Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

CMD: 19-M30

Date signed/Signé le : 6 SEPTEMBER 2019

Annual Report

Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018

Public Meeting

Scheduled for:

6 November 2019

Submitted by:

CNSC Staff

Rapport annuel

Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada : 2018

Réunion publique

Prévue pour :

6 novembre 2019

Soumise par :

Le personnel de la CCSN

e-Doc 5965675 (WORD)
e-Doc 5977745 (PDF)

Canada

Summary

This CMD presents the, *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018*

- Through compliance verification inspections, reviews and assessments, CNSC staff concluded that nuclear power plants (NPPs) and waste management facilities (WMFs) in Canada operated safely during 2018. 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 were reported to the International Atomic Energy Agency.

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

Résumé

Ce CMD présente le *Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada : 2018*

- 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 2018. 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 étaient 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 et radiologique 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.

only.

The following items are attached:

- *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018*

Les pièces suivantes sont jointes :

- *Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada : 2018*

Signed/signé le

6 September 2019

Gerry Frappier, P. Eng.

Director General

Directorate of Power Reactor Regulation

Directeur général

Direction de la réglementation des centrales nucléaires

Haidy Tadros

Director General

Directorate of Nuclear Cycle and Facilities Regulation

Directeur général

Direction de la réglementation du cycle et des installations nucléaires

Table of contents

EXECUTIVE SUMMARY 6

REGULATORY OVERSIGHT REPORT FOR NUCLEAR POWER GENERATING SITES: 2018 9

1 INTRODUCTION 9
1.1 About this regulatory oversight report 9
1.2 Scope 12
1.3 Nuclear facilities covered by this regulatory oversight report 13
1.3.1 Nuclear power generating sites in Canada 14
1.3.2 NPPs 14
1.3.3 WMFs 15
1.4 Regulatory framework and oversight 16
1.4.1 CNSC requirements 16
1.4.2 Licensing 17
1.4.3 Reporting 18
1.4.4 Compliance verification program 19
1.4.5 Enforcement 20
1.4.6 Safety assessment ratings 21

2 GENERAL AND SUPPORTING INFORMATION 23
2.1 Management system 23
2.2 Human performance management 25
2.3 Operating performance 30
2.4 Safety analysis 35
2.5 Physical design 41
2.6 Fitness for service 45
2.7 Radiation protection 55
2.8 Conventional health and safety 60
2.9 Environmental protection 66
2.10 Emergency management and fire protection 69
2.11 Waste management 72

2.12 Security 74
2.13 Safeguards and non-proliferation 76
2.14 Packaging and transport 78
2.15 Other matters of regulatory interest 79

3 NUCLEAR POWER PLANT AND WASTE MANAGEMENT FACILITY SAFETY PERFORMANCE AND REGULATORY DEVELOPMENTS 88
3.1 Darlington site 88
3.1.0 Introduction 89
3.1.1 Management system 94
3.1.2 Human performance management 97
3.1.3 Operating performance 98
3.1.4 Safety analysis 101
3.1.5 Physical design 103
3.1.6 Fitness for service 104
3.1.7 Radiation protection 107
3.1.8 Conventional health and safety 111
3.1.9 Environmental protection 112
3.1.10 Emergency management and fire protection 115
3.1.11 Waste management 117
3.1.12 Security 118
3.1.13 Safeguards and non-proliferation 119
3.1.14 Packaging and transport 120
3.2 Pickering site 122
3.2.0 Introduction 123
3.2.1 Management system 130
3.2.2 Human performance management 131
3.2.3 Operating performance 133
3.2.4 Safety analysis 135
3.2.5 Physical design 138
3.2.6 Fitness for service 139
3.2.7 Radiation protection 142
3.2.8 Conventional health and safety 144
3.2.9 Environmental protection 145
3.2.10 Emergency management and fire protection 149
3.2.11 Waste management 151
3.2.12 Security 152
3.2.13 Safeguards and non-proliferation 153
3.2.14 Packaging and transport 154
3.3 Bruce A and B 156
3.3.0 Introduction 157
3.3.1 Management system 161

3.3.2 Human performance management ... 163
3.3.3 Operating performance ... 165
3.3.4 Safety analysis ... 167
3.3.5 Physical design ... 169
3.3.6 Fitness for service ... 171
3.3.7 Radiation protection ... 175
3.3.8 Conventional health and safety ... 176
3.3.9 Environmental protection ... 177
3.3.10 Emergency management and fire protection ... 180
3.3.11 Waste management ... 182
3.3.12 Security ... 183
3.3.13 Safeguards and non-proliferation ... 184
3.3.14 Packaging and transport ... 185
3.4 WWMF and RWOS-1 ... 186
3.4.0 Introduction ... 187
3.4.1 Management system ... 189
3.4.2 Human performance management ... 190
3.4.3 Operating performance ... 191
3.4.4 Safety analysis ... 192
3.4.5 Physical design ... 193
3.4.6 Fitness for service ... 193
3.4.7 Radiation protection ... 194
3.4.8 Conventional health and safety ... 196
3.4.9 Environmental protection ... 196
3.4.10 Emergency management and fire protection ... 198
3.4.11 Waste management ... 200
3.4.12 Security ... 201
3.4.13 Safeguards and non-proliferation ... 202
3.4.14 Packaging and transport ... 203
3.5 Point Lepreau ... 204
3.5.0 Introduction ... 205
3.5.1 Management system ... 207
3.5.2 Human performance management ... 209
3.5.3 Operating performance ... 212
3.5.4 Safety analysis ... 213
3.5.5 Physical design ... 214
3.5.6 Fitness for service ... 216
3.5.7 Radiation protection ... 219
3.5.8 Conventional health and safety ... 221
3.5.9 Environmental protection ... 222
3.5.10 Emergency management and fire protection ... 224
3.5.11 Waste management ... 226
3.5.12 Security ... 227
3.5.13 Safeguards and non-proliferation ... 228
3.5.14 Packaging and transport ... 229

3.6 Gentilly-2 230
3.6.0 Introduction 231
3.6.1 Système de gestion 232
3.6.2 Gestion de la performance humaine 233
3.6.3 Conduite de l'exploitation 234
3.6.4 Analyse de la sûreté 235
3.6.5 Conception matérielle 236
3.6.6 Aptitude fonctionnelle 236
3.6.7 Radioprotection 237
3.6.8 Santé et sécurité classiques 238
3.6.9 Protection de l'environnement 238
3.6.10 Gestion des urgences et protection-incendie 241
3.6.11 Gestion des déchets 243
3.6.12 Sécurité 244
3.6.13 Garanties et non-prolifération 245
3.6.14 Emballage et transport 246

SUMMARY AND CONCLUSIONS 247

APPENDIX A: DEFINITIONS OF SAFETY AND CONTROL AREAS 249

APPENDIX B: RATING DEFINITIONS AND METHODOLOGY 254
B.1 Definitions 254
B.2 Rating methodology 254
B.3 SCA Ratings from 2017 257

APPENDIX C: RESEARCH AND DEVELOPMENT EFFORTS IN SUPPORT OF NPP OPERATION AND REGULATION 258
C.1 Industry R&D activities 258
C.2 CNSC R&D activities 259
C.3 CANDU safety issues 261

APPENDIX D: DARLINGTON NEW BUILD 262

APPENDIX E: LIST OF REGULATORY REQUIREMENTS AT THE END OF 2018 264

APPENDIX F: FIVE-YEAR TRENDS IN COMPLIANCE ACTIVITIES 267

APPENDIX G: CURRENT AND PREDICTED STATUS OF KEY

PARAMETERS AND MODELS FOR PRESSURE TUBES IN CANADIAN POWER REACTORS 271

APPENDIX H: DERIVED RELEASE LIMITS AND RADIOLOGICAL RELEASES TO THE ENVIRONMENT 273

APPENDIX I: RESPONSIBILITIES AND DETAILS FOR NUCLEAR EMERGENCY PREPAREDNESS AND RESPONSE 283

Executive summary

This report describes the regulatory oversight and safety performance of nuclear power generating sites, consisting of nuclear power plants (NPPs) and adjacent waste management facilities (WMFs) in Canada in 2018. For certain topics, updates on developments in 2019 are also described. This is the second CNSC regulatory oversight report to cover both NPPs and WMFs.

The following list identifies the facilities for each site covered by this report. Each line in the list identifies facilities that are located at the same site and, governed by a single CNSC licence 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 (PLNGS) and Solid Radioactive Waste Management Facility (SRWMF)
- Bruce A Nuclear Generating Station and Bruce B Nuclear Generating Station
- 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 2018 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 2018. CNSC staff continue to follow up on those developments and corrective actions that were not concluded by the end of 2018.

The licensing and compliance activities were conducted in the context of robust regulatory requirements. These requirements include those found in CNSC regulatory documents and CSA Group standards, which continued to evolve in 2018 as both organizations published new and revised documents. NPP and WMF licensees were in the process of implementing various new requirements in 2018, and CNSC staff were satisfied with the overall progress.

CNSC staff concluded that the NPPs and WMFs operated safely in 2018 and that the licensees upheld their responsibilities for safety and promoted healthy safety culture. 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 also below the regulatory limits.
- 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 as follows:

FS fully satisfactory

SA satisfactory

BE below expectations

UA unacceptable

Canadian NPP safety performance ratings for 2018

Safety and control area	DNGS	PNGS	Bruce A	Bruce B	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**	**FS**	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	SA	SA	**FS**	**FS**	SA	SA
Conventional health and safety	**FS**	**FS**	**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	SA	SA	SA	SA	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

Canadian WMF safety performance ratings for 2018

Safety and control area	DWMF	PWMF	WWMF
Management system	SA	SA	SA
Human performance management	SA	SA	SA
Operating performance	SA	SA	SA
Safety analysis	SA	SA	SA
Physical design	SA	SA	SA
Fitness for service	SA	SA	SA
Radiation protection	SA	SA	SA
Conventional health and safety	SA	SA	SA
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

REGULATORY OVERSIGHT REPORT FOR NUCLEAR POWER GENERATING SITES: 2018

1 INTRODUCTION

1.1 About this regulatory oversight report

The *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018* provides Canadian Nuclear Safety Commission (CNSC) staff's assessment of the overall safety performance of Canadian nuclear power plants (NPPs) and their adjacent waste management facilities (WMFs) for 2018.

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 some general assessments of all licensees in the area of security, since the information presented in section 3 for individual sites is limited in most cases.

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 headings 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, as it existed on June 1, 2019. 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.

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

Some of the assessments in sections 2 and 3 include information that addresses requests from the Commission. Specifically, information has been included to fulfill actions that the Commission assigned to CNSC staff through the CNSC's regulatory information bank (RIB) system. Table 2 lists the RIB actions that were requested to be addressed by this report and provides a reference to the relevant part of the report.

Table 2: Actions from Commission Addressed by this report

RIB #	Action	Report section
19297	Include injury data for third-party contractors for operating NPPs	2.8
18711	Include plain-language summary	To be addressed outside this report
17561	Enhance the data for corrective maintenance backlog to show	3.1.6,

RIB #	Action	Report section
	trends during the year	3.2.6, 3.3.6, 3.5.6
17560	Include data for total recordable injury frequency for all workers, including contractors, if it is available	Data is not yet available
17559	Explain the targets used by the World Association of Nuclear Operators for trips of various reactor types	2.3
17557	Follow-up the licence renewal for Pickering Nuclear Generating Station (PNGS) (i) provide update the status of the integrated implementation plan (IIP) (ii) describe methodology and progress for whole site probabilistic safety assessment (PSA) (iii) provide update on the joint fuel machine reliability project	 3.2.0 3.2.4 2.6
17525	Describe implementation of new licensing basis documents for PNGS (i) CNSC REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* (ii) CNSC REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* (iii) CNSC REGDOC-2.4.1, *Deterministic Safety Analysis* (iv) CSA N285.4-14, *Periodic Inspection of CANDU Nuclear Power Plant Components* (v) CSA N285.5-13, *Periodic inspection of CANDU nuclear power plant containment components*	 2.2 2.2 3.2.4 3.2.6 Not covered by this report
17522	Provide update on emergency management and preparedness at PNGS (i) 2017 Ontario Provincial Nuclear Emergency Response Plan (PNERP) (ii) implementation plan for PNGS for 2017 PNERP (iii) results from the technical study for 2017 PNERP (iv) Ontario's unified transport management plan (v) revision of public information and disclosure program for PNGS in regard to emergency preparedness and provision of information to populations beyond the detailed planning zone	 2.10 3.2.10 Info not available 2.10 Info not available
16516	Provide update on PNGS fish diversion system (i) improvements and resulting fish impingement rate (ii) results of OPG's thermal plume monitoring (iii) a) OPG's compliance with its *Fisheries Act* authorization and b) involvement of Indigenous groups in activities related to the authorization	 Info not available Info not available a) 3.2.0 b) 2.15

RIB #	Action	Report section
15153	Explain how provinces share information for nuclear emergencies and exercises	Appendix I
14777	Provide update on improvements related to exposure to alpha particle events (radiation protection measures, regulatory oversight)	2.7
14776	Provide update on Bruce Power's maintenance of nuclear liability insurance	2.15
14763	Describe Bruce Power's corrective action to address equipment performance/fitness for service issues discussed at licence renewal (i) primary heat transport system pumps seals (ii) isolation valves for emergency coolant injection system (quality control issue) (iii) isolation valves for emergency coolant injection system (issue related to vibration)	3.3.5
14762	Describe Bruce Power's corrective action to address design-related non-conformances with modern codes and standards for its fire protection system	3.3.5
14761	Describe enhancements at Bruce A to bring internal fire risk below the safety goal target	3.3.4
14760	Monitor Bruce Power's work to perform site-wide PSA for the next licence renewal	3.3.4
14759	Report Bruce Power's progress on determining aggregate safety goals and targets for the next licence renewal	Nothing to report for 2018
14758	Describe CNSC's work to formally collaborate with Saugeen Ojibway Nation with respect to operation of Bruce A and B	2.15
14757	Describe developments related to pressure tube fracture toughness for Bruce A and B, including fracture toughness modelling and estimates of the maximum amount of equivalent hydrogen	3.3.6
14755	Provide update on the implementation of automated data transfer from Bruce A and B to the CNSC emergency operations centre	3.3.10
14753	Provide update on status of major component replacement for Bruce A and B	3.3.0
8504	Provide update on CNSC's regulatory position on risk aggregation	2.4

The assessment for each site in Section 3 includes a list of the CNSC inspection reports that form the basis of many of the observations and conclusions for that site.

The conclusions of this report are provided in Section 4.

1.2 Scope

The scope of the *Regulatory Oversight Report for Canadian Nuclear Power Generating Sites: 2018* is similar to that of the *Regulatory Oversight Report for Canadian Nuclear Power Plants: 2017*. It covers the NPPs in Canada, including Gentilly-2. General statements in the report that refer to "NPPs" are intended to apply to Gentilly-2, whereas the phrase "operating NPPs" is used

for statements that do not apply to Gentilly-2. The report also covers the WMFs located at the same sites, regardless if they are regulated under the same licence or licensed separately.

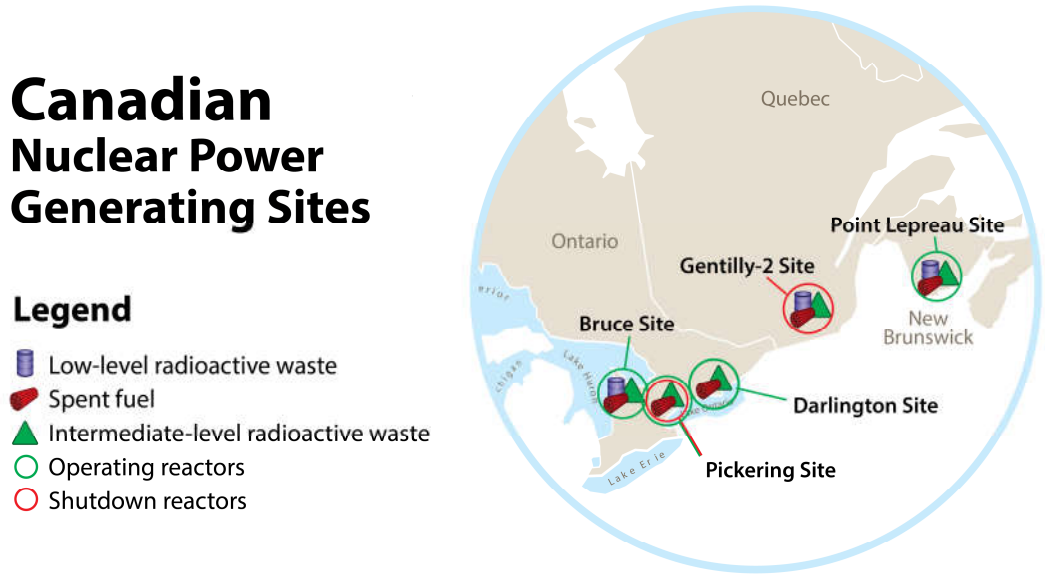
Generally speaking, the information provided in this regulatory oversight report is pertinent to 2018, and the status that is described is valid as of December 2018. The word "UPDATE" is used in the report to identify topics where more recent information (up to June 1, 2019) is included (e.g., descriptions of significant events or updates that were specifically requested by the Commission). Also note that the tables of event initial reports that are provided for each site in Section 3 include any event initial reports that were presented to the Commission related to events from January 1, 2018 to June 1, 2019.

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 sections 2 and 3 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 – the applicability is described in tables in section 3. Some of the applicable specific areas may not have been assessed for 2018 if there was a lack of relevant information; this is discussed further in section 1.4.6. The assessments of the applicable specific areas for each SCA form the basis of the discussion in section 3. In some cases, if the specific area was rated "satisfactory" and there were no significant developments in 2018, there is no discussion of the specific area; this is noted in the tables in section 3, as applicable.

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 of 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 Bruce site is located in Tiverton, ON and consists of the Bruce A and B Nuclear Generating Stations, OPG's Western Waste Management Facility (WWMF) and Radioactive Waste Operations Site-1 (RWOS-1) and Canadian Nuclear Laboratory's (CNL) Douglas Point Waste Facility. Bruce A and B are licenced together. The WWMF, RWOS-1, and Douglas Point Waste Facility are all licenced separately. See Sections 3.3 and 3.4 for details. Note that the Douglas Point Waste Facility 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*.

The Point Lepreau site is located on the Lepreau Peninsula, NB and consists of the Point Lepreau Nuclear Generating Station (PLNGS) and the Solid Radioactive Waste Management Facility (SRWMF). The PLNGS and SRWMF are licenced together. See Section 3.5 for details.

The Gentilly nuclear site is located in Bécancour, QC and consists of CNL's Gentilly-1 Waste Facility 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 Waste Facility 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*.

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

Table 3 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 PROL. Additional information on the NPPs and licences is provided in Section 3.

Table 3: Basic information for operating NPPs

NPP	Licensee	Location	State of reactor units	Gross capacity per unit (MWe)	Startup[1]	PROL expiry
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	September 30, 2028
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
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 reactors and NPP

PNGS also includes Units 2 and 3, which remain defueled and in safe storage. They are also CANDU designs and are governed by the same PROL 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. In 2018, OPG notified the CNSC of its intent to renew the PRSL. OPG also provided a mid- licence-term update to the Commission in 2018.

See Appendix D: for more details and a description of progress on follow-up activities related to the EA.

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 DWMF, PWMF, and WWMF, which are considered Class IB nuclear facilities, as defined in the *Class I Nuclear Facilities Regulations*. Each facility is owned and operated by OPG under a waste facility operating licence (WFOL).

Table 4 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), and high-level waste (HLW)). Additional

information on the facilities and licences is provided in Section 3.

As discussed in section 1.3.1, both the Point Lepreau and Gentilly-2 sites also have WMFs that are further discussed in sections 3.5 and 3.6, respectively.

Table 4: 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 regulates the nuclear sector in Canada, including NPPs and WMFs, through licensing, reporting, compliance verification, and enforcement. The CNSC uses a risk-informed regulatory approach, applying resources and regulatory oversight commensurate with the risk associated with the regulated facility and activity.

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, which includes leading and participating in all inspections of the operating NPPs.

1.4.1 CNSC requirements

The licences for NPPs and WMFs have a requirement for the licensee to operate in accordance with the licensing basis. The licensing basis is defined in CNSC regulatory document REGDOC-3.5.3, *Regulatory Fundamentals*. It comprises:

(i) the regulatory requirements set out in the applicable laws and regulations

(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence

(iii) the safety and control measures described in the licence application and the documents needed to support that licence application

The requirements in parts (ii) and (iii) of the licensing basis are unique to each licensed facility – they depend on the content of 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. CNSC regulatory document REGDOC-1.1.3, *Licence Application Guide: Licence to operate a Nuclear Power Plant* elaborates 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 regulatory documents, CSA Group standards, and other publications, as well as the applicant's own documentation. When a licence is issued, CNSC staff develop a licence conditions handbook (LCH, described further in section 1.4.2) to identify the specific requirements that apply to that licence. Appendix E: lists all CNSC regulatory documents and CSA Group standards that are identified as containing compliance verification criteria in the LCHs for the NPPs and WMFs covered by this regulatory oversight report. Appendix E: illustrates the large number of CNSC regulatory documents and CSA Group standards that provide requirements relevant to all SCAs. The table indicates the similarities and differences in the CNSC regulatory documents 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 regulatory documents 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 regulatory documents and CSA Group standards in a staged, risk-informed manner that takes into consideration the timing of licence renewals, operational needs, and other concurrent changes. Although 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 SCAs.

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 affected community) and Commission meetings. All Commission proceedings are open to the 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 WFOL and a PROL has been ten years and five years, respectively, whereas Gentilly-2 has a licence to decommission a power reactor with a period of ten years. The CNSC is transitioning to longer licence periods for PROLs (ten years). 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 NPP and plant performance to determine the extent to which

the NPP conforms to modern codes, standards, and practices, and to identify any factors that would limit safe, long-term operation. It provides the licensee a framework to systematically identify practicable safety enhancements, which are documented in an integrated implementation plan (IIP). 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 CNSC regulatory documents and CSA Group standards are sufficient to assure safe, long-term operation.

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

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 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 have LCHs (the PWMF 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).

Fisheries Act Authorizations

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

1.4.3 Reporting

Licensees are required to provide various reports and notices to the CNSC in accordance with 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 CNSC regulatory document 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 2018, NPP licensees reported to CNSC staff on 256 events, and submitted 90 scheduled reports. Five of these events were also presented to the Commission as event initial reports 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 2018. The event initial reports for NPPs and reportable events for WMFs are discussed in Section 3. None of these events were above level 0 on the International Nuclear and Radiological Event Scale.

Note that the CNSC published regulatory document REGDOC-3.1.2, *Reporting Requirements for Non-Power Reactor Class I Facilities and Uranium Mines and Mills* in January 2018. Beginning in 2019, the WMF will report to the CNSC in accordance with REGDOC-3.1.2.

1.4.4 Compliance verification program

The safety assessments presented in this report were based on the results of activities planned through the CNSC compliance verification program (CVP). In 2018, these activities included inspections led by inspectors and supported by subject matter experts. CNSC inspections include:

- Type II inspections, which evaluate the outputs and outcomes of licensee programs and typically involve documentation review and on-site activities
- field inspections, which are limited in scope (e.g., focusing on a specific area of the facility) and involve on-site activities to collect data on the outputs and outcomes of licensee programs

The on-site activities during inspections include workplace observations, measurements and worker interviews.

The CVP also includes desktop reviews led by a wide range of subject matter experts and surveillance and monitoring conducted by CNSC inspectors. All CVP activities in 2018 were fully documented.

Tables 5 and 6 show the CVP effort by CNSC staff for each NPP and WMF. “Other activities” includes surveillance and monitoring and desktop reviews of licensee-submitted documents and reports; for WMFs it also includes the review of event reports).

Table 5: Compliance effort for NPPs for 2018

Compliance activity	DNGS	PNGS	Bruce A and B	Point Lepreau	Gentilly-2	Total
Inspections	1,281	1,621	1,633	1,459	98	6,091
Event reviews	132	221	178	40	0	571
Other activities	2,063	3,048	2,769	1,431	214	9,525
Refurbishment	1,736	-	-	-	-	1,736
Total effort	5,212	4,890	4,580	2,929	312	16,187

Table 6: Compliance effort for WMFs for 2018

Compliance activity	DWMF	PWMF	WWMF & RWOS-1	Total
Inspections *	11	86	11	108
Other activities	79	85	219	383
Total effort	90	171	230	491

* Inspection effort is only for the first three quarters of 2018.

The total effort for NPPs and WMFs (approximately 17,000 person-hours) was comparable to 2017. The five-year trend in compliance activities is given in **Error! Reference source not found.**.

At its foundation, the CVP consists of a collection of compliance verification activities covering the 14 SCAs and are 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 example, 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 goal is to ensure that the CVP for NPPs and WMFs are always timely, risk-informed, performance-based and responsive to developments. 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.

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.

The CNSC's strategy to address non-compliances may involve the following regulatory responses and enforcement measures include:

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

Regulatory responses and 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 response or 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 and other observations and information.

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 sometimes rely on inspections conducted in previous years. Inspection findings are supplemented by conclusions from other regulatory oversight, such as review of actions stemming from previous inspections and other developments, monitoring and surveillance at site, and other interactions with the licensees. All the information is categorized into appropriate SCAs and specific areas and assessed against a set of CNSC-developed performance objectives and criteria for the SCAs.

For some specific areas, there was insufficient information to form an assessment (these specific areas are identified as "not rated" in section 3). However, even where specific areas were not assessed in detail for 2018, CNSC staff were confident, based on general regulatory oversight, and an understanding of the degree of stability of licensee programs and past performance, that no serious, safety-significant issues were present under those specific areas.

For 2018, CNSC staff reviewed the criteria for rating specific areas. Besides assessing licensees against continually evolving requirements, CNSC staff also refined its criteria for "fully satisfactory" ratings based on industry best practice. Due to this, some SCAs that were rated "fully satisfactory" in 2017 have been rated "satisfactory" in 2018. The revision of criteria also led to the decision to not include an overall rating for each facility (overall ratings were included in the regulatory oversight report for 2017). See Appendix B.2 for a comprehensive description of the rating methodology for NPPs and WMFs.

In generating the performance ratings, CNSC staff considered 1418 findings for NPPs and WMFs. All but one of the findings were assessed as being either compliant, negligible, or of low safety significance. In other words, they had a positive, insignificant, or small negative impact on safety within the specific area. There was one finding that had a significant negative effect in the context of the assessment of a specific area.

For the Bruce site, Bruce A and B are rated separately from the WWMF because they are operated by different licensees. For the Darlington and Pickering sites, the NPP and WMF are rated separately because they are regulated under separate licences and have facility-specific licensing bases. However, the NPP and WMF are discussed together in the same site sub-section as they have the same licensee and relatively similar regulatory requirements. 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 2018 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. The previous SCA ratings for the NPPs and WMFs for 2017 are provided in Appendix B.3.

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	Bruce A	Bruce B	WWMF	PLNGS	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
- operating experience

Management system

The following publications contain regulatory requirements that were relevant in 2018:

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

Details on the 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 regarding the effectiveness of licensee management systems in accordance with regulatory requirements. All licensees review their management system programs on a periodic basis to assess their effective implementation.

Organization

Each licensee defines its organizational structure, authorities, accountability, and responsibilities

of positions, including internal and external interfaces and how and by whom decisions are made. The CNSC's compliance verification activities verify that the organizational structures, accountabilities, roles and responsibilities are documented and current in the licensee's documentation.

Change management

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

Safety culture

Licensees periodically conduct safety-culture self-assessments, gathering 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, their results and the adequacy of the licensees' follow-up actions.

The following summarizes the status of safety culture self-assessments for each facility/organization.

- OPG conducted safety culture self-assessments in 2018 that covered the corporate organization, the operations and refurbishment organizations at the DNGS, the operations organization at the PNGS and all three WMFs.
- Bruce Power conducted a safety culture self-assessment in 2016 that included contractors.
- NB Power conducted a safety culture self-assessment in 2016

UPDATE: As of June 1, 2019 CNSC staff were preparing to discuss with OPG the results of its self-assessments.

The CNSC published regulatory document REGDOC 2.1.2*, Safety Culture* in April 2018. This document sets out requirements and guidance for fostering a healthy safety culture and for conducting periodic safety cultpure assessments. All licensees were requested to provide implementation plans in 2019. While continuing to plan for implementation, OPG, Bruce Power, and NB Power committed to conduct their next self-assessments in accordance with REGDOC-2.1.2.

Configuration management

Licensees maintain the alignment of the physical and operational configurations of systems, structures and components (SSCs) and their associated documentation, including their design and licensing basis requirements. The configuration management processes include the review of completion assurance prior to turnover of any modified SSCs to operation.

Records management

Records management systems, including document control, ensure that only approved and current documents are issued and used. These systems ensure that:

- Obsolete documents are withdrawn.
- Records are produced and reviewed for acceptance.

- Documents and records are available when they are needed.
- 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' implement supply chain programs that qualify suppliers and manage contractual requirements and suppliers' work. Licensees' management defines, plans, and controls the business by establishing safety objectives that meet regulatory and licensee requirements. Achievement of those objectives is measured and monitored, including aspects that are assigned to suppliers.

Business continuity

All licensees had adequate measures in 2018 to continue achieving their safety objectives in the event of disabling circumstances. Those measures included contingency plans to maintain or restore critical safety and business functions in the event of disabling circumstances, such as a pandemic, severe weather, or labour actions. For NPPs, those measures supported minimum shift complement staffing.

Performance assessment, improvement and management review

Licensees continually assess and improve their management systems. Senior management confirms the effectiveness of its management system in controlling safe operation through periodic, critical assessments. The inputs to these assessments include audit and self-assessment results, status of corrective actions including corrective actions from CNSC's staff compliance activities and key performance indicators used to maintain the control of their processes to operate safely. Licensees take actions from these assessments to resolve identified weaknesses in the management system.

Operating experience

Licensees have problem identification and corrective action programs to identify and resolve problems, as well as operating experience (OPEX) programs to obtain and disseminate lessons learned internally and externally. When problems arise, licensees take 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 underlying causes and to prevent recurrence of systemic events and events having impact on meeting business objectives. The timeframes for controlling problems and completing corrective actions are established.

For lower safety significance problems, the apparent causes are determined. Licensees perform analyses to identify systemic events (i.e. trends). Licensees also have an information gathering and review process to identify and evaluate relevant OPEX to improve and implement actions that prevent the occurrence of potential 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	Bruce A	Bruce B	WWMF	PLNGS	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

In accordance with the *Class I nuclear facilities regulations*, and as a condition of the NPP and WMF licences, licensees are required to implement and maintain human performance programs. The aim of these programs is to ensure that licensees take human and organizational factors into account when safely carrying out licensed activities.

Human and organizational factors are those factors that influence human performance. These factors include, but are not limited to, having a sufficient number of qualified staff who are adequately trained, fit for duty and provided with adequate processes and tools and well-designed and maintained equipment. Human performance tools are applied with the intent of reducing events triggered by human error. While each of these factors are considered individually, the human performance program brings these aspects together to provide a more integrated human centric view of safety.

Personnel training

The following publication contains regulatory requirements applicable to NPPs and WMFs in 2018:

- REGDOC-2.2.2, *Personnel Training*

For details on applicability and implementation, see Appendix E and Section 3.

The licensees use training systems based on the principles of a systematic approach to training (SAT), which is defined in regulatory document REGDOC-2.2.2.

Personnel certification

This specific area applies to the NPPs but does not apply to the DWMF, PWMF, or WWMF due to the absence of certified personnel.

The following CNSC documents contain regulatory requirements applicable to NPPs in 2018:

- CNSC RD-204, *Certification of Persons Working at Nuclear Power Plants*
- Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants

For details on applicability, see Appendix E and Section 3.

To become a certified worker, NPP licensees must demonstrate that the candidate it puts forward for certification meets the requirements of RD-204 and that he/she possesses the knowledge and skills to safely perform the duties of the position. Following the successful completion of a training program and several certification examinations, NPP licensees demonstrate that their candidate for certification meets the aforementioned requirements by submitting an application that provides sufficient proof of competency, a training history, and exam results. Once certified by the CNSC, certified workers undergo continual training and requalification testing to ensure that they maintain the knowledge and skills necessary to safely perform their duties.

The CNSC requires NPP licensees to employ certified shift supervisors, reactor operators and health physicists. Due to the design of Bruce A, Bruce B and Darlington, the CNSC requires that those facilities also employ 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, 2018. 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 available certifications per NPP and certified positions for 2018

Station	Reactor Operator	Unit 0 operators [a]	Shift Supervisor [b]	Health Physicist	Total
DNGS					
Actual	64	17	33	3	117
Minimum	30	10	10	1	51
PNGS 1, 4					
Actual	34		19	3[c]	56
Minimum	20		10	1	31
PNGS 5–8					
Actual	64		16	3[c]	83
Minimum	30		10	1	41
Bruce A					
Actual	56	23	19	4[d]	102
Minimum	30	10	10	1	51
Bruce B					
Actual	60	23	21	4[d]	108
Minimum	30	10	10	1	51
Point Lepreau					
Actual	12		7	2	21
Minimum	6		6	1	13
Gentilly-2 [e]					
Actual				2	2
Minimum				1	1

Notes:

a. There are no Unit 0 positions at PNGS Units 1, 4 and 5–8 or PLNGS.
b. At multi-unit NPPs, the shift supervisor number is the total of certified shift managers plus certified control room shift supervisors.
c. Three health physicists are certified for both PNGS Units 1, 4 and PNGS units 5–8
d. Four health physicists are certified for both Bruce A and Bruce B.
e. There are no reactor operators, U0Os or shift supervisors at Gentilly-2.

Initial certification examinations and requalification tests

This specific area applies to the NPPs but does not apply to the DWMF, PWMF, or WWMF due to the absence of certified personnel.

As noted above, health physicists are the only certified personnel employed at Gentilly-2. Since CNSC staff administer the initial examinations and requalification tests of the health physicists for Hydro-Québec, this specific area does not apply to Gentilly-2.

The following CNSC documents contain regulatory requirements applicable to operating NPPs in 2018.

- CNSC RD-204, *Certification of Persons Working at Nuclear Power Plants*
- CNSC-EG1, *Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants*
- CNSC-EG2, *Requirements and Guidelines for Simulator-based Certification Examinations for Shift Personnel at Nuclear Power Plants*

- *Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants*

For details on applicability, see Appendix E.

Initial certification examinations and requalification tests are part of the programs implemented by licensees in support of CNSC certification. Trainees are required to complete initial certification examinations in order to become certified workers at their NPP. In order to renew their certification, workers are required to complete requalification tests.

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 personnel.

Work organization and job design

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 are required to maintain a minimum shift complement (MSC), which specifies the number of qualified staff who must be present on site at all times for the safe operation of the facility and to ensure adequate emergency response capability.

The MSC is specific to each NPP and is determined through a systematic analysis of the most resource-intensive operating state, including design-basis accidents and emergencies. The results of the analysis are validated through integrated validation exercises and the analysis and validation reports become part of the licensing basis for each NPP.

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 2018:

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

Managing worker fatigue

In accordance with the *Class I Nuclear Facilities Regulations*, licensees are required to ensure workers' fitness for duty. Fatigue is widely recognized to affect fitness for duty because of its potential to degrade several aspects of human performance.

All NPP licensees have procedures in place for managing worker fatigue that includes limits on hours of work. To ensure regulatory clarity and consistency in the area of worker fatigue, the CNSC published regulatory document REGDOC 2.2.4, *Fitness for Duty: Managing Worker Fatigue* in 2017. The REGDOC specifies requirements and guidance for managing worker fatigue at all high-security sites with the aim of minimizing the potential for errors that could affect nuclear safety and security.

Licensees have committed to implement REGDOC 2.2.4 in accordance with timelines that were accepted by CNSC staff. OPG, Bruce Power, and Hydro-Québec planned to implement the REGDOC by 2019, while NB Power planned to implement the REGDOC by 2020 for normal operations and by 2022 for outages [RIB 17525].

Managing alcohol and drug use

Managing worker fitness for duty with respect to alcohol and drug use is another important aspect that affects human performance. The CNSC published regulatory document REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* in 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 provided implementation plans early in 2018, which were accepted by CNSC staff. In late 2018, all licensees impacted by the REGDOC (with the exception of Hydro-Québec) requested amendments to the REGDOC to allow licensees to incorporate oral fluid (i.e., saliva) testing as part of their implementation plans. As a result, OPG, Bruce Power, and NB Power also requested a change to their implementation dates.

In the interest of certainty and recognizing the CNSC's interest in limiting delay, impacted licensees proposed to implement the REGDOC within a period following the date of the amendment of the REGDOC (or from the date it is determined that the REGDOC will not be amended). The licensees proposed, specifically, to implement the requirements other than random testing within 6 months of that date and to implement random testing within 12 months of that date.

CNSC staff accepted these revised implementation plans and continue to review the licensees' substantiations of their requests to amend the REGDOC [RIB 17525].

Gentilly-2 committed to implement the current version of REGDOC-2.2.4 Volume II by July 2019.

Nuclear Security Officer Medical, Physical, and Psychological Fitness

The CNSC published regulatory document REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness* in September 2018. This document sets out the expectations and minimum requirements for medical, physical, and psychological certificates for nuclear security officers. The document supersedes CNSC regulatory document RD-363, *Nuclear Security Officer Medical, Physical, and Psychological Fitness* and contains an updated Canadian nuclear security fitness test.

UPDATE: CNSC requested licensees to submit implementation plans in 2019 for CNSC's staff review.

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: conducting baseline and focused inspections; performing desktop inspections and compliance assessments of licensees' programs; reviewing quarterly and annual scheduled reports; reviewing event reports and follow-up actions associated with reportable events; and follow-up on licensee's responses to inspection findings.

Based on the information assessed, CNSC staff concluded that all licensees of NPPs and WMFs operated their facilities safely and met all the applicable regulatory requirements.

Operating performance ratings

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

Nineteen reactors continued to operate in Canada throughout 2018, along with the WMFs at the same sites -unchanged from the previous year.

CNSC requires all operating NPPs licensees to report serious process failures to CNSC in accordance with regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. REGDOC-3.1.1 also requires operating NPP licensees to report quarterly the performance indicator "Number of unplanned transients", which tracks unplanned transients for each reactor while not in a guaranteed shutdown state. Unexpected reactor power reductions (or transients) indicate problems within a plant and place unnecessary strain on its systems.

Table 8 summarizes the number of unplanned transients for the operating 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.) "Industry total" provides the data for the operating NPPs as a whole. In 2018, all unplanned transients were properly controlled and adequately initiated by the reactor control systems. CNSC staff also determined that there were no serious process failures at any NPP.

Table 8: Number of unplanned transients

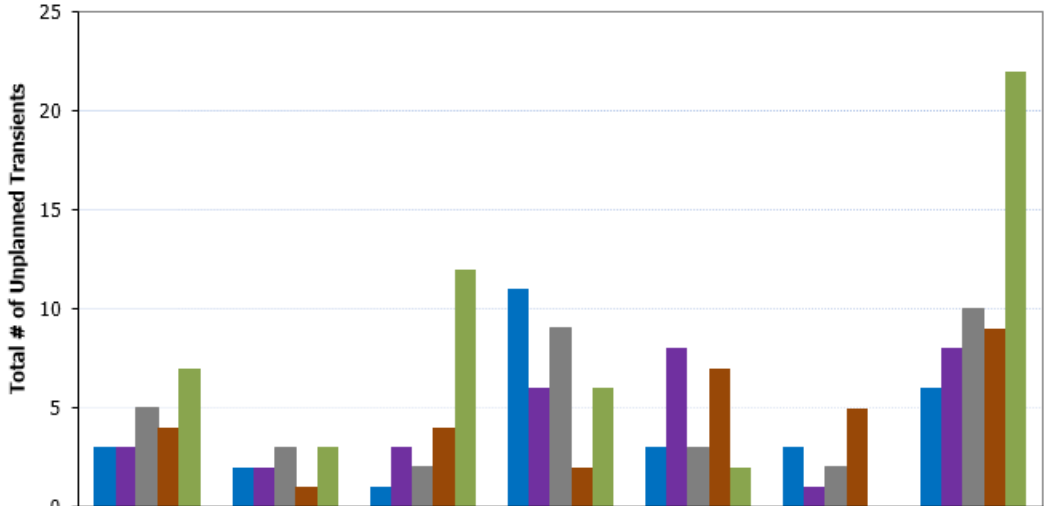
NPP	Number of operating reactors	Number of hours of operation	Un-planned reactor trips[1]	Step backs	Set backs	Total unplanned transients	Number of trips per 7,000 operating hours
DNGS	4	23,730	0	1	3	4	0.00
PNGS 1, 4	2	14,685	1	n/a [2]	2	3	0.48
PNGS 5–8	4	28,750	2	0	10	12	0.49
Bruce A	4	29,143	1	2	3	6	0.24
Bruce B	4	32,268	1	0	1	2	0.22
Point Lepreau	1	7,469	0	0	0	0	0.00
Industry total	19	136,044	5	3	19	27	0.26

Notes:
1 This includes automatic reactor trips only; does not include manual reactor trips or trips during commissioning testing.

2 Stepbacks are not a design feature at PNGS Units 1, 4.

Figure 2 shows the total number of unplanned transients from 2014 to 2018 for the operating NPPs. The number of unplanned transients in 2018 was higher than the numbers from previous years, mostly due to the increased number for PNGS Units 5-8 and DNGS. Nevertheless, the higher numbers were acceptable to CNSC staff.

Figure 2: Trend of unplanned transients for stations and industry



	DNGS	PNGS 1,4	PNGS 5-8	Bruce A	Bruce B	Point Lepreau	Industry Total
2014	3	2	1	11	3	3	6
2015	3	2	3	6	8	1	8
2016	5	3	2	9	3	2	10
2017	4	1	4	2	7	5	9
2018	7	3	12	6	2	0	22

Figure 3 compares the number of unplanned reactor trips for Canada's operating NPPs per 7,000 hours of operation, which is a measure used by the World Association of Nuclear Operators (WANO). In 2016, WANO 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:

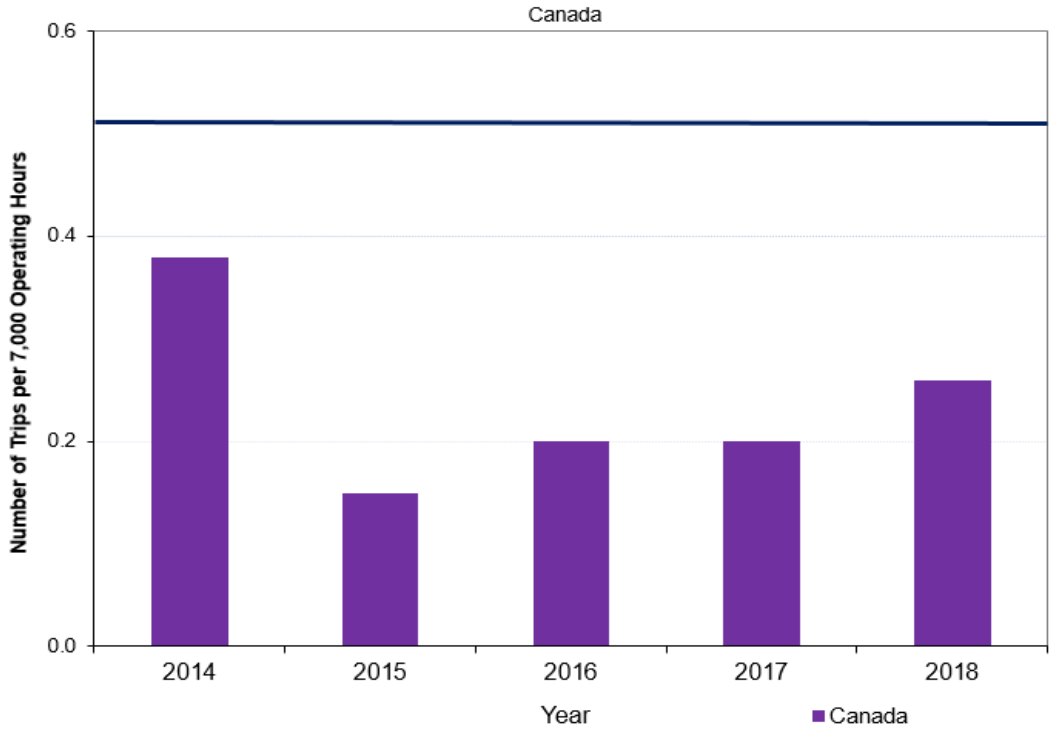
- 0.5 unplanned total scrams (equivalent to a CANDU reactor trip) per 7,000 critical hours for pressurized water reactors (also applies to boiling water reactors and light water cooled graphite-moderated reactors)
- 1.0 unplanned total scrams per 7,000 hours critical for pressurized heavy water reactors

The WANO industry targets were established in 2015 as median values of individual world-wide reactors, by type, over a previous five-year period [RIB #17559]. Although the WANO target for pressurized heavy water reactors (PHWR) 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 2018 WANO performance indicator publication:

- Only 72% of reactors worldwide met the WANO industry target of unplanned total scrams per 7,000 critical hours

Figure 3 indicates that Canadian NPPs were collectively well within those targets since 2014. It is also clear that they would compare even more favourably against the world-wide performance of pressurized heavy water reactors with respect to the relevant WANO target.

Figure 3: Trend of unplanned reactor trips per 7,000 operating hours.



Procedures

All licensees have a defined process 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

The following publication contains regulatory requirements that were relevant in 2018:

- CNSC REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*

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 any effects on the environment, the health and safety of persons and the maintenance of security that have resulted or may result from the situation. The licensee must also describe the actions it has taken or proposes to take with respect to the event. CNSC staff observed that licensees performed all required follow up on all events with corrective actions and root cause analyses, when appropriate, in 2018.

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

The CNSC published regulatory document REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* in January 2018. Beginning in 2019, the WMF licensees will submit reports to the CNSC in accordance with REGDOC-3.1.2.

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 monitor the level of performance and achievement of objectives during planned maintenance outages. During each planned outage at an NPP in 2018, CNSC staff conducted type II and field inspections to confirm regulatory requirements continue to be met and that work was executed safely. CNSC staff confirmed that forced outages and outage extensions were managed safely and in accordance with the applicable regulatory requirements. CNSC staff informed the Commission of unplanned outages resulting from reactor trips and their outcomes via event initial reports and status reports on NPPs in 2018.

Safe operating envelope

The following publication contains regulatory requirements that were relevant in 2018:

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

This specific area only applies to the operating NPPs. The adherence of an operating NPP to its safe operating envelope (SOE) ensures that each reactor operates in an analyzed state, thereby ensuring adequate safety at all times. CNSC staff determined that all licensees hade adequate SOE programs in 2018 that were based on the requirements of CSA Group standard N290.15-10. CNSC staff found that the licensees implemented a hierarchy of documents to support producing,

updating, and maintaining SOE-related documentation. CNSC staff also determined that all licensees operated within the SOE in 2018.

Severe accident management and recovery

The following publication contains regulatory requirements that were relevant in 2018:

- CNSC REGDOC-2.3.2, *Accident Management, (encompasses SAM)*

This specific area only applies to the operating NPPs. All NPP licensees have developed and implemented severe accident management guidelines (SAMGs). SAMGs 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 demonstrate the effectiveness of SAMGs on an ongoing basis through exercises and drills.

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

In 2018, licensees continued to update existing SAMGs 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. (CNSC staff noted that all SAMG updates at Point Lepreau have been completed).

To establish the instructions for use and deployment of emergency mitigating equipment (EME), licensees have EME guidelines. 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.

Accident management and recovery

All NPP 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. CNSC compliance verification activities ensure that up-to-date procedures are available to the operators and that those operators are adequately 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 (PSAs). Appropriate safety margins should be demonstrated to address uncertainties and limitations of safety analysis approaches.

Safety analysis ratings

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

Deterministic safety analysis

The following publications contain regulatory requirements that were relevant in 2018:

- CNSC REGDOC-2.4.1, *Deterministic Safety Analysis* (2014)
- CSA Group standard, N286.7-16, *Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants* (2016)
- CSA Group standard, N290.12-14, *Human factors in design for nuclear power plants* (2015)
- CSA Group standard, N292.2-13, *Interim dry storage of irradiated fuel* (2013)
- 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, N393-13, *Fire protection for facilities that process, handle, or store nuclear substances* (2013)

Per REGDOC 3.1.1, NPP licensees are required to submit an updated facility description and safety analysis report[1] for their facilities every five years in order to demonstrate the adequacy of the design of the facility. These revisions support the transition towards the implementation of REGDOC 2.4.1 requirements and help identify where improvements are necessary.

In 2018, the NPP licensees continued their safety analysis improvement programs, which are linked to the on-going staged implementation of REGDOC-2.4.1. CNSC staff were satisfied with the progress in 2018 and provided feedback to the licensees on their ongoing safety analyses improvements. The existing licensees' deterministic safety analyses remained adequate during the

[1] The safety report provides descriptions of the structures, systems and components of a nuclear facility, including their design and operating conditions. The final safety analysis report demonstrates the adequacy of the design of the facility.

continued implementation of REGDOC-2.4.1 throughout 2018, while the new analyses are compliant with REGDOC-2.4.1.

For the WMFs, OPG submits a safety analysis report that effectively identifies facility hazards and the measures in place to control or mitigate these hazards.

Impact of aging on the safety analysis for NPPs

Licensees' aging management programs (described in section 2.6) include activities to help manage aging-related factors that could affect the conditions of SSCs important to safety. From the perspective of deterministic safety analysis, the aging of a reactor can affect 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. The structures, system and components (SSCs) 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.

Licensees aging management programs systematically monitor important parameters related to the safety analysis of reactor aging. Aging management programs are 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 NPP.

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.

At the conceptual level, the proposed CAA methodology is consistent with the requirements set out in REGDOC-2.4.1. In 2016, CNSC staff determined that the methodology required further validation and refinement before it could be accepted for regulatory application. A number of key activities were identified that would lead to CNSC staff acceptance of the CAA methodology.

Bruce Power submitted a work plan for CAA development in late 2016 intending to use the CAA methodology to quantitatively demonstrate that the LBLOCA safety margins were greater than predicted in the analysis for the Bruce B reactors. In 2017, CNSC staff determined that the proposed work was acceptable, but required further clarification in some areas.

In 2018, Bruce Power responded to CNSC comments on its CAA analysis plan, which led to a CNSC staff request for further clarification and discussion about remaining, unaddressed comments. In December 2018, Bruce Power submitted the technical assessment reports in support of the CAA methodology, which CNSC staff were reviewing at the end of 2018.

OPG continued to support the industry efforts in the resolution of LBLOCA safety margins using the CAA as part of its long-term plan. Meanwhile, OPG had proposed a different approach - a more realistic implementation of the limit of operating envelope methodology - to address the LBLOCA safety margin issue in the short term. In 2018, OPG submitted its update on the application of this approach for the DNGS. Discussions on this approach between OPG and CNSC staff were ongoing at the end of 2018.

As mentioned above, OPG also continued to work with Bruce Power to further develop the CAA methodology for regulatory application. Also, OPG has stated that once the Bruce Power

LBLOCA CAA approach is accepted by the CNSC, OPG will consider customizing the application of the CAA to the safety analysis of OPG reactors, as appropriate.

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

Overall, the licensees of operating NPPs continued to progress well with all identified activities in 2018. CNSC staff confirmed that the licensees made acceptable progress toward confirming the adequacy of LBLOCA safety margins.

Probabilistic safety assessment

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 in 2018.

- 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 (e.g., considerations of other radioactive sources including the irradiated fuel bay, as well as multi-unit impacts). Point Lepreau has been compliant with REGDOC-2.4.2 since 2016.

The DNGS, PNGS and Bruce A and B comply with CNSC 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 2020, 2020 and 2019, respectively. OPG and Bruce Power have already addressed the additional requirements outlined in REGDOC 2.4.2, either through

- PSA, for the consideration of multi-unit impacts, or
- 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.

Table 9 summarizes the status of PSAs at the operating NPPs in 2018.

Table 9: Status of PSAs and reviews

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

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 operating licence for the PNGS in 2013) to develop an approach for whole-site

PSA. Whole-site PSA involves estimating aggregate risk for sites with multiple reactors and other radioactive sources. OPG submitted the whole-site PSA for PNGS in 2017. In 2018, Bruce Power submitted its whole-site PSA methodology.

UPDATE: The aggregated risk values for whole-site PSA for Bruce A and B were submitted in April 2019 and CNSC staff were reviewing them as of June 2019.

DNGS planned to consider a risk aggregation calculation by 2020 based on the available DNGS PSA results using the simplified aggregation method that was recently used for the PNGS.

As part of the action [RIB 8504] on CNSC staff to provide an update to the Commission on the activities associated with the establishment of a proposed regulatory position on risk aggregation, CNSC staff provided the Commission with an update in December 2017 on whole-site PSA [CMD 17-M64]. The update included a presentation on staff's active role in the international effort, especially with the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA), and on site-level PSA (including multi-unit PSA) developments including risk aggregation. The NEA work on the status of site level PSA developments was completed in December 2018 and the final report will be issued by the end of 2019. The following phases were completed as part of the IAEA project on multi-unit PSA:

- Phase 1: Development of a multi-unit PSA methodology (2017)

- Phase 2: Application of the multi-unit PSA methodology to a case study (2018)

UPDATE: The IAEA project entered Phase 3, which consists of revisiting the Phase 1 methodology in light of lessons learned from its application to the case study, and issuing an IAEA Safety Report Series on multi-unit PSA.

Both the NEA and IAEA projects reiterated that the scope of risk aggregation is highly dependent on the regulatory requirements as well as on the intended uses and applications of the PSA.

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 has 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 irradiation of low void reactivity fuel at Bruce B during the 2006 -2007 demonstration period, Bruce Power is required to have a criticality safety program. The following publication contains regulatory requirements that were relevant for Bruce Power in 2018:

- CNSC RD-327, *Nuclear Criticality Safety*

Severe accident analysis

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

In 2018, the NPP licensees continued their severe accident analyses to support PSA level 2 for plant safety goal evaluation, to demonstrate effectiveness of severe accident management and to support severe accident exercises for emergency preparedness and response.

OPG and Bruce Power undertook a project called severe accident software simulator solution (SASS) to improve their methods for deterministic analysis of multi-unit severe accidents. In

2018, CNSC staff completed their review of the SASS modelling summary report and made some recommendations for improvement. However, CNSC staff concluded overall that the SASS project successfully demonstrated the capability to model multi-unit severe accidents.

Management of safety issues

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

CNSC staff continued to undertake systematic evaluations of R&D program activities, as submitted to CNSC staff through annual reporting in accordance with REGDOC-3.1.1. These evaluations confirmed that the licensees maintain or have access to a robust R&D capability to address any emerging issues. Existing safety issues do not present a regulatory concern about the safety of the operating NPPs. The management of safety issues by the licensees of the operating NPPs met CNSC staff's expectations in 2018.

In addition to the information provided below on developments related to CANDU safety issues, Appendix D provides details on R&D projects executed by the licensees and CNSC.

CANDU safety issues

In 2007, CNSC staff identified generic safety issues associated with CANDU reactors because of initiatives started by the IAEA to reassess the safety of operating NPPs. CANDU safety issues (CSI) were classified into three 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 needs to be confirmed.

The CNSC monitors 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.

In 2018, there were four remaining Category 3 CSIs, three of which are related to LBLOCA.

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

The industry continued to develop the composite analytical approach (CAA) in order to address the LBLOCA CSIs. Through an industry-wide agreement, Bruce Power took the lead in the regulatory application of the CAA methodology. In 2013, Bruce Power requested the re-classification of the LBLOCA CSIs to a lower category. 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].

In late 2018, Bruce Power submitted the technical assessment reports for threshold break size and a regulatory communication plan in support of the CAA methodology as well as the previous requests to reclassify these LBLOCA CSIs. CNSC staff were reviewing them at the end of 2018.

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

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

For PNGS Units 1 and 4, OPG submitted a request to the CNSC for the re-categorization of CSI IH6 in June 2018. CNSC provided formal feedback in October 2018.

UPDATE: OPG was in the process of providing additional information as requested, so that the CNSC could complete its assessment by the end of 2019.

NB Power requested re-categorization of CSI IH6 to Category 2 based on pipe-whip and jet-impingement assessments for various systems. In August 2018, NB Power submitted a report to support its IH6 analysis. CNSC staff reviewed the IH6 analysis together with the pipe whip and jet impingement assessments of the high-energy lines inside the reactor building. CNSC staff concurred that the layout/location of the high-energy lines and the safety-critical targets satisfied the separation philosophy in order to minimize the consequential damage associated with the postulated failure of the high-energy lines. In 2018, CNSC staff concluded that NB Power's request to reclassify CSI IH6 was acceptable.

UPDATE: In January 2019, CNSC staff informed NB Power that CSI IH6 was reclassified to Category 2 for Point Lepreau.

CSI AA3, on computer code and plant model validation, had previously been reclassified to Category 2. As part of ongoing work to address the issue, the licensees contributed to the revision of the COG guidelines on code validation and code accuracy assessment. In 2017, CNSC staff noted that, although the majority of its comments on the guidelines had been addressed, minor comments remained. In February 2018, Bruce Power submitted additional information to address CNSC comments.

UPDATE: In February 2019,CNSC staff's review of the latest submission concluded that its comments on the guidelines for code accuracy and validation had been properly addressed, thus satisfying one of the six closure criteria associated with CSI AA3. However, there remained other areas that needed further improvements to meet the objectives of the computer code and plant model validation program associated with CSI AA3. Specifically, the following risk control measures had not fully satisfied their associated closure criteria:

- assessment of code applicability and quantification of code accuracy
- implementation of code accuracy in safety analysis

CNSC sent its comments from the above review to the licensees of the operating NPPs.

UPDATE: As of June 2019, the licensees of operating NPPs were reviewing CNSC's comments.

2.5 Physical design

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

Physical design ratings

DNGS	DWMF	PNGS	PWMF	Bruce A	Bruce B	WWMF	PLNGS	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
- component design

In addition to the extensive design requirements that are applicable to operating NPPs and WMFs and listed in this report, the CNSC has published regulatory document 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 2018, each licensee executed various modifications with no impact on its ability to operate within its safety case, while improving the overall performance of its facilities and improving safety in design and operations.

Design governance

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 an SSC 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 2018:

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

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

Environmental qualification

An environmental qualification program ensures that all required SSCs 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 2018:

- 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 aging reactors and limited resources.

Pressure boundary design

The following publication contains regulatory requirements that were relevant in 2018:

- 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 for pressure boundaries.

Human factors in design

The following publication contains regulatory requirements that were relevant in 2018:

- 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. The implementation of the fire protection program ensures that each licensee is able to efficiently and effectively control and respond to 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 SSCs that directly support the facility and the protected area.

The following publications contain regulatory requirements for operating NPPs or WMFs that were relevant in 2018:

- 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 to CNSC their periodic review and updates of the fire protection program and fire protection assessment. In addition, licensees are required to submit third party reviews of proposed modifications with the potential to impact the fire protection objectives. In 2018, CNSC staff reviewed these updates and reviews and confirmed that licensees are in general compliance with the applicable fire protection requirements.

Site characterization

There is no background information needed for this specific area.

Facility design

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

Structure design

The following publication contains regulatory requirements for NPPs that were relevant in 2018:

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

Details on its applicability are provided in Appendix E.

System design

In 2018, CNSC staff confirmed that the licensees' electrical power systems (EPSs) and instrumentation and control (I&C) functioned as expected.

Electrical power systems

The EPS provides support for the safety of an NPP nuclear power plant and is important for defense-in-depth. It is essential that NPPs have a reliable EPS to control anticipated deviations from normal operation as well as to power, control and monitor the plant during events of all types.

Instrumentation & Control

I&C provides functions of protection, control, and monitoring for the safety of an NPP. I&C consists of measuring devices, controllers, and actuating devices. The devices and controllers must meet the safety and reliability requirements, which are related to defence-in-depth, operational limits and conditions, common-cause failures, separation, diversity, independence, single-failure criteria and fail-safe design. In addition, I&C monitors plant variables and systems over the respective ranges for operational states, design-basis accidents and design extension conditions in order to ensure that adequate information can be obtained on plant status.

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, fuel bundle vibrations). 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 this period. Fuel performance has, for the most part, returned to historic norms with the remaining challenges having well-developed mitigation strategies in place. CNSC staff continued to monitor the status of the mitigation strategies and were satisfied with the industry's management of these issues in 2018. 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 the licensees of operating NPPs to implement cable condition monitoring and surveillance programs, as well as cable aging

management programs to assess the degradation of cable insulation over time.

2.6 Fitness for service

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

Fitness for service ratings

DNGS	DWMF	PNGS	PWMF	Bruce A	Bruce B	WWMF	PLNGS	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. An important consideration for NPPs under this specific area is the reliability of systems important to safety.

The following publication contains regulatory requirements for operating NPPs that were relevant in 2018:

- CNSC REGDOC 2.6.1, *Reliability Programs for Nuclear Power Plants*

Details on its applicability are provided in Appendix E.

Operating NPP licensees' reliability programs include trending of system performance by monitoring process parameters, station condition records, and test and inspection results, and initiating investigations or maintenance activities as needed.

REGDOC-3.1.1 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. They include information on the reliability of the special safety systems (SSSs), including their availability. Availability is defined as the fraction of time that the SSS meets the minimum allowable performance standards. Unavailability targets are established as part of the design requirements of the SSSs, in addition to the other reliability-related design requirements, such as separation and independence, fail-safe, single failure criteria, redundancy and diversity. Unavailability targets of the SSSs are assigned in a way to be consistent with the NPP's safety goals and to maintain a balance between the prevention and mitigation of events. Unavailability targets are established based on frequency of demand, consequence of failure and overall risk.

Licensees monitor the performance or condition of the SSSs against unavailability targets (no higher than 0.001) to ensure that these systems are capable of fulfilling their intended functions. However, activities may result in conditions where the SSS will be incapable of meeting its unavailability target. Examples of these activities include preventative maintenance, testing and corrective repairs to failed components (unscheduled activity), as well as the occurrence, during operation, of initiating events that cause challenges to plant systems and operations.

Overall, the SSSs performed well in 2018 and met their unavailability targets, with some exceptions as outlined in section 3.

REGDOC 2.6.1 specifies that when the performance or condition of any SSC fails to meet established targets, appropriate corrective action should be taken, which may involve a detailed technical analysis. If the analysis demonstrates that the safety objectives and defence-in-depth are ensured, no immediate corrective action may be needed. However, the licensee should continue to monitor the SSC closely.

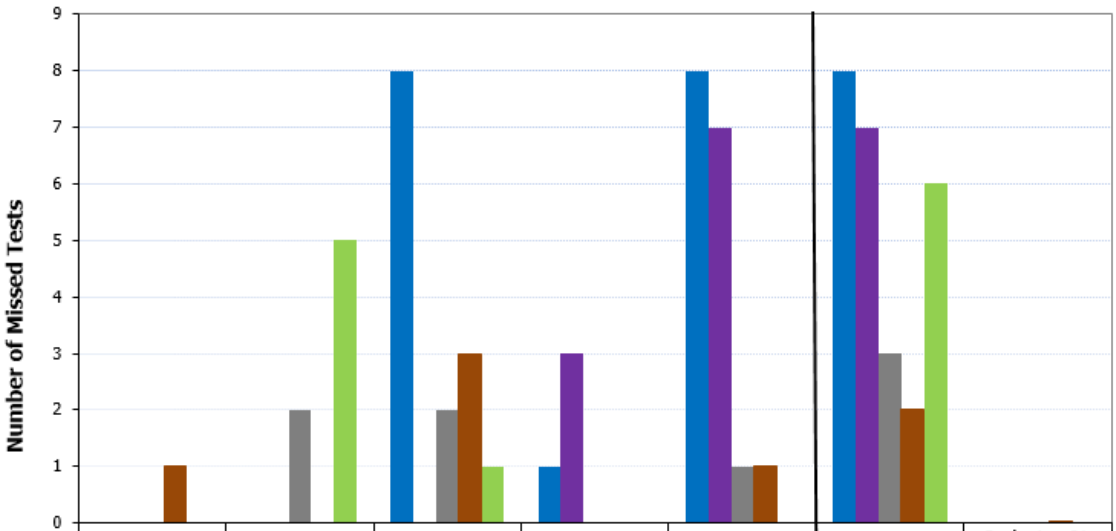
In addition, the licensees' reliability programs require the availability of systems important to safety to be confirmed through surveillance activities such as tests and inspections. Missed tests are tracked by licensees and reported to the CNSC as required by REGDOC-3.1.1. The numbers of missed tests are a measure of a licensee's ability to successfully complete routine tests on safety-related systems and are used in the calculation of the predicted availability of systems. Data for the NPPs and "the industry" as a whole are shown in table 10 and figure 4.

The number of total missed safety system tests remained very low in 2018. In all, 46,116 tests were performed and the percentage of missed tests was 0.01 percent. The impact of missing a single test is negligible because the NPP designs have sufficiently high redundancy to ensure continuous availability of the safety systems. Table 10 indicates that there was one special safety test (SST) that was not fully completed before the due date. Since no deferral was processed, the test was categorized as missed. However, upon identifying the situation, the SST was completed successfully. There was no safety impact from this deferral.

Table 10: Safety system test performance for 2018

Nuclear power plant	Number of annual planned tests	Safety system tests not completed				Percent not completed
		Special safety systems	Standby safety systems	Safety-related process systems	Total	
DNGS	9,976	0	0	0	0	0.00
PNGS	13,462	0	0	5	5	0.04
Bruce A	9,104	1	0	0	1	0.01
Bruce B	9,436	0	0	0	0	0.00
Point Lepreau	4,138	0	0	0	0	0.00
Industry total	46,116	1	0	5	6	0.01

Figure 4: Trend of safety system test performance for NPPs and industry



	DNGS	PNGS	Bruce A	Bruce B	Point Lepreau	Industry Total	Industry % Missed Tests
2014	0	0	8	1	8	8	0.03%
2015	0	0	0	3	7	7	0.02%
2016	0	2	2	0	1	3	0.01%
2017	1	0	3	0	1	2	0.01%
2018	0	5	1	0	0	6	0.01%

In 2016, OPG initiated a joint fueling machine reliability project with NB Power through COG to oversee engineering, testing and manufacturing of new type IV ram seals using current best practices and technologies. This project is expected to prevent premature fuelling machine ram seal failures and thus increase the reliability and service life of the fuelling machine ram. In 2018, significant progress was made in detailed design and testing of the type IV seals. The first set of seals is projected to be delivered to OPG in the second half of 2019 [RIB 17557].

Maintenance

The following publication contains regulatory requirements that were relevant in 2018:

- 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* was published in August 2017. The requirements and guidance remain unchanged in the updated document. REGDOC-2.6.2 replaced RD/GD-210 as compliance verification criteria for each NPP in licence renewals or through LCH revisions.

CNSC staff routinely monitor several maintenance safety performance indicators for operating NPPs, including those that are required to be reported according to REGDOC-3.1.1, namely the "preventive maintenance completion ratio" (PMCR), maintenance backlogs and the number of preventive maintenance deferrals.

The number of deferrals and backlogs by themselves are not a measure of the safety significance, since there are different risks associated with the completion of different maintenance activities. Consequently, 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. Staff

also monitor the licensee's process for prioritizing activities based upon their risk significance to help determine if closer regulatory scrutiny is warranted. Based on the assessment, CNSC might, for example, increase the focus on maintenance during regular field inspections, 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 values observed.

The PMCR quantifies the effectiveness of the preventive maintenance program in minimizing the need for corrective maintenance activities for safety-related systems. The average PMCR value for operating NPPs was 93 percent in 2018. CNSC staff were satisfied with the effectiveness of the licensees' preventive maintenance.

The performance indicators corrective maintenance backlog, deficient maintenance backlog and deferrals of preventive maintenance are used to 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 an SSC 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 SSCs 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 as 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 maintenance backlogs and deferrals for the industry are provided in table 11. The industry average of these three performance indicators significantly reduced in 2018. This resulted from continuous, industry-wide performance improvement in 2018 and re-categorization of critical components at the end of 2017. Overall, CNSC staff were satisfied with the progress in 2018. The current levels of the maintenance backlogs and deferrals for critical components for the NPPs represent a negligible risk to the safe operation of the NPPs.

Table 11: Trend of industry maintenance backlogs and deferrals for critical components of NPPs

Performance indicator	Average quarterly work orders per unit in 2016	Average quarterly work orders per unit in 2017	Average quarterly work orders per unit in 2018	Three year trending
Corrective maintenance backlog	8	4	1	down
Deficient maintenance backlog	111	94	16	down
Deferrals of preventive maintenance	38	30	4	down

Structural integrity

The following publications contain regulatory requirements that were relevant in 2018:

- CSA Group standard N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components* (2005 and 2009)
- CSA Group standard N287.7, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants* (2008)
- CSA Group standard N285.5*, Periodic inspection of CANDU nuclear power plant containment components* (2008)
- CSA Group standard N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors* (2010 and 2015)
- CSA Group standard N291, *Requirements for safety-related structures for CANDU nuclear power plant components* (2008 and 2015)

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

Licensees have processes to monitor and assess structural integrity, such as inspections and tests of safety-significant structures and components. These processes draw on results from aging management and periodic inspection and testing activities, which are described in the following subsections.

The NPP licensees inspect pressure boundary components and containment and also monitor and assess safety-significant balance-of-plant systems and structures. 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*; they are typically considered non-nuclear systems.

At the WMFs, OPG inspects dry storage containers (DSCs), dry storage modules (DSMs) and storage facility structures for WMFs. For example, OPG inspects DSC seal welds after fuel loading and periodically for aging related degradation, as well as welding bay walls.

In 2018, CNSC compliance verification reviews related to structural integrity included 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, and inspection reports and annual aging management reports for DSCs). CNSC staff verified that licensees' evaluations of inspection findings confirmed the structural integrity of the passive SSCs important for safe operation, namely pressure boundary components and civil structures in NPPs and DSCs and civil structures in WMFs.

Aging management

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

The following publication contains regulatory requirements that were relevant in 2018:

- CNSC REGDOC-2.6.3, *Aging Management*

Details on its 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[2], 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 licensees update their LCMPs to incorporate operating experience and research findings and submit them to the CNSC for a review of compliance with the requirements of REGDOC-2.6.3.

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 include desktop reviews of licensee submissions related to integrated aging management programs and components and structure-specific LCMPs, as well as onsite inspections to assess licensees' implementation of these programs.

With respect to the pressure tubes in operating NPPs, overall, CNSC staff were satisfied that the LCMPs reflected sound aging management. CNSC staff also continued to review the results from fuel channel inspections that occurred routinely during planned inspection outages in 2018. CNSC staff confirmed that no new flaw-initiation mechanisms were identified and that licensees appropriately evaluated any findings that required disposition, in accordance with CSA Group standards. CNSC staff concluded that fitness for service of inspected pressure tubes was effectively demonstrated.

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 over time (which could increase the likelihood of pressure tube to calandria tube contact), and correct the positioning if necessary. CNSC staff were satisfied with the licensees' work to ensure fuel channel spacers continued to perform their design function. A review of available information confirmed that the spacers were behaving in a predictable manner.

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

[2] Pressure tubes are tubes that pass through the calandria of a CANDU reactor and contain 12 or 13 fuel bundles. Pressurized heavy water flows through the pressure tubes to cool the fuel.

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, surveillance activities to monitor material property changes, and the development of assessment methodologies and fitness-for-service guidelines.

The licensees demonstrate the ability to safely operate pressure tubes through assessments of the current and expected conditions of the pressure tubes that are 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. To assess mechanisms or parameters that are dependent on neutron flux (e.g., diametral creep of pressure tubes), EFPH is the best indicator. During the PROL renewals for the PNGS and Bruce A and B in 2018, the Commission approved new EFPH limits for pressure tubes in those units, which were identified as compliance verification criteria in the LCHs for the PNGS and Bruce A and B (see sections 3.2.6 and 3.3.6, respectively).

However, for in-service changes in pressure tube properties (e.g., fracture toughness), equivalent hydrogen (Heq) concentration is more important than EFPH. Fracture toughness is an important parameter that is modelled and used for assessments of leak-before-break and fracture protection of pressure tubes. For temperatures below 250°C, Heq content in the pressure tube is a critical input to the fracture toughness model. The analytical fracture toughness model that CNSC currently accepts for use in this temperature range is only valid up to a Heq concentration of 120 ppm.

In addition, improvements related to the model and its applicability were needed to maintain confidence in its use. During the PROL renewals in 2018 for the PNGS and Bruce A and B, the Commission also approved new regulatory requirements to ensure appropriate licensee management of pressure tube fracture toughness. These were also identified as compliance verification criteria in the LCHs for the PNGS and Bruce A and B. For the existing fracture toughness model (governing pressure tube operation below 250°C), the licensees must:

- submit an analysis of model uncertainties
- assess the impact of unexpected fracture toughness test results on any pressure tube assessments that rely on model predictions

CNSC staff consider that the current regulatory process to monitor additional validation of the existing fracture toughness model up to Heq of 120 ppm is adequate to ensure that it will adequately support CSA-mandated assessments.

In preparation for units approaching the validity limit of the existing toughness model (120 ppm Heq in any pressure tube), licensees must also develop a revised toughness model (capable of predicting toughness beyond 120 ppm Heq) and submit the technical basis for CNSC staff's approval well before any pressure tube reaches 120 ppm.

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

At the time of the licence renewal in 2018, it appeared that pressure tubes at Bruce would approach the validity limits of the existing fracture toughness model before major component replacement. Consequently, the Bruce LCH contains additional requirements to:

- modify the programs for in-service inspection of flaws and monitoring of Heq levels, when any pressure tube reaches the CSA "action limits" (70 ppm Heq at the inlet; 100 ppm at the outlet)
- provide periodic updates of the anticipated date by which the first pressure tube will achieve 120 ppm Heq

Since the licence renewal, pressure tube inspections at Bruce supported a revision to the hydrogen uptake model for Bruce B, leading to the following:

- Bruce Power now expects that the earliest any pressure tube will reach 120 ppm Heq will be September 2023 (when Unit 5 reaches 274,800 EFPH).
- This is far beyond the industry's target date for completing its revised pressure tube fracture toughness model and submitting it for CNSC acceptance (planned for October 2020).

Therefore, while some Bruce pressure tubes are still predicted to exceed 120 ppm Heq prior to major component replacement, industry expects to implement a new pressure tube model (valid for predicting fracture toughness at those Heq levels) well before that time.

In 2018, 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 confirmation project, which included the following activities in 2018:

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

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

Chemistry control

REGDOC-3.1.1 requires the licensees of operating NPPs to report data for the performance indicators "chemistry index" and "chemistry compliance index". The chemistry index reflects the control of important chemical parameters for plant operation. The chemistry compliance index reflects the control of safety-related chemical and radiological parameters in both non-guaranteed shutdown states and guaranteed shutdown states. Both indicators are calculated as the average percentage of time that the identified parameters are within the licensee's specifications. Figures 5 and 6 show the values of the chemistry index and chemistry compliance index for operating

NPPs from 2014 to 2018. Based on these values, CNSC staff determined that chemistry control was acceptable for all licensees. The comparatively low results for the Chemistry Compliance Index for Bruce A and B (figure 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. Bruce Power began to see improvements to the D2O isotopic specification over the third and fourth quarters of 2018, which has resulted in an improvement of the overall average of the chemistry compliance index for Bruce A and B in 2018.

Figure 5: Trend of Chemistry Index for industry

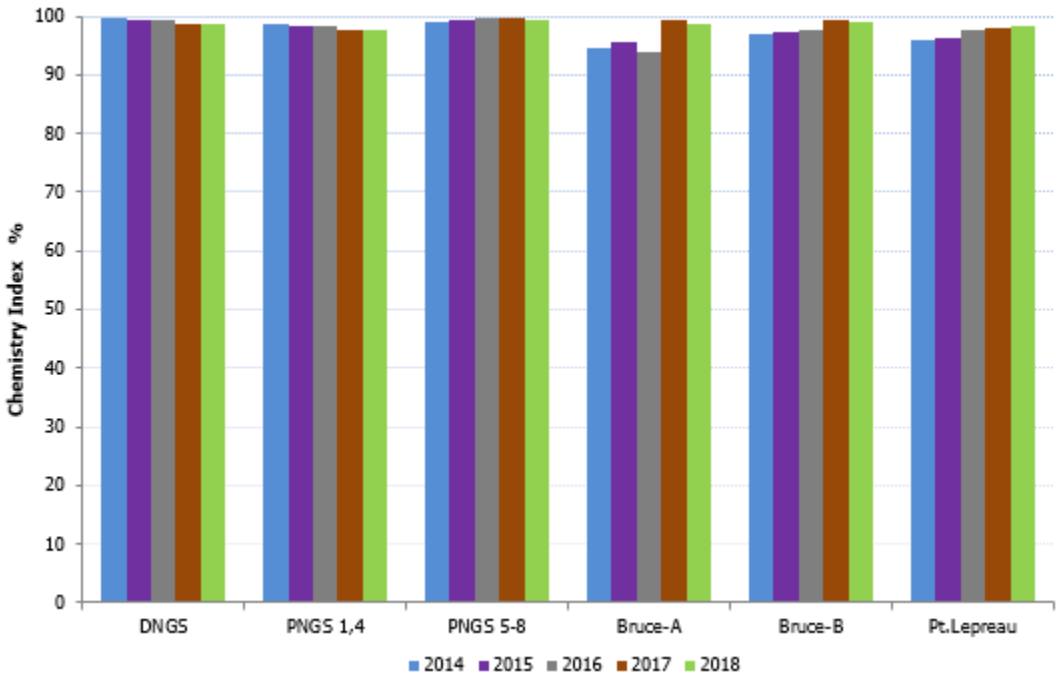
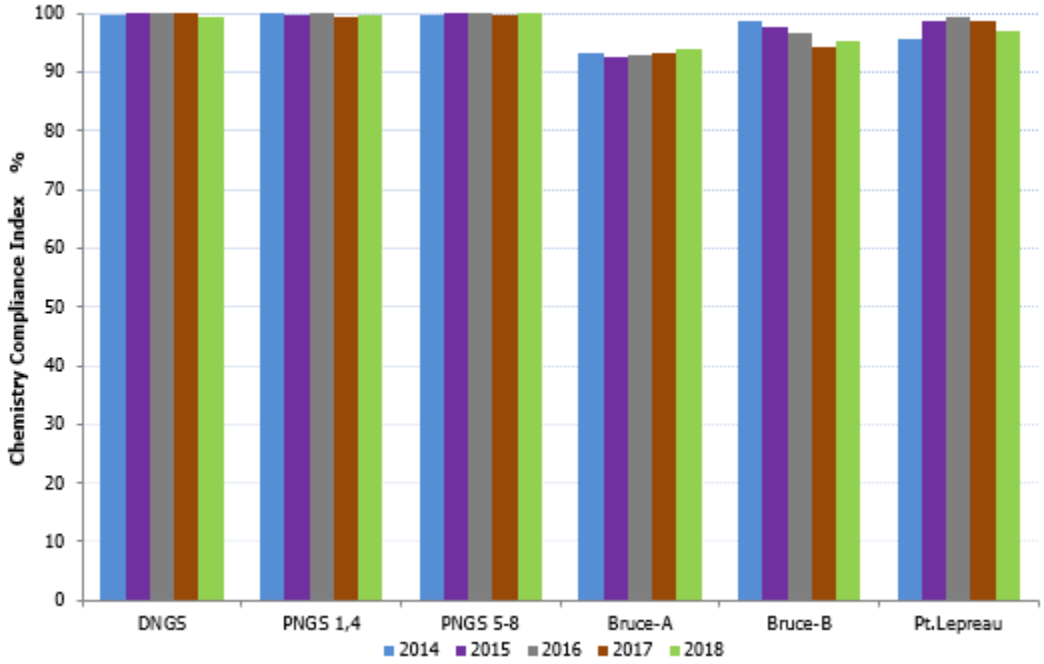


Figure 6: Trend of Chemistry Compliance Index for industry



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 in 2018:

- CSA Group standard N285.4, *Periodic inspection of CANDU nuclear power plant components* (2005, 2009)
- CSA Group standard N285.5, *Periodic inspection of CANDU nuclear power plant containment components* (2008)
- CSA Group standard N287.7*, In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants* (2008)
- CSA Group standard N291, *Requirements for safety-related structures for CANDU nuclear power plant components* (2008 and 2015)

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 pressure boundary and containment SSCs. After every inspection campaign, the results of these inspections and tests are submitted to CNSC staff, who verify the effective licensee implementation of the inspection and testing programs.

Licensees are also required to execute inspection programs for balance-of-plant pressure boundary systems that are not covered under the scope of the CSA group standards listed above, but could have an impact on safe operation. These programs are carried out in accordance with industry best practices. CNSC staff monitors the findings provided in the quarterly pressure boundary reports required by REGDOC- 3.1.1 and verifies licensee compliance with their documented programs through field inspections. The licensees are developing periodic inspection programs that comply with CSA Group standard N285.7, *Periodic inspection and CANDU nuclear power plant balance of plant systems and components*, which will be adopted as compliance verification criteria in the future for all operating NPPs except Pickering. Implementation of a program for N285.7 is not practical for Pickering given the planned shutdown in 2024. However, CNSC staff will apply experience gained from its implementation at other NPPs to Pickering to address potential safety concerns should the need arise.

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 for 2014 to 2018. The estimated dose to the public from Canadian NPPs and WMFs for 2014 to 2018 is provided in table 13.

Radiation protection ratings

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

Radiation protection encompasses the following specific areas:

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

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*. Each licensee develops its own ALARA dose targets that are based on anticipated operational and maintenance activities and take past performance into consideration.

Each licensee also develops forward-looking dose projections and reduction plans for collective radiation exposure.

In 2018, the total collective dose for monitored individuals at all Canadian NPPs and WMFs was 25.9 person-Sieverts (p-Sv), approximately 11 percent higher than the industry-wide collective dose reported for the previous year (23.33 p-Sv). The number of persons that received a reportable dose in 2018 (9,792) was also higher than 2017 values (9,273). 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 NPPs. The collective doses for the individual NPPs are shown in table 12. It illustrates that outages (including refurbishment activities) account for a much greater fraction of the collective dose than routine operations, and that external dose is, collectively, much greater than internal dose.

[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 annual collective dose by the total number of individuals receiving a dose above the minimum reportable level of 0.01 mSv.

Table 12: Breakdown of collective dose for operating NPPs in 2018 (person-mSv)

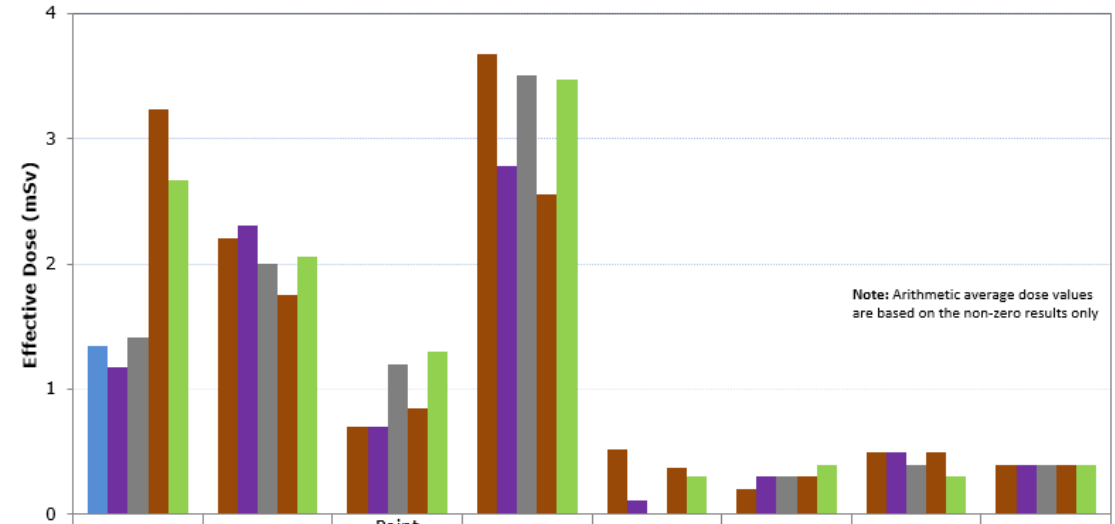
NPP	Routine Operations	Outages	Internal	External	Total
Pickering	795	4109	1007	3897	4904
Darlington	449	9506*	457	9498*	9955*
Point Lepreau	217	963	156	1024	1180
Bruce A	408	6434	283	6560	6842
Bruce B	548	2494	116	2927	3042

*For 2018, only DNGS had dose attributed to refurbishment activities.

The annual average effective dose in 2018 for all operating Canadian NPPs was 2.64 millisieverts (mSv), an approximate increase of 5 percent from the 2017 value of 2.52 mSv.

Figure 7 shows the average effective doses to monitored persons at each NPP and WMF for the period 2014 to 2018. This figure shows that, for 2018, the average effective dose at each facility ranged from 0.30 to 3.47 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 2018.

Figure 7: Trend of Average effective doses of monitored persons



	DNGS	PNGS	Point Lepreau	Bruce A&B	Gentilly-2	WWMF	DWMF	PWMF
2014	1.35	2.21	0.70	3.68	0.52	0.20	0.50	0.40
2015	1.18	2.31	0.70	2.78	0.11	0.30	0.50	0.40
2016	1.42	2.00	1.20	3.51	0.01	0.30	0.40	0.40
2017	3.24	1.75	0.85	2.56	0.37	0.30	0.50	0.40
2018	2.67	2.06	1.3	3.47	0.31	0.40	0.30	0.40

Worker dose control

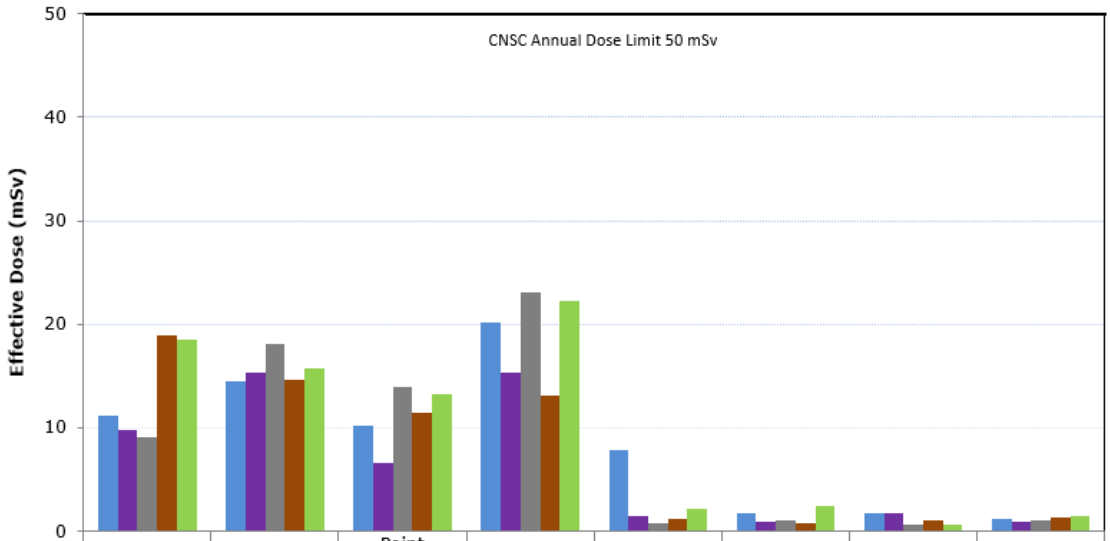
The *Radiation Protection Regulations* require that all licensees implement a radiation protection program to control the occupational doses received by persons. In addition to maintaining doses to persons below regulatory limits, NPP and WMF licensees have established action levels for worker exposures. CNSC staff monitor licensee actions for the affected workers following

unplanned exposures or uptakes. One worker at the DNGS received a dose that exceeded OPG's action level for worker dose. CNSC staff was satisfied with the actions taken by OPG to address the action level exceedance. Additional details are provided in section 3.1.7.

The maximum annual individual effective doses as reported by each NPP and WMF for 2014 to 2018, are presented in figure 8. In 2018, the maximum individual effective dose received at a single site was 22.19 mSv, received by a worker who performed duties at both Bruce A and B. In 2018, there were no radiation exposures, received by persons at any NPP or WMF, that exceeded the regulatory dose limit of 50 mSv/year for nuclear nergy workers, as established in the *Radiation Protection Regulations*.

Overall, CNSC staff were satisfied with the licensees' control of worker doses in 2018.

Figure 8: Trend of Maximum individual effective doses



	DNGS	PNGS	Point Lepreau	Bruce A&B	Gentilly-2	WWMF	DWMF	PWMF
2014	11.13	14.50	10.20	20.17	7.85	1.70	1.70	1.20
2015	9.78	15.38	6.60	15.40	1.46	0.90	1.70	0.90
2016	9.13	18.04	14.01	23.05	0.85	1.10	0.70	1.10
2017	18.94	14.58	11.40	13.05	1.16	0.80	1.10	1.40
2018	18.47	15.70	13.30	22.19	2.16	2.50	0.70	1.50

Radiation protection program performance

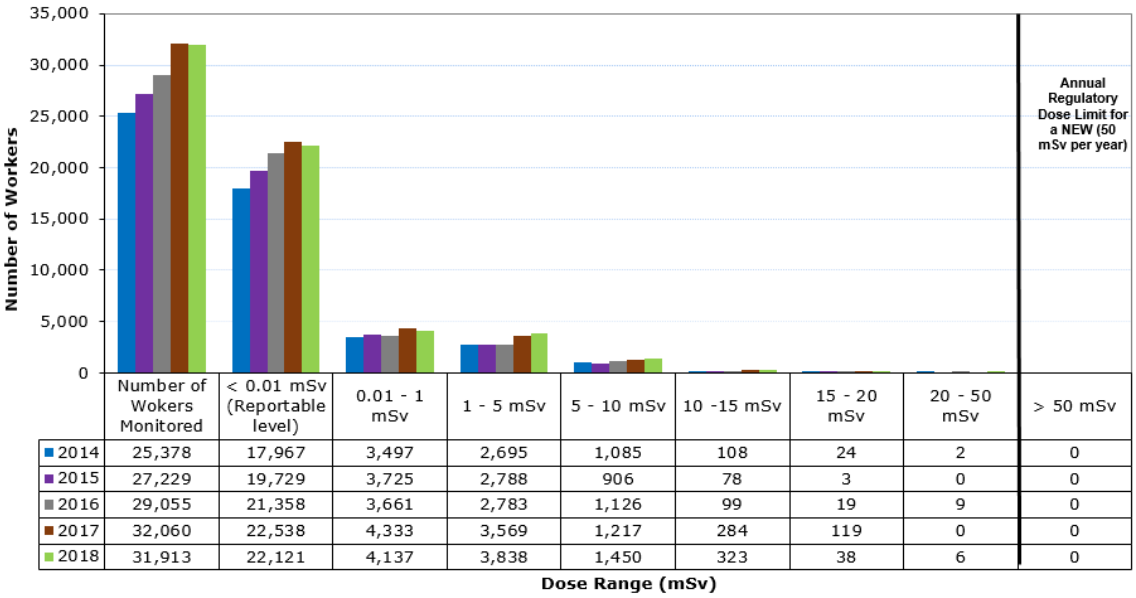
NPP and WMF licensees effectively implement their radiation protection programs and seek to improve program performance through assessment and benchmarking. The licensees maintain program documents and supporting procedures, taking into consideration operating experience and industry best practices.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

Noting the challenges encountered in the past by the NPPs in dealing with alpha contamination, CNSC staff increased the regulatory oversight of these areas of licensee radiation protection programs commensurate with the risks each licensee faced. As an overall approach, CNSC staff introduced new field inspection guides dedicated to radiation protection as part of the baseline compliance plan; these included inspection guidance for the application of ALARA, radiological hazard control and worker dose control. As well, CNSC staff clarified to licensees their requirement to report on alpha-related events under REGDOC 3.1.1. CNSC staff increased their

scrutiny of licensee submissions of safety performance indicators and their revisions to radiation protection program procedures to ensure conservative measures were being applied where alpha hazards were involved. As well, based on experiences from the refurbishment of Darlington Unit 2, CNSC staff enhanced the oversight of refurbishment planning and execution, including increased communication of regulatory expectations [RIB 14777].

Figure 9 provides the distribution of annual effective doses to all monitored persons at all Canadian NPPs from 2014 to 2018. All doses reported over those years were below the annual regulatory dose limit of 50 mSv. In fact, approximately 82 percent of the doses reported were at or below the much lower annual regulatory dose limit of 1 mSv for members of the public.

Figure 9: Trend of distribution of annual effective doses received by all monitored persons at Canadian NPPs



	Number of Wokers 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
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
2018	31,913	22,121	4,137	3,838	1,450	323	38	6	0

Radiological hazard control

NPP and WMF licensees implement measures in their radiation protection programs to monitor, minimize, and control radiological hazards and prevent 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 2018, no contamination control action levels were exceeded and no safety-significant performance issues were identified at any NPP or WMF.

In 2018, additional oversight activities occurred at NPPs related to internal alpha uptakes by workers at the DNGS and Point Lepreau. Additional details are provided in sections 3.1.7 and 3.5.7, respectively.

Estimated dose to the public

The estimated doses to the public for airborne emissions and liquid releases from 2014 to 2018 are provided in table 13. Note that the data for the DWMF, PWMF and WWMF are included in

that of the Darlington, Pickering and Bruce sites, respectively. The table shows that the doses were well below the annual regulatory dose limit of 1 mSv for members of the public, as well as below 1.8 mSv, which is the average national annual background dose. A comparison of the 2018 data to previous years indicates that the values remained within the same general range (<0.01 mSv) as the values for 2014 to 2017.

The value for 2018 for Gentilly-2 was higher than that of previous years, and the values for other NPPs, but was still relatively small and well within regulatory limits.

Table 13.Trend of estimated dose to the public from Canadian nuclear power generating sites

	Darlington Site	Pickering site	Point Lepreau	Bruce Site	Gemtilly-2
2014	0.0006	0.0012	0.0003	0.0020	0.0040
2015	0.0005	0.0012	0.0006	0.0029	0.0010
2016	0.0006	0.0015	0.0009	0.0016	0.0010
2017	0.0007	0.0018	0.0007	0.0021	0.0070
2018	0.0008	0.0021	0.0007	0.0017	0.0090

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 (Ontario's *Occupational Health and Safety Act*, the *Ontario Labour Relations Act*, *Occupational Health and Safety Act* (New Brunswick), Quebec's *Loi sur la Santé et la Sécurité au Travail* (Québec), and the *Canada Labour Code*, Part II: *Occupational Health and Safety*).

Conventional health and safety ratings

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

Conventional health and safety encompasses the following specific areas:

- performance
- practices
- awareness

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. CSA Group standard N286-12, *Management system requirements for nuclear facilities* also contains regulatory requirements that are directly applicable to conventional health and safety.

Performance

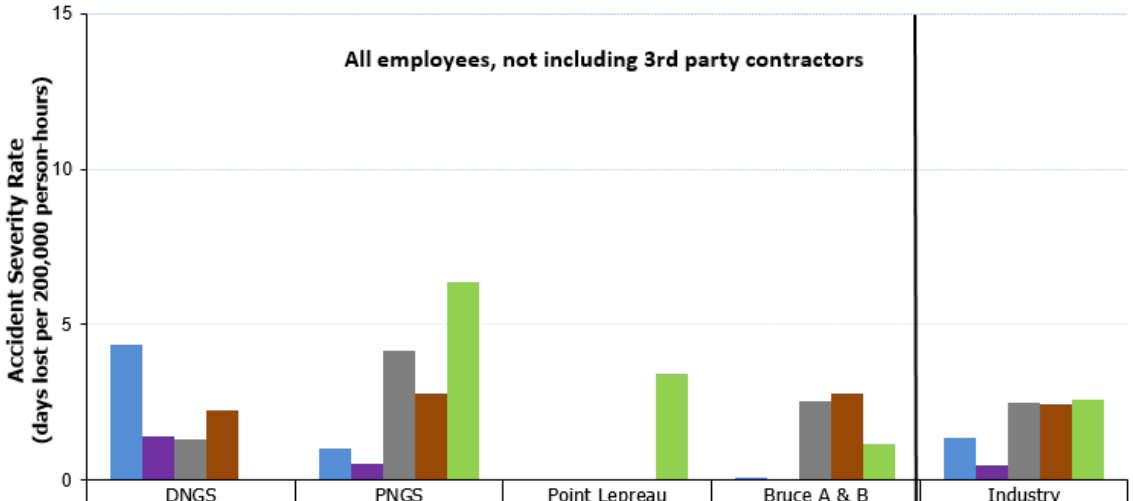
This specific area reflects the processes that monitor, track and report the level of occupational safety of workers. During inspections, CNSC staff record findings on safety practices and the controls being employed to address conventional hazards.

All NPP licensees are required to report safety performance indicators for conventional health and safety in accordance with REGDOC-3.1.1. The performance indicators "accident severity rate" (ASR), "accident frequency" (AF) and "industrial safety accident rate" (ISAR) are the parameters that measure the effectiveness of the conventional health and safety programs with respect to worker safety.

The ASR measures the total number of days lost due to work-related injuries for every 200,000 person-hours (approximately 100 person-years) worked at an NPP. 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 NPP personnel. The ASR, AF and ISAR data presented below includes all employees and contractors, including third party contractors [RIB 19297].

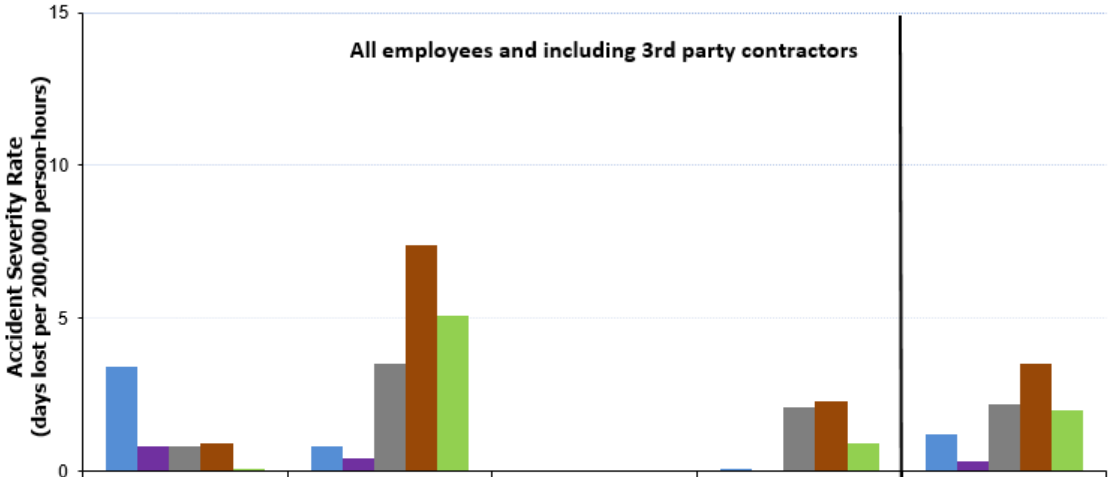
The ASR, AF and ISAR values for the NPPs and industry average are presented in figures 10a, 10b, 11a, 11b, 12a and 12b, respectively. The data in these figures indicate continuing low rates of accidents and lost time due to accidents. CNSC staff observed that there were no work-related fatalities at Canadian NPPs and WMFs in 2018. Figure 13 indicates that accident frequency at the Canadian NPPs continued to be very low in comparison to comparable industries.

Figure 10a: Trend of accident severity rate for NPPs and Canadian industry, not including 3rd party contractors



	DNGS	PNGS	Point Lepreau	Bruce A & B	Industry
2014	4.4	1.0	0.0	0.1	1.4
2015	1.4	0.5	0.0	0.0	0.5
2016	1.3	4.2	0.0	2.6	2.5
2017	2.2	2.8	0.0	2.8	2.4
2018	0.0	6.4	3.4	1.2	2.6

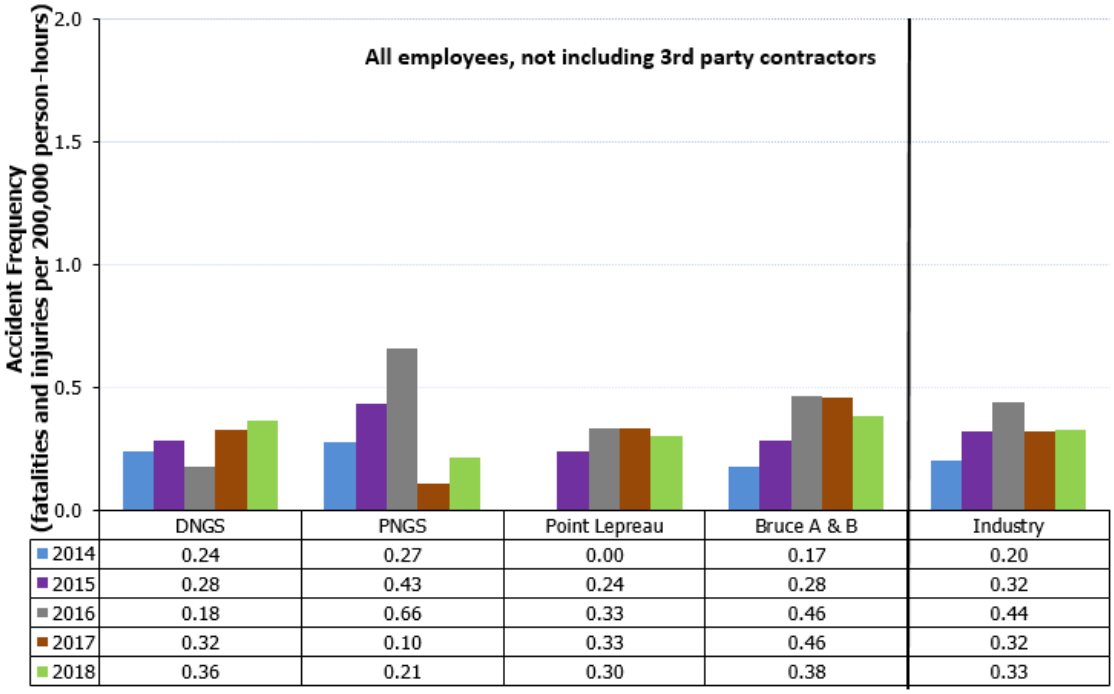
Figure 10b: Trend of accident severity rate for NPPs and Canadian industry, including 3rd party contractors



	DNGS	PNGS	Point Lepreau	Bruce A & B	Industry
2014	3.4	0.8		0.1	1.2
2015	0.8	0.4		0.0	0.3
2016	0.8	3.5		2.1	2.2
2017	0.9	7.4		2.3	3.5
2018	0.0	5.1		0.9	2.0

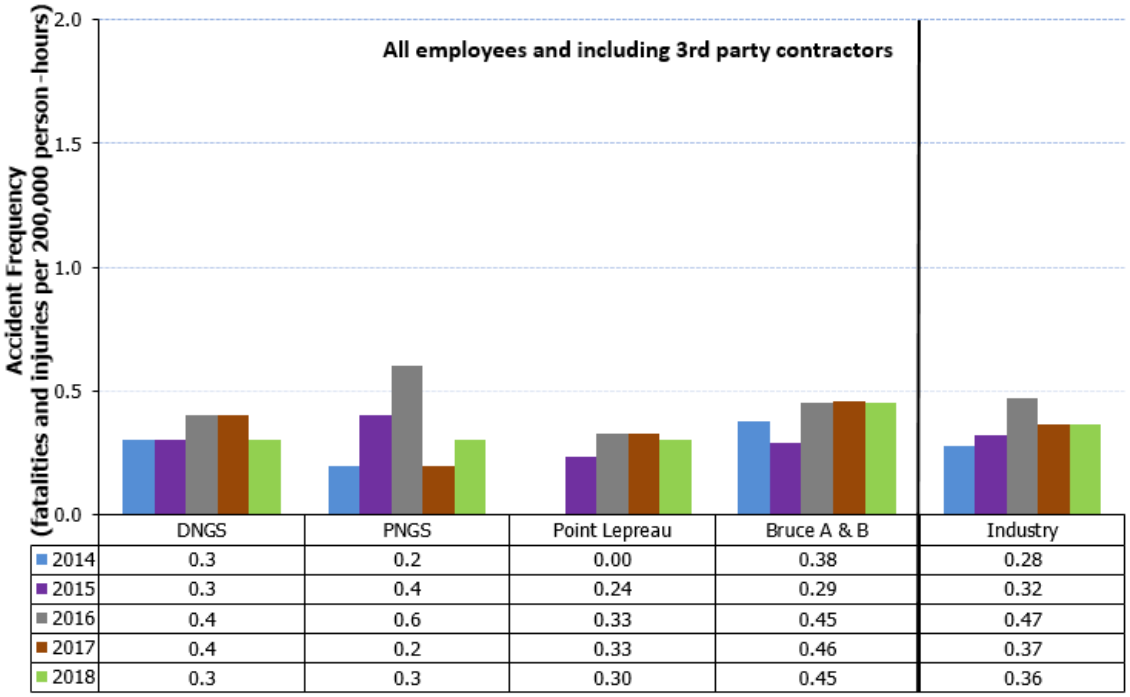
Note: Point Lepreau days lost to injuries are not available for 3rd party contractors, as NB Power does not track the lost days for 3rd party contractors

Figure 11a: Trend of accident frequency for NPPs and Canadian industry, not including 3rd party contractors



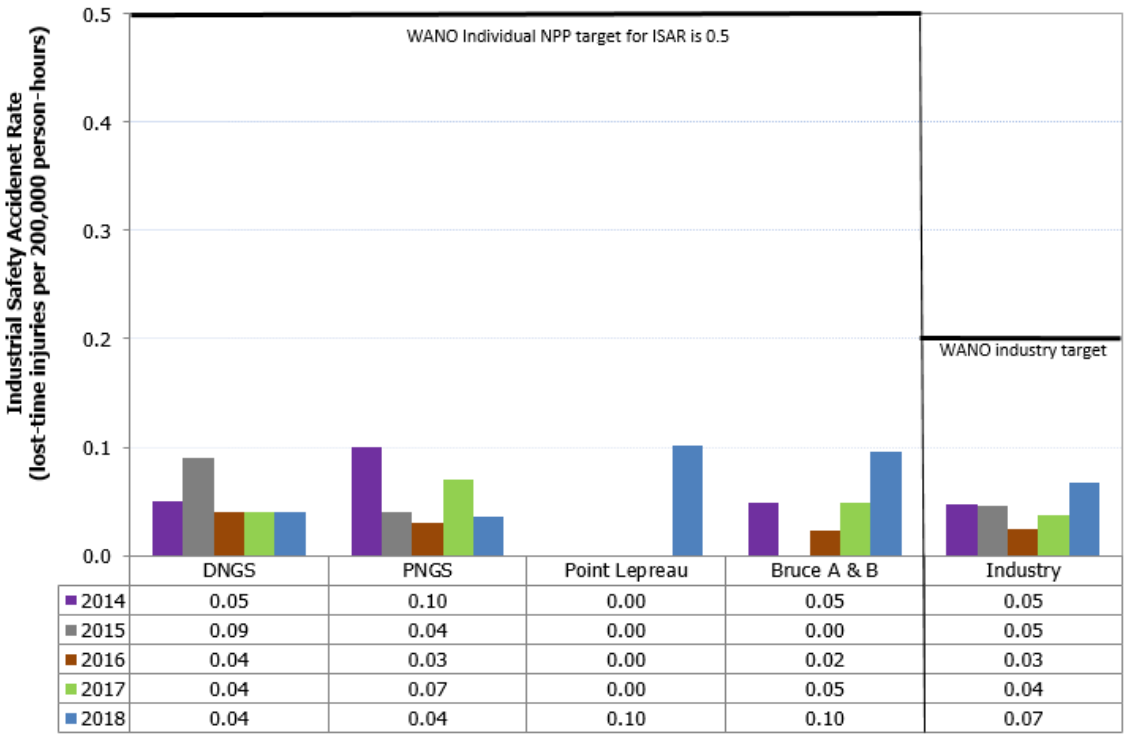
	DNGS	PNGS	Point Lepreau	Bruce A & B	Industry
2014	0.24	0.27	0.00	0.17	0.20
2015	0.28	0.43	0.24	0.28	0.32
2016	0.18	0.66	0.33	0.46	0.44
2017	0.32	0.10	0.33	0.46	0.32
2018	0.36	0.21	0.30	0.38	0.33

Figure 11b: Trend of accident frequency for NPPs and Canadian industry, including 3rd party contractors



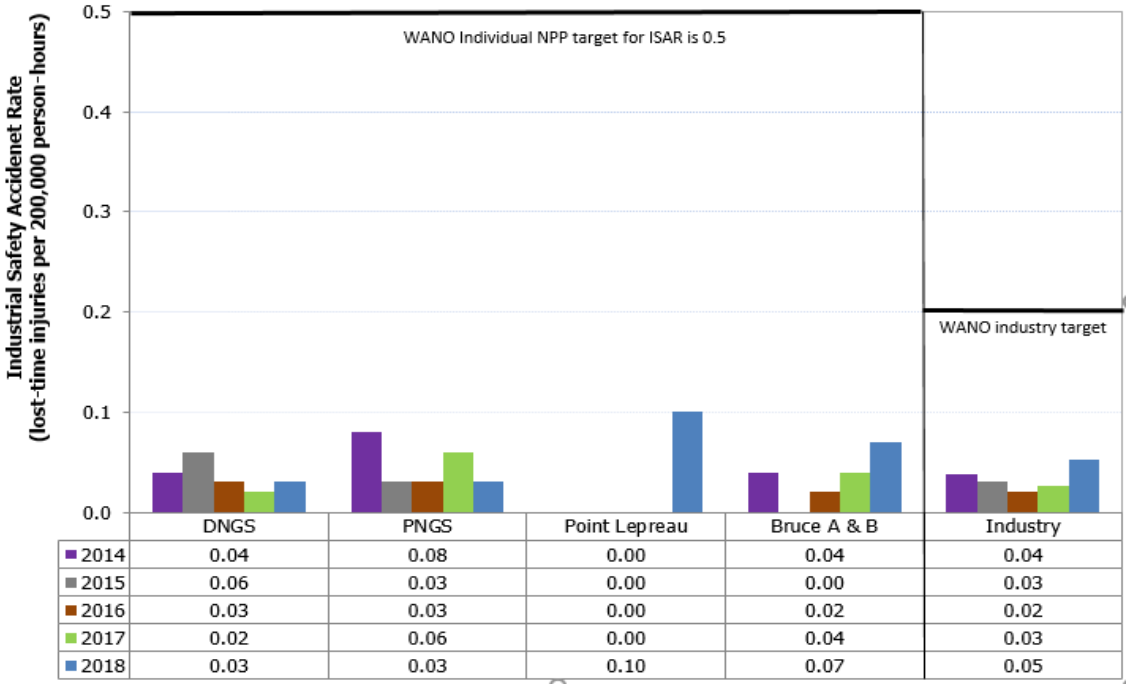
	DNGS	PNGS	Point Lepreau	Bruce A & B	Industry
2014	0.3	0.2	0.00	0.38	0.28
2015	0.3	0.4	0.24	0.29	0.32
2016	0.4	0.6	0.33	0.45	0.47
2017	0.4	0.2	0.33	0.46	0.37
2018	0.3	0.3	0.30	0.45	0.36

Figure 12a: Trend of industrial safety accident rate for NPPs and Canadian industry, not including 3rd party contractors



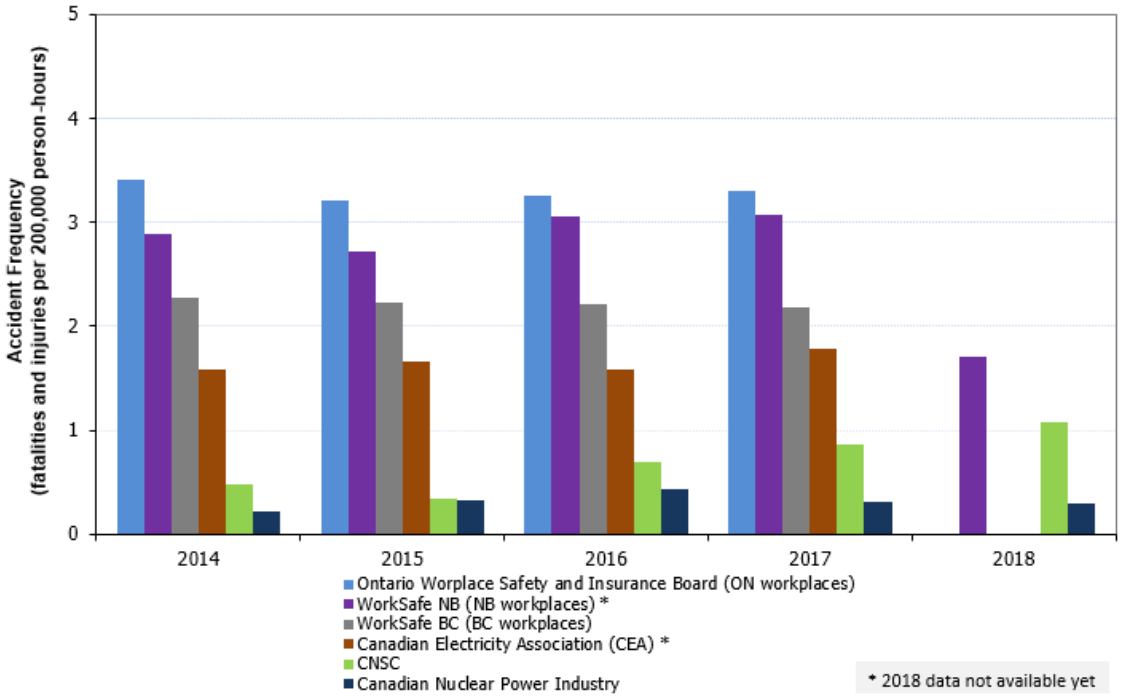
	DNGS	PNGS	Point Lepreau	Bruce A & B	Industry
2014	0.05	0.10	0.00	0.05	0.05
2015	0.09	0.04	0.00	0.00	0.05
2016	0.04	0.03	0.00	0.02	0.03
2017	0.04	0.07	0.00	0.05	0.04
2018	0.04	0.04	0.10	0.10	0.07

Figure 12b: Trend of industrial safety accident rate for NPPs and Canadian industry, including 3rd party contractors



	DNGS	PNGS	Point Lepreau	Bruce A & B	Industry
2014	0.04	0.08	0.00	0.04	0.04
2015	0.06	0.03	0.00	0.00	0.03
2016	0.03	0.03	0.00	0.02	0.02
2017	0.02	0.06	0.00	0.04	0.03
2018	0.03	0.03	0.10	0.07	0.05

Figure 13: Trend of accident frequency for Canadian workplaces



Practices

Practices SpA area reflects processes that ensure that managers and workers are actively involved in the support and enforcement of the safety actions.

The 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. The licensees provide the CNSC with any report they send to other regulatory agencies (e.g., provincial regulatory body for occupational health and safety).

For facilities in Ontario and New Brunswick, CNSC site staff maintain regular communication with the provincial Ministry of Labour regional offices and WorksafeNB, respectively, regarding any conventional health and safety issues.

In regards to radiological hazards, workers could be exposed to other hazardous materials and industrial work hazards. Hazardous materials can also 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, the risks from conventional hazards include, for example, the hazards associated with the control and safe handling of large and heavy equipment, scaffolding, and conventional x-ray equipment for security-related purposes, etc.

Awareness

Awareness reflects processes, which ensure that managers and workers have the knowledge to identify workplace hazards and precautions.

Licensees deliver adequate 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 complete information on the safe use of hazardous and combustible materials.

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	Bruce A	Bruce B	WWMF	PLNGS	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 2018:

- 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 and WMFs can release radioactive substances into both the atmosphere (as gaseous emissions) and bodies of water (as liquid effluents). Licensees are required to control radioactive releases into the environment to ensure they are protective of human health and the environment and do not exceed the regulatory release limits. These radioactive release 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 for the public of 1 mSv per year. The DWMF and PWMF fall under

the DRLs for the DNGS and the PNGS, respectively. The WWMF has its own facility-specific DRLs for airborne and liquid releases. The DRLs are given in Appendix H.

Licensees also establish and use environmental action levels. 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.

Data on releases of radionuclides to the environment in 2018 are provided in Appendix H. The releases were well below the DRLs for each facility; hence no radiological releases to the environment from the facilities exceeded the regulatory limits. 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 2018 at the NPPs and WMFs.

Environmental management system

The following publications contain regulatory requirements that were relevant in 2018:

- 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 and WMFs are also registered to ISO 14001: 2015 standard, *Environmental Management Systems – Requirements with Guidance for Use*. As a result of registration, the EMSs are subject to periodic, independent third party audits and reviews to verify their sufficiency and also identify potential improvements. CNSC staff confirmed through inspections that annual management reviews of the EMS took place in 2018, and that corrective actions were documented.

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 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.

The following publications contain regulatory requirements that were relevant in 2018:

- 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.

REGDOC-3.1.1 requires NPP licensees to submit annual environmental reports to the CNSC. Similar requirements apply to WMFs. Licensees also monitor groundwater around all sites and regularly submit the results to the CNSC. CNSC staff reviewed the 2018 monitoring results and concluded that the licensed operations had no adverse impact on the 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 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.

Based on the IEMP results from previous years, it has been concluded that the 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 as the results submitted by licensees, independently confirming that the licensees' environmental protection programs protect the public 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 health impacts are not expected.

Protection of the public

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

Environmental risk assessment

The following publication contains regulatory requirements that were relevant in 2018:

- 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.

An environmental risk assessment (ERA) is a systematic process used by licensees to identify, quantify and characterize the risk posed by contaminants (nuclear and hazardous substances) and physical stressors in the environment to human and non-human (biological) receptors. The applicant's or licensee's ERA provides science-based information to support regulatory decision-making under the Canadian Environmental Assessment Act (CEAA 2012) and/or under the NSCA.

The CNSC reviews the ERAs of the NPPs and WMFs 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 2018.

NPP licensees have developed and implemented programs to ensure the protection of fish populations from the effects of intake water withdrawal (fish impingement and entrainment) and

cooling water thermal discharge and to verify that measures are in place to ensure that risks to fish and fish populations remain acceptable. This work is conducted at the request of CNSC staff with advice and support from government ministries and agencies including Fisheries and Oceans Canada and Environment and Climate Change Canada through 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 in section 2.5.

Emergency management and fire protection ratings

DNGS	DWMF	PNGS	PWMF	Bruce A	Bruce B	WWMF	PLNGS	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, electricity, compressed gas, 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 ensure a planned, coordinated and controlled approach to conventional safety and response.

Nuclear emergency preparedness and response

The following publication contains regulatory requirements that were relevant in 2018:

- CNSC REGDOC-2.10.1 Version 2, *Nuclear emergency preparedness and response* (2016)

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

NPP and WMF licensees have emergency preparedness programs that identify the concepts, structures, roles, and resources to implement and maintain effective nuclear emergency response capabilities. The programs establish how nuclear facilities and other concerned organizations prepare for and plan to respond to emergencies (including nuclear or radiological emergencies, both on site and off site), in order to protect workers, the 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 and includes the WMFs.

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 off-site 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 I. The following describes developments in 2018 related to the provincial nuclear emergency plans.

Province of Ontario

Provincial Nuclear Emergency Response Plan

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 draft PNERP to the advisory group in August 2017. The updated PNERP Master Plan 2017 was approved by the Lieutenant Governor in Council of Ontario in December 2017, which triggered the development of site-specific implementing plans and subsequent incorporation of the relevant provisions in the Ontario licensees' emergency plans.

In 2018, the work focused on the Darlington, Pickering and Bruce Power PNERP implementing plans to ensure conformity with the Master Plan as well as to update preparedness and response provisions since the last versions were issued in 2009. The Pickering and Bruce Power implementing plans received Order In Council approval in March 2018.

UPDATE: The Darlington implementing plan received final approval in March 2019. The licensees planned to complete the revision of training programs for new emergency response staff in 2019.

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

Since June 2018, the Ontario Ministry of Transportation (MTO) has been working to secure approval to procure a consultant to draft the transportation management methodology and five site-specific unified transportation management plans as required by the 2017 PNERP. MTO staff were also involved in regular intra-ministry discussions to ensure that the unified transportation management plans integrate effective traffic control strategies and can be operationalized in the field [RIB 17522 (iv)].

Office of the Auditor General Report

The OFMEM developed a detailed management action plan to address the recommendations in the 2017 annual report of Ontario's Office of the Auditor General (OAG) on the status of

emergency preparedness. OFMEM staff presented this action plan and a PNERP update to the Commission on April 4, 2018.

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 on-site 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 annual report were consistent with the findings from several major exercises conducted at NPPs in Ontario in recent years.

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

IAEA Emergency Preparedness Review Mission

In 2018, the OFMEM continued to support Health Canada and the CNSC in the Ontario portion of the IAEA Emergency Preparedness Review (EPREV) which focused on the DNGS.

UPDATE: In June 2019, OFMEM hosted the EPREV team in Toronto.

Environmental Radiation and Assurance Monitoring Plan

The OFMEM continued to work with participating stakeholders in the development of a plan for environmental radiation and assurance monitoring and associated procedures and training. Environmental radiation and assurance monitoring is undertaken during a nuclear emergency to inform protective action decision-making as well as recovery planning. Stakeholder involvement includes federal departments as well as several Ontario ministries (Ministry of Health and Long Term Care, Ministry of Labour, Ministry of Agriculture and Food and Ministry of Environment, Conservation & Parks).

Province of New Brunswick

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

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. However, Québec's broader emergency plan ("le Plan national de sécurité civile," or PNSC) remains in place to address emergencies in general. The PNSC involves the cooperation of various Ministers and governmental organizations that have a defined role to play when responding to an emergency. The directorate for public health under Quebec's ministry of health and social services will intervene for infectious, chemical, biological or radiological emergencies.

Emergency Exercises

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 October 3 and 4, 2018, NB Power conducted a full-scale exercise (Exercise Synergy Challenge) at Point Lepreau, which tested the preparedness, response and recovery capabilities and capacities of more than 35 organizations including the CNSC and some non-government agencies. Additional details about the exercise itself are provided in section 3.5.10.

Fire emergency preparedness and response

The following publications contain regulatory requirements that were relevant in 2018:

- 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.

By incorporating the results of the CNSC compliance findings and observations and recommendations from third party reviews into the drill and training program, the performance of emergency response teams continues to improve.

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	Bruce A	Bruce B	WWMF	PLNGS	Gentilly-2
SA	SA	SA	SA	SA	SA	SA	SA	SA

Waste management encompasses the following specific areas:

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

CNSC regulatory document REGDOC-2.11, *Framework for Radioactive Waste Management and Decommissioning in Canada* defines radioactive waste as any material (liquid, gaseous or solid) that contains a radioactive nuclear substance, as defined in section 2 of the NSCA, and which the owner has declared to be waste. In addition to containing nuclear substances, radioactive waste may also contain non-radioactive hazardous substances.

Under Canada's national framework for radioactive waste management, waste owners are required to manage this waste in a safe and secure manner and to make arrangements for its long-term management.

The licensees' waste management programs describe how all streams of wastes are managed throughout their entire lifecycle from the point of their generation to their disposal. This includes waste generation, handling, processing, transporting, storage and disposal. The licensees continued to provide safe and secure waste management solutions for their low-level radioactive wastes (LLW), intermediate-level radioactive wastes (ILW) and high-level radioactive wastes (HLW) in 2018, noting that Bruce Power transfers its LLW, ILW and HLW to OPG's WWMF for management.

OPG is moving forward with a long-term solution for the management of its LLW and ILW, while OPG intends to dispose of LLW and ILW generated during operations and from decommissioning activities in a deep geologic repository proposed for the Bruce site. The deep geologic repository will be owned and operated by OPG.

In 2018, Hydro-Québec and NB Power continued discussions for possible long-term solutions for their LLW and ILW.

OPG, Hydro-Québec and NB Power are stakeholders in the Nuclear Waste Management Organization, which is implementing the Government of Canada's adaptive phased management approach for the long-term management of Canada's used nuclear fuel. CNSC staff will present the next regularly scheduled update on adaptive phased management Initiative to the Commission in 2020.

The following publications contain regulatory requirements that were relevant in 2018:

- CSA Group standard N292.0-14, *General principles for the management of radioactive waste and irradiated fuel*
- CSA Group standard N292.2-13, *Interim dry storage of irradiated fuel*
- CSA Group standard N292.3-14, *Management of low- and intermediate-level radioactive waste*

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

Waste characterization, waste minimization, and waste management practices

All NPP and WMF licensees continued to employ effective programs for the characterization, minimization, handling, processing, transporting, storage and disposal of radioactive and hazardous wastes during 2018.

"Likely clean" programs were in place at the NPPs and WMFs in 2018 that allowed for the separation at the source of waste that is likely not radioactive so as to minimize the generation of LLW at these facilities. During routine inspections in 2018, CNSC staff observed and confirmed OPG's, Bruce Power's and NB Power's implementation of this program.

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. 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 and PNGS, respectively for segregation as necessary and are eventually transported to the WWMF for

processing and storage. LLW at the WWMF is processed and/or stored on site. 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 2018.

Decommissioning plans

The following publication contains regulatory requirements that were relevant in 2018:

- CSA Group standard N294-14, *Decommissioning of facilities containing nuclear substances*

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

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 public and the environment are protected. Decommissioning involves removing radioactive and other hazardous materials from the site, and restoring the site to an agreed upon end-state.

Planning for decommissioning is an ongoing process, taking place throughout each stage of the facility's lifecycle. In accordance with paragraph 3(k) of the *Class I Nuclear Facilities Regulations*, each licensee develops a preliminary decommissioning plan (PDP) for the facility lifecycle stages before decommissioning. The PDP 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 is developed prior to decommissioning in support of an application for a licence to decommission.

The licensees are required to revise the PDPs and associated financial guarantees every five years or when requested by the Commission. For the NPPs, the proposed decommissioning strategies allow 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 strategies for the WMFs, on the other hand, involve 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 DNGS, DWMF, PNGS, PWMF, Bruce A and B and WWMF in January 2017 and submitted them to the CNSC for acceptance. These plans covered the period of 2018 to 2022, when the next regular revision is due. CNSC staff concluded that the plans met or exceeded 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 3.6.11, 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* associated regulatory documents and orders, as well as the expectations for their facilities or activities.

Security ratings

DNGS	DWMF	PNGS	PWMF	Bruce A	Bruce B	WWMF	PLNGS	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

Facilities and equipment

The following publications contain regulatory requirements that were relevant in 2018:

- CSA Group standard N290.7-14, *Cyber security for nuclear power plants and small reactor facilitie*s
- CNSC REGDOC-2.12.1, *High-Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices*

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

There were no significant security equipment failures reported to the CNSC in 2018.

Cyber Security

While not represented as a specific area, cyber security has become an important topic that warrants a discussion in its own section. NPP licensees maintain cyber security programs to protect cyber-essential assets from cyber-attacks. Licensees are working through the COG 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 2018:

- CNSC REGDOC-2.12.1, *High-Security Facilities, Volume I: Nuclear Response Force*, Version 2

Details on its applicability and implementation are provided Appendix E.

All licensees provided well-trained and suitably-equipped nuclear security officers and nuclear response force members for their facilities and have formal arrangements with off-site armed response services. The licensees contributed significant resources to the CNSC performance testing program by providing expert staff and participants to the Canadian Adversary Testing Team, which is utilized to conduct "force-on-force" exercises at high-security sites.

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 2018:

- CNSC REGDOC-2.12.2, *Site Access Security Clearance*
- CNSC REGDOC-2.12.3, *Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material*, Version 2

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

Drills and exercises

Licensees have exercise and drill programs to validate their security programs, ensure regulatory compliance and identify areas for improvement in security operations, including drills with the participation of off-site 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/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	Bruce A	Bruce B	WWMF	PLNGS	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.

Nuclear material accountancy and control

The following publication contains regulatory requirements that were relevant in 2018:

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

Details on its applicability are provided in Appendix E.

CNSC staff confirmed that the accountancy and control of nuclear material at all NPPs and WMFs complied with the applicable regulatory requirements in 2018. The licensees submitted their required monthly general ledgers on time.

The CNSC published regulatory document REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy* in February 2018, superseding RD-336 and GD-336, *Guidance for Accounting and Reporting of Nuclear Material*. REGDOC-2.13.1 sets out requirements and guidance for safeguards programs for applicants and licensees who possess nuclear material, carry out specified types of nuclear fuel-cycle related research and development work, or carry out

specified types of nuclear-related manufacturing activities. REGDOC-2.13.1 aims to establish a common understanding of the information, access and support licensees are to provide to the CNSC and to the IAEA in order to facilitate Canada's compliance with its safeguards agreements.

The CNSC requested the affected licensees to provide an implementation plan for meeting the requirements of REGDOC-2.13.1 by July 31, 2018. All affected NPP and WMF licensees committed to comply with REGDOC-2.13.1. NB Power and Bruce Power planned to implement the new REGDOC by 2019. OPG planned to implement it by 2021, although it was already making significant progress towards implementation in 2019.

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

Access and assistance to the IAEA

The 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. Those activities include inspections and the maintenance of equipment. The inspections may include an annual physical inventory verification and a number of short-notice and unannounced inspections that target certain groups of material or their transfer. The IAEA also conducts verifications of the design information provided by the facility. The IAEA also occasionally performs complementary access visits at these facilities. The purpose of these IAEA activities is to verify the nuclear material inventory and assure the absence of undeclared nuclear material and activities.

In 2018, the IAEA conducted 20 announced, 7 short-notice, and 30 unannounced inspections at the NPPs and WMFs. The numbers of activities conducted by the IAEA at each NPP and WMF in 2018 are provided in table 14.

Table 14: IAEA safeguards activities for 2018

Activity	DNGS	DWMF	PNGS	PWMF	Bruce A	Bruce B	WWMF	Point Lepreau	Gentilly -2	Totals
Physical inventory verifications	1	1	2	1	1	1	1	1	1	10
Design information verifications	1	1	1	1	2	1	1	1	1	10
Short notice random inspections	3	0	1	0	1	1	0	1	0	7
Unannounced inspections	4	3	2	4	4	3	5	3	2	30
Complementary access	0	0	0	0	0	0	0	1	0	1

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

Operational and design information

NPP and WMF licensees are required to submit to the CNSC operational and design information, as well as necessary information pursuant to the IAEA additional protocol.

CNSC staff confirmed that the licensees met the applicable regulatory requirements for operational and design information for the NPPs and WMFs in 2018. The licensees submitted

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

Safeguards equipment, containment and surveillance

CNSC staff confirmed that the licensees met the applicable regulatory requirements for safeguards equipment, containment and surveillance for the NPPs and WMFs in 2018. The licensees supported IAEA equipment operation and maintenance activities, including maintenance and installation of surveillance equipment (e.g., IAEA cameras, seals, and spent fuel monitors) to ensure the effective implementation of safeguards measures at each facility.

In September 2018, the multi-unit CANDU NPPs and their associated WMFs supported IAEA technical visits to discuss a revised safeguards approach for these facilities. This was a follow-up to the IAEA's site surveys in October 2017.

UPDATE: Similar technical visits at Point Lepreau and Gentilly-2 occurred in January 2019.

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 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	Bruce A	Bruce B	WWMF	PLNGS	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

All NPP and WMF licensees have programs 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*. Nuclear substances originating from NPPs and WMFs are required to be transported using packages that meet regulatory

requirements. In addition, all licensees who use a package of a certified design must register their use of the package with the CNSC.

While the *Packaging and Transport of Nuclear Substance Regulations*, 2015 do not apply to on-site transfers of packages, the NPP and WMF licensees ensure a level of safety equivalent to that required for off-site transportation to protect the health and safety of workers, the public and the environment.

There were no packaging and transport events reported in 2018 that had any safety significance

2.15 Other matters of regulatory interest

Other matters of regulatory interest include public information and disclosure, Indigenous consultation, nuclear liability insurance, financial guarantees, and environmental assessment.

Public information and disclosure programs

The availability and clarity of information pertaining to nuclear activities is essential to establishing an atmosphere of openness, transparency and trust between the licensee and the public. Since 2012, the CNSC has required major licensees to maintain a public information and disclosure program that is supported by a robust disclosure protocol and addresses local communities and stakeholders' needs.

CNSC regulatory document REGDOC 3.2.1, *Public Information and Disclosure*, (formerly known as RD/GD-99.3) sets out the requirements for public information and disclosure. The primary goal of the program, as it relates to the licensed activities, is to ensure that information related to the health, safety and security of persons and the environment and other issues associated with the lifecycle of nuclear facilities are effectively communicated to the public. This information promotes transparency and improves the public's understanding of the licensed activities and operations. The program includes a commitment and protocol for ongoing, timely dissemination of information related to the licensed facility during the course of the licence period.

CNSC staff determined that the public information and disclosure programs for the NPPs and WMFs complied with REGDOC 3.2.1 CNSC staff determined that the licensees provided information on the status of their facilities through a variety of communication activities. Some activities included licence renewal briefings for various audiences, facility updates to municipal councils, regular public information sessions, disclosure of on-site events, facility tours, organization of and participation in community events, regular newsletters, and regular promotion of activities and public engagement the use of social and traditional media. CNSC staff participated in licensee activities, conducted regular reviews of the public information and disclosure programs through compliance verification activities and met with licensees yearly to discuss the benefits of their communications programs, areas for improvement and plans for future initiatives.

Some key activities and best practices noted among licensees in 2018 included the following.

Ontario Power Generation

OPG communicated to the public on the mid-term status of the licence to operate DNGS and the refurbishment project through regular newsletter updates to local communities, municipal council updates, open houses and the use of the information center to engage and inform residents and stakeholders on the progress of the refurbishment project.

OPG regularly communicated with stakeholders, Indigenous groups and the local community to provide interested parties with opportunities to discuss the PNGS licence renewal application, various regulatory requirements and the work required at the station through open house sessions that were open to the public.

OPG provided regular updates at community meetings and invited the local communities to participate in special programming at the DNGS and PNGS information centers during each season.

Bruce Power

Bruce Power proactively engaged community members regarding the application for its ten-year licence renewal and the proposed major component replacement activities through various community meetings, open houses and local radio shows.

Bruce Power implemented an extensive community engagement and Indigenous engagement program through hosting tours that include site bus tours, participating in various local community activities and engaging students in various studies through summer employment programs. Bruce Power welcomed over 5000 visitors to the information center.

NB Power

One of the main objectives of the full-scale emergency exercise Synergy Challenge 2018 was to coordinate public communication among all organizations through the province to ensure that messaging was clear, consistent and effective. In addition to the exercise, NB Power developed an overarching public communications strategy, invited members of the media to the site, and coordinated public communication for the exercise with its partner organizations. To demonstrate openness and transparency, stakeholders and Indigenous communities were invited to observe the exercise and provide feedback.

NB Power continued to implement its public engagement program (and Indigenous engagement program) by initiating new activities onsite (see next section on Indigenous engagement).

NB Power continued to maintain an active role in the local community. It engaged regularly with the local school for special events and reading and educational programs. In addition, NB Power worked frequently with the local fishing community and fire department among other community groups, supporting safety programs, sharing operating experience and training and showcasing nuclear power, “women in nuclear” and community safety.

NB Power met regularly with the local community liaison committee, providing regular station updates, information on new technologies, upcoming projects and presentations from various leaders within the organization. This allowed community leaders to ask questions and provide input into how station operations impact the community.

NB Power continued to host a unique monarch butterfly tagging program and the site of a bird observatory for local naturalists.

NB Power hosted various public open houses, produced a quarterly, online newsletter for the community and participated in several community events across New Brunswick.

Hydro-Québec

At the Gentilly-2 facilities, general and specialized media, as well as official representatives of Indigenous and non-Indigenous communities, had the opportunity to observe the status of the decommissioning project through site visits, interviews and meetings. Their questions were answered and they expressed their appreciation through their respective communication channels.

In addition, the decommissioning project website was updated for the public, and an information panel on 30 years of safe management of this nuclear power plant was set up at the Bécancour tourism office in partnership with the town of Bécancour. As well, a legacy video was filmed with employees to document their time at the facility.

Indigenous Consultation and Engagement

General overview

CNSC staff are committed to building long-term relationships with Indigenous groups who have interests in the regulation of nuclear facilities within their traditional and/or treaty territories. By pursuing informative and collaborative ongoing interactions, the CNSC's goal is to build partnerships and trust. The CNSC's Indigenous engagement practices, which include information sharing and funding support (through the CNSC's participant funding program (PFP)) for Indigenous peoples to meaningfully participate in Commission proceedings and ongoing regulatory activities, are consistent with the principles of upholding the honour of the Crown and reconciliation with Indigenous communities.

CNSC staff efforts in 2018 supported the CNSC's ongoing commitment to meeting its consultation obligations and building relationships with Indigenous peoples with interests in Canada's nuclear power generating sites. CNSC staff continued to work with Indigenous communities and organizations to identify opportunities for formalized and regular engagement throughout the lifecycle of these facilities, including meetings and facilitated workshops.

In addition, CNSC staff provided interested communities with notice of the PFP opportunity to review and comment on this report and the opportunity to submit a written intervention and/or appear before the Commission as part of the Commission meeting at which it will be presented. CNSC staff sent copies of the report to all Indigenous communities and organizations who have requested to be kept informed of activities at NPPs and WMFs.

In 2018, CNSC staff monitored the engagement work conducted by NPP and WMF licensees to ensure that they actively engaged and communicated with Indigenous groups who have interest in their facilities. The following summarizes the engagement activities for each site conducted by CNSC staff and the licensees in 2018.

Pickering and Darlington sites

CNSC staff engagement activities

The DNGS, DWMF, PNGS and PWMF lie within the traditional territories of the Williams Treaties First Nations (WTFN), which include the Mississaugas of Alderville First Nation, Curve Lake First Nation, Hiawatha First Nation, Mississaugas of Scugog Island First Nation, Chippewas of Beausoleil First Nation, Chippewas of Georgina Island First Nation and Chippewas of Rama First Nation.

Mohawks of the Bay of Quinte (MBQ) and the MNO on behalf of the MNO Region 8 Consultation Committee are additional Indigenous groups with interest in the DNGS, DWMF, PNGS and PWMF that have also asked to be kept informed of any activities related to these facilities.

In 2018, a major focus of CNSC's engagement activities was regarding the licence renewal of PNGS. Throughout the regulatory process for the renewal, CNSC staff engaged with the identified First Nations and Métis groups, who were encouraged to participate in the review process and in the public hearing to advise the Commission directly of any concerns they may have had in relation to the licence renewal application. Following the Commission's licence

renewal decision, CNSC staff continued to engage with the identified First Nation and Métis groups in recognition of their longstanding interest in the operation of the PNGS.

William Treaties First Nations

CNSC staff provided substantive information and updates to the WTFN throughout the year 2018 relating to the PNGS license renewal and met with the WTFN on multiple occasions to discuss a number of topics of interest including the PNGS licence renewal, the DNGS refurbishment project and the ongoing operations and performance of the DNGS, DWMF, PNGS and PWMF. CNSC staff initiated discussions with the WTFN to determine if they would be interested in formalizing their engagement relationship with CNSC staff. The WTFN expressed interest and the development of terms of reference was discussed with CNSC staff.

Mohawks of the Bay of Quinte

In 2018, CNSC staff organized a meeting with MBQ.

UPDATE: In May 2019, CNSC staff met with MBQ leadership in order to discuss a number of topics of interest including the transport of radioactive materials, the PNGS licence renewal, the DNGS refurbishment project, the ongoing operations and performance of the DNGS, DWMF, PNGS and PWMF. CNSC staff initiated discussions with the MBQ to determine if they would be interested in formalizing the engagement relationship with CNSC staff. The MBQ expressed interest and discussions were initiated to determine the most appropriate frequency of regular engagement meetings and the best approach to formalize the relationship.

Métis Nation of Ontario

CNSC staff and the MNO continued working to develop terms of reference for on-going collaboration. As the MNO is a province-wide organization, a specific engagement plan was being developed with MNO Region 8, which is the consultation committee region that includes the Pickering and Darlington sites to determine the appropriate frequency of regular engagement meetings to address their areas of interest. In 2018, CNSC staff met with MNO Region 8 representatives in order to discuss a number of topics of interest including the PNGS licence renewal, the DNGS refurbishment project and the ongoing operations and performance of the DNGS, DWMF, PNGS and PWMF. CNSC staff committed to continue meeting with MNO Region 8 to provide key updates on nuclear activities and projects in their territory of interest.

Licensee engagement activities

CNSC staff observed that OPG had a dedicated Indigenous engagement program that covers its operations and activities at the Darlington and Pickering sites. CNSC staff recognized OPG's "Indigenous opportunities in nuclear" program, which uses the DNGS refurbishment project as a catalyst for creating jobs in the building trades for Indigenous people.

Throughout 2018, OPG met and shared information with interested Indigenous communities and organizations including the WTFN, MNO and MBQ. Topics of discussion included the DNGS refurbishment project, environmental monitoring activities, fish impingement and entrainment at DNGS and PNGS, OPG's intent to renew the licence for the Darlington new-nuclear project and the proposed DNGS isotope project. In 2018, OPG continued its efforts to address concerns raised by the identified groups. It conducted multiple site visits and regular briefings and involved Indigenous communities in environmental monitoring activities; OPG planned to continue those efforts in 2019. CNSC staff continued to be satisfied with the level and quality of Indigenous engagement conducted by OPG with regards to its operations at the the DNGS, DWMF, PNGS and PWMF.

Bruce site

CNSC staff engagement activities

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

Historic Saugeen Métis

CNSC staff met with HSM representatives on multiple occasions in 2018 to discuss areas of interest such as the CNSC's IEMP, the Bruce Power licence renewal hearings and Bruce Power's *Fisheries Act* authorization. While the HSM did not have any outstanding concerns related to the nuclear activities on the Bruce site, they continued to actively participate and make informed contributions to address any potential impacts on HSM rights and interests.

UPDATE: Terms of reference between CNSC staff and the HSM were signed on April 12, 2019 to formally document CNSC's engagement with the HSM. They include a provision for CNSC to engage and update HSM on regulatory activities on a semi-annual basis.

Métis Nation of Ontario

CNSC staff and the MNO were working towards developing terms of reference for on-going collaboration. As the MNO is a province-wide organization, a specific engagement plan under the terms of reference will be jointly developed with MNO Region 7, which is the consultation committee region that includes the Bruce site to address their areas of interest. In 2018, CNSC staff met with MNO Region 7 representatives to discuss areas of interest such as the IEMP, the licence renewal hearings for Bruce A and B and Bruce Power's *Fisheries Act* authorization.

As discussed at Bruce Power's licensing renewal hearing, the MNO Region 7 would like to be more involved in environmental monitoring activities around the Bruce site. The MNO Region 7 held a workshop in October 2018 that included CNSC, Bruce Power and OPG to collaboratively discuss how the various environmental monitoring programs may be of interest to the community. As a result, the MNO Region 7 agreed to participate in the IEMP sampling campaign scheduled for the fall of 2019 as observers to learn more about the program. Following this, the MNO Region 7 would then further participate in future campaigns through identification of samples of interest and/or sample collection.

In addition, the MNO Region 7 has been conducting surveys of its citizens in the Bruce area. One of the results has shown that a number of its citizens have negative perceptions regarding environmental impacts related to the Bruce site. As a result, CNSC staff committed to continue collaborating with the MNO Region 7 to conduct outreach activities in order to inform MNO citizens of the results of environmental monitoring and risks posed by radiation and answer their questions. CNSC staff will continue to collaborate and engage with the MNO Region 7 on areas of interest with regards to the Bruce site.

Saugeen Ojibway Nation

The Commission's record of decision for the Bruce Power licence renewal highlighted several topics that CNSC staff should address when engaging and collaborating with the SON, including:

- joint review and analysis of licensee submissions, particularly around environmental protection;
- SON participation in the IEMP
- inclusion on the design and review of Bruce Power's study of available mitigation measures for environmental impacts

A work plan was developed with detailed tasks and timelines for each of the items in the record of decision.

CNSC outreach to the SON included the following:

- sharing the results of CNSC's environmental oversight, such as inspection reports
- identifying federal, provincial and municipal decision-making agencies, as needed
- coordinating meetings with federal and provincial crown agencies, as needed

CNSC staff understands that the SON continues to have concerns regarding the environmental impacts resulting from the nuclear activities at the Bruce site, as described in the SON's intervention at the licence renewal hearing in March 2018. The focus of the activities in the work plan is to ensure SON oversight and inclusion and a means to obtain additional information that will provide clarity, transparency and assurances for the communities and SON leadership regarding the interactions between the Bruce facility and the environment. Some of these activities include the expansion of IEMP sampling program to include areas within and around the SON communities and involvement of SON members in the sampling, as well as SON involvement in Bruce Power's environmental monitoring programs. In addition, SON has initiated the coastal waters monitoring program, which is an initiative funded in cooperation with Bruce Power, but designed, led and implemented by the SON to monitor environmental conditions in the nearshore areas of the Saugeen Peninsula. CNSC staff is also interested in the results of the program, as this will provide data that can be used in future environmental risk assessments.

In 2018, CNSC staff met with the SON on multiple occasions and will continue to collaborate and engage with the SON on these initiatives to address their concerns regarding environmental impacts.

UPDATE: SON and CNSC staff signed terms of reference on May 21, 2019 to provide a forum through which they can collaborate and address areas of interest or concern, raised by the SON, regarding CNSC-regulated facilities and activities within the SON's traditional territory [RIB 14758].

Licensee engagement activities

CNSC staff observed that Bruce Power and OPG both had a dedicated Indigenous engagement program that covered their operations and activities at the Bruce site.

Throughout 2018, both Bruce Power and OPG met and shared information with interested Indigenous communities and organizations, particularly the SON, MNO and HSM.

For Bruce Power, information and discussion topics included Bruce Power's operations at the Bruce site, its application for a *Fisheries Act* authorization, the study of available mitigation measures for environmental impacts (including impacts to fish) and the licence renewal application. Bruce Power continued to engage the SON, MNO and HSM on the *Fisheries Act* authorization to adequately address their information requests and concerns raised throughout the

process in its final application, which was submitted to Fisheries and Oceans Canada in November 2018.

In 2018, OPG continued its regular updates and meetings with Indigenous communities who have an interest in their operations and projects at the Bruce site including the WWMF and the proposed deep geologic repository. OPG has been actively engaging with SON community members on the deep geologic repository project, both on and off the reserve, to ensure that community members are able to get all of the information they need to determine if the SON communities are supportive of moving forward with the project on their territory.

CNSC staff continue to be satisfied with the level and quality of Indigenous engagement conducted by both OPG and Bruce Power with regards to their operations at the Bruce site.

Point Lepreau Site

CNSC Staff engagement activities

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

In 2018, major foci of CNSC's engagement activities were the follow up from the licence renewal for Point Lepreau, NB Power's application for a *Fisheries Act* authorization and working to formalize the relationship between the interested First Nations and CNSC staff.

CNSC staff provided information and updates to MTI, WNNB and Peskotomuhkati leadership throughout 2018 and met with them individually, on multiple occasions to discuss a number of topics of interest including

- the CNSC's IEMP
- performance of the PLNGS
- incorporation of Indigenous Knowledge in monitoring activities
- fish impingement and entrainment at Point Lepreau
- management of nuclear waste
- NB Power's application for a *Fisheries Act* authorization
- CNSC's independent lab in Ottawa
- small modular reactors in Canada
- the ongoing engagement relationships between them, other First Nations and CNSC staff

Discussions with the Peskotomuhkati leadership also covered the history of the Peskotomuhkati First Nation.

CNSC staff initiated discussions with both MTI and WNNB to determine if they would be interested in formalizing the engagement relationships between them and CNSC staff. . Both MTI and WNNB have expressed interest and discussions are ongoing on the development of terms of reference to formalize the relationship with CNSC staff.

Licensee engagement activities

CNSC staff observed that NB Power had a dedicated Indigenous engagement program. Throughout 2018, NB Power met and shared information with interested Indigenous communities and organizations, with a specific focus on Indigenous collaboration on the site. NB Power has implemented an Indigenous traditional knowledge program, establishing more awareness among its workers and involving members of local Indigenous communities to participate in regular activities at the site. Point Lepreau leadership and staff learned from Indigenous communities and integrated some of those lessons into its approach in station management, particularly environmental management. As well, NB Power worked with Indigenous groups to build capacity within their communities to better understand and self-direct learning on nuclear technology and its use in New Brunswick, waste management and new opportunities in nuclear development and its role in a clean electricity mix. Through cultural exchanges, NB Power and Indigenous communities have gained greater understanding of each other's outlooks, interests and goals. In 2018, NB Power worked with several communities, including the WNNB, MTI, the Peskotomuhkati Nation at Skutik, Sipekne'katik First Nation, the Union of New Brunswick Indians and Mawiw Council. Information and discussion topics included NB Power's operations at Point Lepreau, its application for a *Fisheries Act* authorization, waste management, environmental monitoring, environmental and regulatory approval processes, education, cultural awareness and sensitivity.

Gentilly-2 site

CNSC Staff engagement activities

The Gentilly-2 site lies within the traditional territory of the Abénaki of Wôlinak and Odanak, represented by the Grand Conseil de la Nation Waban-Aki (GCNWA) as well as the Nation huronne-wendat.

Following CNSC's commitment to build relationships and communicate with Indigenous peoples with interests in the Gentilly-2 site, CNSC staff continued to keep interested First Nations informed throughout 2018 about the IEMP sampling around Gentilly-2 as well as this regulatory oversight report.

Licensee engagement activities

CNSC staff observed that Hydro-Québec had a dedicated Indigenous engagement program. Throughout 2018, Hydro-Québec continued its commitment to engage and communicate with Indigenous groups with an interest in their operations and sites, and met and shared information with interested First Nations communities and organizations, particularly the GCNWA with whom Hydro- Québec met to discuss different topics, including the environmental monitoring activities related to the decommissioning of Gentilly-2 and the project to extend the management of liquid effluents.

As part of their engagement activities, Abenaki representatives expressed interest to Hydro-Québec in a point of land located at the eastern portion of the Gentilly-2 property that may have potential for Indigenous archaeology. It was agreed that this point of land located at the extreme east of the property owned by Hydro-Québec would be visited again in 2019 and that Hydro-Québec would continue to engage the Abenakis regarding their interest in these lands, in particular in their archaeological potential.

Nuclear liability insurance

On January 1, 2017 the *Nuclear Liability and Compensation Act* (NLCA) came into force,

replacing the *Nuclear Liability Act*. 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 *Nuclear Liability Act* 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 licensees to provide proof of compliance with the NLCA on an ongoing basis. Licensees will be expected to meet their obligations for nuclear liability coverage under the NLCA, consistent with the CNSC general licence conditions requiring licensees to be in compliance with all applicable laws.

UPDATE: CNSC staff confirmed with NRCan that the licensees complied with the financial security obligations of the NLCA as of June 1, 2019 [RIB 14776].

Financial guarantees

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, including those at the Bruce site. 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 $18, 689 M in December 2018.

As of March 2017, the value of the financial guarantee for Point Lepreau was $689.7 M, which exceeded the required value of $567.8 M. As of August 2017, the value of the financial guarantee for Gentilly-2 was $835 M, which exceeded the required value of $808 M. CNSC staff did not conduct any assessments of the financial guarantees for Point Lepreau or Gentilly-2 for 2018.

UPDATE: In 2019, NB Power and Hydro-Québec submitted their annual confirmations of the validity and sufficiency of their financial guarantees for decommissioning. CNSC staff were satisfied with the licensees' confirmations. Both NB Power and Hydro- Québec are due to submit their next updates on their financial guarantees in 2020.

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

3.1 Darlington site

The Darlington site consists of the Darlington Nuclear Generating Station (DNGS), the Tritium Removal Facility (TRF), and the Darlington Waste Management Facility (DWMF). This section presents CNSC staff's assessment of OPG's performance at the Darlington site for each SCA. 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 DNGS and DWMF, as of December 2018, are listed in Appendix E.

Overall CNSC staff assessment

The CNSC staff assessment of OPG's performance at the Darlington site for 2018 resulted in the performance ratings shown in table 15. The ratings for the DNGS also apply to the TRF.

Table 15: Performance ratings for the Darlington site, 2018

Safety and control area	DNGS Rating	DWMF Rating
Management system	SA	SA
Human performance management	SA	SA
Operating performance	**FS**	SA[1]
Safety analysis	**FS**	SA[1]
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	SA	SA
Conventional health and safety	**FS**	SA[2]
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Waste management	SA[1]	SA
Security	SA	SA
Safeguards and non-proliferation	SA	SA
Packaging and transport	SA	SA

Legend: FS – fully satisfactory SA – satisfactory
BE – below expectations UA – unacceptable

Notes: [1] The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

For 2018, CNSC staff reviewed the criteria for rating the specific areas under the SCAs. Besides assessing licensees against continually evolving requirements, CNSC staff also refined its criteria for "fully satisfactory" ratings based on industry best practice. Some SCAs that were rated "fully satisfactory" in 2017 have been rated "satisfactory" in 2018 in the context of the revised criteria. The revision of criteria also led to the decision to not include an overall rating for each facility (overall ratings were included in the regulatory oversight report for 2017).

Based on the assessments of the SCAs and other observations in 2018, CNSC staff concluded that OPG operated the DNGS, TRF and DWMF safely, upheld its responsibilities for safety and promoted a healthy safety culture.

3.1.0 Introduction

The Darlington site is located on the north shore of Lake Ontario in Clarington, Ontario, 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 waste facility operating licence (WFOL).

Darlington Nuclear Generating Station

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

OPG intends to refurbish the four reactors; the refurbishment of Unit 2 began in October 2016 and continued throughout 2018. In November 2017, OPG began operating the Retube Waste Processing Building (RWPB) in time for the processing of the removed reactor components from Unit 2 (fuel channel end-fittings, pressure tubes and calandria tubes).

The TRF, which is housed in the Heavy Water Wanagement Building, is used to remove tritium that builds up gradually in some plant systems as a result of day-to-day operations. Removing the tritium minimizes the amount released into the environment and reduces the potential radiation exposure of workers. The tritium is extracted from the reactor's heavy water and stored safely in stainless steel containers as titanium tritide within a concrete vault.

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.

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. The transfer of loaded DSOs from the DNGS to the RWSB is also conducted on OPG property.

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

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

Licensing

Darlington Nuclear Generating Station

The Commission renewed the PROL for the DNGS, which also governs the TRF, in December 2015 for a 10-year period, with an expiry date of November 30, 2025.

Darlington Waste Management Facility

The Commission renewed the WFOL for the DWMF in March 2013, with an expiry date of April 30, 2023. No licensing actions were conducted for the DWMF in 2018.

Licence Conditions Handbook

Darlington Nuclear Generating Station

CNSC staff revised the DNGS licence conditions handbook (LCH) in February 2018 to update the compliance verification criteria in various sections to include new or revised CNSC regulatory documents and CSA Group standards (these developments are described in this report) and licensee documents.

Darlington Waste Management Facility

The DWMF LCH was not revised in 2018. However, OPG implemented several CNSC regulatory documents and CSA Group standards in 2018. Future revisions of the LCH will reflect those new publications (or new versions of existing publications) as sources of compliance verification criteria for the DWMF.

***Fisheries Act* authorization**

Darlington Nuclear Generating Station

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

Refurbishment

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

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

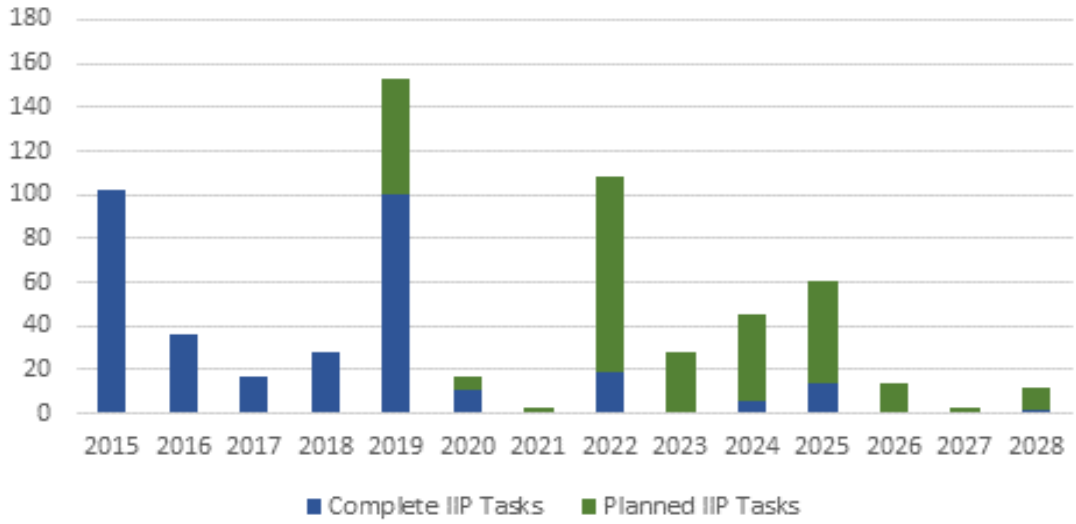
OPG had completed the first two phases for refurbishment and was in the installation phase, in which the main activity was reconstruction of reactor core components.

CNSC staff focused their regulatory oversight on regulatory deliverables specified in the integrated implementation plan (IIP), which was being implemented in accordance with a condition in the PROL (the IIP was approved by the Commission during the licence renewal process).

The work to which OPG committed in the IIP was progressing according to schedule. OPG completed 77 IIP tasks in 2018. Figure 14 summarizes the IIP tasks that were planned and already completed for the duration of the project.

CNSC staff were satisfied with the progress on the IIP in 2018.

Figure 14. DNGS IIP (based on planned dates)



As part of its 2012 environmental assessment for the refurbishment project, OPG had committed to address several safety improvement opportunities (SIO). These commitments were later incorporated in the IIP to consolidate all the implementation activities. The SIOs involved features to improve safety of the plant for beyond-design-basis accidents. All but two SIOs were previously addressed, as described in the regulatory oversight report for 2017. One of the remaining SIOs involves modifications to shield tank over-pressure (STOP)protection. Those modifications were completed for Units 1, 3 and 4 prior to 2018. OPG planned to complete the modification for Unit 2 in 2019 prior to restart in accordance with the IIP schedule. The other remaining SIO concerned emergency service water and diesel-driven, fire-water pumps.

UDATE: OPG submitted its annual report on completed IIP items for 2018 in March 2019. CNSC staff were reviewing the report and proceeding to close IIP items after confirming that they met the applicable regulatory requirements.

In early 2019, OPG submitted to the Commission a request to revise the IIP, directly involving changes to the means by which the SIO associated with the emergency service water system would be implemented. At the time of this report, the Commission was considering the matter.

CNSC and OPG established a protocol to clarify requirements for the return to service of Unit 2 and the removal of regulatory hold points. There was no revision to this protocol in 2018. The protocol requires regular meetings to monitor refurbishment progress.

Event initial reports

CNSC staff submitted one event initial report to the Commission pertaining to the DNGS for the period January 1, 2018 to June 1, 2019. It is described in table 16. No event initial reports pertaining to the DWMF were submitted to the Commission for that period.

Table 16: Event initial reports for the DNGS

Subject	Description
Personal internal contamination event	In February 2018, two workers were contaminated while working in the Retube Waste Processing Building because a wrongly-classified work site had resulted in workers wearing ineffective protective gear for the radiological hazards they encountered. Dose assessments confirmed that the two workers received committed effective doses 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.

Compliance program

The annual CNSC effort on the compliance program is tabulated in Appendix F for the DNGS and DWMF. The inspections conducted at the Darlington site that were considered in CNSC staff assessments in this regulatory oversight report are included in table 17 (inspection reports were included if they were sent to OPG by January 31, 2019).

Table 17 List of inspections at the Darlington site

Safety and control area	Inspection title	Inspection report sent
Management system	Contractor Management (Refurbishment INS-01-04) Report Number: DRPD-2018-005	May 18, 2018
	Management System Program Implementation - Aging Report Number: DRPD-2018-00874	Dec 03, 2018
	Refurbishment Engineering Change Control Report Number: DRPD-2018-00276	Jan 30, 2019
Human performance management	Nuclear Refurbishment Training Change Control Report Number: DRPD-2018-00863	Aug 10, 2018
Operating performance	Darlington Nuclear Generating Station Quarterly Field Inspection Third Quarter FY 2017/18 Report Number: DRPD-2018-002	Mar 20, 2018
	Darlington Nuclear Generating Station Quarterly Field Inspection Fourth Quarter FY 2017/18 Report Number: DRPD-2018-011	Jun 21, 2018
	Planned Outage Inspection (D1831) Report Number: DRPD-2018-00234	Aug 10, 2018
	Darlington Nuclear Generating Station Quarterly Field Inspection First Quarter FY 2018/19	Sep 10, 2018

Safety and control area	Inspection title	Inspection report sent
	Report Number: DRPD-2018-00929	
	Darlington Nuclear Generating Station Quarterly Field Inspection Second Quarter FY 2018/19 Report Number: DRPD-2018-00875	Dec 21, 2018
	Darlington Waste Management Facility Baseline Inspection Fourth Quarter FY 2017/2018 Report Number: OPG-DWMF-2018-01	June 14, 2018
	Darlington Waste Management Facility Baseline Inspection Second Quarter FY 2018/2019 Report Number: OPG-DWMF-2018-02	November 9, 2018
Physical design	Environmentally Qualified Equipment Report Number: DRPD-2018-006	May 1, 2018
Fitness for service	Maintenance -Work Execution (Refurbishment INS-06-06) Report Number: DRPD-2018-007	May 11, 2018
	System Inspection (ECI) Report Number: DRPD-2018-003	Mar 19, 2018
	System Inspection (EFADS) Report Number: DRPD-2018-004	Mar 28, 2018
Radiation protection	Radiation Protection associated with the Construction Island and the Rad Waste Processing Building (Refurbishment INS-07-04) Report Number: DRPD-2018-001	Mar 9, 2018
	Reactive - Contamination Control and Worker Protection Report Number: DRPD-2018-008	Jun 7, 2018
Conventional health and safety	Conventional Health & Safety Review (Refurbishment INS-08-01) Report Number: DRPD-2018-010	Jun 12, 2018
Environmental protection	Darlington Refurbishment Environmental Management System Type II Inspection Report Number: DRPD-2018-00871	Dec 20, 2018
	Darlington Waste Management Facility Focused Environmental Protection Inspection Fourth Quarter FY 2017/2018 Report Number: OPG-DWMF-2018-01	June 14, 2018
Emergency management and fire protection	Refurbishment Fire Protection Program Implementation Unit 2 Report Number: DRPD-2017-00748	Dec 19, 2018
	Darlington Waste Management Facility Focused Emergency Management and Fire Protection Inspection	June 14, 2018

Safety and control area	Inspection title	Inspection report sent
	Fourth Quarter FY 2017/2018 Report Number: OPG-DWMF-2018-01	
Waste management	Reactive - Hazardous Waste Management (INS-11-01 refurb) Report Number: DRPD-2018-009	Jun 1, 2018
Packaging and transport	Darlington Waste Management Facility Focused Packaging and Transport Inspection Second Quarter FY 2018/2019 Report Number: OPG-DWMF-2018-02	November 9, 2018

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.

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and the DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Management system	Y	Assessed, described below	Y	Assessed, but no significant developments
Organization	Y	Assessed, described below	Y	Not rated
Change management	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Safety culture	Y	Not rated	Y	Not rated
Configuration management	Y	Assessed, but no significant developments	Y	Not rated
Records management	Y	Assessed, described below	Y	Assessed, but no significant developments
Management of contractors	Y	Assessed, described below	Y	Assessed, described below
Business continuity	Y	Not rated	Y	Not rated
Performance assessment, improvement and management review	Y	Assessed, described below	Y	Assessed, but no significant developments
Operating experience	Y	Assessed, described below	Y	Assessed, but no significant developments

Management system

CNSC staff determined that OPG's nuclear management system at the Darlington site met the applicable regulatory requirements in 2018. Note that OPG's management system is integrated

for the DNGS and the DWMF, so any issue or improvement that is described for one may also be relevant to the other.

Darlington Nuclear Generating Station

CNSC staff identified one finding of low safety significance, related to the consistent completion of verification steps when executing Inspection Test Plans during a field inspection. CNSC staff accepted OPG's corrective action plan to address the non-compliance.

CNSC staff engaged with OPG on some concerns related to the documentation of OPG management system governance. One particular concern was the use of guidance-type language (i.e., "should") where a requirement was to be addressed (i.e., "shall"). OPG responded favourably to those concerns and made some changes in 2018. CNSC staff were continuing to monitor the work at the end of 2018.

Organization

Darlington Nuclear Generating Station

CNSC staff determined that OPG had adequately defined organizational structures and established roles and responsibilities at the DNGS.

In 2018, CNSC staff performed follow-up verification activities on OPG's corrective actions to non-compliances identified in a 2017 organizational structure inspection at the DNGS. Specifically, CNSC staff performed verification activities to identify if there were any additional:

- records without traceable identifiers
- unclear roles and responsibilities and program owner accountabilities
- governance documents without clear identification of interfaces and process steps

CNSC staff were satisfied with OPG's progress to address the non-compliances; completion of the corrective actions was scheduled for 2019.

OPG submitted several event reports relating to radiation protection in the refurbishment of DNGS Unit 2 (see section 3.1.7 for details). In reviewing the contributing factors to these event reports, CNSC staff observed areas for improvement related to the organization specific area. OPG subsequently made improvements to its organizational structure based on CNSC staff's observations.

Although the results of CNSC's inspection activities applicable to this specific area indicate that OPG complied with the requirements for establishing roles and responsibilities, CNSC staff identified specific deficiencies in internal communication and resource allocation within the refurbishment organization. In light of these deficiencies, OPG improved resource allocation within the refurbishment organization, including improving oversight, internal communications and hiring additional health physics support.

Records management

CNSC staff determined that OPG implemented a document control and records management system at the Darlington site that met the applicable regulatory requirements.

Darlington Nuclear Generating Station

During inspections in 2018 [DRPD-2018-001, DRPD-2018-005, DRPD-2018-008], CNSC staff identified several findings of low safety significance in the control of records and documents. Specifically, CNSC staff found that quality assurance records requiring retention were sometimes

not identified. CNSC staff accepted OPG's corrective action plans, which were subsequently completed to staff's satisfaction.

Management of contractors

In 2018, the management of contractors at the Darlington site met the applicable regulatory requirements.

Darlington Nuclear Generating Station

Although OPG achieved overall compliance with requirements, CNSC inspections in 2018 identified several non-compliances of low safety significance related to contractor qualification and the verification of services. CNSC staff accepted the corrective action plan for some non-compliances and were awaiting updated plans at the end of 2018 for the remaining non-compliances.

CNSC planned to address its concerns with OPG's management of contractors with a compliance activity focused on contractor management by April 2020.

Darlington Waste Management Facility

In the regulatory oversight report for 2017, CNSC staff had reported on the lack of inspection at the manufacturer's sites for DSCs. In 2018, OPG reviewed the quality assurance documentation for all affected DSCs and informed the CNSC that there were no safety, transportability, or structural integrity issues with those DSCs. At the end of 2018, CNSC staff were monitoring the completion of the corrective actions, which are expected to be completed in 2019 and were satisfied with the progress.

Performance assessment, improvement and management review

CNSC staff confirmed that OPG met the applicable regulatory requirements for performance assessment, improvement, and management review at the Darlington site in 2018.

Darlington Nuclear Generating Station

Although OPG complied with the applicable regulatory requirements, CNSC staff identified a small number of low-safety significant findings through its oversight of program assessments, review of documentation, and the proper use of performance indicators.

Operating experience

CNSC staff determined that OPG met the applicable regulatory requirements for operating experience (OPEX) at the Darlington site in 2018. OPG demonstrated that it identified and implemented OPEX from within its organization and from the Canadian and international nuclear industry.

Darlington Nuclear Generating Station

CNSC staff confirmed that OPG had satisfactory problem identification and resolution and use of operating experience.

However, in 2018, CNSC staff inspected OPG's event investigation process and found some deficiencies in the conduct of root cause analyses and identification of corrective actions. OPG submitted a corrective action plan to update its event investigation procedures, clarifying the requirements for the conduct of root cause analyses. At the end of 2018, CNSC staff were satisfied that OPG completed the corrective measures.

3.1.2 Human performance management

CNSC staff concluded that the human performance management 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.

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Human performance program	Y	Assessed, described below	Y	Assessed, described below
Personnel training	Y	Assessed, described below	Y	Assessed, described below
Personnel certification	Y	Assessed, described below	N	No CNSC-certified positions
Initial certification examinations and requalification tests	Y	Assessed, but no significant developments	N	No CNSC-certified positions
Work organization and job design	Y	Assessed, described below	N	No minimum shift complement requirements
Fitness for duty	Y	Assessed, described below	Y	Not rated

Human performance program

CNSC staff determined that OPG's human performance program for the DNGS and DWMF met the applicable regulatory requirements in 2018.

Darlington Nuclear Generating Station

CNSC staff identified recurring deficiencies with respect to procedure use and adherence in the refurbishment organization at DNGS. OPG identified this as a focused area of improvement and committed to improving procedure use and adherence as part of its human performance program. CNSC staff are monitoring OPG's commitment to improved procedure adherence in focused compliance activities of the refurbishment organization.

Darlington Waste Management Facility

In 2018, CNSC staff conducted a general inspection [OPG-DWMF-2018-01] and observed that DWMF workers were well organized and understood how to carry out their tasks safely.

Personnel training

CNSC staff did not conduct any training-specific inspections at the DNGS or DWMF in 2018. Nevertheless, CNSC staff examined training records frequently during inspections related to other SCAs and determined that the training programs at the DNGS and DWMF met the applicable regulatory requirements in 2018. OPG had a robust and well-documented fleet-wide training system based on a systematic approach to training.

Darlington Waste Management Facility

In 2018, CNSC staff conducted a combined general and packaging and transport inspection [OPG-DWMF-2018-02] and determined that the training records reviewed for DWMF workers met the applicable regulatory requirements.

Personnel certification

Darlington Nuclear Generating Station

CNSC staff determined that OPG's personnel certification program at the DNGS met the applicable regulatory requirements in 2018. CNSC staff reviewed the staffing reports for certified personnel and confirmed that OPG had a sufficient number of personnel at the DNGS for all certified positions. All certified workers at the DNGS possessed the knowledge and skills required to perform their duties safely and competently.

Work organization and job design

Darlington Nuclear Generating Station

The minimum shift complement at the DNGS met the applicable regulatory requirements in 2018.

In 2018, there was one violation of the minimum shift complement reported to the CNSC at the DNGS. This violation was due to an off-site commitment of a qualified shift worker, which resulted in a short period of time when the designated position was not filled. This violation had no impact on safety.

Fitness for duty

Darlington Nuclear Generating Station

CNSC staff determined that OPG met the applicable regulatory requirements for worker fitness for duty at the DNGS in 2018. Overall, CNSC staff were satisfied with the fitness for duty of workers in 2018 and noted that OPG had procedures for managing worker fatigue that included limits on hours of work.

OPG committed to implement CNSC regulatory document REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* in 2019. CNSC staff were satisfied with OPG's implementation plans and will continue to monitor its progress.

OPG was also working toward the implementation of two additional CNSC regulatory documents related to fitness for duty: REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* and REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness*. Background information and implementation details are provided in section 2.2.

There was one exceedance of hours-of-work limits reported in 2018, related to insufficient rest between three consecutive day shifts and a night shift. There was no impact on safety at the DNGS resulting from this violation.

3.1.3 Operating performance

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

CNSC staff concluded that the operating performance SCA at the DWMF met the performance objectives and applicable regulatory requirements. As a result, the DWMF received a "satisfactory" rating, reassessed from the "fully satisfactory" rating of the previous year. The

change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Conduct of licensed activity	Y	Assessed, described below	Y	Assessed, described below
Procedures	Y	Assessed, described below	Y	Assessed, but no significant developments
Reporting and trending	Y	Assessed, described below	Y	Assessed, described below
Outage management performance	Y	Assessed, described below	N	No outage management program required
Safe operating envelope	Y	Assessed, but no significant developments	N	No safe operating envelope program required
Severe accident management and recovery	Y	Assessed, described below	N	No severe accident management program required
Accident management and recovery	Y	Assessed, but no significant developments	Y	Not rated

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 met them at the DWMF in 2018. OPG operated the DNGS and DWMF in a safe and secure manner within the bounds of their operating policies and principles and operational safety requirements and with adequate regard for health, safety, security, radiation and environmental protection, and international obligations.

Darlington Nuclear Generating Station

In 2018, the DNGS experienced zero unplanned reactor trips, three setbacks and one stepback. CNSC staff determined that the transients were controlled properly and power reduction was appropriately initiated by the reactor control systems. There was no impact on reactor safety. CNSC staff verified that DNGS staff followed approved procedures and took appropriate actions for all transients.

Darlington Waste Management Facility

In 2018, OPG processed 57 DSCs at the DWMF, which met OPG's internal target. Since the start of facility production to the end of 2018, OPG had processed and placed into storage 590 DSCs at the DWMF. Additionally, OPG placed 87 retube waste containers (RWC) into storage in the RWSB in 2018 (all RWCs from DNGS Unit 2 refurbishment were stored in the RWSB).

Procedures

CNSC staff determined that procedures for the Darlington site met the applicable regulatory requirements in 2018. CNSC staff observed that OPG had governance to ensure that procedures at the DNGS and the DWMF are written in a consistent and usable manner. OPG maintains

expectations for procedure use and adherence and a process to manage procedural changes at the Darlington site.

Darlington Nuclear Generating Station

CNSC staff identified a few minor deficiencies with the control of changes to documentation and the alignment of OPG's documentation and instructions. OPG submitted a corrective action plan and CNSC staff was satisfied that OPG had addressed the deficiencies.

CNSC staff had completed specific subject reviews of documentation submitted by OPG in support of its severe accident management (SAM) program. CNSC staff will integrate its assessment of the adequacy of OPG's SAM program in 2019 and provide the results to OPG.

Reporting and trending

CNSC staff determined that OPG's reporting and trending for the DNGS and DWMF met the applicable regulatory requirements and expectations in 2018.

During 2018, all scheduled reports were submitted to the CNSC in a timely manner and were adequate.

Darlington Nuclear Generating Station

In general, OPG's reporting in 2018 met the requirements of CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

OPG submitted 49 event reports that required a follow-up detailed event report in 2018. All reported events were followed up by OPG with corrective actions and root cause analysis, when appropriate. However, in October 2018 CNSC staff identified seven reportable occurrences under REGDOC-3.1.1 that were identified by OPG as reportable to the CNSC but were not submitted in a timely manner. CNSC staff requested OPG to develop and implement a corrective action plan, which DNGS was addressing at the end of 2018.

UPDATE: In May 2019, CNSC staff accepted OPG's completion of the corrective action plan.

Darlington Waste Management Facility

During 2018, OPG submitted four reports for events of low safety significance regarding the DWMF. The event reports are discussed in detail under their applicable SCA(s) in this report.

Outage management performance

Darlington Nuclear Generating Station

CNSC staff concluded that OPG's management of outages at the DNGS met or exceeded the applicable regulatory requirements and expectations in 2018. In 2018, OPG performed two planned outages (Units 3 and 4) and experienced two forced outages (Units 3 and 4) at the DNGS. CNSC staff observed that OPG demonstrated high levels of performance and achievement of objectives during planned outages. CNSC staff determined that all outage-related undertakings at DNGS, including heat sink management, were performed safely.

Severe accident management and recovery

Darlington Nuclear Generating Station

CNSC staff determined that OPG met the applicable regulatory requirements and expectations for severe accident and recovery in 2018. The program was implemented at the DNGS with an

organizational structure that clearly established the roles and responsibilities of all program participants.

At the end of 2017, as part of a review of Darlington`s integrated accident management program, CNSC staff commenced a desktop review of the DNGS documentation for severe accident management guidelines and emergency mitigating equipment guidelines. CNSC plans to complete the review in 2019.

3.1.4 Safety analysis

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

CNSC staff concluded that the safety analysis SCA at the DWMF met the performance objectives and applicable regulatory requirements. As a result, the DWMF received a "satisfactory" rating, which was reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Deterministic safety analysis	Y	Assessed, described below	Y	Assessed, described below
Probabilistic safety assessment	Y	Assessed, described below	N	No PSA program required
Criticality safety	N	No criticality safety program required	N	No criticality safety program required
Severe accident analysis	Y	Assessed, described below	N	This activity not required
Management of safety issues	Y	Assessed, see section 2.4	N	This activity not required

Deterministic safety analysis

OPG had an effective, well-managed program for performing deterministic safety analyses at the DNGS and DWMF. CNSC staff concluded that OPG's deterministic safety analyses predicted adequate safety margins and met or exceeded the applicable regulatory requirements at the DNGS and met them at the DWMF.

Darlington Nuclear Generating Station

In 2018, OPG updated its plan to implement the requirements of CNSC regulatory document REGDOC 2.4.1, *Deterministic Safety Analysis* and CNSC staff were satisfied with OPG's progress. In December 2018, OPG submitted an update to the DNGS safety analysis report. CNSC staff completed reviews of analysis plans for DNGS loss of flow and loss of power regulation occurrences, determined that these plans met the regulatory requirements and provided

OPG with opportunities for improvement. In December 2018, OPG responded to CNSC staff's recommendations.

UPDATE: In January 2019, CNSC staff determined that OPG's responses adequately dispositioned staff's remaining recommendations.

In 2018 and early 2019, OPG submitted assessments of the impact of pre-equilibrium fuel on the consequences of the loss of flow, small-break loss-of-coolant accidents, in-core loss-of-coolant accidents, and the trip coverage for neutron overpower. These assessments were done to support the return to service of Unit 2 after refurbishment.

UPDATE: In May and June 2019, CNSC staff accepted the conclusion that the fuel cooling, trip coverage, and neutron overpower trip coverage for shutdown systems 1 and 2 (SDS1 and SDS2) were sufficient to provide adequate trip margin for the duration of pre-equilibrium operation of Unit 2.

OPG continued its safety analysis improvement program, which was linked to the ongoing, phased, approach to implementation of REGDOC-2.4.1. In 2018, OPG completed deterministic safety analyses for common-cause events (CCEs) for the PNGS and will submit the DNGS CCE analyses following disposition of CNSC's staff recommendations related to the PNGS analysis.

Darlington Waste Management Facility

OPG submits a safety analysis report for the DWMF to the CNSC every five years that identifies facility hazards and the measures in place to control or mitigate the hazards. In 2017, OPG had submitted an updated safety analysis report. CNSC staff reviewed it in 2018 and concluded that it met the relevant regulatory requirements and concurred with the changes that were made in the 2017 revision. There were no additional changes made to the safety analysis report in 2018. The next revision for the DWMF is expected in 2022.

Probabilistic safety assessment

Darlington Nuclear Generating Station

CNSC staff determined that the DNGS met or exceeded the applicable regulatory requirements for probabilistic safety assessment (PSA) in 2018.

In 2018, as part of its transition to compliance with CNSC regulatory document REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, OPG submitted revised PSA methodologies, which CNSC staff reviewed and accepted. This included the development of new methodologies to address REGDOC-2.4.2 requirements regarding the consideration of non-reactor radioactive sources and different operational states.

UPDATE: OPG continued to submit additional PSA methodologies for CNSC acceptance in 2019.

OPG plans to implement REGDOC-2.4.2 for the DNGS in its next PSA submission (end of 2020). As part of its transition to REGDOC-2.4.2, OPG has submitted several new and revised PSA methodologies. In 2018, CNSC staff reviewed several of OPG's revised PSA models and determined that the DNGS continued to meet the safety goals during the refurbishment project. CNSC staff noted that OPG took an initiative to lead an international effort in the development of new methodologies to address the new REGDOC-2.4.2 requirements for consideration of non-reactor radioactive sources and different operational states. CNSC staff was continuing to monitor OPG's implementation of REGDOC-2.4.2 at the DNGS.

Severe accident analysis

Darlington Nuclear Generating Station

CNSC staff determined that OPG maintained a severe accident analysis program that met or exceeded the applicable regulatory requirements and expectations. OPG continued to support industry R&D program in the area of severe accident analysis. OPG, in collaboration with other licensees, has developed the Severe Accident Software Simulator Solution to improve its methods for the deterministic analysis of multi-unit severe accidents.

3.1.5 Physical design

CNSC staff concluded that the physical design SCA at 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.

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and the DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Design governance	Y	Assessed, described below	Y	Assessed, but no significant developments
Site characterization	Y	Not rated	Y	Not rated
Facility design	Y	Not rated	Y	Not rated
Structure design	Y	Assessed, but no significant developments	Y	Not rated
System design	Y	Assessed, described below	Y	Not rated
Component design	Y	Assessed, described below	Y	Not rated

Design governance

CNSC staff concluded that OPG met the applicable regulatory requirements regarding design governance in 2018 for the DNGS and DWMF.

Darlington Nuclear Generating Station

OPG complied with specific governance requirements related to environmental qualification, seismic qualification, pressure boundary design, human factors in design and fire protection.

Environmental qualification

OPG had an adequate environmental qualification program for all DNGS units. In February 2018, CNSC staff inspected the implementation of environmental qualification [DRPD-2018-06] and identified non-compliances of minor safety significance. CNSC staff identified instances where OPG did not have adequate temperature monitoring in rooms with environmentally-qualified equipment. To address this finding, OPG continued its work to provide temperature monitoring in these rooms by mid-2019. CNSC staff will continue to monitor OPG's progress to address these non-compliances in 2019.

Seismic qualification

CNSC staff concluded that OPG's seismic qualification program complied with the applicable regulatory requirements and CSA standards.

Human factors in Design

In 2018, OPG completed two activities related to the consideration of human factors engineering in the design of its systems. OPG completed modifications to annunciations in the main control room and analyzed the impact of permanent major engineering changes on the minimum shift complement. The changes to the annunciations in the main control room were part of the IIP. In 2018, OPG determined that it met its design requirements and proposed a set of changes to meet the commitment in the IIP. CNSC staff reviewed OPG's proposal and determined that the changes proposed were acceptable.

System design

Darlington Nuclear Generating Station

CNSC staff concluded that OPG met applicable regulatory requirements regarding system design in 2018 at the DNGS, including those for electrical power systems and instrumentation and control.

Instrumentation and Control

In 2018, CNSC staff reviewed several OPG reports regarding the trip computers and monitoring and test computer replacement project for SDS1 and SDS2. New trip, display and test computer hardware and software were installed during Unit 2 refurbishment in December 2018.

UPDATE: The modification was completed in May 2019. The SDS2 display and test computers were declared in-service in early 2019, while the SDS2 trip computers required additional modifications. OPG confirmed that the modifications to the SDS2 trip computers were completed, with closeout activities to be completed in early 2020. OPG committed to install new trip hardware, monitoring and test computers for both the SDS1 and SDS2 systems in Units 1, 3, and 4 during their respective refurbishment outages.

Component design

Darlington Nuclear Generating Station

CNSC staff determined that OPG met the applicable regulatory requirements regarding component design for the DNGS in 2018, including specific requirements related to fuel and cables.

Fuel design

CNSC staff concluded that OPG continued to maintain a mature reactor fuel inspection program. Fuel performance at the DNGS was acceptable in 2018. OPG operated its reactors within the design and operating limits in its licensing basis. Its defect rate was less than the CNSC expectation of one defect per unit per year. The number of defects and inspection findings were consistent with results from previous years. CNSC staff determined that OPG managed fuel performance issues while maintaining safe operations.

3.1.6 Fitness for service

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

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and DWMF and provides notes regarding the assessments for the 2018 regulatory

oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Equipment fitness for service / equipment performance	Y	Assessed, described below	N	This specific area does not apply
Maintenance	Y	Assessed, described below	Y	Assessed, but no significant developments
Structural integrity	Y	Assessed, described below	Y	Not rated
Aging management	Y	Assessed, described below	Y	Assessed, but no significant developments
Chemistry control	Y	Assessed, described below	Y	Assessed, but no significant developments
Periodic inspection and testing	Y	Assessed, described below	N	This specific area does not apply

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 applicable regulatory requirements.

CNSC staff also determined that the reliability program at the DNGS met the applicable regulatory requirements. All special safety systems for DNGS Units 1, 3, and 4 met their unavailability targets in 2018.

Maintenance

CNSC staff determined that OPG's maintenance program met the applicable regulatory requirements for the DNGS and the DWMF in 2018. OPG's maintenance program for its NPPs also covers preventative and corrective maintenance activities for its WMFs.

Darlington Nuclear Generating Station

CNSC staff did not identify any significant concerns with its maintenance-related inspections and review of OPG's maintenance data in 2018. The average preventative maintenance completion ratio for the four units at DNGS was 94%, which compared favourably with the industry average (93%). The corrective critical maintenance backlog, deficient critical maintenance backlog, and the number of deferrals of preventative maintenance for critical components, given in table 18, were below the industry averages.

Table 18: Trend of maintenance backlogs and deferrals for critical components for DNGS, 2016 to 2018

Parameter	Average quarterly work orders per unit			Quarterly 2018 work orders				Industry average for 2018
	2016	2017	2018	Q1	Q2	Q3	Q4	
Corrective maintenance backlog	6	1	0	0	0	1	0	1
Deficient maintenance backlog	48	37	11	13	12	14	7	16
Deferrals of preventive maintenance	22	7	0	0	2	0	0	4

CNSC staff determined that the maintenance backlogs and the number of preventive maintenance deferrals for critical components had negligible overall safety significance for the DNGS and were therefore acceptable.

Structural integrity

Darlington Nuclear Generating Station

CNSC staff concluded that the systems, structures, and components (SSC) required for safe operation continued to meet the structural integrity requirements established in the design basis or in CNSC accepted standards and guidelines for the DNGS in 2018. As part of its periodic inspection program, OPG inspected pressure boundary and containment components in 2018. The pressure boundary inspections covered elements of the primary heat transport and auxiliary systems, feeders and pressure tubes. CNSC staff reviewed these reports and determined that the structural integrity of the components was maintained within the design basis.

Aging management

CNSC staff concluded that OPG's integrated aging management program continued to meet the applicable regulatory requirements at the DNGS and the DWMF in 2018. CNSC staff confirmed that the major component life cycle management plans at the DNGS and the aging management plans for DSCs and DSOs at the DWMF continued to meet the applicable regulatory requirements.

Darlington Nuclear Generating Station

CNSC staff determined that OPG continued to maintain adequate programs 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 acceptance criteria in CSA Group standards. 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. The DNGS is licensed to operate up to 235,000 effective full-power hours (EFPHs). At the end of 2018, the longest operating pressure tubes had seen approximately 204,000 EFPHs of service, and therefore they were not predicted to approach the current licensing limit before the scheduled reactor refurbishment. See section 2.6 for more information.

Chemistry control

CNSC staff determined that OPG's chemistry control program met the applicable regulatory requirements for the DNGS and DWMF in 2018. OPG maintained acceptable system chemistry performance for both the DNGS and DWMF in 2018.

Darlington Nuclear Generating Station

In 2018, CNSC staff concluded that OPG adequately maintained its chemistry control program within the applicable regulatory requirements. The performance indicators "chemistry index" and "chemistry compliance index" demonstrated the satisfactory performance of the DNGS chemistry control program. Refer to section 2.6 for more details on these performance indicators.

There was one reportable event related to chemistry at the DNGS in 2018, regarding an instance of out-of-specification iodine-131 concentrations in the primary heat transport system of Unit 1. CNSC staff were satisfied that OPG took appropriate corrective measures to correct this low safety-significant event.

Periodic inspections and testing

Darlington Nuclear Generating Station

CNSC staff determined that OPG had adequate and well-maintained periodic inspection programs (PIP) in place at DNGS for pressure boundary systems, containment components, and containment structures that complied with the applicable CSA Group standards.

In 2018, OPG continued to transition its periodic inspection plans from the 2005 edition of CSA Group standard N285.4, *Periodic inspection of CANDU nuclear power plant components* towards full implementation of the 2014 edition.

UPDATE: OPG submitted an update on its transition plan in April 2019, stating that it complied with the 2014 edition of the standard with the exception of the requirement for the qualification of inspection procedures. The qualification and update of these inspection procedures remained on schedule; OPG planned to submit a further update to the CNSC in 2019.

3.1.7 Radiation protection

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

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Application of ALARA	Y	Assessed, described below	Y	Assessed, described below
Worker dose control	Y	Assessed, described below	Y	Assessed, described below
Radiation protection program performance	Y	Assessed, described below	Y	Not rated
Radiological hazard control	Y	Assessed, described below	Y	Assessed, described below
Estimated dose to public	Y	Assessed, described below	Y	Assessed, described below

Application of ALARA

CNSC staff determined that OPG implemented a highly 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 DWMF. CNSC staff verified that OPG used ALARA initiatives, work planning, dose monitoring and engineering control practices to work towards the challenging ALARA targets established by OPG at the DNGS and DWMF. In 2018, OPG met their established year-end collective radiation exposure (CRE) target.

Darlington Nuclear Generating Station

In 2018, the year-end CRE at the DNGS was consistent with OPG's established target, with outage-related work as the largest contributor to CRE. For the three operating units, approximately 78.3% of the CRE arose from work performed during two planned outages and 21.7% of the CRE arose from work during online operations. During one of the planned outages (Unit 3), a worker was wetted with tritiated heavy water, resulting in an unplanned exposure. This event, along with an increase in outage scope and radiological conditions that were worse than expected, caused the DNGS to miss its outage dose target; however, by implementing recovery plans, OPG met its overall CRE targets.

For the unit under refurbishment, the annual CRE was reduced in 2018 as a result of the removal of significant radiological sources such as the unit's feeder tubes, pressure tubes and calandria tubes. OPG performed post-work reviews following all major work activities to review dose performance and to document lessons-learned for future work.

CNSC staff noted that OPG continued to implement several longer-term ALARA initiatives associated with source term reduction and shielding at the DNGS. When implemented, these initiatives will help to maintain doses to persons ALARA and to maintain acceptable radiological working conditions.

Worker dose control

CNSC staff determined that OPG met the applicable regulatory requirements to ascertain and record doses received by workers at the DNGS and DWMF in 2018. The data for doses to workers at the Darlington site can be found in section 2.7.

Darlington Nuclear Generating Station

Routine compliance verification activities in 2018 concluded that OPG's worker dose control remained satisfactory at the DNGS.

Radiation doses to workers at the DNGS remained below the regulatory dose limits in the *Radiation Protection Regulations*, as well, with one exception described below, doses to workers were kept below the action levels established in OPG's radiation protection program. However, there was one instance, described below, where an OPG-established action level was exceeded.

In 2018, there was one event report submitted to the CNSC at the operating DNGS reactors, applicable to the worker dose control specific area. A worker received an unplanned exposure in excess of the OPG action level during the March 2018 Unit 3 planned outage; while plugging heat exchanger tubes, their protective clothing was wetted with tritiated heavy water. CNSC staff were satisfied that the dose to the worker was managed according to OPG processes and was well below the annual dose limit of 50 mSv.

CNSC staff continued to apply additional vigilance with respect to the doses received by workers during refurbishment activities, including increased frequencies and enhanced scope of

surveillance and inspection activities in Unit 2. OPG reported six events related to workers performing radiation work for Unit 2 refurbishment without adequate dosimetry or radiation protection oversight in 2018. The most significant of the six events occurred in February 2018, when two workers involved in lidding retube waste containers in the RWPB received unplanned uptakes. Following the event, CNSC staff conducted a reactive inspection [DRPD-2018-008] of OPG's radiation protection program and requested OPG to prepare and implement corrective measures to ensure worker doses were appropriately controlled and monitored, and to take preventative measures to prevent recurrence. At the end of 2018, CNSC staff were monitoring OPG's progress.

From the results of the inspection, CNSC staff concluded that, in the RWPB, OPG:

- inadequately classified known alpha hazards
- conducted insufficient monitoring and oversight to provide timely information about changing alpha hazards
- did not consider all relevant information to make informed dosimetric analysis decisions for workers who had the potential to be exposed to an intake of radioactive material.

To address unresolved concerns with respect to these deficiencies, in June 2018, CNSC staff requested information from OPG under subsection 12(2) of the *General Nuclear Safety and Control Regulations*. At the end of 2018, this request remained open.

UPDATE: In early 2019, CNSC staff confirmed that OPG complied with the request and closed it; however, OPG was requested to assess the implementation of its alpha monitoring program and report the results to CNSC staff prior to the start of Unit 3 refurbishment. This activity was ongoing.

To summarize, compliance verification activities conducted in 2018 observed a declining trend in the performance of worker dose control, most notably with regard to radiation protection practices in the unit under refurbishment. Notwithstanding, worker doses remained well below regulatory dose limits and OPG action levels, and as such CNSC staff concluded that OPG's worker dose control remained satisfactory at the DNGS.

Darlington Waste Management Facility

Radiation doses to workers remained below the regulatory dose limits and related action levels established in OPG's radiation protection program. There were no event reports related to worker dose control at the DWMF in 2018.

Radiation protection program performance

Darlington Nuclear Generating Station

CNSC staff determined that OPG's radiation protection program met the requirements of the *Radiation Protection Regulations*. OPG continued to employ a suite of performance metrics to monitor and control the overall performance of the radiation protection program at the DNGS.

As noted in the worker dose control specific area, resulting from the analysis of the facts of the reactive inspection in the RWPB [DRPD-2018-008], CNSC staff requested OPG to provide information under subsection 12(2) of the *General Nuclear Safety and Control Regulations*. OPG was requested to investigate the deficiencies, as well the process or performance failures that resulted in workers being exposed to alpha hazards. In 2018, OPG submitted 14 event reports to CNSC staff, from both online operations and the refurbishment project, related to radiation

protection that identified poor work practices as a contributing factor. CNSC staff concluded that the frequency and nature of the events was indicative of an overall downward trend in performance of the radiation protection program.

Notwithstanding this trend, CNSC staff identified that OPG regularly measured the performance of its radiation protection program against industry-established objectives, goals, and targets. In 2018, OPG revised numerous radiation protection program procedures to reflect changes in the program, to add improvements related to refurbishment requirements and to update its radiation protection action levels.

Radiological hazard control

Darlington Nuclear Generating Station

There were no safety-significant incidents identified through the reporting of safety performance indicators for either personnel or loose contamination events, nor were there any action level exceedances for surface contamination at the DNGS in 2018. However, CNSC staff inspections found instances where OPG's implementation of radiological hazard controls was inadequate to meet the applicable regulatory requirements in 2018.

As a result of inspections conducted for Unit 2 refurbishment, CNSC staff identified several low safety-significant non-compliances relating to storage of radioactive materials in unapproved locations within the protected area. The inspections also identified several instances where supervisors failed to review and verify radiation survey results in a timely manner [DRPD-2018-001], which was a recurrence from inspections performed in 2017.

In its inspection of the RWPB in February 2018 [DRPD-2018-008], CNSC staff identified several non-compliances of low safety-significance: specifically, that OPG failed to implement contamination monitoring methods and alpha-hazard classification in the RWPB that would adequately identify changing radiological conditions. CNSC staff also found that OPG failed to re-characterize the RWPB once operations began to process waste in the facility and that OPG failed to adapt contamination control measures as radiological conditions changed [DRPD-2018-008]. As a result, CNSC staff began an enhanced monitoring program of OPG's corrective actions to address the non-compliances related to supervisory review and verification of radiological survey results.

In November 2018, CNSC staff were informed that two personal air samplers (PASs) worn by contractors were found to contain low-levels of radioactive particulates including alpha-emitters. In December 2018, a subsequent analysis performed by OPG found seven additional instances where PAS filters showed a positive result for alpha emitters. CNSC staff issued OPG a second request under subsection 12(2) of the *General Nuclear Safety and Control Regulations* to initiate follow-up dose assessments using *in-vitro* bioassay methods for each individual whose PAS showed positive alpha results, and to review and modify its alpha dosimetry program. At the end of 2018, CNSC staff was waiting for OPG's response.

UPDATE: In early 2019, OPG provided an interim response, proposed corrective actions and described its progress towards addressing the deficiencies. CNSC staff met with OPG and were satisfied with its progress towards addressing these deficiencies.

UPDATE 2: In May 2019, CNSC staff were satisfied that OPG had complied with the request. OPG committed to implementing changes to its confirmatory alpha bioassay program by September 2019; CNSC staff were monitoring OPG's implementation of the modification through normal regulatory oversight.

The 14 events mentioned in the discussion of the performance of the radiation protection program were related to radiological hazard control. Several of these events involved improper posting and labelling of radiological hazards, while others involved the unauthorized disposal of radioactive waste and the inadvertent dropping of a fuel channel annulus spacer ring when removing pressure tubes. CNSC staff confirmed that OPG put in place corrective actions for each reportable event and considered that each individual reportable event was of negligible safety significance. However, in reviewing the frequency and nature of these events, CNSC staff concluded that they were indicative of a decreasing trend in radiological hazard control at the DNGS.

CNSC staff observed that both online operations and the Unit 2 refurbishment project exceeded year-end targets for the performance indicator "personnel contamination events"..

CNSC staff noted that, during refurbishment, there was increased potential for workers to be exposed to radiological hazards, and therefore an increased probability that personal contamination events would occur. However, it was expected that the licensee would adapt its radiological hazard control program to assess, confirm, and monitor the challenging and changing radiological environment experienced during a refurbishment outage. CNSC staff determined that OPG did not adequately adapt its radiological hazard control program to adjust to the changing radiological environment of a refurbishment outage.

Darlington Waste Management Facility

CNSC staff determined that OPG implemented radiological hazard controls that met the applicable regulatory requirements for control of radiological hazards and the protection of workers at the DWMF in 2018. There were no contamination control action level exceedances for surface contamination at the DWMF.

CNSC staff examined this specific area as part of a general compliance inspection at the DWMF in 2018 [OPG-DWMF-2018-02]. The inspection yielded three compliant findings related to personnel contamination monitoring, accuracy of radiation hazard signage and the system that displays approved radiation survey locations.

Estimated dose to the public

CNSC staff determined that OPG ensured the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to a member of the public from the Darlington site was 0.0008 mSv, which was well below the annual public dose regulatory limit of 1 mSv. See section 2.7 for additional data.

3.1.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at the DNGS met or exceeded the performance objectives and applicable regulatory requirements. As a result, the DNGS received a "fully satisfactory" rating - unchanged from the previous year.

CNSC staff concluded that the conventional health and safety SCA at the DWMF met the performance objectives and applicable regulatory requirements. As a result, the DWMF received a "satisfactory" rating, which was reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Performance	Y	Assessed, described below	Y	Assessed, described below
Practices	Y	Assessed, described below	Y	Assessed, described below
Awareness	Y	Assessed, described below	Y	Not rated

Performance

CNSC staff determined that OPG met regulatory requirements at the DNGS and the DWMF in regards to conventional health and safety performance. OPG kept workers safe from occupational injuries while conducting its licensed activities at the Darlington site.

Darlington Nuclear Generating Station

Health and safety related incidents were reported by OPG on an ongoing basis.

CNSC staff observed that the accident severity rate (ASR) for DNGS decreased from 2.2 in 2017 to 0.04 in 2018, while the accident frequency (AF) rate increased slightly (0.32 in 2017 to 0.36 in 2018). In 2018, there was one lost-time injuries (LTIs) reported by OPG. CNSC staff found the ASR and AF values at the DNGS in 2018 to be acceptable. Additional ASR and AF data is provided in section 2.8.

Darlington Waste Management Facility

OPG did not report any health and safety related incidents or LTIs to CNSC staff for the DWMF in 2018. In the course of their inspections, CNSC staff participated in pre-inspection health and safety briefings held with OPG staff and management and found them to be satisfactory.

Practices

CNSC staff determined that conventional health and safety practices met the applicable regulatory requirements at the DNGS and DWMF in 2018. The conventional health and safety work practices and conditions at the Darlington site continued to achieve a satisfactory degree of personnel safety. OPG personnel at all levels exhibited proactive attitudes toward anticipating work-related hazards and preventing unsafe conditions. CNSC staff observed safe work practices during inspections and other activities at DNGS and the DWMF. CNSC staff verified that OPG has appropriate procedures at the DNGS and DWMF to ensure the protection of the environment and the health of persons against hazardous materials.

Awareness

Darlington Nuclear Generating Station

CNSC staff determined that OPG met the applicable regulatory requirements for conventional health and safety awareness in 2018 at the DNGS. CNSC staff noted some non-compliances of low safety significance with the allocation of transient combustible materials at the DNGS. CNSC staff reviewed the implementation of OPG's corrective action plan to address the non-compliances and found it to be acceptable.

3.1.9 Environmental protection

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

The following table lists the specific areas under this SCA, explains their applicability for the

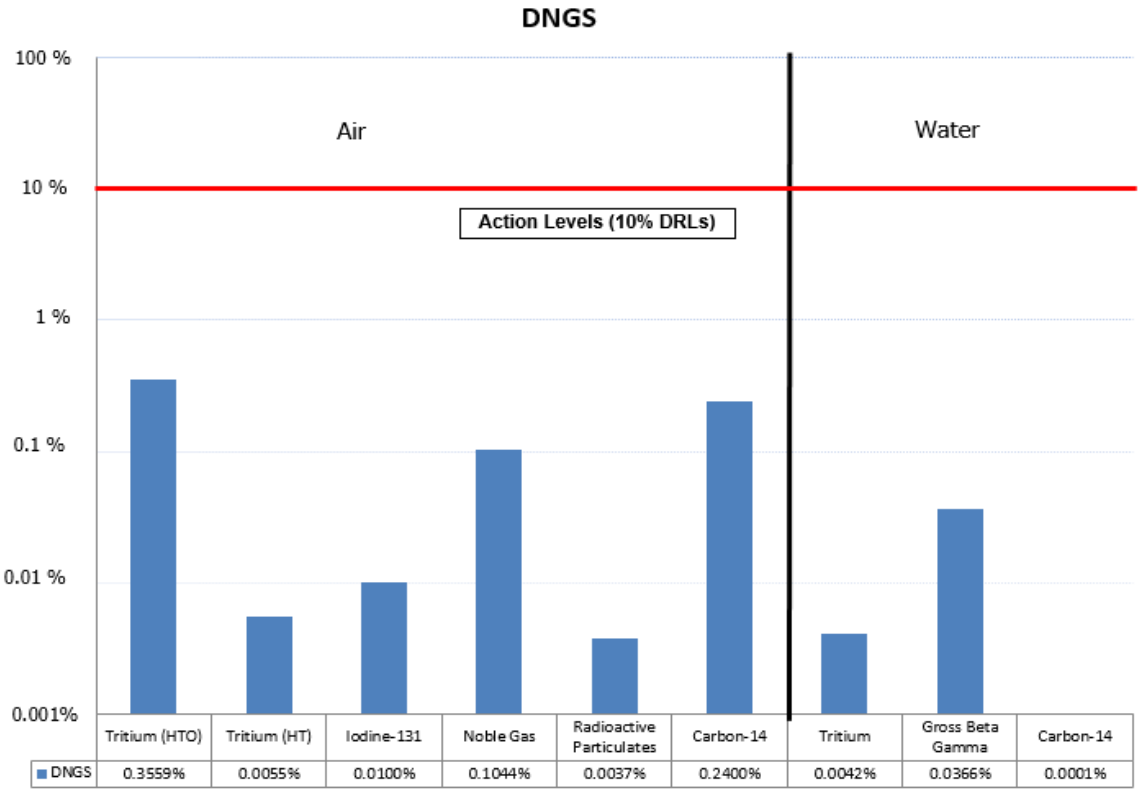
DNGS and DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Effluent and emissions control (releases)	Y	Assessed, described below	Y	Assessed, described below
Environmental management system	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Assessment and monitoring	Y	Assessed, described below	Y	Assessed, described below
Protection of the public	Y	Assessed, described below	Y	Assessed, described below
Environmental risk assessment	Y	Assessed, described below	Y	Assessed, described below

Effluent and emissions control (releases)

CNSC staff observed that all airborne and waterborne radiological releases from the Darlington site remained below the regulatory limits and action levels in 2018. The releases for the Darlington site are shown in Figure 15 as percentages of the applicable DRLs. The absolute values for releases and DRLs for Darlington site are provided in Appendix H.

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



Darlington Nuclear Generating Station

In 2018, CNSC staff conducted a Type II and several field inspections [DRPD-2018-002, DRPD-2018-011, DRPD-2018-00871, and DRPD-2018-00875] and identified one non-compliance of low safety significance related to the calibration of effluent monitoring equipment. At the end of 2018, CNSC staff were monitoring OPG's progress to complete its corrective action plan.

UPDATE: In early 2019, CNSC staff conducted a final review of submitted documentation and determined that OPG adequately completed all corrective actions.

Darlington Waste Management Facility

CNSC staff conducted an inspection at the DWMF in March 2018 [OPG-DWMF-2018-01] with a focus on environmental protection. During document review, CNSC staff noted that the stack monitor readouts were showing a higher flow rate than the actual measured flow rate. The stack monitor had a tag indicating that a work order to fix the monitor was in progress at the time of inspection. OPG provided work summary reports showing OPG had undertaken steps to calibrate the monitor. The proposed resolution was to replace the DWMF stack flow element and re-calibrate the stack flow analyzer. As a result of the inspection, CNSC staff issued an action notice to OPG to have the stack monitor fully functioning within 3 months of issuance of the inspection report or implement compensatory mitigating actions. There were no impacts to the health and safety of the environment as OPG did not undertake any welding activities until the stack monitoring equipment was functioning. OPG has resolved this action noticed to the satisfaction of CNSC staff.

Change to the licensed activity/facility in 2018: OPG completed the implementation of CSA Group standard N288.3.4-13, *Performance testing of nuclear air-cleaning systems at nuclear facilities* in 2018 for the DWMF.

Assessment and monitoring

CNSC staff determined that OPG's programs for assessment and monitoring met the applicable regulatory requirements in 2018. Based on the review of the 2018 environmental monitoring data, CNSC staff concluded that the public and the environment in the vicinity of the site were protected. Control, monitoring, analysis and reporting of environmental data and associated processes were well developed and consistently implemented.

CNSC staff did not conduct independent environmental monitoring around the Darlington site in 2018. The most recent results from 2017 are available on the CNSC's IEMP webpage [http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/darlington.cfm] and indicated that there were no expected health impacts near the Darlington site.

OPG continued satisfactory progress towards implementation 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 with a scheduled implementation date of December 31, 2020.

Protection of the public

CNSC staff confirmed that the public in the vicinity of the Darlington site was protected and that there were no expected health impacts resulting from the operation of the Darlington site in 2018. Dose to the public is discussed in section 3.1.7.

Darlington Nuclear Generating Station

There was one reported hazardous substance release at the DNGS in 2018. The concentration of morpholine discharged from Unit 3 boiler blowdown effluent was measured as slightly above

provincial regulatory limits. CNSC and Environment and Climate Change Canada reviewed the details of the event and determined there was no risk to the public from the release.

Darlington Waste Management Facility

OPG did not report any releases of hazardous substances from the DWMF that exceeded the provincial regulatory limits in 2018.

Environmental risk assessment

CNSC staff determined that OPG implemented an effective environmental risk assessment (ERA) and management program at the Darlington site in accordance with the applicable regulatory requirements.

In 2017, CNSC staff reviewed the Darlington nuclear ERA, which covers the DNGS and DWMF. CNSC staff confirmed that the ERA complied with the applicable regulatory requirements and that the conclusions of the ERA remained valid.

CNSC staff reviewed the 2018 annual compliance report and determined that OPG had taken adequate measures to protect human health and the environment.

3.1.10 Emergency management and fire protection

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

CNSC staff determined that OPG implemented comprehensive conventional, nuclear, and fire emergency response capabilities at all times for the Darlington site. This included personnel and equipment for medical, HAZMAT, search and rescue, and fire response.

OPG conducts training and exercises annually at the Darlington site to ensure all areas of the site have adequate emergency notification or response capability.

OPG has a written agreement with the Municipality of Clarington to provide emergency 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 support from OPG personnel can include operations, security staff, or emergency response team (ERT) personnel. The ERT is part of the DNGS minimum shift complement and will respond to events within the DNGS protected area at any time. The DNGS ERT can also provide off-hours investigation to fire alarms within the DWMF protected area with shift manager approval and under stable conditions at the DNGS.

OPG has a facility emergency program for the DWMF that includes radiation response emergency procedures. OPG also incorporates the Consolidated Nuclear Emergency Plan (CNEP) as part of its on-site requirements for nuclear response at the DWMF.

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and the DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Conventional emergency preparedness and response	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Nuclear emergency preparedness and response	Y	Assessed, described below	Y	Assessed, described below
Fire emergency preparedness and response	Y	Assessed, described below	Y	Assessed, described below

Nuclear emergency preparedness and response

CNSC staff determined that OPG maintained a comprehensive nuclear emergency preparedness and response capability that met all applicable regulatory requirements. OPG continued to support off-site emergency management organizations and commitments throughout 2018.

OPG's nuclear emergency preparedness program is documented in the CNEP that governs the Pickering and Darlington sites. In 2018, OPG revised the CNEP to align with the revised 2017 Provincial Nuclear Emergency Response Plan and associated implementing plans. CNSC staff reviewed the revised CNEP and did not identify any areas of concern.

Darlington Waste Management Facility

OPG has a facility emergency program for the DWMF that includes radiation response emergency procedures. DWMF became fully compliant with version 2 of REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* (2016) on December 20, 2018.

Fire emergency preparedness and response

Darlington Nuclear Generating Station

The DNGS has an extensive fire drill and training program for the ERT, which includes the Wesleyville Fire Training Academy, where live fire training is conducted in conjunction with the Clarington Municipal Fire Department.

The DNGS continues to implement a comprehensive fire protection program in accordance with the applicable regulatory requirements. In 2018, CNSC staff performed several inspections and observed a number of non-compliances of low safety significance in the implementation of the fire protection program. Specifically, CNSC staff identified non-compliances in the areas of problem identification and resolution, control of ignition sources and access to firefighting equipment. OPG committed to address all non-compliances and CNSC staff continued to monitor OPG's corrective action plan.

OPG's annual plant condition assessment for 2018 yielded no significant findings. CNSC staff recommended improvements to the report for OPG to better demonstrate compliance with the applicable regulatory requirements. CNSC staff will continue to monitor the scope and completeness of this assessment in subsequent submissions.

Darlington Waste Management Facility

CNSC staff determined that OPG met the applicable regulatory requirements for fire emergency preparedness and response for the DWMF.

CNSC staff received an updated package of fire protection assessment documentation from OPG for the DWMF. The submission included a code compliance review (CCR), fire hazard

assessment (FHA), fire protection program (FPP) audit and an annual facility condition inspection report. The FPP audit serves as an independent third party review of OPG's fire protection program and its inspection, testing and maintenance procedures for the fire protection systems employed at the DWMF.

CNSC staff observed several findings of low safety significance from their 2018 review of the package that required additional technical information from OPG.

Regarding the CCR, CNSC staff were not satisfied with a disposition that OPG provided to a building code deviation. OPG revised the section with additional technical information to clearly address how the intent of the code was met through alternative means. CNSC staff were satisfied with the revision.

Regarding the FHA, CNSC staff requested further technical information from OPG to clarify its responses to CNSC comments on highlighted issues regarding the fire scenario models used by the licensee. OPG provided further technical justification in late 2018. This satisfied most of CNSC staff's comments from the initial review; OPG continued to address the remaining comments from CNSC staff.

Regarding the FPP audit, CNSC staff noted non-compliances with the applicable regulatory requirements for inspection, testing and maintenance. These were addressed by OPG through several corrections to their procedures for inspection, testing and maintenance. CNSC staff were satisfied with the response.

Overall, CNSC staff were satisfied with the level of rigour presented in the fire protection assessment documentation and the dispositions provided to address CNSC staff comments.

In March 2018, CNSC staff conducted an inspection at the DWMF and found that OPG was not conducting the required annual fire drills to test fire response capability [OPG-DWMF-2018-01]. Following subsequent meetings with CNSC staff, OPG committed to conduct a fire drill at each WMF with mutual aid activation. The drill for the DWMF is scheduled for September 2019.

3.1.11 Waste management

CNSC staff concluded that the waste management SCA at the DNGS met the performance objectives and applicable regulatory requirements. As a result, the DNGS received a "satisfactory" rating, which was reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

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

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Waste characterization	Y	Assessed, described below	Y	Assessed, but no significant developments
Waste minimization	Y	Assessed, but no	Y	Assessed, but no

		significant developments		significant developments
Waste management practices	Y	Assessed, described below	Y	Assessed, but no significant developments
Decommissioning plans	Y	Assessed, described below	Y	Assessed, described below

Waste characterization

CNSC staff determined that OPG's waste characterization for radioactive and hazardous wastes met the applicable regulatory requirements at the DNGS and the DWMF.

Darlington Nuclear Generating Station

An event occurred in 2018 in the Retube Waste Processing Building (RWPB) involving the handling of refurbishment-generated wastes that resulted in alpha contamination. This event was reported under the radiation protection SCA; however, a component of this event relates to the characterization of waste. CNSC staff issued an enforcement action requesting that OPG complete a characterization of radiation hazards associated with refurbishment work taking place in the RWPB. This enforcement action was also a key element of the request issued to OPG under subsection 12(2) of the *General Nuclear Safety and Control Regulations* in June 2018.

Waste management practices

CNSC staff determined that OPG's waste management practices met applicable regulatory requirements at the DNGS and the DWMF and were effective for both radioactive and hazardous wastes in 2018.

Darlington Nuclear Generating Station

OPG used waste management procedures to ensure that waste generated at the facility was managed properly, as noted by CNSC staff during inspections and field verifications in 2018 [DRPD-2018-00929].

Decommissioning plans

The preliminary decommissioning plans (PDP) for the DNGS and DWMF met or exceeded the applicable regulatory requirements in 2018.

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 DNGS decommissioning. There were no changes made to the PDPs for the DNGS or DWMF in 2018. 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 the performance objectives and applicable regulatory requirements. As a result, the DNGS and DWMF received "satisfactory" ratings - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and the DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Facilities and equipment	Y	Assessed, described below	Y	Assessed, described below
Response arrangements	Y	Assessed, described below	Y	Assessed, but no significant developments
Security practices	Y	Assessed, but no significant developments	Y	Assessed, described below
Drills and exercises	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments

Facilities and equipment

CNSC staff determined that OPG met the applicable regulatory requirements for facilities and equipment at the DNGS and DWMF in 2018. OPG continued to sustain its security equipment through life cycle management and has upgraded its radio system to fully integrate with off-site response. No significant equipment failures were reported to the CNSC in 2018.

Darlington Nuclear Generating Station

Cyber Security

CNSC staff concluded that the cyber security program at the DNGS met the applicable regulatory requirements. OPG continued to update its cyber security program to comply with the 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 in 2018.

Response arrangements

CNSC staff determined that OPG met the applicable regulatory requirements for response arrangements at the DNGS and DWMF in 2018.

Darlington Nuclear Generating Station

CNSC staff conducted three field inspections at DNGS in 2018 that were focused on response arrangements, and concluded that OPG met the applicable regulatory requirements.

Security practices

CNSC staff determined that OPG implemented security practices at the DNGS and DWMF that met the applicable regulatory requirements in 2018. OPG had procedures in place at the DNGS and the DMWF to guide plant and security personnel appropriately in security practices.

Darlington Waste Management Facility

During an inspection in 2018 [OPG-DWMF-2018-01], CNSC staff observed a non-compliance with the *Nuclear Security Regulations* related to facility monitoring and prevention. OPG implemented corrective measures to the satisfaction of CNSC staff. CNSC staff have verified the implementation of the corrective measures and confirmed that OPG returned to compliance with the *Nuclear Security Regulations* regarding facility monitoring and prevention.

3.1.13 Safeguards and non-proliferation

CNSC staff concluded that the safeguards and non-proliferation SCA at the Darlington site met the performance objectives and all applicable regulatory requirements. As a result, the DNGS and the DWMF received “satisfactory” ratings - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Nuclear material accountancy and control	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Access and assistance to the IAEA	Y	Assessed, described below	Y	Assessed, described below
Operational and design information	Y	Assessed, described below	Y	Assessed, described below
Safeguards equipment, containment and surveillance	Y	Assessed, described below	Y	Assessed, described below

Access and assistance to the IAEA

Pursuant to the Canada/IAEA safeguards agreements and the facility's licence conditions, 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 DNGS and DWMF. See section 2.13 for additional details and a description of the verification activities conducted.

Operational and design information

CNSC staff confirmed that OPG met the applicable regulatory requirements for operational and design information for the DNGS and DWMF. See section 2.13 for additional information.

OPG submitted its annual operational program with quarterly updates for the DNGS and DWMF 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.

OPG also submitted updated design information questionnaires for the DNGS and the DWMF in 2018. CNSC staff were satisfied with the information provided and concluded that it met CNSC's submission requirements.

Safeguards equipment, containment and surveillance

OPG granted access and provided assistance to the IAEA in September 2018 for a site survey to determine potential locations of additional IAEA surveillance equipment with the goal of optimizing the current safeguards approach at the DNGS and DWMF.

3.1.14 Packaging and transport

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

The following table lists the specific areas under this SCA, explains their applicability for the DNGS and DWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	DNGS		DWMF	
	Applicable	Notes	Applicable	Notes
Package design and maintenance	Y	Assessed, described below	Y	Assessed, described below
Packaging and transport	Y	Assessed, described below	Y	Assessed, described below
Registration for use	Y	Assessed, described below	Y	Assessed, described below

Package design and maintenance, packaging and transport, and registration for use

CNSC staff determined that OPG had a packaging and transport program for the DNGS and DWMF that ensured compliance with the *Packaging and Transport of Nuclear Substances Regulations*, *2015* and the *Transportation of Dangerous Goods Regulations*. The program was effectively implemented and the transport of nuclear substances to and from the facilities was conducted in a safe manner.

For on-site movements of nuclear substances, OPG ensured 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.

OPG did not report any packaging and transport events in 2018 at the Darlington site.

Darlington Nuclear Generating Station

CNSC staff conducted a field inspection for packaging and transport at DNGS in 2018 [DRPD-2018-00929] and verified that all employees who were engaged in transport-related activities were adequately trained, radioactive materials to be transported were appropriately classified and packaged, all safety marks were appropriately displayed on packages and the documentation accompanying the shipments was completed properly.

One non-compliance was noted during the inspection, which was administrative in nature and had no safety significance. CNSC staff were satisfied with actions taken by OPG to prevent recurrence.

Darlington Waste Management Facility

CNSC staff inspected packaging and transport at the DWMF in 2018 [OPG-DWMF-2018-02] and confirmed that there were no off-site packaging and transport activities taking place at the DWMF.

3.2 Pickering site

The Pickering site consists of the Pickering Nuclear Generating Station (PNGS) and the Pickering Waste Management Facility (PWMF). This section presents CNSC staff's assessment of OPG's performance at the Pickering site for each SCA. 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 PNGS and PWMF, as of December 2018, are listed in Appendix E.

Overall CNSC staff assessment

The CNSC staff assessment of OPG's performance at the Pickering site for 2018 resulted in the performance ratings shown in table 19.

Table 19: Performance ratings for the Pickering site, 2018

Safety and control area	PNGS Rating	PWMF Rating
Management system	SA	SA
Human performance management	SA	SA
Operating performance	**FS**	SA[1]
Safety analysis	**FS**	SA[1]
Physical design	SA	SA
Fitness for service	SA	SA
Radiation protection	SA	SA
Conventional health and safety	**FS**	SA[1]
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Waste management	SA[1]	SA
Security	SA	SA
Safeguards and non-proliferation	SA	SA
Packaging and transport	SA	SA

Legend: FS – fully Satisfactory SA – satisfactory
BE – below Expectations UA – unacceptable

Notes: [1] The change in rating from 2017 to 2018 was due to CNSC staff refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

For 2018, CNSC staff reviewed the criteria for rating the specific areas under the SCAs. Besides assessing licensees against continually evolving requirements, CNSC staff also refined its criteria for "fully satisfactory" ratings based on industry best practice. Some SCAs that were rated "fully satisfactory" in 2017 have been rated "satisfactory" in 2018 in the context of the revised criteria. The revision of criteria also led to the decision to not include an overall rating for each facility (overall ratings were included in the regulatory oversight report for 2017).

Based on the assessments of the SCAs and other observations in 2018, CNSC staff concluded that OPG operated the PNGS and PWMF safely, upheld its responsibilities for safety and promoted a

healthy safety culture.

3.2.0 Introduction

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

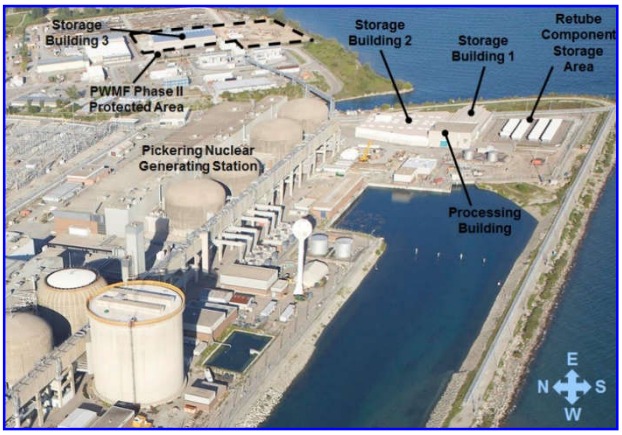
Pickering Nuclear Generating Station

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

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

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

Pickering Waste Management Facility



At the PWMF, OPG processes and stores dry storage containers (DSCs) containing used nuclear fuel (high-level radioactive waste) generated solely at the PNGS. OPG also manages the intermediate-level radioactive waste generated from the refurbishment of the PNGS Units 1-4 in 34 above-ground dry storage modules (DSMs) located at the Retube Component Storage Area (RCSA) at the PWMF. The RCSA is closed to the receipt of any new 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 the DSC Processing Building, two DSC storage buildings (Storage Buildings #1 and #2) and the RCSA. Phase II of the PWMF is located northeast of Phase I and is contained within its own protected area, separate from the protected area of the PNGS, but within the boundary of the Pickering site. Phase II contains Storage Building #3. The PWMF currently has the capacity to store 1,156 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.

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

Following a two-part public hearing in April and June of 2018, the Commission issued the renewed PROL for a 10-year period from September 1, 2018 to August 31, 2028. This licence period covers three phases of operational activities:

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

Pickering Waste Management Facility

Following a public hearing in April 2017, the Commission issued the renewed WFOL for the period April 1, 2018 to August 31, 2028.

Licence Conditions Handbook

Pickering Nuclear Generating Station

In 2018, there was one revision to the licence conditions handbook (LCH) following the PROL renewal. The revision included both administrative and technical changes. Details regarding the technical changes are discussed in the applicable SCA sections of this report.

Pickering Waste Management Facility

CNSC staff issued an associated LCH for the PWMF licence in June 2018 in conjunction with its WFOL renewal. In the latter half of 2018, OPG implemented several CNSC REGDOCs and CSA Group standards. Future revisions of the LCH will reflect those new publications (or new versions of existing publications) as sources of compliance verification criteria for the PWMF.

***Fisheries Act* authorization**

Pickering Nuclear Generating Station

On January 11, 2018, Fisheries and Oceans Canada issued OPG an authorization under paragraph 35(2)(b) of the *Fisheries Act* for the PNGS; it is valid until December 2028. The authorization requires OPG to install a fish diversion system (FDS) barrier net by May 1 each year that will remain in place and function until November 1 to avoid and mitigate serious harm to fish. In 2018, the net was in place and functioning from April 28 to November 12. 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 compensatory measures such as wetland habitat creation projects [RIB 16516].

Under the terms of the authorization, OPG is required to report annually on impingement and entrainment monitoring results as well as progress made on implementing the compensatory measures.

UPDATE: OPG submitted its first report on May 31, 2019 and staff from CNSC and Fisheries and Oceans Canada began their review.

Integrated implementation plan [RIB 17557 (item i)]

Pickering Nuclear Generating Station

In support of its application for a 10-year operating licence, OPG performed a periodic safety review (PSR), in accordance with CNSC regulatory document REGDOC-2.3.3 *Periodic Safety Reviews*. The purpose of the PSR was to confirm and enhance the safety case for continued operation of the PNGS until 2024. A PSR allows a licensee to identify practicable safety enhancements to the plant to bring its overall performance to a level commensurate with that of modern requirements and practices.

In the final phase of the PSR, OPG developed an integrated implementation plan (IIP) that defines resolution actions to address global issues. Each resolution action is completed through the execution of one or more IIP actions. OPG has established a schedule to manage the completion of the 35 resolution actions and the 63 supporting IIP actions.

The IIP forms part of the licensing basis for the PNGS. Therefore, execution and implementation of the IIP is a licensing requirement for OPG and is subject to CNSC regulatory oversight.

Table 20 summarizes the status of OPG's implementation of the IIP as of December 31, 2018.

Table 20. Status of OPG's implementation of IIP

SCA	IIP Actions				IIP Resolution actions			
	Total number	Scheduled for completion	Completed by OPG	CNSC review status[1]	Total number	Scheduled for completion	Completed by OPG	CNSC review status[1]
Safety analysis	**18**	8	5 3-delayed[2]	4-C 1-UR	**8**	3	3	2-C 1-UR
Physical design	**4**	0	0	0	**4**	0	0	0
Fitness for service	**37**	21	21	5-C 11-UR 5-AI	**21**	9	9	9-UR
Emergency management and fire protection	**4**	3	3	2-C 1-UR	**2**	1	1	1-UR
Total	**63**	**32**	**29**	**11-C 13-UR 5-AI**	**35**	**13**	**13**	**3-C 10-UR**

1 C = closed, AI = additional information needed, UR = under review
2 three IIP actions postponed from 2018 to 2019 by three months (November 2018 to February 2019)

CNSC staff were satisfied with OPG's progress on the implementation of the IIP. There were 32 IIP actions planned for completion in 2018. Three of them were rescheduled to be completed in 2019 and the remaining 29 were completed in 2018 per the original plan. The other 34 IIP actions were on track for completion per the original plan (17 + 3 in 2019 and 14 in 2020).

OPG submitted a notification to the CNSC of changes to eight IIP actions, including the three originally scheduled for completion in 2018. One action had a minor change to the closure criteria and seven actions were postponed for two to three months. CNSC staff concurred with OPG that these were "non-intent" changes (did not impact its associated resolution action) and therefore did not require Commission approval since they were within the licensing basis.

At the higher level, OPG completed 13 resolution actions that were planned for completion in 2018. The remaining 22 resolution actions were on track for completion as planned (11 in 2019 and 11 in 2020).

CNSC staff reviewed OPG's completion of each IIP action and resolution action.

To monitor OPG's implementation of the IIP, a process was established that includes tracking all IIP resolution actions and IIP actions through the CNSC RIB system, monthly meetings and verifications activities (desktop reviews and verification at the site). CNSC staff's increased regulatory oversight of OPG's implementation of the IIP is documented and monitored through an internal dashboard. This document provides a repository for all the information related to the IIP:

- each IIP resolution action and IIP action (OPG submissions, CNSC staff reviews, CNSC response letters), including the status of CNSC staff reviews (under review, additional information requested, closure accepted, closure denied)
- additional reporting requirements (IIP quarterly progress reports and annual progress report) as described in the LCH
- each OPG-CNSC monthly teleconference on the IIP progress (the first meeting was held on November 21, 2018)
- any intent or non-intent change(s) to an IIP resolution action or IIP action

As requested by the Commission, details regarding IIP-identified enhancements to OPG's management program for beyond-design-basis accidents as well as aging management-related IIP activities are provided in the following paragraphs.

OPG is implementing design changes to ensure additional barriers exist to prevent a beyond-design-basis accident from progressing to a severe accident and to mitigate the consequence if a severe accident occurs. These enhancements include:

- provision of emergency power and cooling water to the air conditioning units in all reactor units, as well as emergency power to the hydrogen ignitors and filtered air discharge system (FADS, completed by OPG / verified and closed by CNSC)
- actions and modifications to make fire protection system water available to the steam generators, heat transport system and calandria (completed by OPG / additional information requested by CNSC – still under review)
- completion of power and support service connections required to ensure the functionality of one main-volume vacuum pump to containment (to be confirmed by OPG in June 2019)

Many of the IIP actions associated with the fitness for service SCA are related to aging management, such as the fitness for service of major components (including updated life cycle management plans), buried piping, revised criticality coding of cable surveillance program and completion of condition assessments (including safety-related containment and non-containment

structures). CNSC staff were still reviewing many of the completed IIP actions to ensure that the identified issues were resolved before closing them. CNSC staff had no concerns with the progress made in 2018 on these IIP actions.

Operational Safety Review Team Mission

Pickering Nuclear Generating Station

In 2016, the IAEA had conducted an Operational Safety Review Team (OSART) mission to evaluate the PNGS's 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 OSART team concluded that management at the PNGS was committed to improving the operational safety and reliability of the plant. The team identified 8 good practices, 11 suggestions and 10 recommendations for which OPG developed improvement strategies and established action plans.

The IAEA conducted a follow-up mission in 2018 to assess OPG's progress implementing the suggestions and recommendations. CNSC staff plan to review the outcome of the 2018 OSART mission once the report is available and provide the Commission with an update in the regulatory oversight report for 2019.

Event initial reports

CNSC staff submitted two event initial reports [CMD 18-M44 and CMD 18-M45.A] pertaining to the PNGS to the Commission during the period January 1, 2018 to June 1, 2019. Details are provided in table 21. No initial event reports pertaining to the PWMF were submitted in that period.

Table 21: Title Event initial reports for the PNGS

Subject	Description
Units 5-7 unplanned outage due to algae run	From July 21 to 22, 2018, the PNGS was impacted by a large accumulation of algae on the "travelling" screens for condenser cooling water intake. The algae was anticipated during that time of year; however, the volume of algae exceeded expectations and led to a shutdown of Units 5, 6, 7 and 8. Throughout the event, the operators maintained control of reactor power and fuel cooling in each core and the containment was not challenged. The buildup of algae on the screens caused the operators to shut off condenser cooling water pumps, which caused a high condenser pressure condition. Subsequently, Unit 5 automatically initiated a turbine trip. The operators manually initiated turbine trips per operating procedures for Units 6, 7 and 8.
Unit 4 unplanned outage due to condenser cooling backpressure	On August 4, 2018, Unit 4 started to experience a high condenser backpressure alarm due to a clogged debris filter for the condenser. The clogged filter, coupled with an increase in the lake temperature (4ºC) reduced the effectiveness of the Unit 4 condenser. The high condenser backpressure alarm caused an automatic reactor setback to 87% of full power. Concurrently, the operators manually tripped the turbine to account for the reduction in power. During the manual turbine trip, Unit 4 incurred a partial loss of class IV power due to a circuit breaker that failed to close during the transfer of class IV power to the service system transformer.

Compliance program

The annual CNSC effort on the compliance program is tabulated in Appendix F for the PNGS and PWMF. The inspections conducted at the Pickering site that were considered in CNSC staff assessments in this regulatory oversight report are included in table 22 (inspection reports were included if they were sent to OPG by January 31, 2019).

Table 22: List of inspections at the Pickering site

Safety and control area	Inspection title	Inspection report sent
Management system	Problem Identification and Resolution – Event Investigation Report Number:PRPD-2017-019	Feb 16, 2018
Human performance management	Conduct of Simulator Certification Examinations and Requalification Tests Report Number: PRPD-2018-006	Apr 24, 2018
	Operations Testing and Maintenance Procedure Report Number: PRPD-2018-001	Apr 9, 2018
	Design, Development and Grading of a RO Simulator-based Certification Examination - Pickering 5-8 Report Number: PRPD-2018-015	Sep 12, 2018
	Nuclear Power Plant Management Interview for Shift Personnel Report Number: PRPD-2018-014	Jun 12, 2018
	Design and Development of the December 2017 Pickering 1-4 CRSS Simulator-based Certification Examination Report Number: PRPD-2018-004	Feb 23, 2018
Operating performance	Pickering Nuclear Generating Station Quarterly Field Inspection Third Quarter FY 2017/18 Report Number: PRPD-2017-023	Jan 24, 2018
	Pickering Nuclear Generating Station Quarterly Field Inspection Fourth Quarter FY 2017/18 Report Number: PRPD-2018-012	Jun 4, 2018
	Outage inspection (Unit 1) Report Number: PRPD-2017-021	Mar 23, 2018
	Pickering Nuclear Generating Station Quarterly Field Inspection First Quarter FY 2018/19 Report Number: PRPD-2018-00364	Sep 25, 2018
	Pickering Nuclear Generating Station Quarterly Field Inspection Second Quarter FY 2018/19 Report Number: PRPD-2018-00806	Dec 21, 2018
	Outage inspection (Unit 6) Report Number: PRPD-2018-002	Sep 11, 2018
	Outage inspection (Unit 4)	Oct 5, 2018

Safety and control area	Inspection title	Inspection report sent
	Report Number: PRPD-2018-00204	
	Reactive - Fuel Handling Conveyor Tunnel Report Number: PRPD-2018-003	Mar 29, 2018
	Pickering Waste Management Facility Baseline Inspection Fourth Quarter FY 2017/2018 Report Number: OPG-PWMF-2018-01	June 8, 2018
	Pickering Waste Management Facility Baseline Inspection Second Quarter FY 2018/2019 Report Number: OPG-PWMF-2018-02	November 9, 2018
Physical design	Reactive - Physical Design Program Report Number: PRPD-2018-010	Jul 10, 2018
	CANDU Safety Issue IH6 Need for Systematic Assessment of High Energy Line Break Effects, Verification of Methodology Assumptions Report Number: PRPD-2018-013	May 24, 2018
Fitness for service	System Inspection of Vault Vapor Recovery Report Number: PRPD-2018-011	Jun 12, 2018
	System Inspection Report - Irradiated Fuel Bays Report Number: PRPD-00247-2018	Aug 17, 2018
	Annulus Gas Dew Point Hygrometer Calibration Report Number: PRPD-2018-01128	Dec 14, 2018
	Type II Inspection - Change Management - Software Maintenance Report Number: PRPD-2018-01219	Jan 18, 2019
	2018 System Inspection NPC - E-FADs Operability/EME Connections Report Number: PRPD-2018-01524	Dec 20, 2018
Environmental protection	Pickering Waste Management Facility Focused Environmental Protection Inspection Fourth Quarter FY 2017/2018 Report Number: OPG-PWMF-2018-01	June 8, 2018
Emergency management and fire protection	Planned Emergency Response Exercise Report Number: PRPD-2018-005	March 6, 2018
	Pickering Waste Management Facility Focused Emergency Management and Fire Protection Inspection Fourth Quarter FY 2017/2018 Report Number: OPG-PWMF-2018-01	June 8, 2018
Security	Cyber security Report Number: PRPD-2018-008	May 8, 2018
Packaging and	Pickering Waste Management Facility Focused Packaging	November 9,

Safety and control area	Inspection title	Inspection report sent
transport	and Transport Inspection Second Quarter FY 2018/2019 Report Number: OPG-PWMF-2018-02	2018

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 PWMF received "satisfactory" ratings - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Management system	Y	Assessed, described below	Y	Assessed, but no significant developments
Organization	Y	Assessed, but no significant developments	Y	Not rated
Change management	Y	Assessed, described below	Y	Assessed, but no significant developments
Safety culture	Y	Not rated	Y	Not rated
Configuration management	Y	Assessed, but no significant developments	Y	Not rated
Records management	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Management of contractors	Y	Assessed, but no significant developments	Y	Assessed, described below
Business continuity	Y	Not rated	Y	Not rated
Performance assessment, improvement and management review	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Operating experience	Y	Assessed, described below	Y	Assessed, but no significant developments

Management system

CNSC staff determined that OPG's nuclear management system at the Pickering site met the applicable regulatory requirements in 2018. Note that OPG's management system is integrated for the PNGS and PWMF, so any issue or improvement that is described for one may also be relevant to the other.

Pickering Nuclear Generating Station

In 2018, CNSC staff reviewed the implementing programs and interfaces in OPG's nuclear management system. CNSC staff determined that the OPG document used to demonstrate compliance with the CSA Group standard N286-12, *Management system requirements for*

nuclear facilities) was not complete. For example, some nuclear programs owned and implemented by OPG organizations external to nuclear operations (i.e., corporate-led programs) did not include the specific requirements of N286-12. At the end of 2018, CNSC staff were reviewing OPG's corrective action plan.

Change management

CNSC staff determined that OPG had an adequate change management program at the Pickering site that met the applicable regulatory requirements.

Pickering Nuclear Generating Station

In 2018, CNSC staff inspected software maintenance with a focus on change management and concluded that software maintenance met the applicable regulatory requirements [PRPD-2018-01219]. However, there were deficiencies in the area of change management with respect to consistently obtaining the concurrence of the human factors engineer per OPG's procedures. At the end of 2018, OPG was developing a corrective action plan.

Management of contractors

In 2018, management of contractors at the Pickering site met the applicable regulatory requirements.

Pickering Waste Management Facility

In the regulatory oversight report for 2017, CNSC staff reported on the lack of inspection at the manufacturer's sites for DSCs. In 2018, OPG reviewed the quality assurance documentation for all affected DSCs and informed the CNSC that there were no safety, transportability, or structural integrity issues with those DSCs. At the end of 2018, CNSC staff were monitoring the completion of the corrective actions, which were expected to be completed in 2019. CNSC staff were satisfied with the progress in 2018.

Operating experience

CNSC staff determined that OPG met the applicable regulatory requirements for OPEX at the Pickering site in 2018. OPG demonstrated that it identified and implemented OPEX from within its organization and from the Canadian and international nuclear industry.

Pickering Nuclear Generating Station

CNSC staff inspected OPG's event investigation process and found deficiencies in the areas of documentation and change control, event categorization and investigation, ensuring all causes are addressed and independent verification [PRPD-2017-019]. At the end of 2018, CNSC staff were reviewing OPG's corrective action plan.

3.2.2 Human performance management

CNSC staff concluded that the human performance management SCA at the Pickering site met the performance objectives and applicable regulatory requirements. As a result, the PNGS and PWMF received "satisfactory" ratings - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Human performance program	Y	Assessed, but no significant developments	Y	Not rated
Personnel training	Y	Assessed, described below	Y	Assessed, described below
Personnel certification	Y	Assessed, described below	N	No CNSC-certified positions
Initial certification examinations and requalification tests	Y	Assessed, described below	N	No CNSC-certified positions
Work organization and job design	Y	Assessed, described below	N	No minimum shift complement requirements
Fitness for duty	Y	Assessed, described below	Y	Not rated

Personnel training

CNSC staff determined that OPG had a robust and well-documented fleet-wide training system based on a systematic approach to training. CNSC staff did not conduct any training-specific inspections at the PNGS or PWMF in 2018. Nevertheless, CNSC staff examined training records frequently during inspections related to other SCAs [e.g., OPG-PWMF-2018-02] and determined that the training programs and associated records at the PNGS and PWMF met the applicable regulatory requirements in 2018.

Personnel certification

Pickering Nuclear Generating Station

CNSC staff determined that OPG's personnel certification program at the PNGS met the applicable regulatory requirements in 2018. CNSC staff reviewed the staffing reports for certified personnel and the applications for initial certification and renewal of certification and confirmed that OPG had a sufficient number of personnel at the PNGS for all certified positions. All certified workers at the PNGS possessed the knowledge and skills required to perform their duties safely and competently.

Initial certification examinations and requalification tests

Pickering Nuclear Generating Station

CNSC staff concluded that the initial certification examination and requalification testing programs for certified personnel at PNGS Units 1, 4 and PNGS Units 5-8 met the applicable regulatory requirements in 2018.

In 2018, CNSC staff inspected the conduct, design, development and grading of simulator-based certification examinations at both PNGS Units 1 and 4 and PNGS Units 5-8 [PRPD-2018-004], PRPD-2018-006 and PRPD-2018-015]. Staff observed one non-compliance of low safety significance regarding the candidate action checklists in the examiner guides. CNSC staff were satisfied with the progress of OPG's corrective actions at the end of 2018.

Work organization and design

Pickering Nuclear Generating Station

The minimum shift complement at the PNGS met the applicable regulatory requirements in 2018. No minimum shift complement violations were reported in 2018.

Fitness for duty

Pickering Nuclear Generating Station

CNSC staff determined that OPG met the applicable regulatory requirements for fitness for duty at the PNGS in 2018.

OPG has procedures in place for managing worker fatigue that include limits on hours of work. OPG had committed to implement CNSC regulatory document REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* in 2019 (see section 2.2 for background information). CNSC staff were satisfied with OPG's implementation plan and were monitoring its progress [RIB 17525].

OPG is also working toward the implementation of two additional CNSC regulatory documents related to fitness for duty: REGDOC-2.2.4, Fitness for Duty, Volume II: *Managing Alcohol and Drug Use* and REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness*. Background information and implementation details are provided in section 2.2 [RIB 17525].

There were three hours-of-work violations reported for the PNGS in 2018. CNSC staff followed up with OPG and were satisfied that OPG tookis taking action to immediately address hours-of-work violations and to prevent recurrence. CNSC staff observed a downward trend in the number of hours-of-work violations reported for certified staff, indicating that OPG was controlling its hours of work and shift schedules.

3.2.3 Operating performance

CNSC staff concluded that the operating performance SCA at the PNGS met or exceeded the performance objectives and applicable regulatory requirements. As a result, the PNGS received a "fully satisfactory" rating - unchanged from the previous year.

CNSC staff concluded that the operating performance SCA at the PWMF met the performance objectives and applicable regulatory requirements. As a result, the PWMF received a "satisfactory" rating, reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Conduct of licensed activity	Y	Assessed, described below	Y	Assessed, described below
Procedures	Y	Assessed, described below	Y	Not rated
Reporting and trending	Y	Assessed, described below	Y	Assessed, described below
Outage management	Y	Assessed, described below	N	No outage management

performance				program required
Safe operating envelope	Y	Assessed, but no significant developments	N	No safe operating envelope program required
Severe accident management and recovery	Y	Assessed, but no significant developments	N	No severe accident management program required
Accident management and recovery	Y	Not rated	Y	Not rated

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 met them at the PWMF in 2018. OPG operated the PNGS and PWMF in a safe and secure manner within the bounds of their operating policies and principles and operational safety requirements and with adequate regard for health, safety, security, radiation and environmental protection, and international obligations.

Pickering Nuclear Generating Station

In 2018, the PNGS experienced three unplanned reactor trips, no stepbacks and twelve setbacks. The higher than average number of setbacks was due to a variety of causes, including debris runs affecting multiple units (e.g., as described in table 21) and faulty components.

CNSC staff determined that the trip and setbacks were properly controlled and that power reductions were adequately initiated by the reactor control systems. There were no impacts on reactor safety. CNSC staff verified that OPG staff followed approved procedures and took appropriate corrective actions for all transients.

Pickering Waste Management Facility

In 2018, OPG processed 40 DSCs at the PWMF, which met OPG's internal target. Since the start of facility production to the end of 2018, OPG had processed and placed into storage 943 DSCs at the PWMF.

Procedures

Pickering Nuclear Generating Station

CNSC staff determined that the procedures for the PNGS met the applicable regulatory requirements in 2018. CNSC staff determined that OPG had clearly documented expectations for procedural use and adherence and a process to manage procedural change at the PNGS.

In 2018, CNSC staff inspected operations, testing and maintenance procedures used by operations staff who work on and test special-safety systems and safety-related systems [PRPD-2018-001]. CNSC staff identified some non-compliances of low safety significance that were relevant to OPG's procedures (e.g., document change control, procedural adherence and procedural adequacy). OPG implemented corrective actions to the satisfaction of CNSC staff.

Reporting and trending

CNSC staff determined that OPG's reporting and trending met or exceeded the applicable regulatory requirements and expectations in 2018 for the PNGS and PWMF. During 2018, all scheduled reports were submitted to the CNSC in a timely manner and were adequate.

Pickering Nuclear Generating Station

OPG's reporting in 2018 met the requirements of CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. OPG submitted 64 reportable events that required a detailed event report in 2018. All reported events were followed up by OPG with corrective actions and root cause analysis, when appropriate.

Pickering Waste Management Facility

During 2018, OPG submitted two reports for events of low safety significance at the PWMF. The event reports are discussed under the applicable SCA in this report.

Outage management performance

Pickering Nuclear Generating Station

CNSC staff concluded that OPG's management of outages at the PNGS met the applicable regulatory requirements and expectations in 2018. CNSC staff observed that OPG demonstrated satisfactory levels of performance and achievement of objectives during planned outages. In 2018, there were three planned outages (Units 4, 6 and 8) and seven forced outages (Units 1, 4, 5, 6, 7 and 8) at the PNGS.

In addition to the planned maintenance outages, OPG also undertook unplanned forced outages as needed to fix or replace equipment.

CNSC staff determined that all outage-related undertakings including heat sink management were performed safely in 2018.

3.2.4 Safety analysis

CNSC staff concluded that the safety analysis SCA at the PNGS met or exceeded the performance objectives and applicable regulatory requirements. As a result, the PNGS received a "fully satisfactory" rating - unchanged from the previous year.

CNSC staff concluded that the safety analysis SCA at the PWMF met the performance objectives and applicable regulatory requirements. As a result, the PWMF received a "satisfactory" rating, which was reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Deterministic safety analysis	Y	Assessed, described below	Y	Assessed, described below
Probabilistic safety assessment	Y	Assessed, described below	N	No PSA program required
Criticality safety	N	No criticality safety program required	N	No criticality safety program required
Severe accident analysis	Y	Assessed, described below	N	This activity not required
Management of safety	Y	Assessed, see section 2.4	N	This activity not required

issues				

Deterministic safety analysis

OPG had an effective, well-managed program for performing deterministic safety analyses at the PNGS and PWMF. CNSC staff concluded that OPG's deterministic safety analyses predicted adequate safety margins, met or exceeded the applicable regulatory requirements at the PNGS and met them at the PWMF.

Pickering Nuclear Generating Station

In December 2017, OPG completed the analyses of common-cause events (CCE) for the PNGS. The completion of the CCE analyses was a key milestone of the on-going OPG safety analysis improvement project and the implementation plan for CNSC regulatory document REGDOC-2.4.1, *Deterministic Safety Analysis*, which defines the REGDOC-2.4.1-compliant analyses to be undertaken in the 2018 to 2021 timeframe.

CNSC staff determined that the CCE analyses demonstrated the robustness of the PNGS design to cope with design-basis CCs. CNSC staff also recommended future improvements. In December 2018, OPG submitted the updated Pickering A safety report Part 3, which included new appendices for the CCE analyses. As of the end of 2018, CNSC staff was reviewing the submission as well as OPG's response to the CNSC recommendations on the CCE analyses.

UPDATE: In May 2019, CNSC provided staff comments on OPG responses. Generally, OPG's responses were satisfactory, although a number of issues were under discussion and are going to be considered during the planned revision of REGDOC-2.4.1. The CCE analyses were also to be included in the updated Pickering B safety report, which was expected in 2019.

As identified in the IIP, further safety analysis was required to demonstrate that the effect of aging components in the primary heat transport (PHT) system on the small-break loss of coolant accident (SBLOCA), loss of flow (LOF) and slow loss of regulation accident scenarios will not challenge safety margins.

UPDATE: OPG submitted PHT aging safety analysis for PNGS Units 1 and 4 for the SBLOCA, LOF, and NOP scenarios in February 2019. For PNGS, the REGDOC-2.4.1 implementation plan includes consideration for the revision of analyses for large-break loss-of-coolant accidents and loss of reactor power regulation events, contingent upon the equivalent DNGS analyses demonstrating a more robust safety case compared to the existing safety report analyses [RIB 17525 (iii)].

Pickering Waste Management Facility

CNSC staff were reviewing an update of the PWMF safety analysis report that was submitted by OPG in 2018 and requested additional information, including information regarding radiation protection, safety analysis and the management system.

OPG updated the fire hazard assessment (FHA) for the PWMF in 2017. CNSC staff requested additional information regarding the fire safety consequences for a storage area, clarification on design fire scenarios and the use of fire protection assumptions. CNSC staff were satisfied with the additional information and clarifications provided by OPG in 2018 and determined that the FHA met the applicable regulatory requirements.

Probabilistic safety assessment

Pickering Nuclear Generating Station

CNSC staff determined that OPG's performance met or exceeded the applicable regulatory requirements for probabilistic safety assessment (PSA) at the PNGS in 2018.

OPG submitted full-scope PSA updates for PNGS Units 5-8 and PNGS Units 1 and 4 in 2017 and 2018, respectively. CNSC staff completed their review of the PNGS Unit 5-8 PSA update in 2018 and concluded it complies with the applicable regulatory requirements (CNSC regulatory document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*). CNSC staff's review of the PNGS Unit 1 and 4 PSA updates will be completed by the end of 2019.

In addition to the requirements of S-294, REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* introduces new requirements such as considerations of other radioactive sources, including the irradiated fuel bay and multi-unit impacts. As part of its transition to REGDOC-2.4.2, OPG has submitted revised PSA methodologies, which CNSC staff have reviewed and accepted. OPG will continue submitting PSA methodologies/guidelines to the CNSC in 2019 for acceptance. This includes the development of new methodologies to address REGDOC-2.4.2 requirements regarding the consideration of non-reactor radioactive sources and different operational states. OPG plans to fully implement REGDOC-2.4.2 at the PNGS by the end of 2020.

Per the Commission's direction associated with the renewal of the PNGS PROL in 2013, OPG submitted a pilot project report on whole-site PSA for the PNGS in 2017. The results from this project were presented to the Commission in December 2017 [CMD 17-M64]. In 2018, CNSC staff completed a more detailed review of the submission and concluded that the Pickering whole-site PSA, including the methodology used to avoid the double counting of accident sequences, and acknowledged that the results provided a good characterization of the whole-site risk. OPG satisfactorily addressed the majority of CNSC comments and recommendations. CNSC staff will continue to monitor OPG's response to the remaining items. See section 2.4 for additional information on whole-site PSA [RIB 17557].

Pursuant to the record of decision [CMD 14-M42.1] for the Commission hearing in 2014 for the removal of hold points at the PNGS, OPG provided the last update of the implementation of its risk improvement plan in February 2018. CNSC staff reviewed the submission and concluded that all committed risk improvement items were completed.

Severe accident analysis

Pickering Nuclear Generating Station

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

In June 2018, OPG submitted an assessment of containment integrity for beyond-design–basis accidents (BDBA). It assessed the advantages and disadvantages of various options for addressing large radiological releases after BDBAs (e.g., the use of a thick concrete structure maintained at negative pressure by the Vacuum Building and the FADS for controlled filtered venting). Although the FADS were originally designed for design-basis accidents, OPG has procedures in place for their use following a BDBA. CNSC staff were reviewing this report at the end of 2018.

CNSC staff performed a high-level review of the severe accident analysis that supports the Level-2 PSA for Pickering B Units 5 to 8 and only identified minor issues.

UPDATE: CNSC staff completed a detailed review of the severe accident analysis and provided OPG with informal comments.

3.2.5 Physical design

CNSC staff concluded that the physical design SCA at the Pickering site met the performance objectives and applicable regulatory requirements. As a result, the PNGS and PWMF received "satisfactory" ratings - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Design governance	Y	Assessed, described below	Y	Assessed, but no significant developments
Site characterization	Y	Not rated	Y	Not rated
Facility design	Y	Not rated	Y	Not rated
Structure design	Y	Assessed, described below	Y	Not rated
System design	Y	Assessed, described below	Y	Not rated
Component design	Y	Assessed, described below	Y	Not rated

Design governance

CNSC staff concluded that OPG met the applicable regulatory requirements regarding design governance in 2018 for the PNGS and PWMF.

Pickering Nuclear Generating Station

CNSC staff conducted a Type I inspection to assess the compliance of the OPG physical design program with the applicable regulatory requirements. CNSC staff concluded that OPG had a well-defined, developed and implemented design program at the PNGS in addition to having an effective process for maintaining the program. The inspection team observed several areas of strength with respect to the governance, procedures and implementation of the physical design program.

Structure design

Pickering Nuclear Generating Station

CNSC staff concluded that OPG met the applicable regulatory requirements regarding structural design for the PNGS in 2018.

CNSC staff inspected the irradiated fuel bays (IFBs) and concluded that they met all applicable regulatory requirements [PRPD-00247-2018]. CNSC staff confirmed that the IFB system will reliably perform its design mission and that the structural integrity of the IFBs and auxiliary irradiated fuel bay were sound and leak tight.

System design

Pickering Nuclear Generating Station

CNSC staff concluded that OPG met the applicable regulatory requirements regarding system design in 2018 for the PNGS.

Electrical power systems

CNSC staff concluded that the electrical power system at the PNGS met the applicable regulatory requirements. In 2018, the PNGS experienced three transients due to total or partial losses of class IV power. After reviewing the event reports and following up with OPG staff, CNSC staff concluded that there were no safety concerns and the station behaved as per design. CNSC staff were satisfied with OPG's response to these events and confirmed that adequate corrective actions were in place.

Component design

Pickering Nuclear Generating Station

CNSC staff concluded that OPG met the applicable regulatory requirements regarding component design in 2018 for the PNGS.

Fuel design

OPG continued to have a mature reactor fuel inspection and monitoring program. CNSC staff were satisfied with the fuel performance results assessed in 2018. OPG operated its reactors within the design and operating limits in its operating licence and its defect rate remained below the CNSC expectation of one defect per unit per year. CNSC staff determined that OPG adequately managed fuel performance issues while maintaining safe operations.

3.2.6 Fitness for service

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

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Equipment fitness for service / equipment performance	Y	Assessed, described below	N	This specific area does not apply
Maintenance	Y	Assessed, described below	Y	Assessed, but no significant developments
Structural integrity	Y	Assessed, described below	Y	Not rated
Aging management	Y	Assessed, described below	Y	Assessed, but no significant developments
Chemistry control	Y	Assessed, described below	Y	Assessed, but no significant developments
Periodic inspection and testing	Y	Assessed, described below	N	These activities are not required

Equipment fitness for service/equipment performance

Pickering Nuclear Generating Station

CNSC staff determined that the overall equipment fitness for service and performance at the PNGS were satisfactory and met the applicable regulatory requirements. CNSC staff also determined that the reliability program at the PNGS met the applicable regulatory requirements. All special safety systems for PNGS Units 1, 4 and 5–8 met their unavailability targets in 2018.

Maintenance

CNSC staff determined that OPG's maintenance program met the applicable regulatory requirements for the PNGS and PWMF in 2018. OPG's maintenance program for its NPPs also governs preventative and corrective maintenance activities for its WMFs.

Pickering Nuclear Generating Station

In 2018, the average preventive maintenance completion ratio for the six units at the PNGS was 97 percent, which was higher than industry average of 93 percent. The corrective critical maintenance backlog, deficient critical maintenance backlog, and the number of deferrals of preventative maintenance critical components have been trending down and are given in table 23.

Table 23: Trend of maintenance backlogs and deferrals for critical components for PNGS, 2016 to 2018

Parameter	Average quarterly work orders per unit			Quarterly 2018 work orders				Industry average for 2018
	2016	2017	2018	Q1	Q2	Q3	Q4	
Corrective maintenance backlog	19	7	2	2	2	2	2	1
Deficient maintenance backlog	109	104	16	18	18	14	14	16
Deferrals of preventive maintenance	110	81	11	14	8	10	11	4

Structural integrity

Pickering Nuclear Generating Station

CNSC staff concluded that the SSCs required for safe operation continued to meet the structural integrity requirements established in the design basis or in CNSC-accepted standards and guidelines for the PNGS in 2018.

As part of its periodic inspection program (PIP), OPG inspected several pressure boundary and containment components in 2018. 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 the CSA Group acceptance criteria necessary to remain within their design bases.

Aging management

CNSC staff concluded that OPG's integrated aging management program continued to meet the applicable regulatory requirements at the PNGS and the PWMF in 2018. CNSC staff confirmed that the major component life cycle management plans at the PNGS and the aging management plans for DSCs and DSMs at the PWMF continued to meet the applicable regulatory requirements.

Pickering Nuclear Generating Station

OPG's IIP deliverables that are related to fitness for service are described in section 3.2.0.

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

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

The PNGS is licensed to operate up to 295,000 EFPH. At the end of 2018, the longest operating pressure tubes had approximately 241,000 EFPH of service. The pressure tubes are not predicted to approach the current licensing limit until approximately 2024. See section 2.6 for background information.

Following the 2018 PROL renewal, CNSC staff included several new compliance verification criteria in the LCH related to pressure tube fracture toughness. These involved confirmation of the ongoing use of the current model for fracture toughness, the assessment of the time available until the current model cannot be used and the development of a new model.

In 2018, OPG submitted an uncertainty analysis of the results of the current fracture toughness model. CNSC staff reviewed the submission and provided comments for OPG to address.

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

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

Chemistry control

CNSC staff determined that OPG's chemistry control program met the applicable regulatory requirements for the PNGS and PWMF in 2018. OPG maintained acceptable system chemistry performance for both the PNGS and PWMF in 2018.

Pickering Nuclear Generating Station

The PNGS remained within its chemistry specifications, as demonstrated by the performance indicators "chemistry index" and "chemistry compliance index"(see section 2.6).

Periodic inspection and testing

Pickering Nuclear Generating Station

CNSC staff determined OPG had adequate and well-maintained PIPs for pressure boundary systems, containment components and containment structures that complied with the applicable CSA Group standards.

OPG complied with the 2005 edition of the CSA Group standard N285.4, *Periodic inspection of CANDU nuclear power plant components*. Due to some of the significant changes between the 2005 and 2014 editions of N285.4, CNSC staff agreed that full implementation of the 2014 edition of the standard for the PNGS likely would not be achieved before the end of commercial operation in 2024. However, CNSC staff noted that some of the updates in the 2014 edition represent program improvements that should be considered to ensure that there are no weaknesses in the current PIPs during the remaining operation of the station.

In July 2018, OPG submitted a gap analysis for specific elements of N285.4-14 and committed to update the PIP plans for PNGS Units 1, 4, and PNGS Units 5-8 by incorporating the N285.4-14 gap disposition.

UPDATE: The updated PIPs were submitted in February 2019 and accepted by CNSC staff [RIB 17525].

In 2018, CNSC staff accepted OPG's request to defer the Unit 7 reactor building leakage rate test by six months. The applicable CSA Group standard requires a reactor building leakage rate test every six years, and the Unit 7 reactor building test was due to be completed before December 31, 2018. OPG requested the test be deferred to accommodate changes to the Unit 7 planned outage schedule and provided a supporting assessment demonstrating that the Unit 7 reactor building leakage rate at design pressure is expected to remain well below the safety analysis limit until the end of June 2020. Based on their review, CNSC staff concluded that deferring the test for up to six month did not have any safety impact on the Unit 7 reactor building. CNSC staff revised the LCH accordingly.

3.2.7 Radiation protection

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

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Application of ALARA	Y	Assessed, described below	Y	Assessed, described below
Worker dose control	Y	Assessed, described below	Y	Assessed, described below
Radiation protection program performance	Y	Assessed, described below	Y	Not rated
Radiological hazard control	Y	Assessed, described	Y	Assessed, described

		below		below
Estimated dose to public	Y	Assessed, described below	Y	Assessed, described below

Application of ALARA

CNSC staff determined that OPG implemented a highly 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 PWMF. CNSC staff verified that OPG used ALARA initiatives, work planning, dose monitoring and engineering control practices to work towards the challenging ALARA targets established by OPG at the PNGS and PWMF. In 2018, OPG met its established year-end collective radiation exposure (CRE) target.

Pickering Nuclear Generating Station

The largest contributor to CRE at the PNGS was the outage-related work, with approximately 84% of the CRE arising from the 2018 outages. Of the three major planned outages, only one exceeded the collective dose target for the outage. This was due to a leak in the moderator purification room, increased scope and higher than expected dose rates during some planned work. CNSC staff observed that OPG implemented recovery plans to minimize the dose exceedance and return to established targets.

CNSC staff observed OPG implemented lower collective dose targets to challenge its performance in instances where outage scope was reduced or during good outage performance. Ongoing ALARA initiatives continued to be implemented that resulted in improvements, such as lowered average dose rates on the reactor face. CNSC staff noted that OPG conducted work reviews following each outage to review dose performance and to implement lessons learned for future work. CNSC staff observed that OPG shared the results with individual work groups, which led to improved performance.

Worker Dose Control

CNSC staff determined that OPG met or exceeded the applicable regulatory requirements to ascertain and record doses received by workers at the PNGS and PWMF in 2018. The data for doses to workers at the Pickering site can be found in section 2.7. Radiation doses to workers at the PNGS and PWMF were below the regulatory dose limits, as well as the action levels in OPG's radiation protection program. CNSC staff did not observe any adverse trends or safety-significant unplanned exposures at the Pickering site in 2018. Additionally, there were no event reports related to worker dose control in 2018.

Pickering Nuclear Generating Station

Compliance verification activities conducted in 2018 indicated that performance in the area of worker dose control at the PNGS was highly effective [PRPD-2018-00806, PRPD-2018-00364 and PRPD-2018-002].

Radiation protection program performance

Pickering Nuclear Generating Station

CNSC staff determined that OPG's radiation protection program met the requirements of the *Radiation Protection Regulations*. OPG continued to employ a suite of performance metrics to monitor and control the overall performance of the radiation protection program at the PNGS. The oversight applied by OPG in implementing this program was effective in protecting workers at the PNGS.

In 2018, OPG updated numerous procedures to reflect broader changes in the program. CNSC staff observed many improvements.

In 2018, CNSC staff observed some delays in addressing ongoing corrective actions related to the calibration and availability of the fixed area gamma monitoring systems. CNSC staff note that these issues were satisfactorily addressed. CNSC staff also observed that OPG regularly measures the performance of its radiation protection program against industry-established objectives, goals and targets.

Radiological hazard control

CNSC staff determined that OPG implemented radiological hazard controls that met the applicable regulatory requirements at the PNGS and PWMF in 2018.

Pickering Nuclear Generating Station

There were no contamination control action level exceedances for surface contamination at the PNGS in 2018. CNSC staff confirmed that although a slight declining trend in personal contamination events was identified through reporting of safety performance indicators, none of these events were safety significant and OPG implemented corrective actions to address any related issues. CNSC staff also confirmed that no safety-significant incidents were identified through reporting of safety performance indicators on loose contamination events.

Pickering Waste Management Facility

There were no exceedances of action levels for surface contamination control reported by OPG for the PWMF in 2018.

Estimated dose to the public

CNSC staff determined that OPG ensured the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to a member of the public from the Pickering site was 0.0021 mSv, well below the annual public dose regulatory limit of 1 mSv. See section 2.7 for additional data.

3.2.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at the PNGS met or exceeded the performance objectives and applicable regulatory requirements. As a result, the PNGS received a "fully satisfactory" rating - unchanged from the previous year.

CNSC staff concluded that the conventional health and safety SCA at the PWMF met the performance objectives and applicable regulatory requirements. As a result, the PWMF received a "satisfactory" rating, which was reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Performance	Y	Assessed, described below	Y	Assessed, described below

Practices	Y	Assessed, described below	Y	Assessed, described below
Awareness	Y	Assessed, described below	Y	Not rated

Performance

CNSC staff determined that OPG met or exceeded requirements at the PNGS and met them at the PWMF in regards to conventional health and safety performance. OPG kept workers safe from occupational injuries while conducting its licensed activities at the PNGS and PWMF.

Pickering Nuclear Generating Station

OPG reported health and safety related incidents to the CNSC as required by REGDOC-3.1.1.

The accident severity rate (ASR) for the PNGS was 6.4 in 2018, which increased over the 2017 value of 2.8. The accident frequency (AF) for PNGS in 2018 was 0.21. This was higher than the 2017 value of 0.10, but comparable to the five-year average for the PNGS. The number of lost-time injuries (LTIs) for the PNGS in 2018 was 1, compared to 2 lost-time injuries in 2017. CNSC staff found the ASR and AF values for the PNGS in 2018 to be acceptable. Additional data for ASR and AF are provided in section 2.8.

Pickering Waste Management Facility

OPG did not report any health and safety related incidents or LTIs to CNSC staff for the PWMF in 2018. In the course of their inspections, CNSC staff participated in pre-inspection health and safety briefings held with OPG staff and management and found them to be satisfactory.

Practices

CNSC staff determined that conventional health and safety practices met or exceeded the applicable regulatory requirements at the PNGS and met them at the PWMF in 2018. The conventional health and safety work practices and conditions at the PNGS and PWMF continued to achieve a high degree of personnel safety. OPG personnel at all levels exhibited proactive attitudes towards anticipating work-related hazards and preventing unsafe conditions. CNSC staff observed safe work practices during inspections and other activities at the PNGS and PWMF. CNSC staff verified that OPG had appropriate procedures at the PNGS and PWMF to ensure the protection of the environment and the health of persons against hazardous materials.

Awareness

Pickering Nuclear Generating Station

CNSC staff determined that OPG met the applicable regulatory requirements for conventional health and safety awareness in 2018 at the PNGS. Instances of poor housekeeping and other minor deficiencies observed during CNSC field inspections at the PNGS were corrected in a timely manner and no enforcement actions were necessary.

3.2.9 Environmental protection

CNSC staff concluded that the environmental protection SCA at the Pickering site met the performance objectives and applicable regulatory requirements. As a result, the PNGS and PWMF received “satisfactory” ratings - unchanged from the previous year.

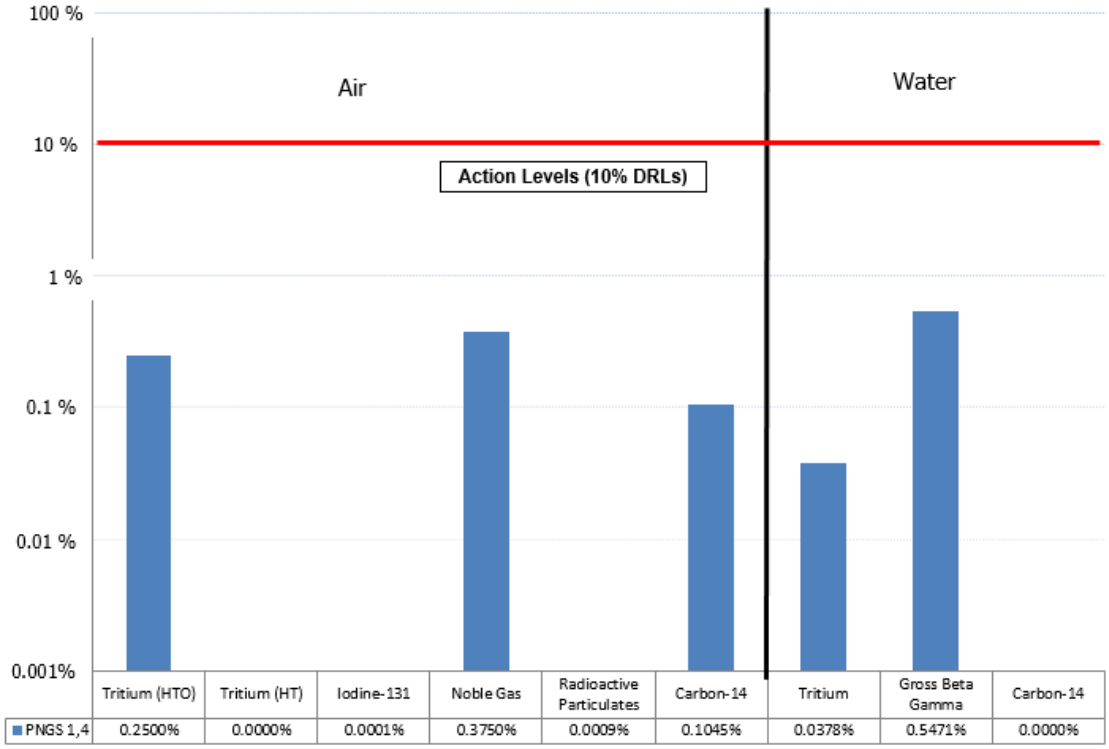
The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Effluent and emissions control (releases)	Y	Assessed, described below	Y	Assessed, described below
Environmental management system	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Assessment and monitoring	Y	Assessed, described below	Y	Assessed, described below
Protection of the public	Y	Assessed, described below	Y	Assessed, described below
Environmental risk assessment	Y	Assessed, described below	Y	Assessed, described below

Effluent and emissions control (releases)

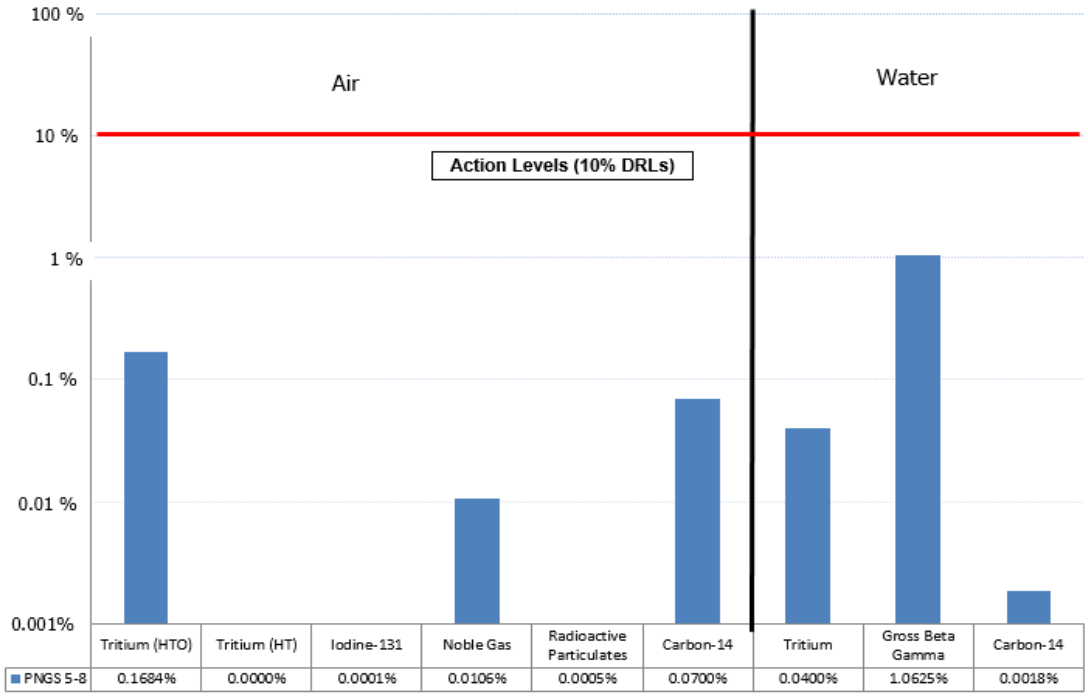
CNSC staff observed that all airborne and waterborne radiological releases from the Pickering site remained below the regulatory limits and environmental action levels (EALs) in 2018. The releases are shown in figures 16 and 17 for PNGS Units 1, 4 and PNGS Units 5-8, respectively, as percentages of the applicable derived release limits (DRLs); the releases for PNGS Units 5-8 include those for the PWMF. The absolute values for the releases and DRLs for the Pickering site are provided in Appendix H.

Figure 16: Effluent and emissions at the PNGS Units 1, 4 as percentages of DRLs



Note: waterborne Carbon-14 for units 1,4 is discharged via PNGS Units 5-8

Figure 17: Effluent and emissions at the PNGS Units 5-8 as percentages of DRLs



Note: includes data for the PWMF and waterborne Carbon-14 discharges from PNGS Units 1,4

In 2018, OPG submitted revised DRLs for the Pickering site; they were in general more restrictive than the previous DRLs. OPG also updated its EALs for the Pickering site. The updated DRLs and EALs became effective January 1, 2019. CNSC staff revised the PNGS LCH to reflect the new values.

OPG completed the implementation of CSA Group standard N288.3.4-13, *Performance testing of nuclear air-cleaning systems at nuclear facilities* in 2018 for both the PNGS and PWMF.

Assessment and monitoring

CNSC staff determined that OPG's programs for assessment and monitoring met the applicable regulatory requirements in 2018. Based on the review of the 2018 environmental monitoring data, CNSC staff concluded that the public and the environment in the vicinity of the site were protected. Control, monitoring, analysis and reporting of environmental data and associated processes were well developed and consistently implemented.

CNSC staff did not conduct independent environmental monitoring around the Pickering site in 2018. The most recent results from 2017 are available on the CNSC's IEMP webpage [http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/pickering.cfm], and indicated that there were no expected health impacts near the Pickering site.

OPG continued satisfactory progress towards implementation of CSA Group standard N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* at the PNGS and PWMF, with a scheduled implementation date of December 31, 2020.

Protection of the public

CNSC staff confirmed that the public in the vicinity of the Pickering site were protected, and that there were no expected health impacts resulting from the operation of the Pickering site in 2018. Dose to the public is discussed in section 3.2.7.

Pickering Nuclear Generating Station

OPG reported four exceedances of provincial hazardous substances limits in 2018. One exceedance was for morpholine concentration, two were for oil and grease, and one was an effluent temperature exceedance. CNSC staff reviewed the details of the events and confirmed that OPG took appropriate corrective action. Staff also determined the environmental risks from these releases to be negligible.

Pickering Waste Management Facility

There were no reported releases of hazardous substances from the PWMF that exceeded the provincial regulatory limits in 2018.

Environmental risk assessment

CNSC staff determined that OPG implemented an effective environmental risk assessment (ERA) and management program at the Pickering site, in accordance with the applicable regulatory requirements.

In 2017, OPG submitted an updated ERA report for the Pickering site to support the licence renewals of the PNGS and the PWMF. CNSC staff confirmed the ERA complied with the applicable regulatory requirements and subsequently conducted a technical review. In early 2018, OPG submitted a revised version of the ERA based on review comments from the CNSC and Environment and Climate Change Canada. CNSC staff concluded that the ERA provided a

complete evaluation of all potential risks to human health and the environment associated with the activities at the Pickering site.

CNSC staff reviewed the 2018 annual compliance report and determined that the conclusions of the ERA remained valid and that OPG had taken adequate measures to protect human health and the environment.

3.2.10 Emergency management and fire protection

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

CNSC staff determined that OPG implemented comprehensive conventional, nuclear and fire emergency response capabilities at all times for the Pickering site. This included personnel and equipment for medical, HAZMAT, search and rescue, and fire response.

OPG conducts training and exercises annually at the Pickering site to ensure all areas of the site have adequate emergency notification and response capability from either the PNGS or the City of Pickering emergency services.

OPG has a written agreement with the City of Pickering to provide emergency response services, with support from site personnel, within the site boundary of the Pickering site (including the PWMF Phase II protected area) but outside the PNGS protected area, for fire, medical, rescue, and HAZMAT events. The support from OPG personnel can include operations, security staff, or emergency response team (ERT) personnel. The PNGS ERT is part of the PNGS minimum shift complement and will respond to events within the PNGS protected area (including the PWMF Phase I), at any time. The PNGS ERT can also provide off-hours investigation to fire alarms within the PWMF protected area with shift manager approval and under stable conditions at the PNGS.

OPG has a facility emergency program for the PWMF that includes radiation response emergency procedures. OPG also incorporates the Consolidated Nuclear Emergency Plan (CNEP) as part of its on-site requirements for nuclear response at the PWMF.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and the PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Conventional emergency preparedness and response	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Nuclear emergency preparedness and response	Y	Assessed, described below	Y	Assessed, described below
Fire emergency preparedness and response	Y	Assessed, described below	Y	Assessed, described below

Nuclear emergency preparedness and response

CNSC staff determined that OPG maintained a comprehensive nuclear emergency preparedness and response capability that met all the applicable regulatory requirements. OPG continued to support offsite emergency management organizations and commitments throughout 2018.

OPG's nuclear emergency preparedness program is documented in the CNEP that governs the Pickering and Darlington sites. In 2018, OPG revised the CNEP to align with the revised 2017 Provincial Nuclear Emergency Response Plan (PNERP) and associated implementing plans. CNSC staff reviewed the revised CNEP and did not identify any areas of concern.

Pickering Nuclear Generating Station

In 2018, CNSC staff conducted field inspections to verify OPG's compliance with its nuclear emergency preparedness and response program. CNSC staff observed a small number of non-compliances of low safety significance in the area of drill conduct and communication with external agencies [PRPD-2018-00806]. CNSC staff were satisfied with OPG's corrective actions by the end of 2018.

Pickering Waste Management Facility

OPG has a facility emergency program for the PWMF that includes radiation response emergency procedures. The PWMF became fully compliant with version 2 of CNSC regulatory document REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* (2016) on December 20, 2018.

Fire emergency preparedness and response

Pickering Nuclear Generating Station

CNSC staff determined that the PNGS implemented a fire protection program in accordance with the applicable regulatory requirements. The PNGS 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 PNGS ERT and the City of Pickering Municipal Fire Department.

During field inspections, CNSC staff observed instances of non-compliance with OPG internal governance dealing with equipment availability and accessibility and fire permits. These were not systemic non-compliances and were considered to be of low safety significance. OPG promptly addressed CNSC findings and no formal enforcement action was required.

CNSC staff's review of the PNGS 2018 annual third party plant condition inspection report confirmed that, overall, the inspection did not identify any significant findings. The submission stated that OPG had enhanced the combustible material safety process that included linking combustible safety to reactor safety and providing additional site fire marshal positions to provide dedicated staff to support fire prevention. However, the assessment was limited in scope and did not fully meet the intent of the applicable requirements for the plant condition inspection. CNSC staff will monitor scope and the effectiveness of the enhancements of combustible material safety in their review of the 2019 annual plant condition assessment.

Pickering Waste Management Facility

CNSC staff determined that OPG met the applicable regulatory requirements for fire emergency preparedness and response for the PWMF.

CNSC staff received an updated package of fire protection assessment documentation from OPG for the PWMF. These third-party submissions included a code compliance review (CCR), fire hazard assessment (FHA), fire protection program (FPP) audit and an annual facility condition inspection report.

CNSC staff observed several findings of low safety significance from their 2018 review of the submitted package. This resulted in comments for the CCR and FHA, discussed below, which required additional technical information from OPG.

Regarding the CCR, CNSC staff were not satisfied with a disposition that OPG provided to a building code deviation. OPG revised the section with additional technical information to clearly address how the intent of the code was met through alternative means. CNSC staff were satisfied with the revision.

Regarding the FHA, CNSC staff requested further technical information from OPG to clarify some highlighted issues regarding the fire safety of a storage area underneath a mezzanine and comments regarding some aspects of the fire scenario models. OPG provided further technical justification to the satisfaction of CNSC staff.

Overall, CNSC staff were satisfied with the level of rigour presented in the fire protection assessment documentation and the dispositions provided to address CNSC staff comments.

In March 2018, CNSC staff conducted an inspection at the PWMF and found that OPG was not conducting the required annual fire drills to test fire response capability [OPG-PWMF-2018-01]. Following subsequent meetings with CNSC staff, OPG committed to conduct a fire drill at each WMF with mutual aid activation. The drill for the PWMF is scheduled for August 2019.

On August 25, 2018, OPG reported a failure of the fire protection system booster panel that rendered a number of beam detectors for smoke detection unavailable in Storage Building #3. OPG stated that there were no environmental, health, safety or security implications for the facility or personnel as a result of this event. Fire watches were implemented on both occasions until the system was repaired. CNSC staff were satisfied with the corrective actions taken by the licensee and subsequently closed the event.

On October 24, 2018, OPG reported that the fire suppression water supply to PWMF had been isolated during maintenance of fire hydrants on the Pickering site. A contingency plan was initiated for the site but it did not include the PWMF. Once the issue was discovered, the PWMF notified the Pickering ERT and a revised contingency plan was issued and implemented. The compensatory measures included restricted hot work and an hourly fire watch by security personnel. CNSC staff were satisfied with the corrective actions taken.

3.2.11 Waste management

CNSC staff concluded that the waste management SCA at the PNGS met the performance objectives and applicable regulatory requirements. As a result, the PNGS received a "satisfactory" rating, which was reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

CNSC staff concluded that the waste management SCA at the PWMF met the performance objectives and applicable regulatory requirements. As a result, the PWMF received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the

PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Waste characterization	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Waste minimization	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Waste management practices	Y	Assessed, described below	Y	Assessed, described below
Decommissioning plans	Y	Assessed, described below	Y	Assessed, described below

Waste management practices

CNSC staff determined that OPG's waste management practices met the applicable regulatory requirements at the PNGS and the PWMF and were effective for both radioactive and hazardous wastes in 2018. OPG used waste management procedures to ensure that waste generated at the facility was managed properly, as noted by CNSC staff during inspections and field verifications in 2018.

Decommissioning plans

The preliminary decommissioning plans (PDPs) for the PNGS and the PWMF met or exceeded the applicable regulatory requirements in 2018. 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. There were no changes made to the PDPs for the PNGS or the PWMF in 2018. 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 the performance objectives and applicable regulatory requirements. As a result, the PNGS and PWMF received "satisfactory" ratings - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Facilities and equipment	Y	Assessed, described below	Y	Assessed, described below
Response arrangements	Y	Assessed, described below	Y	Assessed, but no significant developments
Security practices	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments

Drills and exercises	Y	Assessed, described below	Y	Assessed, but no significant developments

Facilities and equipment

CNSC staff determined that OPG met the applicable regulatory requirements for facilities and equipment at the PNGS and PWMF. OPG continued to sustain its security equipment through lifecycle management and has upgraded its radio system to fully integrate with off-site response. No significant equipment failures were reported to the CNSC in 2018.

Pickering Nuclear Generating Station

Cyber Security

CNSC staff concluded that the cyber security program at the PNGS met the applicable regulatory requirements. OPG continued to update its cyber security program to comply 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 in 2018.

In 2018, CNSC staff inspected the cyber security program at the PNGS with a focus on verifying the design, implementation and maintenance of PNGS's cyber security program. The inspection team concluded that the program complied with the applicable regulatory requirements [PRPD-2018-008]. No enforcement actions were necessary.

Response arrangements

CNSC staff determined that OPG met the applicable regulatory requirements for response arrangements at the PNGS and PWMF in 2018.

Pickering Nuclear Generating Station

CNSC staff conducted four field inspections at PNGS in 2018 that focused on response arrangements and concluded that OPG met the applicable regulatory requirements.

Drills and exercises

CNSC staff determined that OPG's drill and exercise program met the applicable regulatory requirements for the PNGS and PWMF in 2018.

Pickering Nuclear Generating Station

In March 2018, the PNGS conducted its biennial security exercise under the CNSC performance testing program (see section 2.12 for additional information). OPG conducted an effective self-evaluation of the exercise. At the end of 2018, OPG was implementing corrective actions to the satisfaction of CNSC staff.

3.2.13 Safeguards and non-proliferation

CNSC staff concluded that the safeguards and non-proliferation SCA at the Pickering site met the performance objectives and applicable regulatory requirements. As a result, the PNGS and PWMF received "satisfactory" ratings - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Nuclear material accountancy and control	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Access and assistance to the IAEA	Y	Assessed, but no significant developments	Y	Assessed, described below
Operational and design information	Y	Assessed, described below	Y	Assessed, described below
Safeguards equipment, containment and surveillance	Y	Assessed, described below	Y	Assessed, described below

Access and assistance to the IAEA

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

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. See section 2.13 for additional information.

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 Nuclear Generating Station

In September 2018, OPG submitted an updated design information questionnaire for the PNGS. CNSC staff were satisfied with the information provided and concluded that it met CNSC's submission requirements.

UPDATE: CNSC staff forwarded the questionnaire to the IAEA in March 2019.

Safeguards equipment, containment and surveillance

OPG granted access and provided assistance to the IAEA in September 2018 for a site survey to determine potential siting locations of additional IAEA surveillance equipment, with the goal of optimizing the current safeguards approach at the PNGS and PWMF.

3.2.14 Packaging and transport

CNSC staff concluded that the packaging and transport SCA at the Pickering site met the performance objectives and applicable regulatory requirements. As a result, the PNGS and PWMF received "satisfactory" ratings - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the PNGS and PWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	PNGS		PWMF	
	Applicable	Notes	Applicable	Notes
Package design and maintenance	Y	Assessed, described below	Y	Assessed, described below
Packaging and transport	Y	Assessed, described below	Y	Assessed, described below
Registration for use	Y	Assessed, described below	Y	Assessed, described below

Package design and maintenance, packaging and transport, and registration for use

CNSC staff determined that OPG had a packaging and transport program for the PNGS and PWMF that ensured compliance with the *Packaging and Transport of Nuclear Substances Regulations*, *2015* and the *Transportation of Dangerous Goods Regulations*. The program was effectively implemented and the transport of nuclear substances to and from the facilities was conducted in a safe manner.

For on-site movements of nuclear substances, OPG ensured 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.

There were no packaging and transport events reported in 2018 at the Pickering site.

Pickering Waste Management Facility

CNSC staff inspected packaging and transport at the PWMF in 2018 [OPG-PWMF-2018-02] and confirmed that there were no off-site packaging and transport activities taking place at the PWMF.

3.3 Bruce A and B

The Bruce site includes nuclear generating stations at Bruce A and Bruce B. This section presents CNSC staff's safety assessment of Bruce Power's performance at Bruce A and B for each SCA. 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 B, as of December 2018, are listed in Appendix E.

Overall safety assessment

The CNSC staff safety assessment of Bruce A and B for 2018 resulted in the performance ratings shown in table 24.

Table 24: Performance ratings for Bruce A and B, 2018

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**	**FS**
Environmental protection	SA	SA
Emergency management and fire protection	SA	SA
Waste management	SA[1]	SA[1]
Security	SA	SA
Safeguards and non-proliferation	SA	SA
Packaging and transport	SA	SA

Legend: FS – fully satisfactory SA – satisfactory
BE – below expectations UA – unacceptable

Notes: [1] The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

For 2018, CNSC reviewed its criteria for rating the specific areas under the SCAs. Besides assessing licensees against continually evolving requirements, CNS staff also refined its criteria for "fully satisfactory" ratings based on industry best practice. Some SCA ratings that were rated "fully satisfactory" in 2017 have been rated "satisfactory" in 2018 in the context of the revised criteria. The revision of criteria also led to the decision to not include an overall rating for each facility (overall ratings were included in the regulatory oversight report for 2017).

Based on the assessments of the SCAs and other observations in 2018, CNSC staff concluded that Bruce Power operated Bruce A and B safely, upheld its responsibilities for safety and promoted a healthy safety culture.

3.3.0 Introduction

The nuclear generating stations at Bruce A and Bruce B 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, 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 2018.

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 3.4 of this regulatory oversight report.

Licensing

After a two-part public hearing in March and May of 2018, the PROL for Bruce A and B was renewed by the Commission with a period of ten years from October 1, 2018 to September 30, 2028. The PROL encompasses Bruce Power's online operation as well as activities related to the major component replacement (MCR) of Units 3 to 8 (planned to begin in 2020). The Bruce A and B PROL was not amended during the reporting period.

***Fisheries Act* authorization**

In May 2018, Bruce Power provided a revised draft application for a *Fisheries Act* authorization to CNSC. CNSC staff completed a sufficiency review of the draft application in August 2018 and deemed it to be sufficient, providing Bruce Power incorporates the additional information requested by the CNSC and local Indigenous communities. As the consultation coordinator for the Crown, CNSC staff requested that Bruce Power address comments received from the Historic Saugeen Métis (HSM), the Métis Nation of Ontario (MNO) and the Saugeen Ojibway Nation (SON) regarding the *Fisheries Act* authorization application.

In November 2018, Bruce Power submitted a revised application for a *Fisheries Act* authorization to Fisheries and Oceans Canada, which continued discussions with the SON, MNO and HSM on Bruce Power's proposed approach for monitoring fish impingement and entrainment. Bruce Power was also working with the SON on Fisheries and Oceans Canada's monitoring program for

coastal waters. The SON and Bruce Power worked towards completing the plan for monitoring coastal waters throughout 2018, with a goal to commence the program in spring 2019.

Periodic Safety Review

Bruce Power conducted a periodic safety review in support of the 2018 PROL renewal and the planned MCR of Units 3 to 8. Bruce Power developed an integrated implementation plan (IIP) that proposed safety improvements and included timeframes for implementation. In 2018, Bruce Power submitted the first update to the IIP. CNSC staff review confirmed that satisfactory progress was being made on the IIP actions and that six IIP actions were closed.

UPDATE: Bruce Power submitted the annual update for 2018 on the IIP in March 2019. CNSC staff's review of the update resulted in the confirmation of acceptable progress and closure of 15 additional IIP items.

Licence Conditions Handbook

CNSC staff issued a new licence conditions handbook (LCH) for Bruce A and B following the PROL renewal. It was not revised in 2018.

UPDATE: CNSC staff revised the LCH for Bruce A and B on April 1, 2019, identifying various new and revised CNSC regulatory documents and CSA Group standards as sources of either compliance verification criteria or regulatory guidance.

Refurbishment

The MCR project involves Units 3 to 8 and is planned to begin in January 2020 with Unit 6. The MCR project includes replacing major components such as the steam generators, fuel channels and feeders.

In June 2018, Bruce Power submitted its regulatory communications plan for the return to service after MCR for Unit 6. This plan was acceptable to CNSC staff. Additional submissions were made with respect to the MCR project, such as the plan for revising safety analyses and changes to operating limits as a result of isolating Unit 6 from containment.

CNSC staff finalized the compliance verification plan for the Unit 6 MCR project [RIB 14753].

UPDATE: The compliance activities began in January 2019 - one year before the start of the project, with reviews of the processes to manage contractors and the supply chain. No major issues were identified. Oversight of MCR project planning will continue through 2019, followed by oversight of MCR execution beginning in January 2020 when the outage begins.

Event Initial Report

There were two event initial reports [CMD 18-M13, CMD 18-M62] pertaining to the Bruce A and B submitted to the Commission for the period January 1, 2018 to June 1, 2019. Details for these events are provided in table 25.

Table 25: Event initial reports for Bruce A and Bruce B

Subject	Description
Bruce A, Unit 4. failure of the PHT pump seals	On March 4, 2018, while Bruce A Unit 4 was operating, indications of a potential problem were received in the control room. After shutdown of the unit was initiated, a leak developed on the gland seal of primary heat transport (PHT) pump 4 (the leak was related to a design efficiency that is discussed in section 3.3.6). 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 personal protective equipment. The leak was contained in the dyked area. CNSC staff performed a reactive inspection for the pump seal failure [BRPD-A-2018-003]. CNSC staff reviewed Bruce Power's event report as well as additional information provided by Bruce Power and were satisfied with Bruce Power's response. As follow-up, CNSC staff requested Bruce Power to perform a safety analysis for the PHT pump seal failure to demonstrate compliance with REGDOC-2.4.1, *Deterministic Safety Analysis* and confirm that the single-failure dose limit for this event was met. UPDATE: In March 2019, Bruce Power adequately addressed CNSC staff's request, demonstrating that the analysis in the safety report bounded the leak event scenario.
Bruce B Unit 8 station service transformer fire and mineral oil leak	On December 6, 2018, Bruce B experienced a fire at the Unit 8 station service transformer. Unit 8 had been shut down for a scheduled maintenance outage several weeks earlier and was in an over-poisoned guaranteed shutdown state (OPGSS). The automatic deluge fire suppression system activated per design and the Bruce Power onsite fire brigade was deployed. Bruce Power also activated its Emergency Management Centre to provide additional support to the Bruce B response. The brigade brought the fire under control and extinguished it after several hours, but the transformer continued to smolder and required ongoing water spray. The transformer casing cracked and mineral oil, mixed with firefighting water and foam, escaped from the retention basin around the transformer and onto the Bruce site. Bruce Power set up a containment boundary to mitigate the impact to the environment from a possible run-off of mineral oil (the mineral oil does not contain PCBs). Bruce Power promptly began containment and removal of mineral oil, water and foam from the site and monitoring the lake for impact. Bruce Power reported that there was no obvious impact on the lake (i.e., no sheen on water surface observed). Bruce Power notified the Ontario Ministry of Environment, which inspected the site and reported it was satisfied with Bruce Power's containment actions. There was no impact on nuclear systems, no radiological releases and no

	impact on the public as a result of this event. CNSC staff continued to review this event in 2018.

Compliance program

The annual CNSC effort on the compliance program is tabulated in **Error! Reference source not found.** 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 included in table 26 (inspection reports were included if they were sent to Bruce Power by January 31, 2019).

Table 26. List of Bruce A and Bruce B inspections

Safety and control area	Inspection title	Inspection report sent
Management system	Engineering Change Control Report Number: BRPD-AB-2018-004	Jun 20, 2018
	Self and Independent Assessments Report Number: BRPD- AB-2018-332	Dec 12, 2018
Human performance management	Unit 0 CRO Simulator-based Certification Exam Report Number: BRPD-A-2018-005	Sep 27, 2018
	Human Performance Program Report Number: BRPD-AB-2018-005	Jun 21, 2018
	Chemical Technologist and Responsible System Chemists Training Program Report Number: BRPD-AB-2018-00859	Dec 11, 2018
Operating performance	Outage - Planned Unit 1 Report Number: BRPD-A-2018-001	May 14, 2018
	Unit 4 Outage Report Number: BRPD-A-2018-002	Sep 5, 2018
	Bruce A and B Generating Stations Quarterly Field Inspection Report Quarter 4, Fiscal Year 2017-2018 Report Number: BRPD-AB-2018-001	May 15, 2018
	Bruce A and B Generating Stations Quarterly Field Inspection Report Quarter 1, Fiscal Year 2018-2019 Report Number: BRPD-AB-2018-007	Sep 27, 2018
	Bruce A and B Generating Stations Quarterly Field Inspection Report for Q2 2018-19 Report Number: BRPD-AB-2018-0895	Dec 12, 2018
Fitness for service	Class III System Inspection Report Number: BRPD-B-2018-02284	Feb 6, 2019
	Type II inspection on Bruce A Online Maintenance Planning and scheduling Report Number: BRPD-A-2018-00582	Sep 12, 2018
	System Inspection – Low Pressure Service Water	Jul 30, 2018

Safety and control area	Inspection title	Inspection report sent
	Report Number: BRPD-B-2018-00784	
	Bruce B SSC Monitoring Type II Report Number: BRPD-B-2018-01058	Jan 8, 2019
	Class III System Inspection Report Number: BRPD-A-2018-2276	Feb 1, 2018
	Reactive - Bruce A Unit 4 PHT Seal Failure Report Number: BRPD-A-2018-003	May 22, 2018
	Maintenance - Work Execution Report Number: BRPD-B-2018-001	Apr 11, 2018
Environmental protection	Reactive - Fish Impingement Report Number: BRPD-AB-2018-003	Mar 15, 2018
Security	Site Security Inspections - (Rounds) Report Number: BRPD-AB-2018-006	May 3, 2018
Packaging and transport	Packaging and Transport Inspection at NPPs Report Number: BRPD-AB-2018-002	Apr 18, 2018

3.3.1 Management system

CNSC staff concluded the management system SCA at Bruce A and B met the performance objectives and applicable regulatory requirements in 2018. As a result, each station received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Management system	Y	Assessed, described below	Y	Assessed, described below
Organization	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Change management	Y	Assessed, described below	Y	Assessed, described below
Safety culture	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Configuration management	Y	Not rated	Y	Not rated
Records management	Y	Assessed, described below	Y	Assessed, described below
Management of contractors	Y	Assessed, described below	Y	Assessed, described below
Business continuity	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments

Performance assessment, improvement and management review	Y	Assessed, described below	Y	Assessed, described below
Operating experience	Y	Assessed, described below	Y	Assessed, described below

Management system

CNSC staff determined that Bruce Power's management system met the applicable regulatory requirements in 2018. CNSC staff observed that Bruce Power's management system documentation was continuously improved. Bruce Power had historically implemented and complied with the requirements of CSA Group standard N286-05, *Management system requirements for nuclear power plants*. In December 2018, Bruce Power completed the implementation of CSA Group standard N286-12, *Management system requirements for nuclear facilities*.

In March 2018, CNSC staff performed a desktop inspection of the management interview for shift personnel at Bruce A and Bruce B and confirmed compliance with the applicable regulatory requirements. CNSC staff confirmed that Bruce Power's management did a thorough job interviewing the shift personnel in the sample (maintenance staff).

Change management

CNSC staff determined that Bruce Power had an adequate change management program that met the applicable requirements. Bruce Power's management program has established the framework for change management that ensures changes made to the organization, processes, designs, systems, equipment, materials and documents are reviewed before they are implemented. Bruce Power's progress of closing out the remaining design change packages (DCPs) for Units 1 and 2 had a few minor, non-significant issues in 2018.

In 2018, CNSC staff inspected engineering change control (ECC) and human factors in design, and identified areas of improvements related to clarification in process documents related to event investigation [BRPD-AB-2018-004]. At the end of 2018, CNSC staff was monitoring Bruce Power's corrective action plan, which is expected to be completed by 2019.

Records management

CNSC staff determined that Bruce Power implemented a document control and records management system at Bruce A and B that met the applicable regulatory requirements.

Bruce Power adequately rolled out procedural requirements to all relevant staff to address issues related to the quality of records that were identified during previous compliance verification activities. However, minor non-conformances related to records and self-assessments were identified during the subsequent inspection of ECC and human factors in design [BRPD-AB-2018-004]. Bruce Power developed a corrective action plan to address these non-conformances and CNSC staff accepted the plan. The plan included completion of all actions by September 30, 2019. CNSC staff will verify the effectiveness of the corrective actions during future ECC inspections at Bruce Power.

Management of contractors

In 2018, the management of contractors at Bruce A and B met the applicable regulatory requirements. Bruce Power adequately qualified the contractors and performed oversight of their activities, and continued to improve that oversight.

In 2018, Bruce Power completed, to CNSC staff's satisfaction, corrective actions from two previous inspections [BRPD-AB-2015-001 and BRPD-AB-2017-006] to address procedural issues related to contractor management and procurement engineering.

Performance assessment, improvement and management review

CNSC staff confirmed that Bruce Power met the applicable regulatory requirements for performance assessment, improvement, and management review in 2018.

In 2018, CNSC staff inspected self- and independent assessments at Bruce A and B [BRPD-AB-2018-332] and identified some procedural non-compliances, such as those related to the completion of mandatory focus area self-assessments and the specification of some self-assessment tools. Bruce Power was informed of the results of the inspection at the end of 2018, and is expected to develop and implement corrective actions in response to this inspection in 2019.

Operating experience

CNSC staff determined that Bruce Power met the applicable regulatory requirements for operating experience (OPEX) at Bruce A and B in 2018. Bruce Power demonstrated that it identified and implemented OPEX from within its organization and from the Canadian and international nuclear industry.

In 2018, CNSC staff reviewed Bruce Power's implementation of corrective actions for a previous inspection of the OPEX program and confirmed the adequacy of Bruce Power's response. The inspection of self- and independent assessments [BRPD-AB-2018-332] identified some procedural non-compliances related to the independent assessment of recurring problems. As noted above, Bruce Power was expected to develop and implement corrective actions in 2019.

3.3.2 Human performance management

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

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Human performance program	Y	Assessed, described below	Y	Assessed, described below
Personnel training	Y	Assessed, described below	Y	Assessed, described below
Personnel certification	Y	Assessed, described below	Y	Assessed, described below
Initial certification examinations	Y	Assessed, described	Y	Assessed, described

and requalification tests		below		below
Work organization and job design	Y	Assessed, described below	Y	Assessed, described below
Fitness for duty	Y	Assessed, described below	Y	Assessed, described below

Human performance program

CNSC staff determined that Bruce Power's human performance program met the applicable regulatory requirements. Bruce Power continued the development of the initiative "You Can Count on Me. Every Step. Every Time. Every Day" to improve human performance programs at Bruce A and B.

In 2018, CNSC staff inspected the human performance program at Bruce A and B [BRPD-AB-2018-005]. Only positive observations were identified, confirming compliance with the applicable regulatory requirements. There were no ongoing actions identified as result of regulatory oversight activities in 2018.

Personnel training

CNSC staff determined that Bruce Power had a well-documented and robust training system based on a systematic approach to training.

In 2018, CNSC staff performed a desktop inspection of the training program for chemistry personnel at Bruce A and B [BRPD-AB-2018-00859]. CNSC staff requested Bruce Power to address the procedural issues identified during this inspection to ensure that all field checkouts and training materials for the chemistry training program received technical and training quality reviews. CNSC staff noted that Bruce Power adequately addressed all the identified issues and were satisfied with the plan to complete all the corrective actions by December 2019.

Personnel certification

CNSC staff determined that Bruce Power's personnel certification program met the applicable regulatory requirements in 2018. CNSC staff reviewed the staffing reports for certified personnel and the applications for initial certification and renewal of certification, and confirmed that Bruce Power had a sufficient number of personnel at both Bruce A and B for all certified positions. All certified workers 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 the requalification test programs for all certified positions at Bruce A and B met the applicable regulatory requirements in 2018.

In June 2018, CNSC staff performed a desktop inspection of the design and development of a reactor unit comprehensive simulator-based requalification test at Bruce B, which resulted in a non-compliance with the applicable compliance verification criteria for requalification testing for certified shift personnel at NPPs. In August 2018, CNSC staff reviewed Bruce Power's response to address this issue and found it acceptable.

Work organization and job design

The minimum shift complement at Bruce met the applicable regulatory requirements in 2018. Bruce Power had a comprehensive workforce planning process to ensure that an adequate number of workers were maintained for Bruce A and B.

In 2018, Bruce A and B had three reportable events on violations of minimum shift complement; all of them were deemed to have minimal impact on the safe operation of the stations.

Fitness for duty

CNSC staff determined that while Bruce Power met the applicable regulatory requirements for fitness for duty at Bruce A and B in 2018, they exceeded the hours-of-work limits at Bruce A and B for certified staff on numerous occasions in order to maintain the minimum shift complement.

Of particular note were exceedances where certified staff worked over 16 hours in a 24-hr period (one at Bruce A and three at Bruce B). Notwithstanding these exceedances, CNSC staff note that the total number of hours-of-work violations reported at Bruce A and B displayed a significant downward trend over 2017 and 2018. This trend was the result of improvements in the fitness-for-duty programs at both Bruce A and B.

CNSC staff were satisfied with Bruce Power's progress towards the implementation of CNSC regulatory document REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue*, which was completed as of December 31, 2018. CNSC staff were also continuing to monitor hours of work through various compliance activities (e.g., review of licensee quarterly reports, event reports and station condition records, Type II inspections, field inspections and desktop inspections).

Bruce Power was working toward the implementation of two additional CNSC regulatory documents related to fitness for duty: REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* and REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness*. Background information and implementation details are provided in section 2.2. CNSC staff were satisfied with Bruce Power's implementation plans and were monitoring its progress.

3.3.3 Operating performance

CNSC staff concluded that the operating performance SCA at Bruce A and B met or exceeded the performance objectives and applicable regulatory requirements. As a result, each station received a rating of "fully satisfactory" - unchanged for Bruce A and B from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Conduct of licensed activity	Y	Assessed, described below	Y	Assessed, described below
Procedures	Y	Assessed, described below	Y	Assessed, described below
Reporting and trending	Y	Assessed, described below	Y	Assessed, described below
Outage management performance	Y	Assessed, described below	Y	Assessed, described below

Safe operating envelope	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Severe accident management and recovery	Y	Assessed, described below	Y	Assessed, described below
Accident management and recovery	Y	Assessed, described below	Y	Assessed, described below

Conduct of licensed activities

CNSC staff concluded that Bruce Power met or exceeded the applicable regulatory requirements for the conduct of licensed activities at Bruce A and B in 2018. Bruce Power operated Bruce A and B in a safe and secure manner within the bounds of its operating policies and principles (OP&Ps) and operational safety requirements and with adequate regard for health, safety, security, radiation and environmental protection and international obligations.

In 2018, Bruce A experienced one trip, two stepbacks and three setbacks. Bruce B experienced one trip, no stepback and one setback. All transients were controlled properly and power reduction was adequately 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. Bruce Power's target is to operate, on average, with less than one trip for every14,000 hours of operation (based on the industry performance target of less than 0.5 reactor trips per 7,000 hours of operation, which is discussed in section 2.3). Bruce Power met this target and exceeded CNSC staff's expectations by achieving 30,705 hours of operation without a reactor trip.

Procedures

CNSC staff determined that the procedures for Bruce A and B met the applicable regulatory requirements in 2018. CNSC staff determined that Bruce Power had well-defined processes for procedure preparation, review, validation, issuance and revision. Bruce Power had governance to ensure that procedures for Bruce A and B were written in a consistent and usable manner. Bruce Power had clearly documented expectations for procedural use and adherence and a process to manage procedural change at Bruce A and Bruce B.

Reporting and trending

CNSC staff determined that Bruce Power's reporting and trending met or exceeded the applicable regulatory requirements and expectations in 2018 for Bruce A and B. Bruce Power's reporting was generally compliant with CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants.*

During 2018, all scheduled reports were submitted to the CNSC in a timely manner and were adequate.

During 2018, Bruce Power submitted to CNSC 79 event reports in accordance with REGDOC-3.1.1. There was only one instance of a late event report (at Bruce A). All reported events were followed up by Bruce Power with adequate corrective actions and root cause analysis, when appropriate. Two events resulted in event initial reports and are described in table 22.

Outage management performance

CNSC staff concluded that Bruce Power's performance of outage management at Bruce A and B met or exceeded the applicable regulatory requirements and expectations in 2018. CNSC staff observed that Bruce Power demonstrated high levels of performance and achievement of objectives during planned outages.

In 2018, Bruce A had three planned outages and Bruce B had one planned outage. In 2018, Bruce A experienced seven forced outages at its four reactors. Bruce B experienced five forced outages at its four reactors (mostly at Units 2 and 8). There were no process or equipment failures at either station. All forced outages were manual and they were mainly caused by events related to service equipment (main output transformer, bracket in the switchyard and solenoid valve repair). CNSC staff determined that Bruce Power performed all outage-related undertakings safely.

The leak of the PHT pump seal at Unit 4 initiated one of the forced outages at Bruce A (see table 25). CNSC staff performed a reactive inspection [BRPD-A-2018-003] and confirmed that Bruce Power complied with the operational and procedural requirements during the pump seal failure outage.

CNSC staff determined that all outage-related undertakings, including heat sink management at Bruce A and B, were performed safely.

Severe accident management and recovery

CNSC staff determined that Bruce Power maintained a severe accident management program that met the applicable regulatory requirements. In 2018, Bruce Power demonstrated the effectiveness of its severe accident management guidelines through ongoing exercises and plant drills at both Bruce A and B.

In 2018, CNSC staff continued a desktop review of the integrated accident management program and emergency mitigating equipment guidelines at Bruce A and B. CNSC staff planned to complete this review in 2019.

Accident management and recovery

CNSC staff determined that Bruce Power's accident management and recovery programs met the applicable regulatory requirements. There were only positive observations in this area in 2018.

At the inspection of the pump 4 seal failure at Unit 4 [BRPD-A-2018-003], CNSC staff determined that Bruce Power's response complied with the applicable accident management and recovery requirements for the operator actions during the failure. The operations response to the event was appropriate and stopped the leak as quickly as possible.

During the Bruce B Unit 8 fire event on the station service transformer in December 2018 (table 25), CNSC staff confirmed that Bruce Power demonstrated adequate performance of accident management and recovery actions and properly activated its Emergency Management Centre to provide additional support to the Bruce B fire response team. The fire was brought under control and extinguished after several hours. Bruce Power.

3.3.4 Safety analysis

CNSC staff concluded that the safety analysis SCA at Bruce A and B met or exceeded the performance objectives and applicable regulatory requirements. As a result, each station received a "fully satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Deterministic safety analysis	Y	Assessed, described below	Y	Assessed, described below
Probabilistic safety assessment	Y	Assessed, described below	Y	Assessed, described below
Criticality safety	Y	Assessed, described below	Y	Assessed, described below
Severe accident analysis	Y	Assessed, described below	Y	Assessed, described below
Management of safety issues	Y	Assessed, see section 2.4	Y	Assessed, see section 2.4

Deterministic safety analysis

CNSC staff concluded that Bruce Power's deterministic safety analysis predicted adequate safety margins and met or exceeded the applicable regulatory requirements at Bruce A and B in 2018.

Bruce Power had submitted an update of Part 3 of the safety report in December 2017 for both Bruce A and B. It also implemented a safety analysis improvement program with updated procedures designed to comply with CNSC regulatory document REGDOC-2.4.1, *Deterministic Safety Analysis*. In accordance with the requirements in REGDOC-3.1.1, Bruce Power submitted an update of sections of the safety report for both Bruce A and B in February 2018. CNSC staff continued its review of the update in 2018.

In 2018, CNSC staff completed the review of the technical basis documents for common mode events (CMEs) for Bruce A and B. There were no major findings from the review – the CME analysis demonstrated continuous improvement in safety analysis by Bruce Power. At the end of 2018, CNSC staff were reviewing Bruce Power's responses to comments on the analysis.

In 2018, CNSC staff reviewed Bruce Power's submission on updated fire protection assessment (fire protection code compliance review, fire hazard analysis and fire safe shutdown analysis) for Bruce A and B. CNSC staff determined that the fire safety analysis submissions were acceptable and met the applicable regulatory requirements; they also identified some areas for improvement of the reports. The analyses were part of Bruce Power's work to reduce the internal fire risk at Bruce A to below its target value. That work was ongoing at the end of 2018 [RIB 14761].

Probabilistic safety assessment

CNSC staff determined that Bruce Power met or exceeded the applicable regulatory requirements for probabilistic safety assessment (PSA) in 2018.

Bruce Power was in transition to implement CNSC regulatory document REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. In 2018, CNSC staff reviewed and accepted Bruce Power's PSA methodologies and computer codes for REGDOC-2.4.2 compliance. This included the review of the newly developed methodologies to address REGDOC-2.4.2 requirements regarding the consideration of non-reactor radioactive sources, and the different operational states. As part of the transition plan, Bruce Power submitted the new part of the PSA update for REGDOC-2.4.2 compliance in June 2018. Bruce Power also submitted

whole-Site PSA methodologies that were aligned with industry best practice and guidance provided by COG. CNSC staff were reviewing these submissions. Full implementation of REGDOC-2.4.2 was expected by June 2019.

In March 2018, Bruce Power also submitted a policy statement for the treatment of PSA results that meet safety goals targets but not the administrative safety goals. CNSC staff's review concluded that Bruce Power's policy was consistent with the Canadian nuclear industry's practice and that it met CNSC staff's expectations.

Pursuant to the Record of Decision for the PROL renewal, the Commission requested that CNSC staff provide an annual update on progress for the risk reduction plan to reduce the likelihood of internal fires at Bruce A. Bruce Power was reviewing the Bruce A internal fire assessment results for potential improvements. CNSC staff will review this plan and update the Commission as appropriate [RIB 14761].

Criticality safety

CNSC staff determined that Bruce Power's criticality safety program complied with the applicable regulatory requirements. Both the booster fuel assemblies and fuel bundles for the demonstration of low void reactivity fuel were in safe storage. There were no criticality events and no ongoing issues identified at Bruce A and B during 2018.

Severe accident analysis

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

Bruce Power, in collaboration with other licensees, has developed the Severe Accident Software Simulator Solution to improve its methods for the deterministic analysis of multi-unit severe accidents.

3.3.5 Physical design

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

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Design governance	Y	Assessed, described below	Y	Assessed, described below
Site characterization	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Facility design	Y	Not rated	Y	Not rated
Structure design	Y	Assessed, described below	Y	Assessed, described below
System design	Y	Assessed, described below	Y	Assessed, described below
Component design	Y	Assessed, described below	Y	Assessed, described below

Design governance

Bruce Power complied with specific governance requirements in various design-related areas, including environmental qualification, pressure boundary design and human factors in design.

Environmental qualification

In 2018, CNSC field inspections confirmed that Bruce Power adequately maintained the integrity of environmentally-qualified barriers.

Pressure boundary design

In 2018, CNSC staff inspected the implementation of the pressure boundary program, as well as reviewed the authorized inspection agency service agreement with the Technical Standards and Safety Authority. CNSC staff determined that the implementation of the pressure boundary program, for code classification and the design registration reconciliation process, met the applicable regulatory requirements.

Human factors in design

In September 2018, Bruce Power completed a gap analysis and developed an implementation plan to implement CSA standard N290.12-14, *Human factors in design for nuclear power plants* by 2020. In March 2018, CNSC staff confirmed that Bruce Power's updated program on human factors in design complied with N290.12-14 [BRPD-AB-2018-004].

Structure design

Based on compliance activities conducted in 2018, including an inspection of the monitoring of structures, systems and components (SSCs) with a particular focus on system and component health monitoring [BRPD-B-2018-1058], CNSC staff concluded that there were no significant concerns related to SSCs.

System design

CNSC staff concluded that Bruce Power met the applicable regulatory requirements regarding system design in 2018, including those for electrical power systems and fire protection systems.

Electrical power systems

In 2018, Bruce Power continued to upgrade the controls for the standby generators (SGs). The upgrades on the remaining SGs were on schedule and CNSC staff were satisfied with Bruce Power's progress. Bruce Power experienced several reportable events related to SGs testing in 2018. When Bruce Power is at the minimum number of SGs, it is prudent to test the remaining SGs to confirm that they are functional and that safe operation is still supported. The requirements in the OP&Ps do not allow testing when there is a minimum number of SG's available (resulting in a reportable event). CNSC staff agreed to Bruce Power's proposal to revise the OP&Ps to allow testing under those circumstances.

In 2018, CNSC staff inspected the Class III power system [BRPD-A-2018-2276] at Bruce A. CNSC staff did not identify any non-compliances and confirmed that the previously negative trend of the corrective maintenance backlog related to Class III power was improving.

Fire protection systems

In 2018, Bruce Power submitted an update on its seven-year capital project for fire protection.

UPDATE: CNSC staff were satisfied with the project plan and will continue to monitor project execution through the IIP [RIB 14762].

Bruce B experienced one reportable event in 2018 related to a portable generator fire. CNSC staff reviewed the event report and found that Bruce Power's corrective actions in response to the event were acceptable.

Component design

CNSC staff concluded that Bruce Power met the applicable regulatory requirements regarding component design in 2018 for Bruce A and B.

During the licence renewal in 2018, the Commission requested follow-up information on issues related to the performance of certain components and equipment. The resolution of the issues related to the pump seals for the primary heat transport system [RIB 14763 item (i)] is described in table 25.

The Commission also requested information related to heavy water isolation valves in the emergency coolant injection system for Bruce A, stemming from two events where a valve had failed in the open position [RIB 14763 item (ii)]. The first failure occurred in 2015 and was attributed to a vendor control issue, which was subsequently corrected. Although CNSC staff had closed its review of the event, having determined that Bruce Power's response was adequate, staff continued in 2018 to verify the ongoing functioning of the isolation valves. The second failure occurred in 2016 and was partly attributed to vibration in the primary heat transport system [RIB 14763 item (iii)]. Bruce Power made design changes to reduce vibration and also revised safety system tests to align with design requirements. In 2018, a CNSC staff field inspection confirmed that the corrective actions had been adequately implemented.

CNSC staff continued to confirm through compliance verification activities that the pump seals and isolation valves functioned as required and that any other equipment performance issues were being addressed by Bruce Power.

Fuel design

Bruce Power continued to have a mature reactor fuel inspection and monitoring program. CNSC staff were satisfied with the fuel performance results assessed in 2018. Bruce Power operated its reactors within the design and operating limits in its licensing basis. The number of defects observed due to debris fretting at units 1 and 2 of Bruce A have decreased from the highs experienced after their return to service back down to levels comparable with units 3—8. However, the station average defect rate slightly exceeded the CNSC expectation of one defect per unit per year. Overall, CNSC staff determined that Bruce Power adequately managed fuel performance issues while maintaining safe operations.

In 2018, Bruce Power continued to implement corrective action under the IIP to address increased fuel bundle vibration due to acoustically active channels at Bruce B.

Filtered venting

In January 2018, Bruce Power submitted a plan and schedule for the installation of a containment filtered venting system at both Bruce A and B. CNSC staff confirmed that Bruce Power had adequately completed the first milestone (conceptual design and selection of a dry, inline muffler-type venting system). Bruce Power was tracking installation of the system through the IIP.

3.3.6 Fitness for service

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

Refer to section 3.3.0 for Bruce Power's deliverables on the IIP that are related to fitness for service.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Equipment fitness for service / equipment performance	Y	Assessed, described below	N	Assessed, described below
Maintenance	Y	Assessed, described below	Y	Assessed, described below
Structural integrity	Y	Assessed, described below	Y	Assessed, described below
Aging management	Y	Assessed, described below	Y	Assessed, described below
Chemistry control	Y	Assessed, described below	Y	Assessed, described below
Periodic inspection and testing	Y	Assessed, described below	N	Assessed, described below

Equipment fitness for service/equipment performance

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

Bruce Power performed a detailed root cause analysis of the seal failure of the Unit 4 PHT pump (see table 25) and presented the findings to the Commission in 2018. It was determined that there was a design deficiency with the segmented carbon bushing. Its lateral movement with the pump shaft was limited, causing a hard rub. Repairs were completed and the unit was returned to service. CNSC's reactive inspection for the pump seal failure [BRPD-A-2018-003] confirmed that Bruce Power's additional measures to prevent reoccurrence of this event were adequate. CNSC staff will continue monitoring equipment performance at Bruce A and B.

CNSC staff inspected Bruce B's low pressure service water system [BRPD-B-2018-00784] and identified a procedural non-compliance of low safety significance related to system health monitoring. Bruce Power developed a corrective action plan to ensure the accuracy of system health reports, which CNSC staff found acceptable.

In 2018, CNSC staff also inspected the monitoring of SSCs at Bruce B [BRPD-B-2018-1058] and identified only positive observations, confirming compliance with the applicable regulatory requirements.

CNSC staff also 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 2018 with the exceptions of emergency cooling injection (ECI) for Unit 3 and negative pressure containment (NPC) for Unit 4. The ECI system for Unit 3 exceeded the unavailability target because of a faulty limit switch caused by vibration. The NPC system for Unit 4 exceeded the unavailability target because of the removal of airlock dykes during installation of equipment during a planned outage. There was no significant impact on nuclear safety as a result of these unavailabilities. CNSC staff continued to monitor Bruce Power's corrective actions.

For Bruce B Units 5-8, all special safety systems met their unavailability targets in 2018.

Maintenance

CNSC staff determined that Bruce Power's maintenance program met the applicable regulatory requirements in 2018. The maintenance-related inspections and reviews did not identify major issues in 2018.

The average preventive maintenance completion ratios were 88 percent for Bruce A and 89 percent for Bruce B. The maintenance backlog results for Bruce A and B are provided in tables 27 and 28, respectively.

Table 27: Three-year trend of maintenance backlogs and deferrals for critical components for Bruce A, 2016 to 2018

Parameter	Average quarterly work orders per unit			Quarterly 2018 work orders				Industry average for 2018
	2016	2017	2018	Q1	Q2	Q3	Q4	
Corrective maintenance backlog	2	3	0	0	0	0	0	1
Deficient maintenance backlog	123	100	13	14	12	12	15	16
Deferrals of preventive maintenance	12	6	1	0	0	0	1	4

Table 28: Three-year trend of maintenance backlogs and deferrals for critical components for Bruce B, 2016 to 2018

Parameter	Average quarterly work orders per unit			Quarterly 2018 work orders				Industry average for 2018
	2016	2017	2018	Q1	Q2	Q3	Q4	
Corrective maintenance backlog	3	2	0	0	0	0	0	1
Deficient maintenance backlog	165	127	19	28	15	14	18	16
Deferrals of preventive maintenance	14	7	0	0	0	0	1	4

For both Bruce A and Bruce B, Bruce Power reduced its critical maintenance backlogs and the number of deferrals of preventive maintenance for critical components. CNSC staff determined that the maintenance backlogs and number of preventive maintenance deferrals for critical components had low overall safety significance and were therefore acceptable for both Bruce A and B.

Structural integrity

CNSC staff concluded that the SSCs required for safe operation continued to meet the structural integrity requirements established in the design basis or in CNSC accepted standards and guidelines for both Bruce A and B.

In 2018, pressure boundary inspections results were evaluated by Bruce Power to confirm that structural integrity margins were maintained for elements of the primary heat transport and auxiliary systems, steam generators, feeders and pressure tubes. Bruce Power demonstrated that all inspected SSCs were determined to be fit-for-service prior to returning a unit to service following an outage.

Aging management

CNSC staff concluded that Bruce Power's aging management program met the applicable regulatory requirements at Bruce A and B in 2018

Bruce Power is licensed to operate up to 300,000 equivalent full power hours (EFPH) for fuel channels. This is the maximum operational time expected for the units before they begin an MCR outage, during which the fuel channels will be replaced.

Bruce Power's program to support safe operation is required to confirm that fuel channel structural integrity margins are maintained. CNSC staff determined that Bruce Power had adequate programs in place to confirm that fuel channels were fit for service for near-term operation.

In terms of fracture toughness, the CSA Group standards impose two requirements for licensees to i) monitor conditions that might indicate reduced pressure tube toughness and ii) only use pressure tube toughness models within their validity limits. Since the best predictor of reduced pressure tube toughness is hydrogen equivalent concentration (Heq), licensees address requirement i) by monitoring the point at which pressure tubes cross certain thresholds of Heq concentration (e.g., 70 and 100 ppm; see section 2.6). If exceeded, the licensee must satisfy CNSC staff that it understands the number of affected pressure tubes and has plans to mitigate the risk posed by continued operation of those tubes. To address requirement ii), CNSC staff requires that licensees verify the validity limits for their pressure tube toughness models. The Heq limit for industry's current toughness model is 120 ppm.

Bruce Power predicted that some pressure tubes will reach the Heq validity limit of 120 ppm before reaching the licensing limit of 300,000 EFPH of operation. Bruce Power committed to submit a technical basis document for a new fracture toughness model in 2020. The new model will improve on the existing (CNSC-accepted) version by addressing industry OPEX with the latter as well as increasing the Heq validity limit beyond 120 ppm [RIB 14757]. See section 2.6 for background information.

In 2018, CNSC staff reviewed Bruce Power's submission on acceptance of the industry's proposed probabilistic fracture protection methodology and acceptance criteria. CNSC staff found this methodology to be generally acceptable, but concluded that the proposed acceptance criteria could not be immediately accepted and further discussion was required (this applied to all NPPs).

Chemistry control

CNSC staff determined that Bruce Power's chemistry control program met the applicable regulatory requirements for Bruce A and B in 2018.

In 2018, CNSC staff concluded that Bruce A and B adequately maintained its chemistry control program within the applicable regulatory requirements. Its chemistry performance was demonstrated by acceptable values of the "chemistry index" and "chemistry compliance index" performance indicators. Refer to section 2.6 for more details on these performance indicators.

Chemistry control requirements are important for the effective functioning of OPGSS. During the planned outages of Units 1 and 4 in 2018, CNSC staff confirmed that Bruce Power complied with the chemistry control requirement for OPGSS [BRPD-A-2018-001 and BRPD-A-2018-002].

There were no chemistry-related incidents at Bruce A or B in 2018.

Periodic inspections and testing

CNSC staff determined that Bruce Power had adequate and well-maintained periodic inspection programs (PIPs) in place at Bruce A and B for pressure boundary systems, containment components and containment structures.

Bruce Power and the other NPPs have a relief valve testing program to confirm that overpressure protection devices on pressure boundary systems can perform their intended function in the event of operating pressure transients. CNSC staff noted an improvement in the test results for Bruce Power in 2018 - the number of reported relief valve test failures due to seat adhesion on balance of plant pressure boundary systems was down from 25 in 2017 to 5 in 2018.

3.3.7 Radiation protection

CNSC staff concluded that the radiation protection SCA at Bruce A and B met or exceeded the performance objectives and applicable regulatory requirements. As a result, each station received a "fully satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Application of ALARA	Y	Assessed, described below	Y	Assessed, described below
Worker dose control	Y	Assessed, described below	Y	Assessed, described below
Radiation protection program performance	Y	Assessed, described below	Y	Assessed, described below
Radiological hazard control	Y	Assessed, described below	Y	Assessed, described below
Estimated dose to public	Y	Assessed, described below	Y	Assessed, described below

Application of ALARA

CNSC staff concluded that the application of ALARA by Bruce Power met or exceeded applicable regulatory requirements. CNSC staff determined that Bruce Power implemented a highly effective and well-documented program, based on industry best practices, to keep doses to persons as low as reasonably achievable (ALARA) at Bruce A and B. CNSC staff verified that Bruce Power used ALARA initiatives, work planning, and dose monitoring and control to work towards the challenging ALARA targets established at Bruce A and B.

CNSC staff observed that ALARA initiatives were clearly defined and had assigned owners and target completion dates. The implementation and effectiveness of the ALARA initiatives at Bruce A and B and collective radiation exposure performance were tracked by Bruce A and B ALARA committees that hold action holders accountable for meeting targets. Bruce Power regularly reported its progress on implementing ALARA initiatives to the CNSC.

In 2018, Bruce Power met its year-end collective radiation exposure (CRE) target. The largest contributor to CRE at Bruce A and B was the outage-related work (approximately 91%). Bruce Power performed better than its collective dose targets for both planned outages and on-line operations.

Worker dose control

CNSC staff determined that Bruce Power met or exceeded the applicable regulatory requirements to measure and record doses received by workers at Bruce A and B. Compliance verification activities conducted in 2018 indicated that worker dose control was highly effective [BRPD-AB-2018-001, BRPD-A-2018-001, BRPD-AB-2018-007 and BRPD-AB-2018-0895].

In 2018, radiation doses to workers were below the regulatory dose limits and action levels established in the Bruce Power radiation protection program. The individual and collective dose information for workers at Bruce A and B is provided in section 2.7. CNSC staff observed that there were no adverse trends or safety-significant unplanned exposures due to the licensed activities at Bruce A and B. Additionally, there were no event reports related to worker dose control in 2018.

Radiation protection program performance

CNSC staff determined that the Bruce Power radiation protection program met or exceeded the applicable regulatory requirements. CNSC staff confirmed that Bruce Power continually measured the performance of its radiation protection program against industry-established objectives, goals and targets.

Bruce Power's radiation protection program documents and supporting procedures were updated on a regular basis, taking into account (OPEX) and industry best practices. Additionally, improvements to the program were made using self-assessments and effectiveness reviews. CNSC staff concluded that the oversight applied by Bruce Power in implementing and improving the radiation protection program was effective in protecting workers at Bruce A and B in 2018. CNSC staff determined that there were no adverse trends or safety-significant findings associated with this specific area.

Radiological hazard control

CNSC staff determined that Bruce Power implemented radiological hazard controls that met or exceeded the applicable regulatory requirements.

There were no action level exceedances for surface contamination identified at Bruce A and B in 2018. The performance indicators in the radiological hazard control area for Bruce A and B showed that both stations achieved their targets for personal contamination events. Good performance was also noted for loose contamination events.

Compliance verification activities in 2018 indicated highly effective radiological hazard control at the Bruce A and B [BRPD-AB-2018-001, BRPD-A-2018-001, BRPD-A-2018-002, BRPD-AB-2018-007 and BRPD-AB-2018-0895].

Estimated dose to the public

CNSC staff determined that Bruce Power ensured the protection of the public in accordance with the *Radiation Protection Regulations*. In 2018, the reported estimated dose to the members of the public from the Bruce site was 0.0017 mSv, well below the annual public dose regulatory limit of 1 mSv. See section 2.7 for additional data.

3.3.8 Conventional health and safety

Bruce Power continued to implement and maintain a safe conventional health and safety program at Bruce A and B in accordance with provincial and federal regulatory requirements. CNSC staff concluded that the conventional health and safety SCA at Bruce A and B met or exceeded the

applicable regulatory requirements. As a result, Bruce A and B received "fully satisfactory" ratings - unchanged from the previous year for Bruce A and improved for Bruce B, where it was satisfactory in 2017.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Performance	Y	Assessed, described below	Y	Assessed, described below
Practices	Y	Assessed, described below	Y	Assessed, described below
Awareness	Y	Assessed, described below	Y	Assessed, described below

Performance

CNSC staff determined that Bruce Power met or exceeded the applicable regulatory requirements for conventional health and safety performance in 2018. Health and safety related events were promptly reported by Bruce Power to the CNSC on an ongoing basis.

The "accident severity rate" (ASR) performance indicator for Bruce A and B decreased from 2.8 in 2017 to 1.2 in 2018 (the number of "calendar days lost" at Bruce A and B decreased significantly from 116 in 2017 to 49 in 2018). The "accident frequency" (AF) performance indicator for Bruce A and B decreased from 0.46 in 2017 to 0.38 in 2018. CNSC staff found the ASR and AF values at Bruce A and B to be acceptable. Additional descriptions of AF and ASR data are provided in section 2.8.

Practices

CNSC staff determined that conventional health and safety practices met or exceeded regulatory requirements at Bruce A and B in 2018. CNSC staff activities confirmed that the conventional health and safety work practices and conditions at Bruce A and B continued to achieve a high degree of personnel safety.

Awareness

CNSC staff determined that Bruce Power's awareness met or exceeded the applicable regulatory requirements in 2018 at Bruce A and B. All deficiencies noted during inspections were adequately addressed throughout the year. CNSC staff also noticed improved housekeeping at Bruce A and B in 2018.

3.3.9 Environmental protection

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

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Effluent and emissions control (releases)	Y	Assessed, described below	Y	Assessed, described below
Environmental management system	Y	Assessed, described below	Y	Assessed, described below
Assessment and monitoring	Y	Assessed, described below	Y	Assessed, described below
Protection of the public	Y	Assessed, described below	Y	Assessed, described below
Environmental risk assessment	Y	Assessed, described below	Y	Assessed, described below

Effluent and emissions control (releases)

CNSC staff observed that all airborne and waterborne radiological releases from Bruce A and B remained below the regulatory limits and action levels in 2018. The releases are shown in figures 18 and 19 for Bruce A and B, respectively, as percentages of the applicable derived release limits (DRLs). The absolute values of the releases and DRLs are provided in Appendix H.

Figure 18: Effluent and emissions at Bruce A as percentages of DRLs

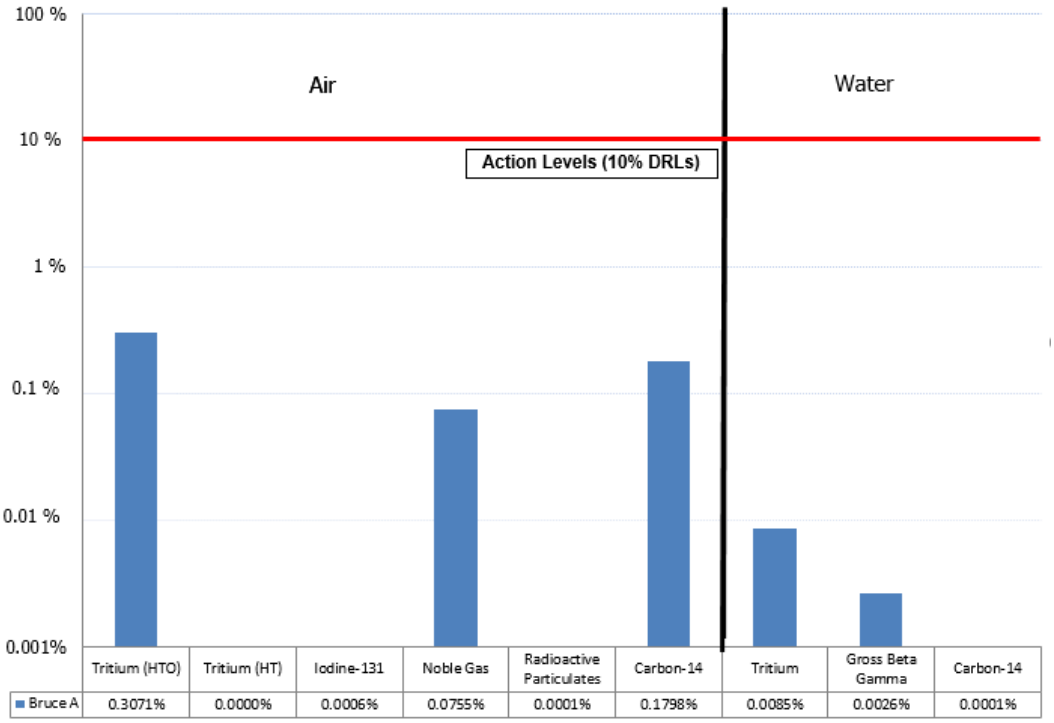
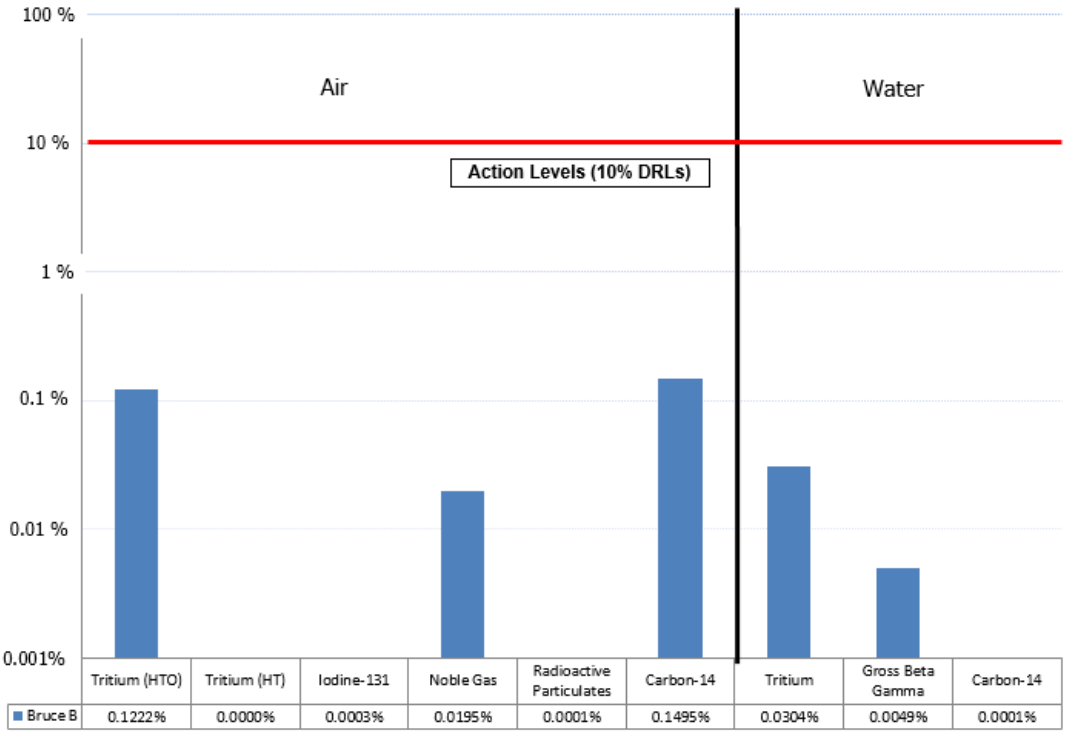


Figure 19: Effluent and emissions at Bruce B as percentages of DRLs



Bruce Power implemented CSA Group Standard N288.5-11, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills* by December 31, 2018.

Environmental management system

CNSC staff determined that environmental risks associated with its nuclear activities were adequately assessed. Bruce Power implemented an environmental management program in accordance with CNSC regulatory document REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures* (2013) to prevent or mitigate adverse environmental effects at Bruce A and B. Bruce Power plans to implement the 2017 revision of REGDOC-2.9.1 by December 31, 2020.

Assessment and monitoring

CNSC staff determined that Bruce Power's programs for assessment and monitoring met the applicable regulatory requirements in 2018. CNSC staff confirmed that control, monitoring, analysis and reporting of environmental data and associated processes were well-developed and consistently implemented. Bruce Power implemented CSA Group standard N288.4-10, *Environmental monitoring programs at class I nuclear facilities and uranium mines and mills* at the end of 2018.

Based on the review of the 2018 environmental monitoring data, CNSC staff concluded that the public and the environment in the vicinity of Bruce Power were protected.

CNSC staff did not conduct independent environmental monitoring around Bruce A and B in 2018. The most recent results from 2016 are available on the CNSC's IEMP webpage

(http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/bruce.cfm), and indicated that there were no expected health impacts in the vicinity of Bruce A and B.

In February 2018, CNSC staff inspected the monitoring of fish impingement [BRPD-AB-2018-003] and identified a need to ensure that only qualified workers perform impingement monitoring. In August 2018, CNSC staff confirmed that all corrective actions were adequately implemented by Bruce Power. Overall, CNSC staff concluded that the monitoring program met the applicable requirements and that fish populations were adequately protected at Bruce A and B.

Bruce Power continued satisfactory progress in 2018 towards full implementation of CSA Group standard N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* by December 31, 2020.

Protection of the public

CNSC staff confirmed that the public in the vicinity of the Bruce site was protected from hazardous substances and that there were no expected health impacts from operations in 2018.

In 2018, CNSC staff observed two minor toxicity exceedances and one ammonia exceedance of the provincial regulatory limits at Bruce A and 1 ammonia exceedance of these limits at Bruce B. CNSC staff confirmed that Bruce Power took appropriate corrective actions to prevent recurrence.

Dose to the public is discussed in section 3.3.7.

Environmental risk assessment

CNSC staff determined that Bruce Power implemented an effective environmental risk assessment (ERA) at the Bruce site in accordance with the applicable regulatory requirements.

In June 2017, Bruce Power submitted an updated ERA to meet the requirements in CSA Group standard N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*. Bruce Power submitted revisions to the ERA in October 2017 and December 2018 to address comments from CNSC and Environment and Climate Change Canada. CNSC staff concluded that Bruce Power had taken adequate measures to protect human health and the environment.

3.3.10 Emergency management and fire protection

CNSC staff concluded that the emergency management and fire protection SCA at Bruce A and B met the performance objectives and applicable regulatory requirements. As a result, each station received a “satisfactory” rating - unchanged from the previous year.

CNSC staff determined that Bruce Power implemented comprehensive conventional, nuclear and fire emergency response capabilities at all times for Bruce A and B. This included personnel and equipment for medical, HAZMAT, search and rescue, and fire response.

Bruce Power conducts training and exercises annually to ensure the facilities have adequate emergency notification and response capability. The Bruce Power emergency response team (ERT) is part of the shift minimum complement and will respond to events within the Bruce Power protected area (including the WWMF) at any time.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Conventional emergency preparedness and response	Y	Assessed, described below	Y	Assessed, described below
Nuclear emergency preparedness and response	Y	Assessed, described below	Y	Assessed, described below
Fire emergency preparedness and response	Y	Assessed, described below	Y	Assessed, described below

Nuclear emergency preparedness and response

CNSC staff determined that Bruce Power maintained a comprehensive nuclear emergency preparedness and response capability that met all applicable regulatory requirements.

Bruce Power was transitioning to compliance with CNSC regulatory document REGDOC-2.10.1, Version 1, *Nuclear Emergency Preparedness and Response* by a target date of December 31, 2018.

UPDATE: Bruce Power became fully compliant with REGDOC-2.10.1, version 1 in February 2019.

Bruce Power implemented the disaster LAN (DLAN) electronic data management system in 2018. In response to a CNSC staff request in 2017, per sub-section 12(2) of the *General Nuclear Safety and Control Regulations*, Bruce Power committed to investigate options for automatic connectivity between plant data systems and the electronic data transfer system. In 2018, Bruce Power started to investigate options for this automated connectivity.

UPDATE: In 2019, Bruce Power was preparing to submit its feasibility assessment of DLAN or Non-DLAN options for automatic electronic data transfer to the CNSC [RIB 14755].

Bruce Power continued to support offsite emergency management organizations and commitments throughout 2018.

UPDATE: In 2019, Bruce Power was planning a full-scale emergency exercise named Huron Resilience. This exercise will test Bruce Power's ability to respond to a full-scale nuclear emergency with the involvement of federal, provincial and municipal partners.

Fire emergency preparedness and response

CNSC staff determined that Bruce Power implemented a 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 at the Bruce site for live fire training.

In December 2018, Bruce B experienced a fire at Unit 8 when the station service transformer had an instantaneous fault that resulted in a fire and automatic isolation (see table 25). The fire was extinguished by the deluge system, as designed. At the end of 2018, Bruce Power was conducting a root cause analysis and CNSC staff were reviewing the details of the event and response. All aspects of the emergency response were considered adequate. The Ontario Ministry of Environment inspected the site and reported that it was satisfied with Bruce Power's containment actions.

In 2018, Bruce Power continued its radio system replacement and updates to radio communications to address issues identified in an earlier fire drill at Bruce A and B. The

initiation, development and definition phases were completed in 2018. CNSC staff were satisfied with the progress of the improvements in 2018. Radio field installation will progress throughout 2019 and 2020; Bruce Power's update on the project status and schedule is expected in September 2019.

3.3.11 Waste management

CNSC staff concluded that the waste management SCA at Bruce A and B met the performance objectives and applicable regulatory requirements. As a result, each station received a "satisfactory" rating, which was reassessed from the "fully satisfactory" ratings of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Waste characterization	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Waste minimization	Y	Assessed, described below	Y	Assessed, described below
Waste management practices	Y	Assessed, described below	Y	Assessed, described below
Decommissioning plans	Y	Assessed, described below	Y	Assessed, described below

Waste minimization

CNSC staff determined that Bruce Power's waste management program for minimizing radioactive waste met the applicable regulatory requirements. There were mainly positive observations from field inspections in this area in 2018, which confirmed that all radioactive waste was properly bagged and located in proper laydown areas.

Waste management practices

CNSC staff determined that Bruce Power's waste management practices met the applicable regulatory requirements and were effective for both radioactive and hazardous waste in 2018. Bruce Power implemented waste management procedures to ensure that waste generated at the facility was properly separated. A CNSC staff field inspection also confirmed that Bruce Power met the requirements for the transfer of radioactive waste at Bruce A and B [BRPD-AB-2018-0895].

Bruce Power implemented CSA Group standard N292.3-14, *Management of low- and intermediate-level radioactive waste* by October 2018.

Decommissioning plans

As the owner of the site, OPG is responsible for maintaining the decommissioning plans for Bruce A and B,. In 2017, the preliminary decommissioning plans (PDPs) and associated financial guarantees had been revised for the period up to 2022. The PDPs for Bruce A and B met or exceeded the applicable regulatory requirements in 2018.

A deferred decommissioning strategy was selected for the decommissioning of Bruce A and B. The associated financial guarantees are discussed in section 2.15.

3.3.12 Security

CNSC staff concluded that the security SCA at the Bruce A and B sites met the performance objectives and applicable regulatory requirements. As a result, Bruce A and B received "satisfactory" ratings in 2018 - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Facilities and equipment	Y	Assessed, described below	Y	Assessed, described below
Response arrangements	Y	Assessed, described below	Y	Assessed, described below
Security practices	Y	Assessed, described below	Y	Assessed, described below
Drills and exercises	Y	Assessed, described below	Y	Assessed, described below

Facilities and equipment

CNSC staff determined that Bruce Power met the applicable regulatory requirements for facilities and equipment at Bruce A and B. Bruce Power continued to sustain its security equipment through life cycle management at Bruce A and B. No significant equipment failures were reported to the CNSC in 2018.

Cyber Security

CNSC staff concluded that the cyber security program at Bruce A and B met the applicable regulatory requirements.

Bruce Power continued to update its cyber security program at Bruce A and B to comply with CSA Group standard N290.7-14, Cy*ber security for nuclear power plants and small reactor facilities* by December 31, 2020. CNSC staff reviewed the annual update on the implementation of N290.7-14 and determined that Bruce Power's overall implementation progress was acceptable and on target.

Response arrangements

CNSC staff concluded that Bruce Power met the applicable regulatory requirements for response arrangements in 2018. CNSC staff confirmed that most observations related to response arrangements noted during the 2018 security exercise were addressed satisfactorily. CNSC staff were satisfied with the progress towards resolution of the remaining observations.

In May 2018, CNSC staff inspected security [BRPD-AB-2018-006] and did not identify any non-compliances.

Security practices

CNSC staff determined that Bruce A and B implemented security practices that met the applicable regulatory requirements in 2018. Bruce Power had a multifaceted security awareness program that was fully integrated into its governance process. CNSC staff concluded that there were no safety-significant issues for this specific area.

In 2018, Bruce Power introduced a new electronic hand-held database tracking tool, which was being utilized by the nuclear response force personnel while conducting security patrols of vital areas. This tool provided the opportunity for immediate deficiency reporting and work order initiation related to security practices, facilities and equipment.

Drills and exercises

CNSC staff determined that Bruce Power's drill and exercise program met the applicable regulatory requirements in 2018.

Bruce Power conducted its biennial security exercise under the CNSC performance testing program in March 2018 and conducted an effective self-evaluation. At the end of 2018, Bruce Power was implementing appropriate corrective actions to the satisfaction of CNSC staff.

3.3.13 Safeguards and non-proliferation

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

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	BRUCE A		BRUCE B	
	Applicable	Notes	Applicable	Notes
Nuclear material accountancy and control	Y	Assessed, but no significant developments	Y	Assessed, but no significant developments
Access and assistance to the IAEA	Y	Assessed, described below	Y	Assessed, described below
Operational and design information	Y	Assessed, described below	Y	Assessed, described below
Safeguards equipment, containment and surveillance	Y	Assessed, described below	Y	Assessed, described below

Access and assistance to the IAEA

Pursuant to the Canada/IAEA safeguards agreements and the facility's licence condition, Bruce Power granted adequate access and assistance to the IAEA for safeguards activities, including inspections and the maintenance of equipment, at Bruce A and B. See section 2.13 for additional details and a description of the verification activities conducted.

Operational and design information

CNSC staff confirmed that Bruce Power met the applicable regulatory requirements for operational and design information for Bruce A and B. See section 2.13 for additional information.

Bruce Power submitted its annual operational program with quarterly updates for 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. CNSC staff were satisfied with the information provided and concluded that it met CNSC's submission requirements.

Bruce Power submitted an updated design information questionnaire for both Bruce A and Bruce B in 2018. CNSC staff were reviewing the information provided.

Safeguards equipment, containment and surveillance

Bruce Power granted access and provided assistance to the IAEA in September 2018 for a site survey to determine potential siting locations of additional IAEA surveillance equipment, with the goal of optimizing the current safeguards approach at Bruce and B.

3.3.14 Packaging and transport

CNSC staff determined that Bruce Power had a packaging and transport program for Bruce A and B that ensured compliance with the *Packaging and Transport of Nuclear Substances Regulations*, 2015 and the *Transportation of Dangerous Goods Regulations*. The program was effectively implemented and the transport of nuclear substances to and from the facility was conducted in a safe manner. As a result, Bruce Power received "satisfactory" ratings - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Bruce A and B and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Bruce A		Bruce B	
	Applicable	Notes	Applicable	Notes
Package design and maintenance	Y	Assessed, described below	Y	Assessed, described below
Packaging and transport	Y	Assessed, described below	Y	Assessed, described below
Registration for use	Y	Assessed, described below	Y	Assessed, described below

Package design and maintenance, packaging and transport and registration for use

In 2018, CNSC staff conducted a field inspection of packaging and transport and a Type II inspection of the transport and packaging of Class 7 materials at Bruce A and B [BRPD-AB-2018-002]. CNSC staff verified that all employees who were engaged in transport-related activities were adequately trained, radioactive materials to be transported were appropriately classified and packaged, all safety markings were appropriately displayed on packages and the documentation accompanying the shipments was properly completed.

No items of non-compliance were noted during the field inspection. CNSC staff noted four non-compliances during the Type II inspection, which were administrative in nature and had no safety significance. CNSC staff were satisfied with Bruce Power's actions to prevent recurrence.

3.4 WWMF and RWOS-1

The licensed site consists of the Western Waste Management Facility (WWMF) and the Radioactive Waste Operations Site-1 (RWOS-1). This section presents CNSC staff's assessment of OPG's performance at the WWMF and RWOS-1 for each SCA. 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 2018, are listed in Appendix E. RWOS-1 has a different set of regulatory requirements than the WWMF due to its lower risk (they are listed in the licence for RWOS-1).

Unless stated otherwise, CNSC staff assessments and conclusions provided in this section regarding the WWMF also pertain in general to RWOS-1.

Overall CNSC staff assessment

The CNSC staff assessment of OPG's performance at the WWMF and RWOS-1 for 2018 resulted in the performance ratings shown in table 29.

Table 29: Performance ratings for the WWMF and RWOS-1, 2017

Safety and control area	Rating
Management system	SA
Human performance management	SA
Operating performance	SA[1]
Safety analysis	SA[1]
Physical design	SA
Fitness for service	SA
Radiation protection	SA
Conventional health and safety	SA[1]
Environmental protection	SA
Emergency management and fire protection	SA
Waste management	SA
Security	SA
Safeguards and non-proliferation	SA
Packaging and transport	SA

Legend: FS – fully satisfactory SA – satisfactory
BE – below expectations UA – unacceptable

Notes: [1] The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

For 2018, CNSC staff reviewed the criteria for rating the specific areas under the SCAs. Besides assessing licensees against continually evolving requirements, CNSC staff also refined its criteria for "fully satisfactory" ratings based on industry best practice. Some ratings that were rated "fully satisfactory" in 2017 have been rated "satisfactory" in 2018 in the context of the revised criteria. The revision of criteria also led to the decision to not include an overall rating for each facility (overall ratings were included in the regulatory oversight report for 2017).

Based on the assessments of the SCAs and other observations in 2018, CNSC staff concluded that OPG operated the WWMF and RWOS-1 safely, upheld its responsibilities for safety and promoted a healthy safety culture.

3.4.0 Introduction

The WWMF and RWOS-1 are located at the site of the nuclear generating stations at Bruce A and Bruce B on the east shore of Lake Huron, in Tiverton, Ontario, 20 kilometers northeast of Kincardine and 30 kilometers southwest of Port Elgin. The CNSC regulates the WWMF under a waste facility operating licence (WFOL) and the RWOS-1 under a waste nuclear substance licence (WNSL). The WWMF and RWOS-1

are owned and operated by OPG.

At the WWMF, OPG processes and stores dry storage containers (DSCs) containing used nuclear fuel (high-level radioactive waste) generated solely at Bruce A and B. At this facility, OPG also manages the low- and intermediate-level radioactive wastes (L&ILW) generated from the operation of OPG-owned facilities including the DNGS, DWMF, PNGS, PWMF, Bruce A and B, and WWMF. Finally, OPG manages the L&ILW generated from the refurbishment of Bruce A at the WWMF.

The WFOL for the WWMF allows limited activities of import and export of nuclear substances, which occur primarily as contaminants in laundry, packaging, shielding or equipment.

The WFOL spans two separate areas - the L&ILW Storage Facility and the 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 ILW. The UFDSF is located within its own protected area, separate from the protected area of Bruce A and B, but within the boundary of the Bruce site. The UFDSF contains one DSC processing building and four DSC storage buildings (Storage Buildings #1, #2, #3, and #4). The WWMF currently has the capacity to store 2,000 DSCs. The transfer of loaded DSCs from Bruce A and B to the WWMF is conducted on property controlled by Bruce Power and OPG, with a security escort.

Under the WFOL for the WWMF, OPG is authorized to construct four additional DSC storage buildings (Storage Buildings #5, #6, #7 and #8), 11 additional LLSBs, 270 additional in-ground containers, 30 in-ground containers for heat exchangers, one large-object processing building, and one waste sorting building. The new structures will provide additional storage for used nuclear fuel and additional storage and processing facilities to manage L&ILW.

At RWOS-1, OPG stores L&ILW generated at the Douglas Point Nuclear Generating Station and PNGS Units 1-4. The RWOS-1 site comprises a number of in-ground waste storage structures, including concrete-lined trenches and steel-lined concrete holes.

Licensing

Following a public hearing on April 12, 2017, the Commission renewed the WFOL for the WWMF for a period of 10 years until May 31, 2027. The WNSL for RWOS-1 is indefinite, i.e., it has no expiry date. No licensing actions were conducted for the WWMF or RWOS-1 in 2018.

License Conditions Handbook

The licence conditions handbook (LCH) for the WWMF was not revised in 2018. However, OPG implemented several CNSC REGDOCs and CSA Group standards in 2018. Future revisions of the LCH will reflect those new publications (or new versions of existing publications) as sources of compliance verification criteria for the WWMF.

The RWOS-1 licence does not currently have an associated LCH.

Event initial reports

No event initial reports pertaining to the WWMF or RWOS-1 were submitted to the Commission for the period January 1, 2018 to June 1, 2019.

Compliance program

The annual CNSC effort on the compliance program is tabulated in **Error! Reference source not found.** for the WWMF and RWOS-1. The inspections conducted at the WWMF and RWOS-1 that were considered in CNSC staff assessments in this regulatory oversight report are included in table 30 (inspection reports were included if they were sent to OPG by January 31, 2019).

Table 30. List of inspections at the WWMF and RWOS-1

Safety and control area	Inspection title	Inspection report sent
Operating performance	Western Waste Management Facility Baseline Inspection Fourth Quarter FY 2017/2018 Report Number: OPG-WWMF-2018-01	July 25, 2018
	Western Waste Management Facility Baseline Inspection First Quarter FY 2018/2019 Report Number: OPG-WWMF-2018-02	July 13, 2018
	Western Waste Management Facility Baseline Inspection Second Quarter FY 2018/2019 Report Number: OPG-WWMF-2018-03	November 29, 2018
	Radioactive Waste Operations Site-1 Baseline Inspection Second Quarter FY 2018/2019 Report Number: OPG-RWOS-1-2018-01	November 2, 2018
Radiation protection	Western Waste Management Facility Focused Radiation Protection Inspection Fourth Quarter FY 2017/2018 Report Number: OPG-WWMF-2018-01	July 25, 2018
Emergency	Western Waste Management Facility Focused Emergency	July 25, 2018

Safety and control area	Inspection title	Inspection report sent
management and fire protection	Management and Fire Protection Inspection Fourth Quarter FY 2017/2018 Report Number: OPG-WWMF-2018-01	

3.4.1 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Management system	Y	Assessed, described below
Organization	Y	Assessed, described below
Change management	Y	Assessed, but no significant developments
Safety culture	Y	Not rated
Configuration management	Y	Not rated
Records management	Y	Assessed, but no significant developments
Management of contractors	Y	Assessed, described below
Business continuity	Y	Not rated
Performance assessment, improvement and management review	Y	Assessed, but no significant developments
Operating experience	Y	Assessed, but no significant developments

Management system

CNSC staff determined that OPG's nuclear management system at the WWMF met the applicable regulatory requirements in 2018. Note that OPG's management system is integrated for its NPPs and WMFs, so any issues or improvements identified in this report for other OPG facilities may also be relevant to the WWMF.

In 2018, OPG submitted the safety analysis summary for receipt, handling and storage of Bruce Power major component replacement retube and steam generator waste for the WWMF. CNSC staff identified issues of low safety significance (references were not listed, details were missing and directions in the documentation were not clear). At the end of 2018, CNSC staff were continuing their review of additional information received from OPG to address CNSC staff's concerns.

Organization

CNSC staff determined that OPG had adequately defined organizational structures and established roles and responsibilities at the WWMF. However, during an inspection [OPG-

WWMF-2018-01], CNSC staff observed that OPG did not define the roles and responsibilities for health physicists (as is done for NPP responsible health physicists). At the end of 2018, CNSC staff were monitoring the progress of OPG's corrective actions.

Management of contractors

In 2018, OPG's management of its contractors at the WWMF met the applicable regulatory requirements.

In the regulatory oversight report for 2017 ROR, CNSC staff had reported on the lack of inspection at the manufacturer's sites for DSCs. In 2018, OPG reviewed the quality assurance documentation for all affected DSCs and informed the CNSC that there were no safety, transportability, or structural integrity issues with those DSCs. At the end of 2018, CNSC staff were monitoring the completion of the corrective actions, which were expected to be completed in 2019. CNSC staff were satisfied with the progress in 2018.

During a general compliance inspection [OPG-WWMF-2018-03], CNSC staff observed that a contractor did not use signage and barricades to secure a work area. OPG corrected the issue to the satisfaction of CNSC staff.

3.4.2 Human performance management

CNSC staff concluded that the human performance management 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Human performance program	Y	Assessed, described below
Personnel training	Y	Assessed, described below
Personnel certification	N	No CNSC-certified positions
Initial certification examinations and requalification tests	N	No CNSC-certified positions
Work organization and job design	N	No minimum shift complement requirements
Fitness for duty	Y	Not rated, but is described below

Human performance program

CNSC staff determined that OPG's human performance program met the applicable regulatory requirements in 2018 for the WWMF. In 2018, CNSC staff identified some non-compliances of low safety significance related to human performance (e.g., the visual survey data system was not current, a waste disposal bag had non-visible labelling, etc.). CNSC staff were satisfied with OPG's corrective action plans for the non-compliances and confirmed that the corrective actions were all competed in 2018.

Personnel training

CNSC staff determined that OPG had a robust and well-documented, fleet-wide training system based on a systematic approach to training.

CNSC staff did not conduct any training-specific inspections at the WWMF in 2018. However, a general Type II inspection [OPG-WWMF-2018-03] identified that worker training records met the applicable regulatory requirements.

Fitness for duty

CNSC staff requested OPG to provide an implementation plan for CNSC regulatory document 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 were monitoring its progress.

CNSC staff requested OPG to provide an implementation plan for CNSC regulatory document REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* by March 31, 2018. However, at the WWMF, although staff are predominantly OPG employees, personnel affected by this REGDOC are all employees of Bruce Power and thus will be subject to the Bruce Power implementation plan. Bruce Power/OPG proposed to implement REGDOC-2.2.4 Volume II requirements within a period following the date of the amendment of the REGDOC (or from the date it is determined that the REGDOC will not be amended). The licensees proposed, specifically, to implement the requirements other than random testing within 6 months of that date, and to implement random alcohol and drug testing 12 months from that date. As noted in section 3.3.2, CNSC staff were satisfied with Bruce Power's implementation plan and will monitor its progress.

3.4.3 Operating performance

CNSC staff concluded that the operating performance SCA at the WWMF met the performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, which was reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Conduct of licensed activity	Y	Assessed, described below
Procedures	Y	Assessed, but no significant developments
Reporting and trending	Y	Assessed, described below
Outage management performance	N	No outage management program required
Safe operating envelope	N	No program for safe operating envelope required
Severe accident management and recovery	N	No program required for severe accident management
Accident management and recovery	Y	Not rated

Conduct of licensed activities

CNSC staff concluded that OPG met the applicable regulatory requirements for the conduct of licensed activities at the WWMF in 2018. OPG operated the WWMF in a safe and secure manner within the bounds of its operating policies and principles and operational safety requirements and with adequate regard for health, safety, security, radiation protection, environmental protection, and international obligations.

High-Level Waste Operations

In 2018, OPG processed 110 DSCs at the WWMF. Since the start of facility production to the end of 2018, OPG had processed and placed into storage 1474 DSCs at the WWMF.

Low- and Intermediate-Level Waste Operations

OPG conducts LLW incineration and compaction activities in order to minimize storage volume 70-fold (incineration) and 5-fold (compaction) in accordance with the waste hierarchy. The total volume of L&ILW received at the WWMF in 2018 was 1,220 m^3. The incinerator was in service for 46.5 days on solids and 26.0 days on liquids in 2018.

At RWOS-1, OPG completed the planned work to characterize and remove any remaining radioactive waste at the Spent Solvent Treatment Facility.

Reporting and trending

CNSC staff determined that OPG's reporting and trending met the applicable regulatory requirements and expectations in 2018 for the WWMF. During 2018, all scheduled reports for the WWMF were submitted to the CNSC in a timely manner and were adequate. OPG submitted three reports for events of low safety significance regarding the WWMF. The event reports are discussed in detail under the applicable SCA(s) in this report.

3.4.4 Safety analysis

CNSC staff concluded that the safety analysis SCA at the WWMF met the performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, which was reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Deterministic safety analysis	Y	Assessed, described below
Probabilistic safety assessment	N	No PSA program required
Criticality safety	N	No criticality safety program required
Severe accident analysis	N	This activity not required
Management of safety issues	N	This activity not required

Deterministic safety analysis

CNSC staff concluded that OPG's deterministic safety analysis predicted adequate safety margins, and met the applicable regulatory requirements at the WWMF.

CNSC staff reviewed and accepted OPG's updated safety analysis report that was submitted in 2018. CNSC staff determined that it met all the applicable regulatory requirements.

CNSC staff completed the review of the fire hazard assessment (FHA) in 2018 and requested additional information regarding fire separation, postulated fire scenarios and the CO_2 suppression system. OPG submitted its response in 2018. Following CNSC staff's review, CNSC staff accepted the FHA for the WWMF in 2018 and directed OPG to include the additional information requested in the next FHA update in 2023.

3.4.5 Physical design

CNSC staff concluded that the physical design 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	**WWMF**	
	Applicable	Notes
Design Governance	Y	Assessed, but no significant developments
Site Characterization	Y	Not rated
Facility Design	Y	Not rated
Structure Design	Y	Not rated
System Design	Y	Not rated
Component Design	Y	Not rated

3.4.6 Fitness for service

CNSC staff concluded that the fitness for service 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	**WWMF**	
	Applicable	Notes
Equipment fitness for service / equipment performance	N	This specific area does not apply
Maintenance	Y	Assessed, but no significant developments
Structural integrity	Y	Assessed, described below
Aging management	Y	Assessed, described below
Chemistry control	Y	Assessed, described below
Periodic inspection and testing	N	This activity not required

Structural Integrity

OPG requested CNSC acceptance for the first-time use of assessment criteria to disposition weld porosity in a DSC seal weld at the WWMF in 2018. While the seal weld is not a pressure boundary weld, OPG adopts the same requirements for welding as a nuclear-class pressure boundary component, including the applicable acceptance criteria for post-weld inspections. In most situations when a weld does not meet the workmanship criteria, OPG carries out a weld repair. However, in this case a repair was not possible due to the location of the porosity. A detailed structural assessment indicated that the unrepaired weld would still have the required safety margins for the design loads. As a result, CNSC staff concluded that the new assessment criteria was sufficient to confirm the structural integrity of the seal weld.

To confirm that there were no systemic issues in the seal welding process that could result in unacceptable levels of porosity, CNSC staff requested OPG to monitor DSCs for any welds with porosity indications that required dispositioning. Of the approximately 80 DSCs that were transferred to storage at the three WMF sites in the last half of 2018, none had such porosity indications.

Aging management

CNSC staff concluded that OPG's integrated aging management program continued to meet the applicable regulatory requirements at the WWMF in 2018. In addition, CNSC staff confirmed that the aging management plans for DSCs continued to meet the applicable regulatory requirements.

Chemistry control

CNSC staff determined that OPG's chemistry control program met the applicable regulatory requirements for the WWMF in 2018 and that the WWMF maintained acceptable performance related to chemistry. There were no chemistry-related incidents at the WWMF in 2018.

3.4.7 Radiation protection

CNSC staff concluded that the radiation protection 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Application of ALARA	Y	Assessed, described below
Worker dose control	Y	Assessed, described below
Radiation protection program performance	Y	Assessed, described below
Radiological hazard control	Y	Assessed, described below
Estimated dose to public	Y	Assessed, described below

Application of ALARA

CNSC staff determined that OPG implemented 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 and RWOS-1. CNSC staff verified that OPG used ALARA initiatives, work

planning, dose monitoring and engineering control practices to work towards the challenging ALARA targets established by OPG at the WWMF. In 2018, OPG met its year-end target for collective radiation exposure.

Worker dose control

CNSC staff determined that OPG met the applicable regulatory requirements to ascertain and record doses received by workers at the WWMF and RWOS-1 in 2018. The data for doses to workers at the WWMF can be found in section 2.7. Radiation doses to workers at the WWMF remained below the regulatory dose limits, as well as the action levels established in OPG's radiation protection program. CNSC staff did not observe any adverse trends or safety significant unplanned exposures at the WWMF or RWOS-1 in 2018.

Radiation protection program performance

CNSC staff determined that OPG's radiation protection program at the WWMF and RWOS-1 met the requirements of the *Radiation Protection Regulations*.

OPG regularly measured the performance of its radiation protection program against established objectives, goals and targets. Improvements to OPG's radiation protection program implemented at the WWMF were identified using self-assessments and effectiveness reviews. The radiation protection program documents and supporting procedures were updated on a regular basis taking into account OPEX and industry-best practices. The oversight applied by OPG in implementing and improving this program was effective in protecting workers at the WWMF.

Radiological hazard control

CNSC staff determined that OPG implemented radiological hazard controls that met the applicable regulatory requirements for control of radiological hazards and the protection of workers at the WWMF in 2018.

There were no exceedances of action levels for surface contamination reported by OPG for the WWMF or RWOS-1 in 2018.

Following a focused inspection of radiation protection in March 2018 [OPG-WWMF-2018-01], OPG implemented several enhancements to the WWMF's routine workplace-monitoring program. These included:

- establishing quarterly workplace monitoring for gaseous C-14
- updating the visual survey data system scheduler to ensure that alpha-specific hazard surveys were consistently recorded and verified in alignment with WWMF routine radiological survey instruction for the WWMF
- updating and issuing the 2018 alpha hazard characterization report for the nuclear waste management division, which confirmed that alpha contamination monitoring and control remained valid and conservative to account for any potential contamination hazard

Estimated dose to the public

CNSC staff determined that OPG ensured the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to a member of the public from the Bruce site, which includes the WWMF, was 0.0017mSv, well below the annual public dose regulatory limit of 1 mSv. See section 2.7 for additional data.

3.4.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at the WWMF met the performance objectives and applicable regulatory requirements. As a result, the WWMF received a "satisfactory" rating, which was reassessed from the "fully satisfactory" rating of the previous year. The change in rating from 2017 to 2018 was due to CNSC staff's refinement of its criteria for "fully satisfactory" ratings and not due to a decline in performance.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Performance	Y	Assessed, described below
Practices	Y	Assessed, described below
Awareness	Y	Assessed, but no significant developments

Performance

CNSC staff determined that OPG met the applicable regulatory requirements at the WWMF for conventional health and safety performance. OPG continued to demonstrate its ability to keep workers safe from occupational injuries while conducting its licensed activities at the WWMF.

OPG did not report any health and safety related incidents or lost-time injuries at the WWMF to CNSC staff in 2018. During various inspections [OPG-WWMF-2018-01, OPG-WWMF-2018-02, and OPG-WWMF-2018-03], CNSC staff 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 2018.

As part of an inspection [OPG-WWMF-2018-03], CNSC staff participated in pre-inspection health and safety briefings held with OPG staff and management and found them to be satisfactory.

Practices

CNSC staff determined that OPG's conventional health and safety practices met the applicable regulatory requirements at the WWMF in 2018. The conventional health and safety work practices and conditions at the WWMF continued to achieve a satisfactory degree of personnel safety. OPG personnel at all levels exhibited proactive attitude towards anticipating work-related hazards and preventing unsafe conditions. CNSC staff observed safe work practices during various site inspections at the WWMF. CNSC staff verified that OPG has appropriate procedures in place at the WWMF to ensure the health of persons against hazardous materials.

3.4.9 Environmental protection

CNSC staff concluded that the environmental protection 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Effluent and emissions control (releases)	Y	Assessed, described below
Environmental management system	Y	Assessed, but no significant developments
Assessment and monitoring	Y	Assessed, described below
Protection of the public	Y	Assessed, described below
Environmental risk assessment	Y	Assessed, but no significant developments

Effluent and emissions control (releases)

The WWMF has its own facility-specific derived release limits (DRLs) and action levels (ALs) for radiological airborne and liquid releases.

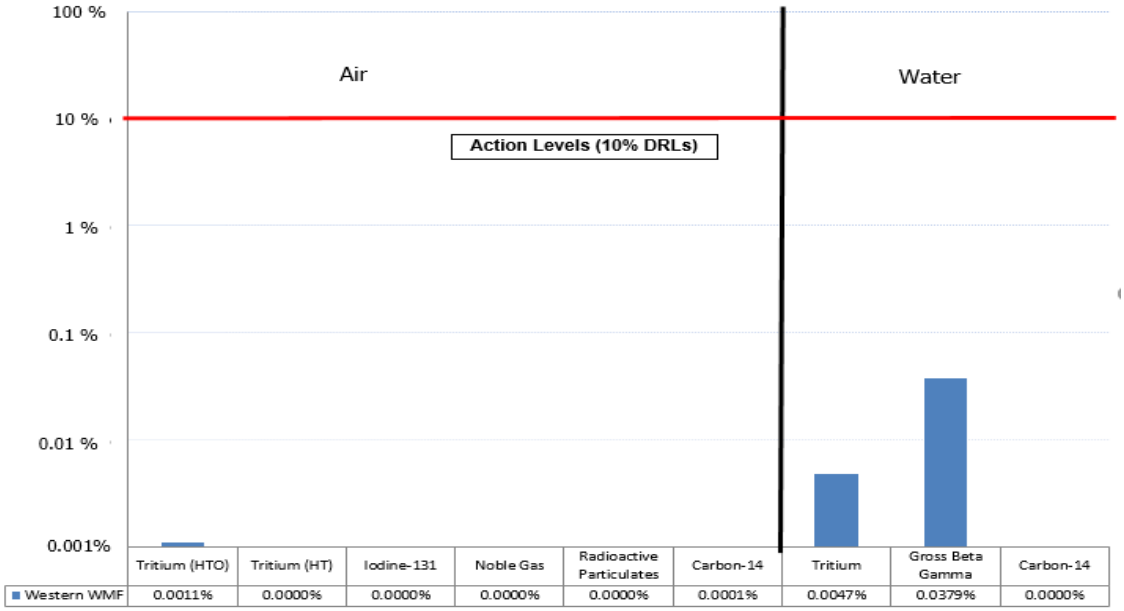
CNSC staff observed that all airborne and waterborne radiological releases from the WWMF remained below the applicable regulatory limits and action levels in 2018. The releases for the WWMF are shown in Figure 20 as percentages of the applicable DRLs. The absolute values for releases and DRLs for the WWMF are provided in Appendix H.

In December 2017, the WWMF submitted revised DRLs and ALs to CNSC staff.

UPDATE: In February 2019, CNSC staff completed their review and accepted the revised DRLs and ALs.

OPG completed the implementation of CSA Group standard N288.3.4-13, *Performance testing of nuclear air-cleaning systems at nuclear facilities* in 2018 for the WWMF.

Figure 20: Effluent and emissions at WWMF as percentages of DRLs



Assessment and monitoring

CNSC staff assessed the 2018 environmental monitoring data provided by OPG for the WWMF and concluded that the public and the environment in the vicinity of the facility were protected. OPG met the applicable regulatory requirements for the WWMF in 2018.

CNSC staff did not conduct independent environmental monitoring around the WWMF in 2018. The most recent results from 2016 are available on the CNSC's IEMP webpage [http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/bruce.cfm] and indicated that there were no expected health impacts in the vicinity of the Bruce site (which includes the WWMF).

During 2018, the WWMF completed an environmental monitoring program design review and provided regular updates to the CNSC. OPG intended to revise the program in 2019 to include recommendations from the design review. OPG planned to address the remaining gaps as part of its implementation of CSA Group standard N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills* and was on track to comply with the standard by August 30, 2019.

During 2017, OPG had completed a gap analysis between its 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 reviewed OPG's implementation plan in 2018 and found the transition date to be acceptable.

Protection of the public

CNSC staff confirmed that the public in the vicinity of the WWMF were protected and that there were no expected health impacts resulting from the operations of the WWMF. OPG did not report any releases of hazardous substances from the WWMF that exceeded the provincial regulatory limits in 2018. Dose to the public is discussed in section 3.4.7.

3.4.10 Emergency management and fire protection

CNSC staff concluded that the emergency management and fire protection 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Conventional emergency preparedness and response	Y	Assessed, no significant developments but see description below
Nuclear emergency preparedness and response	Y	Assessed, described below
Fire emergency preparedness and response	Y	Assessed, described below

Conventional emergency preparedness and response

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.

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 off-site emergency management organizations and commitments throughout 2018.

OPG implemented version 2 of CNSC regulatory document REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* (2016) at the WWMF as of November 14, 2018. CNSC staff conducted a desktop review and confirmed that OPG complied with REGDOC-2.10.1.

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.

Fire emergency preparedness and response

CNSC staff determined that OPG implemented a fire protection program in 2018 in accordance with the applicable regulatory requirements at the WWMF.

CNSC staff received a package of updated fire protection assessment documentation from OPG for the WWMF. This submission included a code compliance review (CCR), fire hazard assessment (FHA), fire protection program (FPP) audit and an annual facility condition inspection report. CNSC staff observed several findings of low safety significance from their review of the package, resulting in several requests for additional information from OPG.

Regarding the CCR, CNSC staff were not satisfied with the information presented in the document. Firstly, CNSC staff identified an issue with the distance requirements regarding the fire extinguishers in the LLSBs. Issues pertaining to fire extinguisher distance requirements, firewalls, automatic fire detection and suppression system requirements for the Retube Component Storage Building and the Steam Generator Storage Building were also identified through CNSC staff's review. OPG provided additional information to address these comments, but some questions remained unresolved. CNSC staff were awaiting further information from OPG.

Regarding the FHA, CNSC staff requested further information from OPG to clarify some highlighted issues regarding the fire scenario models. CNSC staff also had comments regarding the CO2 suppression system, the lighting system and issues with the site drawings. OPG submitted information to address these comments, but some questions remained unresolved. CNSC staff were awaiting further information from OPG.

CNSC staff found the FPP audit and the annual facility condition inspection report to be acceptable. However, CNSC staff indicated that they required a corrective action plan from OPG to address the findings from the reports. CNSC staff were satisfied with the corrective action plan submitted by OPG.

Overall, CNSC staff were satisfied with the level of rigour presented in the fire protection assessment documentation, and the dispositions provided to address CNSC staff comments. CNSC staff concluded that OPG met the applicable regulatory requirements.

In March 2018, CNSC staff conducted an inspection at the WWMF [OPG-WWMF-2018-01] and found that OPG was not conducting the required annual fire drills to test nuclear facility fire response capability. Following a meeting with CNSC staff, OPG committed to conduct a fire drill at each WMF with mutual aid activation.

UPDATE: The drill for the WWMF took place in May 2019.

On May 31, 2018, OPG staff reported an unplanned impairment of the CO_2 fire suppression system at the WWMF. During operator rounds and routines, the CO_2 tank level associated with the system was discovered to be low. A was OPG immediately initiated a fire impairment plan (FIP) and arranged CO_2 delivery to the tank on June 3, at which time the FIP was terminated. CNSC staff were satisfied with the corrective action taken by OPG.

On November 29, 2018, OPG reported that the preventative maintenance identification for the firewater flow switch in the amenities building had not been tested semi-annually, as required by the applicable fire code. OPG changed the test frequency from annual to semi-annual. CNSC staff were satisfied with the corrective action taken by OPG.

3.4.11 Waste management

CNSC staff concluded that the waste management 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Waste characterization	Y	Assessed, but no significant developments
Waste minimization	Y	Assessed, described below
Waste management practices	Y	Assessed, described below
Decommissioning plans	Y	Assessed, described below

Waste minimization

CNSC staff determined that OPG's waste management programs for minimizing radioactive waste continued to meet or exceed 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 2018, OPG continued to send some waste to a licensed external provider for processing.

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. OPG's waste sorting project at the WWMF continued throughout 2018. CNSC staff noted that this initiative exceeded regulatory requirements regarding waste minimization.

Waste management practices

CNSC staff determined that OPG's waste management practices met the applicable regulatory requirements at the WWMF and were effective for both radioactive and hazardous waste in 2018. OPG used waste management procedures to ensure that waste generated at the facility was managed properly, as noted by CNSC staff during an inspection in 2018 [OPG-WWMF-2018-03].

Decommissioning plans

The PDP for the WWMF met or exceeded the applicable regulatory requirements in 2018.

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. There were no changes made to the PDP for the WWMF in 2018. The associated financial guarantee is discussed in section 2.15.

3.4.12 Security

CNSC staff concluded that the security 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Facilities and equipment	Y	Assessed, described below
Response arrangements	Y	Assessed, but no significant developments
Security practices	Y	Assessed, but no significant developments
Drills and exercises	Y	Assessed, but no significant developments

Facilities and equipment

CNSC staff determined that OPG met the applicable regulatory requirements for facilities and equipment at the WWMF in 2018. OPG continued to sustain its security equipment through life cycle management at the WWMF. No significant equipment failures were reported to the CNSC in 2018.

3.4.13 Safeguards and non-proliferation

CNSC staff concluded that the safeguards and non-proliferation 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Nuclear material accountancy and control	Y	Assessed, but no significant developments
Access and assistance to the IAEA	Y	Assessed, described below
Operational and design information	Y	Assessed, described below
Safeguards equipment, containment and surveillance	Y	Assessed, described below

Access and assistance to the IAEA

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

Operational and design information

CNSC staff confirmed that OPG met the applicable regulatory requirements for operational and design information for the WWMF. See section 2.13 for additional information.

OPG submitted its annual operational program with quarterly updates for the WWMF 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.

OPG had submitted to the CNSC an updated design information questionnaire for the WWMF in December 2017. CNSC staff were satisfied with the information provided and concluded that it met CNSC's submission requirements. The CNSC submitted the questionnaire to the IAEA in January 2018.

Safeguards equipment, containment and surveillance

CNSC staff confirmed that OPG met the applicable regulatory requirements for safeguards equipment, containment and surveillance for the WWMF in 2018, including support for routine maintenance of surveillance equipment and testing of a new container radiation profiling system, to ensure the effective implementation of safeguards measures at the facility. See section 2.13 for more details.

There was one reportable event in 2018 related to surveillance equipment. On October 11, the IAEA discovered that communication had been lost with its digital multi-camera optical surveillance system at the WWMF, which is used for surveillance of DSC processing activities and movement. OPG supported the IAEA on troubleshooting with the local service provider and the issue was resolved on October 30, 2018. The IAEA confirmed that there was no impact on safeguards for the WWMF.

OPG granted access and provided assistance to the IAEA in September 2018 for a site survey to determine potential siting locations of additional IAEA surveillance equipment, with the goal of optimizing the current safeguards approach at the WWMF.

3.4.14 Packaging and transport

CNSC staff concluded that the packaging and transport 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.

The following table lists the specific areas under this SCA, explains their applicability for the WWMF and provides notes regarding CNSC staff assessments for the 2018 regulatory oversight report.

Specific Area	WWMF	
	Applicable	Notes
Package design and maintenance	Y	Assessed, described below
Packaging and transport	Y	Assessed, described below
Registration for use	Y	Assessed, described below

Packaging design and maintenance, packaging and transport, and registration for use

CNSC staff determined that OPG had a packaging and transport program for the WWMF that ensured compliance with the *Packaging and Transport of Nuclear Substances Regulations*, *2015* and the *Transportation of Dangerous Goods Regulations*. The program was effectively implemented and the transport of nuclear substances to and from the facility was conducted in a safe manner.

For on-site movements of nuclear substances, OPG ensured 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.

There were no packaging and transport events reported in 2018 at the WWMF.

3.5 Point Lepreau

The Point Lepreau site consists of the Point Lepreau Nuclear Generating Station (PLNGS) and the Solid Radioactive Waste Management Facility (SRWMF). This section presents CNSC staff's assessment of NB Power's performance at Point Lepreau for each SCA. 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, as of December 2018, are listed in Appendix E.

Overall safety assessment

The CNSC staff safety assessment of the Point Lepreau site for 2018 resulted in the performance ratings shown in table 31.

Table 31: Performance ratings for Point Lepreau, 2018

Safety and control area	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	SA
Security	SA
Safeguards and non-proliferation	SA
Packaging and transport	SA

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

For 2018, CNSC reviewed its criteria for rating the specific areas under the SCAs. Besides assessing licensees against continually evolving requirements, CNSC staff also refined its criteria for "fully satisfactory" ratings based on industry best practice. This led to the decision to not include an overall rating for each facility (overall ratings were included in the regulatory oversight report for 2017).

Based on the assessments of the SCAs and other observations in 2018, CNSC staff concluded that NB Power operated Point Lepreau safely, upheld its responsibilities for safety and promoted a healthy safety culture.

3.5.0 Introduction

The Point Lepreau site 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 include a single CANDU reactor with a rated capacity of 705 megawatts electrical (MWe). The Point Lepreau site also includes the SRWMF, which is located a short distance from the power reactor within the exclusion zone. CNSC regulates the PLNGS and the SRWMF under a single power reactor operating licence (PROL).

Radioactive waste storage includes short-term storage in the service building prior to transferr of the waste to the SRWMF for long-term storage. The SRWMF is used for the storage of solid radioactive waste, including nuclear spent fuel, that is produced solely at PLNGS.

The SRWMF comprises Phase I, II and III sites:

- Phase I of the facility is used to store operational waste.
- Phase II is a dry storage facility for spent fuel.
- Phase II Extension is an additional area prepared in 2006 to allow for dry storage of spent fuel. Approval is required in accordance with the PROL prior to commissioning and use.
- Phase III of the facility stores waste from fuel channel replacement and other operations completed during the refurbishment outage.

Licensing

In June 2016, NB Power had applied to have its PROL renewed 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. The Commission renewed the PROL for a period of five years, which authorized 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 licence conditions handbook (LCH) when the PROL was issued on June 30, 2017. It had not been revised as of the end of 2018.

***Fisheries Act* authorization**

According to the provisions of the *Fisheries Act*, NB Power submitted a preliminary self-assessment of serious harm to fish due to cooling water intake for CNSC staff review. In April 2016, CNSC staff reviewed the assessment and met with NB Power to discuss the need for additional information.

NB Power submitted a revised *Fisheries Act* self-assessment to the CNSC in January 2017. CNSC staff completed its technical review of the self-assessment and concluded that an authorization was required in accordance with subsection 35(1) of the *Fisheries Act*. Fisheries and Oceans Canada concurred with CNSC's recommendation. NB Power expected to submit the application in the fall of 2017, but required an extension. NB Power submitted a justification for

the delay and provided a new completion date of December 31, 2018. NB Power submitted a partial draft *Fisheries Act* application to the CNSC on March 27, 2018. CNSC staff reviewed the draft for technical completeness and provided comments to NB Power in May 2018. NB Power provided an update to the Commission in November 2018 and submitted another draft application for CNSC review in December 2018.

UPDATE: CNSC staff sent their comments to NB Power in February 2019. CNSC staff, Fisheries and Oceans Canada and NB Power met in April 2019 to discuss CNSC's comments. In June 2019, NB Power informed CNSC that it will proceed with a new offsetting strategy in the form of a dam removal. Since this strategy will serve as offset for three other NB Power facilities, it was agreed that the Fisheries and Oceans Canada will take the lead as the primary regulatory agency. NB Power was planning to submit a revised application for a *Fisheries Act* authorization to Fisheries and Oceans Canada.

Periodic Safety Review

With the introduction of periodic safet review (PSR) to the CNSC regulatory framework, CNSC staff recommended a five-year PROL to provide adequate time for NB Power to complete a PSR in accordance with CNSC regulatory document REGDOC-2.3.3, *Periodic Safety Reviews*. The PROL requires 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 version in March 2018. CNSC staff sent comments in July 2018. After informal discussions, NB Power submitted a further-revised basis document in December 2018, which was accepted by CNSC staff. NB Power submitted safety factor reports[5] 4, 5, 6, 7, 9, 11, 12, 13 and 14 in December 2018 and safety factor reports 1, 2, 3, 8, 10 and 15 in March 2019 for review by CNSC staff.

Event initial reports

No event initial reports pertaining to Point Lepreau were submitted to the Commission for the period January 1, 2018 to June 1, 2019.

Compliance program

The annual CNSC effort on the compliance program is tabulated in Appendix F for Point Lepreau. The inspections at the Point Lepreau site that were considered in the safety assessments in this regulatory oversight report are tabulated below (inspection reports were included if they were sent to NB Power by January 31, 2019):

Table 32: List of inspection at Point Lepreau

Safety and control area	Inspection title	Inspection report sent
Management system	PLNGS PICA Type II Inspection Report Number: GPLRPD-2018-010	Aug 28, 2018

[5] Refers to safety factor numbers as defined in IAEA PSR guidance

Safety and control area	Inspection title	Inspection report sent
	Type II Software Maintenance Inspection - DCCs, SDS1 PDCs, and SDS2 PDCs at PLNGS 2018 Report Number: GPLRPD-2018-019	Jan 21, 2019
Human performance management	Conduct and Grading of Simulator-based Requalification Test Report Number: GPLRPD-2018-018	Mar 21, 2018
	Nuclear Security Training Report Number: GPLRPD-2018-017	Feb 6, 2018
Operating performance	Planned Outage 2018 Report Number: GPLRPD-2018-008	Aug 24, 2018
	Quarterly Field Inspection Fourth Quarter FY 2017/18 Report Number: GPLRPD-2018-007	Jun 4, 2018
	Quarterly Field Inspection First Quarter FY 2018/19 Report Number: GPLRPD-2018-009	Aug 29, 2018
	Quarterly Field Inspection Second Quarter FY 2018/19 Report Number: GPLRPD-2018-015	Dec 20, 2018
Physical design	Preservation of Seismic Design Basis Report Number: GPLRPD-2018-005	May 8, 2018
	Environmentally Qualified Equipment Report Number: GPLRPD-2018-006	Jun 14, 2018
	Pressure Boundary Report Number: GPLRPD-2018-016	Jan 11, 2018
Fitness for service	Service Water System (SWS) Report Number: GPLRPD-2018-013	Nov 9, 2018
	Aging Management Report Number: GPLRPD-2018-004	Apr 19, 2018
	Electrical Power Systems Report Number: GPLRPD-2018-014	Dec 5, 2018
	Instrument Calibration Report Number: GPLRPD-2018-019	Feb 27, 2018
Waste management	Solid Radioactive Waste Management Facility Report Number: GPLRPD-2018-001	Mar 21, 2018
	Reactive - Waste Management Report Number: GPLRPD-2018-002	Mar 28, 2018

3.5.1 Management system

CNSC staff concluded that the management system SCA at Point Lepreau met the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for this regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Management system	Y	Assessed, described below
Organization	Y	Assessed, but no significant developments
Change management	Y	Assessed, but no significant developments
Safety culture	Y	Not rated
Configuration management	Y	Assessed, but no significant developments
Records management	Y	Assessed, described below
Management of contractors	Y	Assessed, described below
Business continuity	Y	Assessed, but no significant developments
Performance assessment, improvement and management review	Y	Assessed, described below
Operating experience	Y	Assessed, described below

Management system

CNSC staff determined that NB Power's management system at Point Lepreau met the applicable regulatory requirements in 2018, although some findings of low safety significance were identified during numerous inspections related to the organization, management system documentation and self-assessments.

During an inspection on aging management [GPLRPD-2018-004], CNSC staff concluded that NB Power met the applicable regulatory requirements for management system documents. However, the asset management program document was not integrated into the management system. At the end of 2018, CNSC staff were satisfied with NB Power's progress to address the finding.

Following an inspection in March 2018 on environmentally qualified equipment [GPLRPD-2018-006], CNSC staff requested NB Power to develop and implement a procedure to monitor environmentally qualified equipment at Point Lepreau.

UPDATE: In June 2019, CNSC staff concluded that NB Power had successfully addressed the non-compliance.

Records management

CNSC staff determined that NB Power implemented a document control and records management system that met the applicable requirements.

Following a CNSC inspection on chemistry control that had been conducted in September 2017, NB Power initiated a corrective action plan to ensure the chemistry process documentation was reviewed and updated as required, met the required format, and did not contain or reference obsolete documents. In August 2018, CNSC staff found that NB Power had successfully addressed the non-compliance.

CNSC staff identified other findings during compliance activities during the year (e.g., related to deficiencies in the maintenance of records) that NB Power was continuing to address.

Management of Contractors

CNSC staff concluded that NB Power met the requirements for contractor management in 2018, as well as procurement and purchasing, during multiple inspections [GPLPRD-2018-06, GPLRPD-2018-09 and GPLRPD-15]. However, during an inspection of aging management in 2018, CNSC staff identified that NB Power did not meet the requirements to control temperature and humidity sensor setpoints in a storage warehouse [GPLRPD-2018-04]. By the end of 2018, CNSC staff were satisfied with NB Power's progress to address this finding.

Performance assessment, improvement and management review

CNSC staff confirmed that NB Power met the applicable regulatory requirements for performance assessment, improvement and management review in 2018.

In 2017, CNSC staff had conducted a desktop review of NB Power's independent assessment program. This program allows NB Power to independently evaluate the performance and effectiveness of activities, programs, processes and work to compare actual results against expected results. In February 2018, CNSC staff provided the results of the review to NB Power. No regulatory actions were identified and a few recommendations for improvement were included, such as documentation of attendance for nuclear oversight meetings and improved timelines for the list of approval signatures.

Operating experience

CNSC compliance verification activities in 2018 confirmed that NB Power complied with the applicable regulatory requirements for problem identification and resolution and use of operating experience. NB Power demonstrated that it identified and implemented OPEX from within its organization and from the Canadian and international nuclear industry. However, certain non-compliances of low significance were identified, such as failing to:

- initiate records for problem identification and corrective action when required [GPLRPD-2018-008]
- complete effectiveness reviews for significant (Category 2) instances requiring the problem identification and corrective action process [GPLRPD-2018-010]

CNSC staff were satisfied with NB Power's progress in 2018 to address the findings.

3.5.2 Human performance management

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

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Human performance program	Y	Assessed, described below
Personnel training	Y	Assessed, described below
Personnel certification	Y	Assessed, described below
Initial certification examinations and requalification tests	Y	Assessed, described below

Work organization and job design	Y	Assessed, described below
Fitness for duty	Y	Assessed, described below

Human performance program

CNSC staff determined that the NB Power human performance program met the applicable regulatory requirements.

During a field inspection [GPLRPD-2018-009], CNSC staff observed a pre-job briefing for the non-destructive testing of stream generators that did not adequately communicate radiological risks to workers. CNSC staff requested NB Power to develop and implement a corrective action plan to ensure pre-job briefs result in the effective communication of hazards and the necessary measures to manage them. NB Power began its corrective actions in 2018 and CNSC staff were satisfied with NB Power's progress.

Personnel training

CNSC staff determined that NB Power had a robust and well-documented training system based on a systematic approach to training.

In 2017, CNSC staff had inspected the non-licenced operator (NLO) training program. In 2018, CNSC staff were satisfied with NB Power's progress to address the non-compliances found during the inspection, including those related to ensuring that:

- continuing training courses for NLOs are accurately recorded and tracked
- post-training evaluations are consistently completed and documented for NLO training
- meetings of the curriculum review committee/training review group are consistently documented and conducted at the required frequencies

CNSC staff noted that NB Power was on track to complete the corrective actions by the end of 2019.

In November 2018, CNSC staff conducted a nuclear security training inspection at Point Lepreau [GPLRPD-2018-017] that identified certain non-compliances related to inconsistent use of forms for tracking training changes, misalignment of training program documentation, tracking and maintenance of continuing training and maintenance of qualification records. At the end of 2018, NB Power was addressing the non-compliances to the satisfaction of CNSC staff.

Personnel certification

CNSC staff determined that the personnel certification program at Point Lepreau met the applicable regulatory requirements in 2018. CNSC staff reviewed the staffing reports for certified personnel and the applications for initial certification and renewal of certification and confirmed that NB Power had a sufficient number of personnel at Point Lepreau for all certified positions. All certified workers at Point Lepreau possessed the knowledge and skills required to perform their duties safely and competently.

In August 2018, CNSC staff inspected the interview process for shift personnel by management at Point Lepreau [GPLRPD-2018-012]. CNSC staff confirmed that NB Power complied with the management interview requirements for interviews but was not fully compliant with the record retention requirements. CNSC staff requested NB Power to ensure that all required documentation from management interviews for shift personnel would be retained for the required period of time.

UPDATE: In May 2019, CNSC staff concluded that NB Power properly completed the necessary corrective actions.

Initial certification examinations and requalification tests

CNSC staff concluded that the initial certification examination programs for all certified positions at Point Lepreau met the applicable regulatory requirements in 2018.

In 2017, CNSC staff had inspected the conduct of simulator-based initial certification examinations for shift supervisors and the conduct of written certification examinations and observed a non-compliance of low safety significance related to simulator modelling capabilities. NB Power continued to provide updates in 2018 on the progress to address the non-compliance.

Furthermore, as a result of an inspection on the conduct and grading of a simulator-based requalification test [GPLRPD-2018-018], NB Power was requested to implement corrective action to align with the CNSC requirements for immediate assessments of the performance of the certified persons after the conduct of requalification tests.

UPDATE: In March 2019, CNSC staff concluded that NB Power completed the corrective action plan.

Work organization and job design

CNSC staff concluded that NB Power met the applicable regulatory requirements for minimum shift complement in 2018.

In March 2018, CNSC staff accepted NB Power's request to modify its minimum shift complement. NB power replaced the requirement for a mechanical maintainer with an increase of one electrical instrumentation and control maintainer.

In 2018, three violations of minimum shift complement were reported to the CNSC related to the emergency response team and a non-licensed operator at Point Lepreau. Due to the very limited duration of the violations, they had no impact on safety.

Fitness for duty

CNSC staff determined that NB Power met the applicable regulatory requirements for fitness for duty in 2018. Overall, CNSC staff were satisfied with the fitness for duty of workers at Point Lepreau in 2018.

In 2018, NB Power reported no exceedances to hours-of-work limits for certified staff.

NB Power had committed to fully implement CNSC regulatory document REGDOC-2.2.4, *Fitness for Duty Volume I: Managing Worker Fatigue* by June 30, 2022 (see section 2.2 for background information). CNSC staff were satisfied with NB Power's implementation plans and were monitoring its progress.

NB Power was working toward the implementation of two additional CNSC regulatory documents related to fitness for duty: REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* and REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness*. Background information and implementation details are provided in section 2.2.

3.5.3 Operating performance

CNSC staff concluded that the operating performance SCA at Point Lepreau met the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a "fully satisfactory" rating - an increase from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Conduct of licensed activity	Y	Assessed, described below
Procedures	Y	Assessed, described below
Reporting and trending	Y	Assessed, described below
Outage management performance	Y	Assessed, described below
Safe operating envelope	Y	Assessed, but no significant developments
Severe accident management and recovery	Y	Assessed, but no significant developments
Accident management and recovery	Y	Assessed, but no significant developments

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 within the bounds of its operating policies and principles and operational safety requirements and with adequate regard for health, safety, security, radiation and environmental protection and international obligations.

In 2018, Point Lepreau did not experience any unplanned reactor trips, stepbacks or setbacks.

Procedures

CNSC staff determined that the procedures for Point Lepreau met the applicable regulatory requirements in 2018.

As a result of various Type II and field inspections, CNSC staff identified eight compliant findings and two negligible findings that reflected directly on NB Power's conduct of licensed activities and procedural adequacy. The two negligible findings were related to minor procedural deficiencies and were being assessed by NB Power to the satisfaction of CNSC staff.

Reporting and trending

CNSC staff determined that NB Power's reporting and trending met or exceeded the applicable regulatory requirements and expectations in 2018 for Point Lepreau. The reporting complied with CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. During 2018, all scheduled reports were submitted to CNSC in a timely manner and were adequate.

In 2018, NB Power submitted 22 event reports to the CNSC and also undertook an initiative to send reports of regulatory interest to the CNSC. All reported events were followed up by NB Power with corrective action and root cause analysis, when appropriate.

Outage management performance

CNSC staff concluded that NB Power's outage management at Point Lepreau met or exceeded the applicable regulatory requirements and expectations in 2018. CNSC staff observed that NB Power demonstrated high levels of performance and achievement of objectives during the planned maintenance outage. There were no process or equipment failures during the outage and NB Power confirmed that all regulatory commitments were completed. CNSC staff inspected the outage [GPLRPD-2018-008] and determined that all outage-related undertakings at Point Lepreau were performed safely. NB Power was addressing all non-compliances identified through the inspection to the satisfaction of CNSC staff.

UPDATE: In May 2019, CNSC staff concluded that NB Power properly developed and completed the corrective action plans.

There were no forced outages in 2018.

3.5.4 Safety analysis

CNSC staff concluded that the safety analysis SCA at Point Lepreau met or exceeded the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a "fully satisfactory" rating- unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Deterministic safety analysis	Y	Assessed, described below
Probabilistic safety assessment	Y	Assessed, described below
Criticality safety	N	No criticality safety program required
Severe accident analysis	Y	Assessed, but no significant developments
Management of safety issues	Y	Assessed, see section 2.4

Deterministic safety analysis

NB Power's deterministic safety analysis met or exceeded the applicable regulatory requirements and predicted adequate safety margins for Point Lepreau.

CNSC staff completed its review of the updated fire hazard assessment (FHA) and fire safe shutdown analysis (FSSA) in 2018. CNSC staff concluded that the approach and methodology used for the update of the FHA and FSSA were acceptable and consistent with the applicable regulatory requirements. However, CNSC staff submitted comments to be considered by NB Power during the next submission cycle (2022).

Point Lepreau has been experiencing higher than expected temperatures in the reactor inlet header, which is suspected to be due to steam generator fouling. In 2018, NB Power submitted an assessment to demonstrate that adequate safety margins would still exist if it increased the safe operating envelope (SOE) limit for the reactor inlet header. CNSC staff accepted the assessment with the stipulation that NB Power must improve its explanation of the reason for the increased temperatures within a three-year timeframe. In the interim, CNSC staff found the new SOE limit (which is being used in the updated safety analysis as part of the implementation of CNSC regulator document REGDOC 2.4.1, *Deterministic Safety Analysis* to be acceptable. CNSC staff continued to closely monitor NB Power's progress.

In September 2018, NB Power submitted safety analysis for small-break loss of coolant accident as part of its REGDOC 2.4.1 implementation plan. The analysis used the reactor conditions at the time, as well as the projected conditions at mid-life and end of life to account for the aging impacts on the primary heat transport system. CNSC staff, were satisfied with the methodology, implementation and results of the analysis and identified some minor comments and requests for clarifications. NB Power's follow-up actions successfully addressed those comments.

NB Power updated the dose results in the safety report using a new methodology and the Atmospheric Dispersion and Dose Analysis Method, which is an Industry Standard Toolset analytical computer code used to calculate dose. NB Power confirmed that the doses obtained were within the design basis (below the siting guide limits) for single and dual failure events BDBA as well as REGDOC-2.4.1 for design basis accidents. CNSC staff's expectations were met regarding the updating of safety report doses using the new methodology.

Probabilistic safety assessment

CNSC staff determined that NB Power met or exceeded the applicable regulatory requirements for probabilistic safety assessment (PSA) in 2018.

In 2016, NB Power had submitted its second PSA update, which was concluded by CNSC to comply with REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. NB Power's next PSA update is expected by 2021.

NB Power had submitted a revised seismic PSA methodology for Point Lepreau and response to previous CNSC staff comments in November 2017. In 2018, CNSC staff completed the review and concluded that NB Power had properly addressed all previous CNSC staff comments and reflected them in its revised methodology.

In 2018, NB Power submitted its updated PSA methodologies for compliance with REGDOC-2.4.2 and CNSC staff's review will be completed by the end of 2019.

3.5.5 Physical design

CNSC staff concluded that the physical design SCA at Point Lepreau met performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Design governance	Y	Assessed, described below
Site characterization	Y	Not rated
Facility design	Y	Not rated
Structure design	Y	Assessed, but no significant developments
System design	Y	Assessed, described below
Component design	Y	Assessed, described below

Design governance

CNSC staff concluded that NB Power met the applicable regulatory requirements and expectations regarding design governance in 2018, including in the areas of environmental

qualification, seismic qualification, pressure boundary design, human factors in design and fire protection.

Environmental qualification

The environmental qualification program has been implemented and maintained in accordance with regulatory requirements. In March 2018, CNSC staff inspected environmentally qualified equipment at Point Lepreau [GPLRPD-2018-006]. All non-compliances identified through the inspection were being addressed by NB Power to the satisfaction of CNSC staff.

UPDATE: In June 2019, CNSC staff concluded that the corrective action plans were properly developed and completed by NB Power, with the exception of a final corrective action plan which remains to be completed. This will be developed and completed by NB Power by the end of July 2019 to ensure that

- environmental qualification is established for all environmentally qualified equipment and cables
- environmental qualification assessments and information reports are accurate and up to date
- work orders related to environmental qualification are prioritized according to the work management process

Pressure Boundary Design

In 2018, CNSC staff inspected the implementation of the pressure boundary program at Point Lepreau [GPLRPD-2018-016] and concluded that NB Power complied with the applicable pressure boundary requirements.

Human factors in design

In 2017, NB Power completed the implementation of CSA Group standard N290.12-14, *Human factors in design for nuclear power plants*. CNSC staff was planning to conduct a desktop inspection of human factors in design in early 2019 to verify compliance with the standard.

Fire Protection

NB Power continued to implement a comprehensive fire protection program in accordance with CSA group standard N293, *Fire Protection for Nuclear Power Plants*. For the SRWMF, NB Power submitted its implementation plan in September 2017 for CSA Group standard N393, *Fire Protection for Facilities that Process, Handle or Store Nuclear Material Substances* and committed to comply with it by March 2022.

System design

CNSC staff concluded that the design of systems at Point Lepreau met the applicable regulatory requirements in 2018.

Electrical power system

In September 2018 CNSC staff inspected the electrical power system at Point Lepreau [GPLRPD-2018-014]. The results of this inspection are described below, under the specific area component design.

Fire protection design

CNSC staff determined that NB Power complied with the applicable regulatory requirements based on the results of CNSC's compliance activities, including field inspections, and the review of NB Power's independent third party reviews of design modifications and facility condition, all of which were acceptable and did not identify any major findings.

Component design

In 2018, CNSC staff determined that NB Power's implementation of system health monitoring at Point Lepreau was insufficient to meet the applicable regulatory requirements in 2018, described in the cables section below. However, NB Power met all other regulatory requirements covered under component design at Point Lepreau.

Fuel design

CNSC staff determined that NB Power continued to have a mature reactor fuel inspection program. CNSC staff reviewed the annual fuel report and concluded that it was consistent with those of previous years. Based on this review, CNSC staff determined that fuel performance at Point Lepreau was acceptable in 2018. CNSC staff noted that the defect rate at Point Lepreau was above the CNSC expectation of one defect per unit per year. However, NB Power effectively managed fuel performance issues while maintaining safe operations.

Cables

Following the inspection of the electrical power system [GPLRPD-2018-014]. CNSC staff requested NB Power to develop and implement a corrective action plan to establish a cable aging management program that includes provisions to address the implementation of documents and recommendations previously identified during the last CNSC inspection of the electrical power system. NB Power was addressing the non-compliances at the end of 2018.

In December 2018, a damaged cable caused an electrical fault that led to the removal from service of the station service transformer (SST). This left all station services supplied solely from the unit service transformer. CNSC staff closely monitored the repair of the faulty cable and the successful return to service of the SST.

3.5.6 Fitness for service

CNSC staff concluded that the fitness for service SCA at Point Lepreau met the performance objectives and applicable regulatory requirements. As a result, Point Leprau received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Equipment fitness for service / equipment performance	Y	Assessed, described below
Maintenance	Y	Assessed, described below
Structural integrity	Y	Assessed, described below
Aging management	Y	Assessed, described below
Chemistry control	Y	Assessed, described below
Periodic inspection and testing	Y	Assessed, described below

Equipment fitness for service and equipment performance

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

Numerous CNSC inspections in 2018 confirmed NB Power's compliance with the applicable regulatory requirements [GPLRPD-2017-019, GPLRPD-2018-04, GPLRPD-2018-06, GPLRPD-2018-07, GPLRPD-2018-09, GPLRPD-2018-13, GPLRPD-2018-14 and GPLRPD-2018-15]. However, the inspection of the electrical power system determined that NB Power did not comply with the applicable regulatory requirements related to system health monitoring [GPLRPD-2018-014]. CNSC staff were satisfied with NB Power's progress in 2018 to address the non-compliance.

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 2018.

Maintenance

CNSC staff determined that NB Power's maintenance program met the applicable regulatory requirements in 2018. The average preventive maintenance completion ratio at Point Lepreau was 95 percent, which compared favourably with the industry average of 93 percent. The corrective critical maintenance backlog, deficient critical maintenance backlog, and the number of deferrals of preventative maintenance for critical components are provided in table 33.

Table 33: Trend of maintenance backlogs and deferrals for critical components for Point Lepreau, 2016 to 2018

Parameter	Average quarterly work orders per unit			Quarterly 2018 work orders				Industry average for 2018
	2016	2017	2018	Q1	Q2	Q3	Q4	
Corrective maintenance backlog	1	2	1	1	0	1	2	1
Deficient maintenance backlog	114	71	27	41	37	18	12	16
Deferrals of preventive maintenance	6	1	0	0	0	1	0	4

The deficient critical maintenance backlog and the number of deferrals of preventative maintenance for critical components had been trending down since 2016 to the satisfaction of CNSC staff. In addition, the critical corrective maintenance backlog was kept low in 2018.

CNSC staff determined that the maintenance backlogs and the number of preventive maintenance deferrals for critical components had negligible overall safety significance for Point Lepreau and were therefore acceptable.

Structural Integrity

CNSC staff concluded that the SSCs required for safe operation continued to meet the structural integrity requirements in the design basis for Point Lepreau.

In 2018, CNSC staff conducted a field inspection of the leak-rate test for the reactor building during the planned outage [GPLRPD-2018-008]. The inspection found NB Power to be compliant in this area.

In 2018, NB Power continued to implement CSA Group standard N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors* (2010). See the discussion of periodic inspection and testing, below, for further details.

As part of its periodic inspection program (PIP), NB Power inspected pressure boundary and containment components in 2018. NB Power's pressure boundary inspection results indicated that all inspected elements met the necessary CSA acceptance criteria to remain compliant with their design basis.

Aging management

CNSC staff concluded that NB Power's aging management program met the applicable regulatory requirements at Point Lepreau in 2018.

CNSC staff inspect the aging management program in February 2018 [GPLRPD-2018-004]. Based on the scope of the inspection, CNSC staff concluded that NB Power complied with the applicable regulatory requirements; however, several non-compliances with the licensee's governance were observed.

UPDATE: NB Power submitted an action plan to address the non-compliances in June 2019.

CNSC staff confirmed that life cycle management plans for major component continued to meet the applicable regulatory requirements. NB Power submitted a roadmap that indicates how its equipment program plan for fuel channels addresses the CNSC's recommended attributes of an effective aging management plan. CNSC staff was reviewing the roadmap in 2018; it may be included as part of CNSC staff's review of the safety factor report (aging management) for the PSR or included in future compliance verification activities.

Chemistry control

CNSC staff determined that Point Lepreau's chemistry control program met the applicable regulatory requirements for Point Lepreau in 2018. Point Lepreau maintained acceptable chemistry control, as demonstrated by the "chemistry index" and "chemistry compliance index" performance indicators (see section 2.6).

CNSC staff had inspected chemistry control in 2017 and identified non-compliances of low safety significance relating to chemistry documentation. To address them, NB Power ensured that the chemistry process documentation (i.e. procedures and work instructions) were reviewed and updated as required. NB Power completed the corrections to the chemistry documentation in August 2018 to the satisfaction of CNSC staff.

Periodic inspections and testing

CNSC staff determined that NB Power had adequate and well-maintained PIP at Point Lepreau for pressure boundary systems, containment components and containment structures.

NB Power confirmed that the gap analyses of the CSA Group N287 series of standards (CSA N287.1 to CSA N287.8) will be carried out as part of the ongoing PSR scope as an update to the reactor building management plan.

In April, 2018, CNSC staff accepted NB Power's proposal to change the frequency of the leak rate test of the reactor building from three to four years.

In 2018, NB Power provided the CNSC with submissions pertaining to the PIP elements of the fuel channel management plan.

UPDATE: CNSC staff accepted NB Power's revision of its PIP for fuel channels in January 2019.

In March 2018, CNSC staff accepted NB Power's compliance plan for CSA Group standard N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors* (2010).

3.5.7 Radiation protection

CNSC staff concluded that the radiation protection SCA at Point Lepreau met the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Application of ALARA	Y	Assessed, described below
Worker dose control	Y	Assessed, described below
Radiation protection program performance	Y	Assessed, described below
Radiological hazard control	Y	Assessed, described below
Estimated dose to public	Y	Assessed, described below

Application of ALARA

CNSC staff determined that NB Power implemented an effective and well-documented program, based on industry best practices, to keep doses to persons as low as reasonably achievable (ALARA) at Point Lepreau. In 2018, CNSC staff verified that NB Power used ALARA initiatives, work planning, and dose monitoring and control to work towards the ALARA targets established by NB Power [GPLRPD-2018-009].

ALARA plans were developed by NB Power for supporting the outage work to ensure that radiological activities at Point Lepreau were consistent with the ALARA principle. The ALARA plans incorporated radiological control hold points and radiological control measures.

In 2018, NB Power met its established year-end collective radiation exposure (CRE) target. The largest contributor to station CRE at Point Lepeau was the outage-related work. Approximately 82% of the CRE arose from the 2018 planned outage that lasted approximately two months. CNSC staff observed that while NB Power has developed ALARA initiatives to reduce the source terms in the primary heat transport system and to enhance shielding, there was no identified progress to implement these initiatives in 2018. CNSC staff will continue to verify NB Power's implementation of ALARA initiatives.

Worker dose control

CNSC staff determined that NB Power met the applicable regulatory requirements to measure and record doses received by workers at Point Lepreau.

Radiation doses to workers at Point Lepreau were below the regulatory dose limits, as well as the action levels established in NB Power's radiation protection program. The data for doses to workers at Point Lepreau can be found in section 2.7.

Compliance verification activities conducted in 2018 indicated that worker dose control at Point Lepreau was effective [GPLRPD-2018-007, GPLRPD-2018-008, GPLRPD-2018-009, and GPLRPD-2018-015]. CNSC staff identified some non-compliances of low safety significance in the areas of personnel screening and dosimetry, the classification of alpha hazards and NB Power's respirator inspections. Corrective actions were taken and implemented by NB Power to the satisfaction of CNSC staff.

CNSC staff did not observe any adverse trends or safety-significant unplanned exposures at Point Lepreau in 2018. Additionally, there were no event reports related to worker dose control in 2018.

Radiation protection program performance

CNSC staff determined that NB Power's radiation protection program at Point Lepreau met the requirements of the *Radiation Protection Regulations*. NB Power continued to employ a suite of performance metrics to monitor and control the overall performance of the radiation protection program. The oversight applied by NB Power in implementing and improving this program was effective in protecting workers at Point Lepreau in 2018.

As discussed in a Commission update [CMD 18-M26] in May 2018, there was an event involving a worker exposure to low-level alpha contamination during a radiological activity associated with the steam generators. The final calculation of the worker's exposure for this incident was 0.0606 millisievert (mSv) which was below the regulatory action level of 2 mSv and approximately 0.1% of the annual dose limit of 50 mSv. CNSC staff observed that NB Power anticipated the potential alpha hazards and implemented and monitored appropriate protective measures in response to potential exposures. In addition, NB Power revised the ALARA plan related to this radiological work to clarify its expectations for future activities associated with the steam generators. CNSC staff accepted the revised ALARA plan.

Radiological hazard control

CNSC staff determined that NB Power implemented radiological hazard controls that met or exceeded the applicable regulatory requirements.

NB Power did not report any exceedances of action levels for surface contamination control in 2018.

Compliance verification activities conducted in 2018 indicated that radiological hazard control at Point Lepreau was highly effective [GPLRPD-2018-001, GPLRPD-2018-002, GPLRPD-2018-007, GPLRPD-2018-009, GPLRPD-2018-015]. No non-compliances were identified.

In 2018, NB Power focused on improving the control of contamination at Point Lepreau. CNSC staff observed that NB Power exceeded its year-end targets for the personnel contamination events (PCE) safety performance indicator in 2018 and did not report any assigned skin doses for those PCEs. In addition, NB Power's effort toward improving the number of PCEs was noted in 2018.

In July 2018, nine new whole-body monitors were installed and commissioned for detection of personnel contamination from alpha and beta emitters at two boundaries– (Zone 2:1 and Zone 2:Unzoned).

Estimated dose to the public

CNSC staff determined that NB Power continued to ensure the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to members of the public from Point Lepreau was at 0.00072 mSv, well below the annual dose limit of 1 mSv (see section 2.7 for additional data).

NB Power met all emission (release limits (i.e., derived release limits (DRLs)). NB Power did not approach or exceed any action levels in 2018. CNSC staff were extremely satisfied with NB Power's performance in this specific area.

3.5.8 Conventional health and safety

CNSC staff concluded that the conventional health and safety SCA at Point Lepreau met or exceeded the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a "fully satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Performance	Y	Assessed, described below
Practices	Y	Assessed, described below
Awareness	Y	Assessed, but no significant developments

Performance

CNSC staff determined that NB Power met or exceeded requirements at Point Lepreau in regards to conventional health and safety performance. NB Power kept workers safe from occupational injuries while conducting its licensed activities at Point Lepreau. Health- and safety-related incidents were reported by NB Power on an ongoing basis.

CNSC staff observed that the accident severity rate (ASR) for Point Lepreau increased from zero in 2018 to 3.4 in 2018. The accident frequency (AF) remained relatively constant at 0.3 in 2018, unchanged from 2017. CNSC staff found the ASR and AF values at Point Lepreau to be acceptable. Additional ASR and AF data is provided in section 2.8.

Practices

CNSC staff determined through field inspections [GPLRPD-2018-007, GPLRPD-2018-009, GPLRPRD-2018-015] that NB Power met or exceeded the applicable regulatory requirements at Point Lepreau in 2018 regarding practices for scaffolding and ladders. Other inspections on radioactive waste management [GPLRPD-2018-002], the SRWMF [GPLRPD-2018-001] and the planned outage [GPLRPD-2018-008] confirmed that NB Power met the applicable regulatory requirements related to conventional health and safety practices in 2018.

The conventional health and safety work practices and conditions at Point Lepreau continued to achieve a high degree of personnel safety. CNSC staff observed that NB Power encouraged safe operating practices in 2018.

3.5.9 Environmental protection

CNSC staff concluded the environmental protection SCA at Point Lepreau met the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for the Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Effluent and emissions control (releases)	Y	Assessed, described below
Environmental management system	Y	Assessed, described below
Assessment and monitoring	Y	Assessed, described below
Protection of the public	Y	Assessed, described below
Environmental risk assessment	Y	Assessed, described below

Effluent and emissions control (releases)

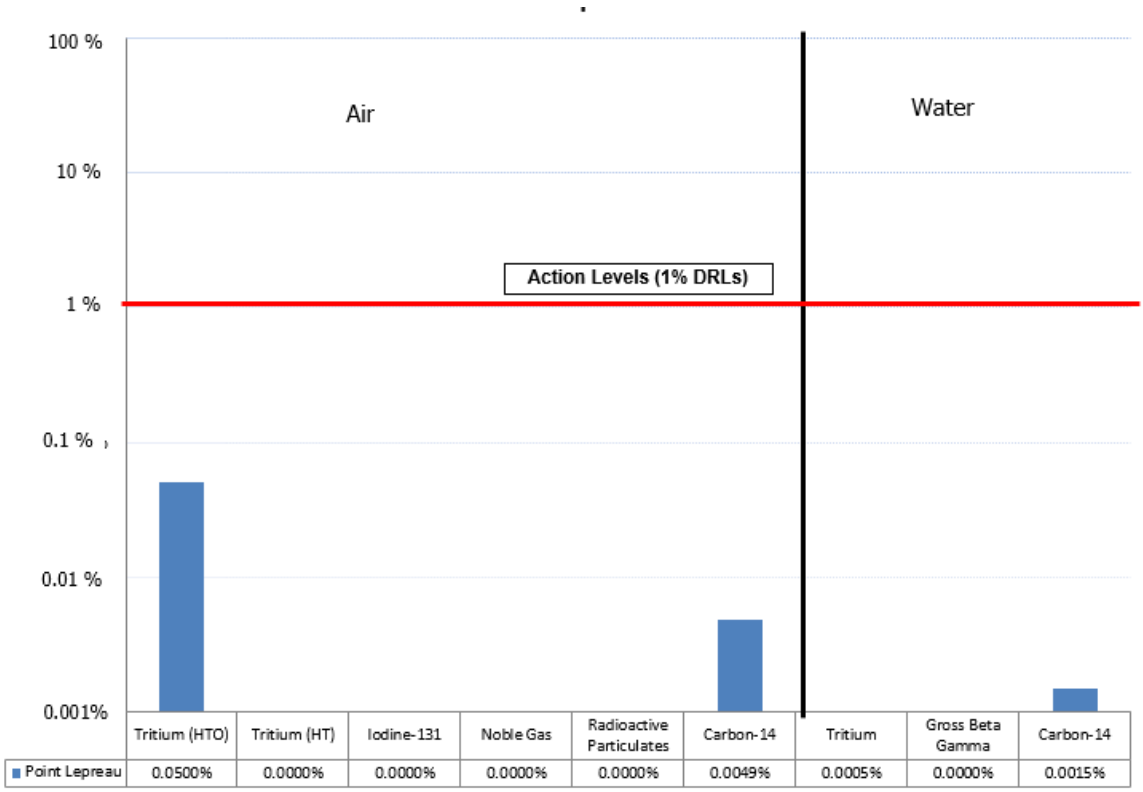
CNSC staff observed that all airborne and waterborne radiological releases from Point Lepreau remained below the regulatory limits and action levels. The releases for Point Lepreau are shown in figure 21 as percentages of the applicable DRLs. The absolute values for releases and DRLs for Point Lepreau are provided in Appendix H.

In 2018, NB Power submitted revised DRLs for Point Lepreau (calculated per Update No.3 of CSA group standard N288.1-14, *Establishing and implementing action levels for releases to the environment from nuclear facilities*). They were, in general, more restrictive (95.6% of airborne DRLs and 89.1% of waterborne) than the previous DRLs. The more restrictive the DRL of a radionuclide is, the more likely the environment is protected from the radiological impacts of that radionuclide.

In June 2018, NB Power confirmed that all implementation plan milestones had been met for CSA Group standard N288.5, *Effluent monitoring programs at Class 1 nuclear facilities and uranium mines and mills*. CNSC staff confirmed that NB Power complied with the standard.

NB Power plans to review and implement 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* as part of the PSR. NB Power included both of these standards in its PSR report for safety factor 14, radiological impact on the environment, which it submitted to the CNSC for review in December 2018.

Figure 21: Effluent and emissions at Point Lepreau as percentages of DRLs



Environmental management system

In 2018, Point Lepreau programs and processes used for environmental monitoring and for the routine recording and evaluation of operating experience related to protection of the environment were well aligned with industry best practices and compliant with the applicable regulatory requirements.

Point Lepreau is certified to the ISO standard 14001:2015: *Environmental management systems - Requirements with guidance for uses*.

NB Power was reviewing the 2017 version of CNSC regulatory document REGDOC-2.9.1 *Environmental Principles, Assessment and Protection Measures* as part of the PSR scope. The review will be completed in June 2021, as part of the review for safety factor 14, radiological impact on the environment.

Assessment and monitoring

CNSC staff determined that NB Power's programs for assessment and monitoring met the applicable regulatory requirements in 2018. Based on the review of the 2018 environmental monitoring data, CNSC staff concluded that the public and the environment in the vicinity of Point Lepreau were protected.

CNSC staff did not conduct independent environmental monitoring around Point Lepreau in 2018. The most recent results from 2017 are available on the CNSC's IEMP webpage [http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/point-

lepreau.cfm], and indicated that there were no expected health impacts in the vicinity of Point Lepreau.

In January 2018, NB Power completed the implementation of CSA Group standard N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*.

NB Power 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.

Protection of the public

CNSC staff confirmed that the public in the vicinity of Point Lepreau was protected from hazardous substances and that there were no expected health impacts from operations. Spills that occurred on site in 2018 were minor in nature and immediately cleaned up. As a result, there were no releases of hazardous substances from Point Lepreau that exceeded the provincial regulatory limits in 2018. Dose to the public is discussed in section 3.5.7.

Environmental risk assessment

CNSC staff determined that NB Power implemented an effective environmental risk assessment (ERA) program at Point Lepreau in accordance with the applicable regulatory requirements.

In 2017, NB Power submitted a revised ERA. CNSC staff completed a detailed technical review and found the methodology to be generally consistent with the applicable requirements. However, CNSC staff recommended that future revisions to the ERA include an assessment of magnitude and extent of the thermal plume from discharged cooling water and a broad risk assessment for the inter-tidal and near-surface zones that may be affected by the thermal plume.

In 2018, NB Power continued to provide regular updates to the CNSC and Environment and Climate Change Canada regarding the work to assess the potential impact of the thermal plume.

CNSC staff concluded from its review of the ERA that NB Power had taken adequate measures to protect human health and the environment.

3.5.10 Emergency management and fire protection

CNSC staff concluded that the emergency management and fire protection SCA at Point Lepreau met the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a “satisfactory” rating - unchanged from the previous year.

CNSC staff determined that NB Power implemented comprehensive conventional, nuclear, and fire emergency response capabilities at all times for Point Lepreau. This included personnel and equipment for medical, HAZMAT, search and rescue and fire response.

NB Power conducts training and exercises annually at the Point Lepreau site to ensure all areas of the site have adequate emergency notification and response capability. The NB Power emergency response team is part of the minimum shift complement for Point Lepreau and responds to events within the PLNGS protected area and the SRWMF.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Conventional emergency preparedness and response	Y	Assessed, but no significant developments

Nuclear emergency preparedness and response	Y	Assessed, described below
Fire emergency preparedness and response	Y	Assessed, described below

Nuclear emergency preparedness and response

CNSC staff determined that NB Power maintained a comprehensive nuclear emergency preparedness and response capability that met all the applicable regulatory requirements. NB Power continued to support offsite emergency management organizations and commitments throughout 2018.

In October 2018, NB Power confirmed to the CNSC that it was fully compliant with Version 1 of CNSC regulatory document REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response*.

UPDATE: In January 2019, CNSC staff completed the assessment of NB Power's direct transfer of plant data to the CNSC Emergency Operating Centre in Ottawa during nuclear emergencies and found that it met the applicable requirements. Hourly plant data and live automatic data transfer from Point Lepreau to CNSC were tested and found to be satisfactory. In November 2017, NB Power provided the detailed design documentation for the new Off-site Emergency Operations Center. CNSC staff plan to conduct a field inspection at the new center in April 2019.

In October 2018, NB Power conducted a full-scale (two-day) nuclear emergency exercise named "Synergy Challenge 2018" at the Point Lepreau site in partnership with the New Brunswick Emergency Measures Organization (NBEMO) and other stakeholders. The objective of Synergy Challenge 2018 was to test the overall emergency response capabilities of the participating organizations with an emphasis on the recovery phase. The CNSC participated in the exercise at its Emergency Operations Centre, Point Lepreau (incident command section), the NBEMO Provincial Emergency Operations Centre in Fredericton and Health Canada.

A CNSC inspection and a third party audit were conducted during the exercise. The CNSC inspection [GPLRPD-2019-001] identified non-compliances regarding detailed logs not being completed as required and the readiness for use of the off-site survey team equipment. NB Power was working to correct these issues at the end of 2018.

NB Power 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 NB Power included:

- Managing response operations: Coordination of response activities could be enhanced with more effective and efficient use of all available resources (including liaison officers and field officers).
- Managing recovery operations: The process and consequences for de-escalation of on-site and/or off-site emergency levels must be fully understood and aligned between agencies.
- Public and media communications: The validation and approval process to notify the public of advisories recommended by the Technical Advisory Group must be formalized and fully understood to optimize timely and efficient communications to the public.

Fire emergency preparedness and response

CNSC staff determined, through field verifications and other activities, that NB Power implemented a fire protection program that met the applicable regulatory requirements.

NB Power has an extensive fire drill and training program that includes a facility for live fire training at the Point Lepreau site.

In addition to CNSC compliance activities, NB Power conducts expert third party reviews: of plant condition inspection (annual), fire drill audit (bi-annual) and fire program audit (tri-annual).

In March 2018, CNSC staff concluded that the approach and methodology used for the update of the fire hazard assessment (FHA) and fire safe shutdown analysis (FSSA) were acceptable and me the applicable regulatory requirements. However, CNSC staff identified additional comments to be considered by NB Power in the next submission (2022). For example, the FSSA referenced codes and applicable standards that were inconsistent with the current version of the applicable CSA Group . In addition, a number of data anomalies were discovered in the PB FANS SIM during the consequence resolution process. Though these were classified as minor deficiencies, NB Power committed to ensure that all the components of the FHA and the FSSA documents are appropriately maintained and aligned with the applicable CSA requirements in the next submission.

3.5.11 Waste management

CNSC staff concluded that the waste management SCA at Point Lepreau as well as at the SRWMF met the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a “satisfactory” rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Waste characterization	Y	Assessed, but no significant developments
Waste minimization	Y	Assessed, described below
Waste management practices	Y	Assessed, described below
Decommissioning plans	Y	Assessed, described below

Waste minimization

CNSC staff determined that NB Power’s waste management program for minimizing radioactive waste met the applicable regulatory requirements.

During field inspections in 2018 [GPRPLD-2018-02, GPLRPD-2018-07, GPLRPD-2018-09 and GPLRPD-2018-15], CNSC staff observed that radioactive waste was properly bagged, tagged and located (with one exception that was corrected at the time of the inspection) and that radioactive waste receptacles and bags were observed to be available in zonal boundary areas.

Waste management practices

CNSC staff determined that NB Power’s waste management practices met the applicable regulatory requirements. In September 2018, NB Power confirmed to have met all its milestones for implementation of CSA Group standard N292.0-14, *General Principles for the management of Radioactive waste and Irradiated Fuel*.

In March 2018, CNSC staff inspected the SRWMF [GPLRPD-2018-001] and confirmed that NB Power met the applicable regulatory requirements in the areas of practices, effluent and emissions

control, maintenance, personnel training, records management, organization, conduct of licensed activity, radiological hazard control, worker dose control and waste management practices.

Also in March 2018, CNSC staff inspected radioactive waste management and found that NB Power complied with the applicable regulatory requirements, except for one non-compliance regarding discrepancies found in a few procedures. In July 2018 CNSC staff confirmed that NB Power had satisfactorily corrected the documentation.

The PROL for Point Lepreau requires NB Power to submit a quarterly report on the SRWMF. CNSC staff were satisfied with all reports and additional information submitted by NB Power for the SRWMF.

Decommissioning plans

The preliminary decommissioning plan for Point Lepreau met the applicable regulatory requirements in 2018.

In September 2018 NB Power was confirmed to have met all implementation milestones to CSA N294-09, Update 1 Decommissioning of Facilities Containing Nuclear Substances. The PDP was not changed in 2018. The associated financial guarantee is discussed in section 2.15.

3.5.12 Security

CNSC staff concluded that the security SCA at Point Lepreau met the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Facilities and equipment	Y	Assessed, described below
Response arrangements	Y	Assessed, described below
Security practices	Y	Assessed, described below
Drills and exercises	Y	Assessed, but no significant developments

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. No significant equipment failures were reported to the CNSC in 2018.

At the end of 2018, NB Power was upgrading the security screening equipment, with a planned completion date by the end of 2019.

Cyber Security

CNSC staff concluded that the cyber security program at Point Lepreau met the applicable regulatory requirements in 2018.

NB Power continued to implement the CSA Group standard N290.7-14, *Cyber security for nuclear power plants and small reactor facilities* to meet the target date of December 31, 2019. CNSC staff were satisfied with the progress in 2018.

In 2017, CNSC staff inspected cyber security at Point Lepreau [GPLRPD-2017-007] and identified non-compliances that were resolved in June 2018 to the satisfaction of CNSC staff.

Response arrangements

CNSC staff conducted three field inspections at Point Lepreau in 2018 that focused on response arrangements and determined that NB Power met the applicable regulatory requirements. An inspection of nuclear security training is discussed above under the specific area personnel training.

Security practices

CNSC staff determined that NB Power implemented security practices at Point Lepreau that met the applicable regulatory requirements. A field inspection in 2018 confirmed compliance and did not identify any safety-significant findings.

3.5.13 Safeguards and non-proliferation

CNSC staff concluded that the Safeguards and non-proliferation SCA at Point Lepreau met the performance objectives and applicable regulatory requirements. As a result, Point Lepreau received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	Point Lepreau	
	Applicable	Notes
Nuclear material accountancy and control	Y	Assessed, but no significant developments
Access and assistance to the IAEA	Y	Assessed, described below
Operational and design information	Y	Assessed, described below
Safeguards equipment, containment and surveillance	Y	Assessed, but no significant developments

Access and assistance to the IAEA

Pursuant to the Canada/IAEA safeguards agreements and the facility's licence conditions, NB Power granted adequate access and assistance to the IAEA for safeguards activities, including inspections and the maintenance of equipment at Point Lepreau. In 2018, the IAEA conducted one complementary access visit at Point Lepreau to verify the nuclear material inventory and assure the absence of undeclared nuclear material and activities. Details on other IAEA activities are provided in section 2.13.

Operational and design information

CNSC staff confirmed that NB Power met the applicable regulatory requirements for operational and design information for Point Lepreau. See Section 2.13 for additional information.

NB Power submitted its annual operational program with quarterly updates for Point Lepreau to the CNSC on time. NB Power 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.

3.5.14 Packaging and transport

CNSC staff determined that NB Power has a packaging and transport program for Point Lepreau that ensures compliance with the P*ackaging and Transport of Nuclear Substances Regulations*, 2015 and the *Transportation of Dangerous Goods Regulations*. The program was effectively implemented and the transport of nuclear substances to and from the facility was conducted in a safe manner. As a result, Point Lepreau received a "satisfactory" rating - unchanged from the previous year.

The following table lists the specific areas under this SCA, explains their applicability for Point Lepreau and provides notes regarding the assessments for the 2018 regulatory oversight report.

Specific Area	**Point Lepreau**	
	Applicable	Notes
Package design and maintenance	Y	Assessed, described below
Packaging and transport	Y	Assessed, described below
Registration for use	Y	Assessed, described below

Packaging design and maintenance, packaging and transport, and registration for use

There was one field inspection of packaging and transport at Point Lepreau in 2018 [GPLRPD-2018-015]. CNSC staff verified that all employees who are engaged in transport-related activities were adequately trained, radioactive materials to be transported were appropriately classified and packaged, all safety marks were appropriately displayed on packages and the documentation accompanying the shipments was properly completed.

3.6 Gentilly-2

L'évaluation de la sûreté présentée pour chaque domaine de sûreté et de réglementation (DSR) dans la section suivante est spécifique aux installations de Gentilly-2. L'information générale pertinente aux DSR est présentée à la section 2. Les documents d'application de la réglementation de la CCSN ainsi que les normes du groupe CSA identifiés comme exigences réglementaires pour les installations de Gentilly-2 à partir du mois de décembre 2018 sont présentés à l'annexe E.

Évaluation globale de la sûreté

Les cotes de performance découlant de l'évaluation de la sûreté réalisée par le personnel de la CCSN pour les installations de Gentilly-2 sont présentées au tableau 34 ci-dessous.

Tableau 34 : Cotes de performance pour les installations de Gentilly-2, 2018

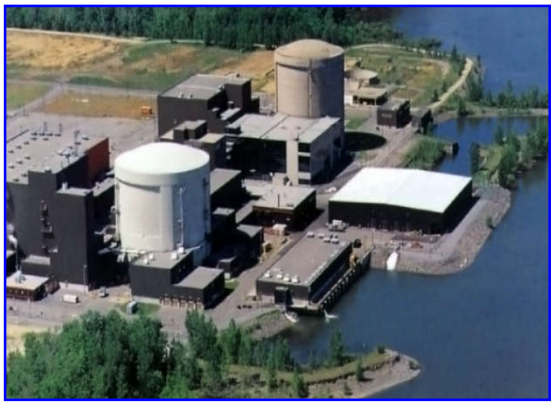
Domaine de sûreté et de réglementation	Cote
Système de gestion	SA
Gestion de la performance humaine	SA
Conduite de l'exploitation	SA
Analyse de sûreté	SA
Conception matérielle	SA
Aptitude fonctionnelle	SA
Radioprotection	SA
Santé et sécurité classiques	SA
Protection de l'environnement	SA
Gestion des urgences et protection incendie	SA
Gestion des déchets	SA
Sécurité	SA
Garanties et non-prolifération	SA
Emballage et transport	SA

Légende : ES – Entièrement satisfaisant SA – Satisfaisant
IA – Inférieur aux attentes I – Inacceptable

En 2018 le personnel de la CCSN a revu ses critères pour coter les domaines particuliers des DSR. En plus d'évaluer les titulaires de permis par rapport à des exigences en constante évolution, le personnel de la CCSN a également resserré ses critères pour la cote « Entièrement satisfaisant ». Dans la foulée de la révision des critères, la décision de ne pas inclure une cote globale pour chaque installation a également été prise (ces cotes globales par installation étaient incluses dans le Rapport de surveillance réglementaire des sites de centrales nucléaires au Canada pour 2017).

En se basant sur l'évaluation des DSR ainsi que d'autres observations réalisées en 2018, le personnel de la CCSN a conclu qu'Hydro-Québec a exploité les installations de Gentilly-2 de façon sûre et s'est acquitté de ses obligations en matière de sûreté en faisant la promotion d'une saine culture de sûreté.

3.6.0 Introduction



Gentilly-2 est située sur la rive sud du fleuve Saint-Laurent à Bécancour (Québec), environ 15 km à l'est de la ville de Trois-Rivières. Elle appartient à Hydro-Québec et est gérée par celle-ci.

Le réacteur CANDU de Gentilly-2 présentait une capacité nominale de 675 mégawatts électriques (MWé). Il est entré en exploitation commerciale en 1983, a été mis à l'arrêt définitif le 28 décembre 2012 et a été complètement déchargé de son combustible le 3 septembre 2013. En décembre 2014, Gentilly-2 a complété la transition vers l'état de stockage sûr, c'est-à-dire que son combustible stocké se trouve dans les piscines de combustible irradié (stockage en piscine) ou dans des modules de stockage CANSTOR (stockage à sec).

Autorisation

Après une audience de la Commission le 5 mai 2016 pour examiner la demande de permis de déclassement et de gestion des déchets d'Hydro-Québec [CMD 16-H4], la Commission a annoncé sa décision de délivrer à Hydro-Québec un permis de déclassement d'un réacteur de puissance (PDRP) pour les installations de Gentilly-2. Le permis est en vigueur du 1er juillet 2016 au 30 juin 2026.

Manuel des conditions de permis

Le Manuel des conditions de permis des installations de Gentilly-2 a été émis en même temps que le permis en 2016.

MISE À JOUR: Le Manuel des conditions de permis a été révisé en février 2019 afin de refléter l'évolution et les changements survenus aux installations de Gentilly-2.

Autorisation en vertu de la *Loi sur les pêches*

Hydro-Québec a réalisé une auto-évaluation en vertu de la *Loi sur les pêches* avant le renouvellement de son permis en 2016. Le personnel de la CCSN a examiné cette auto-évaluation et a conclu qu'une autorisation en vertu de la *Loi sur les pêches* n'était pas requise.

Rapports initiaux d'événements

Aucun rapport initial d'événement mettant en cause Gentilly-2 n'a été présenté à la Commission entre le 1er janvier 2017 et le 1er juin 2018.

Programme de conformité

Les efforts annuels du personnel de la CCSN au niveau du programme de conformité pour les installations de Gentilly-2 sont présentés à l'annexe G.5. Les inspections réalisées aux installations de Gentilly-2 qui ont été considérées pour l'évaluation de la sûreté dans ce rapport de surveillance réglementaire des sites de centrales nucléaires sont incluses dans le tableau 35 ci-après :

Tableau 35 : Liste des inspections aux installations de Gentilly-2

Domaine de sûreté et de réglementation	Titre de l'inspection	Date d'envoi du rapport d'inspection
Gestion des déchets	Installations de gestion des déchets et installations de stockage à sec du combustible Numéro de Rapport : DPRGPL-2017-003	13 février 2018
	Installations de gestion des déchets et installations de stockage à sec du combustible Numéro de Rapport : DPRGPL-2018-002	14 décembre 2018

3.6.1 Système de gestion

Le personnel de la CCSN a conclu que le DSR Système de gestion de Gentilly-2 respecte les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	Gentilly-2	
	Applicable	Notes
Système de gestion	O	Cote pas attribuée
Organisation	O	Cote pas attribuée
Gestion du changement	O	Cote pas attribuée
Culture de sûreté	O	Cote pas attribuée
Gestion de la configuration	O	Cote pas attribuée
Gestion des documents	O	Cote attribuée, décrit ci-dessous
Gestion des entrepreneurs	O	Cote pas attribuée
Continuité des opérations	O	Cote pas attribuée
Expérience d'exploitation	O	Cote pas attribuée
Évaluation du rendement, amélioration et examen de la gestion	O	Cote pas attribuée

Gestion des documents

Le personnel de la CCSN a déterminé qu'Hydro-Québec a appliqué un système de contrôle et de gestion des documents qui a respecté les exigences applicables, puisque les constats reliés à l'inspection sur la conservation des enregistrements ont été fermés en 2018.

Le personnel de la CCSN a réalisé une inspection en 2017 [DPRGPL-2017-001] visant à évaluer la gestion des documents aux installations de Gentilly-2. Le personnel de la CCSN a conclu qu'Hydro-Québec respectait les exigences réglementaires relatives à la gestion des documents, bien que quelques situations de non-conformité mineures aient été relevées à l'égard de la documentation. Plus particulièrement, le personnel de la CCSN a remarqué que le Manuel de gestion de la qualité (MGQ) d'Hydro-Québec ne décrivait pas une interface entre les Installations de Gentilly-2 et le Centre de document semi-actifs (CDSA) situé à Montréal. Cette interface est nécessaire pour établir des mesures visant à communiquer de façon systématique avec le personnel des Installations de Gentilly-2 pour tout événement pouvant affecter la préservation des

documents. Le personnel de la CCSN a également observé des non-conformités mineures au niveau de la maîtrise des paramètres environnementaux et des enregistrements qui y sont reliés.

En 2018, le personnel de la CCSN a continué de faire le suivi sur la mise en œuvre du plan de mesures correctives d'Hydro-Québec pour régler les non-conformités observées lors de l'inspection. Le personnel de la CCSN a jugé que les correctifs mis en place étaient acceptables.

3.6.2 Gestion de la performance humaine

Le personnel de la CCSN a conclu que le DSR Gestion de la performance humaine à Gentilly-2 respectait les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations ont obtenu la cote «Satisfaisant », soit- la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	**Gentilly-2**	
	Applicable	Notes
Programme de performance humaine	O	Cote pas attribuée
Formation du personnel	O	Cote attribuée, décrit ci-dessous
Accréditation du personnel	O	Cote attribuée, décrit ci-dessous
Examens d'accréditation initiale et tests de requalification	O	Cote pas attribuée
Organisation du travail et conception des tâches	O	Cote attribuée, décrit ci-dessous
Aptitude au travail	O	Cote attribuée, décrit ci-dessous

Formation du personnel

Le personnel de la CCSN a déterminé que Gentilly-2 possède un système de formation basé sur une approche systématique à la formation (ASF).

Le personnel de la CCSN a effectué une visite au site de Gentilly-2 au mois de mars 2018 afin d'évaluer divers domaines liés à la formation associée au poste de responsables de site (RDS), au retrait de la brigade incendie industrielle (BII) du site ainsi qu'aux responsables techniques de la radioprotection (RTR). Aucune lacune n'a été relevée en lien avec cette visite au site.

Accréditation du personnel

Le seul poste qui est encore accrédité par la CCSN aux installations de Gentilly-2 est celui de responsable technique de la radioprotection (RTR). Aucune demande d'accréditation ou de renouvellement d'une accréditation en tant que RTR n'a été soumise à la CCSN en 2018. Le personnel de CCSN n'a relevé aucun constat pertinent à ce domaine particulier en 2018. Ainsi la cote de « Satisfaisant » obtenue en 2017 est conservée.

Examens d'accréditation initiale et tests de requalification

Ce domaine particulier n'a pas été coté puisqu'Hydro-Québec, aux installations de Gentilly-2, ne maintient plus de programmes d'examens initiaux et de tests de requalification du personnel accrédité. Les personnes agissant à titre de responsable technique de la radioprotection (RTR) sont les seules personnes encore accréditées à Gentilly-2, et celles-ci sont évaluées directement par le personnel de la CCSN.

Organisation du travail et conception des tâches

La surveillance du site des installations de Gentilly-2 en dehors des heures normales de travail est effectuée en utilisant un système de communication qui déclenche automatiquement le processus de rappel au site d'un responsable de site.

Aucun écart concernant le domaine particulier de l'organisation du travail et de la conception des postes n'était rapporté pour l'année 2018.

Bien qu'il n'y ait pas d'écarts rapportés relatifs à ce domaine particulier, le personnel de la CCSN a analysé en 2018 les rapports trimestriels concernant l'activation du système de rappel des trimestres précédents et l'a jugé acceptable.

Depuis sa mise en service, aucun problème concernant l'utilisation du système n'a été déclaré. Le personnel de la CCSN est satisfait du système. Bien que le personnel de la CCSN ait demandé à Hydro-Québec de conserver les archives des informations reliées aux événements résultant de l'activation du système, la transmission à la CCSN de ces rapports d'événements n'est plus requise depuis 2018.

Aptitude au travail

Le personnel de la CCSN a déterminé qu'Hydro-Québec répondait aux exigences réglementaires applicables en matière d'aptitude au travail à Gentilly-2. Dans l'ensemble, le personnel de la CCSN est satisfait de l'aptitude des travailleurs à l'exercice de leurs fonctions.

À la fin de 2017, le personnel de la CCSN a demandé à Hydro-Québec de soumettre un plan de mise en œuvre du REGDOC-2.2.4, *Aptitude au travail : Gérer la fatigue des travailleurs* et du REGDOC-2.2.4, *Aptitude au travail, tome II : Gérer la consommation d'alcool et de drogues*.

Hydro-Québec a soumis le plan de mise en œuvre comprenant une analyse des écarts à la fin du mois de mars 2018. Le personnel de la CCSN a analysé les soumissions initiales d'Hydro-Québec et noté des progrès significatifs concernant la mise en œuvre. Hydro-Québec s'est engagée à implanter REGDOC 2.2.4 tome II pour Juillet 2019. En ce qui a trait à la gestion de la fatigue des travailleurs, des informations additionnelles ont été soumises et sont actuellement analysées par le personnel de la CCSN.

Le RD-363 a été remplacé par le REGDOC-2.2.4, *Aptitude au travail, tome III : Aptitudes psychologiques, médicales et physiques des agents de sécurité nucléaire,* qui a été publié en septembre 2018. Hydro-Québec travaille à la mise en œuvre des nouvelles exigences.

3.6.3 Conduite de l'exploitation

Le personnel de la CCSN a conclu que le DSR Conduite de l'exploitation a respecté les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	**Gentilly-2**	
	Applicable	Notes
Réalisation des activités autorisées	O	Cote attribuée, décrit ci-dessous
Procédures	O	Cote pas attribuée
Rapports et établissement de tendances	O	Cote attribuée, décrit ci-dessous

Rendement de la gestion des arrêts	N	
Paramètres d'exploitation sûre	N	
Gestion des accidents graves et rétablissement	N	
Gestion des accidents et rétablissement	N	

Réalisation des activités autorisées

Le personnel de la CCSN a conclu qu'Hydro-Québec a respecté les exigences réglementaires applicables pour la réalisation des activités autorisées à Gentilly en 2018.

Il y avait deux constats réalisés dans les inspections de Type II des « installations de gestion des déchets radioactifs» (DPRGPL-2017-003, DPRGPL-2018-002) qui étaient positifs pour ce domaine particulier en 2018. Par exemple : les installations étaient exploitées conformément aux procédures et on a observé un respect général des procédures de port de l'équipement de protection individuelle.

Ces informations ont permis de constater qu'Hydro-Québec s'assure que les activités au site de Gentilly-2 sont conduites de façon sécuritaire et à l'intérieur du cadre réglementaire.

Rapports et établissement de tendances

Le personnel de la CCSN a déterminé qu'Hydro-Québec a respecté les exigences réglementaires applicables pour l'établissement des rapports et des tendances à Gentilly en 2018. Les rapports soumis par Hydro-Québec ont été soumis à temps et selon les exigences réglementaires (REGDOC-3.1.1, *Rapports à soumettre par les exploitants de centrales nucléaire*).

Il n'y a pas eu d'événements rapportés en vertu de REGDOC 3.1.1 par Hydro-Québec durant cette période soit en 2018.

3.6.4 Analyse de la sûreté

Le personnel de la CCSN a conclu que le DSR Analyse de la sûreté pour Gentilly-2 ne peut pas être coté pour l'année 2018 puisque la plupart des domaines particuliers ne s'appliquent plus au contexte de Gentilly-2.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	**Gentilly-2**	
	Applicable	Notes
Analyse déterministe de la sûreté	O	Cote attribuée, décrit ci-dessous
Étude probabiliste de sûreté	N	
Analyse de la criticité	N	
Analyse des accidents graves	N	
Gestion des questions de sûreté	N	

Analyse déterministe de la sûreté

Hydro-Québec a soumis un rapport de sûreté pour ses installations de Gentilly-2 en décembre 2014. Ce dernier a été conçu en se basant sur le document d'application de la réglementation REGDOC 2.4.1, *Analyse déterministe de la sûreté*. Ce rapport décrit les risques qui subsistent aux installations de Gentilly-2 ainsi que les moyens qui sont en place pour atténuer les

événements qui sont reliés à ces derniers. Les deux seuls risques qui demeurent sont : les risques sont associés au stockage de l'eau lourde ainsi qu'au fonctionnement de la piscine de refroidissement du combustible. La mise à jour de ce rapport de sûreté est exigée en décembre 2019.

3.6.5 Conception matérielle

Le personnel de la CCSN a conclu que le DSR Conception matérielle respecte les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations de Gentilly-2 ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	Gentilly-2	
	Applicable	Notes
Gouvernance de la conception	O	Cote attribuée, décrit ci-dessous
Caractérisation du site	O	Cote pas attribuée
Conception de l'installation	O	Cote pas attribuée
Conception des structures	O	Cote pas attribuée
Conception des systèmes	O	Cote attribuée, décrit ci-dessous
Conception des composants	O	Cote pas attribuée

Gouvernance de la conception

Le personnel de la CCSN a clos le suivi sur le rapport des enveloppes de pression d'Hydro-Québec a soumis pour l'année 2016 et a effectué la revue du rapport sur les enveloppes de pression pour l'année 2017. Aucun constat négatif n'a été relevé pour le rapport de 2017.

Au niveau des systèmes d'incendie, Hydro-Québec s'est montrée engagée à respecter la norme du Groupe CSA N293, *Protection contre l'incendie dans les centrales nucléaires,* aux installations nucléaires de Gentilly-2. Le rapport d'inspection annuelle de l'état des installations de Gentilly-2 de 2018 a été revu par le personnel de la CCSN (les constats portent sur des cas de non-conformité n'ayant pas d'impact sur la sûreté). Un plan d'action acceptable pour miser sur les possibilités d'amélioration cernées a été soumis au personnel de la CCSN.

Conception des systèmes

Au niveau des systèmes électriques, Hydro-Québec a fait une demande à la CCSN en 2018. Cette demande visait un changement temporaire de la configuration électrique afin de pouvoir réaliser le remplacement de certaines pièces dans le poste de sectionnement électrique. Une autre demande a également été faite afin de ramener le système électrique dans sa configuration initiale après les travaux. Les deux soumissions d'Hydro-Québec ont été revues et acceptées par le personnel de la CCSN.

Aucune préoccupation majeure n'a été notée aux installations de Gentilly-2 en 2018.

3.6.6 Aptitude fonctionnelle

Le personnel de la CCSN a conclu que le DSR Aptitude fonctionnelle respecte les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations de Gentilly-2 ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	Gentilly-2	
	Applicable	Notes
Aptitude fonctionnelle de l'équipement / performance de l'équipement	O	Cote pas attribuée
Entretien	O	Cote attribuée, mais il n'y a eu aucun développement significatif
Intégrité structurale	O	Cote pas attribuée
Gestion du vieillissement	O	Cote pas attribuée
Contrôle chimique	O	Cote pas attribuée
Inspections et essais périodiques	N	

3.6.7 Radioprotection

Le personnel de la CCSN a conclu que le DSR Radioprotection a respecté les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations de Gentilly-2 ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	Gentilly-2	
	Applicable	Notes
Application du principe ALARA	O	Cote pas attribuée
Contrôle des doses reçues par les travailleurs	O	Cote pas attribuée
Rendement du programme de radioprotection	O	Cote pas attribuée
Contrôle des dangers radiologiques	O	Cote attribuée, décrit ci-dessous
Dose estimée au public	O	Cote attribuée, décrit ci-dessous

Contrôle des dangers radiologiques

Des constats ont été réalisés par le personnel de la CCSN lors de deux inspections pour lesquelles les rapports ont été envoyés à Hydro-Québec pendant l'année 2018. Ces constats font état d'un balisage adéquat des risques radiologiques, du respect général des règles de radioprotection en chantier, ainsi que de la disponibilité des équipements destinés à mesurer les rayonnements. Bien que le personnel de la CCSN ait communiqué certaines lacunes sur le plan des pancartes définissant les risques radiologiques, ces lacunes n'étaient pas significatives au niveau de la sûreté et Hydro-Québec y a remédié.

Aucun événement n'a été rapporté relativement au REGDOC 3.1.1 en ce qui a trait au contrôle des dangers radiologiques pour la période visée, soit en 2018.

Il n'y a pas eu non plus de dépassement des seuils d'intervention reliés au contrôle de la contamination.

Dose estimée au public

En 2018, la dose de rayonnement annuelle estimée chez les personnes représentatives était de 0,009 mSv, valeur très inférieure à la limite de dose réglementaire du public de 1 mSv.

3.6.8 Santé et sécurité classiques

Le personnel de la CCSN a conclu que le DSR Santé et sécurité classiques respecte les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations de Gentilly-2 ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	**Gentilly-2**	
	Applicable	Notes
Rendement	O	Cote attribuée, décrit ci-dessous
Pratiques	O	Cote attribuée, décrit ci-dessous
Sensibilisation	O	Cote attribuée, mais il n'y a eu aucun développement significatif

Rendement

Pour ce domaine particulier, Hydro-Québec reçoit la cote « Satisfaisant » pour 2018.

Pour les installations de Gentilly-2, la source principale pour attribuer une cote à ce domaine est l'indicateur de rendement en matière de sûreté 21 Santé et Sécurité classiques, qui documente le taux de gravité des accidents ainsi que le taux d'accidents de travail. Le personnel a fait la revue des indicateurs de rendement en matière de sûreté pour 2018 et la valeur de l'indicateur 21 pour Hydro-Québec était à zéro pour le taux de fréquence et pour le taux de gravité, ce qui est acceptable.

Pratiques

Pour Gentilly-2 il y a eu deux inspections de type II des installations de gestion des déchets radioactifs pour lesquelles les résultats ont été communiqués à Hydro-Québec pendant l'année 2018 :l'une menée en novembre 2017 (DPRGPL-2017-003) et l'autre,en octobre 2018 (DPRGPL-2018-002). Dans ces deux rapports d'inspection, il a été mentionné à la section (XX) que tous les employés observés pendant l'inspection portaient les équipements de protection individuels tel que requis. Ces deux observations sont de nature positive. Par contre, une observation réalisée dans l'inspection d'octobre 2018 faisait mention d'un manque d'information par rapport à l'application d'une norme reliée aux ponts roulants. Ce constat relève qu'il n'y avait pas de preuve que la norme en question était suivie, et Hydro-Québec a répondu au personnel de la CCSN pour ce point précis en fournissant l'information et les preuves demandées par le personnel de la CCSN. Le suivi de ce sujet a été clos à la satisfaction du personnel de la CCSN.

3.6.9 Protection de l'environnement

Le personnel de la CCSN a conclu que le DSR Protection de l'environnement respecte les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations de Gentilly-2 ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	**Gentilly-2**	
	Applicable	Notes
Contrôle des effluents et des émissions (rejets)	O	Cote attribuée, décrit ci-dessous

Système de gestion de l'environnement	O	Cote attribuée, décrit ci-dessous
Évaluation et surveillance	O	Cote attribuée, décrit ci-dessous
Protection du public	O	Cote attribuée, décrit ci-dessous
Évaluation des risques environnementaux	O	Cote attribuée, décrit ci-dessous

Contrôle des effluents et des émissions (rejets)

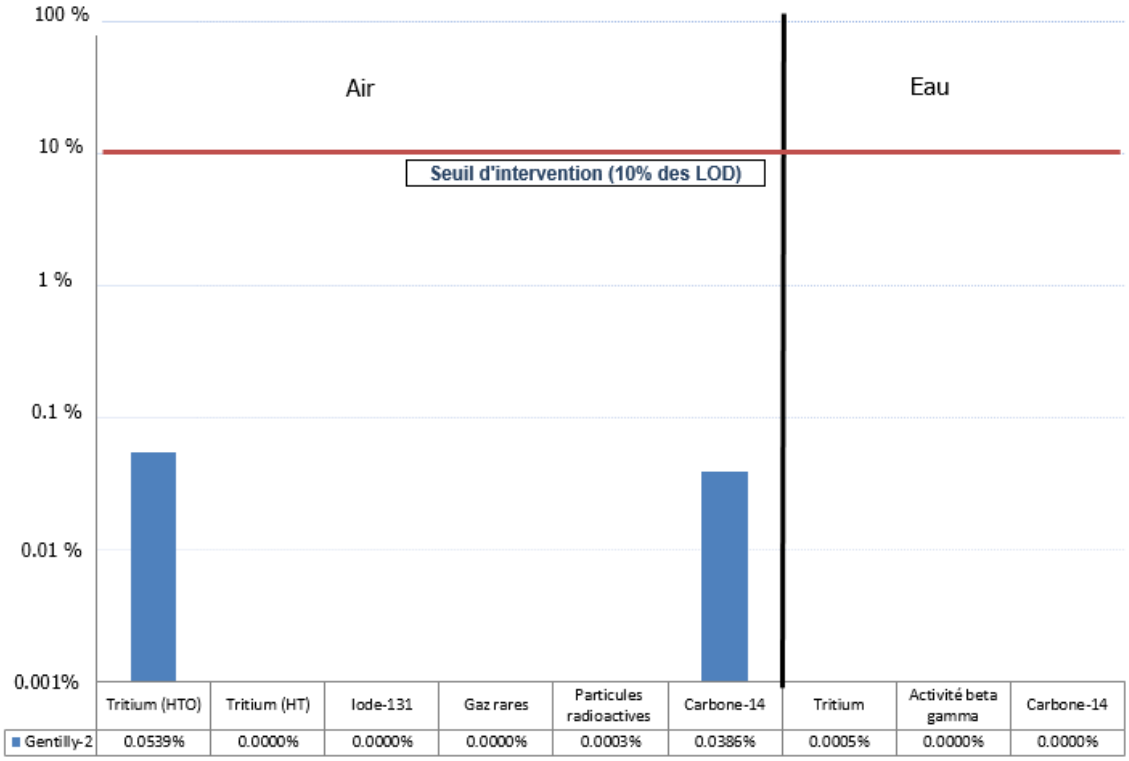
Le personnel de la CCSN a observé que tous les rejets aériens (gazeux) et liquides provenant des installations de Gentilly-2 sont demeurés sous les limites réglementaires et en deçà des seuils d'intervention établis. Les rejets provenant des installations de Gentilly-2 sont présentés au figure 22 et sont exprimés en pourcentage des LOD. Les valeurs absolues des rejets ainsi que les LOD pour les installations de Gentilly-2 sont fournies à l'annexe I.

En 2018, Hydro-Québec a prolongé la ligne de rejet des effluents liquides sur une distance d'environ 800 mètres du début du canal de rejet jusqu'au chenal d'écoulement sud du fleuve Saint-Laurent. À la suite de ce prolongement, Hydro-Québec avait procédé à la révision des LOD liquides.

Les valeurs de LOD (rejets liquides) appliquées en novembre 2018, à la suite de la mise en service du prolongement de la ligne de rejets, étaient de 2,6 à 9,4 fois moins élevées que les valeurs antérieures. Comme le point d'émission des effluents radioactifs liquides est désormais situé dans le chenal sud du fleuve Saint-Laurent, la dose estimée à la population, toujours bien en deçà de la limite permise, pourrait en être influencée. L'estimation de dose tient compte de plusieurs facteurs contributifs, dont celui des voies d'exposition liées à l'emplacement du principal point d'émission des effluents liquides.

Le personnel de la CCSN a fait la revue de l'indicateur de rendement en matière de sûreté n^{o} 5 Rejets dans l'environnement –Radiologiques, pour l'année 2018. Rien d'anormal n'a été remarqué ; et les rejets aux installations de Gentilly-2 pour 2018 étaient bien en deçà des limites applicables. De plus, le personnel de la CCSN en est à revoir le rapport de 2018 sur la protection de l'environnement.

Figure 22: Effluents et émissions à Gentilly-2 en pourcentages de LOD



Système de gestion de l'environnement

En 2018, Hydro-Québec a complété la transition au REGDOC-2.9.1 (version 2013) et confirmé le respect de ce document d'application de la réglementation.

En 2018 également, Hydro-Québec a procédé à la révision 4 de son Manuel de gestion de la qualité (MGQ). Le MGQ inclut de la documentation sur le système de gestion de l'environnement. Il ressort de cette révision 4 un meilleur suivi des tâches. De plus, certaines tâches qui étaient assumées par une seule personne sont maintenant réparties parmi plusieurs.

Évaluation et surveillance

Le personnel de la CCSN a déterminé que les programmes mis en place par Hydro-Québec pour l'évaluation et la surveillance respectaient les exigences réglementaires applicables en 2018. En se basant sur les résultats de sa revue des données de surveillance environnementales pour l'année 2018, le personnel de la CCSN a conclu que le grand public et l'environnement à proximité des installations de Gentilly-2 étaient protégés.

En 2018, le personnel de la CCSN a mené son Programme indépendant de suivi environnemental (PISE) dans les environs des installations nucléaires de Gentilly-2. Les résultats ont indiqué qu'il n'y avait pas d'impacts à prévoir sur la santé aux environs des installations de Gentilly-2 pour l'année 2018.

Les résultats sont disponibles sur le site Web de la CCSN.

http://www.nuclearsafety.gc.ca/fra/resources/maps-of-nuclear-facilities/iemp/gentilly2.cfm

Protection du public

Le personnel de la CCSN a confirmé que le grand public à proximité des installations de Gentilly-2 était protégé des matières dangereuses et qu'il n'y avait pas d'impacts à prévoir sur la santé résultant de l'exploitation de l'installation de Gentilly-2 pour l'année 2018. Aucun rejet de matières dangereuses dépassant les limites réglementaires provinciales n'a été rapportés en 2018 pour les installations de Gentilly-2.

La dose au public est abordée à la section 3.6.7.

Évaluation des risques environnementaux

Le personnel de la CCSN a conclu qu'Hydro-Québec continuait de mettre en œuvre et d'assurer un programme efficace d'évaluation et de gestion des risques environnementaux aux installations de Gentilly-2 conformément aux exigences réglementaires applicables.

Hydro-Québec a soumis sa dernière analyse de risque environnemental en 2006 (pour la réfection anticipée de Gentilly-2). À la suite de la décision d'Hydro-Québec de fermer Gentilly-2, cette dernière avait été jugée acceptable par le personnel de la CCSN pour les activités de déclassement qui y seraient alors entreprises. De plus, le personnel de la CCSN avait également réalisé une évaluation environnementale en vertu de la Loi sur la Sûreté et Réglementation Nucléaire en 2016 pour la demande de permis de déclassement de Gentilly-2.

Le personnel de la CCSN a revu le rapport annuel qui présente les résultats du programme de surveillance de l'environnement aux installations de Gentilly-2 pour l'année 2018 et n'a relevé aucun constat négatif ou préoccupant concernant l'impaction sur les poissons ou les risques radiologiques et chimiques à l'environnement. Le personnel de la CCSN a déterminé que les conclusions de l'analyse de risque environnemental de 2006 demeurent valides dans le contexte actuel des installations de Gentilly-2, et qu'Hydro-Québec a pris les mesures appropriées afin de protéger la santé de la population et l'environnement.

3.6.10 Gestion des urgences et protection-incendie

Le personnel de la CCSN a conclu que le DSR Gestion des urgences et protection-incendie respecte les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations de Gentilly-2 ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Hydro-Québec organise annuellement une formation et des exercices pour s'assurer que le site dispose des capacités adéquates de notification et d''intervention en cas d'urgence.

En poursuivant les activités reliées au déclassement des installations de Gentilly-2, Hydro-Québec a continué à réduire de façon significative les risques aux installations de Gentilly-2 en 2018. Pour cette raison, il n'y a plus de brigade incendie à temps plein, et le personnel n'est plus formé pour une capacité d'intervention HAZMAT. Le protocole d'entente signé avec la municipalité de Bécancour est demeuré en vigueur pendant l'année 2018 afin de fournir des services d'intervention en cas d'urgence. Le personnel d'expérience, c'est-à-dire les « responsables de site » (RDS) de Gentilly-2, demeure en service et est disponible en tout temps (24/7) pour apporter de l'aide et intervenir en cas d'incident concernant les risques conventionnels, au besoin.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	Gentilly-2	
	Applicable	Notes
Préparation et intervention en cas d'urgence classique	O	Cote attribuée, mais il n'y a eu aucun développement significatif
Préparation et intervention en cas d'urgence nucléaire	O	Cote attribuée, décrit ci-dessous
Préparation et intervention en cas d'incendie	O	Cote attribuée, décrit ci-dessous

Préparation et intervention en cas d'urgence nucléaire

Le personnel de la CCSN a déterminé qu'Hydro-Québec a maintenu un programme complet de mesures d'urgences nucléaire et une capacité de réponse qui respecte les exigences réglementaires.

Une organisation des mesures d'urgence est présente sur le site des installations de Gentilly-2 et elle est documentée dans les encadrements d'Hydro-Québec. Un centre d'urgence est disponible sur le site. Il est à noter qu'en fonction des risques radiologiques résiduels présents sur le site de Gentilly-2, tous les systèmes du bâtiment réacteur contenant de l'eau lourde ont été vidangés et asséchés. L'eau lourde provenant du système caloporteur a été valorisée chez un autre titulaire de permis et l'eau lourde provenant du système modérateur est entreposée de façon sécuritaire dans les quatre (4) réservoirs du système d'alimentation de D2O (38110) à l'intérieur du bâtiment des services.

En fonction de l'état actuel des installations, il a été déterminé qu'un événement radiologique n'aurait pas d'effets significatifs à l'extérieur de la zone d'exclusion des installations de Gentilly-2.

En conclusion, l'organisation et le centre des mesures d'urgence sont en mesure de répondre aux urgences qui pourraient survenir aux installations de Gentilly-2.

Préparation et intervention en cas d'incendie

Hydro-Québec a mis en œuvre un programme de protection-incendie aux installations de Gentilly-2 qui respecte les exigences réglementaires applicables. Les activités réalisées dans le cadre du déclassement ont contribué et continuent de contribuer à diminuer de façon significative le risque d'incendie sur le site.

Les grands volumes d'huile, contenus dans les différents systèmes arrêtés, ont été drainés. L'huile usée non contaminée a été évacuée à l'extérieur du site (au Centre de récupération des matières dangereuses d'Hydro-Québec, à Saint-Hyacinthe). Le grand volume d'huile usée faiblement contaminée est entreposé en barils sur le site, dans des conteneurs à double fond conçus pour l'entreposage de matières dangereuses.

Les groupes électrogènes de catégories III et 0, ainsi que les motopompes associées au système d'eau de service re-circulée, ont été mis en retrait. Cette mise en retrait inclut la vidange des réservoirs de diesel, l'évacuation hors site du diesel et le retrait des réservoirs du sol. L'hydrogène contenu dans l'alternateur et les bonbonnes associées a été retiré du site.

La revue du rapport d'inspection annuelle de l'état des installations de Gentilly-2 de 2018 n'a généré aucun constat significatif. Un plan d'action acceptable pour mettre en œuvre les

opportunités d'amélioration relevées, comme la gestion des matières inflammables dans les ateliers et la mise à la terre des cabinets destinés à l'entreposage des matériaux inflammables dans les ateliers, a été soumis au personnel de la CCSN. Les constats relevés sont des non-conformités n'ayant pas d'impact sur la sûreté.

Également, depuis décembre 2017, Hydro-Québec a achevé le retrait de sa brigade incendie du site des installations de Gentilly-2. Hydro-Québec a renouvelé une entente avec le service de sécurité-incendie de la Ville de Bécancour (SSIB) pour le service d'intervention en cas d'incendie. Afin de respecter l'entente, Hydro-Québec doit procéder à deux exercices conjoints par année avec le SSIB. Hydro-Québec a confirmé au personnel de la CCSN que la formation de familiarisation sur le site avait été donnée aux officiers du SSIB. Le personnel de la CCSN a vérifié sur le site des installations de Gentilly-2 que les employés de l'organisation de Gentilly-2, incluant les agents de sécurité nucléaire, sont formés pour le maniement d'extincteur.

3.6.11 Gestion des déchets

Le personnel de la CCSN a conclu que le DSR Gestion des déchets respecte les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations de Gentilly-2 ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	**Gentilly-2**	
	Applicable	Notes
Caractérisation des déchets	O	Cote pas attribuée
Réduction des déchets	O	Cote pas attribuée
Pratiques de gestion des déchets	O	Cote attribuée, décrit ci-dessous
Plans de déclassement	O	Cote attribuée, décrit ci-dessous

Pratiques de gestion des déchets

Le personnel de la CCSN a déterminé que les pratiques d'Hydro-Québec en matière de gestion des déchets aux installations de Gentilly-2 respectaient les exigences réglementaires et qu'elles étaient efficaces pour les matières dangereuses et les déchets radioactifs.

Pour la période couverte en 2018, deux rapports d'inspection de conformité de type II sur les installations de gestions des déchets radioactifs ont été réalisés aux installations de Gentilly-2 (DPRGPL-2017-003, DPRGPL-2018-002).

Des constats positifs ont été réalisés sur l'exploitation de l'aire de stockage des déchets radioactifs (ASDR) ainsi que de l'aire de stockage à sec du combustible irradié (ASSCI), notamment au niveau du respect du port des équipements de protection individuelle et au niveau de l'opération des systèmes requis. Les constats étaient que l'exploitation était faite en conformité avec les exigences. Des cas de non-conformité aux encadrements du titulaire de permis ont été signalés au niveau de l'exploitation de l'aire de stockage à sec du combustible irradié (ASSCI). Ce constat concernait les loquets sur les cabinets d'échantillonnage des Modules CANSTOR. Hydro-Québec a corrigé la situation. Le personnel de la CCSN a revu et accepté les mesures correctives mises de l'avant par Hydro-Québec en décembre 2018. Également, en octobre 2018, des non-conformités mineures au niveau des pancartes de radioprotection, des stations de récupérations pour déversements et de la référence à certaines procédures d'inspection pour les

ponts roulants ont été signalées. Ces dernières ont été corrigées par Hydro-Québec, et le personnel de la CCSN a accepté les mesures prises et clos le suivi en mai 2019 (DPRGPL-2018-002).

Il a également été constaté que l'installation de gestion des déchets radioactifs solides (IGDRS) était exploitée en conformité avec les exigences.

En 2018, Hydro-Québec a finalisé le plan de transition vers la norme CSA N292.0-14 « Principes généraux pour la gestion des déchets radioactifs et du combustible irradié » et la norme CSA N292.2-13 « Entreposage à sec provisoire du combustible irradié ».

Plans de déclassement

Le contenu du Plan de déclassement préliminaire (PDP) était acceptable et adéquat compte tenu de l'état actuel dans lequel se trouvent les installations de Genilly-2.

Les garanties financières sont discutées à la section 2.15.

3.6.12 Sécurité

Le personnel de la CCSN a conclu que le DSR Sécurité a respecté les objectifs de rendement et les exigences réglementaires applicables. Par conséquent, les installations de Gentilly-2 ont obtenu la cote « Satisfaisant », soit - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	Gentilly-2	
	Applicable	Notes
Installations et équipement	O	Cote attribuée, décrit ci-dessous
Arrangements en matière d'intervention	O	Cote attribuée, mais il n'y a eu aucun développement significatif
Pratiques en matière de sécurité	O	Cote attribuée, mais il n'y a eu aucun développement significatif
Entraînements et exercices	O	Cote attribuée, décrit ci-dessous

Installations et équipement

En 2018, il n'y a pas eu d'événements rapportés pour ce domaine particulier. L'inspection menée en chantier a relevé des non-conformités mineures qui ont été rectifiées adéquatement par Hydro-Québec. Le personnel de la CCSN a également évalué un exercice de sécurité et a confirmé l'efficacité de l'équipement et des installations de sécurité à Gentilly-2.

Hydro-Québec a continué d'entretenir l'équipement de sécurité et a un plan de gestion du vieillissement. Aucune défaillance majeure de l'équipement n'a été rapportée pour ce domaine particulier en 2018.

Cyber sécurité

Le personnel de la CCSN a conclu que le programme de cyber-sécurité aux installations de Gentilly-2 respectait les exigences réglementaires.

Les points soulevés par le personnel de la CCSN au niveau de la fréquence de l'auto-évaluation du programme de cyber-sécurité, du manque d'indication d'un spécialiste en cyber-sécurité dans

le programme de cyber-sécurité, et de l'absence de respect d'exigence de l'article 6.1 de la norme CSA N290.7-14 pour les biens électroniques essentiels identifiés, ont été revus et corrigés par Hydro-Québec.

Hydro-Québec doit se conformer à norme N290.7 en suivant une approche graduelle.

Entraînements et exercices

Le personnel de la CCSN a déterminé que le programme d'entraînements et d'exercices aux installations de Gentilly-2 respectait les exigences réglementaires.

Hydro-Québec a réalisé un exercice de sécurité à Gentilly-2 en 2018. Le rapport d'auto-évaluation de cet exercice a été fourni au personnel de la CCSN. À la fin de 2018, Hydro-Québec travaillait à la mise en œuvre des mesures correctives qui ont été relevées dans ce rapport.

3.6.13 Garanties et non-prolifération

Le personnel de la CCSN a conclu que le DSR Garanties et non-prolifération respectait les exigences réglementaires et les objectifs de performance. Ainsi Hydro-Québec a reçu une cote « Satisfaisante » aux installations de Gentilly-2 - la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	Gentilly-2	
	Applicable	Notes
Contrôle et comptabilité des matières nucléaires	O	Cote attribuée, mais il n'y a eu aucun développement significatif
Accès de l'AIEA et assistance à l'AIEA	O	Cote attribuée, décrit ci-dessous
Renseignements sur les opérations et la conception	O	Cote attribuée, décrit ci-dessous
Équipement en matière de garanties, confinement et surveillance	O	Cote attribuée, décrit ci-dessous

Accès de l'AIEA et assistance à l'AIEA

En vertu des accords existants portant sur les garanties entre le Canada et l'AIEA et en vertu des conditions de son permis, Hydro-Québec a continué d'accorder un accès et une assistance adéquats à l'AIEA pour les activités relatives aux garanties à Gentilly-2, y compris l'inspection et l'entretien de l'équipement aux installations de Gentilly-2.

En 2018, l'AIEA a réalisé une vérification de l'inventaire physique, une vérification des renseignements descriptifs ainsi que deux inspections inopinées aux installations de Gentilly-2 afin de vérifier les inventaires de matériel nucléaire et de s'assurer de l'absence d'activités et de matériel nucléaire non déclarés.

Renseignements sur les opérations et la conception

Hydro-Québec a respecté les exigences pour le domaine particulier des Renseignements sur les activités et la conception. Voir la section 2.13 pour plus d'information.

En 2018, Hydro-Québec a présenté la mise à jour du questionnaire sur l'information reliée à la conception. Le personnel de la CCSN était satisfait de l'information communiquée et a conclu que cette dernière respectait les exigences de la CCSN.

Le personnel de la CCSN a confirmé qu'Hydro-Québec respectait les exigences réglementaires applicables à l'égard des renseignements sur les opérations et la conception à Gentilly-2. Voir la section 2.13 pour plus de détails.

Hydro-Québec a présenté à la CCSN son programme opérationnel annuel incluant des mises à jour trimestrielles pour Gentilly-2, ainsi qu'une mise à jour annuelle de l'information conformément au Protocole additionnel de l'AIEA, dans les délais prescrits. Les renseignements fournis respectaient les exigences de la CCSN.

Équipement en matière de garanties, confinement et surveillance

Le personnel de la CCSN a confirmé qu'Hydro-Québec respectait les exigences réglementaires applicables à l'égard de l'équipement en matière de garanties, du confinement et de la surveillance pour les installations de Gentilly-2 en 2018, y compris l'installation d'équipement de surveillance afin d'assurer la mise en œuvre efficace des mesures de garanties aux installations de Gentilly-2. Voir la section 2.13 pour plus de détails.

3.6.14 Emballage et transport

Le personnel de la CCSN a déterminé qu'Hydro Québec a un programme d'emballage et de transport à Gentilly-2 qui assure la conformité aux *Règlement sur l'emballage et le transport des substances nucléaires* (2015) et *Règlement sur le transport des marchandises dangereuses*. Le programme est mis en œuvre de façon efficace, et le transport des substances nucléaires à destination et en provenance de l'installation est effectué de manière sûre.

Par conséquent, les installations ont obtenu la cote « Satisfaisant », soit – la même que l'année dernière.

Le tableau suivant énumère les domaines particuliers dans le cadre de ce DSR, explique leur applicabilité pour Gentilly-2 et fournit des notes concernant les évaluations pour le rapport de surveillance réglementaire 2018.

Domaines particuliers	**Gentilly-2**	
	Applicable	Notes
Conception et entretien des colis	O	Cote attribuée, mais il n'y a eu aucun développement significatif
Emballage et transport	O	Cote attribuée, mais il n'y a eu aucun développement significatif
Enregistrement aux fins de l'utilisation	O	Cote attribuée, mais il n'y a eu aucun développement significatif

Conception et entretien des colis, emballage et transport, et enregistrement aux fins de l'utilisation

Au cours de l'année 2018, il n'y a eu aucune inspection sur l'emballage et le transport à Gentilly-2.

SUMMARY AND CONCLUSIONS

The CNSC conducted numerous activities related to licensing and compliance in 2018. 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 2018, followed up as needed and continued to monitor licensee corrective actions that were not complete at the end of 2018.

The licensing and compliance activities were conducted in the context of robust regulatory requirements. The requirements include CNSC regulatory documents and CSA Group standards, which continued to evolve in 2018 as new documents and new versions were published. NPP and WMF licensees were in the process of implementing various new requirements in 2018 and CNSC staff were satisfied with the overall progress.

CNSC staff concluded that the NPPs and WMFs discussed in this report operated safely in 2018 and that the licensees upheld their responsibilities for safety and promoted healthy safety culture. 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 IAEA. For all events, licensees followed approved procedures 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 public were well below the regulatory limits.
- Radiation doses to workers at the NPPs and WMFs were below the regulatory limits.
- 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.
- The licensees met the applicable requirements related to Canada's international obligations; the results of safeguards inspections were acceptable to the IAEA.

The detailed assessments of each SCA in this regulatory oversight report were based on the systematic consideration of findings and observations 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 36 and 37. All NPPs and WMFs in Canada received SCA ratings of either "fully satisfactory" or "satisfactory" in 2018.

Table 36: Canadian NPP safety performance ratings for 2018

Safety and control area	DNGS	PNGS	Bruce A	Bruce B	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**	**FS**	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	SA	SA	**FS**	**FS**	SA	SA
Conventional health and safety	**FS**	**FS**	**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	SA	SA	SA	SA	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

Table 37: Canadian WMF safety performance ratings for 2018

Safety and control area	DWMF	PWMF	WWMF
Management system	SA	SA	SA
Human performance management	SA	SA	SA
Operating performance	SA	SA	SA
Safety analysis	SA	SA	SA
Physical design	SA	SA	SA
Fitness for service	SA	SA	SA
Radiation protection	SA	SA	SA
Conventional health and safety	SA	SA	SA
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

Appendix A: DEFINITIONS OF SAFETY AND CONTROL AREAS

The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 SCAs. The SCAs are subdivided into 71 specific areas that define the key components of the SCA. The SCAs and specific areas used in the CNSC's safety performance evaluation for 2018 are given in table A.1.

Table A.1: 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 • Performance assessment, improvement and management review • Operating experience
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 assessment • Criticality safety • Severe accident analysis • Management of safety issues (including R&D programs)
Physical design	• Design governance • Site characterizations • Facility design • Structure design • System design • Component design

SCA	Specific area
Fitness for service	• Equipment fitness for service/equipment performance • Maintenance • Structural integrity • Aging management • Chemistry control • Periodic inspections and testing
Radiation protection	• Application of as low as reasonably achievable (ALARA) • Worker dose control • Radiation protection program performance • Radiological hazard control • Estimated dose to public
Conventional health and safety	• Performance • Practices • Awareness
Environmental protection	• Effluent and emissions control (releases) • Environmental management system • Assessment and monitoring • Protection of the public • 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
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.

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.

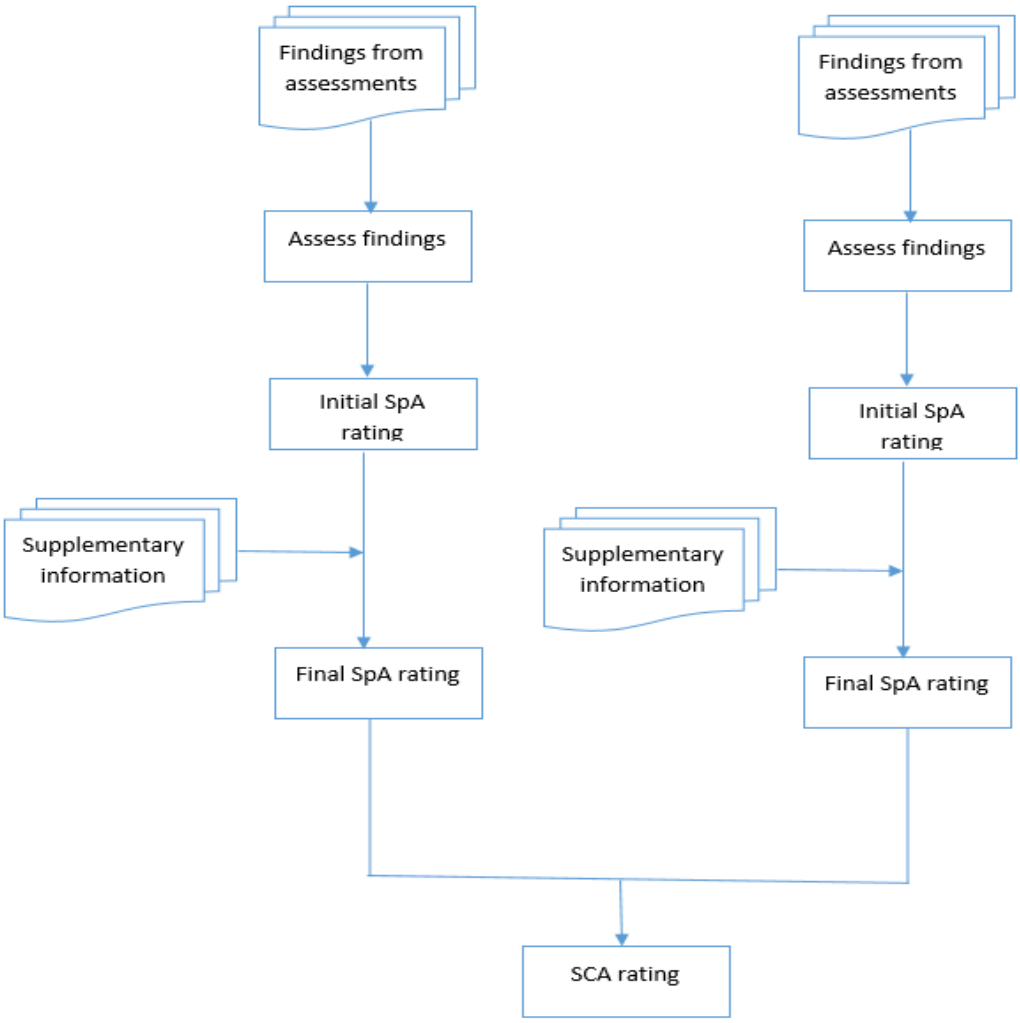
Unacceptable (UA)
Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the SCA is significantly below requirements or CNSC expectations, or there is evidence 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 involves ratings for both specific areas and SCAs.

The methodology is illustrated in figure B.1 for only one SCA. To simplify the illustration, it is assumed that the SCA has only two specific areas.

Figure B.1: Methodology for determining performance ratings



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 and compliance expectations.
Negligible	Performance insignificantly deviates from expectations or objectives of CNSC requirements and compliance expectations.
Compliant	Performance meets applicable CNSC requirements and compliance expectations.

Step 3: Initial rating of the specific area

CNSC staff consider the safety significance of all relevant findings and provide an initial assessment of the 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 an interim performance rating of FS, SA, BE or UA for each specific area.

Step 4: Final rating of the specific area

CNSC staff also consider supplementary information other than findings, such as observations from surveillance and monitoring, safety performance indicators, the licensee's improvement initiatives and R&D effort relevant to the specific area. CNSC staff uses the supplementary information to judge if the interim rating of the specific area should be adjusted.

CNSC staff then convert the performance rating to a numerical value between 0 and 10, 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.

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 5: 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. CNSC staff may use judgement to adjust the value the results from arithmetic averaging.

B.3 SCA Ratings from 2017

Table B.2: 2016 SCA ratings for NPPs

Safety and control area	DNGS	PNGS	Bruce A	Bruce B	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	SA	SA	**FS**	**FS**	SA	SA
Conventional health and safety	**FS**	**FS**	**FS**	SA	**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

Table B.3: 2017 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	SA	SA
Safeguards and non-proliferation	SA	SA	SA
Packaging and transport	SA	SA	SA

Appendix C: RESEARCH AND DEVELOPMENT EFFORTS IN SUPPORT OF NPP OPERATION AND 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
- Strategic R&D

The R&D and IST programs are sponsored by three Canadian utilities (Bruce Power, OPG and NB Power), the Romanian Societatea Nationala Nuclear Electrica, Canadian Nuclear Laboratories and Korea Hydro and Nuclear Power Company In 2018, the CNSC reviewed submissions on the work plans, analysis methodology and results for these ongoing programs.

Bruce Power, OPG, New Brunswick Power and Canadian Nuclear Laboratories also continued a joint COG R&D initiative: the fuel channels R&D. This program addresses the current and future operational needs to support life cycle planning and establishes a strong technical basis for fitness-for-service assessments.

Supporting R&D

In 2018, CNSC staff continued to undertake systematic evaluations to confirm that the industry maintains or has access to a robust R&D capability to address emerging issues and enhance knowledge and confidence in safety provisions in key areas.

The NPP licensees submitted the 2018 COG R&D annual reports, which included:

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

Many topics identified in these reports are under the project on hydrogen behaviour in containment:

- understanding the performance of passive autocatalytic recombiners (PARs) for hydrogen
- assessment of PAR effectiveness for beyond-design-basis accidents in CANDU stations
- hydrogen isotope effects on PAR performance
- combustion and PAR recombination of hydrogen-air-steam mixtures during continuous hydrogen release
- effect of double-sided sheath oxidation on hydrogen source term
- evaluation of PARs as hydrogen sensors

- small-scale hydrogen combustion and recombination testing

Under the category of R&D for severe accidents, the following topics are identified:

- calandria vessel heat stress response during the in-vessel retention phase of a postulated severe accident
- spatial distribution of heat loads from a convecting corium pool in a calandria vessel geometry
- solid crucible experimental investigation of corium miscibility gaps
- report on the state of the art regarding critical heat flux for in-vessel retention of corium
- waterborne fission product transfer and dose assessment methodology for chronic releases and severe accidents
- MAAP-CANDU modelling
- in-vessel retention strategy

Other topics identified under the R&D programs focus on:

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

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 2018 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

New Projects

Leak-Before-Break (LBB) assessment of dissimilar metal weld of outlet feeder in CANDU units

The CNSC contracted an independent third-party to evaluate the final reports of the Leak-Before-Break (LBB) assessment of the Dissimilar Metal Welds in specific CANDU units. This is to improve the quality of the LBB assessment, and to increase the confidence in the position that the CNSC will take on the final submission.

Support for the IAEA International Generic Aging Lessons Learned (IGALL) – Phase 4

Participation in IGALL helps to ensure Canadian facilities will benefit from international experience, proven practices, knowledge, and lessons-learned from other member states and other reactor technologies. The IGALL program provides important support for the CNSC regulatory compliance programs for aging management, integrated safety reviews, and long term operation. IGALL is explicitly referenced in REGDOC-2.6.3, Fitness for Service: Aging Management.

Continuing Projects

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 in events involving degradation or failure involving 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 zirconium-niobium (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 in Canadian NPPs. This information will assist the CNSC in independently verifying fitness-for-service assessments of 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. The research will result in a guide for the regulatory assessment of the design and operation of replacement steam generators for CANDU reactors.

Safety Analysis

New projects

Develop irradiated fuel bay Severe Accident Analysis computer code

The purpose of this project is to develop a computer code to model severe accidents in a CANDU Irradiated Fuel Bay, specifically the loss of cooling/coolant accident. The code will be used for two purposes: to perform detailed analysis on hypothetical accident scenarios to assist review of licensee submissions, and to support the CNSC emergency operations centre.

Investigation of 2 phase-flow phenomena in reactor headers

The project will assess the adequacy of lump and 1-dimensinal modelling of reactor headers for scenarios of interest, such as Small Break Loss of Coolant Accidents (SBLOCA) and Large Break Loss of Coolant Accidents (LBLOCA). Additionally, this project will assess the applicability of common turbulence models to nuclear reactors and advise CNSC staff on the capabilities of modern, three-dimensional thermal hydraulic simulation methodologies to assist the safety analyses of existing CANDU-type reactors by improved modelling of reactor headers.

Continuing Projects

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 testing that uses H2-CO mixtures. The results of the planned experiments 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, and its results are expected to help CNSC staff understand the impact of vessel penetrations on in-vessel retention (IVR) and provide a better technical basis for the evaluation of the licensees' 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 that couple computational procedures for 3D-neutronics and thermal-hydraulics.

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 2018

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 2018

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.

Appendix D: DARLINGTON NEW BUILD

On August 17, 2012, a Panel of the Commission issued a nuclear power reactor site preparation licence (PRSL) to Ontario Power Generation Inc. (OPG) for the Darlington New Nuclear Project (DNNP) at the Darlington site for a period of 10 years. OPG's PRSL expires on August 17, 2022.

Consistent with the Canadian Environmental Assessment Act (1992), an environmental assessment of the project was required prior to any licensing decisions for a PRSL. A joint review panel (JRP) carried out this assessment in 2011. The decisions on the environmental assessment and the PRSL were challenged through an application for judicial review before the Federal Court of Canada and associated appeals.

Ultimately, the decision to issue a PRSL to OPG for the DNNP project was upheld as reported in the 2016 Regulatory Oversight Report for Canadian Nuclear Power Plants.

Subsequent to the Government of Ontario's decision to defer construction of new reactors at the Darlington site in 2013, OPG's efforts have focused on completion of site characterization activities to inform project design and to confirm assumptions made in the environmental assessment. OPG has not commenced any licensed activities covered under section IV of the Power Reactor Site Licence (PRSL). In 2018, OPG continued to undertake the following activities committed at the time of licensing and conduct of the environmental assessment:

- bank swallow monitoring and mitigation
- aquatic community characterization for siting of intake and diffuser

The following activities were also conducted during the course of the year 2018:

- OPG has notified the CNSC of its intent to renew the DNNP PRSL which is due to expire in August 2022.
- As requested by the Commission in its Record of Decision CNSC staff and OPG presented a mid-term update on this licence at a public meeting of the Commission in December 2018.
- OPG continues to monitor land use planning in the vicinity of the DNNP project in coordination with CNSC and the Municipality of Clarington as per the Municipality's Official Plan.
- Identified Indigenous groups with interest in the DNNP project and the Public continued to be informed on the status of the project through OPGs Public and Indigenous Engagement Program activities. These activities included site tours, open house update presentations, the mid-term update to the Commission in December 2018 and maintenance of OPGs website information on the project.

Bank swallow monitoring and mitigation

The construction and operation of a new NPP at the Darlington site could require the removal of a portion 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, OPG has conducted Bank Swallow monitoring studies at the Darlington site since 2013. No Bank Swallow usage has been observed at the earthen mound artificial nesting habitat structure in the past 5 years. As such, OPG is proposing to stop

monitoring for Bank Swallow at this location effective 2019 and continue to explore other artificial nesting structure options.

CNSC staff agree that monitoring of Bank Swallow usage of the artificial nesting structure (earthen mound) currently on the DNNP site may be discontinued given that there has been no usage observed. CNSC staff agree with the OPG proposal to continue to explore other option for artificial nesting structures in consultation with stakeholders.

Aquatic community characterization for siting of intake and diffuser

The EA completed for the DNNP reported a potential loss of some aquatic biota as a result of in-water construction and operation of the condenser cooling water system. To address the JRP recommendations related to condenser cooling water design, OPG has identified once-through cooling as the preferred option based on assessment of factors such as, terrestrial and aquatic habitat loss, amount of excavation and water consumption.

With proposed once-through condenser cooling, OPG completed an aquatic community characterization study in 2018 to support the future completion of deliverables related to the commitments made at the time of the environmental assessment. CNSC staff completed the review of the DNNP aquatic community characterization study to support decision making related to the siting of intake and diffuser for a once-through cooling system design. CNSC staff continue to monitor OPG's ongoing work on data collection to support aquatic characterization.

Appendix E: LIST OF REGULATORY REQUIREMENTS AT THE END OF 2018

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 2018. 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 2018.

In the table, a check mark indicates that the publication was included as compliance verification criteria for the facility at the end of 2018, 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.

Appendix E

Regulatory documents and industry standards to be applied as requirements for all applicants (currently as CVC in LCH)

Legend: v = implemented ; yyyy = to be implemeted by year yyyy ; - = no implementation date

Source	Number	Title	Year	SCA	Bruce	DNGS	DWMF	PNGS	PWMF	PLNGS	Gentilly2	WWMF
CSA	N286	*Management system requirements for nuclear power plants, Update 1, 2007*	2005	1	v	-	-	-	-	-	-	-
CSA	N286	*Management system requirements for nuclear facilities*	2012	1	v	v	v	v	v	v	v	v
CNSC	REGDOC-2.2.2	*Personnel Training*	2014	2	v	v	v	v	v	v	-	v
CNSC	REGDOC-2.2.2	*Personnel Training, version 2*	2016	2	v	-	-	-	-	v	-	-
CNSC	RD-204	*Certification of Persons Working at Nuclear Power Plants*	2008	2	v	v	-	v	-	v	v	-
CNSC	EG1 *	*Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power plants*	2005	2	v	v	-	v	-	v	-	-
CNSC	EG2 *	*Requirements and Guidelines for Simulator-Based Certification Examinations for Shift Personnel at Nuclear Power Plants*	2004	2	v	v	-	v	-	v	-	-
CNSC	*	*Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants*	2009	2	v	v	-	v	-	v	-	-
CNSC	RD-363	*Nuclear Security Officer Medical, Physical and Psychological Fitness*	2008	2	v	v	v	v	v	v	v	v
CNSC	REGDOC-2.2.4	*Fitness for Duty Volume I: Managing Worker Fatigue*	2017	2	v	2019	2019	2019	2019	2022	2019	2019
CNSC	REGDOC-2.2.4	*Fitness for Duty Volume II: Managing Alcohol and Drug*	2017	2	2019	2019	2019	2019	2019	2019	2019	-
CNSC	REGDOC-2.3.3	*Periodic Safety Reviews*	2015	3	v	v	-	v	-	v	-	-
CNSC	REGDOC-3.1.1	*Reporting Requirements for Nuclear Power Plants*	2014	3	-	v	-	-	-	-	v	-
CNSC	REGDOC-3.1.1	*Reporting Requirements for Nuclear Power Plants, version 2*	2016	3	v	-	-	v	-	v	-	-
CSA	N290.15	*Requirements for the safe operating envelope of nuclear power plants*	2010	3	v	v	-	v	-	v	-	-
CNSC	REGDOC-2.3.2	*Accident Management: Severe Accident Management Programs for Nuclear Reactors*	2013	3	v	v	-	v	-	-	-	-
CSA	N290.11	*Requirements for reactor heat removal capability during outage of nuclear power plants*	2013	3	-	-	-	-	-	v	-	-
CSA	N286.7	*Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants*	1999	4	-	v	-	-	-	v	v	-
CSA	N286.7	*Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants*	2016	4	v	-	-	v	-	-	-	-
CNSC	REGDOC-2.4.1	*Deterministic Safety Analysis*	2014	4	v	v	-	v	-	v	v	-
CNSC	REGDOC-2.4.2	*Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*	2014	4	2019	2020	-	2020	-	v	-	-
CNSC	RD-327	*Nuclear Criticality Safety*	2010	4	v	-	-	-	-	-	-	-
CSA	N289.1	*General requirements for seismic design and qualification of CANDU nuclear power plants*	2008	5	v	v	-	v	-	-	v	-
CSA	N289.2	*Ground motion determination for seismic qualification of CANDU nuclear power plants*	2010	5	v	-	-	-	-	-	-	-
CSA	N289.3	*Design procedures for seismic qualification of CANDU nuclear power plants*	2010	5	v	-	-	-	-	-	-	-
CSA	N289.4	*Testing procedures for seismic qualification of nuclear power plants structures, systems, and components*	2012	5	v	-	-	-	-	-	-	-
CSA	N289.5	*Seismic Instrumentation requirements for nuclear power plants and nuclear facilities*	2012	5	v	-	-	-	-	-	-	-
CSA	N290.13	*Environmental Qualification of Equipment for CANDU Nuclear Power Plants (2005/R2015)*	2005	5	v	v	-	v	-	v	-	-
CSA	N285.0	*General requirements for pressure-retaining systems and components in CANDU nuclear power plants*	2008	5	-	v	v	v	v	-	-	v
CSA	N285.0	*General requirements for pressure-retaining systems and components in CANDU nuclear power plants(including updates 1 and 2)*	2012	5	v	-	v	v	v	v	v	v
CSA	N290.12	*Human factors in design for nuclear power plants*	2014	5	v	-	-	v	-	v	-	-
CSA	N290.0	*General requirements for safety systems of nuclear power plants*	2011	5	v	v	-	-	-	-	-	-
CSA	N291	*Requirements for safety related structures for CANDU nuclear power plants*	2008	5	-	v	-	v	-	v	v	-
CSA	N291	*Requirements for safety related structures for CANDU nuclear power plants*	2015	5	v	-	-	-	-	-	-	-
CNSC	RD/GD-98	*Reliability Programs for Nuclear Power Plants*	2012	6	-	v	-	v	-	-	-	-
CNSC	REGDOC-2.6.1	*Reliability Programs for Nuclear Power Plants*	2017	6	v	-	-	-	-	v	-	-
CNSC	RD/GD-210	*Maintenance Programs for Nuclear Power Plants*	2012	6	-	v	-	v	-	-	-	-
CNSC	REGDOC-2.6.2	*Maintenance Programs for Nuclear Power Plants*	2017	6	v	-	-	-	-	v	v	-
CSA	N285.4	*Periodic Inspection of CANDU nuclear power plant components*	2005	6	v	v	-	v	-	-	-	-
CNSC	REGDOC-2.6.1	*Reliability Programs for Nuclear Power Plants*	2009	6	v	-	-	-	-	v	-	-
CSA	N285.4	*Periodic Inspection of CANDU nuclear power plant components*	2009	6	v	-	-	v	-	v	-	-
CSA	N285.5	*Periodic Inspection of CANDU nuclear power plant containment components*	2008	6	v	v	-	v	-	v	-	-
CSA	N287.7	*In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants*	2008	6	v	v	-	v	-	v	-	-
CSA	N285.8	*Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*	2015	6		-	-	v	-	-	-	-

Source	Number	Title	Year	SCA	Bruce	DNGS	DWMF	PNGS	PWMF	PLNGS	Gentilly-2	WWMF
CSA	N285.8	*Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*	2010	6	V	-	-	-	-	V upd2	-	-
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	-	-	V	-	-	-	-	V
CNSC	REGDOC-2.6.3	*Aging Management*	2014	6	V	V	V	V	V	V	V	V
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	V	V	V	V	V	V	-	V
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	-	-	2019	-	-	V	2020
CSA	N288.3.4	*Performance testing of nuclear air-cleaning systems at nuclear facilities*	2013	9	-	-	V	V	V	-	-	V
CNSC	S-296	*Environmental Protection, Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills*	2006	9	-	-	-	-	-	-	-	-
CNSC	REGDOC-2.9.1	*Environmental Policies, Programs and Procedures*	2013	9	V	V	V	V	-	V	V	-
CNSC	REGDOC-2.9.1	*Environmental Principles, Assessments and Protection Measures, version 1.1*	2017	9	2020	-	-	-	V	-	-	V
CSA	N288.4	*Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*	2010	9	V	V	V	V	V	V	-	2019
CSA	N288.5	*Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*	2011	9	V	V	V	V	V	V	-	V
CSA	N288.6	*Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*	2012	9	V	V	V	V	V	-	-	V
CSA	N288.7	*Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*	2015	9	2020	2020	2022	2020	2020	2020		2021
CNSC	RD-353	*Testing and Implementation of Emergency Measures*	2008	10	-	-	V	-	V	-	-	V
CNSC	REGDOC-2.10.1	*Nuclear Emergency Preparedness and Response*	2014	10	2019	V	V	V	V	V	V	V
CSA	N293	*Fire protection for nuclear power plants*	2007	10	-	-	-	-	-	-	-	-
CSA	N293	*Fire protection for nuclear power plants*	2012	10	V	V	-	V	-	V	V	-
CSA	N393	*Fire protection for facilities that process, handle, or store nuclear substances*	2013	10	-	-	V		V	2022	-	V
CSA	N292.0	*General principles for the management of radioactive waste and irradiated fuel*	2014	11	-	-	V	-	V	V	V	V
CSA	N292.2	*Interim dry storage of irradiated fuel*	2007	11	-	-	-	-	-	V	-	-
CSA	N292.2	*Interim dry storage of irradiated fuel*	2013	11	-	V	V	V	V	-	V	V
CSA	N292.3	*Management of low- and intermediate-level radioactive waste*	2008	11	V	V	-	V	V	-	V	-
CSA	N292.3	*Management of low- and intermediate-level radioactive waste*	2014	11	-	-	V	-	-	V	-	V
CSA	N294	*Decommissioning of facilities containing nuclear substances*	2009	11	-	V	V	V	V	V upd1	V	V
CSA	N290.7	*Cyber Security*	2014	12	2020	V	-	2019	V	2019	V	-
CNSC	RD-321	*Criteria for Physical Protection Systems and Devices at High-Security Sites*	2010	12	V	V	V	V	V	V	V	V
CNSC	RD-361	*Criteria for Explosive Substance Detection, X-ray Imaging and Metal Detection at High Security Sites*	2010	12	V	V	V	V	V	V	V	V
CNSC	REGDOC-2.12.1	*High-Security Sites: Nuclear Response Force*	2013	12	V	V	-	V	-	V	-	-
CNSC	REGDOC-2.12.2	*Site Access Security Clearance*	2013	12	V	V	V	V	V	V	V	V
CNSC	REGDOC-2.12.3	*Security of Nuclear Substances – Sealed Sources*	2013	12	V	-	-	V	V	-	-	V
CNSC	RD-336	*Accounting and Reporting of Nuclear Material*	2010	13	V	V	V	V	V	V	-	V
CNSC	REGDOC-2.13.1	*Safeguards and Nuclear Material Accountancy*	2018	13	2019	2021	2021	2021	2021	V	V	2021
CNSC	RD/GD-99.3	*Public Information and Disclosure*	2012	15	V	V	V	V	V	V	V	V

* CNSC staff documents (not published as regulatory documents)

Appendix F: 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). The values for total effort reflect CNSC records for all five years but, for the years 2014 to 2017, the breakdown between some of the categories of effort was estimated.

Table F.1: Five-year trend in compliance activities for DNGS

Compliance activities effort (person-days)	2014	2015	2016	2017	2018
Inspections	1,226	1,079	1,422	1,422	1,281
Event reviews	214	128	114	120	132
Other compliance activities	2,290	2,141	1,947	2,160	2,063
Refurbishment			805	1,174	1,736
Total effort	3,730	3,348	4,288	4,876	5,212

Table F.2: Five-year trend in compliance activities for PNGS

Compliance activities effort (person-days)	2014	2015	2016	2017	2018
Inspections	1,460	1,460	1,156	1,764	1,621
Event reviews	228	132	118	130	221
Other compliance activities	3,245	3,453	3,659	2,603	3,048
Total effort	4,933	5,045	4,933	4,497	4,890

Table F.3: Five-year trend in compliance activities for Point Lepreau

Compliance activities effort (person-days)	2014	2015	2016	2017	2018
Inspections	1,079	1,030	785	981	1,459
Event reviews	80	58	72	70	40
Other compliance activities	1,402	1,874	2,136	1,466	1,431
Total effort	2,561	2,962	2,993	2517	2,929

Table F.4: Five-year trend in compliance activities for Bruce A and B

Compliance activities effort (person-days)	2014	2015	2016	2017	2018
Inspections	1,520	1,030	1,226	1,716	1,633
Event reviews	250	198	192	184	178
Other compliance activities	3,597	3,899	3,632	2,971	2,769
Total effort	5,367	5,127	5,050	4,871	4,580

Table F.5: Five-year trend in compliance activities for Gentilly-2

Compliance activities effort (person-days)	2014	2015	2016	2017	2018
Inspections	490	147	147	98	98
Event reviews	30	4	6	8	0
Other compliance activities	301	416	232	139	214
Total effort	821	567	385	245	312

Table F.6: Five-year trend in compliance activities for Canadian NPPs

Compliance activities effort (person-days)	2014	2015	2016	2017	2018
Inspections	5,775	4,746	4,736	5,981	6,091
Event reviews	802	520	502	512	571
Other compliance activities	10,833	11,783	11,606	9,339	9,525
Refurbishment	-	-	805	1,174	1,736
Total effort	17,410	17,049	17,649	17,006	17,923

Table F.7: Five-year trend in compliance activities for the DWMF

Compliance activities effort (person-days)	2014	2015	2016	2017	2018
Number of Inspections	4	5	6	3	4
Inspections					11*
Licensing activities	10	44	21	75	54
Compliance activities	152	184	136	161	79
Total effort	162	228	157	236	144

* Only tracked for ¾ of the year from April 1 to December 31, 2018

Table F.8: Five-year trend in compliance activities for the PWMF

Compliance activities effort (number of inspections or person-days)	2014	2015	2016	2017	2018
Number of inspections	3	2	4	3	4
Inspections					86*
Licensing activities	12	7	71	209	42
Compliance activities	116	143	128	94	85
Total effort	128	150	198	303	213

* Only tracked for ¾ of the year from April 1 to December 31, 2018

Table F.9: Five-year trend in compliance activities for the WWMF

Compliance activities effort (number of inspections or person-days)	2014	2015	2016	2017	2018
Number of inspections	4	3	6	3	4
Inspections					11*
Licensing activities	57	17	182	258	23
Compliance activities	216	197	237	227	219
Total effort	273	214	419	485	253

* Only tracked for ¾ of the year from April 1 to December 31, 2018

Table F.10: Five-year trend in compliance activities for Canadian WMFs

Compliance activities effort (number of inspections or person-days)	2014	2015	2016	2017	2018
Number of inspections	11	10	16	9	12
Inspections					108*
Licensing activities	79	68	274	542	119
Compliance activities	484	524	501	482	383
Total effort (person-days)	563	592	774	1024	610

* Only tracked for ¾ of the year from April 1 to December 31, 2018

Appendix G: Current and predicted status of key parameters and models for pressure tubes in Canadian power reactors

Unit	Status as of January 1st 2019				Future situation			
	EFPH	Peak Heq concentration, ppm	Existing fracture toughness model valid?		Key date	anticipated EFPH	Predicted maximum Heq conc., ppm	Existing fracture toughness model valid?
Pickering								
Unit 1	143,000	34.5	Yes		End-of-service, December 2024	173,000	39.8	Yes
Unit 4	114,000	25.5	Yes		End-of-service, December 2024	146,000	28.5	Yes
Unit 5	238,000	59.6	Yes		End-of-service, December 2024	283,000	71.1	Yes
Unit 6	241,000	54.8	Yes		End-of-service, December 2024	288,000	67.1	Yes
Unit 7	237,000	55.0	Yes		End-of-service, December 2024	281,000	59.2	Yes
Unit 8	222,000	49.7	Yes		End-of-service, December 2024	268,000	61.1	Yes
Darlington								
Unit 1	204,000	61.9	Yes		MCR (June 2021)	223,000	72.3	Yes
Unit 2	***MCR in-progress (started October 2016)***				***n/a – fuel channels replaced during MCR***			
Unit 3	199,000	65.7	Yes		MCR (February 2020)	208,000	69.6	Yes
Unit 4	196,000	54.9	Yes		MCR	229,000	70.6	Yes

				(January 2023)			
Bruce							
Unit 1	42,040	15.6 *	Yes	Time to reach 120 ppm Heq (beyond February 2046)	>256,000	< 120	Yes
Unit 2	42,596	No data Available	Yes	Time to reach 120 ppm Heq (beyond March 2046)	>257,000	< 120	Yes
Unit 3	217,252	72.3 *	Yes	MCR (2023)	248,125	< 120	Yes
Unit 4	209,847	61.9 *	Yes	MCR (2025)	255,600	< 120	Yes
Unit 5	240,248	68.1 *	Yes	September 2023 – first pressure tube reaches 120 ppm	274,800	120 ppm	Yes – until September 2023 *
Unit 6	235,902	65.1 *	Yes	MCR (2020)	245,000 **	< 120	Yes
Unit 7	232,382	95 *	Yes	July 2024 – first pressure tube reaches 120 ppm	272,000	120 ppm	Yes – until July 2024 *
Unit 8	217,272	47.2 *	Yes	January 2027 – first pressure tube reaches 120 ppm	275,000	120 ppm	Yes – until January 2027 *

* CNSC staff made these estimates for Units 5, 7 and 8 using the most recent reports on hydrogen isotope concentration in pressure tube rolled-joints

** CNSC staff based their estimate on an extrapolation of recent Bruce Power data

Appendix H: DERIVED RELEASE LIMITS AND RADIOLOGICAL RELEASES TO THE ENVIRONMENT

Update on the National Pollutant Release Inventory (NPRI)

The CNSC is making radionuclide release data more readily accessible to the public as part of its commitment to open government and its mandate to disseminate this information to the public. In addition to including the data in the ROR, the CNSC and the National Pollutant Release Inventory (NPRI) are working together to establish active links between the CNSC and NPRI web sites. Stakeholder sub-group consisting of environmental non-governmental organizations and industry are beta testing the links between the NPRI site and existing CNSC data products (RORs, etc). The CNSC has also commenced the creation of downloadable, digital databases of radionuclide releases, further supplementing the range of CNSC environmental data products linked to the NPRI website. The downloadable databases are expected to become part of the active beta testing activities in the latter part of 2019. [RIB #]

Derived Release Limits

Licence release limits known as derived release limits or DRLs are site-specifically calculated rates of release that could, if exceeded, expose an individual of the most highly exposed group to a committed dose equal to the regulatory annual dose limit of 1 mSv/year. DRLs are calculated using CSA standard N288.1-14, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities.*

While it is possible to calculate a specific DRL for each radionuclide, it may not be practical nor necessary to monitor each of these separately. In such cases, emitted radionuclides may be organized into groups that are selected based on factors such as physicochemical properties and method of monitoring. DRLs can then be established for the radionuclide group applying a number of simplifying and conservative (i.e., protective) assumptions such as assuming that the group is composed entirely of the most restrictive radionuclide representative of the group. The most restrictive radionuclide can differ for different nuclear facilities depending on releases, local conditions and the choice of the representative person. Emission monitoring may then be carried out by a non-radionuclide-specific method for the group rather than for specific radionuclides. The most common DRL groupings for airborne releases are noble gases, radio-iodines, particulate beta/gamma, and particulate alpha with those for liquids release being beta/gamma emitters and alpha.

Licensees are required to demonstrate that their releases are not only below their respective DRLs but that the sum of their release are below 1 mSv/year, the public regulatory dose limit. To ensure these limits are respected, licensees also are required to develop action levels significantly below their DRLs as a means of detecting elevated releases meriting follow-up investigations and actions to ensure releases are adequately controlled. For nuclear power plants, the action levels are applied to weekly and monthly monitoring results for emissions to atmosphere and for effluent to surface waters, respectively.

Note that the DRLs shown in the tables of this appendix are applicable for 2018 and may not be applicable for previous years.

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 for the reporting period

of 2011 to 2018[6]. There were no exceedances of the licensees' derived release limits from 2011 to 2018.

As facilities differ with respect to their on-site nuclear activities (e.g., presence of a tritium processing facility) or life-stage activities (e.g., safe shut-down), or operations (e.g., maintenance, rates of power productions), the relevant radionuclides specifically monitored and reported on as well as the actual quantities released will vary. Nuclear facilities monitor and report on a wide range of radionuclides with the standardized reporting provided here being based on the key radionuclides associated with public dose and the facilities derived releases limits. Therefore, direct comparisons between facilities are not possible, since one facility may have different release quantities of radioactive materials than another.

For the facilities associated with this ROR, the most common radionuclides or radionuclide groupings of interest are tritium (HTO), iodine-131, noble gases, particulates (beta/gamma) and carbon-14 for atmospheric releases and tritium (HTO), gross beta-gamma and carbon-14 for liquid releases to surface waters. Since particulate and gross beta-gamma consists of mixtures of radionuclides, the most dose-restrictive (based on potential dose to the public) radionuclide is often chosen to represent the mixture as the basis for comparison with the DRL.

Releases are reported in the following table as total becquerels (Bq) per year or in the case of noble gasses, 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	=	1.2×10^6
4,445,758,748	=	4.4×10^9

[6] The data from 2001 to 2010 is available at http://publications.gc.ca/site/eng/9.506803/publication.html

Bruce Nuclear Power Plant

Bruce Power reports releases from Bruce-A and Bruce-B.

Releases to atmosphere:

Table H.1: Bruce-A annual radionuclide releases to atmosphere for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (beta/gamma) (Bq)	Gross alpha (Bq)
2018 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}**
2018	6.08×10^{14}	1.14×10^{12}	8.46×10^{13}	6.57×10^{6}	1.28×10^{6}	1.10×10^{4}
2017	7.32×10^{14}	1.89×10^{12}	9.48×10^{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^{8}	$<7.45 \times 10^{6}$	$<6.40 \times 10^{5}$
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 H.2: Bruce - B annual radionuclide releases to atmosphere for 2011 – 2018 with weekly releases provided for 2017. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Carbon -14 (Bq)	Noble Gas (Bq-MeV	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
2018 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}**
2018	3.86×10^{14}	1.13×10^{12}	4.24×10^{13}	3.43×10^{6}	2.21×10^{6}	2.37×10^{4}
2017	7.14×10^{14}	1.23×10^{12}	4.82×10^{13}	1.41×10^{6}	2.34×10^{6}	3.70×10^{3}
2016	5.70×10^{14}	1.13×10^{12}	5.25×10^{13}	<LD[a]	1.13×10^{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}	5.25×10^{13}	4.02×10^{7}	1.53×10^{7}	2.26×10^{6}
2013	2.63×10^{14}	1.10×10^{12}	5.25×10^{13}	$<4.04 \times 10^{7}$	$<1.86 \times 10^{7}$	$<2.51 \times 10^{6}$
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 H.3: Bruce-A annual radionuclide releases to surface waters for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
2018 DRL	**2.30×10^{18}**	**4.58×10^{13}**	**1.03×10^{15}**	**1.12×10^{14}**
2018	1.96×10^{14}	1.20×10^{9}	9.73×10^{8}	<LD[a]
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}	9.08×10^{8}	9.95×10^{8}	2.12×10^{6}
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 H.4: Bruce-B annual radionuclide releases to surface waters for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
2018 DRL	**1.84×10^{18}**	**5.17×10^{13}**	**1.16×10^{15}**	**1.21×10^{14}**
2018	5.60×10^{14}	2.55×10^{9}	1.38×10^{9}	<LD[a]
2017	7.15×10^{14}	2.04×10^{9}	2.39×10^{9}	<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^{9}	8.91×10^{6}
2012	1.14×10^{15}	3.35×10^{9}	4.63×10^{9}	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

Western Waste Management Facility at the Bruce Operation

Releases to atmosphere:

Table H.5: Western waste management facility annual radionuclide releases to atmosphere for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Carbon -14 (Bq)	Iodine-131 (Bq)	Particulate (Gross gamma) (Bq)
2018 DRL	**2.96×10^{17}**	**1.09×10^{15}**	**1.90×10^{12}**	**2.34×10^{12}**
2018	3.25×10^{12}	1.57×10^{9}	7.23×10^{4}	2.41×10^{4}
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}	1.57×10^{9}	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 H.6: Western waste management facility annual radionuclide releases to surface waters for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Gross Beta (Bq)
2018 DRL	**7.70×10^{15}**	**4.56×10^{11}**
2018	3.64×10^{11}	1.69×10^{8}
2017	2.59×10^{11}	2.84×10^{8}
2016	6.12×10^{11}	4.62×10^{8}
2015	4.29×10^{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 Nuclear Power Plant

In addition to the standard suite of radionuclides reported for nuclear power plant releases, the Darlington facility also reports on atmospheric elemental tritium releases associated with the Tritium Removal Facility that is on-site.

Releases to atmosphere:

Table H.7: Darlington annual radionuclide releases to atmosphere for 2011 – 2018. The applicable DRLs for 2018 are also presented (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)
2018 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}**
2018	4.7×10^{13}	2.1×10^{14}	8.4×10^{11}	4.7×10^{13}	1.4×10^{8}	2.5×10^{7}	1.1×10^{6}
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 H.8: Darlington annual radionuclide releases to surface waters for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
2018 DRL	**5.3×10^{18}**	**7.1×10^{13}**	**9.7×10^{14}**	**3.2×10^{14}**
2018	2.2×10^{14}	2.6×10^{10}	1.2×10^{9}	$<3 \times 10^{5}$
2017	5.6×10^{14}	2.6×10^{10}	1.7×10^{9}	$<1 \times 10^{6}$
2016	3.5×10^{14}	4.9×10^{10}	2.2×10^{9}	$<1 \times 10^{6}$
2015	2.4×10^{14}	4.9×10^{10}	7.3×10^{9}	$<2 \times 10^{6}$
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 Nuclear Power Plant

Releases at the Pickering Nuclear Power Plant are monitored and reported on separately for Pickering A (units 1 – 4) and Pickering B (units 5 – 8).

Releases to atmosphere:

Table H.9: Pickering - A (units 1 - 4) annual radionuclide releases to atmosphere for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
2018 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}**
2018	3.0×10^{14}	2.3×10^{12}	1.2×10^{14}	7.0×10^{6}	4.2×10^{6}	4.3×10^{5}
2017	3.1×10^{14}	1.3×10^{12}	1.5×10^{14}	9.6×10^{6}	6.9×10^{6}	8.1×10^{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 H.10: Pickering B (units 5 - 8) annual radionuclide releases to atmosphere for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)	Gross alpha (Bq)
2018 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}**
2018	3.2×10^{14}	1.4×10^{12}	5.0×10^{12}	4.7×10^{6}	3.5×10^{6}	7.5×10^{5}
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 H.11: Pickering annual radionuclide releases to surface waters for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Units 1 - 4		Units 5 - 8			
	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	Tritium: (HTO: Bq)	Gross beta/gamma (Bq)	C-14 (Bq)	Gross Alpha (Bq)
2018 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}**
2018	1.4×10^{14}	9.3×10^{9}	2.8×10^{14}	3.4×10^{10}	1.1×10^{9}	2.4×10^{6}
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	1.2×10^{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^{7}

Point Lepreau Nuclear Power Plant

The Point Lepreau nuclear power plant consisting of a single reactor unit has DRLs for each individual noble gas and particulate categories and therefore monitors and reports on wide range of specific radionuclides. For consistency in reporting within this appendix, these have been combined as total noble gases and total particulate in the tables below.

Releases to atmosphere:

Table H.12: Point Lepreau annual radionuclide releases to atmosphere for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)
2018 DRL	**2.8×10^{17}**	**6.8×10^{15}**	**a**	**6.0×10^{13}**	**a**
2018	1.4×10^{14}	3.3×10^{11}	2.5×10^{13}	1.3×10^{6}	$<2.2 \times 10^{6}$
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. None of these individuals DRLS were exceeded.

Releases to surface waters:

Table H.13: Point Lepreau annual radionuclide releases to surface waters for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Gross beta (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
2018 DRL	**4.6×10^{19}**	**a**	**3.3×10^{14}**	**a**
2018	2.4×10^{14}	9.7×10^{7}	4.9×10^{9}	1.7×10^{7}
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

The G-2 facility was permanently shut down in December 2012. Since then, activities conducted by Hydro-Québec have been to stabilize and transition the G-2 facility to safe storage.

Releases to atmosphere:

Table H.14: Gentilly-2 annual radionuclide releases to atmosphere for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Gross beta/gamma) (Bq)
2018 DRL	**1.7×10^{17}**	**1.2×10^{15}**	**NA[1]**	**NA[1]**	**8.0×10^{11}**
2018	9.17×10^{13}	4.63×10^{10}	<LD[a]	<LD[a]	2.15×10^{6}
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}	4.83×10^{11}	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] Not applicable as facility is in safe shut-down.

[a] = less than analytical detection limit

Releases to surface waters:

Table H.15 Gentilly-2 annual radionuclide releases to surface waters for 2011 – 2018. The applicable DRLs for 2018 are also presented.

Year	Tritium: (HTO: Bq)	Gross beta (Bq)	Carbon-14 (Bq)
2018 DRL	**1.1×10^{19}**	**5.3×10^{13}**	**7.3×10^{14}**
2018	5.46×10^{13}	2.51×10^{7}	1.71×10^{8}
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}

Appendix I: 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 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 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:

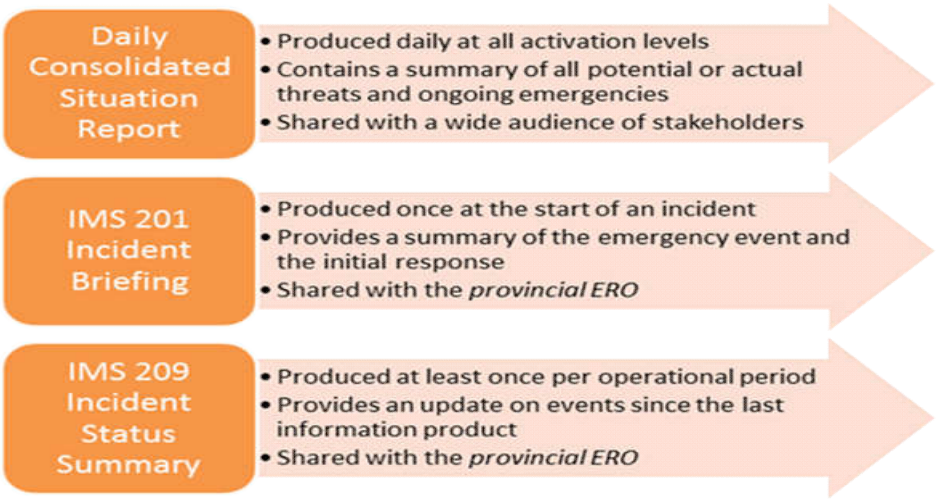
- facilitating the availability of KI pills
- establishing reception and evacuation centres to accommodate evacuees
- establishing emergency worker centres to ensure radiation protection for emergency workers

The provinces have mechanisms to ensure communications and coordinated responses between stakeholders during emergencies. The following describes the arrangements in place for Ontario [RIB 15153].

The provincial emergency operations center (PEOC) is responsible for disseminating information to its members and to the emergency management stakeholders. The PEOC is also responsible for providing information to ministries and communities indirectly involved in the emergency response regarding the province's response to the emergency.

Figure J-1 describes the various information products that the PEOC develops and disseminates to relevant emergency organizations, depending on the situation. (Note that ERO stands for emergency response organization.)

Figure J-1. PEOC information products



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