an inspection conducted in November 2016.

Severe accident management and recovery

CNSC staff determined that severe accident management and recovery met the applicable regulatory requirements at Point Lepreau. NB Power submitted a preliminary implementation plan for CNSC REGDOC 2.3.2 *Accident Management*, version 2. CNSC staff were satisfied with NB Power's plan to complete the full implementation by November 2020.

Accident management and recovery

CNSC staff are satisfied with the implementation of a series of emergency and abnormal operating procedures at Point Lepreau NGS. NB Power continues to maintain an accident management and recovery program that meets the applicable requirements.

3.3.4 Safety analysis

CNSC staff concluded that the safety analysis SCA at Point Lepreau met or exceeded performance objectives and applicable regulatory requirements. As a result, the station received a "fully satisfactory" rating, unchanged from the previous year.

Deterministic safety analysis

The Deterministic Safety Analysis predicts adequate safety margins, and met or exceeded the applicable regulatory requirements at Point Lepreau.

CNSC staff have determined that NB Power has a well-established program on deterministic safety analysis. NB Power continues to implement REGDOC-2.4.1 for Deterministic Safety Analysis requirements. NB Power submitted a detailed and thorough methodology for the identification and prioritization of areas where the current safety report could be updated to align with the REGDOC. CNSC staff are satisfied with the NB Power submission and progress made to date leading up to full compliance. The implementation plan will be revised in 2018 to fully describe the second phase of the implementation.

In June 2016, NB Power submitted an updated version of the Point Lepreau Safety Report to the CNSC. This version includes new sections on PSAs, fire hazards and severe accident management guidelines. CNSC staff completed the review of the Safety Report in early April 2017 and determined that it meets requirements.

Point Lepreau submitted the updated Fire Hazard Analysis (FHA) and Fire Safe Shutdown Analysis (FSSA) in August 2017. CNSC staff determined that the approach and methodology used is consistent with the applicable regulatory requirements. In December 2017, NB Power proposed to change the date for the next submission of both the FHA and FSSA. Given that the documents were updated and submitted to the CNSC in August 2017, CNSC staff accepted NB Power's proposal for the next five year submittal to be due in 2022, in lieu of the previous deadline of 2019.

In December 2017, NB Power formally requested to change the date for the next five year submittal of the FHA and the FSSA from 2019 to 2022 to align with the planned submission of the code compliance review in accordance with the requirements for Fire Protection Assessment in CSA N293-12. To support the request, NB Power provided an interim, updated submission in 2017.

UPDATE: CNSC staff concluded that the date change request was acceptable. CNSC staff will complete its review of the interim, updated submission in 2018.

Probabilistic safety assessment

NB Power has been compliant with REGDOC 2.4.2 *Probabilistic Safety Analysis (PSA) for Nuclear Power Plant*, since 2016.

The submission of the second PSA update was completed in 2016. Next PSA update is expected by 2021.

CNSC found that NB Power's performance in the PSA area met or exceeded the applicable regulatory requirements in 2017.

Criticality safety

This specific area does not apply to Point Lepreau.

Severe Accident Analysis

NB Power has updated the BDBA analysis for LOCA with loss of ECC event. CNSC staff concluded that NB Power exceed expectations in severe accident analysis due to the completion of this improvement. An outcome of regulatory oversight, CNSC staff are fully satisfied with NB Power performance in this specific area

Management of Safety Issues (including R&D programs)

NB Power R&D activities are submitted to the CNSC through annual reporting in accordance with clause 3.6 of REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. CNSC staff evaluations confirm NB Power maintains a robust R&D capability to address any emerging issues. The remaining CANDU Safety Issues do not present a regulatory concern with regards to the safety of the operating reactor. Further information is provided in Section 2.4.

The following supporting R&D project is currently ongoing:

Moderator subcooling requirements methodology

NB Power submitted the conclusion of the review by a Safety Analysis Issue Review Panel of experimental results from the CNSC-sponsored Calandria-Tube Strain Contact Boiling project. These experiments were done at CNL on contract by CNSC. CNSC staff issued an interim report summarizing the results of the experiments and an evaluation of the results. NB Power plans to address the outstanding issues over the next licensing period. This issue is considered to be of low safety significance as it addresses safety margins during postulated severe accidents of a low probability of occurrence.

3.3.5 Physical design

CNSC staff concluded that the physical design SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the station received a "satisfactory" rating, unchanged from the previous year.

Design governance

CNSC staff concluded that NB Power continued to meet regulatory requirements and expectations regarding design governance in 2017.

Environmental qualification

The Environmental Qualification program has been implemented and maintained in accordance with CSA N290.13-05, Environmental Qualification of Equipment for CANDU Nuclear Power Plants.

Human factors in design

NB Power completed the implementation of CSA Group standard N290.12-14, *Human factors in design for nuclear power plants* at Point Lepreau in 2017.

Fire Protection

As the Point Lepreau site includes the SRWMF, NB Power submitted its implementation plan of CSA Group standard N393, *Fire Protection for Facilities that Process, Handle or Store Nuclear Material Substances* in September 2017. NB Power has committed to be in compliance with the standard by March 2022. CNSC staff are satisfied with NB Power's progress and continue to monitor the implementation.

Structure design

CNSC staff concluded that the structure design specific area continued to meet the applicable requirements. As a result of regulatory oversight, CNSC staff were satisfied with NB Power performance in this specific area.

System design

CNSC staff concluded that System Design at Point Lepreau Nuclear Generating station met the applicable requirements.

Electrical power system

In 2017, CNSC staff conducted desktop reviews and followed-up on previous electrical power systems inspection conducted in 2011. Based on these compliance activities, no major issues were found. CNSC staff plan to perform a Type II compliance inspection in September 2018. CNSC staff concluded that the Electrical Power Systems (EPS) at Point Lepreau met the applicable regulatory compliance requirements in 2017.

Fire protection design

NB Power is in compliance with the regulatory requirements based on results of CNSC's ongoing compliance activities including field inspections, independent third party reviews for design modifications and facility conditions inspection.

Independent third party reviews submitted for design modifications were acceptable and no major findings were identified.

The level of compliance is satisfactory and NB Power continues to implement a comprehensive fire protection program at the Point Lepreau Site in accordance with CSA-N293 Fire Protection for Nuclear Power Plants.

Component design

In 2017, CNSC staff concluded that NB Power met the applicable regulatory requirements for component design at Point Lepreau.

Fuel design

CNSC staff determined that NB Power has a mature reactor fuel inspection program. CNSC staff reviewed the Annual Fuel Report and concluded that it was consistent with previous years. Based on this review, CNSC staff determined that fuel performance at Point Lepreau was acceptable in 2017 and that NB Power's fuel inspection program, for which its inspections are reported to the CNSC through the Annual Fuel Report, is satisfactory. CNSC staff note that the defect rate at Point Lepreau was above the industry target by one defect per unit per year. NB Power is able to adequately manage fuel performance issues while maintaining safe operations.

Cables

In 2017, there were no major issues found during compliance verification activities for cables under component design.

CNSC staff conducted an inspection in 2011 and had identified non-compliances relating to cable condition monitoring program. As of 2017, NB Power's implemented corrective actions were acceptable to CNSC staff. The next update on the implementation of remaining corrective actions will be provided to the CNSC by June 2018, following the 2018 planned outage. CNSC staff are satisfied with NB Power's progress.

CNSC staff conclude that the cable management program at PLNGS met the applicable regulatory requirements.

Facility Design

CNSC staff concluded that the facility design specific area continued to meet the applicable requirements. As a result of regulatory oversight, CNSC staff are satisfied with NB Power performance in this specific area.

3.3.6 Fitness for service

CNSC staff concluded that the fitness for service SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the station received a "satisfactory" rating, unchanged from the previous year.

Equipment fitness for service and equipment performance

CNSC staff determined that the overall equipment fitness for service and performance at Point Lepreau was satisfactory and met the applicable regulatory requirements.

NB Power has developed procedures to monitor the fitness for service of equipment to support the continued safe operation. CNSC staff have verified the adequacy of these procedures. NB Power has implemented the corrective actions identified from a previous inspection conducted in 2016 to the satisfaction of CNSC staff.

Reliability of Systems Important to Safety

CNSC staff determined that the reliability program at Point Lepreau met the applicable regulatory requirements.

All special safety systems for Point Lepreau met their unavailability targets in 2017.

Maintenance

In 2017, CNSC staff determined that maintenance program met the applicable regulatory requirements at Point Lepreau.

In 2015, CNSC staff had conducted a reactive inspection and identified non-compliances related to NB Power's system health monitoring process. CNSC staff continued monitoring NB Power's progress on implementing the corrective actions in 2017.

UPDATE: NB Power completed the corrective actions in January 2018 to CNSC staff's satisfaction.

The average preventive maintenance completion ratio at Point Lepreau NGS was 95 percent, which compared favourably with the industry average of 88 percent. The maintenance backlogs were acceptable and are provided in Table 20.

Table 20: Maintenance backlogs and deferrals for critical components for Point Lepreau, 2016

Parameter	Average quarterly work orders per unit in 2017	Average quarterly work orders per unit in 2016	Average quarterly work orders per unit in 2015	Three years trending	Industry average
Corrective maintenance backlog	2	1	1	stable	4
Deficient maintenance backlog	71	114	142	down	94
Deferrals of preventive maintenance	1	6	1	stable	30

As Table 20 illustrates, the average quarterly work orders has been trending down since 2015. In addition, the corrective maintenance backlog, deficient maintenance backlog and number of deferrals of critical component preventive maintenance were all better than the industry average for backlogs.

CNSC staff determined that the overall safety significance of maintenance backlogs and deferrals for critical components was negligible for at Point Lepreau.

Structural Integrity

CNSC staff concluded that SSCs continued to meet the applicable structural integrity requirements at Point Lepreau.

In 2017, pressure boundary inspections results indicated that all inspected elements of the primary heat transport and auxiliary systems, steam generators, feeders and pressure tubes met CSA acceptance criteria.

Aging management

NB Power's aging management program has met the applicable regulatory requirements at Point Lepreau.

NB Power implemented CNSC REGDOC-2.6.3, *Aging Management* in July 2017. CNSC staff were reviewing NB Power's aging management with a focus on fuel channels to ensure that it complies with REGDOC-2.6.3.

CNSC staff has confirmed that the major component LCMPs meet basic requirements, and provide an adequate basis for Point Lepreau's Periodic Inspection Plans.

CNSC staff determined that NB Power had adequate programs in place to confirm that fuel channels were fit for service for near-term operation. NB Power submitted engineering assessments of degradation mechanisms in accordance with the applicable CSA requirements.

NB Power implemented an aging management program for cables, which led CNSC staff to close the related action notice in January 2017, as described under Component Design.

Chemistry control

CNSC staff conducted a chemistry control inspection in September of 2017. While CNSC staff confirmed that Point Lepreau was maintaining systems chemistry within the required parameters, non-compliances of low safety significance relating to documentation were identified.

In a recent response, NB Power acknowledged the non-compliances and has committed to provide an update after the revisions to the appropriate documentations are completed and rolled out by October 31, 2018. CNSC staff are satisfied with NB Power's progress to date.

Periodic inspections and testing

NB Power has well-managed Periodic Inspection Program (PIP) in place at Point Lepreau.

NB Power has provided an implementation plan to update its PIP to comply with the 2014 edition (update 1) of CSA standard N285.4, Periodic inspection of CANDU nuclear power plant components as well as a second implementation plan to comply with the 2013 version of CSA standard N285.5, Periodic Inspection of CANDU Nuclear Power Plant Containment Components. CNSC staff accepted the implementation plans and confirmed that both standards will be implemented, based on the identified gaps, by June 30, 2022.

CNSC staff are satisfied with the plan and the timeline and are monitoring NB Power's progress.

NB Power has confirmed ongoing that the gap analyses of the N287 series of standards will be carried out as part of the PSR scope for comparison against modern codes and standards which may lead to further updates to the Reactor Building Management Plan. To date, CNSC staff are satisfied with NB Power progress for implementation of CSA N287.7, In-Service Examination and Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plant Components.

3.3.7 Radiation protection

CNSC staff concluded that the radiation protection SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the station received a "satisfactory" rating, unchanged from the previous year.

Application of ALARA

NB Power continued to implement an effective and well-documented program that is based on industry best practices, to keep doses as low as reasonably achievable (ALARA) at the Point Lepreau Nuclear Generating Station. ALARA measures are integrated into planning, scheduling and work control. Point Lepreau met the regulatory requirement with respect to ALARA.

Worker dose control

CNSC staff determined that NB Power continued to comply with the regulatory requirements to measure and record doses received by workers at Point Lepreau.

Routine compliance verification activities conducted in 2017 indicated that performance in the area of worker dose control at Point Lepreau were highly effective.

In 2017, radiation doses to workers were below the regulatory dose limits and established action levels in the Point Lepreau radiation protection program. The data for doses to workers at Point Lepreau can be found in Section 2.7.

There were neither Action Level exceedances related to worker exposures (acute or annual exposures), nor unscheduled reports in this specific area in 2017.

CNSC staff observed no adverse trends or safety-significant unplanned exposures due to the licensed activities at Point Lepreau in 2017. The maximum dose received by a worker at Point Lepreau in 2017 was 11.40 mSv, which is approximately 23% of the regulatory dose limit.

Radiation protection program performance

CNSC staff determined that NB Power has implemented a radiation protection program at Point Lepreau that satisfies the requirements of the Radiation Protection Regulations. NB Power regularly measures the performance of its radiation protection program against industry-established objectives, targets and best practices. The oversight applied by NB Power in implementing and improving this program was effective in protecting workers at Point Lepreau in 2017.

Radiological hazard control

CNSC staff determined that NB Power implemented radiological hazard controls that met or exceeded the applicable regulatory requirements. These measures protect workers and ensure radioactive contamination is controlled within site boundaries.

NB Power continued to ensure measures remained in place to monitor and control radiological hazards. In 2017, no contamination control action levels were exceeded.

CNSC staff performed a type II inspection focused on Radiological Hazard Control and confirmed compliance with regulatory requirements at Point Lepreau. CNSC staff also confirmed that NB Power's initiatives for continuous improvement in this area were effectively implemented.

CNSC staff reviewed safety performance indicator reports on personnel and loose contamination events and confirmed that no safety-significant incidents were identified.

Estimated dose to the public

CNSC staff determined that NB Power continued to ensure the protection of members of the general public in accordance with the *Radiation Protection Regulations*. The reported doses to members of the general public from Point Lepreau were estimated at 0.0007 mSv, well below the annual dose limit of 1 mSv for a member of the general public (see section 2.9).

3.3.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at Point Lepreau met or exceeded performance objectives and applicable regulatory requirements. As a result, the station received a "fully satisfactory" rating, unchanged from the previous year.

Performance

CNSC staff determined that NB Power met or exceeded requirements at Point Lepreau in regards to conventional health and safety performance. CNSC staff observed that the accident severity rate (ASR) for Point Lepreau remained at zero in 2017, unchanged from 2016.

Accident frequency (AF) increased from 0.11 in 2016 to 0.35 in 2017. The ASR and AF values at Point Lepreau were found to be acceptable by CNSC staff.

Practices

CNSC staff determined through quarterly field inspection reports that NB Power met or exceeded the applicable regulatory requirements for practices at Point Lepreau in 2017 in regards to practices for scaffolding and ladders and awareness for barriers and warning signs, personal protective equipment and housekeeping.

The conventional health and safety work practices and conditions at the Point Lepreau continued to achieve a high degree of personnel safety. There continues to be a working environment where safe work practices are encouraged.

CNSC staff verified that NB Power has appropriate procedures at Point Lepreau to ensure the protection of the environment and the health of persons against hazardous materials.

Awareness

CNSC staff confirmed that NB Power continued to meet or exceed the applicable regulatory requirements for awareness in 2017 at Point Lepreau. As a result of regulatory oversight, CNSC staff were satisfied with NB Power performance in this specific area.

In 2017, CNSC staff observed that the personnel at Point Lepreau remained sufficiently aware of conventional hazards in the workplace.

3.3.9 Environmental protection

CNSC staff concluded the environmental protection SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the station received a "satisfactory" rating, unchanged from the previous year.

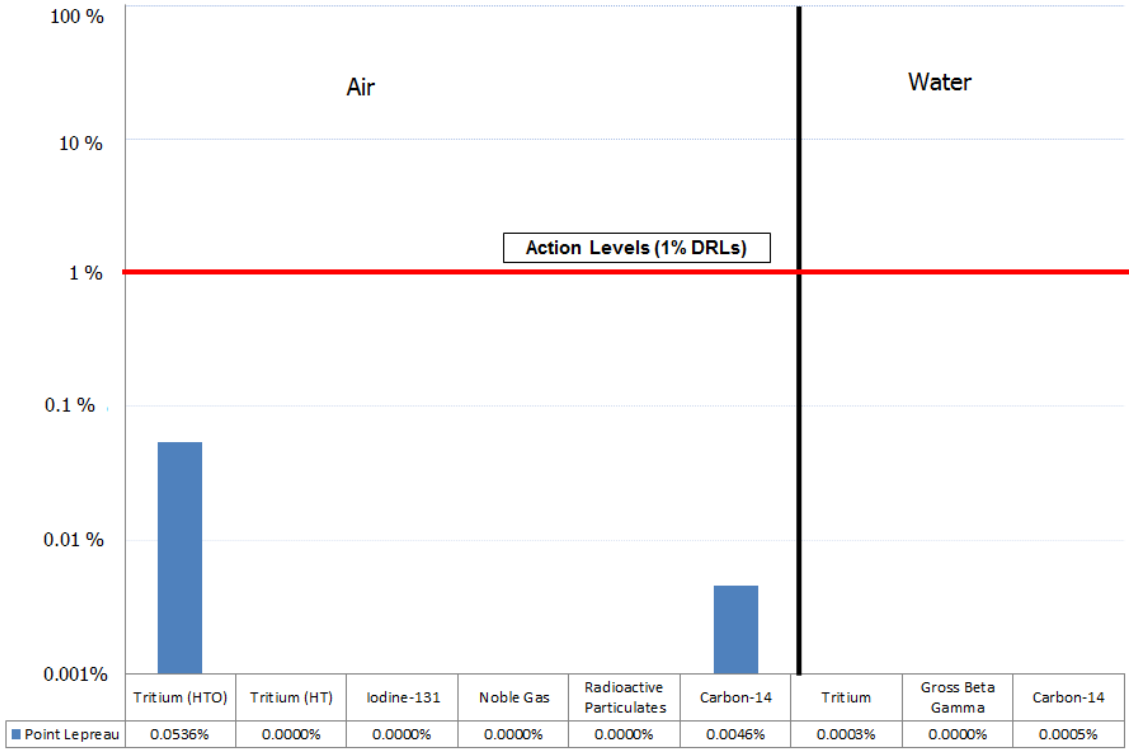
Effluent and emissions control (releases)

CNSC staff reviewed the reported airborne and waterborne radiological releases from Point Lepreau in 2017 and confirmed that they remained below regulatory limits. The releases are shown in figure 19 as percentages of the applicable DRLs. The actual values of releases and DRLs are provided in Appendix I:.

NB Power has committed to implement CSA Group standard N288.5, *Effluent monitoring programs at Class 1 nuclear facilities and uranium mines and mills* by June 30, 2018.

Both CSA Group standards N288.8 *Establishing and implementing action levels for releases to the environment from nuclear facilities* and N288.3.4, *Performance testing of nuclear air-cleaning systems at nuclear facilities* will be reviewed and implemented as part of the Periodic Safety Review (PSR) under prerequisites for comparison against modern codes and standards. The PSR as a whole will be completed in June 2021 and the related Safety Factor 14, Radiological Impact on the Environment, which will include both of these standards, is planned for submission to the CNSC for review in the fall of 2018. The following figure presents the airborne and waterborne radiological releases from Point Lepreau in 2017.

Figure 19: Effluent and emissions at Point Lepreau as percentages of DRLs



Environmental management system (EMS)

NB Power has established and implemented a corporate-wide EMS in accordance with CNSC REGDOC- 2.9.1 (2013) to assess environmental risks associated with its nuclear activities and to ensure these activities are conducted in a way that prevents or minimizes adverse environmental effects.

NB Power is currently reviewing 2017 version of REGDOC 2.9.1 under the PSR scope, which will be completed in June 2021, as part of the Safety Factor 14, Radiological Impact on the Environment.

Assessment and monitoring

CNSC staff reviewed and assessed the NB Power environmental monitoring data and concluded that the general public and the environment in the vicinity of Point Lepreau were protected. NB Power met he applicable regulatory requirements for 2017.

NB Power has aligned their Radiation Environmental Monitoring Program (REMP) to CSA Group standard N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills.*

NB Power has committed to implement CSA Group standard N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* by December 30, 2020.

CNSC staff conducted independent environmental monitoring around the Point Lepreau site in 2017 (see Section 2.9 for a description of the IEMP). The results are available on the CNSC's IEMP webpage [http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp]. The IEMP results indicated that thegeneral public and the environment in the vicinity of Point Lepreau site were protected, and that there were no expected health impacts.

Protection of the public

There were no hazardous substances released from Point Lepreau that exceeded applicable regulatory limits.

Dose to the public is discussed in Section 2.7.

Environmental risk assessment

CNSC staff determined that NB Power has continued to implement and maintain an effective environmental risk assessment and management program at Point Lepreau site in accordance with the applicable regulatory requirements.

In January 2017, NB Power submitted a revised Environmental Risk Assessment (ERA) report, based on effluent and environmental monitoring data from 2007 (pre-refurbishment) and the three year period between 2013 and 2015 (post-refurbishment). The ERA included an ecological risk assessment (EcoRA) and a human health risk assessment (HHRA) for radiological and/or are considered some non-radiological (hazardous) chemicals of potential concern and physical stressors to the environment.

CNSC staff completed a detailed technical review of the 2017 ERA and found the methodology to be consistent with the applicable requirements.

Overall, significant adverse ecological and human health effects from physical stressors and radiological or non-radiological releases from the Point Lepreau NGS were unlikely.

Future revisions to the ERA will include an assessment of magnitude and extent of the thermal plume from discharged cooling water and a broad risk assessment of its effect on the inter-tidal and near surface zones.

Additional assessment of the potential ecological and human health effects from the releases of non-radiological (hazardous) chemicals of potential concern will also be included in future revisions to the ERA.

NB Power has committed to implement CSA standard N288.6-12 *Environmental Risk Assessments at Class I Facilities and Uranium Mines and Mills* by June 30, 2020.

3.3.10 Emergency management and fire protection

CNSC staff concluded that the emergency management and fire protection SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the station received a "satisfactory" rating, unchanged from the previous year.

Conventional emergency preparedness and response

NB Power maintains and continues to support a comprehensive conventional emergency response capability at all times at Point Lepreau. This includes personnel and equipment for medical, HAZMAT, search and rescue as well as fire response.

CNSC staff conclude that NB Power's conventional emergency preparedness and response met the applicable regulatory requirements in 2017.

Nuclear emergency preparedness and response

CNSC staff determined that NB Power maintained and continued to support a comprehensive nuclear emergency preparedness and response capability at all times that met the applicable regulatory requirements. NB Power continued to support offsite emergency management organizations and commitments.

NB Power had plans to be fully compliant with version 1 of CNSC REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response* in 2018.

UPDATE: In April 2018, CNSC confirmed that NB Power complied with REGDOC-2.10.1, version 1.

CNSC staff requested that NB Power prepare an implementation plan in order to share plant data information with the CNSC during an emergency. CNSC staff reviewed NB Power's implementation plan and found it to be acceptable. NB Power submitted a status update on the implementation of the plan on November 23, 2017; CNSC staff were reviewing it at the end of 2017.

In November 2017, NB Power provided the detailed design documentation for the new Off-site Emergency Operations Center. CNSC staff began its review in 2017.

In October 2018, NB Power plans to conduct a full-scale (two-day) nuclear emergency exercise named "Synergy Challenge 2018" at the Point Lepreau site in partnership with NB Emergency Measures Organization and stakeholders. The objectives of Synergy Challenge 2018 are to test overall emergency response capabilities of participating organizations with an emphasis on the recovery phase.

Fire emergency preparedness and response

Through licensing and compliance activities performed during the licensing period, CNSC staff determined that NB Power maintains comprehensive fire response capability and fire protection program that met the applicable regulatory requirements.

NB Power has an extensive fire drill and training program which includes a Training Facility where live fire training is conducted at the Point Lepreau site.

In addition to CNSC compliance activities, NB Power conducts expert Third Party Reviews (TPR) of an annual plant condition, bi-annual fire drill audit and tri-annual fire program audit.

By incorporating the results of the CNSC compliance findings and TPR observations and recommendations into the drill and training program, the emergency response team performance continues to improve.

3.3.11 Waste management

CNSC staff concluded that the waste management SCA at Point Lepreau NGS as well as at the on-site Solid Radioactive Waste Management Facility (SRWMF) met performance objectives and applicable regulatory requirements. As a result, the station received a "satisfactory" rating, unchanged from the previous year.

Waste characterization

CNSC staff determined that NB Power's waste characterization met the applicable regulatory requirements.

NB Power continued to employ effective programs for the characterization of radioactive and hazardous wastes during 2017. As a result of regulatory oversight, CNSC staff were satisfied with NB Power performance in this specific area

Waste minimization

CNSC staff determined that NB Power's waste management programs for minimizing radioactive waste met the applicable regulatory requirements. As a result of regulatory oversight, CNSC staff were satisfied with NB Power performance in this specific area

Waste management practices

CNSC staff determined that NB Power's waste management practices met the applicable regulatory requirements.

NB Power completed a gap analysis as well as the implementation plan for CSA standard N292.0-14, General principles for the management of radioactive waste and irradiated fuel. NB Power plans to be in compliance with this standard by July 2018. In September 2017, NB Power submitted to the CNSC a confirmation of completion of the implementation of CSA standard N292.3-14, Management of low- and intermediate-level radioactive waste. CNSC staff are satisfied with the progress to date and continue to monitor NB Power's implementation of both standards.

Solid Radioactive Waste Management Facility (SRWMF)

The Point Lepreau site includes the SRWMF. The SRWMF is located within the exclusion area of the Point Lepreau NGS and is comprised of Phase I, II and III sites, which provide storage of solid radioactive material produced by the operation of the Point Lepreau NGS. The following is a description of each Phase:

- Phase I of the facility is used to store operational waste.
- Phase II is a dry storage facility for spent fuel.
- Phase II Extension – additional area prepared in 2006 to allow for dry storage of spent fuel. Approval is required in accordance with the current PROL licence condition 15.2 prior to commissioning and use.
- Phase III of the facility stores waste from retubing and other operations completed during the refurbishment outage.

As the SRWMF is located a short distance from the station on the Point Lepreau NGS site, waste must be transported from the station to the facility. CNSC regulatory oversight activities of these waste transfers concluded that NB Power has demonstrated consistent and compliant management and control of waste handling and storage, and has taken the necessary measures to operate the SRWMF safely and meets all applicable regulatory requirements

In 2017, CNSC staff completed a field inspection at the SRWMF. This inspection found minor issues of low safety significance (e.g., graffiti posted on a canister, radiation transport placards present on empty shipping container and radiation stickers on yellow containers do not contain any information) that were addressed by NB Power to the satisfaction of CNSC staff.

CNSC staff conducted an inspection with a focus on waste management practices in April 2016. During this inspection, CNSC staff confirmed that NB Power is in compliance with regulatory requirements; however, identified a non-compliance relating to the protection from the elements of the fuel canister sampling valves. In February 2017, NB Power developed and implemented a corrective active action plan to address the non-compliance to CNSC staff's satisfaction.

As part of Licence Condition 15.4 of the Power Reactor Operating Licence (PROL) 17.00/2022, NB Power must submit a quarterly report on the SRWMF. CNSC staff have reviewed all reports and additional information submitted for 2017 and are satisfied with NB Power's submissions.

CNSC staff confirmed that NB Power has taken the necessary measures to operate the SRWMF safely and meets all applicable regulatory requirements.

Decommissioning plans

The preliminary decommissioning plan for Point Lepreau met the applicable regulatory requirements in 2017. The associated financial guarantee is discussed in section 3.3.15.

In September 2017, NB Power submitted its implementation plan for CSA standard N294-09, Decommissioning of facilities containing nuclear substances.NB Power has committed to be in compliance with the standard by February 2018. CNSC staff are currently satisfied with the progress.

3.3.12 Security

CNSC staff concluded that the security SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the station received a rating of "satisfactory" rating, unchanged from the previous year.

Facilities and equipment

CNSC staff determined that NB Power met the applicable regulatory requirements for facilities and equipment. NB Power continued to sustain security equipment through lifecycle management at Point Lepreau.

Cyber Security

NB Power maintains a cyber security program at Point Lepreau. There were no cyber security events reported in 2017.

CNSC staff conducted a Type II inspection with a focus on Cyber Security in 2017, and identified non-compliances of low safety significance. NB Power submitted a corrective action plan to address the identified non-compliances. CNSC staff were satisfied with the proposed actions and are monitoring progress.

NB Power was updating the cyber security program at Point Lepreau to complyfully with CSA Group standard N290.7-14, *Cyber security for nuclear power plants and small reactor facilities* by December 31, 2019. CNSC staff were satisfied with the progress to date.

CNSC staff concluded that there were no safety-significant issues in this area.

Response arrangements

CNSC staff determined that NB Power met the applicable regulatory requirements for response arrangements at Point Lepreau.

In 2017, CNSC staff measured effectiveness of this area through a force on force security exercise evaluation and a Field Inspection.

NB Power has addressed deficiencies related to in training techniques and to improving management oversight and procedural rigour identified in the exercise report. Corrective action plans in response to compliance verification activities are being implemented. The areas for

improvement identified in the field inspection report were resolved by NB Power in a timely manner.

Based upon the review of the reports, CNSC staff concluded that NB Power is in compliance.

CNSC staff concluded that there were no safety-significant issues in the area of response arrangements.

Security practices

CNSC staff determined that NB Power implemented security practices at Point Lepreau that met the applicable regulatory requirements.

CNSC staff conducted an inspection of NB Power's Security Program in 2017. CNSC staff determined that there are adequate procedures in place, however identified instances of non-compliances against those established procedures, related to access to the Protected Area. NB Power took appropriate corrective actions to address the non-compliances in a timely manner to CNSC staff's satisfaction.

There were no safety significant findings in this specific area. CNSC staff continue to monitor and review reportable events related to deviations from security procedures at the PLGNS.

NB Power intends to meet the new requirements for security screening once the updated REGDOC-2.12.2, *Site Access Security Clearance* is published.

Drills and exercises

CNSC staff determined that NB Power's exercise and drill program met the applicable regulatory requirements.

In 2017, NB Power continued to improve its drills and exercises program and is performing these activities at an acceptable level. NB Power met all regulatory requirements in this specific area and the area for improvement noted through an exercise has been resolved by the licensee.

As a result of findings made during compliance verification activities, CNSC staff concluded that elements of the Drill/Exercise program need to address areas for improvement outlined in the exercise report. NB Power has provided an implementation plan to address several findings made during the compliance activity. CNSC staff concluded that there were no safety significant issues in this specific area.

3.3.13 Safeguards and non-proliferation

CNSC staff concluded that the Safeguards and Non-proliferation SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the station received a "satisfactory" rating, unchanged from the previous year.

Nuclear material accountancy and control

CNSC staff confirmed that NB Power's accountancy and control of nuclear material at Point Lepreau complied with the applicable regulatory requirements in 2017. As a result of regulatory oversight, CNSC staff are satisfied with NB Power performance in this specific area

Access and assistance to the IAEA

In 2017, CNSC staff confirmed that NB Power met the applicable regulatory requirements for access and assistance. NB Power granted adequate access and assistance to the IAEA for

safeguard activities, including inspections, the maintenance of equipment, and routine application of seals at Point Lepreau.

In 2017, the IAEA performed one physical inventory verification, one short-notice random inspection and two unannounced inspections at Point Lepreau.

Operational and design information

CNSC staff confirmed that NB Power met the applicable regulatory requirements for operational and design information for Point Lepreau.

NB Power submitted to the CNSC its annual operational program with quarterly updates for Point Lepreau, as well as the annual update to the information pursuant to the IAEA Additional Protocol, in a timely manner. The information provided met CNSC's submission requirements.

Safeguards equipment, containment and surveillance

CNSC staff concluded that NB Power supported IAEA equipment operation and maintenance activities at Point Lepreau, including maintenance and installation of surveillance equipment, to ensure the effective implementation of safeguards measures at the facility.

In September 2017, NB Power reported an event to the CNSC regarding the movement of a platform at the canister site at Point Lepreau. This resulted in the movement of an IAEA camera without prior notification to the IAEA. The IAEA subsequently confirmed that continuity of knowledge was maintained; and therefore, it did not impact safeguards implementation at the facility. CNSC staff were satisfied with the corrective actions taken by NB Power for this event. This event did not affect the overall rating in this SCA.

3.3.14 Packaging and transport

CNSC staff concluded that the packaging and transport SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, the received a "satisfactory" rating, unchanged from the previous year.

The transport of nuclear substances to and from the facility is conducted in a safe manner.

For on-site movement of nuclear substances, NB Power ensures an equivalent level of safety as is required for off-site transportation to protect the health and safety of workers and the general public, and the environment.

Packaging design and maintenance, packaging and transport, and registration for use

CNSC staff determined that NB Power has a packaging and transport program at Point Lepreau that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the *Transportation of Dangerous Goods Regulations*.

There were no packaging and transport events reported in 2017.

3.3.15 Other Matters of Regulatory Interest

Public Information Program

CNSC staff determined that NB Power met the applicable regulatory requirements related to information and disclosure in 2017. NB Power provided sufficient information on the status of Point Lepreau through a variety of communication activities. In advance of the 2017 licence renewal, NB Power hosted various information sessions in surrounding communities to discuss the licence renewal application.

Indigenous Relations

CNSC staff observed that NB Power has a dedicated Indigenous engagement program. Throughout 2017, it met and shared information with interested Indigenous communities and organizations, particularly the Wolastoqey Nation in New Brunswick, the Mi'gmawe'l Tplu'taqnn Incorporated, the Peskotomuhkati Nation at Skutik, Sipekne'katik First Nation, the Union of New Brunswick Indians, and MAWIW. Information and discussion topics included NB Power's current operations at Point Lepreau, *Fisheries Act* authorization application, waste management, environmental monitoring, environmental and regulatory approval processes, and education, cultural awareness and sensitivity.

Financial Guarantees

In 2017, CNSC staff completed the review of the New Brunswick Power submission of the 2015 Financial Guarantees Annual Update Plan for Point Lepreau Nuclear Generating Station. CNSC staff concluded that the value of the funds was sufficient based on the revised estimates. As of March 31, 2017, the value of the financial guarantee was $689.7 M, which exceeded the required value of $567.8 M.

3.4 Bruce A and B

The safety assessment for each safety and control area (SCA) is facility-specific. General information relevant to the SCAs is provided in section 2. The CNSC regulatory documents and CSA Group standards that were identified as regulatory requirements for Bruce A and Bruce B, as of December 2017, are listed in Appendix E:.

Safety assessment

The safety assessment of Bruce A and B for 2017 resulted in the performance ratings shown in table 21. Based on the observations and assessments of the SCAs, CNSC staff concluded that Bruce A and B operated safely. The overall ratings were "fully satisfactory" for Bruce A and "satisfactory" for Bruce B; both were unchanged from the integrated plant ratings for the previous year.

Table 21: Performance ratings for Bruce A and B, 2017

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

Legend: FS – Fully Satisfactory SA – Satisfactory
BE – Below Expectations UA – Unacceptable

3.4.0 Introduction

Bruce A and Bruce B NGS

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 (Units 1-4) with a gross power of 831 MWe (megawatts electrical) each. Bruce B has four CANDU reactors (Units 5-8) with a gross power of 872 MWe each, All eight units were operational throughout 2017.

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 is 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.

Bruce Power also operates the Central Laundry and Maintenance Facility (CLMF) at the Bruce site. The CLMF handles nuclear substances associated with the maintenance of contaminated equipment and instruments, repair of contaminated suits and laundry of protective clothing. Since it was operated under a different licence from Bruce A and B for much of 2017 (see next section), the general statements in the safety assessment of the Bruce site cannot be considered to apply to CLMF also.

Licensing

The PROL for Bruce A and B expires on May 31, 2020.

On July 1, 2017, the Waste Nuclear Substances Licence (WNSL), which authorized the operation of the CLMF, was revoked. The work authorized under the WNSL supports the licensed activities at Bruce A and B and is also authorized by the PROL. Therefore, no amendment to the PROL was necessary as a result of the revocation of the WNSL. Since the CLMF is a low-risk installation, a straightforward change was made to expand the Bruce LCH to cover ongoing operation of the CLMF, in addition to Bruce A and B. No amendments were made to the Bruce A and B PROL in 2017.

In June 2017, Bruce Power submitted to CNSC a licence renewal application [6], two years prior to the expiry of the current licence, in order to support the planning activities needed to refurbish units 3 to 8 (such as defining the scope of the work). Bruce Power has requested for a renewal

licence period of ten years, which would encompass operation, as well as activities related to the refurbishment (Major Component Replacement or MCR project).

UPDATE: Part 1 of the Commission hearing for the Power Reactor Operating Licence (PROL) renewal was conducted in March 2018 and Part 2 was conducted in May 2018.

Fisheries Act Authorization

Bruce Power provided a draft *Fisheries Act* authorization application to the CNSC in 2016. Based on the feedback from CNSC, Bruce Power provided a revised application in May 2017, which CNSC staff shared with interested Indigenous communities. CNSC staff completed a technical review and requested further information from Bruce Power on uncertainty analysis and details surrounding the methods and monitoring to determine the fish biomass. CNSC staff determined that satisfactory progress was being made by Bruce Power on the *Fisheries Act* authorization application.

UPDATE: Bruce Power provided a revised draft *Fisheries Act* authorization application to CNSC in May 2018. CNSC staff completed a sufficiency review of the draft application in August 2018 and deemed it to be sufficient, providing Bruce Power incorporates additional information requested by the CNSC and local Indigenous communities. As the Crown Consultation Coordinator, CNSC staff requested comments on the draft application from the Historic Saugeen Métis (HSM), the Métis Nation of Ontario (MNO) and the Saugeen Ojibway Nation (SON). Bruce Power is currently consulting the Indigenous communities to adequately address their information requests in the final application. Formal submission by Bruce Power to DFO is expected later in 2018.

Periodic Safety Review

Bruce Power conducted a periodic safety review in support of the 2018 renewal of its PROL and the planned refurbishment of Units 3 to 8. Bruce Power developed an Integrated Implementation Plan (IIP), which proposed safety improvements and included timeframes for implementation. CNSC staff accepted Bruce Power's IIP in September 2017.

UPDATE: In 2018, Bruce Power submitted the first annual update to the IIP. CNSC staff's review confirmed that nine of the IIP items were completed and that satisfactory progress is being made on the remainder of the actions.

LCH

Two revisions were made to the old Bruce A and B LCH in 2017. One of the revisions was related to the revocation of WNSL for the CMLF and the extension of the LCH to cover the activities governed by the WNSL. Appendix F.1 shows a summary of the changes that were made to the LCH in 2017.

Refurbishment

The MCR project involves Units 3 to 8 and is planned to begin in 2020 with Unit 6. As noted above, Bruce Power completed the refurbishment of units 1 and 2 in 2012. The MCR project includes replacing major components such as the steam generators, fuel channels and feeders.

Event Initial Report

Three event initial reports pertaining to the Bruce site were submitted to the Commission for the period January 1, 2017 to June 1, 2018. Details for these EIR are provided in table 22.

Table 22: Event initial reports for Bruce A and B

Subject	Brief description
Bruce B, Unit 5. Worker Injured. CMD 17-M19 [18]	On March 27, 2017, a worker was injured while performing post maintenance testing of a 13.8kV circuit breaker in Unit 5 at Bruce B in accordance with the applicable procedure. The worker contacted the live portion of the circuit and received an electrical shock. Emergency plant personnel responded to treat the worker; who was then sent to the Kincardine Hospital and later transferred to London Hospital's burn unit. All work crews at Bruce A and B were stood down until they had a face-to-face safety discussion with their managers. Bruce Power also put compensatory measures in place for all electrical work. The Ministry of Labour (MoL) led the investigation of this event. According to the MOU with the MOL, CNSC staff assisted the MOL with its investigation. CNSC staff followed-up on the event by reviewing numerous documents, inspecting the scene of the event and interviewing licensee staff. CNSC staff determined that Bruce Power's corrective actions to prevent re-occurrence of this issue were adequate. CNSC staff conducted a reactive inspection to follow-up on this event and found that improvements to work protection practices to prevent reoccurrence for this job were required. Also, CNSC staff determined that the responsible Bruce Power work group performing the post-maintenance testing had not implemented the requirements of the Electrical Safety Program during the 2017 Unit 5 planned outage. Based on follow-up monitoring activities, CNSC staff concluded that the issues were addressed by Bruce Power.
Bruce A, Unit 3. PHT Pump Gland Seal Leak. CMD 17-M52 [19]	On August 2, 2017 during the Unit 3 planned maintenance outage, a seal failure of pump 4 of the primary heat transport system resulted in a leak of heavy water outside of containment that caused a tritium airborne hazard in the area. As a precautionary measure, access to Bruce A was restricted to essential personnel and clean-up was performed by staff wearing appropriate personnel protective equipment (PPE). Some increased airborne tritium emissions occurred that were below Bruce Power's action levels. The total dose attributed to this event for all workers was 1.72 mSv and the highest individual dose was 0.63 mSv, which was well below regulatory limits. CNSC staff confirmed that Bruce Power responded appropriately. The emissions were monitored and found to be below release limits such that there was minimal safety impact on workers, the general public or the environment. In response to a CNSC staff request, Bruce Power completed a root cause analysis of these failures since 2003. Bruce Power identified a number of common causes for the repeat events and probable causes for the Unit 3 event; however, it did not identify the specific root cause of the failure. Bruce Power developed a corrective action plan to address all of the

	probable causes.
Bruce A, Unit 4. Failure of the PHT Pump Seals. CMD 18-M13 [20]	On March 4, 2018, while Bruce A Unit 4 was operating, indications of a potential problem were received in the control room and a unit shutdown was initiated. After shutdown was initiated a leak developed on the gland seal of PHT pump 4. The leak stopped when reactor pressure reached 3 MPa during reactor shutdown. However, five drums of heavy water leaked out of containment, into a dyked area of the powerhouse, causing a tritium and loose contamination hazard in the area. As a precautionary measure, access to Bruce A was restricted to essential personnel and clean-up was performed by staff wearing appropriate PPE. The leak was contained in a dyked area.

Compliance Program

The annual CNSC effort on the compliance program is tabulated in Appendix G: for Bruce A and Bruce B. The inspections at the Bruce site that were considered in the safety assessments in this regulatory oversight report are tabulated in Appendix J:.

3.4.1 Management system

CNSC staff concluded that the Management System at Bruce A and B met performance objectives and applicable regulatory requirements. As a result, each station received a "satisfactory" rating, unchanged from the previous year.

Management system

Bruce Power has implemented and complied with the requirements of the CSA Group management system standard N286-05, *Management system requirements for nuclear power plants*. CNSC staff determined that Bruce Power's management system documentation was adequate. CNSC staff continued to monitor Bruce Power's implementation of CSA Group standard N286-12, *Management system requirements for nuclear facilities*, which is planned to be completed by December 2018. CNSC staff were satisfied with the progress to date.

Organization

CNSC staff determined that Bruce Power has an adequately defined organizational structure and roles and responsibilities. At the end of 2017, there were no ongoing actions identified as a result of regulatory oversight activities.

Change management

CNSC staff determined that Bruce Power has an adequate change management program that complies with the applicable regulatory requirements.

Bruce Power is currently providing annual updates on the progress of closing out the remaining Design Change Packages (DCPs) for the Bruce A Units 1 and 2 restart project with estimated completion by 2019.

Safety culture

CNSC staff were satisfied that Bruce Power continued to foster a healthy safety culture at Bruce A and B in 2017. CNSC staff verified that the Safety culture program at Bruce A and B met an established process for self-assessments of safety culture at planned intervals.

The last safety culture assessment undertaken at Bruce Power was in 2016, which included contractors, and was the first to integrate a self-assessment of the security culture. CNSC will monitor Bruce Power's next safety culture self-assessment, planned for 2019, and any improvement actions initiated.

Configuration management

Bruce Power has maintained the configuration of its Structures, systems, and components (SSCs) in compliance with its configuration management programs and regulatory requirements.

Bruce Power has put a strategy in place to reduce the number of temporary configuration changes (TCCs). CNSC confirmed that TCCs at Bruce A continued to decrease, however were still above the target. TCCs at Bruce B did not exceed the target. CNSC staff will continue to monitor the implementation of the corrective actions to reduce the number of TCCs at both stations.

Records management

CNSC staff determined that Bruce Power continued to maintain and implement a records management system that complied with the applicable requirements. Bruce Power took corrective actions to improve in the area of completeness of records, which was identified in 2017.

Management of contractors

CNSC staff confirmed in 2017 that the interfaces between Bruce Power and its contractors are planned, defined, controlled and understood in accordance with the applicable regulatory requirements.

In 2017, CNSC staff inspected the contractor management program and identified non-compliances of low risk significance related to qualifications of subcontractors; oversight of contractors that performed activities under Bruce Power's management system; and oversight of the contractors' documentation. Bruce Power provided a corrective action plan that will be completed in 2018. CNSC staff found this plan acceptable and were monitoring its implementation.

Business continuity

CNSC staff concluded that Bruce Power met regulatory requirements for business continuity.

Bruce Power has adequate contingency plan to maintain or restore critical safety and business functions in the event of disabling circumstances such as a pandemic, severe weather, or labour actions.

Problem identification and operating experience

CNSC staff determined that Bruce Power met the applicable regulatory requirements for problem identification and OPEX.

In 2017, CNSC staff inspected the implementation of Bruce Power's OPEX program, including its implementation by contractors. The inspection confirmed that Bruce Power identifies and implements OPEX from within its organization and from the Canadian and international nuclear industry.

In 2017, CNSC staff also inspected Bruce Power's problem identification and resolution program and concluded that the root cause analysis and other methods of investigation met the applicable regulatory requirements.

Performance assessment, improvement and management review

CNSC staff confirmed that Bruce Power continued to meet the applicable regulatory requirements for performance assessment, improvement, and management review. There were no significant observations to report in 2017.

3.4.2 Human performance management

CNSC staff concluded that Bruce Power met performance objectives and the applicable regulatory requirements for Human Performance Management in 2017. As a result, each station received a "satisfactory" rating, unchanged from the previous year.

Human performance program

Through regulatory oversight, CNSC staff determined that Bruce Power has implemented and maintained a human performance program that met the applicable regulatory requirements. Bruce Power has implemented several initiatives such as: "*You Can Count on Me. Every Step. Every Time. Every Day*", which aim to continually improve human performance at Bruce A and B. There are no ongoing actions identified as result of regulatory oversight activities.

Personnel training

Bruce Power has a well-documented and robust training system based on a systematic approach to training (SAT). Implementation of this system for the training programs at Bruce A and B met the applicable regulatory requirements.

In 2017, CNSC staff performed a compliance verification inspection of the Engineering Division personnel training program. CNSC staff found that the training program was defined and documented in accordance with the Bruce Power SAT-based training system. A procedural non-compliance of low safety significance was identified with respect to linking engineering and training staff to the appropriate qualifications. CNSC staff were satisfied with Bruce Power's prompt addressing this non-compliance.

Personnel certification

CNSC staff determined that Bruce Power's personnel certification program met the applicable regulatory requirements. CNSC staff reviewed the staffing reports for certified personnel, the applications for initial certification and renewal of certification, and confirmed that certified personnel at Bruce A and B possessed the knowledge and skills required to perform their duties safely and competently.

Initial certification examinations and requalification tests

CNSC staff concluded that the initial certification examination and requalification testing programs for the certified personnel at Bruce A and B met the applicable regulatory requirements.

In 2017, CNSC staff conducted compliance verification activities on the administration of simulator-based initial certification examinations at Bruce A and simulator-based requalification tests at Bruce B. Most of the findings generated recommendations for continuous improvements. CNSC staff observed some low safety significance non-compliances during the design review of a simulator-based initial certification examination at Bruce A. CNSC staff noted that although Bruce Power had more than the minimum required number of valid design features for a simulator-based certification examination, some of the additional design features provided did not meet the intent of the applicable regulatory requirements. Since the simulator-based certification examination met the minimum design requirements, these non-compliances did not impact the validity of the subject examination. Bruce Power implemented a corrective action plan to address these findings, which was reviewed and found acceptable by CNSC staff.

In 2017, Bruce Power submitted its proposal to modify the examination methodology for one of the required certification examinations to multiple-choice question (MCQ) format. CNSC staff reviewed Bruce Power's proposal and have accepted the use of this proposed MCQ examination methodology on a pilot basis for administrating general certification examinations.

Work organization and job design

Minimum shift complement

The minimum shift complement at Bruce A and B met the applicable regulatory requirements. Bruce Power has a workforce planning process in place to ensure that an adequate number of workers is maintained for Bruce A and B.

In 2017, Bruce A and B had four reportable events on violations of minimum shift complement; all of them were promptly reported and were deemed to have minimal to no impact on safe operation of the stations (see section 2.2).

There have been numerous Hours of Work violations reported in 2017. In order to reduce the limits of hours-of-work non-compliances to meet minimum complement, Bruce Power put measures in place to prevent limits of hours-of-work exceedance. For details on reducing limits of hours-of-work exceedance, also see section on fitness for duty.

Fitness for duty

In 2017, Bruce Power exceeded the hours-of-work limits at Bruce A and B for certified staff on several occasions to maintain the minimum shift complement (62 at Bruce A and 59 at Bruce B). These exceedances had potential impact on worker fatigue and could have affected the performance of workers. The exceedances were required to maintain a minimum shift complement Bruce Power's efforts to prevent the likelihood of future hours of work violations are ongoing. CNSC staff will continue to monitor Bruce Power's implementation of REGDOC-2.2.4, *Fitness for Duty Volume I: Managing Worker Fatigue* and progress in addressing the issue of worker fatigue.

As a result of the non-compliances related to limits of hours-of-work, in January 2017 CNSC staff performed a focused desktop review of Fatigue Management to examine whether Bruce Power had put measures in place to reduce the number of non-compliances and mitigate the effects of worker fatigue. CNSC staff identified findings of low significance, specifically related to having a better defined process for managing fatigue and strengthening requirements in procedures for preventing or mitigating the risk of fatigue-related errors. Based on CNSC staff findings, Bruce Power committed to revise its procedures and planned to incorporate the

requirements of REGDOC-2.2.4, *Fitness for Duty Volume I: Managing Worker Fatigue*. Bruce Power's strategy to reduce hours-of-work exceedances was found acceptable to CNSC staff.

Bruce Power also committed to implement REGDOC-2.2.4, *Fitness for Duty Volume II, Managing Alcohol and Drug Use*, which has begun. Full implementation is expected by December 2019.

3.4.3 Operating performance

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

Conduct of licensed activities

CNSC staff concluded that Bruce Power met or exceeded the applicable regulatory requirements for the conduct of licensed activities at both BNGS A & B. CNSC staff observed that Bruce Power continued to operate Bruce A and B in a safe and secure manner, with adequate regard for health, safety, security, radiation and environmental protection and international obligations.

Bruce Power operated both BNGS within the bounds of its operating policies and principles and operational safety requirements.

In 2017, BNGS A experienced two trips, no stepback and no setbacks. BNGS B experienced no trips, one stepback and six setbacks. All transients were controlled properly and power reduction was automatically initiated by the reactor control systems. There was no impact on reactor safety. CNSC staff confirmed that Bruce Power staff followed approved procedures and took appropriate corrective actions for all transients.

Procedures

CNSC staff determined that Bruce Power has well-defined processes for procedure preparation, review, validation, issuance and revision. There majority of observations in this specific area for 2017 were compliant. CNSC staff were satisfied with the quality of the Bruce Power procedures and found that they met the applicable regulatory requirements.

Reporting and trending

During 2017, Bruce Power submitted to CNSC 92 event reports in accordance with REGDOC 3.1.1. Two of the events resulted in EIRs as previously described in Table 22 of section 3.4.0. Bruce Power posted information on all event reports on its website.

All scheduled reports in 2017 were submitted to CNSC in a timely manner and were adequate.

CNSC staff determined that the reporting and trending practices at Bruce A and B met or exceeded the applicable regulatory requirements and expectations in 2017.

Outage management performance

Bruce Power demonstrated good levels of performance and achievement of objectives during maintenance outages. In 2017, Bruce A experienced five forced outages among four reactors. Bruce B experienced six forced outage among four reactors (mostly at Unit 7). All forced outages were initiated by Bruce Power to perform repairs on mainly service equipment that malfunctioned unexpectedly and required repair.

In 2017, Bruce A had one and Bruce B had two planned outages. All planned and unplanned (forced) outages were followed up appropriately by Bruce Power. CNSC staff conducted inspections on all planned outages, which confirmed that all outage-related undertakings, including reactor shutdown guarantees and heat sink management were performed safely by Bruce Power.

CNSC staff found that Bruce Power's outage management performance met or exceeded regulatory requirements and expectations in 2017.

Safe operating envelope

CNSC staff determined that Bruce Power operated within the safe operating envelope (SOE) and met the applicable regulatory requirements. Bruce Power continued to implement ongoing improvements of the SOE in 2017. CNSC staff are satisfied with the progress of SOE implementation at both BNGS.

Severe accident management and recovery

CNSC staff determined that severe accident management and recovery met the applicable regulatory requirements for Bruce A and Bruce B. Bruce Power has demonstrated the effectiveness of severe accident management guidelines (SAMG) through ongoing exercises and plant drills at both Bruce A and B. Updating the SAMG to include countermeasures for multi-unit events is in progress. In 2017, CNSC started a focused desktop review on Bruce A and B SAMG documentation and its recent updates, which is planned to be completed in 2019.

Accident management and recovery

CNSC staff determined that Bruce Power's accident management and recovery programs met the applicable regulatory requirements in 2017. There were no significant observations to report in 2017.

3.4.4 Safety analysis

CNSC staff concluded that the safety analysis SCA at Bruce A and B met or exceeded performance objectives and applicable regulatory requirements. As a result, each station received a "fully satisfactory" rating, unchanged from the previous year.

Deterministic safety analysis

CNSC staff concluded that both Bruce A and B safety analyses predict adequate safety margins. Bruce Power met CNSC regulatory requirements for safe operation. CNSC staff determined that Bruce Power has a well-managed program on conducting deterministic safety analysis and that the existing safety analysis remains adequate during the continued implementation of REGDOC-2.4.1, *Deterministic Safety Analysis*.

Implementation of REGDOC-2.4.1 is a long-term process; Bruce Power completed the first phase (3 years) in 2017. In January 2017, Bruce Power submitted the Bruce A Common Mode Events (CME) technical basis documents and analysis results for CNSC staff review. The CME analyses for Bruce A and B were incorporated in the updated Bruce A and B safety reports. These updates were submitted along with other safety report updates by the end of 2017 and are currently under review by CNSC staff.

UPDATE: Bruce Power submitted the updated fire protection assessment (CCR, FHA and FSSA) in 2017. In January 2018, CNSC staff determined that the fire safety analysis, which included the FHA and FSSA met the applicable regulatory requirements.

Probabilistic safety assessment

CNSC staff determined that Bruce Power is compliant with CNSC Regulatory Document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* and is in transition to implementing of the REGDOC-2.4.2, *Probabilistic Safety Analysis (PSA) for Nuclear Power Plants*. Full implementation of REGDOC-2.4.2 is expected by June 2019.

As part of the transition plan, Bruce Power submitted the new PSA methodologies and computer codes in April 2017. CNSC staff reviewed these submissions and concluded that the submitted PSA methodologies met the requirements of REGDOC-2.4.2. In addition, Bruce Power is committed to submit whole-site PSA methodology by the end of 2018. There are no ongoing issues identified as a result of regulatory oversight activities. CNSC staff found that Bruce Power's performance in the PSA area met or exceeded the applicable regulatory requirements in 2017.

Criticality safety

Both the booster fuel assemblies and LVRF demonstration fuel bundles are currently in storage. CNSC staff found that Bruce Power's criticality safety program is compliant with the applicable requirements. There were no criticality events and no ongoing issues identified at Bruce A and B during 2017.

Severe accident analysis

Bruce Power continues to support industry research and development (R&D) programs in the area of severe accident analysis. Bruce Power is developing a plan for the design and installation phases of the selected containment filtered venting system (CFVS), which will provide additional defense in depth when installed. There are no ongoing improvements identified as a result of regulatory oversight activities in 2017.

Bruce Power, with other licensees, has developed a project called Severe Accident Software Simulator Solution to improve their methods for deterministic analysis of multi-unit severe accidents. CNSC staff has completed the review of the Severe Accident Software Simulator Solution (SASS) modelling summary report and proposed some recommendations. See section 2 for more details.

Management of safety issues (including R&D programs)

The work by NPPs to address the remaining category 3 CANDU safety issues is described in section 2.4.

The following are highlights of two R&D projects that are currently ongoing:

Moderator subcooling requirements methodology: Bruce Power submitted the review of experimental results using the safety analysis issue review panel process for the CNSC sponsored calandria-tube strain contact boiling project. CNSC staff issued an interim report summarizing the results of the experiment along with evaluation of the results. These outstanding issues will be addressed over the next licensing period.

Moderator temperature predictions: The original experiments completed for the validation of moderator temperature predictions were different from the moderator nozzle configuration for Bruce A. To provide additional confirmation, Bruce Power completed several initiatives which

included submission of technical reports and the performance of more experiments representing the specific geometries of the moderator inlet nozzles for the Bruce A and PNGS 1,4 reactors. This experimental work is currently underway at McMaster University. CNSC staff will review the experimental results over the next licensing period.

3.4.5 Physical design

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

Design governance

Environmental qualification

CNSC staff determined that Bruce Power met the applicable regulatory requirements.

Bruce Power has identified components required for replacement to ensure that its environmental qualification will continue to be met. Impact of service life extension will be included in revised EQ design documentation as per the requirements of Bruce Power's governing document.

In 2017, CNSC staff reviewed Bruce Power's response to previous inspection findings on Bruce A and B Environmental Qualification Program efficiency and effectiveness and concluded that Bruce Power adequately addressed issues related to the definition of roles and responsibilities in the EQ process as well as knowledge management. Additional actions were ongoing for the improvement of system performance monitoring walkdown checklists. At the end of 2017, CNSC staff were reviewing Bruce Power's corrective actions.

CNSC staff also reviewed Bruce Power's recent submission on Bruce A Seismic Margin Assessment Upgrades. CNSC staff confirmed that all seismic upgrade installations were completed in 2017, and are available for service.

Pressure boundary design

CNSC staff determined that Bruce Power has a documented pressure boundary program that met the applicable requirements.

In 2017, CNSC staff inspected the implementation of the pressure boundary program, specifically the processes for system code classification, reconciliation and registration, as well as the AIA service agreement (which, for Bruce Power, is with the Technical Standards and Safety Authority). CNSC staff found that the implementation of the pressure boundary program, for both code classification and design registration reconciliation process, met regulatory requirements.

Human factors in design

Bruce Power completed a gap analysis and developed an implementation plan to implement CSA Group standard N290.12-14, *Human factors in design for nuclear power plants* text by September 1, 2018.

UPDATE: An inspection at Bruce Power, conducted early in 2018, confirmed that Bruce Power's updated human factors in design program was in compliance with N290.12-14.

Site Characterization

CNSC staff concluded that site characterization at Bruce A and B met the applicable regulatory requirements. There were no significant observations to report in 2017 for this specific area.

Facility design

CNSC staff concluded that facility design for Bruce A and B met the applicable regulatory requirements. There were no significant observations to report in 2017 for this specific area.

Structure design

CNSC staff concluded that the structure design specific area met the applicable requirements.

In 2017, CNSC staff reviewed Bruce Power's submission in response to the inspection conducted in 2016 on Seismic Design Preservation Program. CNSC staff were monitoring the implementation of the corrective actions, which were ongoing at the end of 2017.

System design

Electrical systems

CNSC staff concluded that Bruce Power's electrical power systems met the applicable regulatory requirements.

Bruce Power continued to upgrade the controls for the standby generators (SGs). In 2017, the upgrades for SG3 at Bruce A and SG7 and SG8 at Bruce B were completed. The upgrades on the remaining SGs were on schedule and CNSC staff were satisfied with Bruce Power's progress.

In 2017, Bruce Power reported two (2) emergency transfer scheme (ETS) vulnerabilities which would only be a concern for a short time during a safety system test (SSTs). The SSTs that affect the availability of SGs to the ETS have been identified and deferred until the test procedures are revised and validated. While this condition needs to be resolved, the risk to the stations remained low. CNSC staff considered the actions in response to this event to be acceptable and is monitoring Bruce Power's completion of the corrective actions, which include a design change to ETS.

In 2017, CNSC inspected the Bruce B electrical power systems (EPSs) and verified that the EPSs were capable of performing their intended safety functions and that the equipment was tested and maintained as required.

Fire protection design

Bruce Power's fire protection program met the applicable regulatory requirements in 2017. Bruce Power continued the implementation of design modification improvements for CSA N293-12, *Fire Protection for Nuclear Power Plant* , which is planned to be completed in 2020 for BNGS A and BNGS B. These improvements are included in the Integrated Implementation Plan for the Periodic Safety Review.

Components design

CNSC staff concluded that Bruce Power met the applicable regulatory requirements for component design

Fuel design

CNSC staff determined that Bruce Power has a well-developed reactor fuel inspection program. Fuel performance at Bruce was acceptable in 2017. The fuel defect rate for Units 1 and 2 at Bruce A continues to trend downwards and the trend in observations of end-plate cracking is stable at Bruce B. In 2017, Bruce Power continued to implement its corrective action plan to address fuel bundle vibration due to acoustically active channels at Bruce B. Bruce Power is able to satisfactorily manage fuel performance issues while maintaining safe operations.

Cables

In 2017, there were no deviations from regulatory requirements found during compliance verification activities (i.e. desktop reviews, periodic safety reviews). As a result, CNSC staff concluded that the cable management program at BNGS-A&B met the applicable regulatory requirements.

3.4.6 Fitness for service

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

Equipment fitness for service/equipment performance

CNSC staff determined that the overall equipment fitness for service and performance at Bruce A and B was satisfactory and met the applicable regulatory requirements.

In January, 2017, CNSC staff inspected Bruce Power's Pressure Boundary Program and reviewed an event report related to pipe hanger failures in the Bruce A steam reject system. Bruce Power developed a corrective action plan to proactively implement the modified design on the remaining hangers in the Bruce A Steam Reject System by 2019. The risk in the interim is negligible and CNSC staff found this plan acceptable.

In August 2017, Unit 3 Heat Transport System (HTS) circulating pump number four experienced a triple seal failure while the unit was shutting down. Bruce Power performed a detailed root cause analysis of this event and presented the findings to the Commission. It was determined that there was a misalignment or imbalance of the rotating assembly. Repairs were completed and the unit was returned to service. Bruce Power has put additional measures in place, such as enhanced vibration monitoring, to prevent reoccurrence of this event. CNSC staff will closely monitor Bruce Power's measures to address the root causes of the equipment failure. A detailed description of this event is provided in table 22 in section 3.4.0.

Reliability of systems important to safety

CNSC staff determined that the reliability program at Bruce A and B met the applicable regulatory requirements.

For Bruce A, all special safety systems met their unavailability targets in 2017, with the exceptions of emergency cooling injection (ECI) for Units 1 and 3. This unavailability was caused by the modified ECI system testing program with a fail-pass parameter that was not used before and resulted in a conservative assumption that the ECI was unavailable.

This unavailability was caused by modifications to the testing program with fail-pass parameters that aligned with the safety analysis. The unavailability target exceedance occurred due to the reportable event for the quicker than analyzed opening of ECI Valve during

scheduled Safety System Test (SST) at Units 1 and 3. This resulted in a conservative assumption that ECI was unavailable. The valves were promptly adjusted to meet the timing requirements. The valve stroke time did not meet the current design criteria for water hammer analysis, for a postulated Secondary Side Line Break event. CNSC staff are satisfied with the corrective actions that Bruce Power took to address this event. Bruce Power has to confirm that no additional gaps exist for SSTs revised during the return to service of Units 3 and 4 by June 2018. .

For Bruce B, all special safety systems met their unavailability targets in 2017.

As described above under the specific area System design, Bruce Power continued to install controls upgrades for all the standby generators (SGs), which is enhancing the reliability of Class III Power System. In 2017, the SGs that were not yet upgraded continued to meet their availability targets through a sufficient supply of spare parts.

Maintenance

In 2017, CNSC staff determined that the maintenance program met the applicable requirements at Bruce A and B stations.

The average preventive maintenance completion ratios were 88 percent for Bruce A and 87 percent for Bruce B (which matched the industry average of 88 percent). The maintenance backlogs for Bruce A and B were acceptable and are provided in tables 21 and 22, respectively.

Table 23: Maintenance backlogs and deferrals for critical components for Bruce A, 2017

Parameter	Average quarterly work orders per unit in 2017	Average quarterly work orders per unit in 2016	Average quarterly work orders per unit in 2015	Three years trending	Industry average
Corrective maintenance backlog	3	2	4	stable	4
Deficient maintenance backlog	100	123	123	down	98
Deferrals of preventive maintenance	6	12	18	down	30

Table 24: Maintenance backlogs and deferrals for critical components for Bruce B, 2017

Parameter	Average quarterly work orders per unit in 2017	Average quarterly work orders per unit in 2016	Average quarterly work orders per unit in 2015	Three years trending	Industry average
Corrective maintenance backlog	2	3	6	down	4
Deficient maintenance backlog	127	165	180	down	98
Deferrals of preventive maintenance	7	14	28	down	30

For Bruce A and B, the corrective maintenance backlogs were maintained below industry average. The deficient maintenance backlogs were reduced to the range of industry average. The number of preventive maintenance deferrals for critical components was reduced to below industry average.

CNSC staff determined that the overall safety significance of maintenance backlogs and deferrals for critical components was negligible for Bruce A and B.

Structural integrity

CNSC staff concluded that SSCs met the applicable structural integrity requirements for both Bruce A and B stations.

In 2017, pressure boundary inspection results for Units 4 to 8 indicated that all inspected elements of the primary heat transport and auxiliary systems, steam generators, feeders and pressure tubes were fit for continued operation. The results of inspections of containment for Unit 5 indicated that all inspected elements of containment components were fit for continued operation. All inspection findings were evaluated by Bruce Power to confirm that CSA acceptance criteria for structural integrity were met. CNSC staff determined that appropriate corrective actions (such as repairs or replacement of components) were implemented to restore margins.

Aging management

CNSC staff determined that Bruce Power's integrated aging management program met the applicable regulatory requirements at BNGSA and BNGSB. In 2017, Bruce Power completed the implementation of its aging-management governance to comply with CNSC REGDOC-2.6.3, *Fitness for Service: Aging Management*.

Based on available information, CNSC staff have confirmed that there is an adequate basis for Bruce Power's Periodic Inspection Plans.

CNSC staff determined that Bruce Power had adequate programs in place to confirm that fuel channels were fit for service for near-term operation. Bruce Power submitted engineering assessments of degradation mechanisms that spanned the near-term and met all applicable CSA acceptance criteria.

In support of future pressure tube engineering assessments (addressing operation of Bruce units up to their respective Major Components Replacement (MCR) outages), Bruce Power submitted detailed plans for activities. These plans include the development and validation of a revised pressure tube fracture toughness model applicable to Hydrogen Equivalent Concentration (HEQ) levels in excess of 120 ppm (currently limit of model validity), and the implementation of a probabilistic evaluation methodology to demonstrate fracture protection of pressure tubes.

To justify operation of pressure tubes beyond HEQ of 120 ppm, Bruce Power will be required to demonstrate that pressure tube fracture toughness is sufficient for safe operation. CNSC staff consider that the existing regulatory process, which was used to monitor additional validation of the existing fracture toughness model up to HEQ of 120 ppm, is adequate to ensure that the pressure tubes will continue to meet CSA acceptance criteria.

See Appendix H: for details on the current and anticipated future fuel channel conditions and validity of analytical models of pressure tube fracture toughness for fuel channels at Bruce (and the other NPPs in Ontario).

To ensure these activities are completed in a timely manner, CNSC staff recommended (as part of the 2018 licence renewal) that the Commission impose a specific licence condition, obliging Bruce Power to demonstrate sufficient pressure tube fracture toughness. CNSC staff also intends to closely monitor Bruce Power's progress on its planned activities, to ensure that they are completed according to the required schedules. (See section 2.6).

Chemistry control

CNSC staff determined that Bruce Power's chemistry control program met the applicable regulatory requirements. Bruce Power has taken appropriate actions to maintain the chemistry control parameters within acceptable limits. The storage of hazardous materials and process chemicals on site was well managed. In the first half of 2017, there was an increasing (positive) trend in the overall chemistry index for Bruce A and B, which was attributed to the chemistry improvements made to the condensate extraction system.

In 2017, CNSC staff inspected chemistry control at Bruce A and B and concluded that Bruce Power met all applicable regulatory requirements for monitoring critical chemistry parameters during the guaranteed shutdown state. Bruce Power provided an adequate corrective action plan, with a target implementation by mid-2018, to address minor issues of negligible safety significance related to independent verification of laboratory results.

Periodic inspections and testing

CNSC staff determined that Bruce Power has adequate and well maintained periodic inspection programs (PIPs) in place at Bruce A and B for pressure boundary systems, containment components and containment structures that met the applicable regulatory requirements

Bruce Power implements a relief valve testing program to confirm that overpressure protection devices on pressure boundary systems will perform their intended function in the event of operating pressure transients. Bruce Power reported several relief valve test failures on balance of plant pressure boundary systems during 2017. CNSC staff confirmed that Bruce Power has implemented adequate corrective actions and concluded that stations safety has not been impacted.

3.4.7 Radiation protection

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

Application of ALARA

CNSC staff determined that Bruce Power continued to implement a highly effective and well-documented radiation protection program, based on industry best practices, to keep doses to persons as low as reasonably achievable (ALARA) at Bruce A and B.

Bruce Power met or exceeded the requirements.

CNSC staff verified that Bruce A and B used ALARA initiatives in work planning, and dose monitoring and control to achieve the challenging ALARA targets established by Bruce A and B. The collective dose at the site was observed to align with those targets. CNSC staff concluded that the application of ALARA by Bruce Power met regulatory requirements and achieved planned goals with a noticeable improving trend.

In September 2017, CNSC staff conducted an inspection focused on the specific area of ALARA Planning. The inspection identified several compliant findings and one area requiring improvement related to self-assessment of the ALARA program. This area does not pose a risk to the health and safety of workers and is of low safety significance. Bruce Power developed a corrective action that was reviewed by CNSC staff and found acceptable.

Worker dose control

CNSC staff determined that Bruce Power continued to comply with the regulatory requirements to measure and record doses received by workers at Bruce A and B.

Routine compliance verification activities in 2017 confirmed that performance in the area of worker dose control at Bruce A and B was highly effective. Radiation doses to workers were below the regulatory dose limits and action levels established in the Bruce Power radiation protection program. The data for doses to workers at Bruce A and B are provided in section 2.7.

Safety performance indicators related to worker dose control include tracking of occurrences involving doses received from unplanned exposures or uptakes. CNSC staff observed that there were no adverse trends or safety-significant unplanned exposures due to the licensed activities at Bruce A and B in 2017.

In 2017, CNSC staff conducted a focused inspection on worker dose control at Bruce A and B. The inspection identified non-compliances of low safety significance related to problem identification and resolution, adherence to radiation protection procedures, selection of appropriate radiological exposures permits (REPs), and control of procedure revisions. Consequently, Bruce Power developed corrective action plans, which CNSC staff reviewed and found acceptable. All corrective actions from this focused RP inspection were implemented and closed, except for one related to improvements in the directions given to workers in the selection and use of the appropriate REP for work execution (scheduled to be completed in April, 2018).

Radiation protection program performance

CNSC staff determined that the Bruce Power radiation protection (RP) program met the requirements of the Radiation Protection Regulations and confirmed that Bruce Power regularly

measures the performance of its RP program against industry-established objectives, goals and targets.

The oversight applied by Bruce Power in implementing and improving this program was highly effective in protecting workers at both Bruce A and B stations in 2017.

Radiological hazard control

CNSC staff determined that Bruce Power implemented radiological hazard controls that met the applicable regulatory requirements. These measures protect workers and ensure radioactive contamination is monitored and controlled within site boundaries.

CNSC staff confirmed that no safety-significant incidents were identified related to personal and loose contamination events. This was also confirmed in the performance indicators results.

The number of personal contamination events (PCEs) was reduced noticeably in 2017. Bruce Power achieved a world industry-best performance for PCEs with less than 0.4 PCEs per outage day in 2017, compared to an industry standard of 1.0 PCEs per outage day.

Estimated dose to the public

CNSC staff determined that Bruce Power continued to ensure the protection of the general public in accordance with the *Radiation Protection Regulations*.

In 2017, the reported dose to the public from the Bruce site was 0.0021 mSv, well below the annual dose regulatory limit of 1 mSv (see Section 2.7) for members of the general public. There were no significant reportable issues on this area during the reporting year.

3.4.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at Bruce A met or exceeded the applicable regulatory requirements, while at Bruce B it met the applicable regulatory requirements. As a result, Bruce A received a "fully satisfactory" rating and Bruce B received a "satisfactory" unchanged from the previous reporting year.

Performance

CNSC staff determined that the performance specific area met or exceeded applicable regulatory requirements at Bruce A but did not meet those requirements at Bruce B in 2017.

Health and safety related incidents are promptly reported by Bruce Power on an ongoing basis. CNSC staff have reviewed Bruce Power's corrective actions and conclude that they are appropriate.

During field inspections, CNSC staff recorded observations on safety practices and the controls being employed to address conventional hazards at both BNGS.

In March 2017, a worker received an electrical shock while performing post maintenance testing of a circuit breaker at Unit 5 (see table 22 in section 3.4.0 for details). CNSC staff conducted a reactive compliance inspection at Bruce B and found two procedural non-compliances – one of medium safety significance and the other of low safety significance. These non-compliances related to work protection practices and the implementation of Bruce Power's electrical safety procedures. In order to prevent recurrence, Bruce Power improved hazard identification and training and made additional procedural changes, which will provide sufficient clarity to workers to identify whether the maintenance work is being performed on an

energized or de-energized bus. CNSC staff determined that the corrective actions were adequate and that performance metrics have been established to drive improvement.

Practices

CNSC staff determined that Bruce Power met or exceeded the applicable regulatory requirements at Bruce A and Bruce B in 2017. There were no reportable issues on this area during the reporting year.

The conventional health and safety work practices and conditions at BNGS A and BNGS B NGS continued to achieve a high degree of personnel safety. There continues to be a safe working environment where safe work practices are encouraged.

CNSC staff verified that Bruce Power has appropriate procedures in place to ensure the protection of the environment and the health of persons against hazardous materials.

Awareness

CNSC staff concluded that Bruce Power met requirements in this area in 2017 at both Bruce A and B. All deficiencies from field inspections were adequately addressed throughout the year. Despite promptly addressing these deficiencies, there was an adverse trend with respect to housekeeping findings in 2017 at Bruce A and B. CNSC staff determined that all these findings were not safety significant.

3.4.9 Environmental protection

CNSC staff concluded the environmental protection SCA at Bruce met performance objectives and applicable regulatory requirements. As a result, each station received a “satisfactory” rating, unchanged from the previous year.

Effluent and emissions control (releases)

Bruce Power has committed to implement CSA Group standard N288.5, *Effluent monitoring programs at Class 1 nuclear facilities and uranium mines and mills* by December 31, 2018.

CNSC staff observed that all airborne and waterborne radiological releases to the environment from Bruce A and B remained below regulatory limits and action levels in 2017. The releases are shown in figures 20 and 21 as percentages of the applicable DRLs for Bruce A and B, respectively. The actual values of the releases and DRLs are provided in Appendix I:.

Figure 20: Effluent and emissions at Bruce A as percentages of DRLs

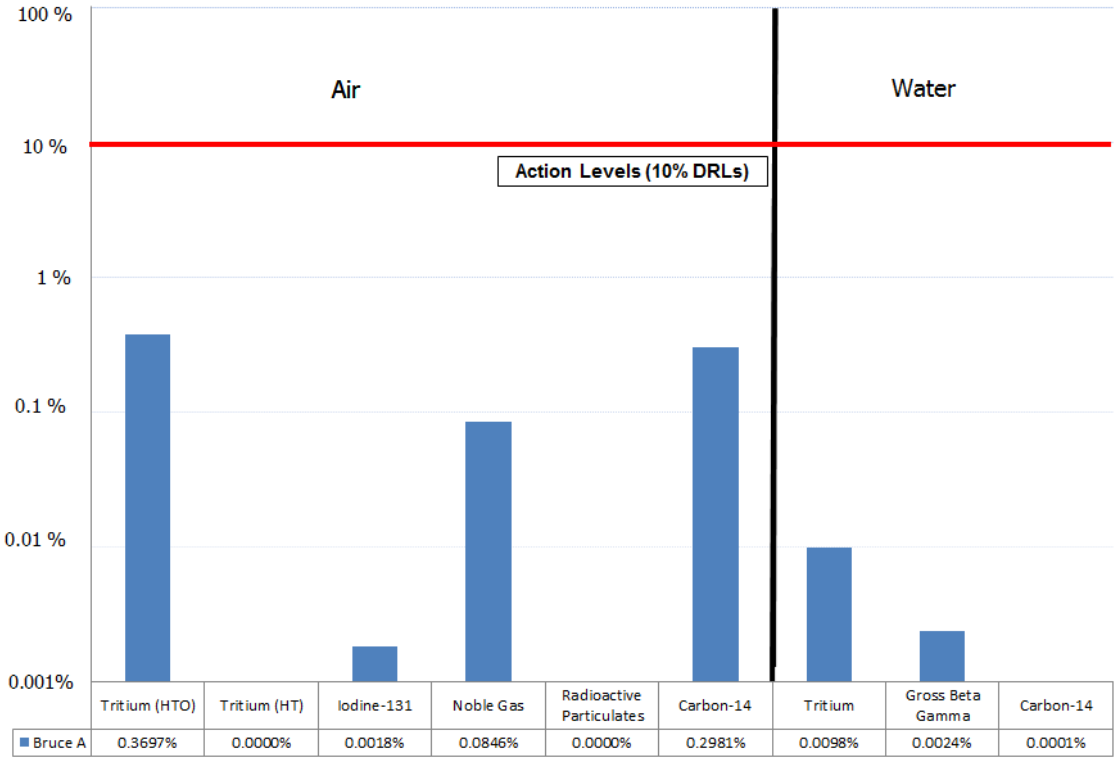
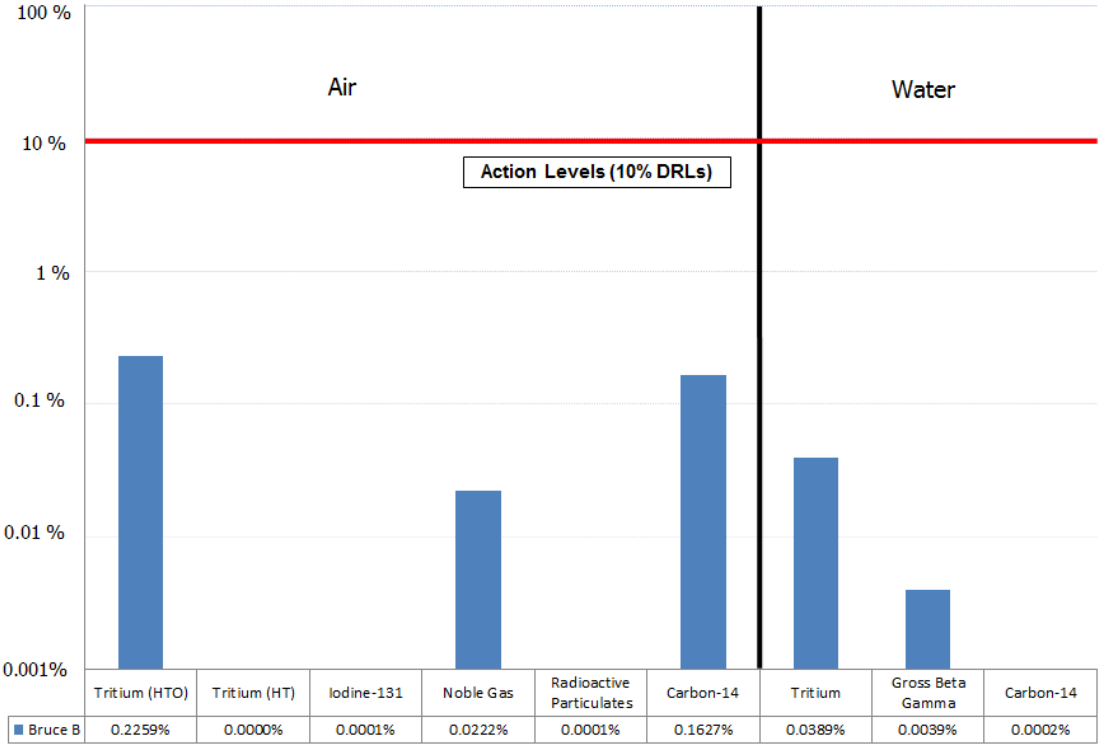


Figure 21: Effluent and emissions at Bruce B as percentages of DRLs



Bruce Power plans to implement CSA Group standard N288.3.4, *Performance testing of nuclear air cleaning systems at nuclear facilities* in 2018.

Environmental management system

Bruce Power has implemented an environmental management program in accordance with REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures (2013)*.

This REGDOC was subsequently updated in 2017. Full implementation by Bruce Power of the 2017 revision of REGDOC-2.9.1 is expected in 2020.

In the fall of 2017, Bruce Power also transitioned to the new ISO 14001:2015, *Environmental management systems - Requirements with guidance for use* [8] edition. See Section 2.9 for further details.

Assessment and monitoring

CNSC staff determined that Bruce Power's programs for assessment and monitoring met the applicable regulatory requirements in 2017. CNSC staff reviewed and assessed the 2017 environmental monitoring data and concluded that the general public and the environment in the vicinity of Bruce Power were protected.

In November 2017, CNSC staff conducted a compliance inspection of Bruce Power's environmental protection program. CNSC staff concluded that the control, monitoring, analysis and reporting of environmental data and associated processes are well-developed, consistently implemented, and are in compliance with regulatory requirements.

An environmental assessment had been conducted prior to the refurbishment of Bruce A Units 1 and 2. Based on the review of final environmental assessment follow-up monitoring report in 2016, CNSC and Environment and Climate Change Canada (ECCC) staff confirmed that no

significant adverse effects resulted from the refurbishment (which concluded in 2012) and that the environmental assessment follow-up monitoring program was completed. Aspects of the follow-up monitoring program will continue as part of Bruce Power's ongoing environmental monitoring program.

Bruce Power is working towards full implementation of CSA Group standard N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* by December 31, 2020.

Protection of the public

During 2017, CNSC staff concluded that there were no hazardous substances released to the environment from Bruce Power that posed an unacceptable risk to the environment or the general public. CNSC staff observed only two minor exceedances of the provincial effluent limits for Bruce Power. In one instance, Bruce B exceeded the ammonia discharge limit; on another occasion, Bruce B exceeded an acute toxicity limit. Both instances were reported to Ontario Ministry of the Environment and Climate Change and corrective actions were taken to prevent recurrence.

Dose to the public is discussed in Section 3.4.7

Environmental risk assessment

CNSC staff determined that Bruce Power continued to implement and maintain an effective environmental risk assessment and management program at the Bruce site in accordance with the applicable regulatory requirements.

In June 2017, Bruce Power submitted an updated Environmental Risk Assessment (ERA) report and a Predictive Environmental Risk Assessment (PEA) report for the Bruce site based on effluent and environmental monitoring data for the five-year period between 2012 and 2016. The ERA included an ecological risk assessment (EcoRA) and a human health risk assessment (HHRA) for radiological and non-radiological (hazardous) chemicals of potential concern and physical stressors. The purpose of the PEA was to assess the potential changes to the baseline environmental and human health risk assessments due future activities at the site, including refurbishment activities.

CNSC staff found the methodology to be consistent with the applicable requirements.

Overall, meaningful adverse ecological and human health effects from physical stressors and radiological and non-radiological releases from the Bruce NPP were unlikely.

Although Bruce Power's 2017 ERA report for Bruce provides a complete evaluation of all potential risks to human health and the environment associated with the facility operations, CNSC staff provided comments to Bruce Power with specific recommendations to validate several ERA conclusions and to improve the ERA quality. CNSC staff also made recommendations regarding the means to reduce assessment uncertainties for future versions of the ERA.

Bruce Power has committed to implementation of CSA Group standard N288.6, *Environmental risk assessments at Class I facilities and uranium mines and mills* by December 30, 2018.

3.4.10 Emergency management and fire protection

CNSC staff concluded that the emergency management and fire protection SCA at the Bruce Power site met performance objectives and applicable regulatory requirements. As a result, the Bruce Power site received a "satisfactory" rating, unchanged from the previous year.

Conventional emergency preparedness and response

Bruce Power maintains and continues to support a comprehensive conventional emergency response capability at all times on site and inside the protected areas of Bruce A and Bruce B. This includes personnel and equipment for medical, HAZMAT, search and rescue as well as fire response.

CNSC staff concluded that Bruce Power's conventional emergency preparedness and response met the applicable regulatory requirements.

Nuclear emergency preparedness and response

CNSC staff determined that Bruce Power continued to support and maintain a comprehensive nuclear emergency preparedness and response capability at all times that met the applicable regulatory requirements. Bruce Power continued to support offsite emergency management organizations and commitments as well.

Bruce Power had plans to be fully compliant with version 1 of CNSC REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response* in 2018.

In December 2017, CNSC staff inspected a Corporate Emergency Exercise to assess compliance with CNSC REGDOC-2.10.1, *Nuclear emergency preparedness and response* and Bruce Power's Nuclear Emergency Plan. The exercise was designed to test Bruce Power's capability to respond to a nuclear emergency and to demonstrate the effectiveness of emergency facilities, equipment and response personnel. The inspection identified one non-compliance of low safety significance related to the assurance of the effectiveness of DLAN training on the system. Bruce Power planned corrective action for 2018.

In August 2017, under sub-section 12(2) of the General Nuclear Safety and Control Regulations, Bruce Power was requested to submit in writing a plan to implement auto data transfer to the CNSC emergency operations centre (EOC) based on the lessons learned from the Huron Resolve corporate drill in 2016. In response to CNSC staff request, Bruce Power committed to initiate a feasibility assessment to investigate options for automatic connectivity between plant data systems and Disaster LAN (DLAN) electronic data transfer system in 2018.

Fire emergency preparedness and response

CNSC staff determined that Bruce Power maintains comprehensive fire response capability and fire protection program that met the applicable regulatory requirements.

Bruce Power has an extensive fire drill and training program which includes a new Emergency and Protective Services Training Facility, where live fire training is conducted, located on the Bruce Power site.

In April 2017, CNSC staff inspected a Bruce A and B fire drill and identified an area of non-compliance related to radio communications for fire response teams. Bruce Power initiated a Radio System Replacement, including an update to radio communications. The development and definition phase has been completed with the site wide radio system project scheduled for completion in 2020. CNSC staff were satisfied with the proposed corrective action plan.

In addition to CNSC compliance activities, Bruce Power is required to conduct expert Third Party Reviews (TPR) of an annual plant condition, bi-annual fire drill audit and tri-annual fire program audit. By incorporating the results of the CNSC compliance findings and TPR observations and recommendations into the drill and training program, CNSC staff observed that the emergency response team performance continued to improve.

3.4.11 Waste management

CNSC staff determined that the waste management SCA at Bruce A and B met or exceeded performance objectives and applicable regulatory requirements. As a result, each station received a "fully satisfactory" rating, unchanged from the previous year.

Waste characterization

CNSC staff determined that Bruce Power's waste characterization met the applicable regulatory requirements. Bruce Power minimized the production of radioactive wastes through various plans, programs and procedures as well as minimizing impacts from such wastes on workers and the environment.

Bruce Power continued to employ effective programs for the characterization of radioactive and hazardous wastes during 2017.

Waste minimization

CNSC staff determined that Bruce Power's waste management programs met or exceeded the applicable regulatory requirements for minimizing radioactive waste. There were only compliant observations from field inspections in this specific area in 2017.

Bruce Power continued to employ effective programs for the minimization of radioactive and hazardous wastes during 2017.

Waste management practices

CNSC staff determined that Bruce Power's waste management practices met the applicable regulatory requirements. Bruce Power continued to employ effective radioactive and hazardous waste management practices during 2017. Bruce Power implements waste management procedures to ensure that waste generated at the facility is separated properly.

Decommissioning plans

CNSC staff concluded that the preliminary decommissioning plans (PDPs) for Bruce A and B, submitted by OPG, met or exceeded the applicable regulatory requirements in 2017.

OPG holds the liability for the Bruce Power site and is therefore responsible for providing the PDPs and cost estimates. A deferred decommissioning strategy was selected for the decommissioning of Bruce A and B NGSs. In 2017, OPG revised the PDPs for all of its facilities for the period up to 2022. The Commission accepted the PDPs and associated financial guarantee. The associated financial guarantee is discussed in section 2.15.

3.4.12 Security

CNSC staff determined that Bruce Power's security program met performance objectives and applicable requirements. All corrective action plans in response to inspection findings are implemented to the satisfaction of CNSC staff.

Bruce A and B received a "satisfactory" rating in 2017, unchanged from the previous year.

Facilities and equipment

CNSC staff determined that Bruce Power met the applicable regulatory requirements for facilities and equipment. Bruce Power continued to sustain its security equipment through lifecycle management. No significant equipment failures were reported in 2017. Bruce Power has measures in place to adequately prevent security events.

Bruce Power made numerous investments in facilities and equipment during this reporting period. In 2017, Bruce Power invested in bulk vehicle screening equipment, which will be used to enhance screening measures presently employed at Bruce A and B. In response to CNSC staff request, Bruce Power not only performed repairs but also replaced all aging security camera equipment at Bruce A. Bruce Power initiated several new capital investments in 2017 to replace aging security equipment and systems across Bruce A and Bruce B including cameras, detection and search equipment.

Cyber Security

Bruce power maintains a cyber security program at Bruce A and B. CNSC staff concluded that the program complied with applicable regulatory requirements. There were no cyber security events reported in 2017.

Bruce Power is updating its current cyber security program at Bruce A and B to be in full compliance with N290.7-14 by December 31, 2020. CNSC staff was satisfied with the progress to date.

CNSC staff concluded that there were no safety significant issues for this specific area.

Response arrangements

CNSC staff determined that Bruce Power met the applicable regulatory requirements for response arrangements.

Bruce Power maintains a Nuclear Response Force that met the applicable requirements. Findings raised during the 2016 security exercise were addressed to the satisfaction of CNSC staff and subsequently closed. The 2017 inspection findings were being addressed to the satisfaction of CNSC staff.

CNSC staff concluded that there were no safety significant issues in the area of response arrangements.

Security practices

CNSC staff determined that Bruce A and B implemented security practices that met or exceeded the applicable regulatory requirements.

Bruce Power has procedures in place at Bruce A and B to provide guidance to security personnel in all areas. Bruce Power has a multifaceted security awareness program that is fully integrated into the Bruce Power governance process. During the reporting period, Bruce Power commenced monthly site wide lock-down drills with Bruce Power staff. Bruce Power also sponsored through their center of excellence program a World Institute of Nuclear Security (WINS) workshop on Incident planning and Emergency Response. Bruce Power intends to meet the new requirements for security screening once the REGDOC-2.12.2, *Site Access Security Clearance* is updated.

CNSC staff concluded that there were no safety-significant issues for this specific area.

Drills and exercises

CNSC staff determined that Bruce Power's exercise and drill program met the applicable regulatory requirements.

In the previous year, CNSC staff identified some deficiencies of low safety significance during the compliance verification activities that were conducted during the "Force on Force" exercise; these include elements of the Bruce Power drills and exercises program. Bruce Power has provided adequate responses to address the deficiencies, identified by CNSC staff, and implemented changes to its program. In 2017, CNSC staff performed a follow-up inspection of the drill/exercise program and was satisfied with the corrective actions being taken to address the deficiencies. During the reporting period, Bruce Power commenced site wide lock-down drills with Bruce Power staff. This activity is a good practice that should be shared with industry peers.

CNSC staff found that there were no safety-significant issues for this specific area.

3.4.13 Safeguards and non-proliferation

CNSC staff concluded that the Safeguards and Non-proliferation SCA at Bruce met performance objectives and all applicable regulatory requirements. As a result, each Bruce A and B stations received a "satisfactory" rating, unchanged from the previous year.

Nuclear material accountancy and control

CNSC staff concluded that Bruce Power's accountancy and control of nuclear material complied with the applicable regulatory requirements at both Bruce A and B in 2017

Access and assistance to the IAEA

CNSC staff concluded that Bruce Power met the applicable regulatory requirements for access and assistance. 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.

In 2017, the International Atomic Energy Agency (IAEA) performed one physical inventory verification (PIV) and five unannounced inspections (UIs) at Bruce A to verify the nuclear material inventory and assure the absence of undeclared nuclear material and activities.

The IAEA performed one PIV, one Design Information Verification (DIV) and four UIs at Bruce B.

Bruce Power granted access and provided assistance to the IAEA in October for a site survey to site potential locations of additional IAEA surveillance equipment in the irradiated fuel bay area, with the goal of optimizing the current safeguards approach at Bruce A and B.

Operational and design information

CNSC staff confirmed that Bruce Power met the applicable regulatory requirements for operational and design information. Bruce Power submitted its annual operational program with quarterly updates for both Bruce A and B to the CNSC on time. Bruce Power submitted the annual update to the information pursuant to the IAEA Additional Protocol to the CNSC on time. The information provided met CNSC's submission requirements.

Safeguards equipment containment and surveillance

CNSC staff confirmed that Bruce Power supported IAEA equipment operation and maintenance activities at Bruce A and B, including routine maintenance of surveillance equipment, to ensure the effective implementation of safeguards measures at the stations.

In September 2017, Bruce B reported that the fuel handling operators discovered a broken IAEA seal that had been attached to an electrical junction box through which the cables to the bundle counter detectors were installed. Bruce Power immediately notified this event to the IAEA, and the seal was replaced by the IAEA the following day. The IAEA performed a follow-up visit and confirmed that the electrical junction box had not been tampered with and it was resealed. Bruce Power provided additional training to staff on reporting procedure and planned to revise the operational manual. CNSC staff were satisfied with the corrective actions taken by the licensee for this event.

3.4.14 Packaging and transport

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

The transport of nuclear substances to and from the facility is conducted in a safe manner.

For on-site movement of nuclear substances, Bruce Power ensures an equivalent level of safety as is required for off-site transportation to protect the health and safety of workers and the general public, and the environment.

Package design and maintenance, packaging and transport

CNSC staff determined that Bruce Power has a packaging and transport program at Bruce A and B that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations* and the *Transportation of Dangerous Goods Regulations*.

There were two separate incidents involving damages to radioactive packages during shipment. Material within the packages shifted during transport. There was no release of material from the packages and the material was properly secured within the packages, before they were returned to the Bruce site.

CNSC staff determined that there was no impact on the health or safety of persons or the environment as a result of the reported events. Bruce Power made changes to its procedures to ensure that such incidents do not re-occur. CNSC staff were satisfied with these changes.

3.4.15 Other Matters of Regulatory Interest

Public Information Program

CNSC staff determined that Bruce Power met the applicable regulatory requirements related to public information and disclosure. Bruce Power provided sufficient information on the status of Bruce A and B through a variety of communication activities.

Bruce Power proactively engaged with community members about its ten-year licence renewal application to include major component replacement activities through various community meetings, open houses, social media, and advertising campaigns.

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.

Indigenous Relations

CNSC staff observed that Bruce Power has a dedicated Indigenous engagement program. Throughout 2017, it met and shared information with interested Indigenous communities and organizations, particularly the Saugeen Ojibway Nation, the Métis Nation of Ontario and the Historic Saugeen Métis.

Information and discussion topics included Bruce Power's current operations at the Bruce site, the *Fisheries Act* authorization application, environmental impacts, including to fish, and the licence renewal application.

3.5 WWMF and RWOS-1

The safety assessment presented below for each SCA is facility-specific. General information relevant to the SCAs is provided in section 2**.** The CNSC regulatory documents and CSA Group standards that were identified as regulatory requirements for the WWMF, as of December 2017, are listed in Appendix E:.

Safety assessment

The CNSC staff safety assessment of the WWMF and the Radioactive Waste Operations Site-1 (RWOS-1) for 2017 resulted in the performance ratings in Table 25. Based on the observations and assessments of the SCAs, CNSC staff concluded that both the WWMF and RWOS-1 operated safely. The overall rating for the WWMF and RWOS-1 was "satisfactory".

Table 25: Performance ratings for the WWMF and RWOS-1, 2017

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

Legend: FS – Fully Satisfactory SA – Satisfactory
BE – Below Expectations UA – Unacceptable

* Also applies to RWOS-1

3.5.0 Introduction

The WWMF and RWOS-1 are located at the site of the Bruce A and Bruce B Nuclear Generating Stations on the east shore of Lake Huron, in Tiverton, ON, 20 kilometers northeast of Kicardine and 30 kilometers southwest of Port Elgin. The CNSC regulates the WWMF under a WFOL and the RWOS-1 under a waste nuclear substance licence (WNSL). The facilities are owned and

operated by OPG.

At the WWMF, OPG processes and stores DSCs containing used nuclear fuel (high-level radioactive waste) generated solely at Bruce A and Bruce B. OPG also manages the low- and intermediate-level radioactive waste (L&ILW) generated from the operation of OPG owned (or previously owned) facilities including the DNGS, PNGS, and Bruce A and Bruce B. Finally, OPG manages the L&ILW generated from the refurbishment of Bruce A and Bruce B.

The current WWMF licence allows limited activities of import and export of nuclear substances occurring primarily as contaminants in laundry, packaging, shielding, or equipment. These activities were previously authorized under a Temporary Possession Licence.

The WWMF spans over two separate areas - the L&ILW Storage Facility and the Used Fuel Dry Storage Facility (UFDSF)- , 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 intermediate-level radioactive waste. The UFDSF is located within its own protected area, separate from the protected area of Bruce A and Bruce B, but within the boundary of the Bruce site. The UFDSF contains one DSC processing building and four DSC storage buildings (Storage Buildings #1, #2, #3, and #4). The WWMF has the capacity to store 2,000 DSCs. The transfer of loaded DSCs from Bruce A and Bruce B to the WWMF is conducted on Bruce Power and OPG property with a security escort.

OPG is authorized under the WFOL 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 the RWOS-1, OPG stores L&ILW generated at the Douglas Point Nuclear Generating Station and the 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.

Unless stated otherwise, observations or conclusions in this report about the WWMF also pertain

in general to the RWOS-1.

Licensing

In May, 2016, OPG submitted a request to the CNSC to have the WWMF licence renewed [21] for a period of 10 years until May 31, 2027. The Public Hearing for the licence renewal was held in Ottawa on April 12, 2017. The Record of Decision and the renewed WFOL were issued on May 29, 2017.

No licensing actions were conducted for the RWOS-1 in 2017.

LCH

The LCH for the WWMF was issued on October 25, 2017. No revisions to the LCH have been made since it was issued.

The WNSL for the RWOS-1 does not currently have an associated LCH.

Event initial reports

No event initial reports pertaining to WWMF or RWOS-1were submitted to the Commission for the period January 1, 2017 to June 1, 2018.

Compliance Program

The annual CNSC effort on the compliance program is tabulated in Appendix G: (Table G.9) for the WWMF and RWOS-1. The inspections at the WWMF and RWOS-1 that were considered in the safety assessments in this regulatory oversight report are tabulated in Appendix J: (Table J.6).

3.5.1 Management system

CNSC staff concluded that the management system SCA at the WWMF met the performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, unchanged from the previous year.

Management system

CNSC staff determined that OPG's nuclear management system at the WWMF met the applicable regulatory requirements in 2017. OPG has completed the transition to the 2012 version of CSA Group standard N286-12, *Management system requirements for nuclear facilities*.

CNSC staff conducted a desktop review of OPG's Nuclear Waste Management documentation for WWMF and determined that it was adequate to meet the applicable regulatory requirements. However, during a 2017 inspection at the DWMF, CNSC staff identified minor issues of low safety significance regarding clarity and consistent application of documentation that was also applicable at the WWMF. OPG committed to applying its corrective action plan at the WWMF as well. At the end of 2017, CNSC staff were monitoring the implementation of the corrective actions and confirming the implementation of OPG's changes at WWMF.

Organization

CNSC staff determined that OPG has continued to adequately define organizational structures and roles and responsibilities at the WWMF.

CNSC staff had no significant observations at the WWMF to report in this specific area in 2017.

Change management

CNSC staff determined that OPG continued to have an adequate change management program at the WWMF that complies with the applicable regulatory requirements.

As a result of an inspection in 2017 at the DWMF, CNSC staff identified that the change management process was ineffective for the inspection of DSCs and for other generic documentation that is used by all OPG WMFs. OPG implemented a change management committee to manage governance and process changes for nuclear waste at all of its WMFs. OPG committed to applying the corrective action plan at the WWMF with respect to change management.

At the end of 2017, CNSC staff were monitoring the implementation of the corrective actions and overseeing the implementation of OPG's changes at the WWMF.

Safety culture

CNSC staff were satisfied that OPG continued to foster a healthy safety culture at the WWMF in 2017. CNSC will monitor OPG's next safety culture self-assessment at the WWMF, scheduled for 2018, and any improvement actions initiated.

Configuration management

CNSC staff determined that OPG maintained the configuration of its SSCs at the WWMF in compliance with its configuration management program and other applicable regulatory requirements.

CNSC staff had no significant observations at the WWMF to report in this specific area in 2017.

Records management

CNSC staff determined that OPG continued to maintain and implement a document control and records management system at the WWMF and RWOS-1 that met the applicable regulatory requirements.

As a result of an inspection at the DWMF that focused on OPG's management system, CNSC staff identified minor issues of low safety significance regarding the control of documents and records that apply to the WWMF as well. OPG committed to applying the corrective action plan at the WWMF with respect to records management. At the end of 2017, CNSC staff were reviewing OPG's corrective action plans and were satisfied with the progress.

Management of Contractors

CNSC staff concluded that the interface between OPG and its contractors at the WWMF did not meet the applicable regulatory requirements in 2017. As a result of an inspection at the DWMF, CNSC staff observed that OPG was no longer performing the receiving inspection, including the verification of the DSC history docket received from the vendors. The discontinuation of receiving inspections and failure to reflect the change in its internal documentation significantly reduced OPG's oversight of vendors. OPG committed to applying the corrective action plan at the WWMF regarding management of vendors. At the end of 2017, CNSC staff was monitoring the implementation of the corrective actions at the WWMF. See Section 3.1.1 for further details.

Business continuity

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements for business continuity at the WWMF. CNSC staff verified that OPG had adequate contingency plans in place to maintain or restore critical safety and business functions in the event of disabling circumstances, such as a pandemic, severe weather, or labour actions.

Problem identification and operating experience

CNSC staff determined that OPG continued to meet the applicable regulatory requirements for problem identification and OPEX at the WWMF.

CNSC staff had no significant observations at the WWMF to report for this specific area in 2017.

Performance assessment, improvement and management review

CNSC staff confirmed that OPG continued to meet the applicable regulatory requirements for performance assessment, improvement, and management at the WWMF.

CNSC staff had no significant observations at the WWMF to report in this specific area in 2017.

3.5.2 Human performance management

CNSC staff concluded that the human performance management SCA at the WWMF met performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, unchanged from the previous year.

Human performance program

CNSC staff determined that OPG's human performance program at the WWMF continued to meet the applicable regulatory requirements.

CNSC staff have no significant observations at the WWMF to report for this specific area in 2017.

Personnel training

CNSC staff confirmed that OPG continued to have a well-documented and robust fleet-wide training system based on a systematic approach to training (SAT). Implementation of this system for the training programs at the WWMF met the applicable regulatory requirements.

In 2017, CNSC staff verified that OPG satisfactorily completed the corrective actions that resulted from the training-focused compliance verification inspection conducted in 2016. Subsequently, CNSC staff closed the action item.

Personnel certification

This specific area does not apply to the WWMF because there are no CNSC certified positions at the facility.

Initial certification examinations and requalification tests

This specific area does not apply to the WWMF because there are no CNSC certified positions at the facility.

Work organization and job design

This specific area does not apply to the WWMF.

Fitness for duty

CNSC staff determined that OPG continued to meet the applicable regulatory requirements for fitness for duty at the WWMF.

CNSC staff requested OPG to provide an implementation plan for REGDOC-2.2.4 *Fitness for Duty, Volume I: Managing Worker Fatigue* by September 30, 2017. OPG committed to the full implementation of this REGDOC at the WWMF by January 1, 2019. CNSC staff were satisfied with OPG's implementation plan and will monitor its progress.

CNSC staff requested OPG to provide an implementation plan for REGDOC-2.2.4 *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* by March 31, 2018. CNSC staff have received, and are currently reviewing, OPG's implementation plan for REGDOC-2.2.4 Volume II. OPG has committed to the full implementation of this REGDOC at all facilities by July 1, 2019, except the WWMF. At the WWMF, staff performing safety critical and safety sensitive functions are employees of Bruce Power, and thus will be subject to the Bruce Power implementation plan. OPG has stated that Bruce Power is currently planning to comply with all REGDOC requirements on the same timeline. Therefore, the full implementation of this REGDOC at the WWMF, in accordance with the Bruce Power implementation plan, is currently July 1, 2019. CNSC staff were satisfied witht his implementation plan and will monitor Bruce Power's progress.

3.5.3 Operating performance

CNSC staff concluded that the operating performance SCA at the WWMF met or exceeded performance objectives and applicable regulatory requirements. As a result, the WWMF received a "fully satisfactory" rating, unchanged from the previous year.

Conduct of licensed activities

CNSC staff confirmed that OPG continued to meet or exceeded the applicable regulatory requirements for the conduct of licensed activities at the WWMF. CNSC staff determined that OPG continued to operate the WWMF in a safe and secure manner, with adequate regard for health, safety, security, radiation protection, environmental protection, and international obligations.

In 2017, OPG operated the WWMF within the bounds of its operating policies and principles and operational safety requirements.

On August 23, 2017, OPG reported an event that occurred at the WWMF to CNSC staff regarding an unplanned power outage at the WUFDSF. The loss of Class IV power at the dry storage facility was restored after six hours. OPG stated that there was no environmental, health, safety or security implications for the facility or personnel as a result of this event. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

This section is divided into the following subsections: High-Level Waste Operations, LLW and ILW Operations, and Construction Activities.

High-Level Waste Operations

In 2017, OPG processed 100 DSCs at the WWMF. Since the start of facility production to the end of 2017, OPG has processed and placed into storage 1364 DSCs at the WWMF.

Low and Intermediate Level Waste Operations

At the WWMF, OPG processes and stores L&ILW generated by DNGS, PNGS and the BNGS. OPG conducts LLW incineration and compaction activities in order to minimize storage volume 70-fold (incineration) and 5-fold (compaction) in accordance with the 3 Rs: reduce, reuse and recycle. The total volume of L&ILW received at the WWMF in 2017 was 2240 m^3.

Construction Activities

OPG did not construct any additional buildings at the WWMF in 2017.

Procedures

CNSC staff concluded that OPG has governance in place that ensures procedures for the WWMF are written in a consistent and usable manner. OPG has clearly documented expectations for procedural use and adherence, and a process to manage procedural change at the WWMF.

CNSC staff were satisfied with the quality of the OPG procedures and found that they continued to meet the applicable regulatory requirements.

Reporting and trending

CNSC staff confirmed that OPG's reporting and trending met or exceeded the applicable regulatory requirements and expectations in 2017 for the WWMF.

During the reporting year, all scheduled reports for the WWMF were submitted to CNSC in a timely manner and were adequate.

During 2017, CNSC staff received six low safety significance event reports from OPG regarding the WWMF. The event reports are discussed in detail in their applicable SCA throughout this report.

Outage management performance

This specific area does not apply to the WWMF.

Safe operating envelope

This specific area does not apply to the WWMF.

Severe accident management and recovery

CNSC staff determined that severe accident management and recovery continued to meet or exceeded the applicable regulatory requirements for the WWMF in 2017. The program is implemented with an organizational structure that clearly establishes the roles and responsibilities of all program participants.

CNSC staff had no significant observations to report at the WWMF in this specific area in 2017.

Accident management and recovery

Through regulatory oversight, CNSC staff determined that OPG's accident management and recovery program for the WWMF continued to meet or exceeded the applicable regulatory requirements in 2017.

CNSC staff had no significant observations to report in this specific area at the WWMF in 2017.

3.5.4 Safety analysis

CNSC staff concluded that the safety analysis SCA at the WWMF met or exceeded performance objectives and applicable regulatory requirements. As a result, the WWMF received a "fully satisfactory" rating, unchanged from the previous year.

Deterministic safety analysis

CNSC staff determined that OPG's deterministic safety analysis predicts adequate safety margins, and met or exceeded the applicable regulatory requirements at the WWMF. OPG submits a safety analysis report for the WWMF every five years that effectively identifies facility hazards and the measures in place to control or mitigate these hazards. The most recent approved revision to this document was submitted to CNSC staff in 2012. CNSC staff reviewed and were satisfied with the updated safety report. OPG submitted the revision to the WWMF safety report in November 2017 and it is currently undergoing CNSC review.

OPG continues to implement a comprehensive fire protection program at the WWMF in accordance with applicable requirements.

OPG submitted the updated Fire Hazard Analysis, Code Compliance Review, and Fire Protection Program Audit for the WWMF. CNSC staff determined that the approach and methodology used is generally consistent with applicable requirements for the Fire Protection Program Audit. At the end of 2017, the Fire Hazard Analysis and Code Compliance Review were undergoing CNSC review.

Probabilistic safety assessment

This specific area does not apply to the WWMF.

Criticality safety

This specific area does not apply to the WWMF.

Severe Accident Analysis

This specific area does not apply to the WWMF.

Management of safety issues (including R&D programs)

This specific area does not apply to the WWMF.

3.5.5 Physical design

CNSC staff concluded that the physical design SCA at the WWMF met performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, unchanged from the previous year.

Design governance

CNSC staff concluded that OPG continued to meet the applicable regulatory requirements regarding design governance in 2017 for the WWMF.

Pressure boundary design

CNSC staff confirmed that OPG continued to implement a comprehensive pressure boundary program at the WWMF. The pressure boundary program is compliant with regulatory requirements.

Site characterization

CNSC staff had no significant observations at the WWMF to report in this specific area in 2017.

Facility design

CNSC staff had no significant observations at the WWMF to report in this specific area in 2017.

Structure design

CNSC staff confirmed that OPG continued to meet the applicable regulatory requirements regarding structure design in 2017 for the WWMF.

CNSC staff had no significant observations at the WWMF to report in this specific area in 2017.

System design

CNSC staff confirmed that OPG continued to meet the applicable regulatory requirements regarding system design in 2017 for the WWMF.

Fire Protection design

CNSC staff confirmed that OPG continued to implement a comprehensive fire protection program at the WWMF in accordance with CSA Group standard N393-13, *Fire protection for facilities that process, handle, or store nuclear substances.*

Component design

CNSC staff confirmed that OPG continued to meet the applicable requirements regarding components design in 2017 for the WWMF.

On September 12, 2017 OPG reported an event that occurred at the WWMF to CNSC staff regarding a pressure vessel certificate of inspection. In 2016, the Technical Standards & Safety Authority had inspected propane tanks at the WWMF and determined that issuance of a Certificate of Inspection was not required. However, on August 2, 2017, OPG confirmed that the Certificate of Inspection was required, and the Technical Standards & Safety Authority issued the certificates the next day.

OPG stated that there were no environmental, health, safety or security implications for the facility or personnel as a result of this event; and there was no effective dose received from this event. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

3.5.6 Fitness for service

CNSC staff concluded that the fitness for service SCA at the WWMF met performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, unchanged from the previous year.

CNSC staff determined that OPG established and maintained fitness for service programs which are effectively implemented at the WWMF, and that satisfy regulatory requirements. The implemented programs ensure the safe physical condition of systems, structures, and components.

Equipment fitness for service and equipment performance

This specific area does not apply to the WWMF.

Maintenance

CNSC staff determined that OPG's maintenance program met the applicable regulatory requirements for the WWMF in 2017.

CNSC staff had no significant observations at the WWMF to report in this specific area for 2017. **Structural Integrity**

CNSC staff confirmed that SSCs important for safe operation at the WWMF continued to meet the applicable structural integrity requirements established in the design basis or in CNSC accepted standards and guidelines for the WWMF in 2017.

Aging management

CNSC staff confirmed that OPG's integrated aging management program at the WWMF continued to meet the applicable regulatory requirements in 2017.

OPG completed its transition to compliance with REGDOC-2.6.3, *Aging Management* in 2017 at the WWMF.

Chemistry control

CNSC staff determined that OPG's chemistry control program met or exceeded the applicable regulatory requirements for the WWMF in 2017.

CNSC staff reviewed the 2017 quarterly reports for the WWMF and concluded that the facility has maintained acceptable performance related to chemistry. There were no chemistry-related incidents at the PWMF in 2017.

Periodic inspections and testing

This specific area does not apply to the WWMF because periodic inspection and testing requirements are addressed under the scope of aging management at the facility.

3.5.7 Radiation protection

CNSC staff concluded that the radiation protection SCA at the WWMF met performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, unchanged from the previous year.

Application of ALARA

CNSC staff determined that OPG continued to implement an effective and well-documented program, based on industry best practices, to keep doses to persons as low as reasonably achievable (ALARA) at the WWMF.

CNSC staff verified that OPG used ALARA initiatives, work planning, and dose monitoring and control to work towards the challenging ALARA targets established by OPG at the WWMF.

CNSC staff verified during 2017 that radiation exposures and doses to workers at the WWMF were below the regulatory dose limits and remained ALARA.

Worker dose control

CNSC staff confirmed that OPG continued to comply with the regulatory requirements to measure and record doses received by workers at the WWMF.

Routine compliance verification activities conducted in 2017 confirmed that performance in the area of worker dose control at the WWMF was effective. Radiation doses to workers were below the regulatory dose limits and action levels established in OPG's Radiation Protection Program.

CNSC staff observed that there were no adverse trends or safety-significant unplanned exposures that resulted from the licensed activities at the WWMF in 2017.

The data for doses to workers at the WWMF can be found in section 2.7.

The maximum dose received by a worker at the WWMF in 2017 was 0.6 mSv, which is 1.2% of the regulatory dose limit.

Radiation protection program performance

CNSC staff determined that OPG continued to implement a radiation protection program at the WWMF that satisfies the requirements of the *Radiation Protection Regulations*.

The oversight applied by OPG in implementing and improving this program was effective in protecting workers at the WWMF. OPG regularly measures the performance of its Radiation Protection Program against industry-established objectives, goals, and targets.

OPG's action levels for the WMFs were revised in 2017 to ensure they were appropriate indicators of a possible loss of control of an element of OPG's Radiation Protection Program at the WWMF. CNSC staff reviewed the revised action levels and found them to be appropriate.

Radiological hazard control

CNSC staff determined that OPG implemented radiological hazard controls that met the applicable regulatory requirements. These measures protect workers and ensured radioactive contamination was controlled within the site boundary for the WWMF.

The were no contamination control action level exceedances for surface contamination at the WWMF in 2017.

On March 10, 2017 OPG reported an event that occurred at the WWMF to CNSC staff regarding the absence of a radiation hazard posting pursuant to Section 21 (b) of the CNSC *Radiation Protection Regulations*. OPG stated that there was no environmental, health, safety or security implications for the facility or personnel as a result of this event. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

On November 8, 2017 OPG reported an event that occurred at the WWMF to CNSC staff regarding an unposted radiation hazard. Upon discovery of the unposted hazard a barrier was established and posted at the 25 μSv/hr [2.5mrem/hr]) boundary. OPG stated that there were no environmental, health, safety or security implications for the facility or personnel as a result of this event with the implementation of the impairment plan. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

Estimated dose to the public

The WWMF is located within the site boundary of the Bruce NGSs. In accordance with licence requirements, Bruce Power has its own programs in place to verify that radiation doses to members of the general public, as a result of releases remain ALARA. As seen in Figure 10 in section 2.7, dose to the public associated with operational activities at the site for 2013 to 2017 was well below the regulatory annual dose limit of 1 mSv for members of the general public.

3.5.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at the WWMF exceeded performance objectives and applicable regulatory requirements. As a result, the WWMF received a "fully satisfactory" rating, unchanged from the previous year.

Performance

CNSC staff determined that OPG met or exceeded requirements at the WWMF in regards to conventional health and safety performance.

OPG continues to demonstrate its ability to keep workers safe from occupational injuries while conducting its licensed activities at the WWMF. Health and safety related incidents are reported by OPG on an ongoing basis, as applicable.

No health and safety related incidents or LTIs at the WWMF were reported by OPG to CNSC staff in 2017.

CNSC staff conducted inspections at the WWMF and recorded findings on the safe practices and controls being employed by OPG to address conventional hazards. CNSC staff did not identify any areas of concern regarding conventional health and safety in 2017.

CNSC staff participated in pre-inspection health and safety briefings held with OPG staff and management. CNSC staff found that the health and safety briefings were satisfactory.

Practices

CNSC staff determined that OPG's conventional health and safety practices met or exceeded the applicable regulatory requirements at the WWMF in 2017.

The conventional health and safety work practices and conditions at the WWMF continued to achieve a high degree of personnel safety. OPG personnel at all levels exhibit proactive attitude towards anticipating work related hazards and preventing unsafe conditions. There continues to be a working environment where safe work practices are encouraged. CNSC staff verified that OPG has appropriate procedures in place at the WWMF to ensure the health of persons against hazardous materials.

CNSC staff observed safe work practices during site inspections at the WWMF. A positive indicator in this regard is the use of their job hazard analysis program which specifies OPG's commitment to conduct pre-inspection tours of jobs and job sites, listing emergency procedures

for such jobs, identifying the minimum level of personal protective equipment required and listing the required permits or work authorizations before starting work.

Awareness

CNSC staff confirmed that OPG continued to meet or exceed the applicable regulatory requirements for awareness in 2017 at the WWMF. CNSC staff determined that OPG continued to maintain a safe working environment at the WWMF. CNSC staff had no significant observations at the WWMF for this specific area in 2017.

3.5.9 Environmental protection

CNSC staff concluded that the environmental protection SCA at the WWMF met performance objectives and applicable regulatory requirements, unchanged from the previous year.

Effluent and emissions control (releases)

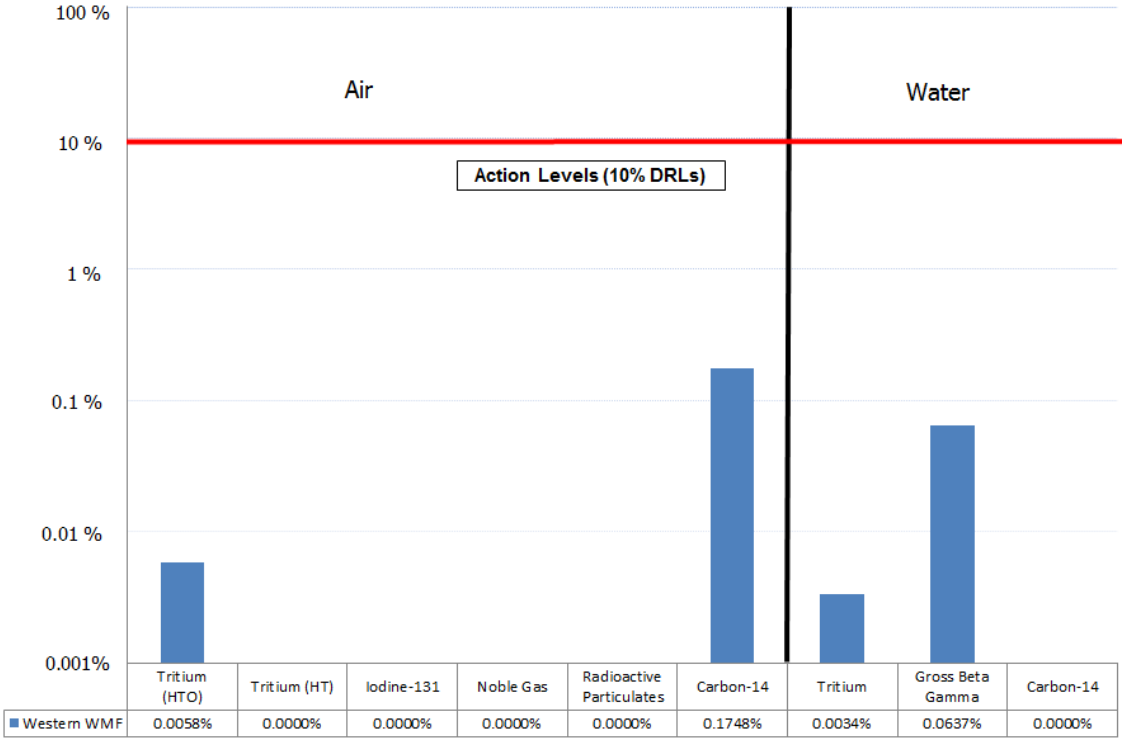
The WWMF has its own facility-specific DRLs and Action Levels for radiological airborne and liquid releases.

CNSC staff observed that all airborne and waterborne radiological releases from the WWMF remained below the applicable regulatory limits and action levels in 2017. The releases are shown in figure 22 as percentages of the applicable DRLs. The actual values of releases and DRLs are provided in Appendix I:.

The WWMF has recently submitted revised DRLs and environmental action levels (EALs) to CNSC staff. The DRL revisions were based on Update No. 2 (November 2017) of CSA Group standard N288.1-14, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities*. At the end of 2017, CNSC staff were reviewing the revisions.

As of December 14, 2017 OPG was fully compliant with the requirements of CSA Group standard N288.3.4-13, *Performance testing of nuclear air-cleaning systems at nuclear facilities* for the WWMF.

Figure 22: Effluent and emissions at WWMF as percentages of DRLs



Environmental management system

CNSC staff confirmed that in 2017, OPG continued to establish and implement a corporate-wide EMS at the WWMF in accordance with CNSC REGDOC-2.9.1, *Environmental Principles, Assessments and Protection Measures*, version 1.1 to assess environmental risks associated with its nuclear activities at the WWMF, and to ensure these activities are conducted in a way that prevented or mitigated adverse environmental effects. The EMS is also registered to the ISO 14001: 2015 – *Environmental management systems – Requirements with guidance for use [8]* standard. As a result of registration, the EMS is subject to periodic independent third party audits and reviews to verify its sufficiency and also identify potential improvements.

Assessment and monitoring

CNSC staff have reviewed and assessed the environmental monitoring data provided by OPG for the WWMF and concluded that the general public and the environment in the vicinity of the facility were protected. OPG met the applicable regulatory requirements for the WWMF in 2017.

During 2017, OPG completed its groundwater monitoring network assessment of the WWMF and have added 22 additional wells to its groundwater monitoring program. The assessment updates and confirms the understanding of the site hydrogeology for the current site and for areas of potential expansion.

OPG completed a gap analysis in 2017 between the existing groundwater monitoring program and CSA Group standard N288.7-15 *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* and developed an implementation plan to be in

compliance with this standard by December 31, 2021. CNSC staff found the transition date to be acceptable.

Protection of the public

CNSC staff confirmed that the general public in the vicinity of the WWMF were protected and that there were no expected health impacts.

OPG made two relevant reports in 2017 to another regulatory body - the Ministry of the Environment and Climate Change (MOECC). In July 2017, OPG reported that the data acquisition and handling software was not normalizing the SO_2 and NOx emissions to 11% oxygen. In December 2017, OPG reported that there was a minor NOx stack emission limit exceedance. CNSC staff concluded that the risks to the general public and the environment due to hazardous substances released to the environment from the WWMF was low. OPG reported that the concentration of NOx exceeded the average 24-hour rolling average based on the MOECC Environmental Compliance Approval performance of section 6(k). OPG reported this incident to the MOECC, and developed an action plan to address the exceedance. Both items have been addressed and are closed.

Dose to the public is discussed in Section 3.5.7.

Environmental risk assessment

CNSC staff determined that OPG continued to implement and maintain an effective environmental risk assessment and management program at the WWMF in accordance with the applicable regulatory requirements.

In April 2016 OPG submitted an Environmental Risk Assessment (ERA) to support its application for a 10-year licence that was presented to the Commission on April 12, 2017. CNSC staff completed a detailed technical review of the ERA against the clauses in CSA Group standard N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* and concluded that some requirements were not met. OPG submitted an updated ERA in October of 2016. CNSC staff concluded that the ERA methodology was consistent with the applicable requirements. Overall, meaningful adverse ecological and human health effects due to releases to air and water from the WWMF were found to be unlikely.

CNSC staff concluded that the revisions to the updated ERA were acceptable.

In May of 2016, OPG submitted a Predictive Effects Assessment (PEA) to support the licensing process for the construction of additional storage and processing buildings and to demonstrate its provisions to protect the environment are adequate.

CNSC staff found that the PEA provided an adequate evaluation of all potential risks to human health and the environment associated with the construction of additional storage and processing buildings during the next licence period. The results of the PEA review by CNSC staff indicate that meaningful human health or ecological effects attributable to the proposed construction activities are unlikely.

CNSC staff reviewed the PEA and the revised ERA and concluded that they complied with N288.6.

3.5.10 Emergency management and fire protection

CNSC staff concluded that the emergency management and fire protection SCA at the WWMF met the applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, unchanged from the previous year.

OPG has contracted Bruce Power to provide comprehensive conventional emergency response capability for the WWMF at all times. This includes personnel and equipment for medical, HAZMAT, search and rescue, as well as fire response.

Conventional emergency preparedness and response

CNSC staff had no significant observations at the WWMF to report in this specific area for 2017.

Nuclear emergency preparedness and response

CNSC staff confirmed that OPG continued to support and maintain a comprehensive emergency preparedness and response capability at all times that met the applicable regulatory requirements at the WWMF. Additionally, CNSC staff confirmed that OPG continued to support offsite emergency management organizations and commitments.

OPG has a facility emergency program for the WWMF that includes radiation response emergency procedures.

Training and exercises are conducted annually at the Bruce site to ensure all areas of the site, including the WWMF, have adequate emergency notification and response capability from Bruce Power Emergency Services.

OPG performs periodic due diligence assessments on Bruce Power's emergency response facilities, equipment, procedures and personnel to confirm the agreed services will continue to meet the requirements.

OPG had a transition plan in place to implement version 2 of REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* (2016) at the WWMF by December 31, 2018. CNSC staff found the transition date to be acceptable.

Fire emergency preparedness and response

Through regulatory oversight, CNSC staff confirmed that OPG continued to maintain comprehensive fire response capability and a fire protection program that met the applicable regulatory requirements at the WWMF.

CNSC staff reviewed OPG's submissions related to fire protection including the WWMF Fire Response Needs Analysis and concluded that they met the applicable regulatory requirements.

On September 25, 2017 OPG reported an event that occurred at the WWMF to CNSC staff regarding loss of fire water. OPG was notified by Bruce Power that a water main on-site had ruptured.

A fire impairment plan was immediately put in place including restriction of hot work on-site. Fire water was restored approximately 12 hours after the fire water main ruptured. OPG stated that there were no environmental, health, safety or security implications for the facility or personnel as a result of this event with the implementation of the impairment plan; and there was no effective dose received from this event. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

3.5.11 Waste management

CNSC staff concluded that the waste management SCA at the WWMF met or exceeded performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, unchanged from the previous year.

Waste characterization

CNSC staff confirmed that OPG's waste characterization continued to meet the applicable regulatory requirements at the WWMF.

OPG continued to employ effective programs for the characterization of radioactive and hazardous wastes at the WWMF during 2017. CNSC staff had no significant observations at the WWMF to report in this specific area in 2017.

Waste minimization

CNSC staff determined that OPG's waste management programs for minimizing radioactive waste continued to meet the applicable regulatory requirements at the WWMF.

Minimal radioactive waste is generated from the waste management activities conducted at the WWMF. Nonetheless, OPG has set a goal to minimize the generation of radioactive waste due to operational activities.

In 2012 and 2013, OPG explored external opportunities for waste reprocessing at the WWMF. Pilot projects were completed to confirm opportunities for volume reduction of large metal components such as heat exchangers and to verify contents of stored non-processible waste, and confirm opportunities for further reprocessing. In 2017, OPG continued to send some waste to a licensed external provider for processing.

In 2013, OPG implemented a "likely clean" program at the WWMF. The "likely clean" program allows for the separation at the source of waste that is likely not radioactive (i.e., "clean"), so as to minimize the generation of LLW at this facility. During routine compliance inspections in 2017, CNSC staff observed and confirmed OPG's implementation of this program.

In 2014, OPG began a waste sorting pilot project at the WWMF. Non-processible LLSB wastes, both stored and new, were opened and sorted into various streams. Incinerable and compactable materials were segregated for further processing at the WWMF. Metals were segregated then either surveyed, decontaminated and free released, or if not able to be decontaminated, stored for future processing or interim storage. Since 2015, LLW was sorted resulting in further volume reduction opportunities through incineration and compaction, as well as being able to free release metals. This program continued in 2017.

Waste management practices

Through regulatory oversight, CNSC staff determined that OPG's waste management practices continued to meet the applicable regulatory requirements. OPG continued to employ effective radioactive and hazardous waste management practices at the WWMF during 2017. OPG uses waste management procedures to ensure that waste generated at the facility is separated properly, as noted by CNSC staff during inspections in 2017.

As of October 31, 2017 OPG had fully implemented the requirements of CSA Group standards N292.0-14, *General principles for the management of radioactive waste and irradiated fuel*, N292.2-13, *Interim dry storage of irradiated fuel* and N292.3-14, *Management of low and intermediate-level radioactive waste* for the WWMF.

Decommissioning plans

The preliminary decommissioning plan for the WWMF met or exceeded the applicable regulatory requirements in 2017.

In 2017, OPG revised the PDPs for all of its facilities for the period up to 2022. An immediate decommissioning strategy was selected for the decommissioning of the WWMF, once all low- and intermediate-level radioactive waste and used fuel is transferred to an appropriate repository. The Commission accepted the PDP and associated financial guarantee. The associated financial guarantee is discussed in section 2.15.

3.5.12 Security

CNSC staff concluded that the security SCA at the WWMF met performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, a downgrade from the previous year.

Facilities and equipment

CNSC staff determined that OPG continued to meet the applicable regulatory requirements for facilities and equipment at the WWMF. OPG continued to sustain its security equipment through life cycle management at the WWMF. No significant equipment failures were reported in 2017. Additionally, OPG has processes in place to adequately prevent security events at the WWMF.

In 2017, OPG replaced screening equipment at the UFDSF. OPG added new security assessment devices to the Protected Area (PA) boundary and upgraded parts of the PA barrier for additional delay, which has improved security measures.

On February 8, 2017, OPG reported an event that occurred at the WWMF to CNSC staff regarding security. OPG stated that there were no environmental, health, safety or security implications for the facility or personnel as a result of this event with the implementation of the impairment plan. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

Response arrangements

CNSC staff determined that OPG continued to meet the applicable regulatory requirements for response arrangements at the WWMF.

In 2017, OPG updated security operating procedures for the WWMF and ensured that its contingency plans meet the Design Basis Threat (DBT) as approved by CNSC. The response force is provided by Bruce Power.

CNSC staff had no significant observations to report in this specific area at the WWMF in 2017.

Security practices

CNSC staff determined that OPG continued to implement security practices at the WWMF that met the applicable regulatory requirements.

OPG has procedures in place to guide security personnel in all areas, although there are signs of non-adherence to these procedures.

CNSC staff had no significant observations to report in this specific area at the WWMF in 2017.

Drills and exercises

CNSC staff determined that OPG's exercise and drill program continued to meet the applicable regulatory requirements for the WWMF.

In accordance with the *Nuclear Security Regulations*, OPG is required to conduct a security drill once every 30 days at the WWMF to test the readiness of one or more of its physical protection systems and the readiness of its security personnel. These drill requirements apply to the Bruce Power NRF that provides the armed response component of the WWMF security program.

CNSC staff had no significant observations to report in this specific area at the WWMF in 2017.

3.5.13 Safeguards and non-proliferation

CNSC staff concluded that OPG met the performance objectives and applicable regulatory requirements for the safeguards and non-proliferation SCA at the WWMF. As a result, the WWMF received a "satisfactory" rating, unchanged from the previous year.

Nuclear material accountancy and control

CNSC staff confirmed that OPG's accountancy and control of nuclear material at the WWMF continued to meet the applicable regulatory requirements in 2017.

Access and assistance to the IAEA

CNSC staff confirmed that the OPG continued to meet the applicable regulatory requirements for access and assistance at the WWMF. OPG granted adequate access and assistance to the IAEA for safeguard activities, including inspections, the maintenance of equipment, and routine application of seals at the WWMF, pursuant to the Canada/IAEA safeguards agreements and the facility's licence conditions.

In 2017, the IAEA performed one physical inventory verification, one design information verification, seven unannounced inspections, and one complementary access at the WWMF to verify the nuclear material inventory and assure the absence of undeclared nuclear material and activities. OPG provided access and support to these inspections and the CNSC was informed by the IAEA that the results of these inspections were satisfactory.

Operational and design information

CNSC staff confirmed that OPG continued to meet the applicable regulatory requirements for operational and design information for the WWMF.

OPG submitted its annual operational program with quarterly updates for the WWMF to the CNSC on schedule. OPG submitted the annual update to the information pursuant to the IAEA Additional Protocol to the CNSC on schedule. The information provided met CNSC's submission requirements.

Safeguards equipment, containment and surveillance

CNSC staff confirmed that OPG met the applicable regulatory requirements for safeguards equipment, containment and surveillance for the WWMF. CNSC staff confirmed that OPG supported IAEA equipment operation and maintenance activities at the WWMF, including routine maintenance of surveillance equipment, to ensure the effective implementation of safeguards measures at the facility.

3.5.14 Packaging and transport

CNSC staff concluded that the packaging and transport SCA at the WWMF met performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, unchanged from the previous year.

Packaging design and maintenance, packaging and transport, and registration for use

CNSC staff determined that OPG has a packaging and transport program at the WWMF that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the *Transportation of Dangerous Goods Regulations*.

For on-site movement of nuclear substances, OPG ensures an equivalent level of safety as is required for off-site transportation to protect the health and safety of workers and the general public, and the environment.

CNSC staff had no significant observations at the WWMF to report in this specific area for 2017.

3.5.15 Other Matters of Regulatory Interest

Public Information program

OPG continued regular communications on the WWMF to engage and inform residents and stakeholders on the facility.

CNSC staff determined that OPG met the applicable regulatory requirements related to public information and disclosure and provided sufficient information on the status of its facility through a variety of communication activities, including: information sessions, facility tours, participation in community events, newsletters, ongoing website updates and the use of social media.

Indigenous Relations

CNSC staff observed that OPG has a dedicated Indigenous engagement program. In 2017 OPG continued its engagement with the Indigenous communities around the WWMF regarding its operations, as well as updating them on the proposed DGR project. OPG held quarterly meetings separately with the Saugeen Ojibway Nation, the Métis Nation of Ontario (Georgian Bat Traditional Territory Consultation Committee, Region 7) and the Historic Saugeen Métis. A key event in 2017 was the April relicensing of the WWMF (which was approved) and featured the participation of the above communities as interveners. Tours were conducted with Indigenous communities of the WWMF and OPG funded community events, summer camps and cultural activations through its Corporate Citizenship program.

3.6 Gentilly-2

The safety assessment for each SCA is facility-specific. General information relevant to the SCAs is provided in section 2. The CNSC regulatory documents and CSA Group standards that were identified as regulatory requirements for Gentilly-2, as of December 2017, are listed in Appendix E:.

Safety assessment

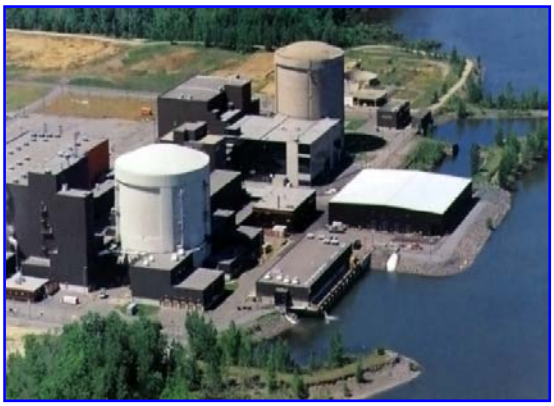
The CNSC staff safety assessment of the Gentilly-2 Facilities for 2017 resulted in the performance ratings as shown in table 26. Based on the observations and assessments of the SCAs, CNSC staff concluded that the Gentilly-2 Facilities were maintained safely. The overall rating was "satisfactory", unchanged from the last year that Gentilly-2 was rated (2015).

Table 26: Performance ratings for Gentilly-2, 2017

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

Legend: FS – Fully Satisfactory SA – Satisfactory
BE – Below Expectations UA – Unacceptable

3.6.0 Introduction



Gentilly-2 is located on the south shore of the Saint Lawrence River in Bécancour, QC, about 15 kilometres east of Trois-Rivières. It is owned and operated by Hydro-Québec.

The CANDU reactor had a nominal capacity of 675 MWe (megawatts electrical). The Gentilly-2 reactor went into commercial operation in 1983, was shut down permanently on December 28, 2012 and was completely defueled by September 3, 2013. In 2015, Gentilly-2 transitioned to a safe storage state, meaning that its fuel stored was in the irradiated fuel bay (wet storage) or in CANSTOR storage units (dry storage).

Licensing

A Commission hearing was held on May 5, 2016 to hear Hydro-Québec's application for a decommissioning and waste management licence (CMD 16-H4 [22]). On June 22, 2016, the Commission announced its decision to issue a power reactor decommissioning licence to Hydro-Québec for the Gentilly-2 Facilities. The licence is valid from July 1, 2016 to June 30, 2026.

Revisions

The Gentilly-2 LCH has not been amended since the licence was issued in 2016.

Fisheries Act authorization

Hydro-Québec completed a *Fisheries Act* self-assessment before its licence renewal in 2016. CNSC staff reviewed the self-assessment and concluded that a *Fisheries Act* authorization would not be required at Gentilly-2.

Event initial reports

No event initial reports pertaining to Gentilly-2 were submitted to the Commission for the period January 1, 2017 to June 1, 2018.

Compliance Program

The annual CNSC effort on the compliance program is tabulated in Appendix G: for Gentilly-2. The inspections at Gentilly-2 that were considered in the safety assessments in this regulatory oversight report are tabulated in Appendix J:.

3.6.1 Management system

CNSC staff concluded that the management system at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Management system

CNSC staff determined that Hydro-Québec's management system at Gentilly-2 met the applicable regulatory requirements in 2017. Hydro-Québec completed the transition to the 2012

version of the CSA Group management system standard N286-12, *Management system requirements for nuclear facilities* in 2016.

Organization

CNSC staff determined that Hydro-Québec has an adequately defined organizational structure and roles and responsibilities at Gentilly-2.

In 2017, CNSC staff inspected records management at Gentilly-2 and identified a non-compliance of low safety significance regarding Hydro-Québec's Quality Management Manual. During this inspection, CNSC staff observed that Hydro-Québec's Quality Management Manual did not detail an interface between the Gentilly-2 Facilities at the site and records repository located in Montreal. In order to establish dispositions to systematically contact the personnel at the Gentilly-2 Facilities for any events impacting the preservation of records, there must be an interface with the semi-active records repository located in Montreal.

Hydro-Québec addressed CNSC staff's concern with Gentilly-2's revised management system manual, which takes into account the current staffing levels and organizational structure.

The organizational structure is now composed of two units: maintenance and technical support.

CNSC staff are satisfied with Hydro-Québec's restructure and will continue to monitor the organizational structure until Dry Safe Storage State is reached in 2020 (

Change management

CNSC staff determined that Hydro- Québec has an adequate change management program that complies with the applicable regulatory requirements. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Safety culture

Hydro-Québec issued a human performance procedure in 2015 to reinforce its expectations for staff behaviour to foster a healthy safety culture. See Human performance program below for additional details.

Configuration management

Hydro-Québec has maintained the configuration of its structures, systems and components (SSCs) in compliance with its configuration management program and regulatory requirements.

In 2017, Hydro-Québec submitted a new revision to the program specific to the control of the configuration of equipment. CNSC staff were satisfied with this revision.

Records management

CNSC staff determined that Hydro-Québec continued to maintain and implement a document control and records management system that met the applicable requirements.

As discussed above, in 2017, CNSC staff conducted an inspection to assess records management at the Gentilly-2 Facilities. CNSC staff concluded that Hydro-Québec met the regulatory requirements for records management, although there were minor non-compliances with Hydro-Québec's documentation. Specifically, some low significance findings were identified concerning the records management at the repository for semi-active records in Montreal. In 2018, CNSC staff will monitor implementation of Hydro-Québec's corrective action plan.

In 2017, Hydro-Québec submitted the plan for the completion of procedures for the retirement of systems from service. CNSC staff continued to monitor Hydro-Québec's records management plan as the facilities transition to the Dry Safe Storage State.

Management of contractors

CNSC staff confirmed that Hydro-Québec continued to meet the applicable regulatory requirements for management of contractors. There were no significant observations to report for this specific area at Gentily-2 in 2017.

Business continuity

CNSC staff concluded that Hydro-Québec met regulatory requirements for business continuity. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Problem identification and operating experience

CNSC staff determined that Hydro-Québec continued to meet the applicable regulatory requirements for problem identification and OPEX. There were no significant observations to report for this specific area at Gentily-2 in 2017.

Performance assessment, improvement and management review

CNSC staff confirmed that Hydro-Québec continued to meet the applicable regulatory requirements for performance assessment, improvement, and management. There were no significant observations to report for this specific area at Gentily-2 in 2017.

3.6.2 Human performance management

CNSC staff concluded that the human performance management SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Human performance program

CNSC staff determined that the Hydro-Québec human performance program met applicable requirements. As mentioned under the specific area Safety culture, Hydro-Québec issued a human performance procedure in 2015 to reinforce the staff behaviour expected to maintain good safety culture and continually reduce the frequency and severity of events. CNSC staff were satisfied with the plans proposed by Hydro-Québec and the actions taken to ensure that human performance remains adequate.

Personnel training

The implementation of Hydro-Québec's new training program, developed in 2014, continued throughout 2017. This program is adapted to the Gentilly-2 Facilities organizational structure and the site's safe storage state activities. As part of the transition to the new organizational structure, Hydro-Québec confirmed that the required training for the new Site Responsible position is being implemented.

Hydro-Québec submitted the training program for the Site Responsible position in 2017; CNSC staff found it to be acceptable.

UPDATE: In early 2018, CNSC staff conducted an on-site follow-up verification activity in order to verify various areas related to training for the Site Responsible position, the removal of the on-site fire brigade as well as for the senior health physicists.

In addition, in 2017, Hydro-Québec submitted in 2017 a gap analysis and transition plan for the implementation of REGDOC 2.2.2, *Personnel training*. CNSC staff reviewed the submission and concluded that the processes and procedures put in place meet the regulatory requirements for SAT-based training.

Overall, CNSC staff concluded that Hydro-Québec met the applicable regulatory requirements for Personnel Training.

Personnel certification

CNSC staff determined that Hydro Québec's personnel certification program at Gentilly-2 met the applicable regulatory requirements. Note that only the senior health physicist position at Gentily-2 is certified. CNSC staff reviewed the staffing reports for certified personnel, the applications for initial certification and renewal of certification, and confirmed that certified personnel at the Gentilly-2 Facilities possessed the knowledge and skills required to perform their duties safely and competently.

Initial certification examinations and requalification tests

Given that the initial certification examination and requalification testing programs for certified health physicists working at the Gentilly-2 Facilities are administered by CNSC staff, it is not required for Hydro-Québec to have an initial certification examination program or a requalification testing program.

Work organization and job design

Hydro-Québec's organization continued to evolve in 2017. Hydro-Québec modified and reduced staffing at the Gentilly-2 Facilities, on the basis of reduced risk and volume of work, by reworking procedures and staff capability as per a plan submitted to the CNSC.

Minimum shift complement

The minimum shift complement at Gentilly-2 met the applicable regulatory requirements.

In 2017, one violation of minimum shift complement was reported to the CNSC for a member of the industrial fire brigade, with no impact to safety. Since December 2017, CNSC staff approved the removal of the industrial fire brigade from the minimum staff complement at Gentilly-2, at which time an agreement was established between Hydro-Québec and the city of Bécancour for the Bécancour fire department to respond to fire alarms at the Gentilly-2 facilities. The minimum staff complement is now comprised of nuclear security officers who are present at all times and are responsible to ensure the safety and security of the facility. In addition, the Site Responsible Position is required to be on site during all maintenance activities which are typically conducted from Monday to Thursday.

Surveillance of the facilities outside of business hours is achieved through an annunciation, communication and recall system that automatically triggers alarms to the Site Responsible position that are on call.

In 2017, CNSC staff requested Hydro-Québec to continue to report activations of the recall system on a quarterly basis. CNSC staff have reviewed Hydro-Québec's submissions for 2017 and are satisfied with the details submitted. There have been no reported problems related to the operation of the automated system since its commissioning. CNSC staff are satisfied with the system. While CNSC staff requested that Hydro-Québec maintain records of the information related to the events that resulted in activation of the system, the transmission of these event reports to the CNSC is no longer required, as of 2018.

Fitness for duty

CNSC staff confirmed that Hydro-Québec continued to meet the applicable regulatory requirements for fitness for duty at the Gentilly-2 Facilities.

In late 2017, CNSC staff requested Hydro-Québec to submit an implementation plans for REGDOC 2.2.4 *Fitness for Duty, Volume I: Managing Worker Fatigue* and for REGDOC 2.2.4 *Fitness for Duty, Volume II: Managing Alcohol and Drug Use*.

UPDATE: Hydro-Québec submitted the implementation plans with supporting gap analyses in end of March, 2018. For *Fitness for Duty, Volume I: Managing Worker Fatigue*, the only applicable workers are nuclear security workers and for *Fitness for Duty, Volume II: Managing Alcohol and Drug Use*, the only applicable workers are nuclear security officers and certified health physicist. CNSC staff's review of the submission is currently underway.

3.6.3 Operating performance

CNSC staff concluded that the operating performance SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Conduct of licensed activities

CNSC staff concluded that Hydro-Québec met the applicable regulatory requirements for the conduct of licensed activities at Gentilly-2. Hydro-Québec continued to conduct its activities at Gentilly-2 in a safe and secure manner, with adequate regard for health, safety, security, radiation and environmental protection and international obligations.

In 2017, Hydro-Québec maintained the Gentilly-2 Facilities within the bounds of its operating policies and principles and operational safety requirements.

Procedures

CNSC staff confirmed that the Gentilly-2 Facilities procedures continued to meet the applicable regulatory requirements.

Hydro-Québec has a defined process in place to ensure that procedures are developed and changes are managed in a consistent manner to support the safe decommissioning of the facilities.

Reporting and trending

During the reporting year, all scheduled reports were submitted to the CNSC in a timely manner and were adequate. CNSC staff determined that reporting and trending at the Gentilly-2 Facilities met the applicable regulatory requirements and expectations in 2017.

Outage management performance

This specific area does not apply to Gentilly-2.

Safe operating envelope

CNSC staff determined that Gentilly-2 operated within the safe operating envelope (SOE) and met the applicable regulatory requirements. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Severe accident management and recovery

CNSC staff confirmed that Hydro-Québec's severe accident management and recovery programs continued to meet the applicable regulatory requirements in 2017. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Accident management and recovery

CNSC staff confirmed that Hydro-Québec's accident management and recovery programs continued to meet the applicable regulatory requirements in 2017. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

3.6.4 Safety analysis

CNSC staff concluded that the safety analysis SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Deterministic safety analysis

The Deterministic Safety Analysis predicts adequate safety margins, and met the applicable regulatory requirements at Hydro-Québec.

Hydro-Québec is continuing its decommissioning activities to achieve the dry Safe Storage State (SSS_{dry}) and expects to reach this state by the end of 2020. For the period between December 2019 and the dry safe storage state declaration, no major changes to the facility are expected. An update of the Hydro-Québec safety report is due for 2019, as per REGDOC 3.1.1, *Reporting Requirements for Nuclear Power Plants*. Currently Hydro-Québec is discussing with CNSC staff the intent to formally request an extension to submit the updated revision of the Safety Report post reaching the dry safe storage state.

Probabilistic safety assessment

This specific area does not apply to Gentilly-2.

Criticality safety

This specific area does not apply to Gentilly-2.

Severe accident analysis

This specific area does not apply to Gentilly-2.

Management of safety issues (including R&D programs)

This specific area does not apply to Gentilly-2.

3.6.5 Physical design

CNSC staff concluded that the physical design SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Design governance

Pressure boundary design

On the basis of compliance verification activities, CNSC staff are satisfied with the implementation of the pressure boundary program at Gentilly-2. In 2017, Hydro-Québec

revised their pressure boundary program to better reflect the facilities current state. CNSC staff have reviewed the revised program and are satisfied with the update.

Site characterization

CNSC staff confirmed that site characterization at Gentilly-2 continued to meet the applicable regulatory requirements in 2017. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Facility design

CNSC staff confirmed that facility design for Gentilly-2 continued to meet the applicable regulatory requirements in 2017. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Structure design

CNSC staff concluded that the structure design Specific Area continued to meet the applicable requirements. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

System design

CNSC staff concluded that system design for Gentilly-2 met the applicable regulatory requirements in 2017.

Electrical power system

Hydro-Québec has maintained the electrical power and instrumentation and control systems at Gentilly-2 required for the safe storage state with fuel stored in the spent fuel pools. Modifications were implemented to ensure the reliability of these systems.

Hydro-Québec does not plan to make other modifications to the electrical systems prior to reaching the dry safe storage state with all spent fuel stored in CANSTOR modules.

Instrumentation and Control

Hydro-Québec submitted a project summary for the installation of a new parameter monitoring system for Gentilly-2, which resulted in the replacement of two control computers. This replacement was conducted in 2016. CNSC staff were satisfied with the system and deemed it acceptable with respect to the present state of the Gentilly-2 facilities. CNSC staff will maintain regulatory oversight of this system up to the Dormancy State for Gentilly-2.

Component design

CNSC staff confirmed that component design for Gentilly-2 continued to meet the applicable regulatory requirements in 2017. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

3.6.6 Fitness for service

CNSC staff concluded that the fitness for service SCA at Gentily-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a “satisfactory” rating.

Equipment fitness for service/equipment performance

CNSC staff confirmed that overall equipment fitness for service and performance at Gentilly-2 continued to meet the applicable regulatory requirements in 2017. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Maintenance

CNSC staff confirmed that Hydro-Québec continued to meet performance objectives and applicable regulatory requirements for maintenance. CNSC staff are satisfied with Hydro-Québec's performance in this specific area.

Structural integrity

CNSC staff confirmed that structural integrity at Gentilly-2 continued to meet the applicable regulatory requirements in 2017. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Aging management

CNSC staff concluded that Hydro-Québec's integrated aging management program continued to meet the applicable regulatory requirements at Gentilly-2. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Chemistry Control

CNSC staff confirmed that Hydro-Québec's chemistry control continued to meet the applicable regulatory requirements at Gentilly-2. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Periodic inspections and testing

CNSC staff determined that Hydro-Québec's periodic inspection (and aging management) programs had been revised to reflect the current state at Gentilly-2 and that the changes to these programs were in effect according to CSA Group standards N291-08, *Requirements for Safety-related Structures for CANDU Nuclear Power Plants* and N286-12, *Management system requirements for nuclear facilities* and CNSC regulatory documents REGDOC 2.6.3, *Aging Management* and REGDOC 2.6.2, *Maintenance Programs for Nuclear Power Plants*. CNSC staff were satisfied with the modifications made to these programs, commensurate with the operational and radiological risk levels.

3.6.7 Radiation protection

CNSC staff concluded that the radiation protection SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Application of ALARA

In 2017, Hydro-Québec submitted their ALARA plan regarding the final phase (phase III,) of draining resins from the storage tank. The two first campaigns for the transfer of resins, in summer/fall 2013 and 2014, were carried out successfully and will serve as operational experience for the third campaign. CNSC staff were satisfied of the plan and conclude that Hydro-Québec met regulatory requirements in 2017.

Worker dose control

CNSC staff determined that Hydro-Québec continued to comply with the regulatory requirements to measure and record doses received by workers at Gentilly-2.

Routine compliance verification activities conducted in 2017 confirmed that performance in the area of worker dose control at Gentilly-2 was effective. Radiation doses to worker were below the regulatory dose limits and action levels established in the Hydro-Québec radiation protection program. The data for doses to workers at Gentilly-2 in 2017 is provided in section 2.7. The maximum dose received by a worker in 2017 was 1.6 mSv, which is approximately 3.2% of the regulatory dose limit.

Radiation protection program performance

CNSC staff confirmed that Hydro-Québec continued to implement a radiation protection program at Gentilly-2 that met the requirements of the Radiation Protection Regulations. CNSC staff are satisfied with Hydro-Québec's performance in this specific area.

Radiological hazard control

CNSC staff determined that Hydro-Québec continued to implement radiological hazard controls that met the applicable regulatory requirements. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Estimated dose to the public

CNSC staff determined that Hydro-Québec continued to ensure the protection of members of the general public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to members of the general public attributed to Gentilly-2 activities was 0.007 mSv, well below the annual dose limit of 1 mSv (see section 2.7).

The Gentilly-2 value for 2017 was higher than the Gentilly-2 values of previous years for two reasons. First, Hydro-Québec changed its approach to the calculations in 2017, which made it possible to consider the actual radioactivity measurements of aquatic fauna. This resulted in a change to the identification of the most exposed member of a critical group (a fisherman fishing near the discharge) and it was also associated with a change in the DRLs. Second, variations in radionuclide releases and their dispersion into the environment as a result of operations leading to safe storage can also explain the higher estimated dose for 2017.

3.6.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Performance

CNSC staff determined that Hydro-Québec met the applicable requirements at Gentilly-2 in regards to conventional health and safety performance.

According to the data submitted by Hydro-Québec, the number of lost days rose from 0 in 2016 to 14 in 2017, while the number of medically treated injuries and of lost-time injuries increased from 0 in 2016 to 2 in 2017, for 119,385 person hours worked.

Practices

At Gentilly-2, Hydro-Québec`s Conventional Health and Safety practices met the applicable regulatory requirements. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Awareness

CNSC staff concluded that Hydro-Québec met or exceeded the applicable regulatory requirements for awareness in 2017 at Gentily-2. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

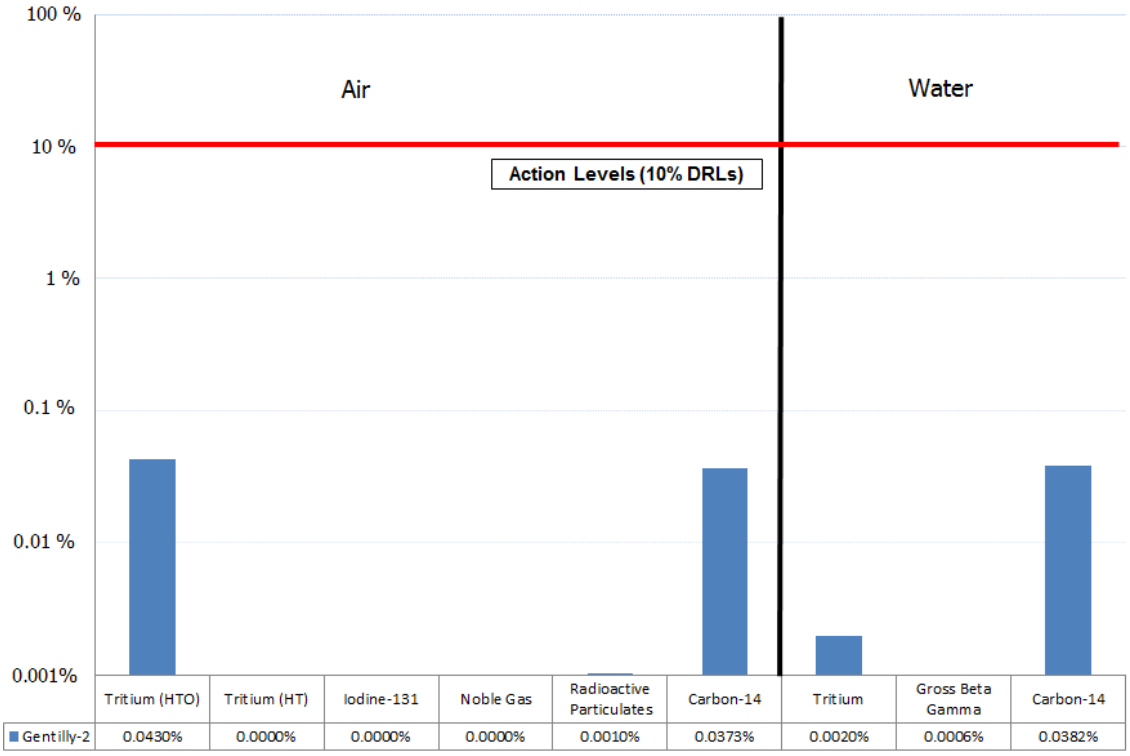
3.6.9 Environmental protection

CNSC staff concluded that the environmental protection SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Effluent and emissions control (releases)

CNSC staff reviewed the reported airborne and waterborne radiological releases to the environment from the Gentilly-2 station and confirmed that the releases remained below regulatory limits and action levels in 2017. Figure 23 presents the airborne and waterborne radiological releases from Gentilly-2 Facilities in 2017, as percentages of the applicable DRLs. The actual values of releases and DRLs are provided in Appendix I:.

Figure 23: Effluent and emissions at Gentilly-2 as percentages of DRLs



Environmental management system

Hydro-Québec has established and implemented an environmental management program to assess environmental risks associated with its decommissioning activities and to ensure these activities are conducted in a way that prevents or mitigates adverse environmental effects. The program meets the applicable regulatory requirements.

The environmental management system at the Gentilly-2 Facilities is detailed in their environmental protection program document which was updated in 2017 by Hydro-Québec. According to Hydro-Québec, this update was the final action to complete in order to be fully compliant with REGDOC-2.9.1, *Environmental Protection Policies, Programs, and Procedure*s. CNSC staff are currently undergoing this review in order to ensure the full implementation of this REGDOC is complete and acceptable.

Assessment and monitoring

CNSC staff reviewed and assessed the environmental monitoring data and concluded that the general public and the environment in the vicinity of Gentilly-2 were protected. Hydro-Québec met the applicable regulatory requirements for 2017.

In 2014, Hydro-Québec removed the surveillance of thermal discharges to fish in the environmental monitoring program. This is explained due to the achievement of wet safe storage with all spent fuel stored in pools, and the decrease of intake water, and decrease in the thermal discharge.

Hydro-Québec's update of its environmental protection program document in 2017 also addressed other changes to environmental monitoring activities that reflect the current state of the Gentilly-2 Facilities.

Protection of the public

There were no hazardous substances released from Gentilly-2 that exceeded applicable regulatory limits.

Dose to the public is discussed in Section 3.6.7.

Environmental risk assessment

CNSC staff determined that Hydro-Québec has continued to implement and maintain an effective environmental risk assessment and management program at Gentilly-2 Facilities in accordance with the applicable regulatory requirements.

With the shutdown of the reactor, the quantity of water pumped at the intake decreased significantly and so was the predicted impingement and entrainment of aquatic biota. Therefore, very little heat was expected in the discharge channel, as well as thermal impacts to aquatic biota were predicted to be minimal. Similarly, impacts on wetland habitats and terrestrial habitats were predicted to be minimal with the shutdown of the reactor. Hence, CNSC staff concluded that the environmental risk following decommissioning would be minimal and expect Hydro-Québec to confirm this conclusion through continued environmental monitoring.

3.6.10 Emergency management and fire protection

CNSC staff concluded that the emergency management and fire protection SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

The achievement of the wet safe storage state and the progression towards the dry safe storage state resulted in a major decrease in radiological risks associated with the site.

As a result of the reduction in risk, in 2016, the province of Québec abolished the external (offsite) nuclear emergency response plan.

Conventional emergency preparedness and response

Hazards at the Gentilly-2 Facilities have been greatly reduced, consequently, eliminating the need for a full time Industrial Fire Brigade with HAZMAT capability on site. A Memorandum of Understanding (MOU) was revised with the Municipality of Bécancour in fall 2017 to provide Emergency Response Services. Experienced Gentilly-2 operations staff remain employed and available on-call 24/7 to assist and respond to conventional hazards if necessary.

CNSC staff concluded that Gentilly-2 conventional emergency preparedness and response met the applicable regulatory requirements.

Nuclear emergency preparedness and response

CNSC staff concluded that Hydro-Québec continued to maintain and support an emergency preparedness and response capability in 2017 that met all applicable regulatory requirements, through the MOU signed with the Municipality of Bécancour in fall 2017.

CNSC staff are satisfied with Hydro-Québec's relocation of the On-site Emergency Operations Center in 2017 and their revised emergency organization and response capability. Hydro-Québec revised its on-site nuclear emergency plan for Gentilly-2 in December 2017.

Fire emergency preparedness and response

CNSC staff confirmed that Hydro-Québec continued to maintain a fire response capability and fire protection program that met the applicable regulatory requirements.

CNSC staff accepted Hydro-Québec's request to remove the Industrial Fire Brigade as of December 22, 2017 once Hydro-Québec adjusted the milestones to integrate CNSC's expectations. The fire emergency response is now provided by surrounding municipalities. As stated previously, a Memorandum of Understanding between Hydro-Québec and the municipalities was signed to support emergency response for the site.

CNSC staff accepted with Hydro-Québec's request to cancel the Industrial Fire Brigade audit, initially scheduled for December 2017, as it is no longer pertinent to the site's current status. Nonetheless, Hydro-Québec will complete an audit on the Fire Protection as planned before end of 2019.

CNSC staff have received the changes in site response to emergencies and concluded that Hydro-Québec continues to ensure adequate emergency response services to the site.

3.6.11 Waste management

CNSC staff concluded that the waste management SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Waste characterization

CNSC staff confirmed that Hydro-Québec's waste characterization continued to meet the applicable regulatory requirements.

Hydro-Québec continued to employ effective programs for the characterization of radioactive and hazardous wastes during 2017.

Waste minimization

CNSC staff determined that Hydro-Québec's waste management programs for minimizing radioactive waste met the applicable regulatory requirements at Gentilly-2. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Waste management practices

CNSC staff determined that Hydro-Québec's waste management practices met the applicable regulatory requirements.

CNSC staff are satisfied with the information provided by Hydro-Québec for the implementation plan of CSA Group standard N292.2-13, *Interim dry storage of irradiated fuel* with a committed completion deadline of June 2018.

Decommissioning plans

The preliminary decommissioning plan for Gentilly-2 met the applicable regulatory requirements in 2017. The associated financial guarantee is discussed in section 3.6.15.

3.6.12 Security

CNSC staff concluded that the security SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a rating of "satisfactory" rating.

The Gentilly-2 Facilities remains a high security site as defined by the *Nuclear Security Regulations*. Hydro-Québec is therefore required to meet the requirements of the regulations until decommissioning is completed, at which time CNSC will assess the licensee's submission for change in security at the site. Hydro-Québec has qualified Nuclear Security Officers and a satisfactory security program.

Facilities and equipment

CNSC staff determined that Hydro- Québec met the applicable regulatory requirements for facilities and equipment. Hydro-Québec provided adequate infrastructure, physical delay barriers, access control and identification, procedures, systems, devices and security personnel to meet its Security Program requirements. In addition, Hydro-Québec has a corrective maintenance program in place for critical security systems and devices at the Gentilly-2 site. Gentilly-2 Protected Areas are equipped with intrusion detection systems.

Gentilly-2 waste facilities utilize CANSTOR units, which are a Canadian design, to store (used) spent fuel. The spent fuel is stored in the irradiated fuel bay in the main station inside the Protected Area. In combination with physical barriers in place along the Protected Area perimeters, CNSC confirm that there is sufficient delay time for response forces to make an effective intervention in the event of an attempt of theft or sabotage of nuclear material at these locations.

CNSC staff conducted a field inspection in 2017 , and confirmed the effectiveness of the security facilities and equipment at the Gentilly-2 Facilities.

Hydro-Québec resolved the areas for improvements as identified by CNSC staff, in a timely manner.

One outstanding area, related to confirming the adequacy of the marine barrier, was resolved in spring of 2018.

Cyber Security

Hydro-Québec maintains a cyber security program at the Gentilly-2 Facilities. During 2017, Hydro-Québec continued to implement CSA standard N290.7, *Cyber Security*. There were no cyber security events reported in 2017. CNSC staff concluded that the program complied with applicable regulatory requirements.

UPDATE: In June 2018, CNSC received Hydro-Québec's final submission on the completion of the implementation of CSA N290.7.

Response arrangements

CNSC staff determined that Hydro-Québec met the applicable regulatory requirements for response arrangements at Gentilly-2.

Hydro-Québec engages trained and suitably equipped Nuclear Security Officers for its facility. In addition, Hydro-Québec established cooperative response arrangements with the Sûreté du Québec through a written Memorandum of Understanding for cases should additional response force services be needed. The radioactive waste concrete storage containers are significantly robust with adequate delay to allow an immediate security response and assistance from off-site response to prevent sabotage and theft. Gentilly-2 response arrangements exceed requirements as nuclear security officers are trained to intervene, equipped with primary and secondary weapons, and are authorized by the Province of Québec as peace officers for the Gentilly-2 facility. Off-site response consists of external police tactical response officers from the Sûreté du Québec.

Security practices

CNSC staff determined that Hydro-Québec met the applicable regulatory requirements for response arrangements at Gentilly-2. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Drills and exercises

CNSC staff determined that Hydro-Québec's exercise and drill program met the applicable regulatory requirements.

In accordance with the *Nuclear Security Regulations*, Gentilly-2 is required to conduct a security drill once every 30 days to test the readiness of one or more of its physical protection systems and the readiness of its security personnel.

CNSC staff found that there were no safety-significant issues in this specific area.

3.6.13 Safeguards and non-proliferation

CNSC staff concluded that the Safeguards and Non-proliferation SCA at Gentilly-2 met performance objectives and all applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

Nuclear material accountancy and control

CNSC staff concluded that Hydro-Québec's accountancy and control of nuclear material at Gentilly-2 complied with the applicable regulatory requirements in 2017. CNSC staff had no significant observations at Gentilly-2 to report in this specific area for 2017.

Access and assistance to the IAEA

CNSC staff concluded that the Hydro-Québec met the applicable regulatory requirements for access and assistance to the Atomic Energy Agency (IAEA). Hydro-Québec granted adequate access and assistance to the International IAEA for safeguard activities, including the maintenance of equipment, and routine application of seals at Gentilly-2.

In 2017, the IAEA performed three unannounced inspections at Gentilly-2. The IAEA did not perform a physical inventory verification at Gentilly-2 in 2017.

Operational and design information

CNSC staff confirmed that Hydro-Québec met the applicable regulatory requirements for operational and design information for Gentilly-2.

Hydro-Québec submitted to the CNSC its annual operational program with quarterly updates for Gentilly-2, as well as the annual update to the information pursuant to the IAEA Additional Protocol in a timely manner. The information provided met CNSC's submission requirements.

Safeguards equipment, containment and surveillance

CNSC staff confirmed that Hydro-Québec met the applicable regulatory requirements for safeguards equipment, containment and surveillance. Hydro-Québec supported IAEA equipment operation and maintenance activities at Gentilly-2, including maintenance and installation of surveillance equipment, to ensure the effective implementation of safeguards measures at the facilities.

3.6.14 Packaging and transport

CNSC staff concluded that the packaging and transport SCA at Gentilly-2 met performance objectives and applicable regulatory requirements. As a result, the facilities received a "satisfactory" rating.

The transport of nuclear substances to and from the facility is conducted in a safe manner.

For on-site movement of nuclear substances, Hydro-Québec ensures an equivalent level of safety as is required for off-site transportation to protect the health and safety of workers and the general public, and the environment.

Packaging design and maintenance, packaging and transport, and registration for use

CNSC staff determined that Hydro-Québec has a packaging and transport program at Gentilly-2 that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the *Transportation of Dangerous Goods Regulations*.

There were no packaging and transport events reported in 2017.

3.6.15 Other Matters of Regulatory Interest

Public Information Program

As stated in the Nuclear Power Reactor Decommissioning Licence for Gentilly-2, in licence condition G.6, the Commission recommended that Hydro-Québec submit a report which summarizes all events and developments occurred at the Gentilly-2 Facilities annually. In 2017, CNSC staff completed the review of the 2016 report and concluded that Hydro-Québec meets all regulatory requirements related to the public information program.

UPDATE: In May 2018, Hydro-Québec submitted the 2017 report. CNSC staff are currently reviewing this submission.

Indigenous Relations

Hydro-Québec's Indigenous engagement program is included in its public information program. As part of that program, Hydro-Québec submits a paper copy of its environmental monitoring report for Gentilly-2 to the Grand Conseil de la Nation Waban-Aki, the Conseil des Abénakis d'Odanak and the Conseil des Abénakis de Wôlinak on an annual basis.

Financial Guarantees

On August 25, 2017, the Commission accepted Hydro-Québec's total Financial Guarantee for the future decommissioning of the Gentilly-2 Facilities (CMD 17-H107 [23]). As of that date, the value of the financial guarantee was $835 M, which exceeded the required value of $808 M.

Summary and conclusions

The CNSC conducted numerous activities related to licensing and compliance in 2017. Licensing activities included licence renewals for NPPs and WMFs. Licensees were conducting PSRs to support long-term operation and implementing the results. CNSC staff also conducted numerous compliance activities in 2017, including inspections, desktop reviews, and surveillance and monitoring. CNSC followed up on these activities as necessary and continue to monitor licensee corrective actions that were not complete at the end of 2017.

The licensing and compliance activities were conducted in the context of robust regulatory requirements. The requirements include CNSC REGDOCs and CSA Group standards, which continued to evolve in 2017 as new documents and new versions were published. NPP and WMF licensees were in the process of implementing various new requirements in 2017, and CNSC staff were satisfied with the overall progress.

CNSC staff concluded that the NPPs and WMFs discussed in this report operated safely in 2017. This conclusion was based on general observations as well as detailed staff assessments for each facility in the context of the 14 CNSC SCAs.

The general observations include the following:

- No events above Level 0 on the International Nuclear and Radiological Event Scale were reported to the International Atomic Energy Agency. For all events, licensees followed approved procedure and took appropriate corrective action.
- 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 general public were well below the regulatory limits.
- Radiation doses to workers at the NPPs and WMFs were below the regulatory limits. The annual average effective radiation dose to workers at NPPs and WMFs remained low in 2017. The small increase (3% as compared to 2016) was primarily attributed to refurbishment activity at the DNGS and was not considered significant.
- The frequency and severity of non-radiological injuries to workers were very 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.

The detailed assessments of each SCA in this regulatory oversight report were based on the systematic consideration of findings from inspections, desktop reviews, surveillance and monitoring and other compliance verification activities against relevant requirements, expectations and performance objectives. The ratings that summarize the results of those assessments are provided in tables 27 and 28. All NPPs and WMFs in Canada received SCA ratings and overall ratings of either fully satisfactory or satisfactory in 2017.

Table 27: Canadian NPP safety performance ratings for 2017

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

Table 28: Canadian WMFs safety performance ratings for 2017

Safety and control area	DWMF	PWMF	WWMF
Management system	SA	SA	SA
Human performance management	SA	SA	SA
Operating performance	FS	FS	FS
Safety analysis	FS	FS	FS
Physical design	SA	SA	SA
Fitness for service	SA	SA	SA
Radiation protection	SA	SA	SA
Conventional health and safety	FS	FS	FS
Environmental protection	SA	SA	SA
Emergency management and fire protection	SA	SA	SA
Waste management	SA	SA	SA
Security	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA
Packaging and transport	SA	SA	SA
Overall rating	SA	SA	SA

Legend: FS – Fully Satisfactory SA – Satisfactory
BE – Below Expectations UA - Unacceptable

References

[1] CMD 17-M15 – Regulatory Oversight Report for Canadian Nuclear Power Plants: 2016

[2] CMD 18-M30 – *Progress Update for CNL's Prototype Waste Facilities, Whiteshell Laboratories and the Port Hope Area Initiative*

[3] Canadian Nuclear Safety Commission (CNSC), INFO-0795, *Licensing Basis Objective and Definition*

[4] CMD 17-M64 – *Update to Commission on the Pickering Whole Site PSA*

[5] CMD 17-M15.A – *Supplementary Submission from CNSC Staff on the Regulatory Oversight Report for Canadian Nuclear Power Plants: 2016*

[6] CMD 18-H4 – *Submission from CNSC Staff on Application by Bruce Power for Renewal*

[7] CMD 17-M14 – *CNSC Staff Assessment of Industry's Disposition of Issues Raised during Bruce and Darlington Licensing Hearings (2015)*

[8] ISO 14001:2015, Environmental management systems - Requirements with guidance for use

[9] CMD 18-M21 – Update on Emergency Management in Ontario and the Provincial Nuclear Emergency Response Plan (PNERP)

[10] CMD 15-H8 –Licence renewal – Ontario Power Generation Inc. - Darlington Nuclear Generating Station

[11] CMD 12-H14 –Licence renewal – Ontario Power Generation Inc. - Darlington Waste Management Facility Licence Renewal

[12] CMD 17-M11 - *EIR: Darlington Nuclear Generating Station - Contaminated Motors Shipped to Unlicensed Vendor*

[13] CMD 18-M14 - EIR: *Darlington Refurbishment -Retube Waste Processing Building - Internal Contamination Event*

[14] CMD 18-H6 – Licence Renewal - Ontario Power Generation Inc. - Pickering Nuclear Generating Station Ontario Power Generation Inc. - Commission Public Hearing

[15] CMD 17-H109 – *Ontario Power Generation - Request for an Amendment to the Power Reactor Operating Licences for Darlington and Pickering Nuclear Generating Stations*

[16] CMD 17-H5 – Licence Renewal - Ontario Power Generation Inc. - Pickering Waste Management facility

[17] CMD 17-H2 – *Licence Renewal - New Brunswick Power Corporation - Point Lepreau Nuclear Generating Station*

[18] CMD 17-M19 – *Status Report on Power Reactors*

[19] CMD 17-M52 – *EIR: Bruce Power - Failure of the primary heat transport pump seals at the Bruce A unit 3 Nuclear Generating Station*

[20] CMD 18-M13 – *EIR: Bruce Power - Failure of the primary heat transport pump seals at Bruce A Nuclear Generating Station Unit 4*

[21] CMD 17-H3 – Licence Renewal - Ontario Power Generation Inc. - Western Waste Management facility

[22] CMD 16-H4 – Licence Renewal - Hydro-Québec - Gentilly-2 Nuclear Facility and Radioactive Waste Management Facilities

[23] CMD 17-H107 – Hydro-Québec Financial Guarantee - Gentilly-2 Nuclear Facilities

[24] CMD 16-M34 – Risk-informed Assessment of CANDU Safety Issues

Appendix A: DEFINITIONS OF SAFETY AND CONTROL AREAS

The Canadian Nuclear Safety Commission (CNSC) evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas (SCAs).

These SCAs are further divided into 69 specific areas that define the key components of the SCA. The SCAs and specific areas used in the CNSC's safety performance evaluation for 2017 are given in table A.1.

Table A.1: The CNSC's SCAs and specific areas for assessing licensee safety performance

SCA	Specific area
Management system	• Management system • Organization • Change management • Safety culture • Configuration management • Records management • Management of contractors • Business continuity • Problem identification and operating experience • Performance assessment, improvement and management review
Human performance management	• Human performance program • Personnel training • Personnel certification • Initial certification examinations and requalification tests • Work organization and job design • Fitness for duty
Operating performance	• Conduct of licensed activity • Procedures • Reporting and trending • Outage management performance • Safe operating envelope • Severe accident management and recovery • Accident management and recovery
Safety analysis	• Deterministic safety analysis • Probabilistic safety analysis • Criticality safety • Severe accident analysis • Management of safety issues (including R&D programs)
Physical design	• Design governance • Site characterizations

SCA	Specific area
	• Facility design • Structure design • System design • Component design
Fitness for service	• Equipment fitness for service/equipment performance • Maintenance • Structural integrity • Aging management • Chemistry control • Periodic inspections and testing
Radiation protection	• Application of as low as reasonably achievable (ALARA) • Worker dose control • Radiation protection program performance • Radiological hazard control • Estimated dose to public
Conventional health and safety	• Performance • Practices • Awareness
Environmental protection	• Effluent and emissions control (releases) • Environmental management system • Assessment and monitoring • Protection of the public • Environmental risk assessment
Emergency management and fire protection	• Conventional emergency preparedness and response • Nuclear emergency preparedness and response • Fire emergency preparedness and response
Waste management	• Waste characterization • Waste minimization • Waste management practices • Decommissioning plans
Security	• Facilities and equipment • Response arrangements • Security practices • Drills and exercises
Safeguards and non-proliferation	• Nuclear material accountancy and control • Access and assistance to the International Atomic Energy Agency • Operational and design information • Safeguards equipment, containment and surveillance

SCA	Specific area
Packaging and transport	• Package design and maintenance • Packaging and transport • Registration for use
Other Matters of Regulatory Interest	• Public Information Program • Indigenous Relations • Nuclear Liability Insurance • Financial Guarantees

1. Management system

This SCA covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives and fosters a healthy safety culture.

Performance objective

There is an effective management system that addresses all requirements and related objectives, enables the licensee to continuously monitor and manage performance against those objectives, and maintain a healthy safety culture.

2. Human performance management

This SCA covers activities that enable effective human performance through the development and implementation of processes that ensure licensees have sufficient personnel in all relevant job areas (i.e., people with the necessary knowledge, skills, procedures and tools to carry out their duties safely).

Performance objective

Workers are sufficient in number, and human performance is managed so that all workers are capable, competent, qualified and supported to carry out their work tasks safely.

3. Operating performance

This SCA includes an overall review of licensed activities as well as the activities that enable effective performance.

Performance objective

Plant operation is safe and secure, with adequate regard for health, safety, security, radiation and environmental protection, and international obligations.

4. Safety analysis

This SCA involves maintaining the safety analyses that support the overall safety case for a facility. Safety analysis involves the systematic evaluation of potential hazards associated with the conduct of a proposed activity or facility. It considers the effectiveness of preventive measures as well as strategies for reducing the effects of such hazards. For nuclear power plants, safety analysis is primarily deterministic in demonstrating the effectiveness of implementing the fundamental safety functions of “control, cool and contain” through a defence-in-depth strategy. To identify challenges to physical barriers, risk contributors are considered using probabilistic

safety analysis. However, appropriate safety margins should be applied to address the uncertainties and limitations of probabilistic safety analysis.

Performance objective

Updates to safety analysis effectively incorporate feedback from various sources to continually demonstrate the ability to adequately control power, cool the fuel and contain or limit any releases from the plant.

5. Physical design

This SCA relates to activities affecting the ability of structures, systems and components to meet and maintain their design basis, taking into account new information as it arises, as well as changes in the external environment.

Performance objective

Structures, systems and components that are important to safety and security continue to meet their design basis.

6. Fitness for service

This SCA covers activities that affect the physical condition of structures, systems and components over time, including programs that ensure that all equipment is available to perform its intended design function.

Performance objective

Structures, systems and components – the performance of which may affect safety or security – remain available, reliable, effective and consistent with design, analysis and quality control measures.

7. Radiation protection

This SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure surface contamination levels and radiation doses received by individuals are monitored, controlled and maintained as low as reasonably achievable (ALARA).

Performance objective

The health and safety of persons are protected through the implementation of a radiation protection program that ensures that radiation doses are kept below regulatory dose limits and are optimized and maintained ALARA.

8. Conventional health and safety

This SCA covers the implementation of a program to manage workplace safety hazards and protect personnel and equipment.

Performance objective

Conventional health and safety work practices and conditions achieve a high degree of personnel safety.

9. Environmental protection

This SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.

Performance objective

The licensee takes all reasonable precautions to protect the environment and the health and safety of persons. This includes identifying, controlling and monitoring the release of nuclear and hazardous substances to the environment.

10. Emergency management and fire protection

This SCA covers emergency plans and preparedness programs for emergencies and non-routine conditions (including any results of participation in exercises).

Performance objective

Emergency preparedness measures and fire protection response capabilities are in place to prevent and mitigate effects of nuclear and hazardous substances releases, both onsite and offsite, and fire hazards, in order to protect workers, the public and the environment.

11. Waste management

This SCA covers a facility's internal waste-related programs up to the point where the waste is removed and transferred to a separate waste management facility. This SCA also covers planning for decommissioning.

Performance objective

A facility- and waste stream-specific waste management program is fully developed, implemented and audited to control and minimize the volume of nuclear waste generated by the licensed activity. Waste management is included as a key component of the licensee's corporate and safety culture. A decommissioning plan is maintained.

12. Security

This SCA covers programs required to implement and support security requirements stipulated in the regulations, in the licence, in orders, or in expectations for the facility or activity.

Performance objective

Loss, theft or sabotage of nuclear material or sabotage of the licensed facility is prevented.

13. Safeguards and non-proliferation

This SCA covers the programs and activities required of a licensee to successfully implement the obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements and the *Treaty on the Non-Proliferation of Nuclear Weapons*.

Performance objective

The licensee conforms with measures required to meet Canada's international safeguards obligations through:

- timely provision of accurate reports and information
- provision of access and assistance to IAEA inspectors for verification activities

- submission of annual operational information and accurate design information on plant structures, processes and procedures
- development and satisfactory implementation of appropriate facility safeguards procedures
- demonstration of capability, as confirmed through CNSC onsite evaluations, to meet all requirements in support of physical inventory verifications of nuclear material by the IAEA

14. Packaging and transport

This SCA covers the programs for the safe packaging and transport of nuclear substances to and from the licensed facility.

Performance objective

Packaging and transport of nuclear substances are conducted in a safe manner.

Glossary

For definitions of terms used in this document, see CNSC REGDOC-3.6, *Glossary of CNSC Terminology*, which includes terms and definitions used in the *Nuclear Safety and Control Act* (NSCA) and the regulations made under it, and in CNSC regulatory documents and other publications. REGDOC-3.6 is provided for reference and information.

The following definitions are also applicable to this document.

accident frequency

A measure of the number of fatalities and injuries (lost-time and medically treated) due to accidents for every 200,000 person-hours (approximately 100 person-years) worked.

accident severity rate

A measure of the total number of days lost due to a work-related injury for every 200,000 person-hours worked.

design life

The period specified for the safe operation of the facility, systems, structures and components.

industrial safety accident rate

A measure of the number of lost-time injuries for every 200,000 hours worked by nuclear power plant personnel.

pressure tubes

Tubes that pass through the calandria and contain 12 or 13 fuel bundles. Pressurized heavy water flows through the tubes, cooling the fuel.

safety report

A report, as described in REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, which provides descriptions of the structures, systems and components of a facility, including their design and operating conditions. This includes a final safety analysis report demonstrating the adequacy of the design of the nuclear facility.

unavailability target

Unavailability targets are compared against actual plant performance to identify deviations from expected performance. Availability is the fraction of time for which the system can be demonstrated to meet all of the minimum allowable performance standards. Licensees are expected to not exceed unavailability targets.

Appendix B: RATING DEFINITIONS AND METHODOLOGY

B.1 Definitions

Performance ratings used in this report are defined as follows:

Fully satisfactory (FS)

Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory, and compliance within the 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.

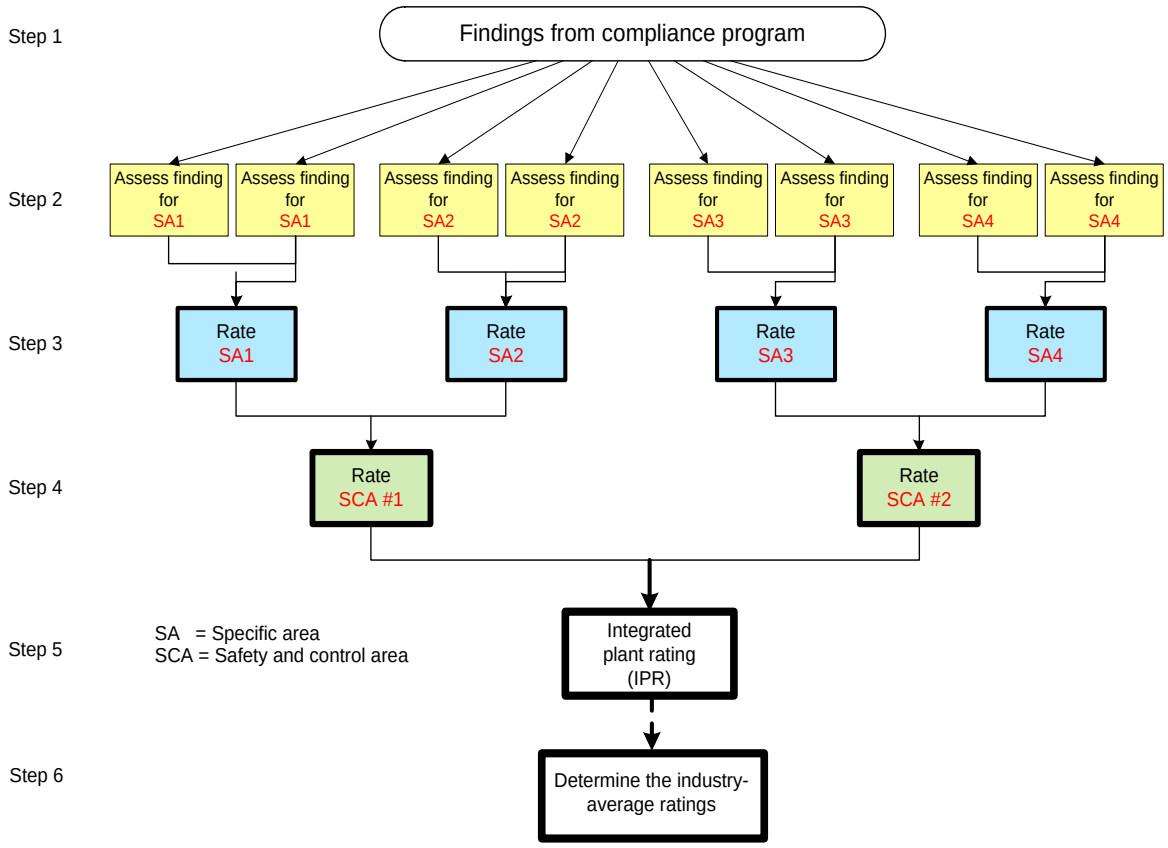
B.2 Rating methodology

The methodology for rating licensees relies on multiple sources of input and involves both the judgment of CNSC staff and a systematic computational roll-up of results. The methodology is based on ratings made at three distinct levels:

- specific areas
- SCAs
- overall rating

The methodology is illustrated in figure B.1. To simplify the illustration, only four specific areas and two SCAs are shown.

Figure B.1: Methodology for determining performance ratings
(needs to be edited in VISIO to remove reference to IPR and industry averages)



Steps shown, from top to bottom in figure B.1, are as follows.

Step 1: Identifying the findings

Findings are identified for each specific area using information from a variety of sources, including CNSC staff compliance verification inspections and desktop reviews. Each finding is assigned to the most applicable specific area under an SCA.

Step 2: Assessing the findings

CNSC staff evaluate the safety significance of each finding and assign it to the appropriate category: high, medium, low, negligible or compliant. The significance depends on the degree to which a specific area's effectiveness is negatively affected and is determined in the context of the verification criteria for the inspection or desktop review that generated the finding. The five categories of safety significance 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 insignificantly deviates from expectations or objectives of CNSC requirements and compliance expectations.

Compliant Performance meets applicable CNSC requirements and compliance expectations.

Step 3: Rating the specific area

CNSC staff consider the safety significance of all relevant findings and assess the overall effectiveness of the safety and control measures for the specific area. The assessment is in the context of the performance objective for the relevant SCA; the result is a performance rating of FS, SA, BE or UA for each specific area.

CNSC staff then convert the performance rating to a numerical value between one and ten, using the grid in table B.1; staff chooses an appropriate value, based on increments of 0.1, within the range shown in the second column. In determining the numerical value, CNSC staff consider information in addition to the relevant findings, such as observations from staff's surveillance and monitoring, the licensee's improvement initiatives and R&D effort relevant to the specific area.

Table B.1: Numerical Ranges for Rating Categories

Rating	SpA Values	SCA Range
UA	0.0 – 3.9	0 – 3.99
BE	4.0 – 5.9	4 – 5.99
SA	6.0 – 7.9	6 – 7.99
FS	8.0 – 10.0	8 - 10

Step 4: Rating the SCA

Individual specific area values are averaged to determine the overall SCA value, which is then converted to an SCA rating using the ranges shown in the second column of table B.1.

Step 5: Determining the overall rating

CNSC staff determine the overall rating for the facility by considering all SCA ratings and judging overall achievement of the performance objectives of all SCAs and the broad safety objectives for the facility.

Example

Steps 1 and 2: Identifying and assessing the findings

This example is for DNGS. For 2017, CNSC specialists identified 361 findings for DNGS from compliance verification activities, assigned them to SCAs and specific areas, and determined their safety significance. The findings included 40 findings of low safety significance, 43 findings of negligible safety significance, and 278 compliant findings (no medium- or high-significance findings).

Step 3: Rating the specific area

The example SCA is conventional health and safety, which had a total of 34 findings for Point Lepreau spread across the three specific areas. Of these findings, 22 were compliant, 9 were of negligible safety significance, and 3 were none of low safety significance. Based on the findings, the CNSC specialists assessed each specific area as "fully satisfactory". The specialists then determined the numerical value for each specific area rating, considering not only the findings but also information from regulatory surveillance and monitoring during 2017. The values chosen are shown in table B.2.

Table B.2: Example SCA rating – Conventional health and safety

Specific Area	Number of Findings by Safety Significance					Specific Area Rating		SCA Rating
	Compliant	Negligible	Low	Medium	High	Category	Value	
Performance	0	0	0	0	0	FS	9.5	
Practices	5	2	0	0	0	SA	7.0	
Awareness	17	7	3	0	0	SA	7.5	
	22	9	3			Average	8.00	FS

Step 4: Rating the SCA

As indicated in table B.2, the numerical ratings for the specific areas were averaged to determine the numerical SCA rating (8.00), which was then converted to a rating category (i.e., fully satisfactory), using the rating grid.

Step 5: Determining the Overall rating

CNSC staff determined the overall rating for DNGS by considering both the SCA ratings (repeated in Table B.4) and subjectively assessing the overall safety of the NPP, as compared to 2016 (and as compared to other Canadian NPP). CNSC staff determined that, overall, DNGS's safety performance warranted a "fully satisfactory" rating for 2017.

Table B.3: SCA ratings for DNGS

SCA	Rating
Management system	**SA**
Human performance management	**SA**
Operating performance	**FS**
Safety analysis	**FS**
Physical design	**SA**
Fitness for service	**SA**
Radiation protection	**SA**
Conventional health and safety	**FS**

Environmental protection	**SA**
Emergency management and fire protection	**SA**
Waste management	**FS**
Security	**SA**
Safeguards and non-proliferation	**SA**
Packaging and transport	**SA**

B.3 SCA Ratings from 2016

Table B.4: 2016 SCA Ratings for NPPs *

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

* The ratings for Gentilly-2 are from the licence renewal in 2015.

Table B.5: 2016 SCA Ratings for WMFs

Safety and control area	DWMF	PWMF	WWMF
Management system	**SA**	**SA**	**SA**
Human performance management	**SA**	**SA**	**SA**
Operating performance	**FS**	**FS**	**FS**
Safety analysis	**FS**	**FS**	**FS**
Physical design	**SA**	**SA**	**SA**
Fitness for service	**SA**	**SA**	**SA**
Radiation protection	**SA**	**SA**	**SA**
Conventional health and safety	**FS**	**FS**	**FS**
Environmental protection	**SA**	**SA**	**SA**
Emergency management and fire protection	**SA**	**SA**	**SA**
Waste management	**SA**	**SA**	**SA**
Security	**SA**	**FS**	**FS**
Safeguards and non-proliferation	**SA**	**SA**	**SA**
Packaging and transport	**SA**	**SA**	**SA**

Appendix C: RESEARCH AND DEVELOPMENT EFFORTS IN SUPPORT OF NPP REGULATION

This appendix provides information on research and development (R&D) activities being conducted by the industry and the CNSC to enhance the safety of NPP operations, as well as information on safety issues that drive the R&D activities and which are the subject of regulatory oversight for NPPs.

C.1 Industry R&D activities

The CANDU Owners Group (COG) R&D program and the Industry Standard Toolset (IST) program were established to support the safe, reliable and efficient operation of CANDU reactors. They are managed under five technical areas:

- Fuel channels
- Safety and licensing
- Health, safety and the environment
- Chemistry, materials and components
- IST

The R&D and IST programs are sponsored by three Canadian utilities (Bruce Power, OPG and NB Power), the Romanian Societatea Nationala Nuclear Electrica, and Canadian Nuclear Laboratories. In 2016–17, Korea Hydro and Nuclear Power Company sponsored the Safety and Licensing R&D technical area and the IST program. In 2017, the CNSC reviewed submissions on the work plans, analysis methodology and results for these ongoing programs.

Bruce Power and OPG also continued a joint COG R&D initiative: the fuel channel life-management program. This program aims to develop the engineering methodologies and analytical tools necessary to continue demonstrating the fitness for service.

C.2 CNSC R&D activities

The CNSC manages an active extramural research program that focuses on regulatory issues and SCAs. The program also contributes to many international programs relevant to NPP safety. Examples of research activities that were active in 2017 and that are relevant to NPPs are given below. When the research activities are completed, the final reports are posted on the CNSC's Scientific and technical information Web page.

Fitness for Service

Analysis of Degradation Mechanisms of Cable Insulation, Due to Ageing in a Decommissioned NPP

Understanding the degradation of cables due to aging and exposure to harsh environmental conditions is an important part of ensuring the fitness for service of an NPP. With the cooperation of Hydro-Québec, cables from the permanently shut down reactor at Gentilly-2 were being recovered. These cables will be subject to laboratory analysis to assess the degree of degradation. The results will be used to validate codes, standards and the accelerated test procedures that are currently in use.

Statistical Modeling of Aging Effects in Failure Rates of Piping Components

The CNSC is sponsoring the development of a generic guidance document that will outline the methods and techniques to determine statistical operability, for events involving degraded or failed metallic (e.g., carbon steel) passive components.

Investigation of Consequences of Concrete Alkali-Aggregate Reaction on Existing Nuclear Structures

As NPPs age and life extension is considered, it is important to understand the effect of potential degradation mechanisms for existing civil structures. Specifically, this project explores the effect that concrete alkali-aggregate reactions have on existing nuclear structures.

Development of Testing Standards to Test Pressure Tube Material Properties

Fracture toughness measurements of irradiated Zr-2.5Nb are important to ensure leak-before-break of pressure tubes. The objective of this project is to standardize small-scale fracture toughness testing procedures for irradiated Zr-2.5Nb pressure tubes used by in Canadian NPPs. This information will assist the CNSC in independently verifying fitness-for-service assessments for pressure tubes.

An Experimental Study of the Effects of Flat Bar Supports on Streamwise Fluidelastic Instability in Nuclear Steam Generators

CANDU utilities are in the process of replacing aging steam generators. The replacement steam generators differ from the original, already-licensed steam generators. The purpose of this project is to better understand flow-induced vibration in steam generator tubes. This research will result in a guide for regulatory assessment of the design and operation of replacement steam generators for CANDU reactors.

Safety Analysis

Analysis of Severe Irradiated Fuel Bay Accident PKPIRT Package

An expert panel was formed to gather the information required to establish a code to model potential severe accidents in a CANDU irradiated fuel bay. The panel delivered the Phenomena and Key Parameters Identification and Ranking Table (PKPIRT) and made recommendations to the CNSC on how to proceed with its implementation of the code.

Hydrogen/CO combustion and Passive Autocatalytic Recombiner (PAR) Behaviour

Studies are needed to determine PAR capacity to oxidize CO under postulated accident conditions. The large scale vented combustion test facility at Whiteshell underwent modifications to allow for testing using H2-CO mixtures. Experiments in the area will help CNSC to regulate severe accident management.

Studies of Molten Metal Solidification in Internal Pipe Flows

This research project aims to analytically and experimentally study molten metal solidification in internal pipe flows to gain insights into corium behaviour for various flow cross section geometries. This study will enhance the understanding of the flow of melted material. The results from this study are expected to help CNSC staff understand the impact of penetrations on in-vessel retention (IVR) and have a better technical judgment and evaluation of the licensees' adopted IVR strategy for severe accident management.

Integrated Framework for Propagation of Uncertainties

The CNSC initiated a study to investigate the feasibility of developing a first-of-its-kind integrated framework for uncertainty characterization, with primary application to CANDU neutronics calculations. This study has been undertaken with the aim of enhancing the CNSC's capability to independently verify safety cases that use more realistic methodologies, in particular those that rely on complex analytical simulations using 3D-neutronics/thermal-hydraulic coupled computational procedures.

C.3 CANDU safety issues

Table C.1: Categories of CSI safety significance

Category	Meaning
1	The issue has been satisfactorily addressed in Canada.
2	The issue is a concern in Canada. However, the licensees have appropriate control measures in place to address the issue and to maintain safety margins.
3	The issue is a concern in Canada. Measures are in place to maintain safety margins, but further experiments and/or analyses are required to improve knowledge and understanding of the issue, and to confirm the adequacy of the measures.

Table C.2: Details of Category 3 LBLOCA CANDU safety issues open during 2017

CSI	Title	Brief description
AA 9	Analysis for void reactivity coefficient	The large loss-of-coolant accident design-basis event is one of the most difficult accidents to analyze for a CANDU reactor because many aspects of reactor behaviour under accident conditions are subject to uncertainties.
PF 9	Fuel behaviour in high-temperature transients	
PF 10	Fuel behaviour in power-pulse transients	

Table C.3: Details of the Category 3 non-LBLOCA CSIs open during 2017

CSI	Title	Brief description
IH 6	Systematic assessment of high-energy line-break effects	Dynamic effects at high-energy line breaks (e.g., pipe whip, jet impingement) can cause consequential failure of structures, systems and components and impair defence in depth.

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Appendix D: DARLINGTON NEW BUILD

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

According to the Canadian Environmental Assessment Act, an environmental assessment of the project is required prior to any licensing decisions for a PRSL. The joint review panel (JRP) carried out this assessment in 2011. The assessment and the PRSL were challenged through an application for judicial review before the Federal Court of Canada and associated appeals

Ultimately, the decision was upheld - see the Regulatory Oversight Report for Canadian Nuclear Power Plants: 2016 for details. The PRSL is for a period of 10 years (i.e., from August 17, 2012 to August 17, 2022).

As required in the PRSL, work activities between 2015 and 2017 were related to the JRP recommendations, specifically, OPG carried out the following activities, which were monitored by CNSC.

- bank swallow monitoring and mitigation
- support for CNSC activities to engage stakeholders in developing policy for land use around nuclear generating stations
- development of a methodology that will help with siting of intake and diffuser structures in Lake Ontario

Bank swallow monitoring and mitigation

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

To address the JRP recommendations, surveys of the bank swallow burrows at the Darlington site and surrounding area have been conducted since 2008 to understand the changes in the population of bank swallows in the natural bluffs at the Darlington site and vicinity over time.

In February 2018, CNSC staff received and reviewed the results of OPG's 2017 bank swallow program. The lowest number of burrows was recorded in 2017 since the initiation of the monitoring surveys. These results were at least partly attributed to the atypical conditions of 2017. Given the ephemeral nature of the Bank Swallow habitat, annual variation in the number of burrows observed is not unexpected.

The bank swallow program report also indicated that no bank swallow nesting within the earthen embankment/mound artificial nesting habitat structure was observed from 2012 to 2017. As part of the mitigation strategies, given the lack of (or minimal) nesting in the artificial mound over the survey period, OPG elected to design a new nesting structure, which will be tested once finalized.

Land use planning

Taking into consideration the lessons learned from the Fukushima Daiichi accident, the JRP was of the opinion that a situation in which residential areas are located within three kilometres of a nuclear site must be avoided. Appropriate steps must therefore be taken to evaluate and define buffer zones around nuclear facilities. Given this, the JRP directed recommendations to the CNSC, the Government of Ontario and the Municipality of Clarington regarding land use planning.

Specifically, the JRP's recommendations were in relation to:

- development of policy for land use around nuclear generating stations
- provincial prevention of sensitive land uses within three kilometres of the site boundary
- municipal prevention of sensitive land uses within three kilometres of the site boundary
- management of development in the vicinity of the project site to ensure capacity for evacuation

Significant efforts have been undertaken by various levels of government following the JRP recommendations around land use planning. In 2013, as part of its activities to address the JRP recommendations, the CNSC hosted a land use planning workshop for OPG staff as well as municipal, regional and provincial stakeholders. The CNSC continues to monitor recommendations stemming from this workshop.

The key activities and progress to date are as follows.

- The Government of Ontario released the revised Provincial Policy Statement (PPS) 2014 (which came into effect April 30, 2014). The statement included a new policy on land use compatibility, which was further supported by definitions for "sensitive land uses" and "major facilities" that include energy generating facilities such as NPPs.
- The Region of Durham has committed to updating its official plan to align with the PPS. The MCR (Municipal Comprehensive Review) was initiated in June 2018 and this process is expected to be complete by 2022.
- The Municipality of Clarington revised its Official Plan on November 1, 2016. It included municipal policies to align to the 2014 PPS land use planning policy. CNSC staff continued to coordinate with OPG and the Municipality of Clarington to monitor the implementation of the revised Official Plan to ensure the intent of the JRP recommendations are met.

Methodology to determine potential location for intake and diffuser structure in Lake Ontario

In preparation to build the cooling structure of a new NPP, OPG was evaluating the potential impact of the future cooling intake and outtake on Lake Ontario. In 2016, OPG prepared sampling methodology for a field collection program on different fish species to assist in siting the new intake and diffuser. The sampling methodology report was submitted in 2017. The CNSC, in cooperation with Environment and Climate Change Canada and Fisheries and Oceans Canada, reviewed this report and accepted the methodology .

Work activities anticipated in 2018

The following work activities are anticipated by OPG for 2018.

- Implementation of aquatic sampling to support decision-making related to the siting of intake and diffuser
- Continuation of the monitoring of bank swallows natural habitat along the lakeshore on the Darlington site and surrounding area and finalizing the design and construction of the fixed-face earthen embankment
- Continuation of the monitoring of the implementation of the PPS at the regional and municipal level with regards to land use planning
- OPG's presentation of a mid-term report to the Commission on the activities undertaken during the first 5 years of the PRSL

Appendix E: LIST OF REGULATORY REQUIREMENTS AT THE END OF 2017

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 2017 (PWMF did not yet have an LCH at that time, but the draft LCH for the licence renewal was used). The main body of this report may include more up-to-date information related to the implementation of some of these documents, as well as more recently-published documents, that were not reflected as compliance verification criteria in LCHs in 2017.

In the table, a check mark indicates that the publication was included as compliance verification criteria for the facility at the end of 2017, a dash indicates that 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.

Source	Number	Title	Year	SCA	Bruce	DNGS	DWMF	PNGS	PWMF	PLNGS	Gentilly2	WWMF
CSA	N286	*Management system requirements for nuclear power plants*	2005	**1**	√	-	-	-	-		-	-
CSA	N286	*Management system requirements for nuclear facilities*	2012	**1**	-	√	√	√	√	√	√	√
CNSC	REGDOC-2.2.2	*Personnel Training*	2014	**2**	-	√	√	√	√	√	-	√
CNSC	RD-204	*Certification of Persons Working at Nuclear Power Plants*	2008	**2**	√	√	-	√	-	√	√	-
CNSC	EG1 *	*Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants*	2005	**2**	√	√	-	√	-	√	√	-
CNSC	EG2 *	*Requirements and Guidelines for Simulator-Based Certification Examinations for Shift Personnel at Nuclear Power Plants*	2004	**2**	√	√	-	√	-	√	√	-
CNSC	*	*Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants*	2009	**2**	√	√	-	√	-	√	√	-
CNSC	RD-363	*Nuclear Security Officer Medical, Physical and Psychological Fitness*	2008	**2**	√	√	√	√	√	√	√	√
CNSC	REGDOC-2.2.4	*Fitness for Duty Volume I: Managing Worker Fatigue*	2017	**2**	-	2019	2019	2019	2019	2022	-	2019
CNSC	REGDOC-2.2.4	*Fitness for Duty Volume II: Managing Alcohol and Drug*	2017	**2**	-	2019	2019	2019	2019	-	-	-
CNSC	REGDOC-2.3.3	*Periodic Safety Reviews*	2015	**3**	-	√	-	-	-	√	-	-
CNSC	REGDOC-3.1.1	*Reporting Requirements for Nuclear Power Plants*	2014	**3**	-	√	-	√	-	-	√	-
CNSC	REGDOC-3.1.1	*Reporting Requirements for Nuclear Power Plants, version 2*	2016	**3**	√	-	-	-	-	√	-	-
CSA	N290.15	*Requirements for the safe operating envelope of nuclear power plants*	2010	**3**	√	√	-	√	-	√	-	-
CNSC	REGDOC-2.3.2	*Accident Management: Severe Accident Management Programs for Nuclear Reactors*	2013	**3**	√	√	-	-	-	-	-	-
CSA	N290.11	*Requirements for reactor heat removal capability during outage of nuclear power plants*	2013	**3**	-	-	-	-	-	√	-	-
CSA	N286.7	*Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants*	1999	**4**	-	√	-	√	-	√	√	-
CSA	N286.7	*Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants*	2016	**4**	√	-	-	-	-	-	-	-
CNSC	REGDOC-2.4.1	*Deterministic Safety Analysis*	2014	4	√	√	-	TBC	-	√	√	-
CNSC	REGDOC-2.4.2	*Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*	2014	4	2019	2020	-	TBC	-	√	-	-
CNSC	RD-327	*Nuclear Criticality Safety*	2010	**4**	√	-	-	-	-	-	-	-

* CNSC staff documents (not published as regulatory documents)

Source	Number	Title	Year	SCA	Bruce	DNGS	DWMF	PNGS	PWMF	PLNGS	Gentilly2	WWMF
CSA	N289.1	*General requirements for seismic design and qualification of CANDU nuclear power plants*	2008	**5**	-	√	-	-	-	-	√	-
CSA	N290.13	*Environmental Qualification of Equipment for CANDU Nuclear Power Plants*	2005	**5**	√	√	-	√	-	√	-	-
CSA	N285.0	*General requirements for pressure-retaining systems and components in CANDU nuclear power plants*	2008	**5**	-	√	√	√	√	-	-	√
CSA	N285.0	*General requirements for pressure-retaining systems and components in CANDU nuclear power plants(including updates 1 and 2)*	2012	**5**	√	-	-	-	√	√	√	-
CSA	N290.12	*Human factors in design for nuclear power plants*	2014	**5**	-	-	-	-	-	√	-	-
CSA	N290.0	*General requirements for safety systems of nuclear power plants*	2011	**5**	-	√	-	-	-	-	-	-
CSA	N291	*Requirements for safety related structures for CANDU nuclear power plants*	2008	**5**	-	√	-	-	-	√	√	-
CNSC	RD/GD-98	*Reliability Programs for Nuclear Power Plants*	2012	**6**	√	√	-	√	-	√	-	-
CNSC	RD/GD-210	*Maintenance Programs for Nuclear Power Plants*	2012	**6**	√	√	-	-	-	√	√	-
CSA	N285.4	*Periodic inspection of CANDU nuclear power plant components*	2005	**6**	-	√	-	√	-		-	-
CSA	N285.4	*Periodic inspection of CANDU nuclear power plant components*	2009	**6**	√	-	-		-	√	-	-
CSA	N285.5	*Periodic inspection of CANDU nuclear power plant containment components*	2008	**6**	√	√	-	√	-	√	-	-
CSA	N287.7	*In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants*	2008	**6**	√	√	-	√	-	√	-	-
CSA	N285.8	*Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*	2010	**6**	-	-	-	√	-	-	-	-
CSA	N285.8	*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**	√	√	-	-	√	√	√	-
CSA	N288.1	*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**	-	√	√	√	√	√	√	√
CSA	N288.1	*Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*	2014	**9**	2020	-	-	-	-	-	-	TBD
CSA	N288.3.4	*Performance testing of nuclear air-cleaning systems at nuclear facilities*	2013	**9**	-	-	-	-	√		-	√
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**	2018	√	√	-	-	√	√	-
CNSC	REGDOC-2.9.1	*Environmental Principles, Assessments and Protection Measures, version 1.1*	2017	**9**	-	-	-	-	√	-	-	√
CSA	N288.4	*Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*	2010	**9**	2018	√	√	√	√	√	-	TBD
CSA	N288.5	*Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*	2011	**9**	2018	√	√	-	√	-	-	√
CSA	N288.6	*Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*	2012	**9**	2018	√	-	-	√	-	-	√

Source	Number	Title	Year	SCA	Bruce	DNGS	DWMF	PNGS	PWMF	PLNGS	Gentilly2	WWMF
CNSC	RD-353	*Testing and Implementation of Emergency Measures*	2008	**10**	-	-	√	√	√	√	-	√
CNSC	REGDOC-2.10.1	*Nuclear Emergency Preparedness and Response*	2014	**10**	2018	√	-	-	2018	-	√	2018
CSA	N293	*Fire protection for nuclear power plants*	2007	**10**	-	-	-	√	-	-	-	-
CSA	N293	*Fire protection for nuclear power plants*	2012	**10**	√	√	-	-	-	√	√	
CSA	N393	*Fire protection for facilities that process, handle, or store nuclear substances*	2013	**10**	-	-	-		√	-	-	√
CSA	N292.0	*General principles for the management of radioactive waste and irradiated fuel*	2014	**11**	-	-	-	-	√	-	√	√
CSA	N292.2	*Interim dry storage of irradiated fuel*	*2007*	**11**	-	-	√	-	√	√	-	√
CSA	N292.2	*Interim dry storage of irradiated fuel*	*2013*	**11**	-	-	-	-	-	-	-	√
CSA	N292.3	*Management of low- and intermediate-level radioactive waste*	2008	**11**	-	√	√	√	√	√	√	√
CSA	N292.3	*Management of low- and intermediate-level radioactive waste*	2014	**11**	-	-	-	-	-	√	-	√
CSA	N294	*Decommissioning of facilities containing nuclear substances*	2009	**11**	-	√	√	√	√	√	√	√
CSA	N290.7	*Cyber Security*	2014	**12**	2020	√	-	2019	-	2019	√	-
CNSC	RD-321	*Criteria for Physical Protection Systems and Devices at High-Security Sites*	2010	**12**	√	√	√	√	√	√	√	√
CNSC	RD-361	*Criteria for Explosive Substance Detection, X-ray Imaging and Metal Detection at High Security Sites*	2010	**12**	√	√	√	√	√	√	√	√
CNSC	REGDOC-2.12.1	*High-Security Sites: Nuclear Response Force*	2013	**12**	√	√	-	√	-	√	-	-
CNSC	REGDOC-2.12.2	*Site Access Security Clearance*	2013	**12**	√	√	√	√	√	√	√	√
CNSC	REGDOC-2.12.3	*Security of Nuclear Substances – Sealed Sources*	2013	**12**	-	-	-	√	√	-	-	√
CNSC	RD-336	*Accounting and Reporting of Nuclear Material*	2010	**13**	√	√	√	√	√	√	√	√
CNSC	RD/GD-99.3	*Public Information and Disclosure*	2012	**15**	√	√	√	√	√	√	√	√

Appendix F: LICENCE AMENDMENTS AND LICENCE CONDITIONS HANDBOOK REVISIONS

The tables in this appendix outline amendments to the licences and revisions to the licence conditions handbook (LCH) for each NPP and WMF licensee from January 1, 2017 to April 30, 2018.

F.1 Bruce A and B

Table F.1: Significant changes to the Bruce A and Bruce B LCH

Section	Description of change	Revision type
LCH-BNGS-R002 February 1, 2017 Sections 4.1, 6.1, 12.1; Part I, several sections and appendices	Section 4.1: The implementation strategy for transitioning to REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* has been updated and target date for full compliance to REGDOC-2.4.2 was set by June 30, 2019. This change has been reviewed and accepted by CNSC staff. Section 6.1: The expected dates for compliance with the REGDOC-2.6.3, *Fitness for Service: Aging Management* for remaining LCMPs have been set for the feeders and steam generators by April 2017 and for the fuel channels by June 2017. This change has been reviewed and accepted by CNSC staff. Part I (several sections and appendices): Minor editorial changes made throughout LCH text. Section 12.1: A new CSA standard, N290.7-14, *Cyber security for nuclear power plants and small reactor facilities* was added to the list of documents requiring version control. The date for Bruce Power's transition to the CSA N290.7-14 was December 31, 2020. This change has been reviewed and accepted by CNSC staff.	Technical/ administrative
LCH-BNGS-R003 July 1, 2017 Section G.1, G.2, 3.1, 4.1, 5.2, 6.1, 7.1, 9.1, 9.2 and 10.2, Appendices C.1, D.1 and D.2	Section G.1, G.2: Added the text to incorporate the supporting activities at the Central Maintenance and Laundry Facilities (CMLF). Administrative and editorial changes. Section 3.1: Administrative and editorial changes. Sections 4.1. Added the text to the implementation strategy for REGDOC-2.4.1, *Deterministic Safety Analysis* that Bruce Power, along with industry partners, has developed a set of derived acceptance criteria (DAC) for slow events. Section 5.2: Removed CSA N285.6 from this section of LCH since CSA N285.0-12, *General requirements for pressure-retaining systems and components in*	Technical/ administrative

Section	Description of change	Revision type
	CANDU nuclear power plants now captures this aspect. Section 6.1: Administrative and editorial changes. Section 7.1: CMLF Action Levels were added to the table, specifically the following additions were made: Unplanned External Exposure: 250µSv (25 mrem) or more above planned dose. Editorial changes. Sections 9.1, 9.2: CMLF Derived Release Limits were added to the table. Editorial changes. Section 10.2: Editorial changes. Appendices C.1, D.1 and D.2: Added REGDOC-2.3.2, *Accident Management*, CSAs and COG documents	

F.2 Darlington

Table F.2: Significant changes to the Darlington LCH

Section	Description of change	Revision type
LCH-PR-13.00/2025-R001 February 13, 2018	Several administrative changes and updates, including: - Corrections to titles and text, including grammatical errors; - Updated financial guarantee; - Revision to minimum shift complement to reflect Unit 2's defueled status; - Alignment with other power reactor LCH's for consistency; - Updates to text reflecting completion of implementation plans, insertion of new REGDOCS and introduction of new CVC from R+G; - Correction of previous erroneous omission of elemental tritium in the DRL table; - Implementation of cyber security requirements; Updates to Safeguards reporting requirements.	Administrative

F.3 Pickering

Table F.3: Significant changes to the Pickering LCH

Section	Description of change	Revision type
2017	Updated CVC to reflect new *Nuclear Liability and Compensation Act* Removed requirement for licensee to notify CNSC when insurance policy is changed. Updated reference to WN document. Updated CVC with OPG implementation plan for REGDOC-2.2.4 Updated to MSC table – removed stock keeper role Updated CVC to reflect • CSNC approval to defer Unit 8 reactor building leakage rate test; and • CNSC acceptance of OPG compliance plan for N285.8-15 Updated CVC to reflect latest submission of PDP Updated CVC to reflect OPG compliance with REGDOC-2.12.3 Revised Preamble and CVC to reflect the end of commercial operation date of December 31, 2024 and revised CNSC expectations New licence condition and LCH section for PROL amendment authorizing import/export of contaminated laundry.	Technical/administrative

F.4 Point Lepreau

Table F.4: Significant changes to the Point Lepreau LCH

Section	Description of change	Revision type
LCH-PR-17.00/2022-R000 July 1, 2017	No changes were made to the LCH following the PROL renewal	

F.5 Gentilly-2

Table F.10: Significant changes to the Gentilly-2LCH

Section	Description of change	Revision type

Section	Description of change	Revision type
MCP-GENTILLY-2- R000 July 1, 2016	No changes were made to the MCP-GENTILLY-2-R000 since July 1, 2016.	

F.6 DWMF

Table F.6: Significant changes to the DWMF LCH

Section	Description of change	Revision type
	No changes (per section 3.1.0)	

F.7 PWMF

Table F.7: Significant changes to the PWMF LCH

Section	Description of change	Revision type
	No changes (per section 3.5.0)	

F.8 WWMF

Table F.8: Significant changes to the WWMF LCH

Section	Description of change	Revision type
	New LCH	

Appendix G: FIVE-YEAR TRENDS IN COMPLIANCE ACTIVITIES

In the following tables, "other compliance activities" includes verification activities such as surveillance, monitoring and reviews of licensee-submitted documents and reports (other than event reports)

G.1 Bruce A and B

Table G.1: Five-year trend in compliance activities for Bruce A and B

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Inspections	1,540	1,520	1,030	1,226	1,716
Event reviews	234	250	198	192	184
Other compliance activities	3,297	3,597	3,899	3,632	2,971
Total effort (person-days)	5,071	5,367	5,127	5,050	4,871

G.2 DNGS

Table G.2: Five-year trend in compliance activities for DNGS

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Inspections	1,275	1,226	1,079	1,422	1,422
Event reviews	180	214	128	114	120
Other compliance activities	2,338	2,290	2,141	1,947	2,160
Total effort (person-days)	3,793	3,730	3,348	3,483	3,702

G.3 PNGS

Table G.3: Five-year trend in compliance activities for PNGS

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Inspections	1,643	1,460	1,460	1,156	1,764
Event reviews	286	228	132	118	130
Other compliance activities	2,702	3,245	3,453	3,659	2,603
Total effort (person-days)	4,630	4,933	5,045	4,933	4,497

G.4 Point Lepreau

Table G.4: Five-year trend in compliance activities for Point Lepreau

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Inspections	1,520	1,079	1,030	785	981
Event reviews	82	80	58	72	70
Other compliance activities	1,435	1,402	1,874	2,136	1,466
Total effort (person-days)	3,037	2,561	2,962	2,993	2517

G.5 Gentilly-2

Table G.5: Five-year trend in compliance activities for Gentilly-2

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Inspections	882	490	147	147	98
Event reviews	18	30	4	6	8
Other compliance activities	706	301	416	232	139
Total effort (person-days)	1,606	821	567	385	245

G.6 Canadian NPPs

Table G.6: Five-year trend in compliance activities for Canadian NPPs

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Inspections	6,860	5,775	4,746	4,736	5,981
Event reviews	814	802	520	502	512
Other compliance activities	10,463	10,833	11,783	11,606	9,339
Total effort (person-days)	18,137	17,410	17,049	16,844	15,832

G.7 DWMF

Table G.7: Five-year trend in compliance activities for the DWMF

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Number of Inspections	1	4	5	6	3
Licensing activities	7	10	44	21	75
Compliance activities	96	152	184	136	161
Total effort (person-days)	103	162	228	157	236

G.8 PWMF

Table G.8: Five-year trend in compliance activities for the PWMF

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Number of Inspections	2	3	2	4	3
Licensing activities	16	12	7	71	209
Compliance activities*	85	116	143	128	94
Total effort (person-days)	101	128	150	198	303

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

G.9 WWMF

Table G.9: Five-year trend in compliance activities for the WWMF

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Number of Inspections	3	4	3	6	3
Licensing activities	6	57	17	182	258
Compliance activities	203	216	197	237	227
Total effort (person-days)	209	273	214	419	485

G.10 Canadian WMFs

Table G.10: Five-year trend in compliance activities for Canadian WMFs

Compliance activities effort (person-days)	2013	2014	2015	2016	2017
Number of Inspections	6	11	10	16	9
Licensing activities	29	79	68	274	542
Compliance activities	384	484	524	501	482
Total effort (person-days)	413	563	592	774	1024

Appendix H: Current and predicted status of key parameters and models for pressure tubes in Canadian power reactors

Unit	Status as of January 1st 2018				Future situation			
	EFPH	Heq concentration, ppm (inlet / outlet)	Existing fracture toughness model valid?		Key target (date)	anticipated EFPH	predicted Heq conc., ppm (inlet / outlet)	Existing fracture toughness model valid?
Pickering Unit 1	134,825	29 / 34	Yes		End of service Dec. 31 2024	192,000	36 / 84	Yes
Pickering Unit 4	107,980	22 / 25	Yes		As above	167,500	34 / 64	Yes
Pickering Unit 5	229,800	43 / 58	Yes		As above	287,500	49 / 97	Yes
Pickering Unit 6	234,850	36 / 56	Yes		As above	295,000	48 / 90	Yes
Pickering Unit 7	228,750	38 / 55	Yes		As above	287,000	48 / 91	Yes
Pickering Unit 8	216,650	35 / 51	Yes		As above	274,000	48 / 86	Yes
Darlington Unit 1	≈196,000	48 / 59	Yes		MCR begins June 2021	≈224,000	48 / 71	Yes
Darlington Unit 2	**MCR started, October 2016**				**n/a** (fuel channels replaced during MCR)			
Darlington Unit 3	≈193,000	44 / 82	Yes		MCR begins Feb. 2020	≈210,000	67 / 108	Yes
Darlington Unit 4	≈188,000	45 / 50	Yes		MCR begins Jan. 2023	≈230,000	45 / 72	Yes
Bruce Unit 1	35,877	17 / 13	Yes		**n/a** (fuel channels replaced before Sept. 2012 Return-to-Service)			
Bruce Unit 2	≈36,200	No data available			**n/a** (fuel channels replaced before August 2012 Return-to-Service)			
Bruce Unit 3	210,042	50 / 93	Yes		MCR begins 2023	≈245,000	52 / 102	Yes
Bruce Unit 4	204,451	40 / 90	Yes		MCR begins 2025	≈255,000	42 / 104	Yes

Bruce Unit 5	232,130	40 / 111	Yes		MCR begins 2026	≈300,000	45 / 151	***Pre-requisite***: existing fracture toughness model must be validated for Heq levels above 120 ppm
Bruce Unit 6	227,844	40 / 112	Yes		MCR begins 2020	≈245,000	44 / 121	As above
Bruce Unit 7	224,310	40 / 92	Yes		MCR begins 2028	≈300,000	45 / 147	As above
Bruce Unit 8	211,781	44 / 69	Yes		MCR begins 2030	≈300,000	52 / 139	As above

Appendix I: DERIVED RELEASE LIMITS AND RADIOLOGICAL RELEASES TO THE ENVIRONMENT

Derived Release Limits

Derived release limits (DRLs), which are uniquely calculated for each site, are 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 N288.1-08, *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 on the basis of such factors as physico-chemical 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, exposed 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.

Licensees are required to demonstrate that their releases are not only below their respective DRLs but that the sum of their release is below 1 mSv/year, the regulatory dose limit for the general public. 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 NPPs, the action levels are applied to weekly and monthly monitoring results for emissions to atmosphere and for effluent to surface waters, respectively.

Total Annual Release of Relevant Radionuclides to the Environment

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. The selected reporting period encompasses 2011 to 2017, addressing the interval since the last publication of such data in 2012[6] which reported on the years 2001 – 2010. Over this current reporting period (2011 – 2017), there have been no exceedances of DRLs.

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 dose to the general public 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.

[6] http://publications.gc.ca/site/eng/9.506803/publication.html

For the facilities associated with this report, 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 general public) radionuclide is often chosen to represent the mixture as the basis for comparison with the DRL.

Releases are reported in the following tables as total becquerels (Bq) per year or in the case of noble gases, bequerels-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:

100 = 1.0×10^{2}

1,260,000 = 1.3×10^{6}

4,445,758,748 = 4.4×10^{9}

Bruce A and B

Bruce Power reports releases separately from Bruce-A and Bruce-B.

Releases to atmosphere:

Table I.1: Bruce-A annual radionuclide releases to atmosphere for 2011 – 2017

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (beta/gamma) (Bq)	Gross alpha (Bq)
2017 DRL	1.98×10^{17}	6.34×10^{14}	1.12×10^{17}	1.14×10^{12}	1.73×10^{12}	2.96×10^{11}
2017	7.32×10^{14}	1.89×10^{12}	9.40×10^{13}	2.06×10^{7}	4.39×10^{5}	4.08×10^{3}
2016	5.66×10^{14}	1.69×10^{12}	5.63×10^{13}	4.40×10^{6}	3.14×10^{5}	2.46×10^{3}
2015	7.05×10^{14}	3.15×10^{12}	5.62×10^{13}	5.15×10^{7}	1.06×10^{7}	1.23×10^{6}
2014	7.51×10^{14}	1.64×10^{12}	5.30×10^{13}	3.94×10^{8}	3.13×10^{6}	8.02×10^{5}
2013	5.04×10^{14}	2.53×10^{12}	6.66×10^{13}	$<4.94 \times 10^{7}$	$<4.84 \times 10^{6}$	$<6.67 \times 10^{5}$
2012	4.50×10^{14}	2.30×10^{12}	6.82×10^{13}	2.18×10^{6}	$<7.45 \times 10^{6}$	$<6.40 \times 10^{5}$
2011	6.00×10^{14}	1.36×10^{12}	6.68×10^{13}	3.58×10^{7}	$<7.06 \times 10^{6}$	$<5.99 \times 10^{5}$

Table I.2: Bruce - B annual radionuclide releases to atmosphere for 2011 – 2017 with weekly releases provided for 2017

Year	Tritium: (HTO: Bq)	Carbon -14 (Bq)	Noble Gas (Bq-MeV	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
2017 DRL	3.16×10^{17}	7.56×10^{14}	2.17×10^{17}	1.35×10^{12}	3.61×10^{12}	5.77×10^{11}
2017	7.14×10^{14}	1.23×10^{12}	4.82×10^{13}	$1.41X\ 10^{6}$	2.34×10^{6}	3.70×10^{3}
2016	5.70×10^{14}	1.13×10^{12}	5.25×10^{13}	<LD[a]	1.13×100^{6}	1.85×10^{3}
2015	3.74×10^{14}	1.16×10^{12}	5.25×10^{13}	4.01×10^{7}	1.63×10^{7}	2.34×10^{6}
2014	4.13×10^{14}	1.26×10^{12}	3.71×10^{13}	4.02×10^{7}	1.53×10^{7}	2.26×10^{6}
2013	2.63×10^{14}	1.10×10^{12}	3.64×10^{12}	$<4.04 \times 10^{7}$	$<1.86 \times 10^{7}$	$<2.51 \times 10^{6}$
2012	3.26×10^{14}	1.16×10^{12}	3.64×10^{12}	4.13×10^{7}	1.80×10^{7}	$<4.38 \times 10^{5}$

2011	7.17×10^{14}	1.44×10^{12}	3.64×10^{12}	4.19×10^{7}	5.07×10^{7}	1.78×10^{7}

a = less than analytical detection limit

Releases to surface waters:

Table I.3: Bruce-A annual radionuclide releases to surface waters for 2011 – 2017

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
2017 DRL	2.30×10^{18}	4.58×10^{13}	1.03×10^{15}	1.12×10^{14}
2017	2.26×10^{14}	1.08×10^{9}	9.13×10^{8}	<LD[a]
2016	2.36×10^{14}	9.96×10^{8}	1.66×10^{9}	6.96×10^{4}
2015	2.20×10^{14}	9.17×10^{8}	2.45×10^{9}	1.31×10^{6}
2014	1.94×10^{14}	1.02×10^{9}	1.13×10^{9}	1.77×10^{6}
2013	1.96×10^{14}	2.12×10^{6}	9.95×10^{8}	9.08×10^{8}
2012	1.40×10^{14}	5.79×10^{8}	5.37×10^{8}	1.60×10^{6}
2011	2.95×10^{14}	6.29×10^{8}	1.70×10^{9}	1.09×10^{6}

a = less than analytical detection limit

Table I.4: Bruce-B annual radionuclide releases to surface waters for 2011 – 2017

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
2017 DRL	1.84×10^{18}	5.17×10^{13}	1.16×10^{15}	1.21×10^{14}
2017	7.15×10^{14}	2.04×10^{9}	2.39×10^{8}	<LD[a]
2016	5.07×10^{14}	1.42×10^{9}	1.76×10^{9}	<LD[a]
2015	6.72×10^{14}	1.53×10^{9}	9.07×10^{9}	1.40×10^{6}
2014	6.42×10^{14}	1.99×10^{9}	8.06×10^{9}	1.49×10^{6}
2013	4.19×10^{14}	3.95×10^{9}	4.90×10^{8}	8.91×10^{8}
2012	1.14×10^{15}	3.35×10^{9}	4.63×10^{8}	1.11×10^{6}
2011	5.10×10^{14}	2.38×10^{9}	2.82×10^{9}	1.48×10^{6}

a = less than analytical detection limit

WWMF

Releases to atmosphere:

Table I.5: WWMF annual radionuclide releases to surface waters for 2011 – 2017

Year	Tritium: (HTO: Bq)	Carbon -14 (Bq)	Iodine-131 (Bq)	Particulate (Gross gamma) (Bq)
2017 DRL	2.96×10^{17}	1.09×10^{15}	1.90×10^{12}	2.34×10^{12}
2017	1.72×10^{13}	4.09×10^{9}	1.38×10^{5}	4.52×10^{3}
2016	2.06×10^{13}	3.94×10^{9}	1.71×10^{5}	5.42×10^{3}
2015	4.14×10^{12}	1.41×10^{9}	1.21×10^{5}	4.89×10^{5}
2014	7.17×10^{12}	2.96×10^{8}	1.22×10^{5}	5.12×10^{4}
2013	1.43×10^{13}	1.96×10^{9}	6.38×10^{4}	3.78×10^{5}
2012	1.04×10^{13}	1.88×10^{9}	6.06×10^{4}	1.26×10^{5}
2011	1.99×10^{13}	3.45×10^{9}	8.95×10^{4}	1.34×10^{5}

Releases to surface waters:

Table I.6: WWMF annual radionuclide releases to surface waters for 2011 – 2017

Year	Tritium: (HTO: Bq)	Gross Beta (Bq)
2017 DRL	7.70×10^{15}	4.46×10^{11}
2017	2.59×10^{11}	2.84×10^{8}
2016	6.12×10^{11}	4.62×10^{8}
2015	4.21×10^{11}	1.56×10^{8}
2014	2.44×10^{11}	1.26×10^{8}
2013	1.42×10^{11}	1.26×10^{8}
2012	1.00×10^{11}	6.80×10^{7}
2011	1.20×10^{11}	9.02×10^{7}

Darlington

The data for Darlington covers both DNGS and DWMF. In addition to the standard suite of radionuclides reported for DNGS, OPG also reports atmospheric elemental tritium releases associated with the tritium removal facility.

Releases to atmosphere:

Table I.7: Darlington annual radionuclide releases to atmosphere for 2011 – 2017
(Note elemental tritium DRL is applicable to tritium removal facility).

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)
2017 DRL	8.5×10^{17}	5.9×10^{16}	3.5×10^{14}	4.5×10^{16}	1.4×10^{12}	6.7×10^{11}	1.0×10^{11}
2017	1.4×10^{14}	2.4×10^{14}	1.4×10^{12}	1.5×10^{13}	$<1.5 \times 10^{8}$	2.6×10^{7}	2.0×10^{6}
2016	1.7×10^{13}	1.8×10^{14}	1.6×10^{12}	1.6×10^{13}	1.4×10^{8}	3.2×10^{7}	$<5.0 \times 10^{6}$
2015	1.7×10^{13}	2.5×10^{14}	1.3×10^{12}	2.2×10^{13}	1.4×10^{8}	3.5×10^{7}	$<6.4 \times 10^{6}$
2014	5.2×10^{13}	2.7×10^{14}	1.3×10^{12}	4.6×10^{13}	1.6×10^{8}	3.1×10^{7}	$<6.4 \times 10^{6}$
2013	1.8×10^{13}	2.1×10^{14}	1.0×10^{12}	3.2×10^{13}	1.4×10^{8}	2.9×10^{7}	$<6.2 \times 10^{6}$
2012	2.6×10^{13}	1.3×10^{14}	1.0×10^{12}	1.9×10^{13}	1.4×10^{8}	3.4×10^{7}	---
2011	8.8×10^{13}	1.4×10^{14}	1.0×10^{12}	2.2×10^{13}	1.5×10^{8}	4.0×10^{7}	---

Releases to surface waters:

Table I.8: Darlington annual radionuclide releases to surface waters for 2011 – 2017

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
2017 DRL	5.30×10^{18}	7.10×10^{13}	9.70×10^{14}	3.20×10^{14}
2017	5.6×10^{14}	2.6×10^{10}	1.7×10^{9}	$<1.6 \times 10^{6}$
2016	3.5×10^{14}	4.9×10^{10}	2.2×10^{9}	$<1.6 \times 10^{6}$
2015	2.4×10^{14}	4.9×10^{10}	7.3×10^{9}	$<1.7 \times 10^{6}$
2014	1.7×10^{14}	3.0×10^{10}	5.5×10^{9}	1.8×10^{6}
2013	1.1×10^{14}	2.8×10^{10}	3.2×10^{9}	8.5×10^{5}
2012	1.3×10^{14}	3.0×10^{10}	6.3×10^{9}	9.0×10^{5}
2011	1.1×10^{14}	3.1×10^{10}	1.9×10^{9}	1.1×10^{6}

Pickering

OPG reports releases separately for PNGS 1-4 and PNGS 5-8. The data for Pickering B includes that for PWMF.

Releases to atmosphere:

Table I.9: PNGS 1-4 annual radionuclide releases to atmosphere for 2011 – 2017

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
2017 DRL	1.2×10^{17}	2.2×10^{15}	3.2×10^{16}	9.8×10^{12}	4.9×10^{11}	8.7×10^{10}
2017	3.1×10^{14}	1.3×10^{12}	1.5×10^{14}	9.6×10^{6}	6.9×10^{6}	4.8×10^{5}
2016	2.2×10^{14}	1.2×10^{12}	1.1×10^{14}	9.9×10^{6}	5.5×10^{6}	3.7×10^{5}
2015	2.4×10^{14}	1.0×10^{12}	9.3×10^{13}	1.4×10^{7}	5.3×10^{6}	4.5×10^{5}
2014	2.5×10^{14}	9.1×10^{11}	1.1×10^{14}	1.0×10^{7}	4.1×10^{6}	3.4×10^{5}
2013	1.7×10^{14}	7.8×10^{11}	1.1×10^{14}	8.4×10^{6}	3.7×10^{6}	4.4×10^{5}
2012	2.6×10^{14}	8.8×10^{11}	1.1×10^{14}	1.1×10^{7}	4.5×10^{6}	---
2011	2.1×10^{14}	1.0×10^{12}	9.9×10^{13}	1.5×10^{7}	8.2×10^{6}	---

Table I.10: PNGS 5-8 annual radionuclide releases to atmosphere for 2011 – 2017

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
2017 DRL	1.9×10^{17}	2.0×10^{15}	4.7×10^{16}	8.9×10^{12}	7.2×10^{11}	1.2×10^{11}
2017	3.8×10^{14}	1.3×10^{12}	3.5×10^{12}	4.3×10^{6}	2.0×10^{8}	3.7×10^{5}
2016	4.6×10^{14}	1.2×10^{12}	5.8×10^{12}	4.1×10^{6}	2.4×10^{7}	6.2×10^{5}
2015	3.0×10^{14}	1.0×10^{12}	1.6×10^{13}	4.6×10^{6}	1.5×10^{7}	6.1×10^{5}
2014	2.8×10^{14}	9.1×10^{11}	1.1×10^{13}	5.2×10^{6}	3.8×10^{6}	5.2×10^{5}
2013	2.4×10^{14}	9.1×10^{11}	6.5×10^{12}	4.4×10^{6}	5.0×10^{6}	5.8×10^{5}
2012	2.8×10^{14}	9.4×10^{11}	1.9×10^{13}	6.6×10^{6}	3.6×10^{6}	---
2011	3.4×10^{14}	7.7×10^{11}	8.4×10^{13}	8.8×10^{6}	3.6×10^{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 I.11: Pickering annual radionuclide releases to surface waters for 2011 – 2017

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 DRL	3.7×10^{17}	1.7×10^{12}	7.0×10^{17}	3.2×10^{12}	6.0×10^{13}	2.6×10^{13}
2017	1.1×10^{14}	6.6×10^{9}	2.7×10^{14}	2.0×10^{10}	1.9×10^{9}	$<2.5 \times 10^{6}$
2016	1.1×10^{14}	6.8×10^{9}	2.1×10^{14}	5.1×10^{10}	4.7×10^{9}	$<3.7 \times 10^{6}$
2015	9.9×10^{13}	4.9×10^{9}	2.7×10^{14}	1.7×10^{10}	2.8×10^{9}	5.4×10^{6}
2014	1.0×10^{14}	9.0×10^{9}	2.4×10^{14}	2.3×10^{10}	1.5×10^{9}	3.2×10^{6}
2013	1.8×10^{14}	6.7×10^{9}	1.9×10^{14}	2.6×10^{10}	1.7×10^{9}	1.3×10^{6}
2012	1.1×10^{14}	1.1×10^{10}	1.8×10^{14}	1.9×10^{10}	1.1×10^{9}	7.7×10^{6}
2011	1.2×10^{14}	5.1×10^{9}	2.0×10^{14}	1.4×10^{10}	2.2×10^{9}	4.8×10^{6}

Point Lepreau

Point Lepreau has DRLs for each individual noble gas and particulate category and therefore monitors and reports on a 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.12: Point Lepreau annual radionuclide releases to atmosphere for 2011 – 2017

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)
2017 DRL	2.8×10^{17}	6.8×10^{15}	a	6.0×10^{13}	a
2017	1.5×10^{14}	3.1×10^{11}	4.6×10^{13}	$<5.2 \times 10^{5}$	$<2.2 \times 10^{6}$
2016	1.5×10^{14}	1.1×10^{11}	9.5×10^{13}	5.2×10^{5}	$<2.2 \times 10^{6}$
2015	1.4×10^{13}	7.1×10^{10}	5.9×10^{12}	$<5.0 \times 10^{5}$	$<8.1 \times 10^{5}$
2014	6.6×10^{13}	8.4×10^{10}	3.8×10^{12}	---	---
2013	9.1×10^{13}	8.0×10^{10}	4.6×10^{12}	---	---
2012	1.4×10^{14}	3.7×10^{10}	8.0×10^{11}	---	---
2011	4.3×10^{11}	3.3×10^{15}	---	---	---

a: Specific DRLs are calculated for a range of noble gas and particulate categories

Releases to surface waters:

Table I.13: Point Lepreau annual radionuclide releases to surface waters for 2011 – 2017

Year	Tritium: (HTO: Bq)	Gross beta (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
2017 DRL	4.6×10^{19}	a	3.3×10^{14}	a
2017	1.2×10^{14}	7.8×10^{7}	1.8×10^{9}	7.9×10^{6}
2016	1.8×10^{14}	7.8×10^{7}	2.9×10^{9}	7.9×10^{6}
2015	1.4×10^{14}	5.5×10^{7}	1.0×10^{10}	6.7×10^{6}
2014	3.2×10^{14}	1.5×10^{8}	6.6×10^{9}	8.6×10^{6}
2013	2.9×10^{14}	1.5×10^{8}	4.3×10^{9}	8.6×10^{6}
2012	7.8×10^{14}	7.2×10^{7}	3.8×10^{10}	6.5×10^{6}
2011	3.4×10^{13}	8.2×10^{7}	1.4×10^{7}	5.8×10^{6}

a: Specific DRLs are calculated for a range of noble gas and particulate categories

Gentilly-2

Releases to atmosphere:

Table I.14: Gentilly-2 annual radionuclide releases to atmosphere for 2011 – 2017.
The applicable DRLs for end of calendar year 2017 (updated[1] and in force July 2017) are presented.

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)
2017 DRL	1.7×10^{17}	1.2×10^{15}	NA[2]	NA[2]	8.0×10^{11}
2017	7.31×10^{13}	4.47×10^{11}	<LD[a]	<LD[a]	8.32×10^{6}
2016	7.31×10^{13}	3.79×10^{11}	<LD[a]	<LD[a]	5.17×10^{5}
2015	1.12×10^{14}	4.10×10^{11}	<LD[a]	<LD[a]	1.35×10^{6}
2014	1.19×10^{14}	4.83 X 1011	3.15×10^{9}	<LD[a]	2.92×10^{5}
2013	1.14×10^{14}	7.49×10^{11}	6.96×10^{8}	<LD[a]	8.65×10^{5}
2012	2.13×10^{14}	4.41×10^{11}	3.87×10^{11}	8.31×10^{6}	1.79×10^{6}
2011	1.90×10^{14}	2.71×10^{11}	1.16×10^{11}	<LD[a]	9.13×10^{5}

[1] Updated to CSA N288 -14.
[2] Not applicable as facility is in safe shut-down.
[a] = less than analytical detection limit

Releases to surface waters:

Table I.15 Gentilly-2 annual radionuclide releases to surface waters for 2011 – 2017
The applicable DRLs for end of calendar year 2017 (updated[1] and in force July 2017) are presented.

Year	Tritium: (HTO: Bq)	Gross beta (Bq)	Carbon-14 (Bq)
DRL	1.1×10^{19}	5.3×10^{13}	7.3×10^{14}
2017	2.17×10^{14}	3.28×10^{8}	2.79×10^{11}
2016	3.83×10^{13}	1.33×10^{8}	5.64×10^{10}
2015	1.51×10^{14}	5.28×10^{8}	3.00×10^{11}
2014	3.56×10^{14}	2.86×10^{8}	5.28×10^{10}
2013	2.14×10^{14}	1.84×10^{9}	1.15×10^{10}
2012	3.51×10^{14}	1.09×10^{9}	2.88×10^{10}
2011	2.44×10^{14}	5.35×10^{9}	1.89×10^{10}

[1] Updated to CSA N288 -14.

Appendix J: LIST OF COMPLETED CNSC INSPECTIONS IN 2017

J.1 Bruce A and B

Safety and control area	Inspection title	Inspection report sent date
Management System	Contractor Management Report Number: BRPD-AB-2017-006	May 3, 2017
	OPEX Report Number: BRPD-AB-2017-010	Jul 6, 2017
Human performance management	Fatigue Management (Desktop Review) Report Number: BRPD-AB-2017-007	Mar 8, 2017
	Design, Development, and Grading of a Bruce A Simulator-based Examination (Desktop Review) Report Number: BRPD-A-2017-002	Apr 4, 2017
	Bruce Engineering Division Personnel Training Program Report Number: BRPD-AB-2017-013	Nov 17, 2017
	Design and Development of the July 2017 Bruce A ANO Simulator-based Certification Examination (Desktop Review) Report Number: BRPD-A-2017-007	Dec 20, 2017
	Reactor Unit Comprehensive Simulator-Based Requalification Test at Bruce B Report Number: BRPD-B-2017-007	Jan 25, 2017
Operating performance	Bruce A and B Generating Stations Quarterly Field Inspection - Quarter 4, Fiscal Year 2016-2017 Report Number: BRPD-AB-2017-011	Jun, 6, 2017
	Unit 5 Planned Outage Report Number: BRPD-B-2017-001	Jul 7, 2017
	SDS2 System Inspection Report Number: BRPD-A-2017-003	Aug 15, 2017
	Bruce A and B Generating Stations Quarterly Field Inspection - Quarter 1, Fiscal Year 2017-2018 Report Number: BRPD-AB-2017-015	Sep 13 , 2017
	Event Investigation Inspection Report Number: BRPD-AB-2017-017	Nov 9, 2017
	Bruce A and B Generating Stations Quarterly Field Inspection - Quarter 2, Fiscal Year 2017-2018 Report Number: BRPD-AB-2017-019	Nov 20, 2017
	Unit 2 Forced Outage Report Number: BRPD-A-2017-006	Nov 22, 2017
	Unit 3 Planned Outage	Dec 19, 2017

Safety and control area	Inspection title	Inspection report sent date
	Report Number: BRPD-A-2017-004	
	Bruce A and B Generating Stations Quarterly Field Inspection - Quarter 3, Fiscal Year 2017-2018 Report Number: BRPD-AB-2017-020	Jan 17, 2018
	Unit 6 Planned Outage Report Number: BRPD-B-2017-006	Jan 18, 2018
Physical design	Fire Protection Bruce A and B Report Number: BRPD-AB-2017-004	May 2, 2017
	Instrumentation Calibration Report Number: BRPD-AB-2017-016	Nov 7, 2017
	Electrical Power Systems Report Number: BRPD-B-2017-005	Dec 13, 2017
	Pressure Boundary Program Report Number: BRPD-AB-2017-002	Apr 3, 2017
	Software Maintenance Report Number: BRPD-AB-2017-018	Dec 13, 2017
Fitness for service	Chemistry Control Report Number: BRPD-AB-2017-005	Apr 12, 2017
	Emergency Water System and Interunit Feedwater Tie System Report Number: BRPD-B-2017-002	Apr 28, 2017
	Emergency Boiler Cooling System Report Number: BRPD-A-2017-001	May 2, 2017
Radiation protection	Worker Dose Control at Bruce Power Report Number: BRPD-AB-2017-001	Mar 7, 2017
	Occupational ALARA Planning and Controls Report Number: BRPD-AB-2017-014	Nov 10, 2017
Conventional health and safety	Electrical Shock Reactive Inspection - B-2017-28612767 Report Number: BRPD-B-2017-004	Aug 15, 2017
Environmental protection	Conventional Hazardous Waste Report Number: BRPD-AB-2017-003	Apr 12, 2017
	Environmental Monitoring Report Number: BRPD-AB-2017-021	Feb 2, 2018
Emergency management and fire protection	Fire Drill Report Number: BRPD-AB-2017-009	Jun 14, 2017
	Emergency Exercise Bruce B Report Number: BRPD-B-2017-008	Jan 26, 2018
Security	Security Inspection (BRPD-AB-2017-008)	Jun 6, 2017

Safety and control area	Inspection title	Inspection report sent date
	Security Inspection (BRPD-AB-2017-012)	Oct 13, 2017

J.2 Darlington

Safety and control area	Inspection title	Inspection report sent date
Management system	Problem Identification and Resolution (Event Investigation) Report Number: DRPD-2017-023	Dec 22, 2017
	Management Systems Report Number: OPG-DWMF-2017-01	Jul 17, 2017
	OPG Contract Management Personnel Training Report Number: OPG-2017-005	Jan 18, 2018
Human performance management	Authorized Nuclear Operator Training Program Report Number: OPG-2017-004	May 24, 2017
	Conduct of a Simulator-based certification examination Report Number: DRPD-2017-015	Sep 15, 2017
	Chemical Laboratory Staff Training Program Report Number: OPG-2017-008	
Operating performance	Refurbishment Work Planning and Scheduling Report Number: DRPD-2017-002	Feb 28, 2017
	Quarterly Inspection, Third Quarter FY 2016/17 Report Number: DRPD-2017-003	Mar 13, 2017
	Defueling inspection Report Number: DRPD-2017-004	Mar 24, 2017
	Refurbishment INS-14-01 Report Number: DRPD-2017-005	May 26, 2017
	Tritium Removal Facility Inspection Report Number: DRPD-2017-006	Apr 6, 2017
	Quarterly Field Inspections - Q4 Report Number: DRPD-2017-011	Jun 28, 2017
	Quarterly Field Inspections – Q1 Report Number: DRPD-2017-016	Sep 15, 2017
	Foreign Material Exclusion Report Number: DRPD-2017-019	Nov 24, 2017
	Outage Inspection (Generic: GSS, HS, Start-up, Maintenance, HP-TII-3A) D1711 Report Number: DRPD-2017-020	Nov 2, 2017
	Quarterly Refurbishment Field Inspections - Q1 Report Number: DRPD-2017-021	Dec 15, 2017

Safety and control area	Inspection title	Inspection report sent date
	Quarterly Field Inspections - Q2 Report Number: DRPD-2017-024	Dec 22, 2017
	Supply Management (Refurbishment INS-01-01) Report Number: DRPD-2017-025	Jan 22, 2018
	Multiple SCAs (Operating Performance) Report Number: OPG-DWMF-2017-02	Feb 13, 2018
Physical design	Pressure Boundary Program and AIA Services Agreement Inspection Report Number: DPRD-2017-008	Jun 5, 2017
	Unit 2 Refurbishment Temporary Containment Boundary Pressure Test Report Number: DRPD-2017-009	Aug 3, 2017
	Safety Improvement Opportunity Compliance Verification: Containment Filtered Venting System Report Number: DRPD-2017-012	Jul 21, 2017
System Design	Safety Improvement Opportunity Compliance Verification: Powerhouse Steam Venting System Report Number: DRPD-2017-001	Feb 9, 2017
Fitness for service	Software Maintenance Report Number: DRPD-2017-018	Nov 24, 2017
Radiation protection	Radiation Protection activities associated with the reactor vault during refurbishment (Refurb INS-07-03) Report Number: DRPD-2017-027	Jan 18, 2017
	Worker Dose Control Report Number: DRPD-2017-013	Jul 21, 2017
Conventional Health and Safety	Darlington Refurbishment Conventional Health and Safety, INS-08-01 Report Number: DRPD-2017-007	Jun 5, 2017
Emergency management and fire protection	Emergency Exercise (RD-353) Report Number: DRPD-2017-022	Dec 15, 2017
	Fire Protection (Refurbishment INS-10-02) Report Number: DRPD-2017-026	Jan 22, 2017
	Safety Improvement Opportunity Compliance Verification: Emergency Power Generator 3 Report Number: DRPD-2017-014	Jul 21, 2017
Security	Force on Force Report Number: DRPD-2017-010	
	Site Security Inspections - SS1 (Rounds) Report Number: DRPD-2017-017	

J.3 Pickering

Safety and control area	Inspection title	Inspection report sent date
Management system	Organization Roles & Responsibilities Report Number: PRPD-2017-003/ OPG-2017-003"	April 6, 2017
	Self & Independent Assessments Report Number: PRPD-2017-013	Aug 31, 2017
	Contractor Management Inspection Report Number: PRPD-2017-010	Sep 26, 2017
	OPG Contract Management Personnel Training Report Number: OPG-2017-005	Jan 18, 2018
Human performance management	Conduct of Simulator Based Requalification Tests Report Number: PRPD-2016-022	Feb 13, 2017
	Pickering Radiation Protection Technician Training Program Report Number: PRPD-2017-005	Mar 07, 2017
	Authorized Nuclear Operator Training Program Report Number: PRPD-2017-004 /OPG-2017-004	May 24, 2017
	Minimum Shift Complement Report Number: PRPD-2017-011	Jul 28, 2017
	Chemical Laboratory Staff Training Program Report Number: OPG-2017-008	
Operating performance	Q3 Quarterly Report 17-18 Report Number: PRPD-2015-29	Feb 29, 2016
	Unit 6 P1561 Outage Report Number: PRPD-2015-26	Mar 14, 2016
	Q1 Quarterly Report 16-17 Report Number: PRPD-2016-016	Aug 31, 2016
	Q3 Quarterly Report 16-17 Report Number: PRPD-2016-025	Mar 13, 2017
	P1671 Unit 7 Planned Maintenance Outage Report Number: PRPD-2016-026	Apr 12, 2017
	Q4 Quarterly Report 17-18 Report Number: PRPD-2017-012	Jun 13, 2017
	Pickering Waste Management Facility Report Number: OPG-PWMF-2017-01	Jul 04, 2017
	Q1 Quarterly Report 17-18 Report Number: PRPD-2017-018	Aug 21, 2017
	Planned Maintenance Outage Report Number: PRPD-2017-014	Sep 20, 2017

Safety and control area	Inspection title	Inspection report sent date
	Q2 Quarterly Report 17-18 Report Number: PRPD-2017-020	Dec 8, 2017
	Pickering Waste Management Facility Report Number: OPG-PWMF-2017-02	Feb 14, 2018
Physical design	Units 1-4 Electrical Distribution System Report Number: PRPD-2016-019	Feb 2, 2017
	Environmentally qualified equipment Report Number: PRPD-2016-020	Feb 21, 2017
Fitness for service	Chemistry Control Report Number: PRPD-2017-002	May 15, 2017
	Instrument Air Report Number: PRPD-2017-001	May 29, 2017
	Fuel Channel Pressure Tubes Analysis and Methodologies Report Number: PRPD-2017-007	Sep 13, 2017
	Maintenance & Reliability - Reactive Desktop Review Report Number: PRPD-2017-022	Jan 25, 2018
Radiation protection	Fixed Area Gamma Monitoring (FAGM) and Semi-Portable Alarming Gamma Monitoring (S-PAGM) systems Report Number: PRPD-2016-023	Mar 6, 2017
	Worker Dose Control Report Number: PRPD-2017-008	Apr 4, 2017
Environmental protection	Non Radiological Hazardous Waste Management Report Number: PRPD-2017-009	Aug 30, 2017
Emergency management and fire protection	Fire Protection Program Report Number: PRPD-2017-006	May 15, 2017
	Record of Fire Protection Equipment Deficiencies Report Number: PRPD-2017-FIR-043	Dec 21, 2017
Security	Pickering Waste Management Facility Report Number: PWMF-NSD-2017-001	Nov 29, 2017

J.4 Point Lepreau

Safety and control area	Inspection title	Inspection report sent date
Operating performance	Quarterly Field Inspection Report Q3 2016-2017 Report Number: GPLRPD-2017-001	May 4, 2017
	Quarterly Field Inspection Report Q4 2016-2017 Report Number: GPLRPD-2017-005	Jun 8, 2017
	Quarterly Field Inspection Report Q1 2017-2018 Report Number: GPLRPD-2017-009 Q1 2017-2018	Aug 8, 2017
	Quarterly Field Inspection Report Q2 2017-2018 Report Number: GPLRPD-2017-014 Q2 2017-2018	Nov 28, 2017
	Quarterly Field Inspection Report Q3 2017-2018 Report Number: GPLRPD-2017-022	Jan 25, 2018
	Site Outage Inspection Report Number: GPLRPD-2017-018	Jan 24, 2017
	Outage Inspection Report Number: GPLRPD-2017-004	Jul 20, 2017
Human performance management	Training Programs (for NLOs) Report Number: GPLRPD-2017-008	Aug 3, 2017
	Conduct of Simulator Certification and Examinations and Requalification Tests Report Number: GPLRPD-2017-015	Dec 22, 2017
	Conduct of a Simulator Based Certification Examination Report Number: GPLRPD-2017-002	May 16, 2017
	Conduct of Written Certification Examinations and Requalification Tests Report Number: GPLRPD-2017-020	Jan 19, 2018
Fitness for service	Instrument Calibration Report Number: GPLRPD-2017-011	Dec 12, 2017
Radiation protection	Radiological Hazard Control Report Number: GPLRPD-2017-006	Jul 4, 2017
Environmental Protection	Effluent Control and Monitoring - EF2 Site Specific Report Number: GPLRPD-2017-016	Jan 24, 2018
Packaging and Transport	Packaging and Transport Inspection at NPP's Report Number: GPLRPD-2017-017	Dec 12, 2017
Security	Security	

Safety and control area	Inspection title	Inspection report sent date
	Report Number: GPLRPD-2017-003	
	Cyber Security Report Number: GPLRPD-2017-007	
	Monitor Security Exercise (SSE) Report Number: GPLRPD-2017-010	
	Site Security Inspections – SS1 (Rounds) Report Number: GPLRPD-2017-012	
	Site Security Inspections – SS2 Report Number: GPLRPD-2017-013	

J.5 Gentilly-2

Safety and control area	Inspection title	Inspection report sent date
Management system	Conservation des enregistrements à Gentilly-2 Report Number: DPRGPL-2017-001	Sep 17, 2017
Security	Security Inspection Report Number: DPRGPL-2017-002	Aug 14, 2017

J.6 WWMF

Safety and control area	Inspection title	Inspection report sent date
Management System	Management Systems Report Number: OPG-DWMF-2017-01	Jul 17, 2017
	Management Systems Report Number:OPG-RWOS1-2017-01	Jul 17, 2017
Operating Performance	Baseline Inspection Western Waste Management Facility Report Number:OPG-WWMF-2017-01	Jul 4, 2017
	Baseline Inspection Western Waste Management Facility Report Number:OPG-WWMF-2017-02	Aug 8, 2017
	OPG's Western Waste Management Facility Report Number:OPG-WWMF-2017-03	Feb 5, 2018
Security	Security Inspection at WUFDSF Report Number: WUFDSF-NSD-2017-001	Jan 10, 2018

Appendix K: RESPONSIBILITIES AND DETAILS FOR NUCLEAR EMERGENCY PREPAREDNESS AND RESPONSE

Nuclear Emergency Response in Canada

In Canada, nuclear emergency response is a shared responsibility among all levels of government and the private sector. In accordance with International Atomic Energy Agency (IAEA) guidance and requirements, Canadian nuclear emergency response responsibilities are subdivided into onsite and offsite nuclear emergency response.

Onsite nuclear emergency response pertains to all actions and measures taken within the boundary of the licensee site, whereas offsite nuclear emergency response pertains to actions and measures taken outside and beyond the boundary of the licensee site. These two areas of response require specific roles and responsibilities from different stakeholders yet, closely related as they are, they also require coordination between all levels of government and the CNSC licensee. For example:

- CNSC licensees are responsible for onsite nuclear emergency response and emergencies that may occur offsite.
- Provincial governments are responsible for offsite nuclear emergency response.
- If requested by the provincial government, the federal government may provide support to the province.

All levels of government and the CNSC have nuclear emergency response plans in place, including operational facilities equipped and staffed for coordinating and directing their responses to a nuclear emergency. In addition, all CNSC licensees have emergency response plans and/or measures in place to effectively respond in the event of an emergency. The CNSC maintains regulatory oversight of the nuclear emergency response carried out by the licensee.

Licensees

In Canada, the CNSC licensees are the onsite authorities responsible for the management and implementation of onsite emergency response, in accordance with their CNSC-approved emergency response plans and procedures. This means that the licensees are directly responsible for:

- identifying and assessing the safety significance of the emergency
- controlling and mitigating the emergency
- notifying and coordinating with the offsite authorities and the CNSC
- notifying the CNSC in accordance with applicable regulations and licence conditions
- providing recommendations regarding offsite protective actions
- informing the general public about onsite actions and conditions (e.g., reactor status)

The licensees' communications and alert strategies include sirens (in the immediate vicinity of NPPs), automated phone dialing systems, vehicle-mounted mobile public address systems, media messages (radio/television), Web site information, email alerts and, in some areas, door-to-door notification.

Provincial, territorial or municipal governments

For emergencies that have an offsite impact, the provincial, territorial or municipal government is the appropriate responsible authority for offsite actions.

Provincial and territorial governments have the primary responsibility for protecting public health and safety, property, and the environment within their borders. They are also the primary authorities for informing the general public about protective actions and offsite conditions.

The provinces determine the needs for, and direct the implementation of, protective actions, which can include:

- sheltering
- evacuation
- ingestion of KI pills
- ingestion control measures

The provinces also ensure, in coordination with municipalities, that arrangements are in place for:

- facilitating the availability of KI pills
- establishing reception and evacuation centres to accommodate evacuees
- establishing emergency worker centres to ensure radiation protection for emergency workers

Federal government

Under the *Emergency Management Act* (EMA), the Minister of Public Safety is responsible for coordinating the Government of Canada's (GC) response to an emergency. The Federal Emergency Response Plan (FERP) is the GC's "all-hazards" response plan. The Federal Nuclear Emergency Plan (FNEP) is an annex to the FERP, providing the supplemental and specific multi-departmental and inter-jurisdictional arrangements necessary to address the health risks associated with a radiological or nuclear emergency.

During an integrated GC response to a nuclear emergency under the FERP/FNEP, all levels of government and various agencies and organizations have the responsibility to develop and implement emergency response plans to deal with the consequences and impacts outside the boundaries of the nuclear facility licensed by the CNSC. The licensee is responsible for the response inside the boundaries of its facility.

An integrated GC response is required when:

- a province/territory requests federal support to deal with an emergency
- an emergency affects multiple jurisdictions and/or government institutions, and requires a coordinated response
- an emergency directly involves federal assets, services, employees, statutory authority or responsibilities, or affects confidence in government

- an emergency affects other aspects of the national interest

Global Affairs Canada (GAC) is also responsible for liaisons with the international community and their diplomatic missions in Canada, for assisting Canadians abroad, and for coordinating the national response to nuclear emergencies that occur in foreign countries, but have an impact on Canada.

CNSC

For nuclear emergencies involving licensed facilities and substances, the CNSC:

- performs regulatory oversight of the licensee's activities (monitoring, evaluation of protective action recommendations, advice, assistance, and, when appropriate, direction in the form of directives and orders)
- performs an independent assessment of the onsite conditions and potential offsite consequences, to provide or confirm the licensee's recommendations concerning any protective measures that may be needed
- participates, as a federal agency, in the whole-of-government response to a nuclear emergency, in accordance with the requirements of both the FERP and the FNEP

For nuclear emergencies not involving licensed substances, the CNSC plays a supporting role to the response under the FERP/FNEP. This includes (but is not limited to) providing technical assistance and support to the lead organization, in accordance with CNSC's authorities and responsibilities.

Compliance verification by CNSC Inspectors

CNSC inspectors, including emergency preparedness inspectors, perform inspections routinely to confirm the licensees' emergency preparedness programs are always fully implemented and functional.

The NPP and WMF licensees maintain emergency plans that include measures to address on-site emergencies as well as measures that support planning, preparedness and response for off-site emergencies. Each licensee's emergency plan is specific to its particular site and organization; however, all emergency plans typically cover:

- documentation of the emergency plan
- basis for emergency planning
- personnel selection and qualification
- emergency preparedness and response organizations
- staffing levels
- emergency training, drills and exercises
- emergency facilities and equipment
- emergency procedures
- assessment of emergency response capability
- assessment of accidents
- activation and termination of emergency responses
- protection of facility personnel and equipment
- interface arrangements with offsite organizations
- arrangements with other agencies or parties for assistance

- recovery program
- public information program
- public education program