Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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ORIGINAL/ORIGINAL

CMD: 18-H4

Date signed/Signé le : 12 FEBRUARY, 2018

A Licence Renewal

Un renouvellement de permis

Bruce Power Inc.

Bruce Power Inc.

Bruce Nuclear Generating Station A and B

Centrale nucléaire de Bruce A et B

Commission Public Hearing – Part 1

Audience publique de la Commission – Partie 1

Scheduled for:

14 March 2018

Prévue pour :

14 Mars 2018

Submitted by:

CNSC Staff

Soumise par :

Le personnel de la CCSN

e-Doc 5292456 (WORD)
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Summary

This CMD presents information about the following matters of regulatory interest with respect to Bruce Power Inc.:

- renewal of the Power Reactor Operating Licence (PROL) for the Bruce Nuclear Generating Station (NGS) A and B
- major component replacement (MCR) and life extension of the Bruce NGS Units 3 to 8
- compliance with the safety and control areas for the safe operation of the facility

CNSC staff recommend the Commission take the following actions:

- accept the following conditions to be included in the proposed licence requiring Bruce Power to:
  - implement the Integrated Improvement Plan resulting from the current Periodic Safety Review (PSR)
  - maintain pressure tube fracture toughness sufficient for safe operation
  - implement a return to service plan for MCR activities
  - obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points during return to service
  - conduct and implement a PSR prior to the renewal of the next licence

Résumé

Le présent CMD présente de l’information sur un ensemble de questions d’ordre réglementaire concernant Bruce Power Inc.:

- renouvellement du permis d’exploitation d’un réacteur de puissance (PERP) des centrales nucléaires de Bruce-A et B
- remplacement de composants majeurs et prolongement de la durée de vie des tranches 3 à 8 des centrales de Bruce
- conformité aux domaines de sûreté et de réglementation pour l’exploitation sécuritaire de l’installation

Le personnel de la CCSN recommande que la Commission prenne les mesures suivantes:

- accepter les conditions suivantes à inclure dans le permis proposé pour exiger que Bruce Power :
  - mette en œuvre le plan d’amélioration consécutif au bilan périodique de la sûreté (BPS)
  - maintienne la ténacité des tubes de force pour l’exploitation sûre
  - mette en œuvre un plan de remise en service pour les activités de remplacement de composants majeurs
  - obtienne l’approbation de la Commission, ou le consentement d’une personne autorisée par la Commission, avant de lever, au cours de la remise en service, les points d’arrêt réglementaires établis
  - réalise et mette en œuvre le plan

intégré de mise en œuvre découlant du BPS

- amend the PROL to consolidate the specified licences (Class II and nuclear substances and radiation devices) identified in Part 2 of this CMD that support the operations of Bruce A and B
- authorize Bruce Power to operate Bruce A and B up to a maximum of 300,000 Equivalent Full Power Hour
- delegate authority as set out in Section 5.12 of this CMD
- issue, pursuant to section 24 of the *Nuclear Safety and Control Act*, a single Bruce A and B operating licence to Bruce Power for a period of 10 years from September 1, 2018 to August 31, 2028

- modifier le PERP afin d'y regrouper des permis précis (catégorie II et substances nucléaires et appareils à rayonnement) dans la partie II du présent CMD, à l'appui de l'exploitation de Bruce-A et B
- autoriser Bruce Power à exploiter les centrales de Bruce-A et B jusqu'à ce que les réacteurs soient mis à l'arrêt pour procéder aux travaux de réfection proposés, jusqu'à un maximum de 300 000 heures équivalentes pleine puissance
- déléguer l'autorité comme il est décrit à la section 5.12 du présent CMD
- délivrer, conformément à l'article 24 de la *Loi sur la sûreté et la réglementation nucléaires*, un seul permis d'exploitation à Bruce Power pour les centrales de Bruce-A et B du 1er septembre 2018 au 31 août 2028

The following items are attached:

- The proposed PROL 18.00/2028
- The draft Licence Conditions Handbook
- The current PROL 18.00/2020
- The 2017 Environmental Assessment Report

Les pièces suivantes sont jointes :

- permis proposé – PERP 18.00/2028
- version provisoire du manuel des conditions de permis
- permis actuel – PERP 18.00/2028
- rapport d'évaluation environnementale 2017

Signed/signé le

12 February, 2018

Gerry Frappier, P. Eng

Director General

Directorate of Power Reactor Regulation

Directeur général

Direction de la réglementation des centrales nucléaires

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EXECUTIVE SUMMARY

The Bruce Nuclear Generating Stations (NGS) A and B are located in the Municipality of Kincardine, in the County of Bruce, Ontario. Bruce A and B are part of the Bruce Nuclear Power Development site on the shores of Lake Huron. The site also contains three waste management facilities and the decommissioned demonstration Douglas Point power reactor. Bruce A consists of four 750 megawatt CANDU reactors which came into service between 1977 and 1979. Bruce B consists of four 822 megawatt CANDU[1] reactors which came into service between 1984 and 1987. Ontario Power Generation (OPG) owns Bruce A and B. Bruce Power has been operating these stations under a lease agreement with OPG since 2001. Bruce Power refurbished and returned Units 1 and 2 to service in the fall of 2012.

The current Bruce A and B power reactor operating licence, PROL 18.00/2020 expires on May 31, 2020. Bruce Power submitted a licence renewal application two years prior to expiry of the current licence (i.e., 2018) in order to obtain the Commission's approval needed to refurbish its units (as development of the refurbishment plans requires a significant lead time). Bruce Power has requested a renewal licence period of ten (10) years which encompasses operation as well as activities related to refurbishment (which will be referred to as Major Component Replacement[2] or MCR) of Units 3 to 8, which is planned to begin in 2020.

In support of the licence application and activities associated with the MCR, Bruce Power has completed a Periodic Safety Review (PSR) in accordance with Canadian Nuclear Safety Commission (CNSC) Regulatory Document REGDOC-2.3.3, *Periodic Safety Reviews*. The results of the PSR are used to establish safety improvements to the plant (as captured in an Integrated Improvement Plan or IIP) which will be implemented over the proposed licence period.

CNSC staff are recommending a 10-year operating licences for nuclear power plants (NPP) so that the PSR frequency of every 10 years will coincide with licence renewals. Based on the submitted application and CNSC staff's evaluation of Bruce Power's programs, CNSC staff determined that the criteria for a 10 year licence term defined in Commission Member Document (CMD) 02-M12, *New Staff Approach to Recommending Licence Periods* have been met. Therefore, CNSC staff are recommending a 10-year licence period for the Bruce A and B licence. In support of its next licence application, CNSC staff have included a condition in the proposed PROL requiring Bruce Power to perform the next PSR in accordance with REGDOC-2.3.3, *Periodic Safety Reviews*. In addition, Bruce Power will need to demonstrate in the next licensing period that the items identified in the IIP, resulting from the PSR, are being implemented. Prior to returning a unit to service after an MCR outage, Bruce Power will need to demonstrate that return-to-service requirements have been met through CNSC regulatory hold points.

[1] CANDU: **CAN**ada **D**euterium **U**ranium

[2] Note: The term "MCR" is used for the refurbishment of Bruce Units 3 to 8. For refurbishment projects at other nuclear power plants (such as Pt. Lepreau and Darlington) and existing plants at Bruce site (Units 1 and 2), the term "refurbishment" is used.

In its application, Bruce Power requested the consolidation of other types of Bruce Power licences (Class II and Nuclear Substance and Radiation Devices Licences) into the PROL. It is CNSC staff's view that the proposed request do not remove any regulatory requirements and will provide regulatory oversight of these activities in a more efficient and effective manner. CNSC staff recommend that the Commission amend the PROL to consolidate the specified licences.

The current licence authorizes Bruce Power to operate Bruce A and B up to 247,000 Equivalent Full Power Hour (EFPH). Bruce Power is seeking Commission approval to operate up to 300,000 EFPH. This is the maximum operational time expected for the units before they enter an MCR outage, during which the major components will be replaced.

Currently, Bruce Power has fracture toughness models for [Heq] levels up to 120 ppm to demonstrate safe operations. For operations up to 300,000 EFPH, Bruce Power estimated that [Heq] could reach as high as 147 ppm. Bruce Power has made detailed plans for activities required to demonstrate that the condition of pressure tubes will support safe operations up to 300,000 EFPH. The plan includes ongoing monitoring of hydrogen content during regular inspection campaigns, and continued research and development work aimed at producing a pressure tube fracture toughness model for [Heq] levels in excess of 120 ppm. CNSC staff will closely monitor Bruce Power's progress to ensure that these activities are completed according to the required schedules.

CNSC staff recommend that the Commission approve operation of Bruce A and B up to a maximum of 300,000 EFPH. A specific licence condition (and the compliance verification criteria found in its associated Licence Conditions Handbook) is recommended by CNSC staff requiring Bruce Power to maintain pressure tube fracture toughness sufficient for safe operation. Although approval for the operation of Bruce A and B up to a maximum of 300,000 EFPH is recommended by CNSC staff, the Units will not be allowed to operate with [Heq] in excess of 120 ppm until the acceptance criteria in the CVC have been met.

An Environmental Assessment (EA) under the *Canadian Environmental Assessment Act 2012*[3] (CEAA 2012) was not required for this licence renewal application, nor did section 67 of CEAA 2012 apply, as no new project (defined under section 66 of CEAA 2012) or physical activities are being authorized under the proposed licence. However, an EA under the *Nuclear Safety and Control Act* (NSCA)[4] and its regulations was conducted for this application. CNSC staff conclude that the licensee will make adequate provision for the protection of the environment and health of persons.

The public, Indigenous groups and other stakeholders were invited to participate in the relicensing process, and up to $100,000 was made available to enable their participation through the CNSC's Participant Funding Program (PFP). Eight (8) applicants were awarded PFP funds for the Bruce licence renewal application to the amount of $76,500. In addition, funds were awarded to two (2) Indigenous groups (Saugeen Objiway Nation to the amount of $78,750 and Métis Nation of Ontario to the amount of $24,470) to hold

[3] S.C. 2012, c. 19, s. 52
[4] S.C. 1997, c. 9

meetings with CNSC staff on regulatory matters such as: licence renewal, *Fisheries Act* authorization, EA and MCR.

In this CMD, CNSC staff present the assessments of the licence application and the documents submitted in support of the application, as well as Bruce Power's performance to date (2015-2017) for the licence period. CNSC's regulatory oversight of the Bruce A and B also included assessments of Bruce Power's efforts in continuous safety improvements.

In addition to the assessments, this CMD also provides comprehensive information on the issues on which CNSC staff have been focusing, the current status of these issues, and CNSC staff's future expectations of Bruce Power. It presents the rationale for staff's conclusions and recommendations to the Commission on section 24 of the NSCA.

This CMD provides information in all CNSC safety and control areas (SCAs) with focused highlights on:

- CNSC staff's EA under the NSCA
- Bruce Power's environmental risk assessment and predictive environmental risk assessment
- refurbishment - MCR
- PSR, including the Global Assessment Report (GAR) and the IIP
- fitness for service for major components (pressure tubes, steam generators and feeders)
- an update on Fukushima action items (FAIs)
- engagement with Indigenous groups

Table 1 lists CNSC staff's rating for Bruce Power's performance in each SCA to the end of 2016. Note that preliminary ratings for 2017 show the same trend, however they are not finalized and will be presented in the CNSC staff's *Regulatory Oversight Report for Canadian Nuclear Power Plants* later in 2018.

The table shows that Bruce Power met or exceeded regulatory requirements in all SCAs and that Bruce Power has operated Bruce A and B safely during the current licensing period. It is CNSC staff's view that Bruce Power will:

- continue to operate Bruce A and B safely
- continue to maintain and implement adequate programs
- fulfill commitments made in the licence renewal applications and complete the planned improvements (such as those found in the IIP) during the proposed licensing period

Table 1: Bruce A and B Performance Ratings for 2014, 2015 and 2016

Safety and Control Area (SCA)	Ratings					
	2014*		2015		2016	
	Bruce A	Bruce B	Bruce A	Bruce B	Bruce A	Bruce B
Management system	SA	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA	SA
Operating performance	SA	FS	FS	FS	FS	FS
Safety Analysis	SA	SA	SA	SA	FS	FS
Physical Design	SA	SA	SA	SA	SA	SA
Fitness for Service	SA	SA	SA	SA	SA	SA
Radiation Protection	SA	SA	SA	SA	FS	FS
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	FS	FS	FS	FS	FS	FS
Security	FS	FS	FS	FS	SA	SA
Safeguards and Non-proliferation	SA	SA	SA	SA	SA	SA
Packaging and Transport	SA	SA	SA	SA	SA	SA
Integrated Plant Rating	**SA**	**FS**	**FS**	**FS**	**FS**	**SA**

FS: fully satisfactory SA: satisfactory

***note**: *2014 Ratings were not finalized in time for the 2015 licence renewal and are included to show historical trends*

During the current licensing period, there were no serious process system failures, the availability of special safety systems was acceptable, and doses to workers and the public were well below regulatory limits. Risk to the public and workers have been kept low, and in CNSC staff's view, should remain low over the proposed licence period.

CNSC staff concluded that Bruce Power has made and will continue to adequately provide for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

CNSC staff recommend the Commission to:

- accept the following licence conditions (LC) to be included in the proposed licence requiring Bruce Power to:
  - LC 15.2, implement the IIP resulting from the current PSR
  - LC 15.3, maintain pressure tube fracture toughness sufficient for safe operation
  - LC 15.4, implement a return to service plan for MCR activities
  - LC 15.5, obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points during return to service

  - LC 15.6, conduct and implement a PSR prior to the renewal of the next licence

- amend the Power Reactor Operating Licence (PROL) to consolidate the specified licences (Class II and nuclear substances and radiation devices) identified in Part 2 of this CMD that support the operations of Bruce A and B
- authorize Bruce Power to operate Bruce A and B up to a maximum of 300,000 Equivalent Full Power Hour
- delegate authority as set out in Section 5.12 of this CMD
- issue, pursuant to section 24 of the NSCA, a single Bruce A and B operating licence to Bruce Power for a period of 10 years from September 1, 2018 to August 31, 2028.

The proposed PROL, as well as a draft Licence Conditions Handbook are presented in Part 2 of this CMD.

PART ONE

This CMD is presented in two parts.

Part One includes:

1. An overview of the matter being presented
2. Overall conclusions and overall recommendations
3. Major Component Replacement project (including PSR, GAR and IIP review)
4. General discussion pertaining to the SCAs that are relevant to this submission
5. Discussion about other matters of regulatory interest
6. Addenda material that complements items 1 through 5

Part Two includes:

1. All available information pertaining directly to the current and proposed licence.

1. OVERVIEW

1.1 Background

The Bruce A and B Nuclear Generating Stations (NGSs) are located in the Municipality of Kincardine, in the County of Bruce, Ontario. Bruce A and B are part of the Bruce Nuclear Power Development site on the shores of Lake Huron. Ontario Power Generation (OPG) owns the Bruce A and B which Bruce Power has been operating under a lease agreement with OPG since 2001.

Figure 1: Aerial view of Bruce A

Bruce A (Figure 1) consists of four 750 megawatt CANDU reactors which came into service between 1977 and 1979. The Bruce A units were put in laid up condition by OPG in 1998. In 2001, Bruce Power leased the facilities and undertook a project to re-start Bruce A Units 3 and 4. Bruce Power returned Unit 4 to service in October 2003 and returned Unit 3 to service in January 2004. In 2005, Bruce Power submitted a project proposal for refurbishing Units 1 and 2, which underwent an environmental screening under the *Canadian Environmental Assessment Act, 1992.* In June 2006, the Commission accepted the results of the environmental assessment screening report for the project and Bruce Power commenced physical work. Bruce Power returned Unit 1 to service in September 2012 and returned Unit 2 to service in October 2012.

Figure 2: Aerial view of Bruce B

The Bruce B station (Figure 2) consists of four 822 megawatt CANDU reactors which came into service between 1984 and 1987.

1.2 Highlights

In 2017, Bruce Power submitted an application, including supplemental information [1-10], for the renewal of its Bruce A and B Power Reactor Operating Licence (PROL). The current PROL expires on May 31, 2020. Bruce Power submitted a licence renewal application two (2) years prior to expiry of the current licence (i.e., 2018) in order to obtain the Commission's approval needed to refurbish its units (as development of the refurbishment plans requires a significant lead time). Bruce Power has requested a renewal licence period of ten (10) years which encompasses operation as well as activities related to refurbishment (hereto referred to as Major Component Replacement[5] or MCR), which is planned to begin in 2020.

The proposed consolidated licence includes the following activities:

- operation of the Bruce A and B nuclear facilities
- operation of a Class II nuclear facility and prescribed equipment for the purpose of calibration
- operation of radiography throughout the Bruce site
- import and export nuclear substances, except controlled nuclear substances, that are required for, are associated with, or arise from the three (3) activities listed above

[5] Note: The term "MCR" is used for the refurbishment of Bruce Units 3 to 8. For other nuclear power plants (such as Pt. Lepreau and Darlington) and existing plant at Bruce site (Units 1 and 2), the term "refurbishment" is used.

- possess, manage and store Cobalt-60 at Bruce B
- possess, manage and store booster fuel assemblies at Bruce A

The Commission approved REGDOC-2.3.3, *Periodic Safety Reviews* (PSRs). This regulatory document requires an applicant to perform an assessment of the current state of the plant and its performance to determine the extent to which it conforms to applicable modern codes, standards and practices, and to identify any factors that would limit safe long-term operation. In accordance with international practice, 10 years is considered an appropriate interval between PSRs.

The recommended licence term is also based on criteria set out in CMD 02-M12, *New Staff Approach to Recommending Licence Periods*. Based on the submitted application and CNSC staff's evaluation of Bruce Power's programs, CNSC staff determined that the criteria in CMD 02-M12 have been met and that Bruce Power has and will make reasonable and practical improvements to ensure safety over the next 10 years. Therefore, CNSC staff are recommending a 10-year operating licences (from 5-year licences) with a licence condition requiring PSR done every 10 years to coincide with licence renewals.

The purpose of this CMD is to provide CNSC staff's conclusions and recommendations to support the Commission's decision on the licence renewal application.

This CMD provides information in all the CNSC safety and control areas with focused highlights on:

- CNSC staff environmental assessment under the NSCA
- Bruce Power's environmental risk assessment and predictive environmental risk assessment
- refurbishment - MCR
- PSR, including the global assessment report and integrated improvement plan
- fitness for service for fuel channels, feeders and steam generators and operation up to 300,000 Equivalent Full Power Hours
- update on Fukushima Action Items (FAIs)
- engagement with Indigenous groups

Recommendations made by Commission members in the previous licence renewal Records of Proceedings, including Reasons for Decision in 2015 [16] are summarized in Table 2 and the specific details are provided in Section 5.11 of this CMD. The recommendations were directed to CNSC staff and Bruce Power for action.

Table 2: Summary of Recommendations made by Commission members

Item	Action	Description	Status
1.	Submit PSR and IIP in event of an application for refurbishment	In the event of an application for MCR, the process should include an integrated safety review, implementation and maintenance of return-to-service plan, and periodic updates on progress of project.	PSR and IIP submitted. **Action Completed.**
2.	Provide Bruce A Units 1 and 2 fuel defects update	Bruce Power to provide annual updates on Bruce Units 1 and 2 fuel defects, Bruce B endplate cracking and analysis of Primary Heat Transport (PHT) Pressure Relief Valve (PRV) sizing.	Bruce Power providing annual updates. **Action Completed.**
3.	Form a fish impingement and entrainment monitoring plan Working Group	CNSC staff and Bruce Power to form a working group with interested Indigenous groups for fish impingement and entrainment monitoring plan component of the EA Follow-up Monitoring Program (FUMP).	Working Group formed. **Action Completed.**
4.	Provide progress update on Department of Fisheries and Ocean (DFO) Application	CNSC staff to provide annual updates on progress of authorization under Section 35 of the *Fisheries Act*. The *Fisheries Act* authorization process is independent from the CNSC licensing process.	Bruce Power providing annual updates. **Action Completed.**
5.	Develop policy on enhancements to Bruce A and Bruce B if PSA results are between the safety limit and the target	Bruce Power to develop a policy and formal document stipulating that enhancements to Bruce A and Bruce B will be considered if PSA results are between the safety limit and the target, specifically, with respect to achieving large release frequency safety goal targets of 1.0E-6/yr.	Bruce Power will issue policy document in March 2018. **Action Completed.**
6.	Evaluate CANDU safety issues (CSI) raised	Establish a forum to further evaluate CSI brought forth in Dr. Sunil Nijhawan's intervention.	Hearing held to disposition CSI raised. **Action Completed.**
7.	Reduce backlog for deficient and deferred preventative maintenance	Achieving industry norms for backlog of deficient and deferred preventative maintenance should be a priority for Bruce Power. Progress will be monitored through annual updates via CNSC staff Annual Regulatory Oversight Report for Canadian NPP.	Progress being monitored through annual report. **Action Completed.**
8.	Evaluate adequacy of nuclear emergency response plans	Bruce Power to consult with local municipalities to ensure that its nuclear emergency response plans are adequate.	Municipality of Kincardine is updating response plan with support from Bruce Power. **Action Completed.**

Request to Adjourn Hearing by Saugeen Ojibway Nation

On November 20, 2017, the Commission invited Bruce Power to file a response based on Saugeen Ojibway Nation's (SON) request [11] to adjourn the hearing dates planned for March and May 2018. SON expressed concerns with the timelines and process planned for the review of Bruce Power's proposed MCR. It is SON's opinion that MCR is considered to be a significant proposal with serious implications for their territory and people, and they believe that there is insufficient time to engage on the issues raised by the application or the materials supporting it. SON also expressed concerns with the Commission hearing process to consider an application to "double the operating life of six of the Bruce facility's reactors" and that characterizing this as a 10-year licence renewal is disingenuous. Finally, SON also expressed concern with regard to the nature of the process, specifically that no environmental assessment under *Canadian Environmental Assessment Act, 2012* is being undertaken.

On December 1, 2017, Bruce Power responded [12] to the Commission's request. Bruce Power stated that they do not share the same concern as SON with the Commission's hearing process. The following key points were identified by Bruce Power:

- It would be unfair to change the dates of the hearing months after they were initially announced.
- While operation for some units to 2064 is contemplated, Bruce Power has requested to renew the licence for a 10-year term which follows the current Canadian regulatory framework. Bruce Power believes that they have demonstrated that all legal and regulatory requirements have been met through its application.
- Bruce Power has actively engaged SON early and often in the licence renewal process. Specifically, in the past two years, Bruce Power has repeatedly provided information on the licence application with SON and sought direct meetings to discuss its contents. It is Bruce Power's opinion that SON have not made reasonable efforts to work within the existing process by engaging with Bruce Power on the application in a meaningful way.

On December 14, 2017, SON provided a further response [13] to address Bruce Power's December 1, 2017 submission [12].

On December 21, 2017, based on the submitted information, the Commission issued its Record of Decision [14]. The Commission concluded that the hearing dates as set are reasonable and fair, and that there is sufficient time provided for all participants, including SON, to prepare. The decision to hold the hearing as planned does not subjugate SON's Aboriginal and treaty rights to Bruce Power's business interests; both can be accommodated within the set timelines.

The Commission acknowledged SON's concerns and noted that monies are available under the CNSC's participant funding program to support SON's participation in the licence renewal process.

Therefore, the request to adjourn the hearing dates was denied by the Commission. However, the Commission stated that it retains the authority to provide more time after the Part 1 hearing, if required.

1.3 Overall Conclusions

CNSC staff have concluded the following with respect to paragraphs 24(4)(*a*) and (*b*) of the NSCA, in that the applicant:

1. Is qualified to carry on the activity authorized by the licence.
2. Will, in carrying out that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

1.4 Overall Recommendations

CNSC staff recommend to the Commission the following:

1. accept the following Licence Conditions (LC) to be included in the proposed licence requiring Bruce Power to:
   - LC 15.2, implement the IIP resulting from the current PSR
   - LC 15.3, maintain pressure tube fracture toughness sufficient for safe operation
   - LC 15.4, implement a return to service plan for MCR activities
   - LC 15.5, obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points during return to service
   - LC 15.6, conduct and implement a PSR prior to the renewal of the next licence
2. amend the Power Reactor Operating Licence (PROL) to consolidate the specified licences (Class II and nuclear substances and radiation devices) identified in Part 2 of this CMD that support the operations of Bruce A and B
3. authorize Bruce Power to operate Bruce A and B up to a maximum of 300,000 Equivalent Full Power Hour
4. delegate authority as set out in Section 5.12 of this CMD
5. issue, pursuant to section 24 of the NSCA, a single Bruce A and B operating licence to Bruce Power for a period of 10 years from September 1, 2018 to August 31, 2028.

The proposed PROL, as well as a draft Licence Conditions Handbook (LCH) are presented in Part 2 of this CMD.

2. MATTERS FOR CONSIDERATION

2.1 Environmental Assessment

An Environmental Assessment (EA) under the CEAA 2012 was not required for this licence renewal application, nor did section 67 of CEAA 2012 apply, as no new project (defined under section 66 of CEAA 2012) or physical activities are being authorized under the proposed licence. However, an EA under the NSCA and its regulations was conducted for this application.

More information can be found in the EA Report appended to this CMD (Addendum G). CNSC staff conclude that the licensee will make adequate provision for the protection of the environment and health of persons.

2.2 Safety and Control Areas (SCAs)

Regulatory oversight is performed in accordance with the 14 SCAs that are applicable to an operating Nuclear Power Plant (NPP). For each SCA, "specific areas" of regulatory interest were identified by CNSC staff. Addendum A "Safety and Control Area Framework" provides further information about the SCAs:

- A.1 - Safety and Control Areas Defined
- A.2 - Specific Areas for this Facility Type

Risk Ranking and Rating Levels

The CNSC has applied a risk-informed regulatory approach to each SCA to determine the relative risk rankings as they relate to NPPs. An overview of the risk ranking, and the management and monitoring approach associated with the various degrees of risk, can be found in Addendum B "Risk Ranking".

The rating level for each relevant SCA indicates the overall compliance with regulatory requirements for implementation. Information and definitions can be found in Addendum C "Rating Levels".

Table 3 summarizes the plant safety performance ratings for those SCAs that applied to the licensed activities from 2014 to 2016.

Table 3: Plant Safety Performance Ratings 2014-2016

Safety and Control Area (SCA)	2014*		2015		2016	
	Bruce A	Bruce B	Bruce A	Bruce B	Bruce A	Bruce B
Management system	SA	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA	SA
Operating performance	SA	FS	FS	FS	FS	FS
Safety Analysis	SA	SA	SA	SA	FS	FS
Physical Design	SA	SA	SA	SA	SA	SA
Fitness for Service	SA	SA	SA	SA	SA	SA
Radiation Protection	SA	SA	SA	SA	FS	FS
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	FS	FS	FS	FS	FS	FS
Security	FS	FS	FS	FS	SA	SA
Safeguards and Non-proliferation	SA	SA	SA	SA	SA	SA
Packaging and Transport	SA	SA	SA	SA	SA	SA
Integrated Plant Rating	SA	FS	FS	FS	FS	SA

Note: FS = fully satisfactory SA = satisfactory

***Note:** *2014 Ratings were not finalized in time for the 2015 licence renewal and are included to show historical trends*

2.3 Other Matters of Regulatory Interest

The following table identifies other matters that are relevant to this CMD. The relevant "other matters" of regulatory interest are discussed in section 5 of this CMD.

Table 4: Other Matters of Regulatory Interest

OTHER MATTERS OF REGULATORY INTEREST	
Area	**Relevant to this CMD?**
Fukushima action items	Yes
Operational safety review team mission	Yes
Bruce A Environmental Assessment follow-up program	Yes
Fisheries Act authorization	Yes
Licensee public information program	Yes
Aboriginal consultation and engagement activities	Yes
Cost recovery	Yes
Financial guarantees	Yes
Nuclear liability insurance	Yes
Consolidation of other types of licences	Yes
Previous commitments raised by the Commission	Yes
Delegation of authority	Yes

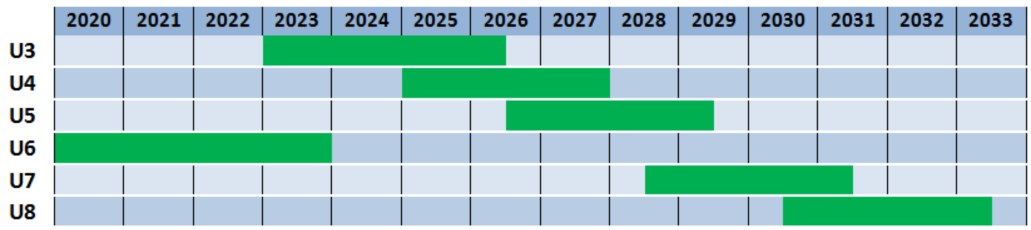
2.4 Regulatory and Technical Bases

The regulatory and technical bases for the matters discussed in this CMD, including international guidance documents, national standards and CNSC regulatory documents, are provided in the preamble sections of the Licence Conditions Handbook.

3. MAJOR COMPONENT REPLACEMENT PROJECT

Bruce Power has entered into an agreement with the Province of Ontario to conduct the MCR, beginning with Unit 6 in 2020. A high level timeline of the MCR outages (including their duration) for Units 3 to 8 is provided in Table 5.

Table 5: Bruce Power MCR project high level timeline



The main items of the MCR are the replacement of the major components including: fuel channels (including pressure tubes, calandria tubes and end fittings), feeders and steam generators.

While the scope of the MCR (further discussed in Section 3.3 of this CMD) is included in the Integrated Improvement Plan, Bruce Power plans to conduct additional work on the units as part of its asset management program (further discussed in Section 3.4 of this CMD). Bruce Power's plan is to complete any required asset management work in normal maintenance outages but, where this is not possible (e.g., where the work requires significant field time – greater than 90 days, or a defueled/dewatered state), this work will fall within the MCR outages.

As discussed at the re-licensing hearings in 2015, the Commission required, under Licence Condition 15.2 of the PROL 18.00/2018, that the MCR process would include:

- a PSR (formerly known as Integrated Safety Review)
- implementation and maintenance of a return-to-service plan
- periodic updates on the progress of the project and any proposed changes

The Commission also concluded that a licence application would be submitted with this information and public hearings would be held to provide an opportunity for the public to intervene.

Details of the CNSC staff assessment of the submitted PSR, including the Global Assessment Report and Integrated Improvement Plan, are presented in Sections 3.1 and 3.2 of this CMD.

3.1 Periodic Safety Review

As outlined in REGDOC-2.3.3, *Periodic Safety Review*, a PSR involves an assessment of the current state of the plant and plant performance to determine the extent to which the plant conforms to modern codes, standards and practices, and to identify any factors that would limit safe long-term operation. A PSR also takes into account worldwide operating experience, and in particular, assessment of the impact of plant aging on safety. This assessment enables the determination of reasonable and practical modifications that should be made to the plant or operational programs in order to enhance the safety of the facility to a level approaching that of a modern NPP and to allow for long-term operation.

Bruce Power began working on the PSR in 2014. It was then submitted to CNSC staff in two parts, the first covering Bruce A in 2015 and the second covering Bruce B in 2016. The submitted PSR documents [17] are publicly available through Bruce Power's external website. REGDOC-2.3.3 requires that the PSR be conducted according to the following four phases:

1. prepare a PSR basis document
2. submit safety factor reports for the review of each safety factor area
3. submit a Global Assessment Report (GAR) based on findings from the safety factor reports
4. submit an Integrated Implementation Plan (IIP) to address the findings of the GAR

A summary of CNSC staff's review of the PSR basis document and safety factor reports is provided in Section 3.1.1 of the CMD, and the GAR and IIP are provided in Section 3.1.2 of this CMD.

3.1.1 PSR basis document and safety factor reports

CNSC staff conducted an extensive review of the PSR over a three-year period (2015 to 2017). Following CNSC staff's acceptance of the PSR basis document, Bruce Power submitted safety factor reports that addressed 15 safety factors described in REGDOC-2.3.3. Each safety factor is broken down into specific review tasks based on guidance provided in IAEA SSG-25, *Periodic Safety Review for Nuclear Power Plants*. The safety factors addressed in the PSR and their objectives are presented in Table 6.

Table 6: 15 Safety Factors described in REGDOC-2.3.3

Safety Factor	Objective
1. Plant Design	To determine the adequacy of the design and its documentation in an assessment against modern national and international standards and practices.
2. Actual Condition of Structures, Systems and Components (SSCs)	To determine the actual condition of SSCs important to safety and whether it is adequate for them to meet their design requirements. In addition, the review should confirm that the condition of SSCs is properly documented.
3. Equipment Qualification	To determine whether equipment important to safety is qualified to perform its designated safety function throughout its installed service life.
4. Aging	To determine whether aging is being effectively managed so that required safety functions are maintained and whether an effective Aging Management Program is in place for future plant operation.
5. Deterministic Safety Analysis	To determine to what extent the existing Deterministic Safety Analysis remains valid when the following aspects have been taken into account: actual plant design; the actual condition of SSCs and their predicted state at the end of the period covered by the PSR; current deterministic methods; and current safety standards and knowledge. In addition, the review should also identify any weaknesses relating to the application of the defence in depth concept.
6. Probabilistic Safety Analysis	To determine to what extent the existing PSA remains valid as a representative model of the plant when the following aspects have been taken into account: changes in the design and operation of the plant; new technical information, current methods; and new operational data.
7. Hazard Analysis	To determine the adequacy of protection of the Nuclear Power Plant (NPP) against internal and external hazards taking into account the actual plant design, actual site characteristics, the actual condition of SSCs and their predicted state at the end of the period covered by the PSR, and current analytical methods, safety standards and knowledge.
8. Safety Performance	To determine the safety performance of the NPP and its trends from records of operating experience and performance indicators
9. Use of Experience from Other plants and Research Findings	To determine whether there is adequate feedback of safety experience from other NPPs and of the findings of research.
10. Organization and Administration	To determine whether the organization and the administration are adequate for the safe operation of the NPP.
11. Procedures	To determine whether the procedures are of an adequate standard to ensure plant safety.
12. Human Factors	To determine the status of the various human factors that may affect the safe operation of the NPP.

Safety Factor	Objective
13. Emergency Management	To determine whether the licensee has adequate plans, staff, facilities and equipment for dealing with emergencies and whether the licensees arrangements have been adequately coordinated with local and national systems and are regularly exercised.
14. Radiological Impact on the Environment	To determine whether the licensee has an adequate program for surveillance of the radiological impact of the plant on the environment, which ensures that emissions are properly controlled and are as low as reasonably achievable.
15. Radiation Protection	To determine whether the plant has an adequate design for minimizing doses, both to workers and to the public.

Bruce Power's submitted PSR addressed 64 modern codes and standards considered most likely to apply to a new NPP. The list of modern codes, standards and practices submitted in the PSR were assessed and accepted by CNSC staff through the approval of the PSR basis document [18]. The set of modern codes, standards and practices selected for the PSR included:

- CNSC regulatory documents
- Canadian Standards Association (CSA) and other Canadian standards
- International standards and practices, including applicable IAEA safety requirements and guides

Overall, the submitted PSR demonstrated compliance with modern codes, standards and practices. CNSC staff confirmed that Bruce Power has adequately identified strengths and gaps (with respect to meeting the modern codes, standards and practices) in the safety factor reports. In cases where gaps with the modern standards were identified, the gaps were categorized and prioritized according to their safety significance and assessed by Bruce Power for resolution in the GAR. Bruce Power has classified the gaps into the following four categories:

1. Category 1 gaps: these are gaps for which no reasonable and practical improvement can be identified.
2. Category 2 gaps: these are gaps which are not relevant to safety and therefore unnecessary to implement.
3. Category 3 gaps: these are gaps for which safety improvements are considered necessary and are already in progress.
4. Category 4 gaps: these are gaps for which safety improvements are considered necessary and are planned in the IIP.

Resolution of the gaps which resulted in achievable improvements (i.e., Category 3 and 4) to safety of the facility were then included in the IIP (see Section 3.1.2 of this CMD).

CNSC staff concluded that the submitted PSR has adequately identified gaps and strengths in the current state of the plant, its performance and the conformance to modern standards and practices and that Bruce Power has completed a comprehensive review of plant design, condition, and operational programs.

3.1.2 Global Assessment Report and Integrated Implementation Plan

REGDOC-2.3.3 requires that the results of the safety factor review be incorporated into a GAR and IIP. The GAR presents the results of the review in an integrated manner and provides an overall risk assessment on the acceptability of continued operation for the proposed operating period. The IIP presents the proposed safety improvements and includes timeframes for implementation.

There are a total of 191 identified IIP improvements to Bruce A and B. In addition, Bruce Power has also identified other programmatic improvements outside of the IIP (i.e., Category 2 gaps), which will be captured in its corrective actions program. Most of the IIP items are included in the scope of the MCR outages. As such, the completion of these items will be scheduled for the MCR outages and have staggered due dates in-line with the MCR timeline as previously provided in Table 5. For the other improvements which can be completed on-line or as part of normal maintenance outages, these will be implemented in the first half of the proposed 10-year licence period. The identified IIP improvements include:

- replacement of major components (fuel channels, feeders and steam generators)
- system upgrades to address Fukushima related action items such as:
  - providing an external water make-up source to the heat transport and moderator system
  - installation of containment filtered venting system to maintain containment integrity and filter radioactive releases
- completion of the new neutronics trip feasibility study
- upgrades to the emergency power generators
- replacement of the maintenance cooling heat exchangers
- upgrades to the fire protection system
- modifications to address heat transport vibrations

CNSC staff reviewed the first draft of the GAR (including the rationale for the gaps identified) and IIP submitted in December 2016. Based on the review comments provided by CNSC staff, a revised version of the GAR/IIP was submitted by Bruce Power in July 2017. The revised GAR/IIP was conditionally accepted by CNSC staff in September 2017 [19]. The conditions were mainly clarification items to ensure that the work description for the items reflected the scope of work including:

- correctly referencing all of the issues addressed by the asset management program (see Section 3.4 of this CMD) implementation
- providing details on the initiatives (i.e., category 2 gaps) that Bruce Power is pursuing which are not part of the IIP

- updating Bruce Power's equipment reliability program to clarify how dependence on essential services external to the plant is managed
- clarifying that all options have been considered for the modifications to address the heat transport vibrations issue
- clarifying that the code concessions are reviewed once a database has been created in order to determine which concessions are able to be resolved during the MCR
- clarifying that the radiation protection instrumentation life cycle management plan will include tritium area monitors

In November 2017, Bruce Power agreed with the conditions set out by CNSC staff [20].

CNSC staff concluded that results of the safety factor assessments were incorporated into the submitted GAR and IIP. The submitted IIP presented the proposed safety improvements and included timeframes for implementation. Bruce Power has identified the corrective actions and safety improvements necessary to address PSR findings to improve the level of safety.

CNSC staff are recommending that a condition requiring Bruce Power to implement the IIP resulting from the PSR be placed in the proposed licence, with additional details laid out in the draft LCH. See Part Two of this CMD for the proposed licence conditions related to PSR and IIP.

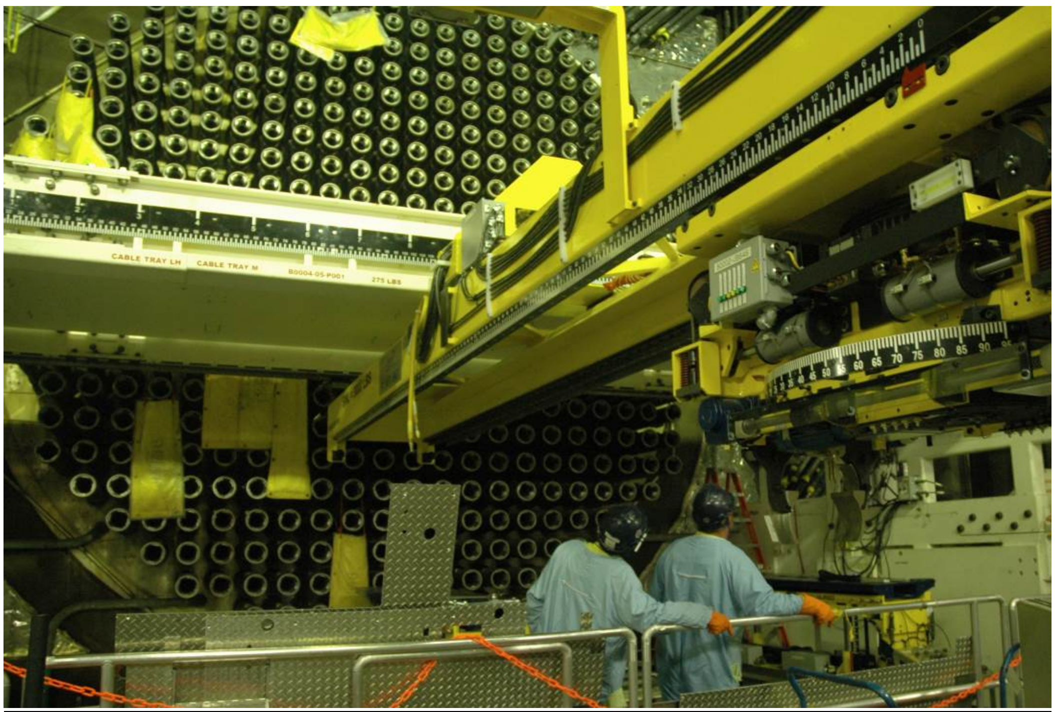
3.1.2.1 Regulatory Focus

Over the next licensing period, CNSC staff will perform compliance activities to ensure that Bruce Power meets the commitments identified in the IIP. In addition, CNSC staff will update the Commission on the status of the MCR, including the status of all IIP commitments as part of the annual Regulatory Oversight Report (ROR) for NPPs.

3.2 Major Component Replacement Project Execution

In order for Bruce Power to execute the MCR, they have established a major projects organization which contains an MCR program controls and support division as well as an MCR project delivery division. These divisions will be responsible for executing the project under Bruce Power's governance. Unlike the refurbishment of Bruce A Units 1 and 2 where new programs and procedures were created to conduct the project, Bruce Power will use the current programs and procedures as described in its licence application to manage future MCR outages.

Figure 3: Fuel channel replacement work during Bruce A refurbishment (*photo courtesy of Bruce Power*)



<u>Scope of MCR and asset management program</u>

As previously stated, Bruce Power is planning on staggering the proposed MCR outages, beginning with Unit 6 in January 2020. The main items of the MCR are the replacement of the major components including: fuel channels (including pressure tubes, calandria tubes and end fittings), feeders and steam generators. While the scope of the MCR is included in the IIP, Bruce Power plans to conduct additional work on the Units as part of its asset management program (asset management program is further discussed in Section 3.3 of this CMD). Bruce Power's plan is to complete any required asset management work in normal maintenance outages but, where this is not possible, (e.g., where the work requires significant field time – greater than 90 days, or a defueled/dewatered state) this work will fall within the MCR outages.

CNSC staff reviewed the scope of the MCR and the asset management program through the PSR, and concluded that the programs met regulatory requirements for the management of aging of Structures, Systems and Components (SSCs).

Contractor Management

In order to manage the volume of contractors that will be on site to support the outages, Bruce Power will be using an integrated project team approach. Bruce Power will lead the overall contractor management program. However, the contract execution approaches will differ based on the type and complexity of the work.

Bruce Power will be following its contractor management processes as outlined in BP-PROG-05.01, *Supply Chain*, BP-PROG-14.01, *Project Management and Construction*, and BP-PROG-14.02, *Contract Management* for the MCR. Previous CNSC inspections on Bruce Power's contractor management process have demonstrated that regulatory requirements were met.

Experience from other MCR Projects

Bruce Power collected information during the refurbishment of Bruce A Units 1 and 2 to facilitate future improvements to its programs, processes and procedures (e.g., use of best practices and recognizing areas for improvements). The information was gathered throughout the execution of the project, including an extensive set of focus group discussions at the end of the project such that as much data could be gathered as possible. The gathered information was then utilized in developing the plans for the MCR.

In addition to the extensive experience gathered internally, Bruce Power is also working closely with OPG on the Darlington refurbishment project. The Ontario Long Term Energy Plan contains a requirement to "*find ways of finding ratepayer savings through leveraging economies of scale in the area of refurbishment and operations*". As a result, Bruce Power and OPG have formed joint working groups in the following areas:

- common engineering procedures
- common training qualification (such as radiation protection training)
- vendor performance (including capacity and onboarding)
- quality management and document management
- supply chain (such as pooling critical spares, stocking models and auditing processes)
- safety analysis and licensing

Bruce Power and OPG also have a formal document exchange process where information (such as programs and procedures, refurbishment plans, reports and modification packages) can be shared. Finally, Bruce Power has seconded a number of staff to the Darlington refurbishment project in the areas of engineering and construction. When the MCR outage is closer to execution, OPG will also be seconding staff to the Bruce site. The aim of all of this work is to share information in order to ensure successful outages at both stations.

CNSC staff concluded that Bruce Power has an adequate process in place to take into account past and current lessons learned refurbishment experience, and will apply this experience during the MCR.

Worker Training for MCR

Bruce Power formed a project training team and developed a work plan to provide oversight on the training impacts associated with all scopes of work associated with MCR outages.

Facilities and Infrastructure

As Bruce Power has already executed the refurbishment of Bruce A Units 1 and 2, many of the necessary facilities for MCR are already in place. However, there are some incremental facilities and infrastructure needs for the MCR program. This includes the addition of:

- parking spaces for the anticipated volume of workers on the projects
- a modular building at Bruce B to accommodate additional MCR and contractor staff
- a centralized storage facility for tools and equipment required for the MCR
- a Bruce B simulator for testing of MCR modifications and training staff
- an offsite office complex which will also contain some training and mock-up facilities for detube/retube, steam generator replacement and balance of plant work

Return to Service

REGDOC-2.3.1, *Conduct of Licensed Activities: Construction and Commissioning Programs* outlines the following four commissioning phases:

Phase A: Focuses on ensuring that the systems required to ensure safety with fuel loaded in the reactor have been adequately commissioned. This phase must be successfully completed **prior to loading fuel** in the reactor.

Phase B: Focuses on ensuring that fuel is loaded in the reactor safely, confirming that the reactor is in a suitable condition to be started up and that all prerequisites for permitting the reactor to go critical have been met. This phase must be successfully completed **prior to the removal of the guaranteed shutdown state (GSS)**.

Phase C: Focuses on confirming reactor behaviour at the state of initial criticality and subsequent low power tests. This includes activities that cannot be performed during GSS and is conducted **before exceeding 1% reactor power**.

Phase D: Focuses on demonstrating reactor and systems behaviour at **higher power levels**, including activities that could not be carried out at the lower power levels in Phase C.

As part of the licence application, Bruce Power submitted NK29-PLAN-09700-002, *Return to Service plan* that describes the process of returning the nuclear and non-nuclear systems back to commercial operation following an MCR outage. This includes demonstrating that the associated work meets specified requirements and that management system arrangements have been updated appropriately.

Following an MCR outage, return to service is achieved through a number of milestones, including regulatory holds points which are typically aligned with the four phases of commissioning described above. CNSC staff are proposing the following four regulatory hold points for the return to service:

1. Prior to fuel load
2. Prior to GSS removal
3. Prior to exceeding 1% full power
4. Prior to exceeding 35% full power

Each of these hold points will serve as regulatory verification to ensure operational readiness of SSCs to support full power operation and satisfy regulatory requirements for staged increases in reactor power.

Approval to remove a hold point will be contingent on Bruce Power's submission of completion assurance documentation which provides evidence that all pre-requisites have been met. The criteria for releasing the hold points include:

- all IIP commitments required prior to the hold point are completed
- all SSCs required for safe operation beyond the hold point are available for service
- staffing levels to safely operate the unit are adequate
- specified operating procedures for the hold point have been formally validated
- specified training for the hold point is complete and staff qualified
- specified SSCs meet the quality and completion requirements of CSA N286
- all non-conformance and open items identified leading up to the hold point are addressed
- verification by CNSC staff that all construction, commissioning, re-start, and available for service activities required prior to the hold point have been successfully completed

CNSC staff are recommending that approval to remove regulatory hold points be delegated to the Executive Vice President and Chief Regulatory Operations

Officer. For reference, similar delegation of authority was previously granted by the Commission for the Bruce Units 1 and 2, Point Lepreau and Darlington refurbishment projects. The criteria and process for hold points are also identical to those placed on the aforementioned refurbishment projects.

Prior to releasing a regulatory hold point, CNSC staff will verify compliance and provide a report to the Executive Vice President and Chief Regulatory Operations Officer. Based on the review of this report, the Executive Vice President and Chief Regulatory Operations Office, Regulatory Operations Branch will issue a record of decision.

CNSC staff concluded that Bruce Power has programs and processes in place to manage the MCR. There is a contractor management process in place to ensure that MCR work is well managed. Knowledge and experiences gained from previous and ongoing refurbishment projects will be applied to the MCR.

3.2.1.1 Regulatory Focus

Over the next licensing period, CNSC staff will perform compliance activities to ensure that the MCR will be well managed. In addition, CNSC staff will update the Commission on the status of the MCR as part of the annual ROR for NPPs. The public will have an opportunity to participate in the proceedings when the ROR is presented to the Commission each year.

CNSC staff will also continue to update the Commission on the performance of the Bruce A and B, including MCR, as part of the routine status reports on power reactors and through event initial reports as necessary.

3.3 Asset Management

As previously discussed, while the scope of the MCR is included in the IIP, Bruce Power plans to conduct additional work on the Units at Bruce A and B as part of its asset management program. Bruce Power has developed an asset management program to support long term planning for the continued operation of Bruce A and B to 2064, pending future licensing decisions by the Commission. This section provides asset management aspects related to the PSR.

CNSC staff determined that requirements of REGDOC-2.6.3 were met, including the attributes for an effective aging management plan. CNSC staff also concluded that the safety factor report 2, "*Actual Condition of Systems, Structures and Components*" requirements of REGDOC-2.3.3 are met. Bruce Power's Asset Management program, if implemented as planned, will be adequate to manage the condition of the SSCs.

The asset management program is used to monitor the condition of the plant SSCs and manage repairs, replacements or modifications as necessary. The asset management program will play a key role in managing the aging of the facilities and include safety systems tests, periodic inspection, system/component health monitoring, life cycle management plans and technical basis assessments. The aging assessments will be performed on a periodic basis and will consider inputs such as equipment failures, maintenance backlogs, performance trends and obsolescence issues.

By gathering all of the data into the assessment management program, Bruce Power will be able to manage the facilities and plan work until the end of commercial operation. Some examples of asset management work include inspections of the calandria vessel, replacement of the maintenance cooling heat exchangers, replacement of the control distribution frame and replacement of the electrical systems.

Asset management is a living program as the maintenance, inspection and replacement strategies for each SSC are adjusted based on the information gathered through on-going plant condition monitoring. If inspection results show faster than expected degradation, then a replacement may take place earlier than initially planned and inspection frequencies will be increased. If the inspection results show that the degradation effects are minor, then the replacement may be made at a later date.

The submitted safety factor report 2, "*Actual Condition of Systems, Structures and Components*" of the PSR relied heavily upon the asset management program. Bruce Power's asset management program addressed the following items:

- aging processes for SSCs
- operational limits and conditions
- obsolescence
- implications of changes to design requirements on the SSCs

- findings from tests of the functional capability of SSCs
- results of inspections and/or walk downs
- maintenance
- evaluation of the operating history of the SSCs

CNSC staff reviewed the asset management program as part of the PSR desktop review. In addition, CNSC staff conducted site visits to obtain field evidence as part of their overall assessment of the asset management program. Bruce Power also provided a summary report on the condition of all the safety significant equipment in the plant. CNSC staff used this information to select SSCs (based on risk informed decision process) to confirm that the conditions of the SSCs were adequately assessed and that plans were in place to manage the conditions of the SSCs, including aging degradation mechanisms.

The implementation of the asset management program has been included in the IIP. Bruce Power will be providing routine updates on the status of the asset management program to ensure that the conditions of the SSCs will continue to be managed.

3.3.1.1 Regulatory Focus

Over the next licensing period, CNSC staff will perform compliance activities to ensure that Bruce Power continues to manage of the aging of SSCs to support continued operation of Bruce A and B.

3.4 Overall Conclusion and Recommendation for MCR Project

Bruce Power submitted an application which included a PSR, including a GAR and IIP that met the requirements of REGDOC-2.3.3.

Through the PSR, Bruce Power has adequately identified gaps and strengths in the current state of the plant, its performance and the conformance to modern standards and practices. The submitted PSR has systematically reviewed modern codes, standards and practices and has identified a number of practical improvements that will be made to Bruce A and B.

Bruce Power has programs and processes in place to ensure that the MCR will be managed effectively. In addition to the MCR work, the asset management program will support long term planning for the continued operation of Bruce A and B to 2064, pending future licensing decisions by the Commission. CNSC staff did not identify factors which would limit safe operation over the next licensing period.

CNSC staff recommend the following conditions, as it pertains to PSR, to be included in the proposed licence requiring Bruce Power to:

- implement the IIP resulting from the current PSR
- implement a return to service plan for MCR activities
- obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points during return to service
- conduct and implement a PSR prior to the renewal or the expiry of the proposed licence period to August 31, 2028

CNSC staff will maintain oversight of the programs by conducting detailed MCR inspections. The inspections will include, but not limited to the following areas:

- MCR project execution
- contractor and project management
- training needs for the MCR including onboarding (i.e., orientation) training program and oversight training, analysis for changes on training programs and return-to-service training

In addition, CNSC staff will update the Commission on the status of the MCR as part of the annual ROR. The public will have an opportunity to participate in the proceedings when this report is presented to the Commission each year.

4. GENERAL ASSESSMENT OF SCAS

CNSC staff assessments, presented in the following sections, are based on the review of the safety and control measures to be implemented by Bruce Power for the next licensing period outlined in Bruce Power's licence renewal application (including supplemental information) [1-10] and documentation submitted in support of the applications and the review of Bruce Power's past performance. The assessments are based on desktop reviews and inspection activities at the Bruce site including surveillance, monitoring and walkdowns.

Figure 4: CNSC staff perform routine inspections at the Bruce nuclear facilities

CNSC staff performed a technical sufficiency review of the submitted application and requested additional clarifications. The objective of the review was to determine whether sufficient technical details were provided to assess the application. Bruce Power provided a response to CNSC staff in September 2017 [15].

The specific areas that comprise the SCAs for this facility or activity type are identified in Addendum A, section A.2.

4.1 Management System

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

This CMD covers the following specific areas of Management System:

- Management system and Organization
- Performance assessment, improvement and management review
- Operating experience (OPEX)
- Change management, configuration management and records management
- Safety culture
- Management of contractors
- Business continuity

4.1.1 Trends

The following table indicates the overall rating for the Management System SCA over the current licensing period:

TRENDS FOR MANAGEMENT SYSTEM			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	SA
Bruce B	SA	SA	SA
Comments			
The Management System SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a "satisfactory" rating during all years of the licence period.			

4.1.2 Discussion

Over the current licence period, CNSC staff concluded the Management System SCA at Bruce Power met performance objectives and all applicable regulatory requirements. Bruce Power has made adequate provision to monitor and improve its management system, and promoted a healthy safety culture.

Details of the CNSC staff assessment in this SCA are presented in the following sections.

Management System and Organization

CNSC staff determined that Bruce Power has a management system that met the requirements in CSA N286-05, *Management System requirements for Nuclear Power Plants*. The organizational structure, and roles and responsibilities are adequately defined and documented in the Bruce Power's governance document.

Bruce Power Management System (BPMS) describes the structure of Bruce Power documentation, processes, and expectations. The BP-MSM-1, *Management System Manual* provides a description of how Bruce Power's business works. CNSC staff reviewed licensee documents listed in LCH during desktop reviews and Type II inspections. CNSC staff concluded that Bruce Power has a process in place to continuously improve the management system documentation.

As a result of the desktop reviews or Type II inspections, CNSC staff provided recommendations for improving the program documents that were of low risk significance. Bruce Power will address CNSC staff's comments in future revisions of the documents.

Performance assessment, improvement and management review

CNSC staff determined that Bruce Power's programs on performance assessment and management review met the requirements of CSA N286-05. Bruce Power performs annual oversight activities and performance assessment of its programs and its overall management system. In addition, Bruce Power performed self-assessments and audits to ensure that its programs and procedures are being continuously verified and complies with the requirements.

Over the current licensing period, CNSC staff performed Type II inspections on Bruce Power's self-assessment program and confirmed that, overall, the program met requirements.

In 2015, CNSC staff performed an inspection on the effectiveness of corrective actions and found that Bruce Power staff followed its governance [21]. The corrective actions program also applies to contractors. Areas of minor non-compliances of low risk significance with Bruce Power's internal procedures were identified related to quality of the effectiveness records. Bruce Power took appropriate corrective actions to improve the quality of the records.

In 2017, CNSC staff assessed the event investigation program and concluded that the root causes analysis and other methods of investigation met regulatory requirements [22]. CNSC identified only minor documentation issues of low risk significance that were communicated to Bruce Power for actions.

Operating Experience (OPEX)

CNSC staff determined that Bruce Power has an OPEX program in place that met regulatory requirements. In 2017, CNSC staff inspected the implementation of Bruce Power's OPEX program including contractor management [23]. Bruce Power demonstrated that it has identified and implemented OPEX from within its organization and from the Canadian and international nuclear industry. All vendor technical briefings, bulletins and alerts were evaluated. CNSC staff identified areas of minor non-compliance of low risk significance related to the identification of OPEX training needs for Bruce Power staff and contractors, and the quality of completion notes in the OPEX records. Over the next licensing period, CNSC staff will monitor the implementation of the improvements.

Change Management, Configuration Management and Records Management

CNSC staff determined that change management, configuration management and records management at Bruce A and B met requirements.

The BPMS 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 has maintained the configuration of SSCs and is in compliance with its configuration management programs. In 2015, CNSC staff identified that Bruce Power had a high number of temporary configuration changes (TCCs). Bruce Power has put a strategy in place to reduce the number of TCCs, especially at Bruce A. Since then, CNSC confirmed that TCCs at Bruce A continued to decrease while Bruce B did not exceed its target. CNSC staff will continue to monitor the implementation of the corrective actions.

Implementation of records management program continues to be monitored by CNSC staff through on-going compliance activities. Overall, records management program met CNSC requirements. However, an area of improvement of low risk significance was identified in the completeness of records and storage. Corrective actions were put in place by Bruce Power which have been accepted by CNSC staff. CNSC staff will monitor the improvements in future compliance activities.

In 2013, CNSC staff conducted a Type II inspection on Bruce A Units 1 and 2 restart effectiveness. Overall, the issues identified by CNSC staff have been satisfactorily addressed. Bruce Power has provided a close-out transition plan in 2016 and all remaining work is expected to be completed by 2019. The outstanding items of low risk significance included document updates and system improvements. CNSC staff will continue to monitor the implementation of the corrective actions over the next licensing period.

Safety Culture

CNSC staff determined that Bruce Power’s safety culture program met requirements. CNSC staff are satisfied with the safety culture and security culture assessment performed at the Bruce site. Bruce Power continued to follow the established processes for self-assessments of safety culture at planned intervals. CNSC staff will continue to monitor these assessments and resulting initiatives.

In 2016, a safety culture and security culture assessment (self-assessment) was undertaken at Bruce Power. The scope of the self-assessment also included Bruce Power contractors. The data collection methods included surveys, interviews and focus group discussions. The results indicated that Bruce Power has made improvements since the last self-assessment in 2013. There were corrective actions in place to address findings from the safety culture and security culture assessment.

Management of Contractors

CNSC staff determined that the process for management of contractors and supply chain at Bruce Power met applicable CNSC requirements.

In 2015, CNSC staff identified deficiencies of low risk significance related to supply management program. Corrective actions were implemented, such as making improvements to documents related to supply chain management and specifying quality assurance requirements for non-engineering service contracts. The remaining corrective action was related to the implementation of purchasing requirements for low safety significant items. Over the next licensing period, CNSC staff will monitor the implementation of the remaining corrective action.

In 2017, CNSC staff performed an inspection on the contractor management program [23] and identified areas of improvements of low risk significance related to qualifications of subcontractors, oversight of contractors that performed activities under Bruce Power's own management system and oversight of contractor's documentation. Bruce Power provided a corrective action plan that will be completed in 2018. CNSC staff will monitor the implementation of the corrective actions over the next licensing period.

Business Continuity

Bruce Power met the regulatory requirements for business continuity. Bruce Power has developed an adequate contingency plan to maintain or restore critical safety and business functions in the event of disabling circumstances such as a pandemic, severe weather, or labour actions. The plan will help guide the recovery director in developing an incident-specific recovery plan to maintain or recover critical functions.

4.1.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.1.3.1 Past Performance

CNSC staff confirmed, based on the results of Type II inspections and desktop reviews, that Bruce Power has implemented and maintained a management system that met CNSC requirements for the period from 2015 to 2017 at both Bruce A and B. Over the licence period, Bruce Power has completed or is in the process of completing corrective actions raised during CNSC compliance activities. The implementation of corrective actions is being monitored by CNSC staff on an ongoing basis.

4.1.3.2 Regulatory Focus

CNSC staff will continue to perform compliance activities to ensure that Bruce Power meets applicable regulatory documents, codes and standards in the management system SCA for the upcoming proposed 10-year licence period.

4.1.3.3 Proposed Improvements

In January 2016, Bruce Power submitted a detailed transition plan from the 2005 to the 2012 edition of CSA N286. The adoption of CSA N286-12 does not represent a fundamental change to the current Bruce Power Management System. CSA N286-12 allows Bruce Power to continually improve its processes, promotes a healthy safety culture, and emphasizes safety as paramount in making decisions and taking actions.

CNSC staff reviewed the gap analysis assessments (gaps between the 2005 and 2012 editions of the standard) carried out by the licensee and are satisfied with the methodology and the proposed updates to the existing management system. Implementation of the CSA N286-12 has begun and full implementation is expected by December 2018. Most of the Bruce Power top-tier program documents have been transitioned to meet the new standard. CNSC staff determined that the revised top-tier documents met the requirements of CSA N286-12. Due to the high volume of documents in Bruce Power's management system, Bruce Power will revise the lower-tier documents as they come due for revision, usually in a three year period.

4.1.4 Conclusion

Bruce Power continued to implement and maintain a management system in accordance with CNSC requirements. Bruce Power has made adequate provision to monitor and to improve its governance and management oversight and promoted a healthy safety culture.

Licence Condition 1.1 in the proposed licence pertains to implementing and maintaining a management system. Compliance Verification Criteria for this Licence Condition are provided in the draft LCH.

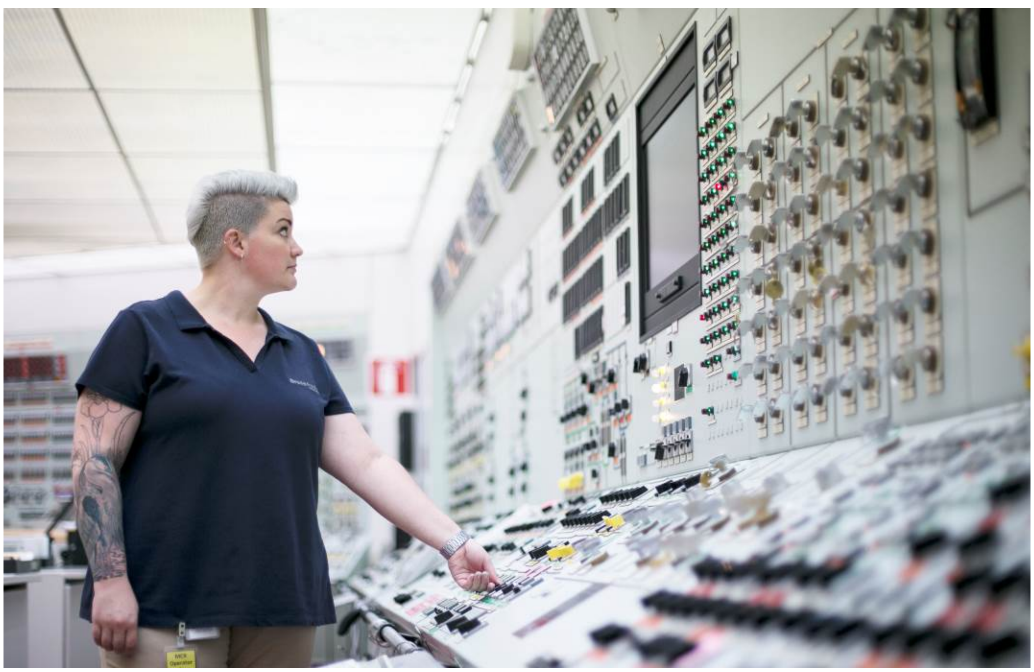
4.2 Human Performance Management

The Human Performance Management SCA covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

This CMD covers the following specific areas of Human Performance Management:

- Human performance program
- Personnel training
- Personnel certification
- Initial certification examinations and requalification tests
- Work organization and job design
- Fitness for duty

Figure 5: Workers inside the Main Control Room are required to be trained and certified in accordance with CNSC requirements found in REGDOC-2.2.2 and RD-204 (*photo courtesy of Bruce Power*)



4.2.1 Trends

The following table indicates the overall rating for the Human Performance Management SCA over the current licensing period:

TRENDS FOR HUMAN PERFORMANCE MANAGEMENT			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	SA
Bruce B	SA	SA	SA
Comments			
The Human Performance Management SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a "satisfactory" rating during all years of the licence period.			

4.2.2 Discussion

Over the current licensing period, CNSC staff concluded that Bruce Power met performance objectives and applicable regulatory requirements considered under the Human Performance Management SCA.

Bruce Power has workers who possess the necessary knowledge and skills to safely carry out the licensed activities. Bruce Power was also committed to increase the numbers of certified staff to provide flexibility to its workforce regarding minimum shift complement, fitness for duty: fatigue management and outage management. See section on "work organization and job design" related to staffing.

In November 2017, the Commission published of REGDOC-2.2.4 (Volume II), *Fitness for Duty: Managing Alcohol and Drug Use*. Bruce Power will submit an implementation plan by March 2018.

Given the performance with respect to the human performance management considerations, and Bruce Power's continued commitment to increase its certified workforce, CNSC staff are satisfied that Bruce Power continued to operate the Bruce A and B in a safe manner.

Details of the CNSC staff assessment in this SCA are presented in the following sections.

<u>Human Performance Program</u>

CNSC staff determined that Bruce Power has implemented and maintained a human performance program that met regulatory requirements. Bruce Power has implemented several initiatives which have been influential in improving its human performance program.

BP-PROG-00.07, *Human Performance Program* defined how Bruce Power planned, implemented, detected and corrected human performance. The program provided support to all workers, including contractors, and its objectives included:

- continual improvement of plant worker safety, plant performance and event-free operations
- promoting a healthy safety culture
- managing and understanding safety, design and operating margins
- sustaining a highly-skilled and collaborative workforce
- maintaining readiness to respond to accident and emergency situations

The human performance program used a strategic approach to managing human performance by reducing errors and managing defence against events, which included engineering and human factors in design activities. The program also included human performance tools for workers, work planning and control, procedure alterations, training and qualification and human performance oversight.

In addition, Bruce Power had a number of initiatives to improve human performance. This included having numerous human performance advocates on site as well as dedicated human performance managers that focused on issues such as outage and maintenance services, project management and construction, and centre of site. In addition, dynamic learning activities, which simulate work tasks containing error traps, were being developed by individual station departments under the oversight of human performance managers.

Personnel Training

CNSC staff determined that Bruce Power has a well-documented and robust systematic approach to training (SAT)-based training system, which is described in BP-PROG-02.02, *Worker Learning and Qualification*, that met CNSC requirements stipulated in REGDOC-2.2.2, *Personnel Training* version 1.

Over the licence period, CNSC staff conducted compliance activities to verify implementation of Bruce Power's training system for the various types of workers (such as Unit 0 certified control room operator, health physicist, mechanical maintainers, security personnel and contractors).

Overall, CNSC staff determined that Bruce Power has implemented these training programs in accordance with its SAT-based training system. Minor deficiencies of low risk significance identified by CNSC staff were addressed by Bruce Power in accordance with its corrective action plan process. Only one action of low risk significance identified during the contractor management training program inspection remains open [23]. CNSC staff will continue to monitor Bruce Power's progress towards completion of this action through ongoing compliance verification activities.

Personnel Certification

CNSC staff determined that Bruce Power's personnel certification program met the requirements of RD-204, *Certification of Persons Working at Nuclear Power Plants*. The positions requiring certification by the CNSC are:

- The authorized health physicist
- The authorized nuclear operator (ANO)
- The Unit 0 control room operator
- The control room shift supervisor (CRSS)
- The shift manager (SM)

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

CNSC staff reviewed the staffing reports for certified personnel, the applications for initial certification and renewal of certification. CNSC staff confirmed that certified workers at Bruce A and B possessed the knowledge and skills required to perform their duties safely.

Initial Certification Examinations and Requalification Tests

CNSC staff concluded that the initial certification examination and requalification testing program for the certified staff at Bruce A and B met requirements. As part of the personnel certification program to become certified workers, candidates are required to complete initial certification examinations. Workers that are certified are required to complete requalification tests as part of the requirements to renew their certification.

CNSC staff administer the initial certification examinations and requalification tests for authorized health physicists while Bruce Power is responsible for the administration of the certification examinations and requalification tests for all other certified staff.

Over the current licensing period, CNSC staff conducted compliance activities [24-26] on simulator-based certification examinations. Although minor program deficiencies were identified, these were of low safety significance.

CNSC staff are currently reviewing Bruce Power's proposal to modify the examination methodology of one of the required certification examinations, the general certification examination, from a short essay question format to a multiple-choice question (MCQ) format.

Based on assessments performed by CNSC staff conducted to date, CNSC staff found that Bruce Power's proposed MCQ examination methodology adequately discriminates candidates who possess the required knowledge from those who do not. As a result, the CNSC has approved Bruce Power's use of this proposed MCQ examination methodology on a pilot basis for administrating general certification examinations. CNSC staff will assess the outcome of this pilot project by March 2018.

Work Organization and Job Design

CNSC staff determined that Bruce Power met minimum shift complement requirements at Bruce A and B. Bruce Power's minimum shift complement was capable of responding to the most resource-intensive conditions under all operating states and that minimum shift complement was being maintained.

Bruce Power had a workforce planning process in place to ensure that an adequate level of certified workers was maintained for Bruce A and B. In addition, Bruce Power met the regulatory requirements for minimum shift complement.

In 2016, Bruce Power addressed discrepancies between its minimum shift complement documentation and the requirements of Regulatory Guide G-323, *Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities - Minimum Staff Complement*. Bruce Power provided CNSC staff with the technical basis for minimum shift complement and performed validation of the minimum shift complement numbers [27]. CNSC staff were satisfied with the basis for minimum shift complement and the validation of its numbers.

In accordance with the PROL, Bruce Power provided to the CNSC a rolling 5-year staffing profile of certified operators on an annual basis. This requirement was imposed on Bruce Power during the restart of Bruce A Units 1 and 2 (2012) to increase staffing levels. Typically, it takes 7 years for an operator to become certified. Although, following the restart of Bruce A Units 1 and 2, there was a sufficient number of certified staff to maintain minimum shift complement, Bruce Power occasionally required ANOs at Bruce A to work beyond their regular 12 hour shift which resulted in limits-of-hours of work non-compliances (see fitness for duty: managing worker fatigue section below).

In order to reduce the limits of hours-of-work non-compliances to meet minimum complement, Bruce Power put a staffing plan in place to increase the number of ANOs on shift to 40 (current number is 37) at Bruce A. Bruce Power will also be increasing the number of SM/CRSS on shift to 15 (current number is 10) at both Bruce A and B by December 2018. This increase in staffing numbers will provide Bruce Power with additional flexibility for work coordination and outage oversight activities.

See Table 7 and Table 8 for ANO and SM/CRSS staffing levels (Actuals vs Planned) for Bruce A and B.

Table 7: Bruce A ANO and SM/CRSS staffing levels (workers on shift)

	Actuals			Planned			
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Total ANO available	45	47	51	57	59	66	66
ANO on shift	**35**	**35**	**37**	**40**	**40**	**40**	**40**
Total SM/CRSS available	16	17	18	20	22	23	24
SM/CRSS on shift	**10**	**10**	**10**	**15**	**15**	**15**	**15**

Table 8: Bruce B ANO and SM/CRSS staffing levels (workers on shift)

	Actuals			Planned			
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Total ANO available	46	50	55	59	62	62	60
ANO on shift	**35**	**35**	**40**	**40**	**40**	**40**	**40**
Total SM/CRSS available	15	17	19	21	29	31	30
SM/CRSS on shift	**10**	**10**	**10**	**15**	**15**	**15**	**15**

CNSC staff determined that Bruce Power's staffing plan is adequate in maintaining the minimum staff complement at Bruce A and B (minimum complement: 30 ANOs on shift, 10 SM/CRSS on shift).

Fitness for Duty

Fitness for duty encompasses all aspects of a worker's fitness to perform work, including fatigue, physical health and mental health.

BP-PROC-00005, *Limits to Hours of Work* defines the reporting requirements for non-compliances related to exceedance of limits of hours-of-work for certified staff on a quarterly basis. To mitigate the risk of hours-of-work non-compliances, Bruce Power employed a guidance document GRP-OPS-00055, *Fitness for Duty Considerations for Shift Complement Staff Held Over for More than 13 hours* that contained strategies and measures to mitigate risk in this regard. The procedure also dealt with a subset of BP-PROC-00610, *Fitness for Duty* which describes the processes for management of fitness for duty issues and for dealing with incidents.

As discussed in the previous section, due to the time it takes to certify an operator, in order to meet minimum shift complement, some workers were required to exceed their limits of hours-of-work. Exceedances can have a potential impact on worker fatigue which could lead to the impairment of the performance of workers performing safety-sensitive work. Table 9 provided the number of limits of hours-of-work exceedance (>13 hours in a shift) at Bruce A and B for certified staff.

The reasons stated by Bruce Power for the exceedance included maintaining minimum shift complement due to sick/vacation leave, severe weather (winter storm) coverage and outage work deployment. However, the workers deployed to an outage were not required to maintain shift complement.

Table 9: Number of Limits of Hours of Work Non-compliances (>13 hours in a shift) at Bruce A and B

Year	# of Non-compliances at Bruce A	# of Non-compliances at Bruce B	Reasons provided by Bruce Power for the non-compliances
2015	22 (min.comp.) 2 (outage)	19 (min. comp.) 68 (outage)	Bruce A: 17 related to severe weather, 5 related to minimum shift complement (sick/vacation leave coverage), 2 related to outage work Bruce B: 14 related to severe weather, 5 related to minimum shift complement (sick/vacation leave coverage), 68 related to outage work
2016	23 (min. comp.)	18 (min. comp.) 58 (outage)	Bruce A: 23 related to severe weather Bruce B: 13 related to severe weather, 5 related to minimum shift complement (sick/vacation leave coverage), 58 related to outage work
2017*****	2 (min. comp.)	0 (min. comp.) 12 (outage)	Bruce A: 2 related to minimum shift complement (sick/vacation leave coverage) Bruce B: 0 related to minimum shift complement (sick/vacation leave coverage),12 related to outage work

** Numbers are gathered up to a cut-off date of June 30, 2017.*

As a result of the high number of non-compliances related to limits of hours-of-work, CNSC staff conducted a focused review [28] in 2017 to examine whether Bruce Power had put measures in place to reduce the number of non-compliances and mitigate the effects of worker fatigue. The review included examining Bruce Power's program related to staffing, fitness for duty measures and limits to hours-of-work. CNSC staff identified areas for improvement, specifically related to having a better defined process for managing fatigue and strengthening requirements in procedures for preventing or mitigating the risk of fatigue-related errors. Although the number of non-compliances related to limits of hours-of-work was high, Bruce Power did not identify any events at Bruce A and B that were directly attributed to workers who were fatigued.

Based on CNSC staff's findings, Bruce Power committed to revise its procedures and planned to incorporate the requirements of REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* (published in March 2017) by December 2018. As part of Bruce Power's preparation for implementation of REGDOC-2.2.4, Bruce Power has strengthened its guidance document GRP-OPS-00055 to assess and mitigate the risks associated with worker fatigue.

In addition, Bruce Power is managing the hours-of-work issue with internal work policies (such as recalling staff who are on training or day-shift workers who are on their time off). Finally, as mentioned in the previous section, Bruce Power continued to increase the number of certified workers to reduce the number of hours-of-work exceedance.

The proposed corrective actions for reducing hours-of-work exceedance are acceptable to CNSC staff. CNSC staff will continue to monitor the limits of hours-of-work non-compliances and Bruce Power's progress in addressing worker fatigue over the next licensing period.

4.2.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.2.3.1 Past Performance

CNSC staff determined that Bruce Power has implemented and maintained a human performance program that met CNSC requirements. The human performance program used a strategic approach to managing human performance by reducing errors and managing defence against events. The SAT-based training programs ensured workers have necessary knowledge, skills, procedures and tools in place to safely carry out their duties. The examination and certification programs for positions requiring certification by the CNSC met regulatory requirements.

Hours-of-work non-compliances continued throughout the current licence period. Although the number of non-compliances related to limits of hours-of-work was high, Bruce Power did not identify any events at Bruce A and B that were directly attributed to workers who were fatigued. In addition, Bruce Power has strengthened its procedures and is committed to increase the numbers of certified staff to address this issue. The proposed corrective actions for reducing hours-of-work exceedance are acceptable to CNSC staff. Implementation of the corrective actions is being monitored by CNSC staff on an ongoing basis.

4.2.3.2 Regulatory Focus

CNSC staff will continue to verify the performance of Bruce Power in all aspects of the Human Performance Management SCA with specific focus on fitness for duty and general certification examination.

Over the next licensing period, CNSC staff will make a determination on whether or not MCQ general examinations can be incorporated into the CNSC's regulatory framework. In addition, CNSC staff will continue to monitor Bruce Power's progress in reducing the number of limits of hours-of-work non-compliances and implementation of mitigation action.

4.2.3.3 Proposed Improvements

Over the proposed 10 year licensing period, Bruce Power has agreed to implement the following new regulatory documents referenced in the LCH:

Document Title	Implementation Date
REGDOC-2.2.2, Personnel Training, version 2	September 1, 2018
REGDOC-2.2.4, Fitness for Duty: Managing Worker Fatigue, version 1	December 31, 2018
REGDOC-2.2.4 (Volume II), Fitness for Duty: Managing Alcohol and Drug Use	December 31, 2018

CNSC staff will monitor Bruce Power's implementation of these documents over the next licensing period.

The proposed MCQ examination methodology will continue to be used on a pilot basis for administrating general certification examinations. CNSC staff will determine over the next licensing period whether this methodology is acceptable and can be integrated into the regulatory framework.

4.2.4 Conclusion

Bruce Power implemented and maintained programs for the Human Performance Management SCA in accordance with CNSC requirements.

Licence Condition 2.1 in the proposed licence pertains to implementing and maintaining a human performance program.

Licence Condition 2.2 in the proposed licence pertains to implementing and maintaining the minimum shift complement and control room staffing at Bruce A and B.

Licence Condition 2.3 in the proposed licence pertains to implementing and maintaining training programs for workers.

Licence Condition 2.4 in the proposed licence pertains to implementing and maintaining certification programs in accordance with regulatory document RD-204.

Compliance Verification Criteria for the above Licence Conditions are provided in the draft LCH.

4.3 Operating Performance

The Operating Performance SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance. This SCA also includes an accident management program for design and beyond design basis accidents.

This CMD covers the following specific areas of Operating Performance:

- Conduct of licensed activity
- Procedures
- Reporting and trending
- Outage management performance
- Safe operating envelope
- Accident management and recovery

4.3.1 Trends

The following table indicates the overall rating for the Operating Performance SCA over the current licensing period:

TRENDS FOR OPERATING PERFORMANCE			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	FS	FS
Bruce B	FS	FS	FS
Comments			
The Operating Performance SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a “fully satisfactory” rating during all years of the licence period except for Bruce A in 2014 which received a “satisfactory” rating.			

4.3.2 Discussion

CNSC staff determined that Bruce Power continued to operate Bruce A and B safely, and in accordance with regulatory requirements. CNSC staff found that Bruce Power’s Operating Performance SCA exceeded expectations and received a “fully satisfactory” rating for Bruce A and B.

Bruce Power has ensured the safety of the workers, plant equipment, the public and the environment under normal and accident conditions.

Bruce Power continued to implement capital projects, outage and on-line maintenance which are aimed at improving equipment health and operating performance. Improvements are also being made to outage milestones such that the work is properly planned and executed.

Details of the CNSC staff assessment in this SCA are presented in the following sections.

Conduct of Licensed Activity

Over the current licensing period, CNSC staff confirmed through compliance verification activities such as Type II inspections and desktop reviews that Bruce A and B operated safety and in compliance with the NSCA, its regulations and the conditions of the PROL.

Bruce Power continued to operate Bruce A and B within the bounds of the operating policies and principles (OP&Ps). The OP&Ps, in combination with the safe operating envelope (SOE) limits, clearly outlined the boundaries within which the stations may be operated safely. They specified how Bruce Power operated, maintained and modified station systems to maximize nuclear safety and minimize risk to public. Compliance with the OP&Ps and SOE is mandatory at all times.

All reactor units operated within the power limits prescribed by the Bruce A and B licence. Stepbacks and setbacks were controlled properly and power reduction was adequately initiated and executed by the reactor control systems. CNSC staff verified that for all events, Bruce Power staff followed approved procedures and took appropriate corrective actions.

CNSC staff found that Bruce Power’s operating performance exceeded regulatory requirements and expectations.

Unplanned transients

Unplanned transients that lead to unexpected power reductions may indicate problems within the plant and place unnecessary strain on the plant process systems to respond to the transients. Unplanned transients include stepbacks, setbacks and reactor trips where the trip resulted in a reactor shutdown.

CNSC staff monitored the unplanned transients by verifying that Bruce Power has adhered to the SOE limits. CNSC staff also performed evaluations on how well Bruce Power has managed its response to the transients.

CNSC staff followed up on events related to unplanned transients and concluded that Bruce Power followed approved procedures, determined the root causes of the events and took appropriate corrective actions. Although the unplanned transients during the licensing period placed unnecessary burden on the plant and its operating staff, the risks associated with the transients were low.

The number of unplanned transients is provided in Table 10. It showed a stable trend over the licence period.

Table 10: Unplanned Transients at Bruce A and B

Station	Unplanned transients	2015	2016	2017*****
Bruce A	Unplanned Reactor Trips	0	0	1
	Stepbacks	1	4	0
	Setbacks	5	5	0

Station	Unplanned transients	2015	2016	2017*
	Total	6	9	1
Bruce B	Unplanned Reactor Trips	1	0	0
	Stepbacks	0	0	1
	Setbacks	7	3	6
	Total	8	3	7

***** *Numbers reported are gathered up to a cut-off date of June 30, 2017.*

Procedures

CNSC staff determined that Bruce Power has developed processes and procedures that met regulatory requirements. The procedures used to prepare, review, validate, issue and revise documents are well-defined. Bruce Power also ensured that its documents, including its structure and content, are consistently written to reduce error-likely situations.

Reporting and Trending

CNSC staff determined that Bruce Power met the reporting requirements in REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, version 2.

Over the licensing period, REGDOC-3.1.1 reports were submitted to CNSC staff in a timely manner. Bruce Power was also required to follow up on all events with corrective actions, and root cause analysis where appropriate. CNSC staff did not identify any safety significant issues from these reports.

CNSC staff followed up on all reportable events in a graded approach based on the risk significance of the event, including the corrective actions that are taken. CNSC staff can put further actions on Bruce Power (such as performing a focused inspection and order) when negative trends have been identified or if the event merits further investigations. For example, CNSC staff performed a focused inspection in August 2017 when Unit 3 HTS circulating pump no. 4 experienced a triple seal failure while the unit was shutting down (this event was reported to the Commission in October 2017 and is further described in Section 4.6 of this CMD).

Based on the reportable event reviews, no safety significant regulatory issues were identified. Any events of note are discussed in other sections of this CMD.

Outage Management Performance

CNSC staff determined that Bruce Power demonstrated good performance and achievement of objectives during maintenance outages. In order to ensure that the plant remained fit for service, planned outages occur routinely to conduct maintenance, testing or inspections that cannot be performed with the reactor online.

Figure 6: Turbine casing being installed during an unit outage (*photo courtesy of Bruce Power*)

All planned and unplanned (forced) outages were followed up appropriately by the licensee. CNSC staff conducted inspections on all planned outages which confirm that all outage–related undertakings, including reactor shutdown guarantees and heat sink strategy management were performed safely by Bruce Power.

Table 11 provides the number of maintenance outages which occurred over the current licensing period.

Table 11: List of planned outages which occurred over the current licensing period

# of Planned Outages	2015	2016	2017
Bruce A	3	3[6]	1
Bruce B	5[7]	3	1

** Numbers reported are gathered to a cut-off date of June 30, 2017.*

Bruce A and B also undertook several forced unplanned outages over the current licensing period to either fix or replace equipment. These were communicated to the Commission via early notification reports, status reports on power reactors or the ROR. These events were of low safety significance and all systems operated as designed. CNSC staff confirmed that Bruce Power conducted appropriate follow-up actions for these events.

[6] Includes a Station Containment Outage in which all units were shutdown
[7] Includes a Vacuum Building Outage in which all units were shutdown

Bruce Power is required to carry out a test to measure the leakage rate at full design pressure of station containment and in-service examination for the associated concrete structures and components once every six (6) years. The leakage rate tests and examinations were carried out in 2016 at Bruce A and 2015 in Bruce B, which confirmed that the leak rates and examination results met the acceptance criteria and the requirements for containment in CSA N287.7.

A leakage rate test of the vacuum building is required to be carried out at full design pressure every twelve (12) years as per the LCH. The leakage rate tests and in-service examinations of vacuum buildings were carried out in 2009 at Bruce A and 2015 at Bruce B. The results demonstrated that the leak rates and examination results met the acceptance criteria and the requirements in CSA N287.7.

Safe operating envelope

CNSC staff determined that Bruce Power operated within the safe operating envelop (SOE) and met the requirements of CSA N290.15-10, *Requirements for the Safe Operating Envelope of Nuclear Power*. The limits and conditions defined by the SOE are documented in operational safety requirements (OSR) documents, including the associated instrument uncertainty calculations (IUC) documents. Over the current licensing period, Bruce Power continued to implement ongoing improvements of the SOE.

A licensed NPP must be controlled in accordance with a set of operational safety requirements, derived from the safety analysis, within the boundaries of the SOE. The SOE is the set of limits and conditions within which a NPP must be operated and which is monitored and controlled by the operator. The objective of the SOE is to ensure compliance with the detailed safety analyses that are submitted by the licensee to demonstrate safe operation.

Over the licensing period, there were two reportable events related to SOE implementation. In both cases, the SOE compliance documents, which are the tests, maintenance and/or operating procedures that confirm compliance with the OSR limits, had not been updated to reflect the most current analyses. CNSC staff determined that these were change management issues of low risk significance.

In 2016, Bruce Power transitioned to meet the requirements of CSA N290.15-10. Bruce Power completed a review of its SOE program and identified gaps with CSA N290.15. Bruce Power submitted a plan to address the gaps by December 2018. In the meantime, adequate mitigation measures have been put in place to ensure compliance with SOE limits. CNSC staff will monitor the progress through normal compliance verification activities over the next licensing period.

CNSC staff are recommending that the OSR documents be included as written notification documents in the proposed LCH.

Accident Management and Recovery

CNSC staff determined that Bruce Power maintained an accident management and recovery program that met regulatory requirements. In addition, Bruce

Power's severe accident management program met the requirements of REGDOC-2.3.2, *Accident Management: Severe Accident Management Program for Nuclear Reactors* (2013).

Licensees must have procedures capable of dealing with abnormal incidents and design basis accidents. Bruce Power has a series of abnormal incident manuals (AIMs) and emergency operating procedures (EOPs) to mitigate situations to return the plant to a safe and controlled state and to prevent the further escalation of the abnormal incident into a more serious accident.

Over the current licensing period, CNSC staff verified that Bruce Power has up-to-date AIMs and EOPs available to the operators and that the operators are trained in their use.

A severe accident management program provides an additional layer of defence against the consequences of beyond design basis accidents (BDBAs) including severe accidents. Severe accident management guidelines (SAMGs) ensure that personnel involved in managing a BDBA have the information, procedures and resources necessary to carry out effective actions.

Bruce Power demonstrated the effectiveness of its SAMGs through ongoing exercises and plant drills at both Bruce A and B. In addition, Bruce Power has revised and validated its SAMG to address concerns raised as a result of the Fukushima event.

In October 2016, Bruce Power conducted a full scale severe accident exercise named Exercise Huron Resolve. The exercise was observed by the CNSC staff and demonstrated Bruce Power's capability to deal with severe accidents effectively. Specific details on the Exercise Huron Resolve are further discussed in Section 4.10 of this CMD.

4.3.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.3.3.1 Past Performance

Based on the results of Type II inspections and desktop reviews, CNSC staff determined that Bruce Power continued to operate Bruce A and B safely, and in accordance with regulatory requirements. Over the current licensing period, Bruce Power has improved its operating performance rating to "fully satisfactory" rating for Bruce A and maintained its "fully satisfactory" rating for Bruce B. This is attributed to strong performance in the conduct of licensed activities, outage management, reporting and trending by Bruce Power.

4.3.3.2 Regulatory Focus

CNSC staff will continue to verify the performance of Bruce Power in all aspects of the Operating Performance SCA, including outage related activities, SOE limits and SAMG exercises.

4.3.3.3 Proposed Improvements

As previously indicated in the SOE section, CNSC staff will be including OSR documentation in the Bruce LCH, as prior notification document, under the proposed Licence Condition 3.1. The SOE is considered part of the licensing basis.

4.3.4 Conclusion

Based on the assessment of Bruce Power's licence application, supporting documents and past performance, CNSC staff conclude that Bruce Power continued to implement and maintain an effective operations program at Bruce A and B in accordance with requirements.

Licence Condition 3.1 in the proposed licence pertains to implementing and maintaining an operations program.

Licence Condition 3.2 in the proposed licence pertains to the requirements to restart a reactor after a serious process failure.

Licence Condition 3.3 in the proposed licence pertains to the notification and reporting requirements for NPPs.

Compliance Verification Criteria for the above Licence Conditions are provided in the draft LCH.

4.4 Safety Analysis

The safety analysis SCA covers the maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.

This CMD covers the following specific areas of safety analysis:

- Deterministic safety analysis
- Probabilistic safety analysis
- Criticality safety
- Severe accident analysis
- Management of safety issues (including R&D programs)

4.4.1 Trends

The following table indicates the overall rating trends for the Safety Analysis over the current licensing period:

TRENDS FOR SAFETY ANALYSIS			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	FS
Bruce B	SA	SA	FS
Comments			
The Safety Analysis SCA at Bruce A and B met applicable CNSC requirements and performance objectives. Bruce Power improved to a “fully satisfactory” rating in 2016.			

4.4.2 Discussion

CNSC staff determined that Bruce Power continued to implement and maintain a safety analysis program at Bruce A and B in accordance with regulatory requirements and that the overall safety case for the facility continued to be met.

Bruce Power is required to conduct safety analyses for Bruce A and B to demonstrate that the design continued to provide adequate prevention and mitigation to protect against postulated accidents and that the plant met safety requirements.

A number of submissions related to the different aspects of safety analysis have been reviewed in the licensing period and the most significant of these are presented in the following sections.

Deterministic Safety Analysis

CNSC staff determined that Bruce Power has a well-managed program on deterministic safety analysis and that the existing deterministic safety analysis remained adequate during the continued implementation of REGDOC-2.4.1, *Deterministic Safety Analysis*.

Over the licensing period, Bruce Power made significant progress in the implementation of REGDOC-2.4.1. CNSC staff recognized that full implementation with REGDOC-2.4.1 may not be possible (as some requirements do not apply to existing facilities) or provide any additional safety benefit beyond the current safety case. Therefore, in 2013, Bruce Power submitted a Safety Report Improvement (SRI) plan which consisted of a 3-year project to upgrade the Bruce A and B safety reports to align with regulatory requirements, and an ongoing SRI program to perform REGDOC-2.4.1 gap analysis on an ongoing basis.

The 3-year project plan was to resolve the most safety significant gap, specifically on analysis of common mode events (CME), to the extent practicable and establish framework for the implementation of REGDOC-2.4.1. The long-term SRI plan is to resolve the gaps against REGDOC-2.4.1 in a prioritized manner while performing safety analyses to address any emerging safety issues and support safe operation. The plan was accepted by CNSC staff in 2014 [29].

In January 2017, Bruce Power submitted the Bruce A CME technical basis documents and analysis results, and subsequently organized several meetings with CNSC staff to facilitate the technical review. The CME analyses for Bruce A and B were incorporated in the updated Bruce A and B safety reports in December 2017. In early 2018, CNSC staff will perform a review of the CME analyses and continue to monitor the progress of the SRI program over the next licensing period.

Additional work performed by Bruce Power in the area of deterministic safety analysis is provided in the sections below. The topics include:

- impact of standing flame in containment
- neutron overpower protection trip setpoints
- impact of aging on safety analysis margins
- Large LOCA safety margins

Impact of standing flame in containment

As part of the lessons learned from the Fukushima event, the impact of a standing flame in containment has been recognized as a potential safety concern in the event of a severe accident. During a postulated loss of coolant accident (LOCA) with impairment of the emergency cooling injection system (ECI) in a CANDU reactor, a break in the primary heat transport system can cause the release of high temperature hydrogen-steam mixtures into containment. The hydrogen-steam mixture can ignite at the break if its temperature is sufficiently high or if there is an ignition source in the vicinity, and create a standing flame.

In 2016, Bruce Power submitted its assessment of the impact of standing flames on critical equipment at Bruce A and B. CNSC staff determined that Bruce Power has adequately addressed issues related to hydrogen behaviour in containment and agreed with Bruce Power's assessment that the impact of standing flames and multiple hydrogen burns on equipment is inconsequential for design basis accidents [30]. Bruce Power incorporated the assessment in the recent safety report update.

Neutron Overpower Protection Trip Setpoints

Neutron overpower protection (NOP) trips are designed to protect against a loss of reactor power regulation in a CANDU reactor. The design basis used to derive the NOP trip setpoints is a slow loss of regulation (SLOR) event.

Historically, the original calculations for NOP trip setpoints for SLOR were determined through the use of partly deterministic and partly statistical methods. The trip setpoints are selected with a set probability and confidence level.

Bruce Power submitted NOP trip setpoints based on a new enhanced NOP (E-NOP) extreme value statistics (EVS) methodology. E-NOP was developed to address the impact of aging (which was not covered in the original design analysis) to demonstrate that the installed trip setpoints remain adequate under aging conditions.

In 2016, CNSC accepted the use of the new methodology [31]. Based on CNSC staff's reviews and assessment, CNSC staff concluded that Bruce A and B were well protected against SLOR events.

Impact of Aging on the Safety Analysis Margins

CNSC staff determined that the Bruce Power has an acceptable aging management program in place to monitor, assess and mitigate the impact of heat transport system (HTS) aging on safety analysis results. Bruce Power systematically monitored aging related parameters important to safety analysis and performed assessment of the impact of the change in core conditions on existing safety margins.

As the reactor core ages with time, aging effects on various SSCs have an impact on the overall safety case of the NPPs. In December 2013, Bruce Power submitted the safety analysis, in support of the 2015 licence renewal, for impact of aging on safety margins for small LOCA, loss of regulation and loss of flow for reactor operation. The safety analysis demonstrated that the safety systems will remain effective with adequate margin until December 2019.

CNSC staff reviewed and assessed Bruce Power's safety case and concluded that adequate safety margins are being maintained based on existing analysis. Prior to December 2019, Bruce Power will need to submit a new safety analysis to demonstrate that the existing margins remain adequate. Bruce Power will take further compensatory measures (such as de-rating its own units) if CNSC staff determine that the new analysis cannot demonstrate sufficient safety margins. CNSC staff will continue to monitor Bruce Power's progress in the development of the new safety analysis to ensure that sufficient safety margins are maintained over the next licensing period.

Large LOCA Safety Margins

Currently, the Bruce B units remain de-rated from full power (93 percent) to ensure adequate safety margins (related to maintaining safety margins due to large LOCA power pulse issues) are being maintained.

CNSC staff determined that Bruce Power continued to make positive progress in addressing the large LOCA safety margin issue using the composite analytical approach (CAA) (see also section on “management of safety issues” for the CAA issues that are currently open).

The CAA is an analytical approach for large LOCA analysis. One of the key elements of the CAA is to demonstrate that the probability of having a break in large pipes is low enough to permit reclassification of a portion of the large break spectrum from DBA to BDBA. Instantaneous guillotine break in a large pipe may be justifiably precluded based on physical considerations, and application of more realistic methods in analysis of the BDBA large LOCA scenarios will yield much larger calculated safety margins relative to application of traditional conservative methodology. Development of the CAA is an industry-wide effort, and is championed by Bruce Power.

In late 2016, Bruce Power submitted a work plan to complete a large LOCA licensing analysis for Bruce B reactors using the CAA, to demonstrate quantitatively that the large LOCA safety margins are greater than represented in the current analysis of record. CNSC staff’s review of the proposed CAA work plan concluded that the methodology is compliant with the REGDOC-2.4.1 requirements at a high level. However, further validation and clarification are still required in some areas in order for CNSC staff to accept the methodology. One of the areas was the determination of the delineation between the DBA and BDBA breaks. To justify the delineating break sizes, Bruce Power proposed a multi-faceted analysis approach including deterministic and probabilistic fracture mechanics assessments of piping systems, combined with a detailed review of the aging management activities in place to prevent pipe breaks. CNSC staff accepted this path forward and expect the analysis to be submitted for review in 2019.

In addition, under the Bruce A and B new neutronic trips feasibility project, Bruce Power is currently pursuing installation of design demonstration units (DDUs) of the new Linear Rate Trip on a Unit at Bruce B to demonstrate their feasibility. The purpose is to demonstrate an improvement of the effectiveness of the shutdown system (SDS) and large LOCA safety margins. The installation of the DDUs is expected to be completed by end of 2018.

During the continued development of the CAA, the licensing basis of the operating reactors for the large LOCA scenario will continue to be based on traditional conservative safety analysis (i.e., large LOCA being a DBA). CNSC staff will continue to follow-up on the large LOCAs issue over the next licensing period.

Probabilistic Safety Assessment

CNSC staff determined that Bruce Power continued to implement and maintain an effective probabilistic safety assessment (PSA) program. In 2014, REGDOC-2.4.2, *Probabilistic Safety Assessment for Nuclear Power Plants* superseded S-294, *Probabilistic Safety Assessment for Nuclear Power Plants*. Implementation of REGDOC-2.4.2 has begun and full implementation is expected by June 2019.

In 2014, Bruce Power submitted S-294-compliant Bruce A and B PSA reports, which included Level 1 and Level 2 PSAs for both internal and external (seismic, high winds, internal fires, internal floods and other hazards) events, for both at-power and shutdown states. As part of the REGDOC-2.4.2 transition plan, Bruce Power submitted the new PSA methodologies and computer codes in April 2017 [32] for CNSC acceptance. Bruce Power will also need to perform additional assessment for other significant radioactive sources such as those found in the irradiated fuel bay. CNSC staff reviewed the submissions, and concluded that the submitted PSA methodologies met the intent of REGDOC-2.4.2.

In addition to the activities on the PSA updates for the purpose of REGDOC-2.4.2 compliance, the Commission requested Bruce Power to perform following task raised during the last licence renewal hearing:

- development of a policy stipulating that enhancements will be considered if PSA results are between the safety limit and the safety goals target (specifically, with respect to achieving large release frequency safety goal targets of $1.0E^{-6}$/yr), expected to be submitted in early 2018
- development of a whole-site PSA methodology with industry partners, expected to be submitted by end of 2018

The above two (2) tasks are further discussed in Section 5.11 of this CMD.

Seismic Analysis

CNSC staff determined that seismic analysis performed by Bruce Power met regulatory requirements. CSA N289.1-08, *General Requirements for Seismic, Design and Qualification of CANDU Nuclear Power Plants* provided the guidance for the design, installation and maintenance requirements for seismically credited safety-related SSCs in a nuclear facility required to perform their safety function during earthquakes.

Fire Protection Assessment

CNSC staff determined that the fire safety analysis, which includes fire hazard assessment (FHA) and fire safe shutdown analysis (FSSA), performed by Bruce Power met the requirements of CSA N293-07, *Fire Protection for Nuclear Power Plants* and best industry practices.

Bruce Power submitted a plan to transition to the 2012 edition of CSA N293. Bruce Power is already complying with its programmatic and operation requirements. The FHA and FSSA will only be updated to meet the additional clarifications specified within CSA N293-12. Bruce Power has submitted the updated analysis for Bruce A and B. CNSC staff will finalize the review of the updated FHA and FSSA in early 2018.

Criticality Safety

Bruce Power is required to have a criticality safety program. Bruce Power updated its criticality safety program in 2016 and CNSC staff found that it met the requirements of RD-327, *Nuclear Criticality Safety*.

Severe Accident Analysis

Bruce Power will continue to support industry research and development (R&D) program in the area of severe accident analysis.

As part of the R&D program and to address Fukushima lessons learned, Bruce Power successfully completed a severe accident software simulator solution (SASS) project, jointly conducted with OPG, in 2015. The SASS project is used to verify the multi-unit severe accident modeling capability of the MAAP-CANDU severe accident computer code. CNSC staff will monitor the continued development of the MAAP-CANDU code over the next licensing period.

Management of Safety Issues (including R&D programs)

CANDU Safety Issues

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

In March 2017, CNSC staff provided the basis for re-categorization of Category 3 CSI as well as responding to the intervenors comments in CMD 17-M12 [33] that questioned the basis for categorization and re-categorization of CSI. CNSC staff also described the systematic and rigorous process that was followed for the re-categorization of the Category 3 CSI.

After examining the contents regarding the CSIs and with consideration to the information provided by licensees and CNSC staff, the Commission confirmed CNSC staff's categorization of the CSIs. The Commission directed CNSC staff to include in future ROR an appendix that includes all Category 3 CSI issues as well as an appendix that tracks any changes in categorization of CSIs. While the work to re-categorize the remaining four (4) CSIs is ongoing, it is CNSC staff's view that there are adequate safety margins in place to ensure the safe operation of Bruce A and B. Re-classification of the large break LOCA issue is described in the following text.

Large Break LOCA CSI

There are currently four CSI that are still open for Bruce A and B related to large break LOCA (as discussed previously in the deterministic safety analysis section). They are as follows:

- AA9 – analysis for void reactivity coefficient (Category 3)
- PF9 – fuel behaviour in high temperature transients (Category 3)
- PF10 – fuel behaviour in power pulse transients (Category 3)
- PF12 – channel void during a large LOCA (Category 1)

Bruce Power has developed a path forward for the reclassification of AA9, PF9 and PF10 to Category 2 CSI under the framework of the CAA development, through the completion of technical area 1 “Quantification of reactor physics parameters” and technical area 2 “Acceptance criteria”.

The work done under technical areas 1 and 2 has been reviewed. CNSC staff concluded that further work is needed until the information provided in these two technical areas is sufficient to allow reclassification of CSI AA9, PF9 and PF10. It should be noted that reclassification of these three CSIs also depends on successful development of the CAA. Although the resolution of the issues under these two technical areas is not an impediment to the application of the CAA methodology to delineate between DBA and BDBA scenarios as they apply to large break LOCA, the output of these two technical areas are key inputs to the demonstration of adequacy of safety margins using the CAA methodology.

For PF12, significant work was completed and supported by an extensive experimental program in the RD14M facility at Whiteshell Nuclear Laboratories. This work was complemented by demonstration of relevance of the facility to CANDU geometry via performing a complex scaling analysis. CNSC staff reviewed all submitted information and concluded that there was sufficient information to re-categorize PF12 to Category 1 [34].

Others CSI

An action item has been raised by CNSC staff to monitor completion of existing COG work packages associated with the re-categorization of AA3, *Computer Code and Plant Model Validation*. Bruce Power has submitted the COG guidelines on code validation and code accuracy assessment. CNSC staff reviewed and concluded that the code validation process in the guidelines adheres with the majority of the requirements and guidelines in REGDOC-2.4.1. CNSC staff identified some deficiencies in the submitted guidelines which require clarification or modification before they are finalized [35]. These issues will be addressed over the next licensing period.

For non-LLOCA issues that have been re-categorized into lower risk categories based on Bruce Power submissions, CNSC staff will continue to monitor the licensees’ management of these safety issues.

Research and Development

Over the current licensing period, CNSC staff continued to undertake systematic evaluations of Bruce Power’s R&D program activities, as submitted to CNSC staff through annual reporting in accordance with Section 3.6 of REGDOC-3.1.1. These evaluations confirmed that Bruce Power, in corporation with other NPP licensees, maintains a robust R&D capability to address any emerging issues. CNSC staff will continue to review the results of the R&D projects over the next licensing period. The following are highlights of two R&D projects that are currently ongoing:

- Moderator subcooling requirements methodology

  Bruce Power submitted the review of experimental results using the safety analysis issue review panel process for the CNSC sponsored calandria-tube strain contact boiling project. CNSC staff issued an interim report summarizing the results of the experiment along with evaluation of the results [36]. These outstanding issues will be addressed over the next licensing period.

- Moderator temperature predictions

  The original experiments completed for the validation of moderator temperature predictions were different from the moderator nozzle configuration for Bruce A. To provide additional confirmation, Bruce Power completed several initiatives which included submission of technical reports and the performance of more experiments representing the specific geometries of the moderator inlet nozzles for the Bruce A and Pickering A reactors. This experimental work is currently underway at McMaster University. CNSC staff will review the experimental results over the next licensing period.

4.4.3 Summary

A summary of the licensee’s past performance, challenges and proposed improvements are presented in the following subsections.

4.4.3.1 Past Performance

CNSC staff rated Bruce Power’s performance for the Safety Analysis SCA at Bruce A and B as “satisfactory” in 2014 and 2015. All units were operated safely and within licensing limits during the current licensing period. Both stations improved to a “fully satisfactory” rating (i.e., exceeds CNSC requirements and expectations) in 2016, which reflects the progress Bruce Power has been made in implementing REGDOC-2.4.1 and REGDOC-2.4.2.

4.4.3.2 Regulatory Focus

CNSC staff will continue to verify the performance of Bruce Power in all aspects of the Safety Analysis SCA. Over the current licensing period, CNSC staff monitored Bruce Power's progress in transitioning to meet the following regulatory documents:

- REGDOC-2.4.1 for deterministic safety analysis
- REGDOC-2.4.2 for probabilistic safety analysis

In 2013, Bruce Power submitted an SRI plan to align with the requirements of REGDOC-2.4.1. Implementation of REGDOC-2.4.1 has begun. In December 2017, Bruce Power updated Part 3, accident analysis, of the Bruce A and B safety report by including the analysis on CME. In 2018, CNSC staff will review the updated safety report to determine whether the requirements in REGDOC-2.4.1 have been addressed.

Bruce Power submitted an implementation plan to meet the requirements of REGDOC-2.4.2 by the June 2019. In April 2017, as part of the REGDOC-2.4.2 transition plan, Bruce Power submitted new PSA methodologies and computer codes. CNSC staff reviewed the submissions, and concluded that the submitted PSA methodologies met the intent of REGDOC-2.4.2. CNSC staff will continue to monitor Bruce Power's progress in the implementation of REGDOC-2.4.2.

In addition, CNSC staff will continue to monitor Bruce Power's progress in the reclassification of Category 3 CSI to Category 2, related to demonstrating sufficient margins to protect against large break LOCAs. Bruce Power has developed a path forward for the reclassification under the framework of the CAA development.

4.4.3.3 Proposed Improvements

Bruce Power is working with industry partners (COG) to develop a site-based PSA methodology and will provide its plan in early 2018. In early 2018, Bruce Power will also provide a policy stipulating that enhancements to Bruce A and Bruce B will be considered if PSA results are between the safety goal limit and the safety goal target, specifically, with respect to achieving large release frequency safety goal targets of $1.0E^{-6}$/yr. CNSC staff will monitor the progress of these two items in 2018.

Finally, Bruce Power, along with the industry, continues to develop a CAA to demonstrate that there are sufficient margins to protect against large LOCAs. CNSC staff will continue to monitor the progress of CAA development over the next licensing period.

4.4.4 Conclusion

Bruce Power implemented and maintained programs for the Safety Analysis SCA in accordance with CNSC requirements and that the overall safety case for the facility continued to be met.

Licence Condition 4.1 in the proposed licence pertains to implementing and maintaining a safety analysis program.

Compliance Verification Criteria for this Licence Condition are provided in the draft LCH.

4.5 Physical Design

The Physical Design SCA relates to activities that impact on the ability of the structures, systems and components (SSCs) to meet and maintain their design basis, given new information arising over time and taking changes in the external environment into account.

This CMD covers the following specific areas of physical design:

- Design governance
- Site characterization
- Facility design and structure design
- System design
- Component design

4.5.1 Trends

The following table indicates the overall rating for the Physical Design SCA over the current licensing period:

TRENDS FOR PHYSICAL DESIGN			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	SA
Bruce B	SA	SA	SA
Comments			
The Physical Design SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a "satisfactory" rating during all years of the licence period.			

4.5.2 Discussion

CNSC staff determined that the physical design programs at Bruce A and B met regulatory requirements. There are no safety significant outstanding issues related to physical design.

Details of the CNSC staff assessment in this SCA are presented in the following sections.

Design Governance

CNSC staff determined that Bruce Power has developed and implemented a design program, consisting of plant design basis management, engineering change control and configuration management programs, that met the regulatory requirements. Bruce Power has revised the programs and implementing documents to improve the clarity of the information. CNSC staff concluded that Bruce Power's design program met regulatory requirements.

Human Factors in Design

CNSC staff determined that Bruce Power has controlled and conducted human factors in design activities in accordance with CNSC requirements. Bruce Power updated DPT-PDE-00013, *Human Factors Program Plan* in 2016 to reflect CSA N290.12-14, *Human Factors in Design for Nuclear Power Plants*.

Environmental Qualification

CNSC staff determined that Bruce Power maintained an environmental qualification (EQ) program in accordance with the requirements of CSA N290.13, *Environmental Qualification of Equipment for CANDU Nuclear Power Plants*. An EQ program ensures that qualified SSCs are capable of performing designated safety functions during and following postulated harsh environments resulting from design basis accidents. The EQ program is implemented for all units at Bruce A and B.

In 2015, CNSC staff performed a Type II inspection of Bruce Power's EQ program. CNSC findings from compliance verification activities identified some opportunities for improvement of low risk significance [37]. CNSC staff determined that the submitted corrective action plan was acceptable.

Bruce Power has identified components required for replacement to ensure that its environmental qualification will continue to be met. Impact of service life extension will be included in revised EQ design documentation as per the requirements of Bruce Power's governing document.

Pressure Boundary

CNSC staff determined that Bruce Power has a documented pressure boundary program that met the requirements of CSA N285.0, *General Requirements for Pressure-retaining Systems and Components in CANDU Nuclear Power Plants*. There is a formal agreement in place for the Technical Standards and Safety Authority (TSSA) to act as an Authorized Inspection Agency (AIA) to provide services for the pressure boundary components.

Historically, modifications were made by Ontario Hydro and then by Ontario Power Generation and Bruce Power in order to raise safety to more modern codes and standards. However, design registrations to pressure retaining systems were not updated to reflect the modifications made to Bruce A and B. This issue is administrative in nature and of low safety significance. Bruce Power has implemented a legacy project to resolve this issue. Registration updates for Bruce A were completed in March 2015 while updates for Bruce B are on target to be completed by May 2018.

In 2017, CNSC staff conducted a Type II inspection on the implementation of the pressure boundary program, specifically processes for system code classification, reconciliation and registration, as well as the AIA service agreement [38]. CNSC staff found that the implementation of the pressure boundary program, for both code classification and design registration reconciliation process, met requirements.

Site Characterization

There are currently no ongoing actions identified as a result of regulatory oversight activities or requests from the Commission in the area of site characterization.

Facility Design and Structure Design

CNSC staff determined that overall design of the facility and structure is adequate. Facility design and structure design is governed by the Bruce Power's design program. There are no areas of concerns on the facility and structure design.

System Design

Electrical Systems

CNSC staff determined that the electrical systems at Bruce A and B met design requirements. Based on the results of the compliance activities performed over this licensing period, CNSC staff determined that there is no safety concern with the electrical systems.

Bruce Power has submitted plans (as part of IIP) to install controls upgrades for all the standby generators (SGs) at Bruce A (expected to be completed by 2020), SG5 and SG6 (expected to be completed in 2022) at Bruce B and emergency power generator (EPG) 1 at Bruce B (expected to be completed in 2018). The purpose of the controls upgrade project is to ensure that the reliability targets continue to be met in the future as the control systems age and obsolescence issues become more prevalent. Bruce Power also has a project to overhaul all EPG turbines at Bruce B on a rotating period of every 15 years. CNSC staff are satisfied with the progress made to upgrade the electrical systems.

Over the current licensing period, Bruce Power reported two (2) emergency transfer scheme (ETS) vulnerability which would only be a concern for a short time during a safety system test (SSTs). The SSTs affected by the availability of SGs to the ETS have been identified and deferred until the test procedures are revised and validated. While this condition needs to be resolved, the risk to the station remained low. CNSC staff considered that the actions in response to this event to be acceptable and will follow-up on Bruce Power's corrective actions.

In May 2017, Unit 4 was shut down after a circuit breaker on the system service transformer spuriously opened due to a circuit breaker deficiency. This opening resulted in a loss of Class IV power to two main HTS pumps which resulted in an unplanned reactor shutdown. CNSC staff reviewed the REGDOC-3.1.1 report and determined that the event was of low risk significance. CNSC staff concluded that Bruce Power responded adequately to the event.

Instrumentation and Control

CNSC staff determined that instrumentation and control systems at Bruce A and B met design requirements based on the results of past inspections and desktop reviews.

As a follow-up to the 2015 licence renewal, CNSC staff identified a minor concern related to low flow indication of Units 3 and 4 SDS channel flow transmitters due to orifice degradation. Bruce Power provided a corrective action plan and initiated the installation of ultrasonic flow devices in all units to provide direct confirmation of the heat transport system flow rates for the SDS1 and SDS2 flow measurement channels. CNSC staff will continue to monitor the progress until the ultrasonic measurement installation is complete.

Fire Protection Design

Based on results of past inspections and desktop reviews, CNSC staff concluded that Bruce Power's fire protection design program met regulatory requirements.

Due to the date of construction of the Bruce A and B versus the date of issuance of the codes (construction: 1970s vs modern standard: 2012), a number of historical design related non-conformances were identified. Bruce Power has implemented compensatory measures (such as combustion free zones and walkdowns by operators) and provided an implementation plan to address the non-conformances by 2021. The corrective action plan includes fire detection upgrades in lower risk fire zones and protection of cables for possible fire damage scenarios. Bruce Power has agreed to report annually in the ROR to the Commission to provide the progress on the upgrades. CNSC staff is satisfied with the corrective actions taken by Bruce Power.

In 2013, Bruce Power carried out a code compliance review of Bruce A and B against the 2007 edition of CSA N293, *Fire Protection for Nuclear Power Plants* as well as key standards referenced therein (such as the *National Building Code of Canada*, *National Fire Code of Canada* and associated *National Fire Protection Association* standards). At the time, CNSC staff concluded that the programmatic and operational requirements of CSA N293 have been met and the review findings were of low risk significance.

The updated code compliance reviews for Bruce A and for Bruce B were submitted by Bruce Power recently in early 2018. CNSC staff is currently reviewing the updated documents.

Bruce Power continues to submit third party reviews (TPR) of proposed modifications with the potential to impact protection from fire. The submission of the TPRs provides evidence to CNSC staff that the compliance criteria for modifications are being met. CNSC staff have performed desktop reviews of the TPRs and found that regulatory requirements are met.

Component Design

Fuel Design

CNSC staff determined that Bruce Power continued to operate its units safely and within the fuel power limits specified in the licence, and had a well-developed reactor fuel inspection program. Fuel usage remained safe for all units and that fuel performance requirements have been met.

The fuel defect rate for Bruce A Units 1 and 2 was higher than industry average due to fretting defects (as a result of damage caused by debris introduced during unit refurbishment). However, the defect rate is trending downwards and is expected to return to industry average because the debris is gradually being removed from the primary heat transport system. The fuel defect rate for Units 3 to 8 was within industry average of about one bundle per year.

Although endplate cracking continued to be observed at Bruce B, Bruce Power has mitigating measures in place to address fuel bundle endplate cracking. The observed rate remained consistent over the licensing period.

CNSC staff concluded that Bruce Power fuel usage remained safe for all units and that fuel performance met requirements. Bruce Power continued to implement its corrective action plan to address increased fuel bundle vibration, due to acoustically active channels, in units 5-8.

Cables

CNSC determined that Bruce Power's cable management program met regulatory requirements. Cables are critical to the safe and reliable operation of NPPs due to their widespread use as the connection medium with many systems important to safety. Cable management program includes surveillance and condition monitoring of cables and their degradation mechanisms.

Based on the results of the compliance activities performed over this licensing period, CNSC staff determined that there is no safety concern with the cables.

4.5.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.5.3.1 Past Performance

Performance in the physical design SCA at Bruce A and B continued to meet CNSC requirements. The plant design basis management, engineering change control and configuration management programs have been maintained. Fuel usage remained safe for all units and fuel performance requirements have been met.

4.5.3.2 Regulatory Focus

CNSC staff will continue to verify the performance of Bruce Power in all aspects of the Physical Design SCA. CNSC staff will monitor fuel defect rate at Bruce A Units 1 and 2 to ensure that the defect rate will return to industry norms.

4.5.3.3 Proposed Improvements

Over the proposed 10 year licensing period, Bruce Power has agreed to implement the following new codes and standards referenced in the LCH:

Document Title	Implementation Date
CSA N289.1-18, General requirements for seismic design and qualification of CANDU nuclear power plants	September 1, 2018
CSA N289.2-10, Ground motion determination for seismic qualification of CANDU nuclear power plants	September 1, 2018
CSA N289.3-10, Design procedures for seismic qualification of CANDU nuclear power plants	September 1, 2018
CSA N289.4-12, Testing procedures for seismic qualification of nuclear power plant structures, systems, and components	September 1, 2018
CSA N289.5-12, Seismic instrumentation requirements for nuclear power plants and nuclear facilities	September 1, 2018
CSA N290.12-14, Human factors in design for nuclear power plants	September 1, 2018
CSA N290.14-07, Qualification of pre-developed software for use in safety-related instrumentation and control applications in nuclear power plants	September 1, 2018

4.5.4 Conclusion

Bruce Power continued to implement and maintain an effective design program at Bruce A and B in accordance with CNSC requirements.

Licence Condition 5.1 in the proposed licence pertains to implementing and maintaining a design program.

Licence Condition 5.2 in the proposed licence pertains to implementing and maintaining a pressure boundary program and having a formal agreement in place with an Authorized Inspection Agency.

Licence Condition 5.3 in the proposed licence pertains to implementing and maintaining an environmental qualification program.

Compliance Verification Criteria for the above Licence Conditions are provided in the draft LCH.

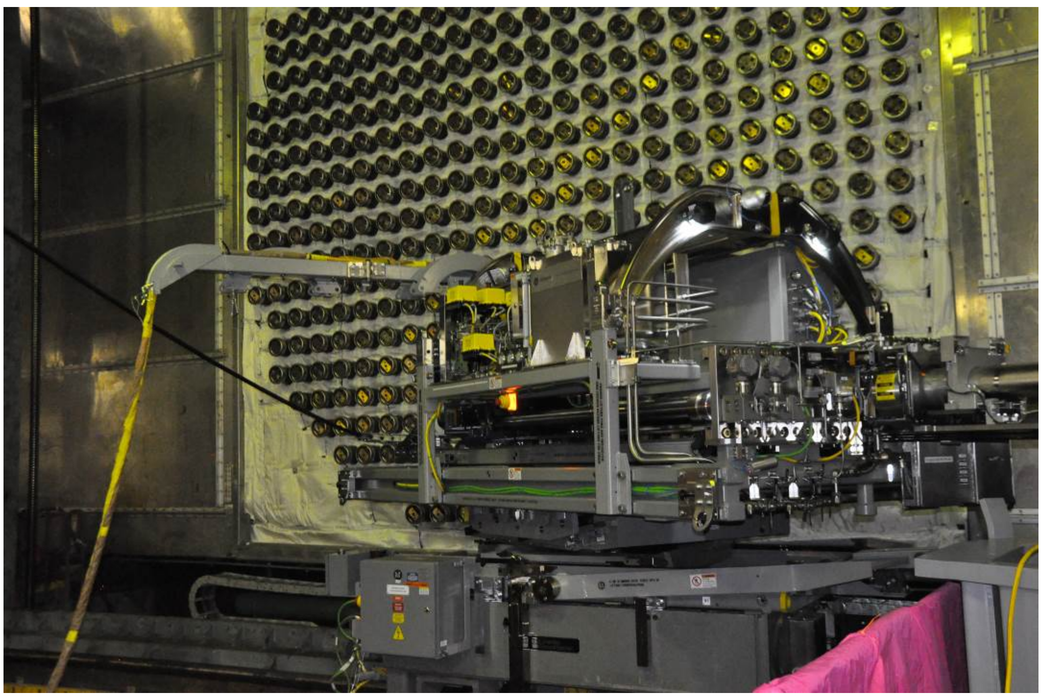
4.6 Fitness for Service

The Fitness for Service SCA covers activities that impact on the physical condition of structures, systems and components to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended function when called upon to do so.

This CMD covers the following specific areas of fitness for service:

- Equipment fitness for service/equipment performance (system health)
- Maintenance
- Structural integrity
- Aging management
- Chemistry control
- Periodic inspection and testing

Figure 7: Periodic inspection programs are in place to ensure that pressure tubes meet fitness-for-service requirements (*photo courtesy of Bruce Power*)



4.6.1 Trends

The following table indicates the overall rating for the Fitness for Service SCA over the current licensing period:

TRENDS FOR FITNESS FOR SERVICE			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	SA
Bruce B	SA	SA	SA
Comments			
The Fitness for Service SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a “satisfactory” rating during all years of the licence period.			

4.6.2 Discussion

CNSC staff determined that Bruce Power continued to implement and maintain a fitness for service program at Bruce A and B in accordance with regulatory requirements.

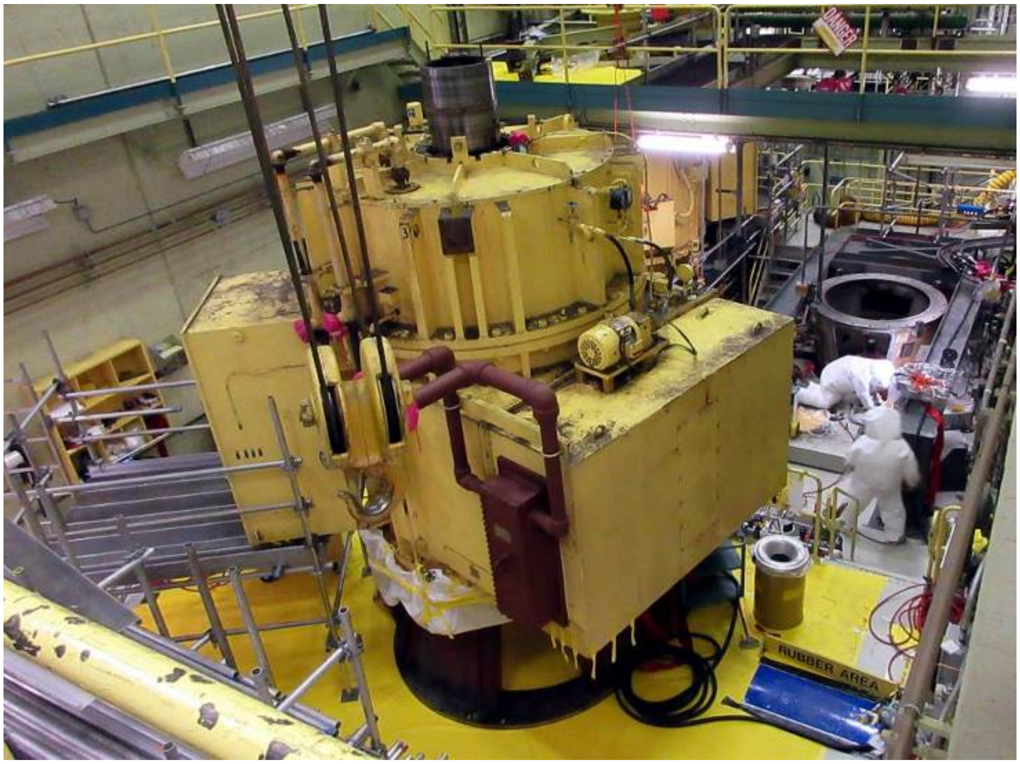
Details of the CNSC staff assessment in this SCA are presented in the following sections.

Equipment Fitness for Service/Equipment Performance (System Health)

CNSC staff determined that the overall equipment fitness for service and performance at Bruce A and B met regulatory requirements. Bruce Power has programs in place to manage the aging facilities and provide condition monitoring of systems which include safety systems tests, inspection, assessment and review of OPEX. System health reports and component health reports are produced on a routine basis and include items such as equipment failures, maintenance backlogs, aging and obsolescence issues.

Nevertheless, there were several equipment performance issues reported the current licensing period. These equipment issues are further highlighted in the subsequent paragraphs. CNSC staff will continue to monitor the resolution of these issues through the normal compliance program.

Figure 8: Repair work being performed on the HTS pump



In August 2017, Unit 3 HTS circulating pump no. 4 experienced a triple seal failure while the unit was shutting down. Bruce Power performed a detailed root cause analysis of this event and presented the findings to the Commission in CMD 17-M52.1 [39]. It was determined that there was a misalignment or imbalance of the rotating assembly which caused the contact between the pump shaft and stationary seal components. Repairs were completed and the unit was returned to service. Bruce Power has put additional measures (such as enhanced vibration monitoring) in place to prevent recurrence of this event. As well, longer-term corrective actions are being developed by Bruce Power. CNSC staff will review these longer-term actions over the next licensing period to ensure that the event has been adequately addressed.

In 2015, one of the heavy water isolation valves of Bruce A Unit 1 ECI system failed in the open position, due to a vendor quality control issue with the return springs used in the valve limit switch. The vendor has since corrected the quality control issue. Bruce Power also revised the control maintenance procedure to provide additional information about the limit switch. CNSC staff determined that the event was of low risk significance and did not have an impact on safety.

In 2016, one of the isolation valves of Bruce A Unit 4 ECI system failed in the open position. One of the contributing factors identified was the high vibration from the HTS piping. The event was of low risk significance and did not have an impact on safety. Bruce Power is currently evaluating design changes to reduce the vibration. CNSC staff will monitor the corrective actions that will be taken by Bruce Power over the next licensing period.

Reliability Program

CNSC staff determined that the reliability program at Bruce A and B met regulatory requirements. Over the current licensing period, Bruce Power submitted an implementation plan for RD/GD-98, *Reliability Programs for Nuclear Power Plants*. Bruce Power is currently developing system reliability models to meet the requirements of S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* for systems important to safety (SIS). The SIS list will be revised by June 2018.

Reliability (unavailability) targets are reliability indicators that are commensurate with the safety importance of the systems. The targets are compared with actual plant performance in order to identify deviations from expected performance.

Over the licensing period, Bruce Power took appropriate actions to address the temporary impairments to special safety systems and corrective actions were taken to prevent recurrence. The temporary impairments resulted in the following special safety systems not meeting their unavailability targets:

- In 2015, Units 1 and 4 negative pressure containment systems (NPCS), Units 1 and 2 shutdown system 2 (SDS2), and Unit 2 shutdown system 1 (SDS1)
- In 2016, Units 1 and 3 ECI systems

The above temporary impairments for the various safety systems occurred during separate occasions. At no time are the shutdown systems allowed to be ineffective; in some rare circumstances, their capability might be reduced but coverage is always assured by other redundant system and immediate actions are always taken by the operating crew to restore capability. No reactor is allowed to operate without the availability of the special safety systems. If unavailability is detected, immediate actions are taken to ensure safety is maintained at all times. CNSC staff are satisfied with the actions that Bruce Power has taken; no additional follow-up actions are required.

Maintenance

CNSC staff determined that Bruce Power's maintenance program met the requirements of RD/GD-210, *Maintenance Program for Nuclear Power Plants*.

To prioritize maintenance work at a nuclear facility, backlogs are sorted in different categories such as corrective, deficient and preventative. Corrective maintenance is action taken to restore the capability of a failed SSC to perform its defined function within acceptance criteria. Deficient maintenance backlog indicates when SSCs have been identified as degrading but still capable of performing their design function. Preventative maintenance is action taken in accordance with a set time period or a given amount of operation.

Listed in Table 12, Table 13 and Table 14 are the key maintenance performance indicators.

Table 12: Performance Indicator for maintenance backlogs for Bruce A

Performance indicator	Average work orders 2015	Average work orders 2016	Average work orders 2017*	Industry average 2016
# of Corrective maintenance backlog	4	2	4	8
# of Deficient maintenance backlog	123	123	119	111

Table 13: Performance indicator for maintenance backlogs for Bruce B

Performance indicator	Average work orders 2015	Average work orders 2016	Average work orders 2017*	Industry average 2016
# of Corrective maintenance backlog	6	3	2	8
# of Deficient maintenance backlog	180	165	155	111

Table 14: Deferrals of preventive maintenance at Bruce A and B

Performance indicator	Average work orders 2015	Average work orders 2016	Average work orders 2017*	Industry average 2016
# of Deferrals of preventive maintenance at Bruce A	18	12	10	38
# of Deferrals of preventive maintenance at Bruce B	28	14	13	38

* *Numbers are gathered up to a cut-off date of June 30, 2017.*

The corrective maintenance backlogs were within the range of industry best practice and indicated normal equipment failure rate.

The deficient maintenance backlogs were above industry average. However, CNSC staff determined that Bruce Power has work management process in place to control the risk for the associated work and equipment.

The number of deferrals of critical preventive maintenance work was within the range of industry best practices and has been continuously reduced in the current licence period. In addition, all deferrals have an approved engineering assessment to document the technical justification and if necessary, have required contingencies in place until the completion of the delayed work. The preventive maintenance completion ratios were approximately 88 percent for Bruce A and Bruce B, which indicated an effective preventive maintenance program.

CNSC staff determined that the overall safety significance of maintenance backlogs and deferrals for critical components was low for both Bruce A and B and are being adequately managed by the plant maintenance program.

Structural Integrity

CNSC staff determined that SSCs required for safe operation continued to meet structural integrity requirements established in the design basis for Bruce A and B.

Structural integrity evaluations for pressure boundary components, containment SSCs and safety related civil structures are completed by the licensee to demonstrate that margins established for the design and licensing basis are not reduced below acceptable levels (such as those defined in codes and standards) due to aging related degradation.

Bruce Power follows a 3-year outage cycle and is required to undertake inspections of:

- pressure boundary components under the CSA N285.4, *Periodic inspection of CANDU nuclear power plant components*
- containment components under the CSA N285.5, *Periodic inspection of CANDU nuclear power plant containment components*

All inspection findings were evaluated by Bruce Power to confirm that structural integrity margins are maintained and where results indicated that margins were reducing, CNSC staff determined that appropriate corrective actions (such as repairs or replacement of components) were implemented to restore margins.

Bruce Power conducted positive pressure tests and inspection of the containment structures in accordance with the programmatic requirements of CSA N287.7, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants* during the station containment outages for all Bruce A units in 2016 and Bruce B units in 2015. The test and inspection results indicated that the leakage rates remained acceptably low and the concrete structures were in good condition. Minor deterioration detected as a result of inspections was repaired.

Aging Management

CNSC staff determined that Bruce Power's aging management program met the requirements of REGDOC-2.6.3, *Fitness for Service: Aging Management*. Bruce Power has an integrated aging management program at Bruce A and B to ensure the condition of SSCs important to safety is maintained, and all required activities (such as inspection, testing, surveillance and monitoring) are in place to assure the health of SSCs as the plants age.

Bruce Power's asset management program was updated in 2016 to comply with REGDOC-2.6.3. This integrated asset management program was developed by Bruce Power to support long-term operation of the Bruce site. The plan coordinates capital projects, maintenance outages and MCR outages to ensure that SSCs important to safety are fit for service. Asset management program is discussed in Section 3.4 of this CMD.

Bruce Power has a life cycle management plan (LCMP) in place to manage the aging of major components prior to them being replaced during MCR. LCMP for major components is further discussed in the section below.

The existing licence authorizes Bruce Power to operate up to 247,000 Equivalent Full Power Hour (EFPH) for fuel channels [16]. Bruce Power is seeking Commission approval to operate Bruce A and B up to a maximum of 300,000 EFPH. This is the maximum operational time expected for the Units before they enter an MCR outage, during which the major components will be replaced (see Table 15 below for predicted EFPH prior to MCR outage). Bruce Power's request to operate up to a maximum of 300,000 EFPH is further discussed in this section of the CMD under life cycle management plans for major components – fuel channels.

Table 15: Predicted EFPH for Bruce Units prior to MCR outage

Unit	Outage Date	Predicted EFPH
3	2023	242,000
4	2025	251,000
5	2026	294,000
6	2020	243,000
7	2028	297,000
8	2030	298,000

In 2016, CNSC staff conducted a Type II Inspection to measure compliance with REGDOC-2.6.3 and the associated documents pertaining to Bruce Power's aging management program. CNSC staff concluded that Bruce Power met the requirements of REGDOC-2.6.3 with minor exceptions relating to governance, and noted some areas for improvement of low safety significance. Bruce Power made the required procedural content adjustments [40] to the satisfaction of CNSC staff.

Life Cycle Management Plans for Major Components

CNSC staff determined that Bruce Power has a program in place to manage the aging of major components in accordance with REGDOC-2.6.3, and the periodic in-service inspection programs met the requirements of Update 2 of CSA N285.4-09, *Periodic inspection of CANDU nuclear power plant components*. Bruce Power BP-PROC-00778, *Scoping and Identification of Critical SSC* described the process for identifying SSCs that are important to maintain safe, reliable operation. It provided scoping criteria and identified functions of SSCs related to safety and reliability, critical SSCs that supported these functions, non-critical components and run-to-failure components. Based on these criteria, Bruce Power has identified a list of SSCs for which component specific aging management plans, or life cycle management plans (LCMPs), are required. The LCMPs for major components include:

- feeders
- steam generators and preheaters
- fuel channels
- civil structures

Over the next licensing period, CNSC staff will continue to monitor the effectiveness of the LCMPs through the review of their updates, their associated periodic inspection reports and outcome from research activities. CNSC staff's review of Bruce Power's LCMPs for the major components is further discussed in the following paragraphs.

FEEDERS

CNSC staff determined that Bruce Power Bruce Power is effectively managing the expected aging of feeders, and the inspection programs met the requirements of CSA N285.4-09. Bruce Power continued to update the LCMP for feeders along with its technical basis assessment.

The LCMP for feeders was revised to include information pertaining to feeder management strategies to address active wall thinning due to flow accelerated corrosion (FAC) and other degradation mechanisms. FAC is the most significant life limiting degradation and is managed by performing wall thickness measurements and stress analysis to ensure that the required feeder wall thickness is met.

Bruce Power, jointly with CANDU industry, developed a fitness-for-service guideline FFSG for feeders. The FFSG provides refined engineering analysis methodologies to evaluate structural integrity of feeders with service induced degradations. The methodologies were reviewed and accepted by CNSC staff.

Bruce Power's aging management strategies include provisions for identifying and selectively replacing individual feeders that will not meet the required structural margins prior to the planned MCR outages for Units 3 to 8, at which time all feeders will be replaced to support extended operation. The Unit 1 and 2 feeders were replaced during the refurbishment of those units.

STEAM GENERATORS AND PREHEATERS

CNSC staff determined that Bruce Power is effectively managing the expected aging of steam generators and preheaters, and the inspection programs met the requirements of Update 2 of CSA N285.4-09. Bruce Power's LCMP for steam generators and preheaters defines, integrates, and schedules actions to be performed in order to achieve safe and reliable steam generator operation. Bruce Power continued to update the LCMP for steam generators and preheaters along with their technical basis assessments. The LCMP provides:

- current conditions of the components

- active degradation mechanisms
- remaining life assessment
- foreign material exclusion plan
- tube plugging
- industry operating experience
- research and development programs

Based on understanding of degradation mechanisms, the LCMP also provides maintenance activities including periodic in-service inspection scope and frequency, testing and surveillance, chemistry control and monitoring, acceptance criteria for the plugging or repair of flawed tubes and leakage monitoring requirements.

Bruce Power, jointly with CANDU industry, developed a FFSG for steam generators and preheaters. The FFSG provides refined engineering analysis methodologies to evaluate structural integrity of steam generators and preheaters tubes with service induced degradations. Tubes containing flaws which challenge the acceptance criteria will be removed from service via tube plugging. The methodologies were reviewed and accepted by CNSC staff.

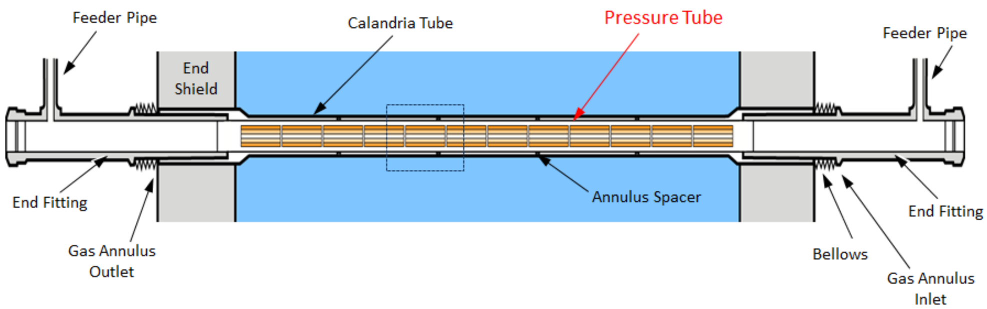
Based on Bruce Power's current estimates, adequate margins remain such that operation will not be impacted by the numbers of steam generator tubes that may require plugging prior to the MCR outages for Units 3 to 8 (at which time the steam generators will be replaced). The original steam generators in Units 1 and 2 were recently replaced during the refurbishment of those units.

FUEL CHANNELS

Based on Bruce Power's inspection programs and the past inspections results, CNSC staff determined that Bruce Power effectively managed the conditions of fuel channels[8] over the current licence period and that Bruce Power's inspection programs met the requirements of CSA N285.4-09, *Periodic inspection of CANDU nuclear power plant components* and CSA N285.8-10, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*. Bruce Power's LCMP for fuel channels defines, integrates, and recommends actions to be performed in order to address fuel channel degradation and ensure safe operation.

[8] Elements of the CANDU fuel channel include pressure tube, calandria tube, spacers, end fittings, etc.

Figure 9: Elements of the CANDU fuel channels



Safe operation of fuel channels is demonstrated through inspections and engineering assessments that are based on an understanding of degradation mechanisms. Inspection and maintenance programs, along with a research and development program, provide the data needed to validate the input parameters required for the engineering assessments. Specifically, to demonstrate that acceptance criteria can be met for pressure tubes, licensees must continue to:

- demonstrate that detected flaws do not adversely impact the integrity of inspected pressure tubes
- demonstrate that pressure tubes will maintain adequate resistance to fracture during normal operation and transients
- maintain required margins to demonstrate leak-before-break behaviour during normal operation
- demonstrate that potential pressure tube to calandria tube contact will not impact safe operation

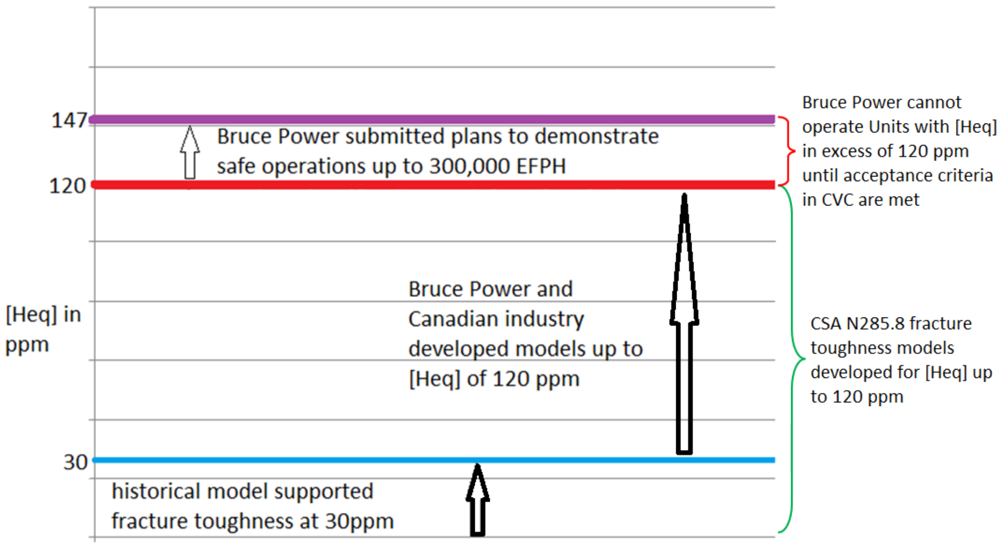
In January 2018, CNSC staff provided a technical update to the Commission [41] on fuel channel evaluations for Canadian NPPs, specifically addressing the pressure tube fitness-for-service requirements and evaluation methodologies that are established in CSA N285.4 and N285.8 based on the following requirements:

- evaluation of in-service inspection results
- assessments of the reactor core, including demonstration of leak-before-break and evaluation of pressure tube to calandria tube contact
- evaluation of material surveillance measurements

For assessment of reactor core, the dominant contributor to risk of pressure tube failure (owing to its impact on fracture toughness) is deuterium uptake, measured in hydrogen equivalent concentration [Heq]. Deuterium uptake is not a life-limiting mechanism on its own. However, an increase in [Heq] affects pressure tube material property over time, due to a reduction in material ductility.

As previously stated, the existing licence authorizes Bruce Power to operate Bruce A and B up to 247,000 EFPH. Bruce Power is seeking Commission approval to operate up to 300,000 EFPH (see Figure 10).

Figure 10: Fracture toughness work by Bruce Power to support operation of Bruce A and B up to 300,000 EFPH



In the past, Bruce Power, along with the Canadian industry, utilized a fracture toughness relation that supported [Heq] levels up to 30 ppm. To demonstrate safe reactor operations up to 247,000 EFPH, Bruce Power, along with the Canadian industry, developed two (2) fracture toughness models for pressure tubes with [Heq] levels up to 120 ppm. These models are used in Bruce Power's assessment to demonstrate safe operation of pressure tubes in the unlikely event that a crack initiates and propagates through the wall of a pressure tube. In addition, Bruce Power, along with the Canadian industry, performs research and development work which involves periodic examination of pressure tubes (bursts tests) to confirm that there is adequate fracture toughness over the near-term as required by CSA N285.4. Based on these factors, the Commission approved the operations of Bruce A and B up to 247,000 EFPH.

For operations up to 300,000 EFPH, Bruce Power estimated that [Heq] could reach as high as 147 ppm (i.e., [Heq] in excess of 120 ppm). Bruce Unit 5 is predicted to be the first Unit to go beyond [Heq] of 120 ppm in approximately 2020 (see Table 16 for estimated EFPH/dates at 120 ppm and EFPH/dates prior to MCR for Bruce Units 3-8).

To demonstrate safe operations using reactor core assessments, Bruce Power must develop a fracture toughness model applicable to [Heq] levels in excess of 120 ppm. Currently, Bruce Power and the industry are working on such a model.

Bruce Power submitted detailed plans that contain activities to demonstrate that the condition of pressure tubes can be assessed to support safe operations up to 300,000 EFPH. The plan includes ongoing monitoring of hydrogen content during regular inspection campaigns, and continued research and development work [7] aimed at producing a pressure tube fracture toughness model for [Heq] levels in excess of 120 ppm. CNSC staff will closely monitor Bruce Power's progress to ensure that these activities are completed according to the required schedules.

In addition, Bruce Power will continue to implement the inspection/maintenance programs necessary to ensure the fitness-for-service of inspected pressure tubes. The necessary Compliance Verification Criteria (CVC) are in place for CNSC staff's oversight of Bruce Power's fitness-for-service program.

Table 16: Bruce Units 3-8 with estimated EFPH/dates at 120ppm and EFPH/dates prior to MCR

Unit	Estimated EFPH at 120 ppm	Estimated Date Unit will reach 120 ppm	Estimated EFPH at time of MCR	MCR Outage Year
3	Units will not reach 120 ppm prior to MCR outage		242,000	2023
4			251,000	2025
5	247,609	March 2020	294,000	2026
6	243,128	December 2019	243,000	2020
7	252,818	January 2022	297,000	2028
8	274,126	February 2027	298,000	2030

Based on the submitted information, CNSC staff recommend that the Commission approve operation of Bruce A and B up to a maximum of 300,000 EFPH. A specific licence condition is recommended by CNSC staff requiring Bruce Power to maintain pressure tube fracture toughness sufficient for safe operation. The specific acceptance criteria for demonstration of fracture toughness at [Heq] in excess of 120 ppm are defined in the CVC of the Licence Conditions Handbook (LCH). The CVC is defined in two parts:

1. Bruce Power shall obtain prior approval before operating any pressure tube predicted to have a [Heq] in excess of 120 ppm and submit annual reports to indicate when each unit is predicted to reach 120 ppm
2. Bruce Power shall submit a validated fracture toughness model for [Heq] in excess of 120 ppm by January 2020 and provide semi-annual updates on the progress of the work

Although CNSC staff recommend approval for the operation of Bruce A and B up to a maximum of 300,000 EFPH, the Units will, in line with current requirements, not be allowed to operate with [Heq] in excess of 120 ppm until the acceptance criteria in the CVC have been met.

In addition, the above activities will be reported by Bruce Power through its IIP updates. The CVC in the LCH will be subject to CNSC staff compliance monitoring reviews. CNSC staff will report on Bruce Power's progress to the Commission in the annual ROR for NPPs.

CIVIL STRUCTURES

Based on the inspection programs that Bruce Power has in place and the results of the civil structures inspections, CNSC staff determined that Bruce Power has the appropriate strategies in place to manage the expected aging of the civil structures, which includes containment structures and safety-related structures. Safe-related structures include:

- structures that support, house or protect nuclear safety systems
- components of structures that are required for the safe operation and/or safe shutdown of the reactor
- structures for storage of wet and dry irradiated fuel
- structures for storage of radioactive waste material

Chemistry Control

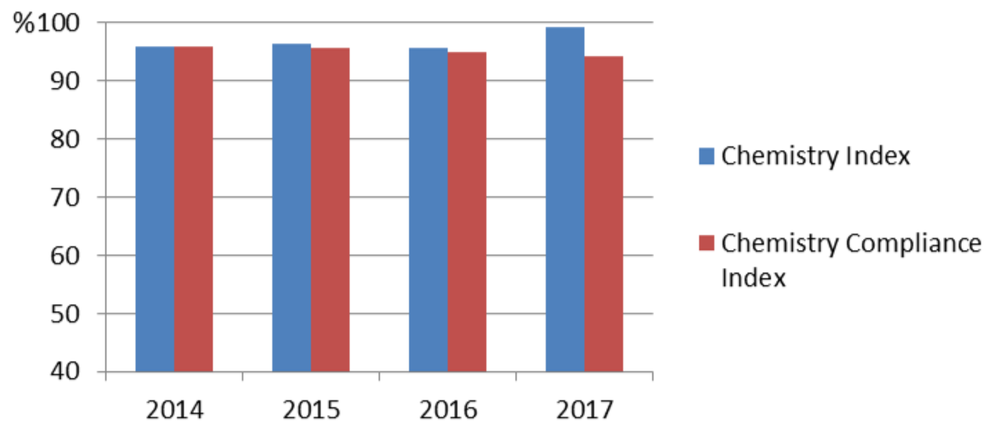
CNSC staff determined that Bruce Power's chemistry control program met regulatory requirements. Plant chemistry control was effective during all operational states. Bruce Power has taken appropriate actions to maintain the chemistry control parameters within acceptable limits. The storage of hazardous materials and process chemicals was well managed.

Bruce Power has maintained good chemistry performance throughout the licence period as demonstrated through the chemistry index and chemistry compliance index performance reported quarterly in accordance with REGDOC-3.1.1. Chemistry index and chemistry compliance index are both defined as the average percentage of time that the selected chemical parameters are in specification during the quarter. Chemistry index monitors chemistry parameters for systems such as annulus gas, feedwater, steam generators and condensate. Chemistry compliance index monitors safety-related chemical and radiochemical parameters for systems such as liquid injection safety system, poison injection tanks, moderator, primary heat transport and emergency coolant injection.

In the first half of 2017, there was an increasing (positive) trend in the overall chemistry index for Bruce A and B, which was attributed to the chemistry improvements made to the condensate extraction system.

An annual average of their overall performance is shown in Figure 11.

Figure 11: 2014-2017 Chemistry Index and Chemistry Compliance Index Annual Averages



* *Numbers are gathered up to a cut-off date of June 30, 2017.*

Over the current licensing period, CNSC staff reviewed the REGDOC-3.1.1 report and confirmed that Bruce Power's isotopic purity was within licensing limits. CNSC staff identified a downward trend in moderator D_2O isotopic purity for all units of both Bruce A and B. However, Bruce Power has since put corrective actions in place through the use of its D_2O upgraders and de-tritiation program. There is no impact on the safe operation of the plant and safety systems functions were not impaired. CNSC staff will monitor this issue closely over the next licensing period to ensure that the D_2O isotopic purity does not continue to trend negatively downwards.

Figure 12: Bruce Power's chemistry program ensures that chemistry control parameters are within acceptable limits (*photo courtesy of Bruce Power*)

<u>Periodic Inspection and Testing</u>

CNSC staff determined that Bruce Power has adequate and well maintained periodic inspection programs (PIP) in place at Bruce A and B for pressure boundary systems, containment components and containment structures that met the requirements of CSA Standards N285.4, *Periodic inspection of CANDU nuclear power plant components*, N285.5, *Periodic inspection of CANDU nuclear power plant containment components* and N287.7, *In-service examination and testing requirements for concrete containment structures*, as referenced in the LCH.

CNSC staff evaluated the PIP against CNSC regulatory requirements on an ongoing basis through three primary activities:

- desktop review of PIP documents to assess compliance with the governing CSA standards
- desktop review of outage inspection reports to assess compliance with the processes described in the PIP documents
- on site Type II inspections to confirm compliance with requirements that are difficult to verify through document reviews

CNSC staff reviewed the PIP documents received to date and found them acceptable. Bruce Power submitted a transition plan to meet Update 1 of the 2009 edition of CSA standard N285.4. Implementation of the updated program has begun and full implementation is expected by 2018.

In 2016, a Type II inspection was completed to confirm Bruce Power's compliance with CSA N285.4-09 requirements to qualify inspection procedures for PIP activities [42]. Overall, CNSC staff concluded that the regulatory requirements have been met. CNSC staff identified some minor non-compliances of low risk significance with Bruce Power's governance. These non-compliances have been addressed to the satisfaction of CNSC staff.

In addition to the PIP, Bruce Power implements a relief valve testing program to confirm that overpressure protection devices on pressure boundary systems will perform their intended function in the event of operating pressure transients. Bruce Power reported several relief valve test failures on balance of plant pressure boundary systems from 2015 to 2017. However, CNSC staff confirmed that Bruce Power has undertaken a review and implemented corrective actions. CNSC staff concluded that plant safety has not been impacted by these findings and will continue to monitor the results of the relief valve testing program.

Balance of Plant

CNSC staff determined that Bruce Power has implemented an effective inspection programs to monitor the effects of potential aging related degradation of balance of plant (BOP) pressure boundary components and civil structures that could impact safe operation.

During the licensing period, CNSC staff did not identify compliance issues or reports of degradation that would affect safe operation. CNSC staff continued to provide regulatory oversight in this area to ensure that Bruce Power's implementation of inspection activities of safety-related BOP pressure boundary components and civil structures met regulatory requirements.

4.6.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.6.3.1 Past Performance

As a result of the compliance monitoring activities carried out over the current licensing period, CNSC staff concluded that Bruce Power met regulatory requirements for the Fitness for Service SCA and maintained a "satisfactory" rating.

4.6.3.2 Regulatory Focus

CNSC staff will continue to verify the performance of Bruce Power in all aspects of the Fitness for Service SCA, including aging management activities undertaken to support on-going operations and life extension of Bruce A and B. Over the next licensing period, Bruce Power will need to demonstrate to the satisfaction of the CNSC that fuel channel structural integrity margins will be maintained up to 300,000 EFPH and beyond [Heq] beyond 120 ppm.

4.6.3.3 Proposed Improvements

CNSC staff recommend one (1) licence condition to be included in the proposed licence requiring Bruce Power to maintain pressure tube fracture toughness sufficient for safe operation.

Over the proposed 10 year licensing period, Bruce Power has agreed to implement the following new regulatory documents, codes and standards referenced in the LCH:

Document Title	Implementation Date
REGDOC-2.6.1, Maintenance programs for nuclear power plants	September 1, 2018
REGDOC-2.6.2, Reliability programs for nuclear power plants	September 1, 2018
CSA N285.7-15, Periodic inspection of CANDU nuclear power plant balance of plant systems and components	March 29, 2019
CSA N291-15, Requirements for safety-related structures for CANDU nuclear power plants	July 1, 2018

4.6.4 Conclusion

Bruce Power continued to implement and maintain an effective fitness for service program at Bruce A and B in accordance with CNSC requirements and has maintained a "satisfactory" rating for this SCA over the current licensing period.

Licence Condition 6.1 in the proposed licence pertains to implementing and maintaining a fitness for service program.

Licence Condition 15.3 in the proposed licence pertains to demonstrating that the reduction in pressure tube fracture toughness expected at Hydrogen equivalent concentrations in excess of 120 parts per million does not impact safe operation.

Compliance Verification Criteria for this Licence Condition are provided in the draft LCH.

4.7 Radiation Protection

The Radiation Protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained As Low As Reasonably Achievable (ALARA).

This CMD covers the following specific areas of Radiation Protection:

- Application of ALARA
- Worker dose control
- Radiological hazard control
- Radiation protection program performance
- Estimated Dose to public

Figure 13: Bruce Power's radiation protection program ensured that contaminations are being monitored and controlled (*photo courtesy of Bruce Power*)

4.7.1 Trends

The following table indicates the overall rating for the Radiation Protection SCA over the current licensing period:

TRENDS FOR RADIATION PROTECTION			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	FS
Bruce B	SA	SA	FS
Comments			
The Radiation Protection SCA at Bruce A and B met applicable CNSC requirements and performance objectives. Both stations improved to a "fully satisfactory" rating in 2016.			

4.7.2 Discussion

CNSC staff determined that Bruce Power implemented and maintained an effective radiation protection program at Bruce A and B. Based on reviews of documentation and assessments of past performance, CNSC staff concluded that the radiation protection program at Bruce Power met requirements or exceeded performance objectives and applicable regulatory requirements, maintained doses below regulatory limits and ALARA, and protected the health and safety of persons. In 2016, Bruce Power exceeded CNSC requirements and expectations and received a "fully satisfactory" rating.

The *Radiation Protection Regulations* require licensees to establish a radiation protection program to keep exposures ALARA, taking economic and social factors into account, through the implementation of a number of control programs, including:

- Management control over work practices
- Personnel qualification and training
- Control of occupational and public exposures to radiation
- Planning for unusual situations

Bruce Power's BP-PROG-12.05, *Radiation Protection Program* is designed to ensure that:

- all applicable regulatory requirements are met
- public and occupational exposures to ionizing radiation are controlled such that individual doses are kept below regulatory dose limits and unplanned exposures are avoided
- individual and collective doses are maintained ALARA, taking into account social and economic factors

- the movement of people and materials is done in a manner that prevents the uncontrolled release of contamination or radioactive materials from Bruce Power facilities
- high standards of radiation protection performance are achieved

These objectives are achieved through the establishment and implementation of standards and processes for the conduct of licensed activities.

Over the current licensing period, Bruce Power continued to implement alpha monitoring and control measures that have been accepted by CNSC staff and are consistent with industry best practices. The radiation protection program contained provisions to detect alpha contaminants in the work environment and to reduce worker exposures.

Details of CNSC staff's assessment are presented in the following sections.

<u>Application of ALARA</u>

CNSC staff assessed Bruce Power's radiation protection program and confirmed that Bruce Power continued to implement a highly effective and well-documented ALARA program, based on industry best practices, to keep doses ALARA at Bruce A and B.

Bruce Power's commitment to the ALARA principle has been demonstrated through the radiation protection program implemented at the Bruce A and B, which was developed in line with CNSC regulatory guide G-129, *Keeping Radiation Exposures and Doses "As Low As Reasonably Achievable" (ALARA).* Bruce Power integrated ALARA into planning, scheduling, and work control, and established and monitored performance against ALARA targets for work conducted at Bruce A and B.

Bruce A and B have 5-year collective radiation exposure (CRE) dose projection and reduction plans in place, which include ALARA initiatives both planned and currently underway that are expected to reduce collective dose. These plans are used to track dose reduction initiatives on an on-going basis. The collective doses (see Figures in Addendum D.1) align with the Bruce A and B dose targets.

In September 2017, CNSC staff conducted a Type II inspection focused on occupational ALARA planning and control [43]. The inspection identified several positive findings and one area requiring improvement related to self-assessment of the ALARA program. This area for improvement does not pose a risk to the health and safety of workers and is of low risk significance. CNSC staff will monitor Bruce Power's progress on the corrective action plan over the next licensing period.

In support of continuous improvement, Bruce Power has plans to make provisions to adopt processes that keep all radiation doses ALARA during the execution of the MCR. These provisions will include but not limited to: source term mitigation, shielding, and radiological engineering controls.

Worker Dose Control

CNSC staff determined that Bruce Power has a radiation protection program in place to control worker dose. The radiation protection program implemented at Bruce Power is designed to ensure that doses to workers are controlled and do not exceed regulatory limits.

Over the licensing period, radiation doses to workers were below the regulatory dose limits and action levels (see Section 7 of the current LCH for limits and action levels) established in the radiation protection program. There were no adverse trends or safety-significant unplanned exposures due to the licensed activities at Bruce A and B.

Bruce Power used CNSC licensed dosimetry services to monitor, assess, record and report doses of ionizing radiation received by employees, visitors and contractors as a result of activities at the Bruce Power site. Doses for individuals are reported to the National Dose Registry. The available types of dosimetry, criteria and procedures for use are implemented through the radiation protection program.

In addition, Bruce Power used a combination of action levels, staff training and qualification, and dose management tools (work planning and management oversight) to ensure radiation doses to workers are controlled and kept ALARA. Action levels are established for unplanned dose in a single shift, as well as accumulated dose in a 1-year and 5-year dose periods. Action levels are not intended to remain static and are to be reviewed periodically, or as required, to ensure that they remain meaningful. Bruce Power reaffirmed that the current action levels pertaining to exposure control remain relevant and appropriate without change.

In December 2016, CNSC staff conducted a focused inspection of worker dose control at Bruce A and B [44]. The inspection identified areas of strength and opportunities for improvement. The improvement areas were of low safety significant items related to problem identification and resolution, adherence to radiation protection procedures, selection of appropriate radiological exposures permits, and control of procedure revisions. Consequently, Bruce Power developed corrective action plans which CNSC staff reviewed and found acceptable. CNSC staff will monitor Bruce Power's progress on the remaining corrective actions over the next licensing period.

Worker dose information (maximum and average doses) from the current licensing period can be found in Figure 25 of Addendum D.1. The numbers indicated that Bruce Power maintained control over worker exposure. An average of 78% of monitored workers received less than 1 mSv per year between 2014 and 2016 and regulatory limits were not exceeded.

In addition, Bruce Power has several ongoing or planned dose reduction initiatives to reduce worker dose. These include:

- implementation of nano-fiber filtration in the primary heat transport system to improve performance of the primary heat transport purification system, and reduce the source term (and therefore dose)
- continued improvements to the implementation of Bruce reactor inspection and maintenance system (BRIMS) technology and the circumferential wet scrape tool in place of spacer location and repositioning tool to reduce overall dose. The implementation of this technology has had a significant collective dose savings of 400 mSv per outage
- implementation of sub-micron filtration on fueling machines for fuel handling heavy water purification to reduce source term and therefore worker exposures
- use of robotics to reduce worker dose will be explored for MCR, outages, and routine tasks

<u>Radiological Hazard Control</u>

CNSC staff determined that Bruce Power continued to implement its workplace monitoring programs to protect workers and ensure radioactive contamination is controlled within site boundaries. Bruce Power has noticeably improved performance in personal contamination events since 2013. No action levels were exceeded for surface contamination and no safety-significant performance issues were identified at Bruce A and B.

Bruce Power’s radiation protection program ensured that there were adequate measures in place to monitor and control radiological hazards. The measures included contamination control, radiation dose rate control and airborne radiation monitoring and control. The radiological hazards were either eliminated (if possible), or controlled with engineered barriers and signage identifying the level and extent of hazard areas. Shielding was used to reduce radiation exposures to workers during operational and maintenance activities. In addition, extensive work planning and use of adequate personal protective equipment (PPE) ensured doses to workers remain ALARA.

The contamination control process at Bruce Power was designed to ensure that radioactive contamination was controlled at the source to prevent contamination spread to worker, equipment and areas between work locations in order to maintain exposures ALARA. This was achieved by establishing radiological zones, having a routine hazard monitoring program, classifying areas according to their radiation hazard potential, posting signs identifying the radiation areas and potential radiation hazards, restricting access to authorized personnel and monitoring personnel and material prior to leaving contaminated or potentially contaminated areas.

Bruce Power has defined Actions levels for surface contamination levels in zone 1, which is treated as an area equivalent to the public domain. Over the current licensing period, Bruce Power reviewed and updated action levels pertaining to contamination levels in zone 1 areas. This change was reviewed and accepted by CNSC staff.

In July 2015, CNSC staff conducted a focused inspection on radiological hazard control [45]. The inspection identified several positive findings and one area requiring improvement (of low safety significance related to the labelling and calibration of radiation protection instrumentations. All corrective actions from this inspection were completed in 2016. CNSC staff were satisfied that Bruce Power took appropriate actions to address the inspection findings.

<u>Radiation Protection Program Performance</u>

Based on routine compliance verification activities, CNSC staff determined that Bruce Power was effective in the area of radiation protection program performance. An improving trend in this specific area was noted during the licensing period.

BP-PROG-12.05, *Radiation Protection Program* was revised during the current licensing period. The program contained a series of standards and procedures which described the means by which radiation protection was integrated within the day-to-day operations of the facilities. The major program changes included:

- alignment with the management system requirements of CSA N286-12
- clarifications to roles, responsibilities and expectations to align with the organizational change in the nuclear operations support division specific to radiation protection programs
- updates to implementing procedures and related programs and references

CNSC staff reviewed and accepted the revision to the program and concluded that applicable regulatory requirements were met.

The oversight applied by Bruce Power in implementing and improving its program was effective in protecting workers at both Bruce A and B. Bruce Power continually measured the performance of its radiation protection program against industry established objectives, goals and targets.

Some of the ongoing/implemented improvement initiatives include:

- the use of BRIMS technology as previous discussed
- installation of alpha sensitive whole body monitors for improved detection of personal detection with alpha radiation
- ongoing replacement of small article monitors with a new model which automatically links monitor alarms with the user. The new model will allow Bruce Power to explore the use of lower alarm set points in the future
- enhancements to remote monitoring capability with the implementation of a remote monitoring system that provides real-time radiation hazard information. Currently the system covers tritium and gamma hazards.

Bruce Power plans to include other types of hazards (alpha and particulates) in the future.

Estimated Dose to Public

CNSC staff determined that Bruce Power ensured the protection of members of the public in accordance with the requirements of *Radiation Protection Regulations*. The reported estimated dose to a member of the public from Bruce Power site over the current licensing period remained well below the annual public dose limit of 1 mSv/year (1000 μSv/year).

Table 17 below presents the estimated annual effective doses to a member of the public from licensed activities conducted at the Bruce site over the current licensing period.

Table 17: Maximum Effective Dose to a Member of the Public

Dose Statistic	2014	2015	2016	Regulatory Limit
Maximum Effective Dose (μSv/yr)	2.0	2.9	1.6	1000

** Note: Canada natural background is ~2300 μSv/year. 2017 data is not shown as it is not available at time of CMD publication.*

4.7.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.7.3.1 Past Performance

Based on CNSC staff's routine compliance verification activities, CNSC staff concluded that the Radiation Protection SCA at Bruce A and B met or exceeded applicable CNSC requirements and performance objectives in the current licensing period.

CNSC staff rated Bruce Power's performance for the Radiation Protection SCA at Bruce A and B as "satisfactory" in 2014 and 2015. Both stations improved to a "fully satisfactory" rating (i.e., exceeds CNSC requirements and expectations) in 2016, attributed to the achieved radiation protection performance objectives.

4.7.3.2 Regulatory Focus

CNSC staff will continue to monitor Bruce Power's performance in the Radiation Protection SCA through regulatory oversight activities including onsite inspections, desktop reviews of quarterly compliance reports, and desktop reviews of revisions to relevant program documentation pertaining to this SCA.

Furthermore, CNSC staff activities over the next licensing period will also include the review and verification of ALARA management plans related to the MCR. Given that these activities will be very dose intensive, with large-scale cutting and removal of contaminated components, CNSC staff will also ensure that Bruce Power will maintain a continued focus on contamination control, as well as the mitigation and control of tritium and other airborne radiological hazards.

4.7.3.3 Proposed Improvements

Bruce Power has plans in place to ensure that radiation doses to worker and the public are kept ALARA. Over the next licensing period, CNSC staff will continue to monitor Bruce Power's progress in its planned dose reduction initiatives.

4.7.4 Conclusion

CNSC staff concluded that the radiation protection SCA at Bruce A and B met or exceeded performance objectives and applicable regulatory requirements. Bruce Power is qualified to carry out the authorized activities in this SCA. In 2016, Bruce Power has exceeded CNSC requirements and expectations and received a "fully satisfactory" rating.

CNSC staff were also satisfied with Bruce Power's efforts in applying the ALARA principle to keep the doses to persons ALARA over the current licensing period.

Licence Condition 7.1 in the proposed licence pertains to implementing and maintaining a radiation protection program, which includes a set of action levels. As part of this licence condition, Bruce Power is required to notify the Commission within seven days of becoming aware that an action level has been reached.

Compliance verification criteria for this licence condition are provided in the draft LCH.

4.8 Conventional Health and Safety

The Conventional Health and Safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

This CMD covers the following specific areas of Conventional Health and Safety:

- Performance
- Practices
- Awareness

4.8.1 Trends

The following table indicates the overall rating for the Fitness for Service SCA over the current licensing period:

TRENDS FOR CONVENTIONAL HEALTH AND SAFETY			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	FS	FS	FS
Bruce B	FS	FS	SA
Comments			
The Conventional Health and Safety SCA at Bruce A and B met applicable CNSC requirements and performance objectives. Bruce Power received a "fully satisfactory" rating for Bruce A and B since 2009. However, in 2016, the Bruce B rating was downgraded to a "satisfactory" rating.			

4.8.2 Discussion

CNSC staff determined that Bruce Power met regulatory requirements in the area of 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. However, Bruce B performance in this area was downgraded to "satisfactory" rating in 2016 due to two events related to worker injury that were reported to the Commission (see description in performance section below).

Bruce Power's conventional safety program is designed to minimize and manage workplace non-radiological safety hazards and to protect personnel and equipment. The program is regulated by the *Occupational Health and Safety Act* (Ontario), the *Labour Relations Act* (Ontario), and supported by Bruce Power's occupational health and safety policy.

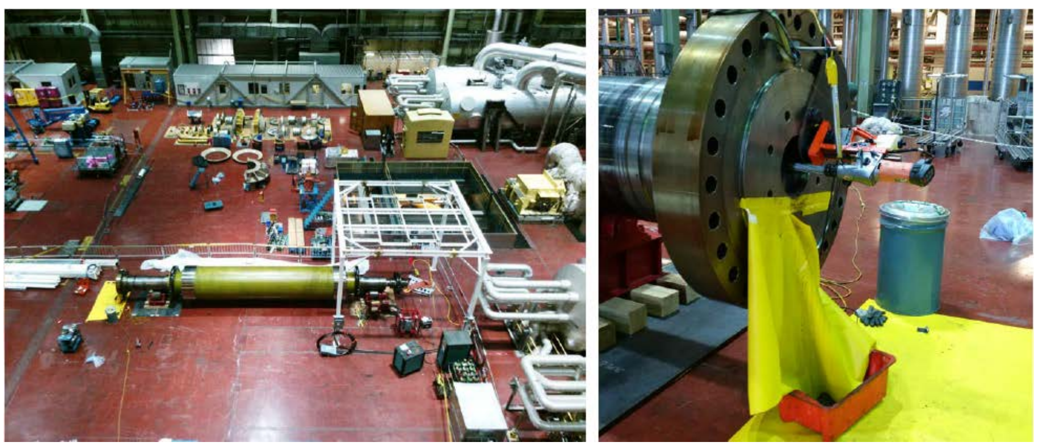
The worker injury events have been, or are in the process of, being investigated by the Ministry of Labour (MOL). CNSC and MOL have a memorandum of understanding where the CNSC oversee matters related to the NSCA, including licensing and exposures, while the MOL oversee issues related to occupational health and safety. In addition, CNSC inspectors provide support to MOL as necessary during the investigations.

Performance

Performance in the area of conventional health and safety has degraded at Bruce B as a result of two separate worker injury events.

In February 2016, a worker was performing maintenance on the Unit 8 generator rotor at Bruce B, which had been removed from the generator (see Figure 14). The worker was in the process of drilling a hole in a component of the rotor using normal procedures when a flash occurred due to a hydrogen interaction. The worker suffered burns to his arms, chest and face, and was promptly transported to the Kincardine hospital. CNSC staff conducted a focused inspection and identified areas for improvement. Bruce Power implemented corrective actions to the satisfaction of CNSC staff. In April 2016, the event was reported to the Commission in CMD 16-M18.1 [46]. The MOL fined Bruce Power to the amount of $110,000 as a result of the injury.

Figure 14: Work on Unit 8 generator rotor which resulted in worker injury (photo courtesy of Bruce Power)



In March 2017, a worker received an electrical shock while preparing to re-install a breaker in a 13.8 kV cubicle. The worker was treated for electrical burns by Bruce Power emergency personnel and was transported offsite to the Kincardine hospital. Within the electrical cabinet, there is an engineered barrier known as a shutter to protect the worker from the electrical hazard presented by the electrical bus. The worker had opened the barrier and made contact with the circuit assuming that the bus was de-energized (see Figure 15 and Figure 16). In order to prevent recurrence, Bruce Power has implemented improvements in hazard identification, training, and additional procedural changes which will make it more clear to workers whether the maintenance work is being performed on an energized or de-energized bus. In April 2017, the event was reported to the Commission in CMD 17-M19.1 [47].

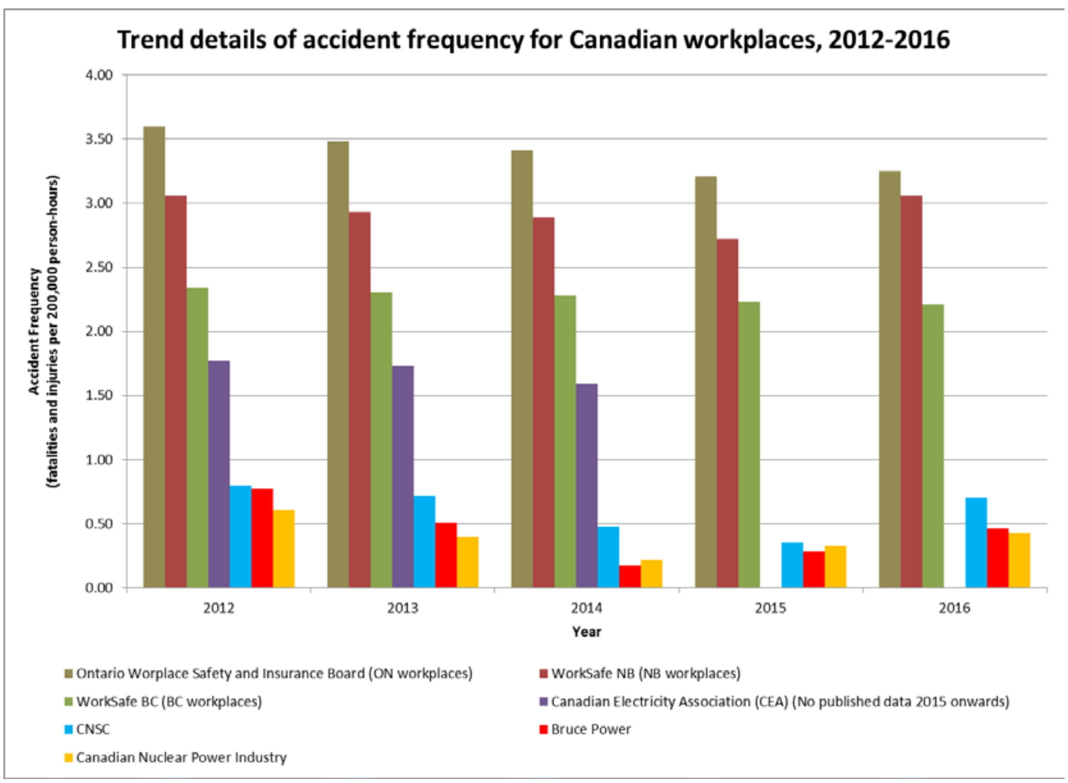
Figure 15: Photo showing work area as left after worker injury in March 2017.

Figure 16: Photo showing circuit breaker with shutter open. Employee was injured in March 2017 when contact was made with top right bus stab.

While these improvements will prevent recurrence of the event, CNSC staff has issued a corrective action on Bruce Power to address the decline in performance in the conventional safety area. CNSC staff will monitor the corrective actions that will be taken over the next licensing period.

Despite these events, the accident frequency at Bruce Power remained low compared to Canadian industry and was comparable to Canadian nuclear industry average (see Figure 17).

Figure 17: Trend of Accident Frequency for Canadian Workplaces



<u>Practices</u>

CNSC staff determined that Bruce Power was compliant with the relevant provisions of the *Occupational Health and Safety Act of Ontario* and the *Labour Relations Act*.

<u>Awareness</u>

Over the current licensing period, CNSC staff determined that Bruce Power's conventional safety awareness program was satisfactory at both Bruce A and B. All deficiencies from on-site inspections were of low risk significance and were adequately addressed throughout the year. Areas for improvement have been identified by CNSC related to housekeeping issues. However, these issues were of low risk significance.

4.8.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.8.3.1 Past Performance

Bruce Power demonstrated a "fully satisfactory" performance at Bruce A and "satisfactory" performance at Bruce B in the conventional health and safety SCA. Corrective actions were put in place to improve performance and prevent reoccurrence of past incidents at Bruce B.

4.8.3.2 Regulatory Focus

CNSC staff will continue to focus on verifying compliance with all applicable documents, standards and licence conditions in the Conventional Health and Safety SCA. CNSC staff will continue to monitor corrective actions related to work protection events to ensure that they prove effective.

CNSC staff will continue to support MOL for matters related to occupational health and safety.

4.8.3.3 Proposed Improvements

Bruce Power has started a number of initiatives in response to recent conventional health and safety incidences. These include the "You Can Count on Me" campaign, improved hazard identification tools, enhanced tracking, and additional training related to leadership, observation, and coaching. Bruce Power expects these compensatory actions to improve performance and prevent reoccurrence of workplace accidents.

4.8.4 Conclusion

CNSC staff determined that Bruce Power continued to implement and maintain a conventional health and safety program at Bruce A and B in accordance with CNSC requirements.

Licence Condition 8.1 in the proposed licence pertains to implementing and maintaining a conventional health and safety program. Compliance Verification Criteria for this Licence Condition are provided in the draft LCH.

4.9 Environmental Protection

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

This CMD covers the following specific areas of Environmental Protection:

- Effluent and emissions control (releases)
- Environmental Management System (EMS)
- Assessment and monitoring
- Protection of the public
- Environmental risk assessment

In addition, CNSC staff conducted an EA under the NSCA to assess the protection of the environment and the health of persons. The EA report, found in Addendum G of this CMD, provides CNSC staff's assessment of the licence application and the documents submitted in support of the application (including the Environmental Risk Assessment and Predictive Environmental Risk Assessment), annual environmental monitoring reports, the results of previous studies, compliance activities, CNSC's Independent Environmental Monitoring Program (IEMP) and the Preliminary Decommissioning Plan (PDP).

Figure 18: Environmental samples being taken near the Bruce site (*photo courtesy of Bruce Power*)

4.9.1 Trends

The following table indicates the overall rating for the Environmental Protection SCA over the current licensing period:

TRENDS FOR ENVIRONMENTAL PROTECTION			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	SA
Bruce B	SA	SA	SA
Comments			
The Environmental Protection SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a "satisfactory" rating during all years of the licence period.			

4.9.2 Discussion

CNSC staff determined that there is an effective environmental protection program in place at Bruce A and B during the continued implementation of REGDOC-2.9.1, *Environmental Protection Policies, Programs and procedures*. Implementation of REGDOC-2.9.1 version 1 has begun and full implementation was expected by December 2018. However, as version 1.1 of REGDOC-2.9.1 was published in April 2017, the implementation date was moved back to December 2020.

Bruce Power has undertaken measures to assess, control and monitor releases of nuclear and hazardous substances in accordance with regulatory requirements.

Regulatory requirements were met by Bruce Power in the areas of:

- effluent and emissions control
- environmental management system
- assessment and monitoring activities to assess the accuracy of the predictions and the effectiveness of mitigation measures
- protection of the public
- environmental risk assessment

Actions to date carried out by Bruce Power provide adequate controls for protection of the environment and the public.

The EA report (included in Addendum G of this CMD) included CNSC staff's assessment of:

- Bruce Power's licence application and the supplemental information
- annual environmental monitoring reports
- results of previous studies

- compliance verification activities (e.g., inspections, audits and reviews)
- findings of CNSC's independent environmental monitoring program

CNSC staff are satisfied that risks to the environment or human health for the continued operation of the Bruce Power, including MCR are low to negligible. CNSC staff concluded that, based on the EA conducted under the NSCA, Bruce Power has and will continue to make adequate provision for the protection of the environment and the health of persons.

Details of the CNSC staff assessment in this SCA are presented in the following sections.

Effluent and Emissions Control (Releases)

CNSC staff determined that Bruce Power has an environmental management system in place to ensure that effluent and emissions were controlled. A new CSA Standard N288.5-11, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*, was released during this licensing period and Bruce Power has committed to meet the standard by December 31, 2018.

In March 2016, CNSC staff conducted a Type II inspection of the effluent monitoring program at the Bruce A site as part of the CNSC baseline compliance program. The inspection covered the control, monitoring and reporting of emissions of nuclear substances from Bruce Power to the environment. The scope of the inspection encompassed airborne and waterborne effluent control and monitoring, maintenance and calibration of effluent control and monitoring equipment, airborne and waterborne effluent analytical procedures and data reporting. CNSC staff determined that the control, monitoring and reporting of emissions at Bruce Power were well-developed, implemented, and were in compliance with regulatory requirements.

Based on the assessment of the Bruce Power annual reports, quarterly reports, and regulatory performance indicators over the current licensing period, CNSC staff concluded that all of the reported radiological releases at Bruce A and B remained well below their respective regulatory limits.

Environmental Management System (EMS)

CNSC staff determined that Bruce Power has established and implemented an environmental management program to prevent or mitigate adverse environmental effects at Bruce A and B. Environmental risks associated with its nuclear activities have been assessed.

Bruce Power met the requirements in REGDOC-2.9.1 v1. However, CNSC staff identified two minor gaps associated with its implementation, specifically the implementation of CSA N288 series and administrative documentation updates. In April 2017, CNSC staff issued an update to REGDOC-2.9.1 (version 1.1), which includes administrative updates to two sections of the document and to the definition of "environmental effects". Full implementation of REGDOC-2.9.1 v1.1 is expected in December 2020.

In addition, Bruce Power used ISO 14001: 2004, *Environmental Management System* as a framework for achieving continual improvement and sustainable performance. In November 2017, Bruce Power transitioned to the 2015 edition of ISO 14001. CNSC staff determined that Bruce Power has met the requirements of ISO 14001.

Assessment and Monitoring

CNSC staff determined that Bruce Power continued to implement an effective environmental monitoring program over the current licence period. A revised CSA N288.4-10 (2015), *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*, was released during this period. Bruce Power has committed to implement the 2015 edition by December 31, 2018.

Bruce Power's radiological environmental monitoring program (REMP) served to demonstrate that site emissions of nuclear material were properly controlled. The program provided data for estimates of annual dose to the public, and that public dose was in compliance with the regulatory dose limit. Annual summary reports of the REMP were posted on the Bruce Power external website and included:

- a summary of the results of the radiological environmental monitoring program
- an analysis of the significance of the results with respect to health and safety of persons and protection of the environment
- calculations of the radiation doses to the critical group via environmental pathways associated with the operation of the nuclear power plant
- a description of the models used to calculate the radiation doses reported
- results of the quality assurance program
- a description of any significant events or findings

In November 2017, CNSC staff conducted a Type II inspection of Bruce Power's environmental protection program. The inspection focused mainly on the licensee's REMP and covered the monitoring and reporting of radiological parameters in various environmental media around the Bruce Site. CNSC staff concluded that the control, monitoring, analysis and reporting of environmental data and associated processes were well-developed, consistently implemented, and were in compliance with regulatory requirements.

To complement ongoing compliance activities, the CNSC has implemented its own IEMP. The IEMP results were used to confirm that the public and the environment in the vicinity of the Bruce site were protected. The IEMP results for 2013, 2015 and 2016 were published on the CNSC's website. Additional IEMP information is provided in the EA report (See Addendum G of this CMD).

Additionally, other regional monitoring initiatives are carried out by other government organizations in the area around the Bruce site, which the CNSC takes into account when assessing the protection of health and the environment. The monitoring initiatives include:

- Ministry of Environment and Climate Change's (MOECC) drinking water surveillance program
- Ministry of Labour's Ontario reactor surveillance program
- Health Canada's radiation monitoring network and fixed point surveillance system

Further discussion and information on these monitoring programs are provided in the EA report (See Addendum G of this CMD). These programs provide further confirmation that the environment around the Bruce site are protected and that there are no expected health impacts.

Based on the review of the annual summary reports and the inspection findings, CNSC staff concluded that Bruce Power's environmental monitoring program met regulatory requirements and that the implemented REMP continued to perform satisfactory.

CNSC and Environment and Climate Change Canada (ECCC) continued to monitor the potential impact of thermal discharges on temperature-sensitive fish species living in the environment surrounding the Bruce site. Assessment of existing information and data indicated that no significant exposure or potential effects to the environment have occurred over the current licensing period.

<u>Protection of the Public</u>

Based on the assessment of the Bruce Power annual reports, quarterly reports and regulatory performance indicators over the current licensing period, CNSC staff concluded that risks to the public due to hazardous substances released to the environment were low to negligible.

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. At Bruce A and B, systems that discharge conventional (non-radiological) contaminants to the environment are approved under the MOECC in the form of Environmental Compliance Approvals. These approvals are issued in accordance with provincial legislation (e.g., *Environmental Protection Act, Water Resources Act*).

CNSC received reports of discharges to the environment (e.g., spills) through reporting requirements outlined in REGDOC-3.1.1 and determined that the risks to environment were low to negligible. In addition, Bruce Power provided CNSC with copies of the environmental reports on the releases of hazardous substances whenever they were provided to other regulatory agencies (i.e., ECCC and the MOECC). This is expected to continue for the proposed licence period.

<u>Environmental Risk Assessment</u>

CNSC staff determined that Bruce Power implemented an effective environmental risk assessment and management program at Bruce A and B that met the requirements of CSA standard N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*. The program was used to assess, evaluate and mitigate environmental risks. Bruce Power has committed to comply with the 2012 edition by December 31, 2018.

In 2015, Bruce Power conducted an environmental risk assessment (ERA). Bruce Power included a revised version (2017) as a supplemental submission to its 2017 licence application, which addressed previous CNSC staff's review comments. The application also included a predictive environmental risk assessment (PEA) which assessed the potential environmental (ecological and human health) effects from radiological, non-radiological and physical stressors associated with continued operations and the MCR.

CNSC staff reviewed the 2017 ERA and the PEA and provided further feedback [48] to Bruce Power which included:

- making improvements to the clarity and transparency in the analysis or risk
- ensuring that all pathways and receptors were adequately assessed
- ensuring that the conclusions of no unreasonable risk to the environment and human health are fully supported by the ERA and the PEA.

In December 2017, Bruce Power submitted supplemental information [8] to address CNSC staff's comments by incorporating:

- results from routine environmental monitoring since June 2017
- additional information on the rights and interests of potentially affected Indigenous groups
- information provided in response to CNSC staff comments [38]
- information provided in response to feedback received from the public and other stakeholders through Bruce Power's outreach and engagement activities

Based on the information provided, CNSC staff concluded that the potential risks from physical stressors and radiological and non-radiological releases to the atmospheric, terrestrial, hydrogeological, aquatic and human environment are low to negligible. CNSC staff's review identified five actions for Bruce Power to undertake to enhance the ERA which included:

- future monitoring and assessment to address potential risks to aquatic and semi-aquatic receptors
- future monitoring of impingement and entrainment to reduce data uncertainties
- development of a winter thermal plume model and action plan to reduce uncertainties
- future monitoring and assessment to address knowledge and data gaps in bird, plant, invertebrate, etc.
- providing further information on beta and gamma emitters in soils and dose due to animal product ingestion

However, the supplemental information [8] and additional actions identified by CNSC staff do not change any conclusions of the 2017 ERA and the PEA.

CNSC staff will review the implementation of these actions through the review of the environmental monitoring program reports submitted annually to the CNSC, as well as future revisions of the ERA that is updated on a periodic cycle. See the EA report in Addendum G for the actions that have been identified.

4.9.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.9.3.1 Past Performance

CNSC staff determined that Bruce Power continued to implement an effective environmental protection program and associated environmental management system that met CNSC requirements. Performance levels for this SCA have been consistent from year to year, with "satisfactory" ratings given throughout the licensing period, which indicated that Bruce Power has implemented effective safety and control measures.

4.9.3.2 Regulatory Focus

CNSC staff will continue to monitor Bruce Power's performance in the Environmental Protection SCA through regulatory oversight activities including onsite inspections, desktop reviews of quarterly compliance reports, and desktop reviews of revisions to relevant program documentation pertaining to this SCA.

CNSC staff will also continue the IEMP sampling over the next licensing period.

4.9.3.3 Proposed Improvements

Over the proposed 10 year licensing period, Bruce Power has agreed to implement the following new CSA standards referenced in the LCH:

Document Title	Implementation Date
REGDOC-2.9.1 v1.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures	December 31, 2020
CSA N288.1-2014, Update 2, Guidelines for calculating derive release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	December 31, 2020
CSA N288.4-2010, Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills	December 31, 2018
CSA N288.5-2011, Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills	December 31, 2018
CSA N288.6-2012, Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills	December 31, 2018
CSA N288.7-2015, Groundwater Protection Programs	December 31, 2020

4.9.4 Conclusion

Based on CNSC staff assessments of Bruce Power’s safety and control measures regarding the elements of the Environmental Protection SCA and upon review of Bruce Power’s licence renewal application, supporting documentation and past performance, there are no concerns related to this SCA.

Bruce Power continued to implement and maintain an effective environmental protection program at Bruce A and B that met CNSC requirements. An environmental management system was in place to ensure that effluent and emissions were controlled.

Licence Condition 9.1 in the proposed licence pertains to implementing and maintaining an environmental protection program.

Compliance Verification Criteria for this Licence Condition are provided in the draft LCH.

4.10 Emergency Management and Fire Protection

The Emergency Management and Fire Protection SCA covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions including any results of exercise participation. This also includes response to conventional emergency as well as fire response.

This CMD covers the following specific areas of Emergency Management and Fire Protection:

- Conventional emergency preparedness and response
- Nuclear emergency preparedness and response
- Fire emergency preparedness and response

Figure 19: A new indoor fire training facility opened in 2015 at the Bruce site (*photo courtesy of Bruce Power*)

4.10.1 Trends

The following table indicates the overall rating for the Emergency Management and Fire Protection SCA over the current licensing period:

TRENDS FOR EMERGENCY MANAGEMENT AND FIRE PROTECTION			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	SA
Bruce B	SA	SA	SA
Comments			
The Emergency Management and Fire Protection SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a “satisfactory” rating during all years of the licence period.			

4.10.2 Discussion

CNSC staff determined that Bruce Power implemented and maintained effective emergency preparedness and fire protection programs at Bruce A and B that met regulatory requirements. Bruce Power has sufficient provisions for preparedness and response capability to mitigate the effects of accidental releases of nuclear and hazardous substances on the environment, and maintain the health and safety of persons and the national security.

Details of the CNSC staff assessment in this SCA are presented in the following sections.

Conventional Emergency Preparedness and Response

CNSC staff determined that Bruce Power maintained its conventional emergency preparedness and response commitments, including making enhancements to its emergency (non-nuclear) drill program.

Bruce Power continued to have an agreement in place with Bruce County to provide additional emergency services on site if needed, and to provide ambulance services to take any casualties to Kincardine general hospital that require transportation by ambulance.

All large scale emergency exercises that are held on site have components in them to test and evaluate Bruce Power’s response to conventional emergencies. A severe accident management exercise was conducted in December 2017 that included scenarios to test the ability of Bruce Power to respond to conventional emergencies. CNSC staff will issue an inspection report on the exercise in early 2018.

Nuclear Emergency Preparedness and Response

CNSC staff determined that Bruce Power has the capability to respond effectively to a nuclear emergency. The response capability was documented by Bruce Power in the consolidated emergency plan, the associated emergency preparedness program and demonstrated through the conduct of simulated emergencies.

Over the current licensing period, Bruce Power submitted a transition plan to meet the requirements of REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* by August 2018.

In 2015, Bruce Power met the requirement on the distribution of potassium iodide (KI) tablets. In partnership with the Municipality of Kincardine and the Grey Bruce health unit, Bruce Power enhanced the availability of KI tablets pre-distributed to households and businesses in the primary (10 km) and pre-stocked in the secondary (50km) zones. A back-up contingency supply of KI tablets is maintained at municipal emergency response centres.

In addition, KI tablets were distributed to both Bluewater and Grey Bruce Catholic School Board for re-distribution to the fifty two (52) schools within the secondary zone. Prior to distribution, Bruce Power worked with the school boards to ensure that emergency procedures and policies were updated appropriately. The schools also provided consent forms and information sheets to parents regarding the KI tablets.

The dissemination of emergency preparedness pamphlets to residents around the plant was completed, enhancing public awareness of nuclear emergency preparedness and response.

The following topics are further discussed in the section below:

- Province of Ontario’s Nuclear Emergency Response Plan
- emergency response facility and equipment
- Huron resolve exercise
- data transfer to CNSC EOC during emergencies

Province of Ontario’s Nuclear Emergency Response Plan

The Province of Ontario sets out the requirements for the Province of Ontario’s Nuclear Emergency Response Plan (PNERP). CNSC staff maintain the oversight of Bruce Power to ensure the implementation of the requirements. Following a formal public consultation, the updated PNERP was adopted by Executive Council of Ontario in 2017. The PNERP master plan sets out the overall principles, policies, basic concepts, organization structures and responsibilities, functions, and inter-relationships that govern nuclear emergency management in Ontario.

The 2017 PNERP master plan introduced a new emergency planning zone out to 20km. The plan also aligned with:

- CSA N1600, *General requirements for nuclear emergency management programs*, specifically, the latest nomenclature and terminology used, and requirements and focus on public education and awareness

- new Health Canada guidance for generic criteria and operational intervention levels, and the removal of previously used protective action levels

The 2017 PNERP master plan did not impose any additional requirements on Bruce Power as the requirements for KI tablets, public alerting and communications, or the designation of emergency response centres remained the same. Bruce Power will only need to update their procedures to reference the 2017 PNERP master plan.

Emergency Response Facility and Equipment

CNSC staff determined that Bruce Power has adequate emergency response facilities and equipment in place to monitor and respond to a nuclear emergency.

Bruce Power's emergency management centre (EMC) continued to function as a key component of the emergency response plan. As per the LCH, Bruce Power is exempt from Clause 2.2.6(4) of REGDOC-2.10.1 which requires an emergency response facility to be located on-site. The EMC, located off the Bruce site in the visitor information center, provides for a designated location for coordinating response efforts and providing the needed support to the station(s) that are experiencing an emergency. Other emergencies at the Bruce Power site can also be effectively managed at this facility.

The EMC is staffed by response personnel of the ERO. The EMC provides Bruce Power the ability to capture and disseminate information accordingly which allows Bruce Power to meet its offsite commitments and requirements in case of a radiological release. CNSC staff are satisfied with Bruce Power's alternate location (visitor's centre) as they have implemented supporting procedures on security and made the necessary communications arrangements between the stations and EMC.

Bruce Power continued to use WebEOC as a tool within their incident management to allow the ERO to effectively and expediently maintain logs, actions, and to disseminate information with Bruce Power staff, the CNSC and other external stakeholders.

Bruce Power has a comprehensive and robust onsite and offsite automated gamma monitoring system in place to monitor radiological releases. The system has monitors within site boundaries as well as various locations within the primary zone (up to 10 km). The off-site radiological monitoring consists of fixed gamma monitors, deployable gamma monitors and air samplers. Real time information is available to Bruce Power staff and response organizations such as Health Canada, Office of the Fire Marshal and Emergency Management and the CNSC. Thermoluminescent dosimeters are located inside the site fence and within a 10 km radius of the site.

In accordance with the PNERP, public alerting sirens are installed and tested to ensure the ability to provide audible alerts in case of a nuclear emergency. Eight sirens are located off site and two are located on site.

Huron Resolve Exercise

In October 2016, Bruce Power, with assistance from the Office of the Fire Marshal and Emergency Management, tested its emergency response organization (ERO) by simulating a multi-unit scenario during the “Huron Resolve exercise”, which ran across the region. There was interaction between approximately 500 people and 30 municipal, provincial and federal organizations, which tested Bruce Power’s emergency capability over a five day period.

Through the Huron Resolve exercise, Bruce Power demonstrated its response capabilities to nuclear emergencies as well as conventional types of emergencies that could present themselves on site. A multi-unit Fukushima type scenario (including site blackout) was also incorporated into the response. Lessons learned from this exercise are being implemented into Bruce Power’s emergency response plans.

Bruce Power has shown adequate response to a nuclear emergency scenario through completion of Huron Resolve exercise. In October 2016, CNSC identified in a type II inspection [49] some issues of low risk significance related to procedural non-compliance in the Bruce Power emergency operations centre (EOC) and validity of data reported in non-automatic data sharing system. Bruce Power submitted a corrective action plan to address these findings. CNSC staff will confirm the adequacy of the corrective actions and their implementation in future exercises.

Data Transfer to CNSC EOC During Emergencies

Under the mandate of the NSCA, CNSC has the responsibility under the Federal Nuclear Emergency Plan to provide an independent assessment of the onsite conditions and potential release information to the federal response organizations. Information from the CNSC EOC are critical inputs for the federal government’s assessment of the emergency.

In the event of a nuclear emergency, prompt and accurate plant information is required by the CNSC EOC to independently understand the onsite situation and to predict the possibility of a radiological release into the environment with its associated source terms characteristics. The source term information would be used by the offsite organizations for protective actions preparedness activities.

Bruce Power currently has a Disaster LAN (DLAN) incident management electronic data transfer system in place to transfer the data to the CNSC EOC. However, the DLAN system relied on human intervention to acquire and enter the data (i.e., non-automatic). CNSC staff highlighted in the lessons learned from Huron Resolve exercise the importance for automatic data transfer to the CNSC EOC in event of a nuclear emergency. In addition, automatic plant data transfer aligned with international best practices and is part of the lessons learned from the Fukushima nuclear accident.

In August 2017, under subsection 12(2) of the *General Nuclear Safety and Control Regulations*, Bruce Power was requested to submit in writing a plan to implement automatic data transfer to the CNSC EOC. Bruce Power responded in

September 2017 [50] that it will begin a feasibility assessment to investigate options for automatic connectivity between plant data systems and DLAN in 2018.

CNSC staff determined that automated data sharing is vital during a nuclear emergency and will review Bruce Power's plan to implement automatic data transfer over the next licensing period.

Fire Emergency Preparedness and Response

CNSC staff determined that Bruce Power implemented an acceptable fire protection program and continued to implement a comprehensive fire response capability that included effective procedures, training and maintenance of proficiency. The fire protection program met the requirements of CSA N293-2012, *Fire Protection for Nuclear Power Plants* as well as key standards referenced therein such as the *National Building Code of Canada*, *National Fire Code of Canada* and associated National Fire Protection Association standards.

The Bruce Power fire protection program identified how protection from fire was achieved through planned, coordinated and controlled activities to reduce the risk to the health and safety of persons and to the environment from a fire.

The Bruce Power emergency services team served as the Industrial Fire Brigade (IFB). In April 2015, Bruce Power opened an indoor fire training facility. The facility allowed the IFB to continually conduct live fire drills on site (i.e., on a more frequent basis compared to the past) and to ensure that firefighting competencies are maintained as required by the applicable standards.

Figure 20: IFB training inside the fire training facility (*photo courtesy of Bruce Power*)

Drills were performed on a regular basis and include mutual aid exercises with Bruce County responders to ensure interoperability (i.e., in situations where emergencies requiring off-site assistance would be required on site).

The firefighting equipment at Bruce Power was well maintained. Bruce Power acquired five pumper trucks based on lessons learned from Fukushima event. In emergency situations where primary cooling water may be lost, additional connection points have been installed to provide alternate cooling (see Section 5.1 on modifications made to address lessons learned from Fukushima event).

4.10.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.10.3.1 Past Performance

Over the current licence period, CNSC staff determined that Bruce Power's emergency preparedness and fire protection programs met regulatory requirements. Bruce Power has also demonstrated that its current emergency preparedness and response capabilities, as well as applying lessons learned from the Fukushima event, through the 2016 Huron Resolve exercise.

Bruce Power continued to make many improvements to its emergency response capabilities. The new automated gamma monitoring system greatly enhanced the speed in which data can be collected and shared in case of a release of radioactivity.

4.10.3.2 Regulatory Focus

CNSC staff will continue to verify the performance of Bruce Power in all aspects of the Emergency Management and Fire Protection SCA through routine compliance and monitoring program over the next licensing period.

Over the current licensing period, Bruce Power has agreed to implement REGDOC-2.10.1 by August 2018. In addition, Bruce Power continued to implement the Fukushima event related upgrades (as discussed in Section 5.1 of this CMD). CNSC will monitor the progress of these upgrades over the next licensing period.

4.10.3.3 Proposed Improvements

In August 2017, under Section 12(2) of the *General Nuclear Safety and Control Regulations*, CNSC staff requested Bruce Power to submit in writing a plan to implement automatic data transfer to the CNSC EOC. CNSC staff stated that an automatic data transfer system will greatly enhance the efficiency and validity of the data to be shared with the CNSC in the event of an emergency. CNSC staff intend to revise REGDOC-2.10.1 over the next licensing period to make automatic data transfer a mandatory requirement.

4.10.4 Conclusion

Over the current licensing period, Bruce Power's emergency management and fire protection SCA was rated as "satisfactory". Bruce Power continued to implement and maintain an emergency management and fire protection program at Bruce A and B that met CNSC requirements.

Bruce Power has sufficient provisions for emergency preparedness and response capability that would mitigate the effects of releases of nuclear substances and hazardous substances on the environment, and maintain the health and safety of persons and national security.

In addition, CNSC staff concluded that Bruce Power's fire protection program, which includes fire response, complied with CNSC requirements for fire protection (CSA N293 for an industrial fire brigade) and that the fire response capability and performance of the industrial fire brigade met regulatory requirements and expectations.

Licence Condition 10.1 in the proposed licence pertains to implementing and maintaining an emergency management program.

Licence Condition 10.2 in the proposed licence pertains to implementing and maintaining a fire protection program.

Compliance Verification Criteria for the above Licence Conditions are provided in the draft LCH.

4.11 Waste Management

The Waste Management SCA covers internal waste-related programs which form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. It also covers the planning for decommissioning.

This CMD covers the following specific areas of waste management:

- Waste minimization/characterization/management practices
- Decommissioning plans

4.11.1 Trends

The following table indicates the overall rating for the Waste Management SCA over the current licensing period:

TRENDS FOR WASTE MANAGEMENT			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	FS	FS	FS
Bruce B	FS	FS	FS
Comments			
The Waste Management SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a "fully satisfactory" rating during all years of the licence period.			

4.11.2 Discussion

CNSC staff determined that Bruce Power implemented and maintained an effective program for radioactive waste management at Bruce A and B that met the guidance laid out in CSA N292.3-14, *General principles for the management of radioactive waste*. The decommissioning plan for Bruce Power was updated in 2017.

Bruce Power's waste management program covered internal waste processes which form part of the facility's operations up to the point where wastes are transferred to another licensed facility.

Details of the CNSC staff assessment in this SCA are presented in the following sections.

Waste minimization/characterization/management practices

CNSC staff determined that Bruce Power's waste management programs exceeded expectations in all specific areas for managing radioactive waste. Bruce Power has minimized the production of radioactive wastes through various plans, programs and procedures as well as minimizing impacts from such wastes on workers and the environment.

The waste management program is captured under Bruce Power's BP-PROC-00878, *Radioactive Waste Management Program*, which is a procedure level document and fell under the overall environmental program in BP-PROG-00.02, *Environmental Safety Management*.

Decommissioning plans

OPG maintains the preliminary decommissioning plans (PDP) for all of its Ontario facilities, including Bruce A and B. The plans are revised on a five-year cycle. CNSC staff determined that the PDP submitted by OPG regarding Bruce A and B met the requirements of CSA N294-09, *Decommissioning of facilities containing nuclear substances* and the guidance of CNSC Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities*.

The CNSC expects that future decommissioning of a nuclear facility will be considered in all phases of its life cycle. In practice, this consideration takes the form of a PDP, which is a requirement of the *Class I Nuclear Facilities Regulations*. Licensees are required to maintain an acceptable PDP that sets out the manner by which the nuclear facility will be decommissioned in the future.

The PDP must be kept current to reflect any changes in the site or facility. The licensee's submitted PDP is reviewed and assessed by CNSC staff in accordance with these documents. The PDP and the associated cost estimate form the basis of the financial guarantee.

OPG selected a deferred dismantling strategy for decommissioning of the Bruce A and B. The stations will be put into a state of "safe storage", which includes removal of fuel and drainage of the moderator and heat transport systems. This provides for a storage period of 30 years in order to allow for radioactive and thermal decay of the used fuel and activated components prior to the onset of active decommissioning. The proposed end-state of the Bruce site after completion of decommissioning is that it will be free of industrial and radiological hazards and meet the criteria for release from regulatory control.

Figure 21 and Figure 22 show the life cycle timeline for the Bruce A and B, utilizing dates from OPG's PDP that was submitted to CNSC staff in early 2017. The figures include an estimated timeframe for safe storage and dismantling of Bruce A and B, taking MCR into consideration.

Station	Start of preparation (yr)	Duration of preparation	Safe Storage	Dismantling
Bruce A	2044	18 years (2044-2062)	23 years (2062-2085)	10 years (2095)
Bruce B	2059	4 years (2059-2063)	26 years (2063-2089)	10 years (2099)

Figure 21: Life Cycle Timeline for the Bruce A, including an estimated timeframe for safe storage and dismantling

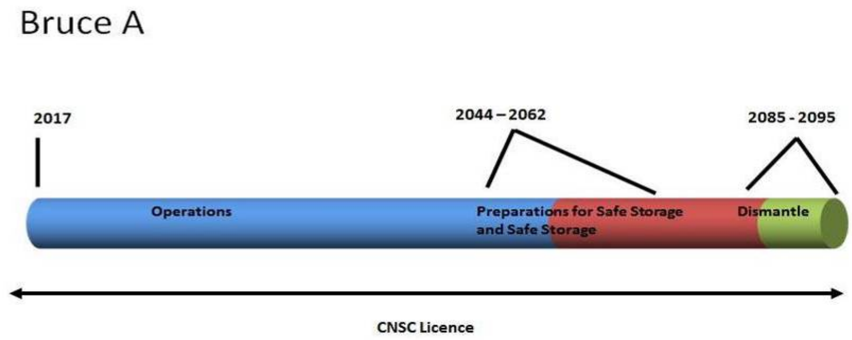
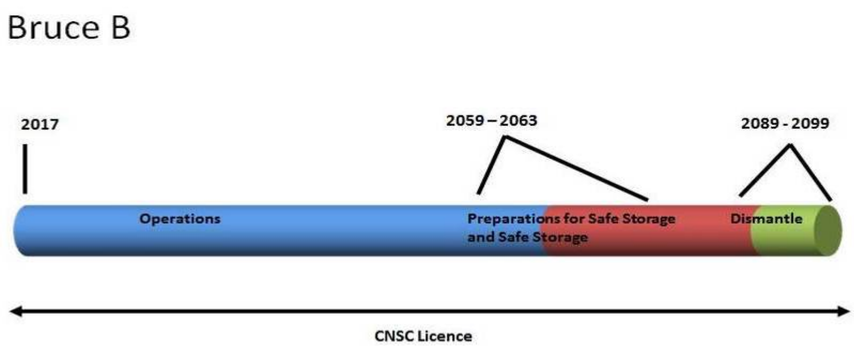


Figure 22: Life Cycle Timeline for the Bruce B, including an estimated timeframe for safe storage and dismantling



4.11.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.11.3.1 Past Performance

Bruce Power implemented and maintained an effective program for radioactive waste management at Bruce A and B. The Waste Management SCA has been rated as "fully satisfactory".

4.11.3.2 Regulatory Focus

CNSC staff will continue to monitor and verify compliance with applicable regulatory documents, and codes and standards in the Waste Management SCA.

4.11.4 Conclusion

CNSC staff concluded that Bruce Power implemented and maintained a waste management program at Bruce A and B that met CNSC requirements and is rated as "fully satisfactory". The PDP submitted by OPG regarding Bruce A and B is acceptable to CNSC staff.

Licence Condition 11.1 in the proposed licence pertains to implementing and maintaining a waste management program.

Licence Condition 11.2 in the proposed licence pertains to the notification requirements regarding the obligations of decommissioning and financial guarantees.

Compliance Verification Criteria for the above Licence Conditions are provided in the draft LCH.

4.12 Security

The Security SCA covers the programs requirement to implement and support the security requirements stipulated in the regulations, in their licence, in orders, or in expectations for their facility or activity.

This CMD covers the following specific areas of security:

- Facilities and equipment
- Security practices
- Response arrangements
- Drills and exercises
- Cyber security

4.12.1 Trends

The following table indicates the overall rating for the Security SCA over the current licensing period:

SECURITY			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	FS	FS	SA
Bruce B	FS	FS	SA
Comments			
The Security SCA at Bruce A and B met applicable CNSC requirements and performance objectives. In 2016, Bruce Power's rating was changed from "fully satisfactory" to a "satisfactory" rating.			

4.12.2 Discussion

CNSC staff determined that Bruce Power's security program met the requirements of the *Nuclear Security Regulations* and associated regulatory documents. All corrective action plans in response to inspection findings are implemented to the satisfaction of CNSC staff.

In addition to new technologies, security equipment and enhanced barriers, Bruce Power continued to improve its security program. Bruce Power is planning enhancements to the Bruce A physical protection system as well as the operations and emergency protective services radio system. Once completed, both of these projects will enhance security operations by providing improved detection and response capabilities when responding to any possible security incident at Bruce Power. The radio system will also improve the existing interoperability between Bruce Power and the Ontario Provincial Police Tactical Rescue Unit. Bruce Power will provide regular updates via REGDOC-3.1.1 quarterly reports and regular submissions on the project. Over the current licensing period, Bruce Power continued to identify and update security equipment to enhance the security operations.

In 2016, CNSC staff conducted a “Force on Force” performance testing exercise and in 2017, CNSC staff conducted two inspections of the security program at Bruce Power. Several findings were raised as a result of the inspections. Bruce Power provided CNSC staff with acceptable implementation plans. CNSC staff will review the corrective actions over the next licensing period.

Over the current licensing period, Bruce Power undertook several initiatives to improve nuclear security. Bruce Power obtained a new bulk vehicle screening equipment which will enable x-ray screening to improve security searches of commercial vehicles. Bruce Power also sponsored, through its center of excellence program, a World Institute of Nuclear Security (WINS) workshop on incident planning and emergency response. Through its security awareness campaign, Bruce Power hosted an employee event which highlighted insider threat.

In 2017, the overall security rating was changed from “fully satisfactory” to “satisfactory” based on challenges Bruce Power faced within the areas of security practices, and drills and exercises.

Details of the CNSC staff assessment in this SCA are presented in the following sections.

<u>Facilities and equipment</u>

CNSC staff concluded that there were no safety significant issues in the area of facilities and equipment. Bruce Power continued to sustain its security equipment through lifecycle management. There were no significant equipment failures reported. As previously stated, Bruce Power invested in 2017 a bulk vehicle screening equipment which will be used to enhance screening measures at Bruce A and B. Bruce Power has accommodations in place to adequately prevent security events.

<u>Security practices</u>

CNSC staff determined that Bruce Power’s security practices met requirements. However, CNSC staff identified challenges within this area in 2016. CNSC staff will monitor the corrective actions taken by Bruce Power over the next licensing period.

Bruce Power has procedures in place at Bruce A and B to provide guidance to security personnel in all areas. Bruce Power has a multifaceted security awareness program that is fully integrated into the Bruce Power governance process. Through its security awareness campaign, Bruce Power hosted an employee event which highlighted insider threat. Bruce Power invited the director of national and strategic foresight from the Conference Board of Canada who provided a presentation on personal security protection.

<u>Response arrangements</u>

CNSC staff determined that Bruce Power’s response arrangements met regulatory requirements. Findings raised during the 2016 security exercise were addressed to the satisfaction of CNSC staff and subsequently closed. The 2017 inspection findings are being addressed to the satisfaction of CNSC staff.

Bruce Power contributed significant resources to the CNSC performance testing program by providing expert staff and participants to the Canadian Adversary Testing Team.

Drills and exercises

CNSC staff determined that Bruce Power's security drills and exercises met requirements. In 2016, CNSC staff identified some deficiencies of low risk significance with elements of the Bruce Power drills and exercises program as a result of findings made during compliance verification activities that were conducted during the "Force on Force" exercise. Bruce Power has provided adequate responses to address the deficiencies identified by CNSC staff and implemented changes to its program.

In 2017, CNSC staff performed a follow-up inspection of the drill/exercise program and was satisfied with the corrective actions being taken to address the deficiencies.

Cyber security

Over the current licensing period, Bruce Power continued to implement a cyber security program at Bruce A and B, and that there were no safety significant issues for this specific area. There were no significant findings reported from the Type II inspection conducted in 2015.

With the issuance of CSA N290.7-14, *Cyber Security for Nuclear Power Plants and Small Reactor Facilities* in October 2015, CNSC staff requested Bruce Power to do a gap analysis between the current Bruce Power cyber security program at Bruce A and B and the requirements of the CSA N290.7-14, and submit an implementation plan to address any identified gaps.

In 2016, Bruce Power submitted an implementation plan to address the identified gaps between the current Bruce Power cyber security program and the requirements of CSA N290.7-14. The implementation plan will improve cyber security measures, including obtaining more cyber essential assets. Since 2016, Bruce Power has been updating its cyber security program to comply with CSA N290.7-14 with full implementation by the December 2020.

4.12.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.12.3.1 Past Performance

CNSC compliance verification program activities have identified some minor areas for improvement but these did not compromise the facility security measures. All of these opportunities for improvement have been addressed to the satisfaction of CNSC staff.

4.12.3.2 Regulatory Focus

CNSC staff will continue to verify the performance of Bruce Power in all aspects of the Security SCA through regulatory oversight activities, including onsite inspections and desktop reviews of compliance reporting and revisions to relevant program documentation pertaining to this SCA.

4.12.3.3 Proposed Improvements

Over the current licensing period, Bruce Power agreed to implement CSA N290.7-14 by December 2020. CNSC staff will continue to monitor the Bruce Power progress in this area through the conduct of regular compliance verification activities.

4.12.4 Conclusion

Based on CNSC staff's assessments of Bruce Power's licence application, supporting documents and past performance, CNSC staff concluded that Bruce Power met regulatory requirements and made adequate provisions for the maintenance of national security. Bruce Power continued to implement and maintain an effective nuclear security program at the Bruce A and B.

Licence Condition 12.1 in the proposed PROL pertains to implementing and maintaining a security program. Compliance Verification Criteria for this Licence Condition are provided in the draft LCH.

4.13 Safeguards and Non-Proliferation

The Safeguards and Non-Proliferation SCA covers the programs and activities required for the successful implementation of the obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements as well as other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons (NPT)*. This SCA comprises a safeguards program and a non-proliferation program.

The scope of the non-proliferation program for Bruce Power is limited to the tracking and reporting of foreign obligations and origins of nuclear material. This tracking and reporting assists the CNSC in the implementation of Canada's bilateral Nuclear Cooperation Agreements with other countries. The import and export of controlled nuclear substances, equipment and information identified in the *Nuclear Non-proliferation Import and Export Control Regulations* require separate authorization from the CNSC, consistent with section 3(2) of the *General Nuclear Safety and Control Regulations*.

4.13.1 Trends

The following table indicates the overall rating for the Safeguards and Non-Proliferation SCA over the current licensing period:

TRENDS FOR SAFEGUARDS AND NON-PROLIFERATION			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	SA
Bruce B	SA	SA	SA
Comments			
The safeguards and non-proliferation SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a "satisfactory" rating during all years of the licence period.			

4.13.2 Discussion

CNSC staff determined that Bruce Power implemented and maintained a safeguards and non-proliferation program at Bruce A and B that ensured the effective implementation of both safeguards measures and nuclear non-proliferation commitments.

Bruce Power's safeguards program conformed to measures required by the CNSC to meet Canada's international safeguards obligations as well as other measures arising from the *NPT*. Pursuant to the *NPT*, Canada has entered into a *Comprehensive Safeguards Agreement and Additional Protocol* with the IAEA (hereafter, the safeguards agreements). The objective of the safeguards agreements is for the IAEA to provide annual assurance to Canada and to the international community that all declared nuclear material is in peaceful, non-explosive uses, and that there is no indication of undeclared material and activities.

The CNSC provides the mechanism, through the NSCA, regulations and a licence condition, for the CNSC to implement the safeguards agreements. Conditions for the application of IAEA safeguards are contained in the PROL and criteria in order to meet the conditions are contained in the LCH and in regulatory document RD-336, *Accounting and Reporting of Nuclear Material*. Compliance criteria included the timely provision of reports on the movement and location of all nuclear materials, the provision of access and assistance to IAEA staff for safeguards activities, and the submission of annual operational information, additional protocol updates as well as accurate design information on plant operations and procedures.

Over the current licence period, the IAEA performed inspections and verifications, including three short-notice random inspections and fourteen unannounced inspections. CNSC staff also performed an evaluation of Bruce Power's preparedness for the physical inventory verification in 2015 and 2016, since it was not selected by the IAEA for this type of inspection during those two years. In all instances, the IAEA was with the necessary access and assistance to perform the inspection activities and the inspection results indicated that all regulatory requirements have been met. CNSC staff determined that Bruce Power have adequately prepared for IAEA physical inventory verification each year.

Bruce Power continued to support IAEA equipment operation and maintenance activities at Bruce A and B, including maintenance work on the VXI integrated fuel monitor and a digital multi-camera optical surveillance upgrade, to ensure the effective implementation of safeguards measures.

Safeguards and non-proliferation reportable events

Since 2015, there was one safeguards and non-proliferation related reportable event at the Bruce A and B. However, the event was of low safety significance and the impact on safeguards measures was mitigated through corrective actions acceptable to CNSC staff.

In November 2016, Bruce Power reported an event at Bruce A that a discrepancy was found between the bundle location and the inventory data of two bundles. This issue was resolved shortly thereafter with the identification of these two bundles in the fuel bay. This discrepancy was due to a missing update of a record from the legacy accounting system used to track fuel bundles in the 1980s into the current fuel accounting system.

In the second event at Bruce B reported in September 2017, the fuel handling operators discovered a broken IAEA seal that had been attached to a junction box through which the cables to the bundle counter detectors were installed. Bruce Power immediately notified this event to the IAEA, and the seal was replaced by the IAEA the following day. However, the CNSC was notified at the same time as the IAEA (i.e., a few days after the event has occurred). As a follow-up on this issue, Bruce Power provided additional training to staff on reporting procedure, and planned to revise the operational manual to correctly identify the person responsible for reporting incidents to the CNSC.

4.13.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.13.3.1 Past Performance

CNSC staff determined that Bruce Power's programs for safeguards and non-proliferation at Bruce A and B met regulatory requirements. Bruce Power provided the CNSC and IAEA with all reports and information necessary to comply with safeguards requirements for Bruce A and B, including those related to nuclear material accounting and reporting.

4.13.3.2 Regulatory Focus

CNSC staff will continue to monitor Bruce Power's performance through participation in IAEA inspections, evaluations independent of the IAEA, and ongoing assessments of compliance with the various reporting requirements.

4.13.4 Conclusion

CNSC staff assessed Bruce Power's documentation and analyses under the Safeguards and Non-Proliferation SCA, and have found them to be acceptable and compliant with regulatory requirements. CNSC staff concluded that the overall performance for the SCA is "satisfactory" and that Bruce Power is qualified to carry out the authorized activities in this SCA.

Licence Condition 13.1 in the proposed licence pertains to implementing and maintaining a safeguards and non-proliferation program. Compliance verification criteria for this licence condition are provided in the draft LCH.

4.14 Packaging and Transport

The Packaging and Transport SCA covers programs for the safe packaging and transport of nuclear substances to and from the licensed facility.

This CMD covers the following specific areas of packaging and transport:

- Packaging and transport
- Package design and maintenance
- Registration for use

4.14.1 Trends

The following table indicates the overall rating for the Packaging and Transport SCA over the current licensing period:

TRENDS FOR PACKAGING AND TRANSPORT			
Overall Ratings			
Station	**2014**	**2015**	**2016**
Bruce A	SA	SA	SA
Bruce B	SA	SA	SA
Comments			
The Packaging and Transport SCA at Bruce A and B met applicable CNSC requirements and performance objectives, and each station received a "satisfactory" rating during all years of the licence period.			

4.14.2 Discussion

CNSC staff determined that Bruce Power has implemented a packaging and transport program to ensure all shipments leaving the site met the requirements of *Packaging and Transport of Nuclear Substances Regulation, 2015* (PTNSR 2015) and the *Transportation of Dangerous Goods (TDG) Regulations*. Bruce Power's packaging and transport program also covers elements of package design, maintenance and the registration for use of certified packages as required by the regulations.

The PTNSR 2015 apply to the packaging and transport of nuclear substances, including the design, production, use, inspection, maintenance and repair of packages, and the preparation, consigning, handling, loading, carriage and unloading of packages.

Bruce Power has the appropriate training for personnel involved in the handling, offering for transport and transport of dangerous goods at the Bruce Power site, and has issued training certificates to those workers in accordance with the *TDG Regulations*.

In 2016, Bruce Power reported a non-compliance to the requirements of PTNSR 2015. Bruce Power did not recognize a minor change that was made to the IAEA's Regulations for the Safe Transport of Radioactive Material which came into force with the adoption of the PTNSR 2015. The change requires consignors of certain types of shipments to notify the CNSC prior to the transport. However, the shipment met all other regulatory requirements. Bruce Power has since corrected this issue and is providing the notifications in a timely manner.

In 2017, there were two separate incidents (both incidents were documented in one report) involving damages to radioactive packages during shipment. Material within the packages shifted during transport. Emergency response personnel from Bruce Power responded to the incidents. Before they were returned to the Bruce site, the emergency response personnel confirmed there was no release of material from the packages and the material was properly secured within the packages.

CNSC staff determined that there was no significant impact on the health or safety of persons or the environment as a result of the reported events. Bruce Power made changes to its procedures to ensure that such incidents do not re-occur. CNSC staff are satisfied with these changes.

4.14.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

4.14.3.1 Past Performance

Bruce Power continued to demonstrate compliance with the *PTNSR 2015* and the *TDG Regulations*, and as such, obtained a "satisfactory" rating over the current licensing period.

4.14.3.2 Regulatory Focus

CNSC staff will continue to ensure shipments transported to and from the Bruce Power site meet all regulatory requirements though the CNSC compliance program.

4.14.3.3 Proposed Improvements

Transport Canada has recently published a number of amendments to the *TDG Regulations*. Although regulatory changes are minor, these revisions may have an impact and Bruce Power will need to review its packaging and transport program to ensure continued compliance with the revised regulations.

4.14.4 Conclusion

Based on CNSC staff's assessments of Bruce Power's licence application, supporting documents and past performance, Bruce Power implementation of the packaging and transport SCA has met and continues to meet all applicable regulatory requirements.

Licence Condition 14.1 in the proposed licence pertains to implementing and maintaining a packaging and transport program. Compliance Verification Criteria for this Licence Condition are provided in the draft LCH.

5. OTHER MATTERS OF REGULATORY INTEREST

Other Matters of Regulatory Interest cover the following topics:

- Fukushima action items
- Central Maintenance and Laundry Facility
- Operational safety review team (OSART)
- Bruce A Environmental Assessment follow-up monitoring program
- *Fisheries Act* authorization
- Licensee public information program
- Aboriginal consultation and engagement activities
- Cost recovery
- Financial guarantees
- Nuclear liability insurance
- Consolidation of other types of Bruce licences into the PROL
- Previous commitments raised by the Commission

5.1 Fukushima Action Items

Bruce Power submitted an improvement plan to address Fukushima action items (FAIs) dealing with lessons learned from the Fukushima event. This included making safety improvements to the SSCs and enhancements to procedures, which is expected to be completed by end of 2019.

70 generic FAIs and 13 stations specific action items were raised. The submitted improvement plan allowed for the closure of the all 70 generic FAIs and 9 station specific action items. Only 4 of the 13 station specific AIs remain open. In June 2017, Bruce Power submitted progress report No. 10 on the FAI [51].

CNSC staff determined that Bruce Power has made significant progress in addressing FAIs and will continue to monitor Bruce Power's progress in closing out the remaining FAIs. The following sections provide a summary of the remaining four (4) station specific actions and their progress.

Shield Tank Overpressure Protection

Bruce Power has completed the detailed design of the Shield Tank Overpressure Protection (STOP), which will be installed in all Bruce A and B Units by end of 2019 as the STOP can only be installed during the unit's planned outage. In the event of a beyond design basis accident, the shield tank may act as the primary source of heat removal. The function of the STOP is to prevent the failure of the shield tank due to overpressure by passively discharging excess steam from the top of the shield tank back to containment.

Containment Filtered Venting System

In 2017, Bruce Power selected a dry in-line muffler type Containment Filtered Venting System (CFVS) due to its capability to handle higher aerosol loads. Bruce Power will provide a plan and schedule for the design and installation of the selected CFVS in early 2018. In the event of a severe accident where the containment heat sink is lost (as a result of a loss in electrical power) and containment overpressure occurs, the CFVS will maintain the containment pressure below the failure pressure and filter radioactive releases during a severe accident.

Coolant Makeup

For short-term makeup water, Bruce Power has installed connection points to the steam generators. For longer-term makeup water, a connection point to the shield tank has been installed. The remaining connection points to the heat transport and moderator system for longer-term makeup water will be completed by mid-2019 as the work can only be completed during the unit's planned outage. The connection points will provide short and longer-term makeup water cooling to the reactor in the event of a severe accident.

External Event Hazard Assessment

Bruce Power performed an external hazard assessment that is specific to the Bruce site. CNSC staff determined that Bruce Power site-specific hazard assessment was performed in accordance with CNSC S-294.

There were several recommendations identified in the analysis which dealt with the impacts of high winds, seismically induced internal fires and internal floods. Bruce Power submitted a plan which includes an evaluation of the recommendations and preparing detailed designs based on the recommendations. CNSC staff reviewed and accepted the plan and will follow-up on this issue over the next licensing period.

5.2 Operational Safety Review Team Mission

In 2015, an international review team conducted an operational safety review team (OSART) mission to evaluate Bruce B operational safety performance against IAEA safety standards. The IAEA OSART program began in 1982, providing member states with opportunity to share best practices and to support continuous improvements to their operations. The international multi-disciplinary review team performed evaluations in the following areas:

- leadership and management for safety
- training and qualifications
- operations
- maintenance
- technical support
- OPEX feedback
- radiation protection
- chemistry
- emergency preparedness and response
- accident management
- human-technology and organization interactions
- long term operations

The 2015 OSART team concluded that management at Bruce B is committed to improving the operational safety and reliability of the plant. The team found 25 areas of good performance or practice, while 19 items were identified as recommendations, suggestions and self-identified opportunities for improvement.

In 2017, a follow-up mission was held to review the progress Bruce Power has made since 2015. Bruce Power has completed, or is in the process of implementing 18 of the 19 improvements. The remaining improvement is related to drug and alcohol testing of key staff in safety important roles, which was not a regulatory requirement at the time.

To this effect, in November 2017, the Commission published of REGDOC-2.2.4 (Volume II), *Fitness for Duty: Managing Alcohol and Drug Use*. CNSC staff requested Bruce Power to submit an implementation plan by March 2018. Overall, the OSART follow-up team concluded that satisfactory progress was made on all other items.

CNSC staff reviewed the OSART report and confirmed that in the areas where the OSART team identified opportunities for improvements, Bruce Power remained compliant to Canadian regulatory requirements. CNSC staff also reviewed the progress made by Bruce Power on these actions and concluded that all suggested improvements have been addressed to improve processes and practices at Bruce A and B.

5.3 Bruce A Environmental Assessment Follow-up Monitoring Program

CNSC staff concluded that actions related to the EA Follow-up Monitoring (FUMP) are closed. Two elements from the FUMP (winter thermal effects on sensitive stages of whitefish development and the potential impact to deepwater sculpin due to entrainment) will continue to be assessed as part of the ongoing ERA to reduce uncertainties through additional monitoring and/or data interpretation.

As part of the Bruce A refurbishment project, an Environmental Assessment (EA) under CEAA 1992 concluded that the project, taking into account identified mitigation measures, was not likely to cause significant adverse environmental effects. Following this, Bruce Power implemented a follow-up monitoring program (FUMP) in order to confirm the predictions made in the EA.

Bruce Power submitted the latest EA FUMP report in 2016. The FUMP confirmed that there were no significant adverse effects as a result of the refurbishment of Bruce A [52]. This submission was reviewed and accepted by CNSC and ECCC staff.

Going forward, regulatory oversight of environmental protection will continue under the NSCA (i.e., the monitoring requirements will not change from CEAA 1992) and the associated environmental protection programs. CNSC staff will perform desktop reviews on updates to the ERA (which is updated on a periodic cycle) and annual reports on the environmental monitoring program for Bruce A and B.

5.4 Fisheries Act Authorization

Bruce Power conducted an EA, environmental monitoring and an ERA to examine the impact of the cooling water intake, and resulting fish impingement and entrainment, on fish populations of Lake Huron. CNSC staff agreed with Bruce Power's conclusion that impingement and entrainment of fish did not result in population-level effects on fish populations in Lake Huron. Based on the results of Bruce Power's assessments, CNSC staff concluded that fish populations were adequately protected. Bruce Power will continue to collect additional data and perform assessments to continue to refine the impingement and entrainment numbers.

The *Fisheries Act* uses a different threshold than the environment protection requirements of the NSCA and CEAA 2012 at the population-level and is driven by the definition of "serious harm" to fish, which includes the death of fish and the possibility of an effect on fish populations in the immediate vicinity of the cooling water intakes. Accordingly, Department of Fisheries and Ocean (DFO) determined in 2015 that there is a need for an authorization under the *Fisheries Act*.

The process for obtaining a *Fisheries Act* authorization is separate from that of CNSC licence renewal, as they are covered by different legislation. While the various legislations applying to the protection of the environment are intended to be complementary, each piece of legislation must be complied with independently of the others. Compliance with one law does not impact the authority or application of another. Issuing a licence under the NSCA will not limit the ability for DFO to fulfill its mandate under the *Fisheries Act*.

Based on Bruce Power's 2013 and 2014 fish impingement and entrainment monitoring results, the CNSC and DFO determined that the number and types of fish impinged and entrained at Bruce A and B met the definition in the *Fisheries Act*. Therefore, Bruce Power was required to obtain an authorization under section 35 of the *Fisheries Act* for the intake of cooling water and the resulting death of fish due to impingement and entrainment.

In December 2013, DFO and the CNSC signed a Memorandum of Understanding (MOU) outlining areas for cooperation and administration of the *Fisheries Act*. Under the MOU, DFO will rely on the CNSC to take on responsibilities for the assessment and monitoring of environmental impacts on fish, including species listed in the *Species at Risk Act* (SARA) and to make recommendations to DFO related to authorizations under the *Fisheries Act*. The DFO remains accountable for decisions under the habitat provisions of the *Fisheries Act* and for protecting aquatic species listed under the SARA.

In September 2016, Bruce Power submitted a draft *Fisheries Act* authorization application to the CNSC. CNSC staff completed a concordance review of the application and determined that there were details missing in the draft application, which were issued to Bruce Power as information requests.

Based on the feedback from CNSC, Bruce Power submitted a revised draft application in May 2017. CNSC staff requested further information from Bruce Power, such as an uncertainty analysis and details surrounding the methods and monitoring to determine the fish biomass for the proposed offsetting projects. This information will also be included in the final application. Bruce Power expects that *Fisheries Act* authorization application will be ready to be submitted to DFO in the latter part of 2018, pending outcomes of the continuing discussions with the CNSC and DFO. It is CNSC staff's view that satisfactory progress is being made by Bruce Power on the *Fisheries Act* authorization application.

During the application process, Bruce Power is proceeding at its own discretion with collecting baseline data for two fish habitat improvement projects, which is included in the offsetting plan section of its *Fisheries Act* authorization application. DFO has informed Bruce Power that the habitat improvement projects may not provide adequate fish production to offset the loss of fish from the cooling water intakes.

In addition to the engagement efforts made by Bruce Power, CNSC staff met with First Nations and Métis groups to exchange information and gather feedback on the *Fisheries Act* application process or the technical details supporting the application.

For example, the Métis Nation of Ontario provided detailed technical comments on the September 2016 *Fisheries Act* authorization application that were considered in the revised May 2017 application. Saugeen Ojibway Nation have expressed concerns regarding the precision of the impingement and entrainment data used in the assessments, and how uncertainty and adaptive management are addressed in the review of the *Fisheries Act* authorization application. CNSC staff has and will continue to meet with the Indigenous groups on this subject (see also Section 5.6 of this CMD) to address their concerns.

Overall, CNSC staff conclude that fish populations were adequately protected. CNSC staff determined that satisfactory progress is being made by Bruce Power on the *Fisheries Act* authorization application, which is expected to be ready for submission to the DFO by June 2018.

5.5 Licensee Public Information Program

CNSC staff determined that Bruce Power has a well-established public information and disclosure program that met the requirements of RD/GD-99.3, *Public Information and Disclosure*. The program ensured that information about health, safety and security of persons and the environment, and other issues associated with the lifecycle of Bruce Power's facilities were effectively communicated to the public. The program demonstrated an open and transparent dialogue with their target audiences and stakeholders. Through extensive community engagements, Bruce Power staff had the opportunity to host tours with approximately 4300 people through its visitor center in 2016.

Specific to licence renewal, Bruce Power hosted a series of open houses, in person, by telephone and webinar in late 2016 and 2017. They produced a series of supplemental materials for the public to review at the open house and published *Bruce Power's 2018 Licence Renewal Briefing*, highlighting Bruce Power's role in the community and the importance of renewing its licence for the future.

The communication program at Bruce Power was thorough and fulsome. Its program offered information to audiences in plain and clear language which explained how they managed and maintained assets with the intention of continued safe, reliable operations until 2064, pending approval by the Commission. Bruce Power seeked to explain technical, scientific processes including PSR, PSA, EA, and technology and innovation to Canadians through a variety of means.

Bruce Power's information delivery was consistent and timely and used a variety of methods which took into account target market audience preference. Through the production and distribution of community newsletters, website updates, event reports, news releases, community partnership and sponsorship, public and Aboriginal engagement, social and traditional media, government relations, external stakeholder engagement and employee and retiree communications tools, Bruce Power worked to keep the public informed of current and future station activities, emergency preparedness measures and its commitment to safety, security and the environment.

The availability and clarity of information pertaining to nuclear activities was essential to establishing an atmosphere of openness, transparency, and trust between the licensee and the public. Since 2012, the CNSC required NPP operator and other major licensees to maintain a public information disclosure program supported by a robust disclosure protocol that addresses stakeholder needs. These requirements built on previously established guidance put in place in 2004.

Bruce Power has been providing annual reports on the implementation of RD/GD-99.3. The 2016 communications report provided a clear overview of the regular communication activities outlined above.

Through frequent conversations with Bruce Power communications staff, program verification through participation in public activities and communication monitoring, CNSC staff concluded that Bruce Power's public information and disclosure program met regulatory requirements.

Licence Condition G.5 in the proposed licence pertains to implementing and maintaining a public information and disclosure program.

5.6 Aboriginal Consultation and Engagement Activities

The CNSC recognizes that Indigenous groups have concerns with regard to the nuclear sector and that it is important to seek opportunities to work together in ensuring the safe and effective regulation of nuclear energy and materials. For this reason, CNSC is committed to building long-term relationships with Indigenous groups who have interest in the facilities it regulates and proactively engages with groups on a regular basis both prior to and post licensing decisions to discuss topics of interest and address their concerns.

The common law duty to consult with Aboriginal peoples applies when the Crown contemplates actions that may adversely affect potential or established Aboriginal and/or treaty rights. The CNSC, as an agent of the Crown and as Canada's nuclear regulator, recognizes and understands the importance of building relationships and consulting with Indigenous peoples in Canada. The CNSC ensures that all of its licensing decisions under the NSCA uphold the honour of the Crown and consider Aboriginal peoples' potential or established Aboriginal and/or treaty rights pursuant to section 35 of the *Constitution Act, 1982*.

The Bruce site lies within traditional Indigenous territory which includes the following three local Indigenous groups:

- Chippewas of Nawash Unceded First Nation and Saugeen First Nation who together form Saugeen Ojibway Nation (SON)
- Métis Nation of Ontario (MNO)
- Historic Saugeen Métis (HSM)

See Addendum E for a description of the established and asserted Aboriginal rights that are relevant to this licensing matter. See Addendum F for a summary of some of the key activities between CNSC staff and Indigenous groups, specific to the operations of Bruce A and B.

CNSC staff considered the information received from Bruce Power in the licence renewal application, as well as information received from Indigenous groups, to determine whether there is a duty to consult on this application. Based on the information received and reviewed, CNSC staff determined that the licence renewal application does not propose any changes to the facility's footprint, is located in a secure fenced-in site that has been in operation for many decades, and there are no new activities/changes that could reasonably be anticipated to have any novel off-site impacts.

The SON and the MNO, however, raised concerns related to impacts on fish from the operation of the Bruce NPP. CNSC staff are of the opinion that the operations of the Bruce NPP are not having population level effects on fish in Lake Huron, but acknowledge that there is some uncertainty related to the extent of potential localized effects on fish. In light of this, the CNSC is consulting Indigenous groups in an effort to better understand their concerns. In addition, ongoing monitoring, data collection, and analysis, including ongoing consultation as information is received, will occur. Given this, CNSC staff view any duty to consult as being at the low end of the spectrum.

CNSC staff and Bruce Power have continually engaged with the SON, MNO and HSM (both individually and jointly) since the last licence renewal in 2015 and will continue to do so throughout the lifecycle of the facilities.

All of the identified Indigenous groups have been encouraged to participate in the review process and in the public hearing to advise the Commission directly of any concerns they may have in relation to this licence application. The CNSC also continues to meet with Indigenous groups to encourage and maintain productive and respectful relationships.

5.6.1 Licensee engagement efforts with Indigenous Groups

Bruce Power has a formal relationship with each of SON, MNO and HSM through established protocol/relationship agreements. These agreements provide the framework for continued collaboration between Bruce Power and each group. Each agreement functions as a broad umbrella agreement, under which information sharing and meaningful discussion can occur and shared priorities can be advanced, including on training, employment, and business development opportunities. The agreements provide annual funding and a mechanism to discuss funding beyond what has been agreed in order to ensure that each community is able to meaningfully participate in regulatory approval processes relating to the Bruce site.

REGDOC-3.2.2, *Aboriginal Engagement* sets out requirements and guidance for licensees whose proposed projects may raise the Crown's duty to consult. Bruce Power proactively followed the guidance in REGDOC-3.2.2 by continuing to engage the SON, MNO and HSM to support and maintain their relationships with the groups.

Bruce Power provided information to the groups that included its 5-year look ahead on regulatory matters such as: licence renewal, *Fisheries Act* authorization, EA including the ERA and PEA and the MCR. CNSC staff is kept apprised of Bruce Power's engagement activities with the SON, MNO and HSM and has its own meetings with the groups. In addition, Bruce Power provided in its application [9] supplemental information on Bruce Power's current and historic engagement with SON, MNO and HSM.

5.6.2 Summary of CNSC Discussions with Indigenous Groups

As a life cycle regulator, CNSC staff will continue to meet with SON, the MNO and HSM on a regular basis and address any emerging issues as they arise. Details on the discussions with each group are provided below.

As part of the CNSC's ongoing discussions with these groups and in relation to consultation activities for this application in particular, SON, the MNO and HSM were identified as potentially having an interest in the matter, as the proposed activities are located within their respective treaty lands and/or asserted traditional territories. Two affiliated organizations, the Union of Ontario Indians and the

Chiefs of Ontario were also identified as they have requested that the CNSC keep them informed of Bruce Power's licensing reviews.

Following receipt of the application from Bruce Power in June 2017, CNSC staff sent letters of information in August 2017 to the 5 identified groups, which included: the licence application (along with information on the MCR), notification that the CNSC's Participant Funding Program would make funds available to participate in the process and CNSC staff contact details. In September 2017, follow-up phone calls were conducted to ensure the information has been received and to provide any clarifications if required.

Since the last Bruce Power licence renewal hearings in 2015, CNSC staff continued to consult with SON, the MNO and HSM on topics related to Bruce Power's facilities as well as other regulatory reviews at the site. Consultation activities included phone calls, emails and face-to-face meetings to discuss issues. In addition, the CNSC provided participant funding to support consultation activities with each group.

As well, each Indigenous group also sent representatives to the "CNSC's Lake Huron/Saugeen watershed workshop: BNGS Interaction with fisheries resource" in June 2017. During the workshop, each group informed the CNSC that they planned to participate in the licensing process following receipt of a relicensing application from Bruce Power. Based on their interests, additional meetings were proposed and scheduled to discuss the application in more detail. CNSC staff also met with the HSM in August 2017, SON in September and October 2017 and the MNO in November 2017. In 2018, further meetings took place with SON in January and February, with the MNO in January and the HSM in February.

Saugeen Ojibway Nation

Over the current licensing period, CNSC staff continued to meet regularly with SON to discuss topics related to the *Fisheries Act* authorization, the current licence renewal, the MCR as well as CNSC's role as an agent of the Crown.

In November 2017, SON submitted in writing to the Commission outlining their concerns with the timelines and process planned for the review of the Bruce Power proposed MCR. Specifically, they requested for an adjournment of the hearing which was subsequently denied by the Commission in December 2017. This item was previously discussed in Section 1.2 of this CMD.

The specific issues on impingement and entrainment of fish, thermal releases, and impact on treaty rights are summarized below.

Impingement and Entrainment of Fish

CNSC staff and SON representatives met numerous times over the past few years to identify and address issues related to SON's concerns on the impingement and entrainment monitoring plan, which was captured within the EA FUMP, developed as part of the Bruce A Units 1 and 2 Refurbishment project (EA FUMP previously discussed in Section 5.3 of this CMD).

CNSC staff reviewed the historical information on fish loss due to impingement and entrainment, relative to commercial harvesting quotas for Lake Whitefish (i.e., commercial fishing) that are jointly set by SON and the Ministry of Natural Resources and Forestry (MNRF). The data showed that foregone fishery yield annual losses due to impingement and entrainment during 2013 and 2014 was relatively low - less than 1% of the harvesting quotas that are established by SON and the MNRF for the protection of the Lake Huron Lake Whitefish fishery. These concerns were also raised during the 2015 licence renewal hearings. CNSC staff determined during the 2015 licence renewal hearings that, while the impingement and entrainment activities were killing fish, the operation of Bruce A and B did not have an adverse impact on fish populations in Lake Huron [16]. Therefore, CNSC staff concluded that impingement and entrainment at Bruce site do not having an adverse impact to SON's Aboriginal or treaty rights.

SON did not agree with CNSC staff's conclusions during the 2015 licence renewal hearings and asserted that the ongoing operation of the Bruce Power reactors have an adverse impact on SON's Aboriginal and treaty rights. Specifically, SON had concerns with the methodology used to determine fish loss due to impingement and entrainment, and that any mitigation or offset measures would not properly address this. As part of the ongoing consultation efforts, CNSC staff continued to provide SON with information on the applicable regulatory processes, including the *Fisheries Act* authorization application, related to the operation of Bruce A and B that could have an impact on Lake Huron (*Fisheries Act* authorization previously discussed in Section 5.4 of this CMD).

In ongoing discussions with SON to address their concerns, a facilitated workshop was held in May 2017 with the CNSC. At SON's request, the CNSC provided funding for Dr. Findlay of the University of Ottawa to facilitate discussions on matters related to SON's concerns. Many of the concerns raised at the workshop were in regards to the *Fisheries Act* authorization (such as study design and methods used to assess and quantify fish impingement and entrainment) since the same data generated by the impingement and entrainment plan in question were used in the EA FUMP. Following the workshop, Dr. Findlay provided a report to SON and CNSC that summarized the issues, points of agreement and potential next steps. SON and CNSC staff had subsequent meetings and workshops to further discuss SON's concerns and to explain the processes and procedures that the CNSC relies on for science-based decision making, such as fish studies. These meetings also explained the relicensing process of the Bruce site.

Impact on Aboriginal and Treaty Rights

SON asserted to the CNSC that they were not part of the original decision to construct a nuclear facility within their traditional territory. Therefore, an approval by the Commission for a licence for continued operations of Bruce A and B would have an adverse impact on their Aboriginal and treaty rights. In addition, SON considers the MCR to be a significant proposal with serious implications for their territory and people.

The Supreme Court of Canada's decision, in *Rio Tinto Alcan Inc. v. Carrier Sekani Tribal Council, 2010, SCC43* [53], states of the duty to consult, "the question is whether there is a claim or right that potentially may be adversely impacted by the current government conduct or decision in question. Prior and continuing breaches, including prior failures to consult, will only trigger a duty to consult if the present decision has the potential of causing a novel adverse impact on a present claim or existing right."

CNSC staff determined that the licence renewal and MCR will not expand the footprint of the Bruce site, and therefore, have not been persuaded that the proposed activities could cause novel adverse impacts to rights in the area. However, CNSC staff and Bruce Power will continue to meet with the SON to share information and to ascertain if there are any new concerns.

Further, the decision to undertake the MCR activities to extend the life of the Bruce A and B rests with the Province of Ontario, and was made in 2013. According to the mandate of the CNSC provided by the NSCA, a decision by the Commission on the current licence application must be based upon whether the MCR project can be undertaken safely, not whether MCR should be pursued or not. The Commission is also responsible for ensuring that its decisions uphold the honour of the Crown.

<u>Métis Nation of Ontario</u>

Over the current licensing period, CNSC staff continued to meet regularly with the MNO to discuss topics related to the *Fisheries Act* authorization, the current licence renewal, the MCR as well as CNSC's role as an agent of the Crown.

The MNO through the Georgian Bay Traditional Territory Consultation Committee (GBTTCC) has raised concerns that Métis valued components (VCs) have not been properly identified and included for consideration in Bruce Power's ERA and environmental monitoring programs, nor the CNSC's IEMP. In response to these concerns, Bruce Power and OPG jointly funded a study to identify the VCs. The study was completed and a report was shared with CNSC staff in July 2017.

Bruce Power has committed to work with the MNO to discuss how the identified VCs can be incorporated into their environmental monitoring programs and subsequent ERA. CNSC will continue to meet with the MNO to discuss how the information can also be incorporated into the IEMP.

In regards to the *Fisheries Act* authorization application, MNO provided their "species of interest" to Bruce Power and will review the offsetting measures once the application is finalized.

CNSC staff met with MNO staff in July 2017 to receive their report on VC and hosted a booth at the MNO's annual general assembly in August 2017. In November 2017, CNSC staff provided information to the MNO on the licence renewal application, *Fisheries Act* authorization application, IEMP and MCR oversight processes. In January 2018, CNSC staff met with the MNO to continue this dialogue.

Historic Saugeen Métis

Over the current licensing period, CNSC staff continued to meet regularly with the HSM to discuss topics related to the *Fisheries Act* authorization, the current licence renewal, the MCR as well as CNSC's role as an agent of the Crown.

CNSC staff met with representatives of HSM numerous times since the 2015 licence renewal hearings. Most recently, CNSC staff met with HSM in August 2017 and February 2018 to discuss the current licence renewal application. During the meeting, HSM continued to share their environmental interests with both Bruce Power and the CNSC. HSM also stated that they had a good working relationship with both Bruce Power and the CNSC, that they trusted their concerns and asserted rights were being protected, and that they continue to support the licence renewal. The HSM also shared that they were happy to have participated in the "Lake Huron/Saugeen watershed workshop: BNGS interaction with fisheries resources". As agreed by the HSM, CNSC staff will continue to share information related to the Bruce site at regular bi-annual meetings.

5.7 Cost Recovery

It is a requirement of the NSCA under paragraph 24(2)(c) that the licence application is accompanied by the prescribed fee. The *Cost Recovery Fees Regulations* (CRFR) set out the specific requirements based on the activities to be licensed. An applicant for a Class I facility licence is subject to “Part 2” of the CRFR, which is based on “Regulatory Activity Plan Fees”.

Bruce Power has requested to consolidate other licences (Class II and nuclear substance and radiation devices) into the PROL (see Part Two of this CMD). The costs associated with the regulation of those licensed activities will continued to be assessed under “Part 3” of the CRFR.

Bruce Power’s application for the licence renewal of Bruce A and B are not new applications, and as such, the applicant is not required to submit the initial fee of $25,000 as described in paragraph 7(1)(a). In this case, Bruce Power is subject to paragraph 5(2), which relates to quarterly invoices sent to licensees.

Bruce Power is in good standing with respect to CRFR requirements for Bruce A and B. Based on Bruce Power’s previous performance, CNSC staff determined that there is no concern with payment of future cost recovery fees.

5.8 Financial Guarantees

CNSC staff are satisfied that the financial guarantee for the Bruce facilities met the guidance set out in Regulatory Guide G-206, *Financial Guarantees for the Decommissioning of Licensed Activities*.

OPG is responsible for all costs of decommissioning of the Bruce nuclear facilities. All such costs are included in the decommissioning cost estimates and are covered by OPG's consolidated financial guarantee for decommissioning. OPG is required to revise the financial guarantee and the associated decommissioning plans at a minimum every five years or when requested by the Commission. In October 2017, the Commission held a hearing on the revised financial guarantee for OPG, and in its decision, accepted the financial guarantee. Therefore, the costs associated with decommissioning of the Bruce nuclear facilities have also been accepted.

In terms of operational financial guarantees, Bruce Power Limited Partnership maintains an investment grade credit rating for the operation of the Bruce nuclear facilities. Bruce Power is required to inform CNSC staff in writing of any changes to this credit rating.

Based on the OPG's current cost estimates and projections [54], OPG proposed to meet the entire estimated value of cost for decommissioning of its facilities through OPG's nuclear funds without a Provincial guarantee for the 2018-2022 period. The forecasted fair market value of those funds is projected to be $18.2 B as of January 1, 2018.

By 2022, the present value of the future decommissioning liability is projected to be $18.8 B while the OPG's nuclear funds fair market value is expected to be $21.2 B.

The *Ontario Nuclear Funds Agreement* (ONFA) funds are available to the CNSC upon demand. CNSC access to the ONFA funds is provided through legal agreements between the CNSC, OPG and the Province of Ontario.

Licence Condition 11.2 in the proposed licence pertains to financial guarantees. Compliance Verification Criteria for this Licence Condition are provided in the draft LCH.

5.9 Nuclear Liability Insurance

CNSC staff confirmed with Natural Resources Canada (NRCan) that Bruce Power is compliant with the *Nuclear Liability and Compensation Act* (NLCA) financial security obligations. CNSC staff did not identify any areas of concern.

On January 1, 2017 the NLCA came into force, replacing the *Nuclear Liability Act* (NLA). Whereas the administration of the previous NLA was shared between the CNSC and NRCan, the role of administering the new NLCA resides solely with NRCan. Therefore, the CNSC will not require that Bruce Power provide proof of compliance with the NLCA in the future.

Bruce Power is expected to meet its obligation for nuclear liability coverage under the NLCA, consistent with the CNSC general licence conditions requiring licensees to be in compliance with all applicable laws.

5.10 Consolidation of other types of Bruce licences into the PROL

In its application [10], Bruce Power requested the consolidation of other types of Bruce Power licences (Class II and Nuclear Substance and Radiation Devices Licences) into the PROL, including:

- 13152-3-20.2 – Industrial radiography
- 13152-1-20.4 – Consolidated use of nuclear substances
- 13152-2-21.1 – Operate a calibration irradiator facility

Bruce Power requested the consolidation of the licences for the following reasons:

- the activities arising from the above licences directly result from, and provide support for, the licensed activities at Bruce A and B
- the proposed change does not add or remove any regulatory requirements
- the proposed change is administrative in nature
- the proposed change will eliminate duplication of regulatory requirements and conditions
- the proposed change will simplify revision and approval of documents referenced in licences
- the proposed change will reduce the number of required licences amendment requests
- the activities will continue to be monitored but controlled under the PROL

Prior to this request, the Waste Nuclear Substance Licence (WNSL-W2-323.05/2017) was consolidated into the PROL in 2017 based on a similar determination. The activities under this licence directly resulted from, and provided support for, the licensed activities at Bruce A and B.

It is CNSC staff's view that the proposed request to consolidate the other licences into the PROL do not remove any regulatory requirements and will provide regulatory oversight of these activities in a more efficient and effective manner.

If, having received an application to consolidate the licences, the Commission approves the PROL, the licences listed below would go to the relevant Designated Officers for revocation:

- 13152-3-20.2 – Industrial Radiography
- 13152-1-20.4 – Consolidated Use of Nuclear Substances
- 13152-2-21.1 – Operate a calibration irradiator facility

CNSC staff recommend the Commission amend the PROL to consolidate the specified licences as the activities under those licence (Class II and Nuclear Substances and Radiation Devices Licences) directly resulted from, and provided support for, the licensed activities at Bruce A and B.

The PROL and LCH are to be amended as shown in Part Two of this CMD to accommodate the consolidation of the requirements, compliance verification criteria and guidance from these licences.

5.11 Previous Commitments Raised by the Commission

In 2015, the Commission, through its decisions recorded in the *Record of Proceedings, Including Reasons for Decision* [16] directed Bruce Power to complete the following actions:

- submit PSR and IIP in event of an application for MCR
- provide Bruce A Units 1 and 2 fuel defects update
- form a fish impingement and entrainment monitoring plan working group
- provide progress update on *Fisheries Act* authorization application
- develop a policy and formal document stipulating that enhancements to Bruce A and B will be considered if PSA results are in between the safety limit and the target, specifically, with respect to achieving large release frequency safety goal targets of $1.0E^{-6}$/yr
- evaluate CANDU safety issues (CSI) raised by an intervenor during re-licensing
- reduce backlog for deficient and deferred preventative maintenance
- evaluate adequacy of nuclear emergency response plans

CNSC staff considers all previous actions from the 2015 Commission's decisions recorded in the *Record of Proceedings, Including Reasons for Decision* to be completed.

For actions where an annual update is required, CNSC staff will continue to provide those to the Commission. Specific details on the actions taken to address commitments raised by the Commission are presented in the following sections.

5.11.1 Submit PSR and IIP in event of an application for Refurbishment

The Commission requested that in the event of an application for refurbishment (MCR), the process should include a PSR (formerly known as an integrated safety review), implementation and maintenance of return-to-service plan, and periodic updates on progress of project.

The current licence renewal application provided Bruce Power's intent to extend the operating life of Units 3 through 8 and submitted a PSR-based licence application. CNSC staff considers this action closed as Bruce Power has submitted a PSR and IIP.

CNSC staff's review of the PSR, including the GAR and IIP was provided in Section 3 of this CMD.

5.11.2 Provide annual updates on fuel defects, endplate cracking and relief valve sizing

Bruce Power was requested to provide annual updates on Bruce Units 1 and 2 fuel defects, Bruce B endplate cracking and analysis of HTS pressure relief valve sizing.

The defect rate for Units 1 and 2 was higher than industry average due to fretting defects as a result of damage caused by debris introduced during unit refurbishment. The defect rate has decreased and returned to industry average.

Although endplate cracking continued to be observed at Bruce B, Bruce Power has a corrective action plan in place that CNSC staff have reviewed and accepted. Bruce Power also continues to implement an enhanced inspection regime to monitor both the instances of endplate cracking and the effectiveness of its mitigating strategies. The mitigating measures include using different fueling strategies and design modifications if required (such as design change to shield plugs). The observed rate of endplate cracking remained consistent over the licensing period.

During the 2015 licence renewal hearing, an intervenor expressed concerns related to the primary heat transport system pressure relief valves (PRVs). The intervenor expressed concerns that the PRVs are inadequately sized which could lead to inadequate steam relief capacity and over-pressurization during a severe event. Bruce Power provided an evaluation of the intervenor's concerns and determined that the steam relief capacity provided by the PRV was adequate. Although the intervenor continues to express concerns on this matter, no new information was presented. CNSC staff reviewed Bruce Power's evaluation and concluded that the PRV issue raised by the intervenor had limited-to-no safety significance to the operation of CANDU reactors and closed this action.

CNSC staff concluded that Bruce Power fuel usage remained safe for all units and that fuel performance met requirements. CNSC staff consider the action closed as Bruce Power is providing the REGDOC-3.1.1 updates and will continue to monitor the annual reports to ensure that fuel performance will continue to be met.

5.11.3 Form a fish impingement and entrainment monitoring plan working group

CNSC staff and Bruce Power were requested to form a working group with interested Indigenous groups for fish impingement and entrainment monitoring plan component of the EA FUMP.

Following the 2015 Bruce Power licence renewal, CNSC staff worked with local Indigenous groups to provide them with the most recent knowledge regarding fisheries issues at the Bruce site to work towards resolving their concerns. This took the form of a multi-stakeholder workshop held in June 2017 titled "Lake Huron/Saugeen watershed workshop: BNGS interaction with fisheries resources".

The purpose of the workshop was to exchange knowledge and share information on fisheries monitoring programs, present the current state-of-knowledge of fish studies and activities of local governmental and non-governmental organizations with interest in fisheries resources in the vicinity of the Bruce site. The aim was to disseminate scientific, technical and regulatory information related to the operation of the Bruce A and B, and the impacts on the environment.

There were over 70 people in attendance from 17 different organizations with activities related to Lake Huron or the watershed around the Bruce site. Each of the regulatory agencies provided an overview of their monitoring programs and their results. Several community groups presented recently completed fisheries improvement projects. A group of scientists from a number of universities provided information on their research projects. The HSM provided a history of their relationship with the operators at Bruce site and the MNO outlined their concerns with respect to fisheries resources.

CNSC staff consider this action closed. CNSC staff will continue to meet the Indigenous groups on any concerns they may have on fisheries resources on an individual basis, as requested by the communities.

5.11.4 Provide Progress Update on Department of Fisheries and Ocean (DFO) Application

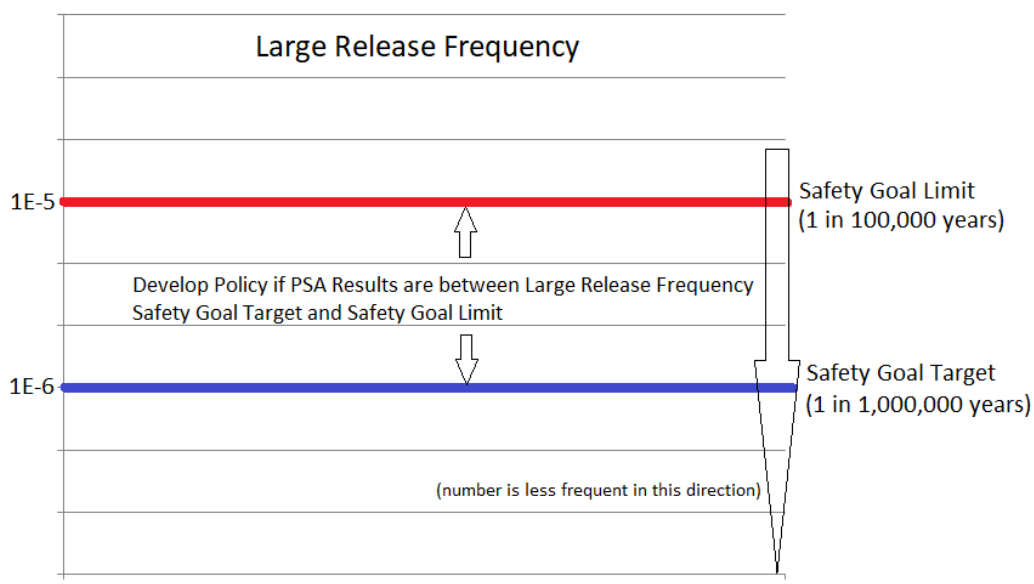
CNSC staff were requested to provide annual updates on progress of *Fisheries Act* authorization under Section 35 of the *Fisheries Act*. The *Fisheries Act* authorization process is independent from the CNSC licensing process.

CNSC staff consider this action closed. This issue is being reported annually since the 2014 ROR. CNSC staff will continue to provide updates on this matter in the annual ROR for CANDU NPP. See also Section 5.4 of this CMD.

5.11.5 Develop policy on safety enhancement to Bruce A and B

The Commission recommended that Bruce Power develop a policy and formal document stipulating that enhancements to Bruce A and Bruce B will be considered if PSA results are in between the safety goal limit and the safety goal target (or administrative safety goal target), specifically, with respect to achieving large release frequency safety goal target of 1.0E^{-6}/yr (See Figure 23 below).

Figure 23: Large release frequency safety goal target vs limit



Bruce Power's governance document for PSA development and application is currently under revision as part of REGDOC-2.4.2 transition plan. The revised governance document will contain policy to investigate PSA results and safety enhancement actions if PSA results are above either the safety goals (safety goal limits) or the safety goal targets (administrative safety goals).

The Commission also recommended Bruce Power to develop a whole-site PSA methodology with industry partners.

Although the policy has not been developed, Bruce Power continues to meet safety analysis requirements. CNSC staff consider this action closed since the policy document will be issued in early 2018 and the whole-site PSA methodology will be submitted by end of 2018. CNSC staff will review the documents once they have been submitted. CNSC staff do not consider this issue to be an impediment for relicensing.

5.11.6 Evaluate CANDU Safety Issues Raised

The Commission requested CNSC staff to evaluate CANDU safety issues raised by an intervenor during re-licensing [16]. In March 2017, CNSC staff addressed the comments [33] raised in Dr. Nijhawan's intervention (see also other interventions raised in Section 4.4 of this CMD related to CANDU CSI).

CNSC staff concluded [55] that the assertions and issues raised by the intervenor have limited-to-no safety significance to the operation of CANDU reactors, and that the actions completed by COG, at the request of the industry, were complete. All issues identified by the intervenor have been dispositioned appropriately. CNSC staff identified a limited number of topics, deemed of low safety significance, where a more complete experimental or a documented technical basis for the arguments in COG joint project COG-JP-4534-02 is needed.

The Canadian licensees, including Bruce Power, were requested by CNSC staff to submit a high level overview document describing COG R&D work (those performed to date, work in progress and planned) to specifically address these topics. This document was submitted to the CNSC in December 2017.

CNSC staff consider this action closed given that the CANDU safety issues have been evaluated and the COG R&D report has been submitted. CNSC staff will continue to track the COG R&D work and provide updates on this matter in the annual ROR.

5.11.7 Reduce backlog for deficient and deferred preventative maintenance

The Commission stated that achieving industry norms for backlog of deficient and deferred preventative maintenance should be a priority for Bruce Power. CNSC staff provided annual updates on this issue via the annual ROR. CNSC staff concluded that, based on the preventive maintenance completion ratios and the backlog results, Bruce Power has adequately addressed this issue.

Therefore, CNSC staff consider this action closed. CNSC staff will continue to monitor Bruce Power's performance on maintenance backlogs to ensure that it does not increase over the next licensing period. See also Section 4.6 of this CMD.

5.11.8 Evaluate adequacy of nuclear emergency response plans

The Commission requested that Bruce Power consult with local municipalities to ensure that their nuclear emergency response plans are adequate. Bruce Power completed this action by working with local municipalities (Kincardine and Saugeen Shores). The Municipality of Kincardine is currently updating its nuclear emergency response plan with support from Bruce Power. Bruce Power also meets with the school boards (within the secondary zone) twice annually to ensure that emergency procedures and policies were updated appropriately. Finally, offsite response drills are performed twice annually with each of the municipalities.

CNSC staff determined the actions taken by Bruce Power to be adequate and consider this action closed.

5.12 Delegation of Authority

5.12.1 Licence

The Commission may include in a licence any condition it considers necessary for the purposes of the NSCA. The Commission may delegate authority to CNSC staff with respect to the administration of licence conditions, or portions thereof.

For reference, information on delegation of authority will be included in the LCH. There are two proposed licence conditions in the Bruce A and B PROL that contain the phrase "a person authorized by the Commission":

- LC 3.2 (Restart after a serious process failure)
- LC 15.5 (Removal of regulatory hold points)

With respect to LC 3.2, CNSC staff recommend the Commission delegate the authority for consent to restart a reactor after a serious process failure to the following CNSC staff:

- Director, Bruce Regulatory Program Division
- Director General, Directorate of Power Reactor Regulation
- Executive Vice-president and Chief Regulatory Operations Officer, Regulatory Operations Branch

For reference, this delegation of authority was previously granted by the Commission for the Bruce A and B licence renewal in 2015 [16]. Additional information on the proposed licence conditions subject to a delegation of authority are provided in the LCH which is included in Part Two of this CMD.

<u>Regulatory Hold Points</u>

With respect to LC 15.5 (removal of regulatory hold points), as further described in Part Two of this CMD, CNSC staff recommend that the Commission delegate the authority to remove regulatory hold points for the return to service of each unit undergoing MCR activities to the Executive Vice President and Chief Regulatory Operations Officer, Regulatory Operations Branch. For reference, similar delegation of authority was previously granted by the Commission for the Bruce Units 1 and 2, Point Lepreau and Darlington refurbishment projects.

Prior to releasing a regulatory hold point, CNSC staff will verify compliance and provide a report to the Executive Vice President and Chief Regulatory Operations Officer, Regulatory Operations Branch. Based on the review of this report, the Executive Vice President and Chief Regulatory Operations Officer, Regulatory Operations Branch will issue a record of decision. The same process was used successfully for the Bruce Units 1 and 2 and Point Lepreau refurbishment projects.

The four regulatory hold points for the return-to-service of each unit undergoing MCR are:

- prior to fuel load

- prior to guaranteed shutdown state (GSS) removal
- prior to exceeding 1% full power
- prior to exceeding 35% full power

5.12.2 Licence Conditions Handbook

The LCH associated with the PROL provides compliance verification criteria used to determine whether the conditions listed in the PROL have been met.

In addition, the LCH sets out how CNSC staff will assess compliance with the licence. It provides details associated with each LC, such as applicable standard or regulatory document, regulatory interpretation, compliance verification criteria, version-controlled documents, licensee written notification documents and guidance. This structure allows more freedom for the facility to evolve and update its documentation within the licensing basis. Therefore, CNSC staff recommend the Commission consider the LCH in making its decision on the renewal of the Bruce A and B, and accept that the Director General, Directorate of Power Reactor Regulation will be the sole process owner for modifying this staff-level document during the licence period.

6. OVERALL CONCLUSIONS AND RECOMMENDATIONS

CNSC staff have concluded the following with respect to Section 24(4)(a) and (b) of the NSCA, in that Bruce Power:

1. is qualified to carry on the activities authorized by the licence
2. in carrying out the licensed activities, has made, and will continue to make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed

Therefore, CNSC staff recommend that the Commission:

1. accept the following licence conditions (LC) to be included in the proposed licence requiring Bruce Power to:
    - LC 15.2, implement the IIP resulting from the current PSR
    - LC 15.3, maintain pressure tube fracture toughness sufficient for safe operation
    - LC 15.4, implement a return to service plan for MCR activities
    - LC 15.5, obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points during return to service
    - LC 15.6, conduct and implement a PSR prior to the renewal of the next licence
2. amend the Power Reactor Operating Licence (PROL) to consolidate the specified licences (Class II and nuclear substances and radiation devices) identified in Part 2 of this CMD that support the operations of Bruce A and B
3. authorize Bruce Power to operate Bruce A and B up to a maximum of 300,000 Equivalent Full Power Hour
4. delegate authority as set out in Section 5.12 of this CMD
5. issue, pursuant to section 24 of the NSCA, a single Bruce A and B operating licence to Bruce Power for a period of 10 years from September 1, 2018 to August 31, 2028.

The proposed PROL, as well as a draft Licence Conditions Handbook (LCH) are presented in Part 2 of this CMD.

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GLOSSARY

Acronym	**Term**
AIA	Authorized Inspection Agency
AIM	Abnormal Incident Manuals
ALARA	As Low As Reasonable Achievable
ANO	Authorized Nuclear Operator
BDBA	Beyond Design Basis Accident
BOP	Balance of Plant
BPMS	Bruce Power Management System
CAA	Composite Analytical Approach
CEAA	Canadian Environmental Assessment Act
CFVS	Containment Filtered Venting System
CMD	Commission Member Document
CME	Common Mode Event
CMLF	Central Maintenance and Laundry Facility
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CRE	Collective Radiation Exposure
CRSS	Control Room Shift Supervisor
CSA	Canadian Standards Association
CSI	CANDU Safety Issues
CVC	Compliance Verification Criteria
DBA	Design Basis Accidents
DFO	Fisheries and Oceans Canada
ECCC	Environment and Climate Change Canada
ECI	Emergency Cooling Injection System
EFPH	Equivalent Full Power Hour
EMC	Emergency Management Centre
EMS	Environmental Management System
EMP	Environmental Monitoring Report
EOC	Emergency Operations Centre

EOP	Emergency Operating Procedures
EPG	Emergency Power Generator
EQ	Environmental Qualification
ERA	Environmental Risk Assessment
ERO	Emergency Response Organization
EVS	Extreme Value Statistics
FAI	Fukushima Action Items
FHA	Fire Hazard Assessment
FSSA	Fire Safe Shutdown Analysis
FUMP	Follow-up Monitoring Program
GAR	Global Assessment Report
GBTTCC	Georgian Bay Traditional Territory Consultation Committee
GSS	Guaranteed Shutdown State
HSM	Historic Saugeen Métis
HTS	Heat Transport System
IAEA	International Atomic Energy Agency
IEMP	Independent Environmental Monitoring Program
IFB	Industrial Fire Brigade
IIP	Integrated Implementation Plan
IUC	Instrument Uncertainty Calculations
LC	Licence Condition
LCH	Licence Conditions Handbook
LCMP	Life Cycle Management Plan
LOCA	Loss of Coolant Accident
MCQ	Multiple-Choice Question
MCR	Major Component Replacement
MNO	Métis Nation of Ontario
MOECC	Ministry of Environment and Climate Change
MOL	Ministry of Labour
NGS	Nuclear Generating Station
NLA	Nuclear Liability Act
NLCA	Nuclear Liability and Compensation Act

NOP	Neutron Overpower Protection
NPCS	Negative Pressure Containment System
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRCan	Natural Resources Canada
NSCA	Nuclear Safety and Control Act
ONFA	Ontario Nuclear Funds Agreement
OP&P	Operating Policies and Principles
OPEX	Operating Experience
OPG	Ontario Power Generation
OSART	Operational Safety Review Team
OSR	Operational Safety Requirements
PERA	Predictive Environmental Risk Assessment
PIP	Periodic Inspection Program
PPE	Personal Protective Equipment
PROL	Power Reactor Operating Licence
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PTNSR	Packaging and Transport of Nuclear Substance Regulations
SAMG	Severe Accident Management Guidelines
SASS	Severe Accident Software Simulator
SCA	Safety and Control Areas
SCO	Station Containment Outage
SDS	Shutdown System
SG	Standby Generators
SLOR	Slow Loss of Regulation
SM	Shift Manager
SOE	Safe Operating Envelope
SON	Saugeen Ojibway Nation
SRI	Safety Report Improvement
SSC	Structures, Systems and Components
SST	Safety System Test
TCC	Temporary Configuration Changes

TDG	Transportation of Dangerous Goods
TPR	Third Party Reviews
TSSA	Technical Standards and Safety Authority
VBO	Vacuum Building Outage
VC	Valued Components
WNSL	Waste Nuclear Substance Licence

A. SAFETY AND CONTROL AREA FRAMEWORK

A.1 Safety and Control Areas Defined

The safety and control areas identified in section 2.2, and discussed in summary in sections 3.1 through 3.14 are comprised of specific areas of regulatory interest which vary between facility types.

The following table provides a high-level definition of each SCA. The specific areas within each SCA are to be identified by the CMD preparation team in the respective areas within section 3 of this CMD (refer to Addendum A of the guide to writing CMD).

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
Management	Management System	Covers the framework which establishes the processes and programs required to ensure an organization achieves its safety objectives and continuously monitors its performance against these objectives and fostering a healthy safety culture.
	Human Performance Management	Covers activities that enable effective human performance through the development and implementation of processes that ensure that licensee staff is sufficient in number in all relevant job areas and that licensee staff have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.
	Operating Performance	This includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.
Facility and Equipment	Safety Analysis	Maintenance of the safety analysis that supports that overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.
	Physical Design	Relates to activities that impact on the ability of systems, components and structures to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
	Fitness for Service	Covers activities that impact on the physical condition of systems, components and structures to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.
Core Control Processes	Radiation Protection	Covers the implementation of a radiation protection program in accordance with the RP Regulations. This program must ensure that contamination and radiation doses received are monitored and controlled.
	Conventional Health and Safety	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.
	Environmental Protection	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.
	Emergency Management and Fire Protection	Covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This also includes any results of exercise participation.
	Waste Management	Covers internal waste-related programs which form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. Also covers the planning for decommissioning.
	Security	Covers the programs required to implement and support the security requirements stipulated in the regulations, in their licence, in orders, or in expectations for their facility or activity.
	Safeguards and Non-Proliferation	Covers the programs and activities required for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreements as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
	Packaging and Transport	Programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.

A.2 Specific Areas for this Facility Type

The following table identifies the specific areas that comprise each SCA for a Class I Facility:

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
Management	Management System	▪ Management System ▪ Organization ▪ Performance Assessment, Improvement and Management Review ▪ Operating Experience (OPEX) ▪ Change Management ▪ Safety Culture ▪ Configuration Management ▪ Records Management ▪ Management of Contractors ▪ Business Continuity
	Human Performance Management	▪ Human Performance Programs ▪ 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

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
		▪ Safe Operating Envelope ▪ Severe Accident Management and Recovery ▪ Accident Management and Recovery
Facility and Equipment	Safety Analysis	▪ Deterministic Safety Analysis ▪ Hazard Analysis ▪ Probabilistic Safety Analysis ▪ Criticality Safety ▪ Severe Accident Analysis ▪ Management of Safety Issues (including R&D Programs)
	Physical Design	▪ Design Governance ▪ Site Characterization ▪ Facility Design ▪ Structure Design ▪ System Design ▪ Components Design
	Fitness for Service	▪ Equipment Fitness for Service/Equipment Performance ▪ Maintenance ▪ Structural Integrity ▪ Aging Management ▪ Chemistry Control ▪ Periodic Inspection and Testing
Core Control Processes	Radiation Protection	▪ Application of 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

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
		(releases) ▪ Environmental Management System (EMS) ▪ Assessment and Monitoring ▪ Protection to 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 IAEA ▪ Operational and Design Information ▪ Safeguards Equipment, Containment and Surveillance ▪ Import and Export
	Packaging and Transport	▪ Package Design and Maintenance ▪ Packaging and Transport ▪ Registration for Use

B. RISK RANKING

The CNSC uses a risk-informed regulatory approach in the management and control of regulated facilities and activities. CNSC staff have therefore established an approach to identifying appropriate levels of regulatory monitoring and control for specific classes of licensed facilities and types of licensed activities based on risk ranking.

Risk ranking is applied to each SCA, and is determined by considering the probability and consequence of adverse incidents associated with each SCA as it relates to the given facility and activity types.

The methodology used to determine risk ranking is based on Canadian Standards Association guideline CAN/CSA-Q850, *Risk Management: Guideline for Decision Makers*. This guideline provides a description of the major components of the risk management decision process and their relationship to each other, and describes a process for acquiring, analyzing, evaluating, and communicating information that is necessary for making decisions.

In section 2.2 of the CMD, in the relevant SCA table, the “Risk Ranking” column shows a high (H), moderate (M) or low (L) indicator for each SCA that is relevant to the current facility and activities being addressed in this CMD. The risk rankings are not static and will change over time for a given facility and activities (e.g., facilities age, facilities and equipment are upgraded, activities cease or begin, licensees change, technology and programs mature, knowledge and understanding of impacts and probabilities increase, etc.).

The following matrix provides a high-level overview of risk ranking, and the management and monitoring approach associated with the various degrees of risk.

APPROACH TO ASSESSING AND MANAGING POTENTIAL RISK			
CONSEQUENCE	**MANAGEMENT/MONITORING APPROACH**		
Significant Impact	Considerable management of risk is required	Must manage and monitor risk with occasional control	Extensive management is essential. Constant monitoring and control
Moderate Impact	Occasional monitoring	Management effort is recommended	Management effort and control is required
Low Impact	Random monitoring	Regular monitoring	Manage and monitor
Probability of Occurrence	Unlikely to Occur	Might Occur	Expected to Occur

RISK RANKING LEGEND	
L	Low Risk
M	Moderate Risk
H	High Risk

On this basis, a high-risk SCA would be subject to increased regulatory scrutiny and control while a low-risk SCA would generally require minor verification and control.

Due to the complex nature of power reactors, this simplified approach gives insufficient differentiation between the areas reviewed. Therefore, the *CNSC Risk Informed Decision Making* process has been applied to generate relative risk rankings for the purpose of determining a risk estimate for each SCA.

Over the span of a year, individual inspection findings at a facility are risk ranked as high, medium or low. When these are combined, a rating for each specific area can be found for that year. These specific area ratings can then be grouped to determine a risk ranking for an entire SCA. Then the annual integrated plant rating is found by integrating the scores for the individual SCAs and factoring in licensee’s past performance, the weighing factors, and expert judgment.

Generally, a high-risk SCA would be subject to increased regulatory scrutiny and control (e.g., high frequency of inspection) while a low-risk SCA would generally require minor verification and control. These risk rankings are not static and will change over time for a given facility and activities (e.g. phase, age, condition of plant, evolution of program knowledge and understanding, etc.).

C. RATING LEVELS

The following rating levels reflect the rating terminology used by the CNSC.

RATING LEVEL	DESCRIPTION
FS	Fully Satisfactory
SA	Satisfactory
BE	Below Expectations
UA	Unacceptable

Note: For SCAs with a security classification of "PROTECTED B" or higher, the classification is indicated in place of the rating level.

Fully Satisfactory (FS)

Compliance with regulatory requirements is fully satisfactory. Compliance within the area exceeds requirements and CNSC expectations. Compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Compliance with regulatory requirements is satisfactory. Compliance within the area meets requirements and CNSC expectations. Any deviation is only 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)

Compliance with regulatory requirements falls below expectations. Compliance within the area deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant is taking appropriate corrective action.

Unacceptable (UA)

Compliance with regulatory requirements is unacceptable, and is seriously compromised. Compliance within the overall area is significantly below requirements or CNSC expectations, or there is evidence of overall non compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

D. SUPPORTING DETAILS

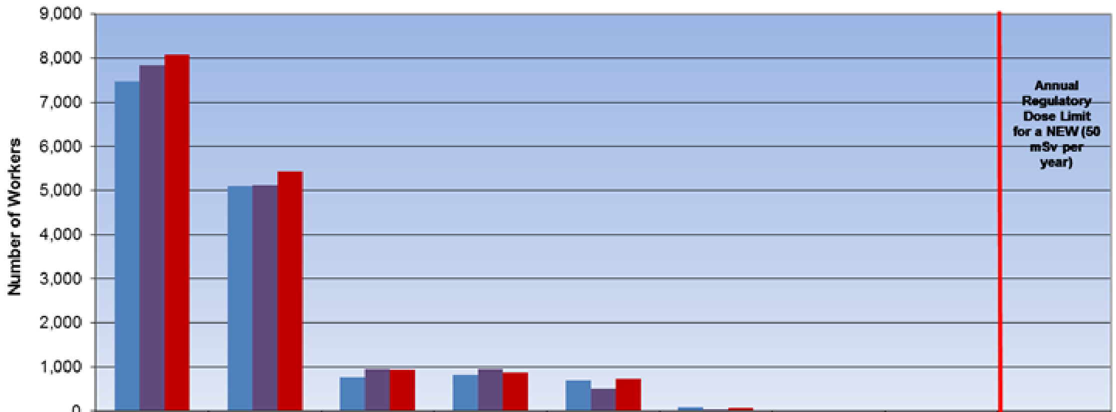
D.1 Radiation Protection

Individual Effective Doses at Bruce A and B

Figure 24 presents the distribution of annual effective doses to all monitored persons at Bruce A and B according to dose information from the national dose registry (NDR).

The figure also shows that in the current licensing period, there were no radiation exposures received at Bruce Power that exceeded the annual regulatory dose limit of 50 mSv for a Nuclear Energy Worker (NEW).

Figure 24: Annual Effective Dose Distribution to Workers at Bruce Power

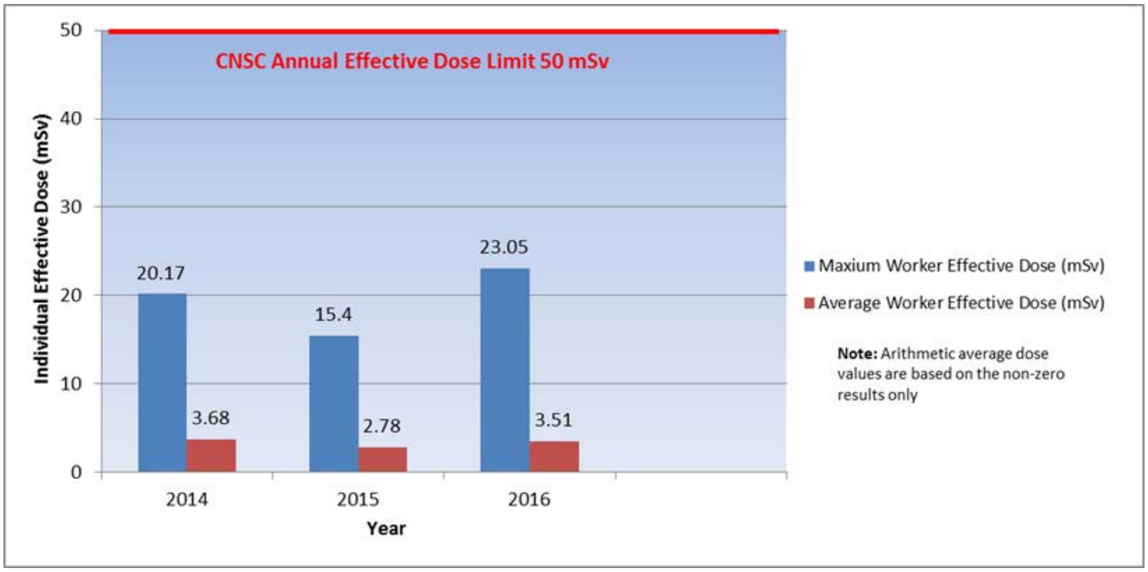


	Number of Workers Monitored	< 0.01 mSv (Reportable Level)	0.01 - 1 mSv	1 - 5 mSv	5 - 10 mSv	10 - 15 mSv	15 - 20 mSv	20 - 50 mSv	> 50 mSv
2014	7,475	5,091	772	814	690	82	24	2	0
2015	7,850	5,124	955	952	515	31	3	0	0
2016	8,082	5,435	931	880	734	78	15	9	0

Dose Range (mSv)

Note: 2017 data is not shown as it is not available from the National Dose Registry in time for CMD publication (data is gathered at the beginning of each year for the previous year).

Figure 25: Maximum and Average Individual Effective Dose to Workers



Note: 2017 data is not shown as it is not available from the National Dose Registry in time for CMD publication (data is gathered at the beginning of each year for the previous year).

Figure 25 presents the maximum and average individual effective dose to monitored persons at Bruce A and B. This figure shows that the annual average[9] effective dose at Bruce A and B ranged from 2.78 to 3.68 mSv. The maximum individual effective dose received by a worker at the Bruce Power site ranged from 15.40 to 23.05 mSv.

In general, the fluctuations in maximum and average doses observed from year to year are reflective of the type and scope of work being performed at the facility. No negative trends were identified in 2016. CNSC staff will continue to monitor doses to workers through the compliance verification program.

[9] The "average effective dose" or "average effective dose – non-zero results only" is obtained by dividing the total collective dose by the total number of individuals receiving a dose above the minimum reportable level of 0.01 mSv.

Annual collective doses at Bruce A and B

During the licensing period, Bruce Power has implemented at Bruce A and B work management and planning strategies to control collective dose and minimize individual exposures as low as reasonably achievable (ALARA). Collective doses at Bruce A and B were maintained within or below dose targets.

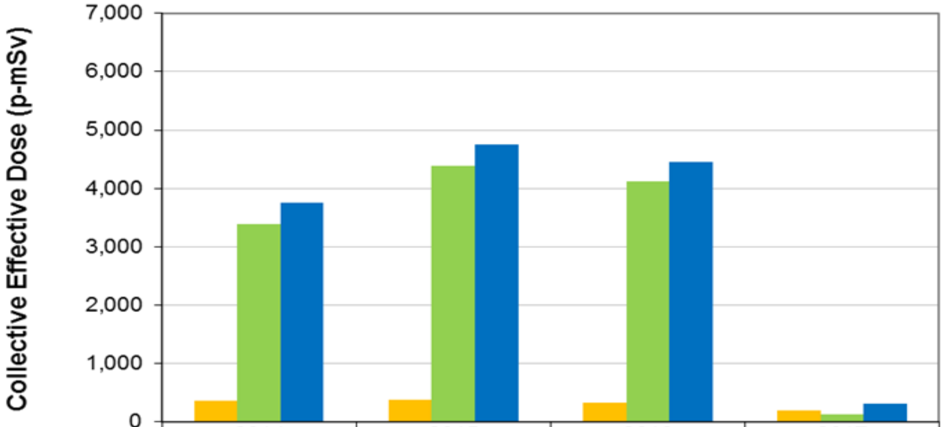
Bruce A

Figure 26 and Figure 27 illustrate the distribution of annual collective effective dose per operational state (routine versus outage) and the distribution of dose by internal and external doses for Bruce A, Units 1-4.

During the current licensing period, all four units were operational at Bruce A. Outage activities accounted for approximately 92 percent of the total collective dose and most of the radiation dose received by workers came from external exposure. Routine operations accounted for an average of about 8 percent of the total collective dose and remained nearly constant. Approximately 7 percent of the collective dose was from internal exposure, with tritium being the main contributor to exposed workers' internal doses.

For routine operations, variations between years are attributed partly to how long the plant operated during each year as well as to typical dose rates associated with the station's operation. The outage dose (planned and forced) includes the dose to all personnel, including contractors. Parameters affecting the dose include the number of outages for the year, the scope and duration of the work, the number of workers involved and dose rates associated with the outage work.

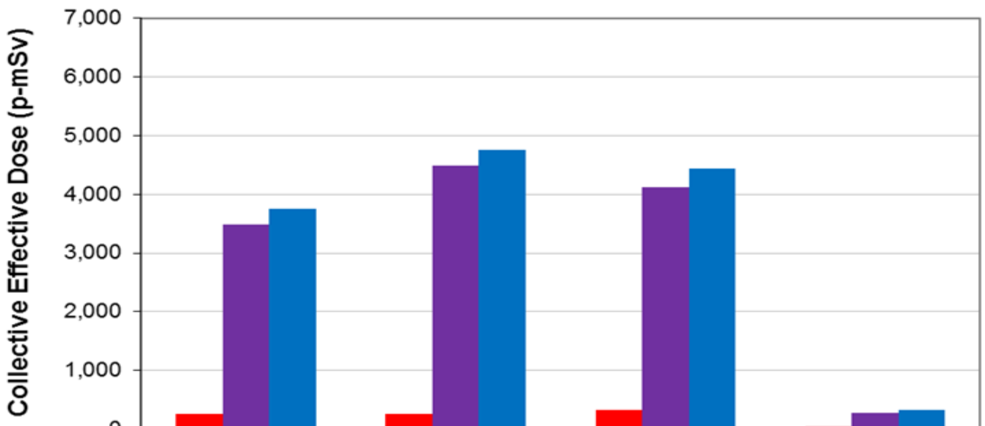
Figure 26: Collective effective dose by operational state for Bruce A, Units 1 to 4, 2014-2017*



	2014	2015	2016	2017
Routine Operations	367	372	329	195
Outages	3,385	4,383	4,118	125
Total	3,752	4,755	4,447	321

Year

Figure 27: Collective dose from internal and external exposures for Bruce A, Units 1 to 4, 2014–17*



	2014	2015	2016	2017
Internal Dose	260	259	329	42
External Dose	3,492	4,496	4,118	280
Total	3,752	4,755	4,447	321

Year

** Numbers reported are gathered up to a cut-off date of June 30, 2017. Data is gathered on a quarterly basis.*

Note: *The external dose is the portion of the dose received from radiation sources outside the body. The internal dose is the portion received from radioactive material taken into the body.*

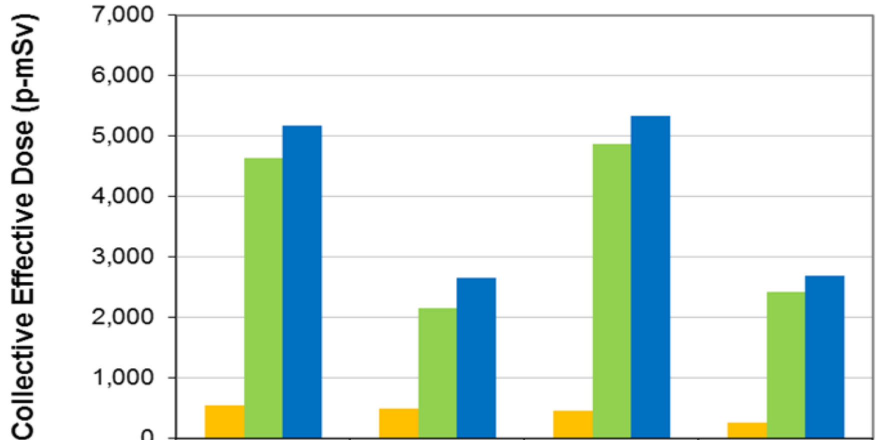
Bruce B

Figure 28 and Figure 29 illustrate the distribution of annual collective effective dose per operational state (routine versus outage) and the distribution of dose by internal and external doses for Bruce B.

During the current licensing period, all four units were operational at Bruce B. Outage activities accounted for approximately 87 percent of the total collective dose and most of the radiation dose received by workers came from external exposure. Routine operations accounted for an average of about 13 percent of the total collective dose. Approximately 4.5 percent of the collective dose was from internal exposure with tritium being the main contributor to exposed workers' internal doses.

For routine operations, variations between years are attributed partly to how long the plant operated during each year as well as to typical dose rates associated with the station's operation. The outage dose (planned and forced) includes the dose to all personnel, including contractors. Parameters affecting the dose include the number of outages for the year, the scope and duration of the work, the number of workers involved and dose rates associated with the outage work.

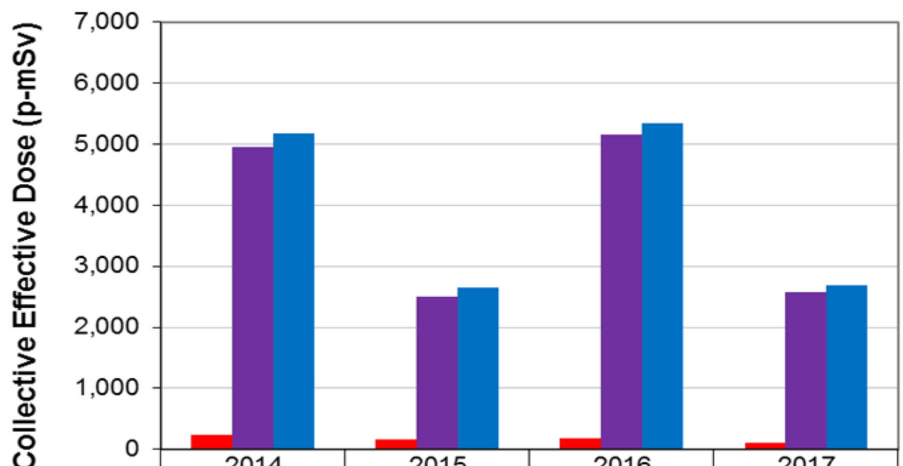
Figure 28: Collective effective dose by operational state for Bruce B, Units 5 to 8, 2014-2017*



	2014	2015	2016	2017
Routine Operations	547	506	470	263
Outages	4,632	2,149	4,863	2,433
Total	5,179	2,655	5,333	2,696

Year

Figure 29: Collective dose from internal and external exposures Bruce B, Units 5 to 8, 2014–17*



	2014	2015	2016	2017
Internal Dose	228	154	180	115
External Dose	4,951	2,501	5,153	2,581
Total	5,179	2,655	5,333	2,696

Year

** Numbers reported are gathered up to a cut-off date of June 30, 2017. Data is gathered on a quarterly basis.*

Note: *The external dose is the portion of the dose received from radiation sources outside the body. The internal dose is the portion received from radioactive material taken into the body.*

E. ESTABLISHED AND ASSERTED ABORIGINAL RIGHTS

Saugeen Ojibway Nation (SON)

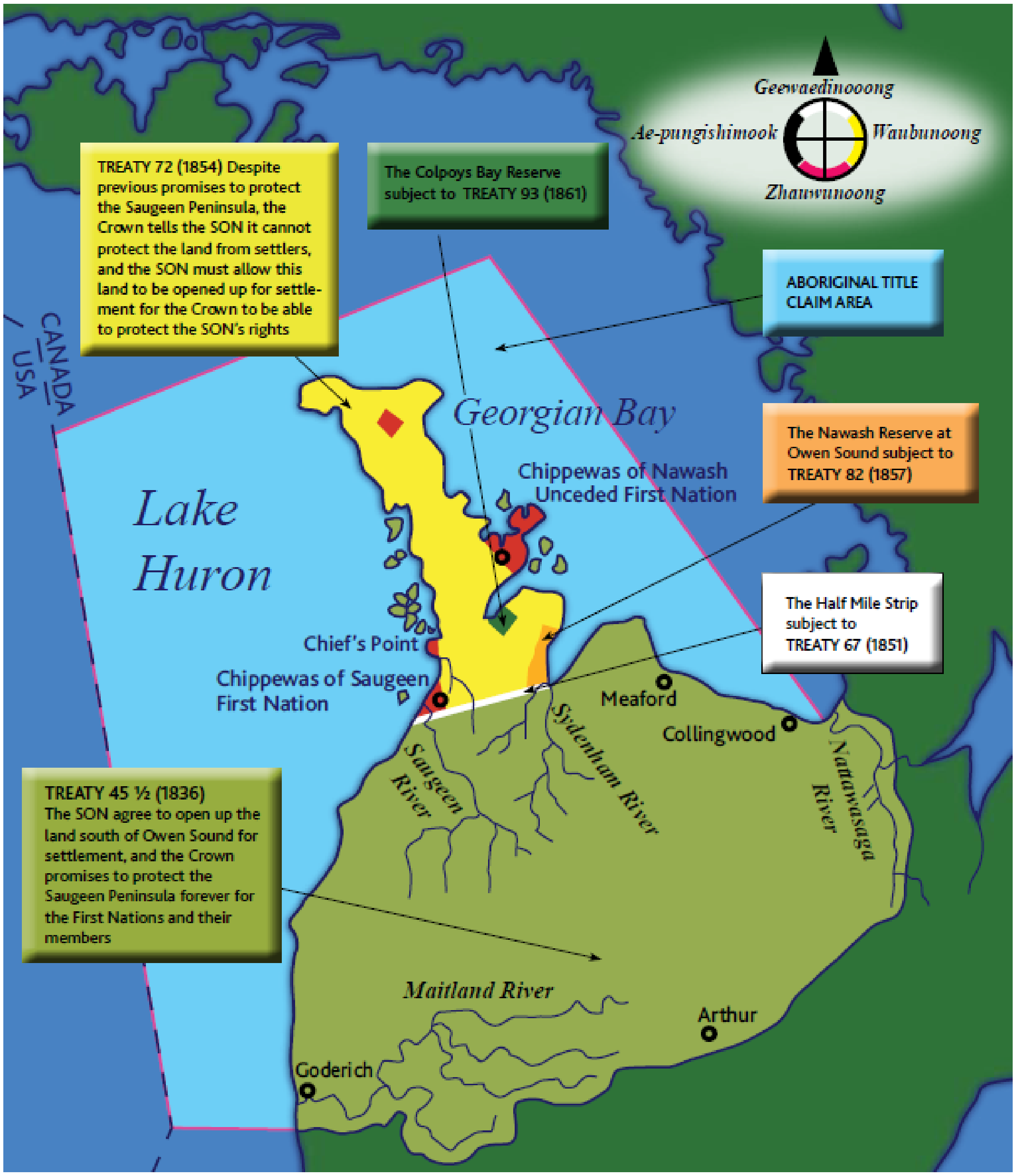
Together, the Chippewas of Nawash Unceded First Nation (Cape Croker, Ontario) and the Saugeen First Nation (Bruce Peninsula, Ontario) constitute SON. SON defines its traditional territory as extending from the northern tip of the Bruce Peninsula to Maitland River on Lake Huron, inland to the town of Arthur, and then north to Georgian Bay, east of the city of Owen Sound. This territory also includes the water around the Bruce Peninsula (see Figure 30).

SON are signatories to various treaties with the Crown, including the 1836 Surrender of Southern Saugeen & Nawash Territories (Treaty No. 45 ½) and the 1854 Surrender of the Saugeen (Bruce) Peninsula (Treaty No. 72). However, SON assert that they never surrendered their right to fish for food, ceremony or commerce, and they never surrendered their right to manage their own fisheries.

In 1998, SON reached an agreement with OPG for access to the Bruce nuclear site for ceremonial activities associated with the Jiibegmegoong Spirit Place burial ground. This agreement is still in place today. The Jiibegmegoong site is located approximately 3 km from Bruce A and 1 km from Bruce B, the Western Waste Management Facility (WWMF) and the road leading to the main gate.

In October 2012, the Ontario government and SON signed another five year agreement (last agreement signed in 2005) to manage the commercial fishery in the waters of Lake Huron and Georgian Bay around the Bruce Peninsula. Under the terms of this agreement, the two First Nations will be responsible for designating community members to fish and monitor the commercial fishery through catch sampling. The agreement addresses commercial fishing only and does not seek to regulate the Aboriginal right to fish for subsistence, social, or ceremonial purposes.

Figure 30: Traditional Territories of Saugeen Ojibway Nations. (Illustrative map kindly provided by SON. Map drawn by Polly Keeshig-Tobias. Anishnabemowin names from SON elders.)



Historic Saugeen Métis (HSM)

The HSM identify themselves as an independent, historic Métis community located at Southampton, Ontario, which represent the descendants of Métis in the historic Saugeen community prior to settlement. The HSM asserts that community members have lived, fished, hunted, trapped, and harvested the lands and waters of the Bruce Peninsula, the Lake Huron proper shoreline and its watersheds, with continuity for almost two hundred years.

The HSM has been recognized by the federal government as well as the Ontario Ministry of Natural Resources (MNR) to have an asserted claim of Aboriginal rights in the Métis Saugeen territory.

<u>Métis Nation of Ontario (MNO)</u>

The MNO was established in 1993 to represent the collective aspirations, rights and interests of Métis people and communities throughout Ontario. The MNO has a democratic, province-wide governance structure which ensures Métis people are represented at the local, regional and provincial levels. There are nearly 20,000 currently registered MNO citizens with thousands of new applicants in the process of obtaining their citizenship.

The MNO recognizes nine distinct Regions. The Bruce site is located within the Georgian Bay Region (Region 7). The three Métis councils located closest to the Bruce site are the Moon River Métis Council, the Georgian Bay Métis Council and the Great Lakes Métis Council. The traditional Métis harvesting territory, which includes the Bruce site, is a territory of approximately 37,000 km (see Figure 31). According to the Georgian Bay Consultation Protocol, consultation involves the creation of a four person consultation committee. The Committee includes the MNO Regional Councillor and one representative designated by each of the MNO Community Councils. They work together to develop and implement a mutually agreeable consultation workplan to ensure that the Crown fulfills its constitutional duties to the rights-bearing Métis Community in relation to any projects.

The Métis do not have reserves or a common land base. An interim agreement between the MNO and the Ministry of Natural Resources and Forestry which recognizes the MNO's Harvest Card system was reached in 2004. This means that MNO Harvester's Certificate holders, engaged in traditional Métis harvest activities will not be charged unless they are in violation of conservation or safety standards. An amendment was made to the agreement in 2015 which allowed the MNO to issue an additional 200 harvesting cards provided they share data regarding the Métis harvest to assist in effective natural resource management and planning. In addition, Ontario is obligated to share information with the MNO about moose harvesting pressures.

In 2008, the MNO and Ontario Government signed the MNO-Ontario Framework Agreement, and renewed it in 2014. The Agreement seeks to advance “reconciliation between the Crown and the Métis people” and provide “a framework for meeting Ontario’s constitutional obligations towards the Métis people consistent with the honour of the Crown and decisions of the courts.” It commits to develop MNO consultation capacity, support economic development initiatives, and improve the outcomes for Métis students. It also calls for the MNO and Ontario to jointly pursue discussions with the Government of Canada on Métis rights issues and the Crown’s consultation duties.

On July 31, 2015, a bi-lateral agreement was signed that establishes a consultation process with members of the Ontario Métis communities represented by the Métis Nation of Ontario. The Agreement establishes a clear and efficient means for Canada and the Métis Nation of Ontario to consult on proposed actions or decisions that may adversely impact asserted or established Aboriginal rights.

The MNO has completed a valued components monitoring report with regards to the Bruce Site. The MNO Métis-specific valued components and indicators represent Métis rights and interests that have a reasonable probability of experiencing change as a result of the Project that were not covered in the OPG and Bruce Power monitoring programs.

The Report indicated that trends related to selected indicators were broadly negative in terms of environmental effects and positive or requiring more information in terms of social effects.

Figure 31: MNO Regions (Source: MNO website: http://www.metisnation.org/programs/economic-development/mno-regions)

F. SUMMARY OF KEY CNSC MEETINGS/ACTIVITIES WITH INDIGENOUS GROUPS RELATED TO THE BRUCE SITE

The following table contains summary of some key meetings and activities, specific to the operations of Bruce A and B, carried out between CNSC staff and the local Bruce Indigenous groups since 2014. CNSC staff also carried out other activities associated with the Bruce site (such as Nuclear Power Demonstrator at Douglas Point, Deep Geological Repository, Western Waste Fuel Management, etc.) which are not included in this table.

Date	Indigenous group	Activity	Key Issues/Topic
27-Feb-14	SON	Meeting	Discussions on deep geological repository and other matters related to the Bruce NPP site such as impingement and entrainment (I&E) of fish.
20-Mar -14	SON	Email	Follow-up to Feb. 27, 2014 meeting regarding potential meetings/workshops on items related to Bruce Power's EA follow-up monitoring program (EA FUMP), including an update on the preliminary results of the work to date on thermal effects, and a review and resolution of the SON's comments on the entrainment/impingement portion of the EA FUMP.
22-April-14	MNO HSM (separately)	Email	Offer to meet to discuss Bruce Power's licence renewal applications for Bruce NGS A and B.
25-April-14	SON	Meeting	Planning discussions for workshop related to SON's I&E concerns.
6-May-14	SON	Email	Follow-up on some of the CNSC action items from the Apr. 25, 2014 meeting.
13-May-14	HSM	Meeting	Discussed the CNSC licensing review process; the status of Bruce Power's licence renewal applications; CNSC – Department of Fisheries and Oceans Memorandum of Understanding regarding the *Fisheries Act*; Bruce site *Fisheries Act* authorization application and related processes; and HSM activities update.
5-June-14	SON	Teleconference	Discussions on *Fisheries Act* authorization process (workshop logistics discussed).
31-July-14	SON	Teleconference	Continued discussions on a proposed workshop on fish related matters as well as a Bruce site wide issues meeting.
8-Sept-14	SON	Teleconference	Discussions on the technical aspects of SON's comments on Bruce Power's I&E program. CNSC staff requested that SON organize their concerns into themes which could be discussed in a one-day workshop format.
3-Oct-14	SON	Teleconference	First technical meeting to discuss SON/UofG's concerns with the Bruce EA follow-up program re: fish I&E.
27-Oct-14	SON	Meeting	Provided an update on the licence renewal process, work related to understanding the thermal discharge, how environmental protection is performed under the NSCA and an update on the *Fisheries Act* authorization process.
24-Oct-15	MNO	Meeting	Participation in MNO Georgian Bay Regional Council meeting.

Date	Indigenous group	Activity	Key Issues/Topic
19-Feb-16	SON	Teleconference	Discussions on use of a facilitator for fish I&E workshop and the draft Terms of Reference (ToR).
3-June-16	SON	Teleconference	Discussions on the revised ToR. CNSC strongly emphasized that the facilitator should have facilitation experience rather than focusing on science background. SON disagreed and felt that a science person would work better. After agreeing that the facilitator would not be making independent third-party recommendations on the technical matters, SON appeared to agree that facilitation experience was important however still wanted it to be in a scientific or regulatory context.
27-Sept-16	MNO	Meeting	Discussions on various aspects of CNSC oversight such as WWMF, licence renewal, regulatory oversight, licence process, PFP opportunity.
4-Oct-16	SON MNO HSM (separately)	Email	Confirmed that Bruce Power's *Fisheries Act* authorization application was received and informed that the CNSC will be doing a sufficiency check over the next few weeks.
3-Nov-16	SON MNO HSM (separately)	Email	Provided an update on the status of the *Fisheries Act* authorization application. Noted that the CNSC staff sufficiency review resulted in a need for more information on a few subjects, including proposed offsetting plans and feedback received from SON, MNO and HSM.
4-Nov-16	SON	Meeting	Meeting with CNSC senior management to discuss the CNSC's role as an agent of the Crown.
9-Nov-16	HSM	Meeting	Discussions on potential for fish conference and whether they would be interested in attending or participating.
27-Feb-17	SON	Meeting	Discussions on Bruce licence renewal as part of a discussion on Western Waste Management Facility (WWMF).
7-Mar-17	MNO	Meeting	Discussions on *Fisheries Act* authorization, Lake Huron Saugeen Watershed Conference, WWMF, and relationship building.
8-Mar-17	HSM	Meeting	Discussions on *Fisheries Act* authorization, Lake Huron Saugeen Watershed Conference, WWMF, and relationship building.
20-Apr-17	SON	Teleconference	Discussions on logistics of upcoming (May 25, 2017) workshop. Provided clarification on *Fisheries Act* authorization process.
25-May-17	SON	Workshop	Facilitated workshop to discuss SON's I&E concerns. Report was issued on workshop which categorized SON's concerns into 5 areas. These issues will be addressed in future workshops.
24-Jul-17	MNO	Meeting	Meeting to discuss valued components report.
1-Aug-17	HSM	Meeting	Discussions on Bruce licence renewal, including process timelines.

Date	Indigenous group	Activity	Key Issues/Topic
18-20 - Aug-17	MNO	Meeting	CNSC staff had a booth and many topics were discussed, including CNSC oversight of nuclear power plants, protection of major water bodies where nuclear facilities are located, CNSC's approach to Aboriginal consultation and engagement, and CNSC's Participant Funding Program.
8-Sept-17	SON MNO HSM (separately)	Letter	Letter of notification regarding Bruce Power's application to renew its power reactor operating licence, interest in hearing SON's, MNO's and HSM's views at the hearing, and the availability of and deadline to apply for participant funding.
12-Sep-17	SON	Meeting	Discussions on mandate mapping (consultation mandate of government agency), workshop report, and licence renewal including MCR. SON was disappointed in the hearing process being used. CNSC staff provided response to their concerns.
19-Oct-17	SON	Meeting	Discussions on *Fisheries Act*, MCR/relicensing process, and mandate mapping.
4-Nov-17	MNO	Meeting	At the annual meeting of Region 7 councillors, MNO requested CNSC staff to provide a presentation on the status of *Fisheries Act* authorization, the licence renewal and the MCR project.
17-Jan-18	MNO	Meeting	Discussions on IEMP, status update on *Fisheries Act* authorization and status update on licence renewal.
19-Jan-18	SON	Workshop	Discussions on CNSC regulatory oversight of environmental issues and *Fisheries Act* authorization.
07-Feb-18	SON	Workshop	Discussions on CNSC regulatory oversight of environmental issues and *Fisheries Act* authorization, duty to consult and reconciliation.

G. ENVIRONMENTAL ASSESSMENT REPORT

Environmental Assessment Report:

Bruce Power Inc. – Bruce Nuclear Generating Stations A and B – Licence Renewal (eDocs 5401045)

Canada's Nuclear Regulator

Environmental Assessment Report:

Bruce Power Inc. – Bruce Nuclear Generating Station A and B – PROL 18.00/2020 Licence Renewal

February 2018

e-Doc: 5388185 (Word)
e-Doc: 5401045 (PDF)

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

REVISION HISTORY

The following table identifies the revision history of this document.

Revision number	Change	Summary of changes	Date
000	Initial release	N/A	

EXECUTIVE SUMMARY

The Canadian Nuclear Safety Commission (CNSC) conducts environmental assessments (EA) under the *Nuclear Safety and Control Act* (NSCA) for all projects, in accordance with its mandate, to ensure the protection of the environment and the health of persons. The safety component of CNSC's mandate is covered in the safety case assessment carried out for all projects.

This EA report, written by CNSC staff for the Commission and the public, describes the findings of the EA under the NSCA completed for the licence application by Bruce Power Inc. (Bruce Power) to renew the Bruce A and B Nuclear Generating Stations Power Reactor Operating Licence (PROL 18.00/2020) for a period of 10 years, from September 1, 2018 to August 31, 2028. During the licensing period, Bruce Power is also proposing to implement the Major Component Replacement Project (MCR) for the purpose of extending the operational life of Bruce A and B.

This EA report includes CNSC staff's assessment of the licence application and the documents submitted in support of the application, annual environmental monitoring reports, the results of previous studies, compliance verification activities (e.g., inspections, audits, and reviews) conducted at the Bruce site, as well as the findings of CNSC's Independent Environmental Monitoring Program (IEMP).

The EA report focuses on items that are of current public and regulatory interest such as releases to air, groundwater and surface water, for ongoing operations and those related to the MCR project.

CNSC staff's findings from this EA under the NSCA include, but are not limited to, the following:

- Bruce Power's environmental protection programs meet CNSC regulatory requirements.
- Bruce Power's environmental risk assessment (ERA), which assessed the environmental (ecological and human health) risks from radiological, non-radiological and physical stressors associated with current facility operations, is in accordance with CSA Group Standard N288.6-12, *Environmental risk assessment at class I nuclear facilities and uranium mines and mills* (2012).
- Bruce Power's predictive environmental assessment (PEA) within the ERA, which assessed the potential environmental (ecological and human health) effects from radiological, non-radiological and physical stressors associated with continued operations and the Major Component Replacement Project, is in accordance with the overall methodology of CSA Group Standard N288.6-12, *Environmental risk assessment at class I nuclear facilities and uranium mines and mills* (2012).
- The results from other regional monitoring programs carried out by other levels of government confirm that the environment and health of persons around the Bruce site are protected.

- The results of CNSC's IEMP confirm that the public and the environment in the vicinity of the Bruce site are protected from the releases from Bruce A and B.

CNSC staff concluded that the potential risk from physical stressors and radiological and non-radiological releases to the atmospheric, terrestrial, hydrogeological, aquatic and human environment are generally low to negligible and the ERA to be consistent with the overall methodology of the CSA Group Standard N288.6-12. CNSC staff's review of the Bruce Power ERA identified areas that would benefit from further clarification and/or additional information. CNSC staff will review the implementation of these recommendations through the review of Bruce Power's environmental monitoring program reports and through future revisions of the ERA.

This EA under the NSCA conducted for the renewal of the Bruce A and B Power Reactor Operating Licence concludes that Bruce Power has and will continue to make adequate provision for the protection of the environment and the health of persons. The implementation of the recommendations outlined above do not affect these conclusions. CNSC staff will continue to verify and ensure that, through ongoing licensing and compliance activities and reviews, the environment and the health of persons are protected and will continue to be protected until the safe state and abandonment of Bruce A and B.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Environmental Assessment (EA) Report is to document the results of the EA conducted under the *Nuclear Safety and Control Act* (NSCA) for the licence application by Bruce Power Inc. (Bruce Power) [1] to renew the Bruce A and B Nuclear Generating Stations Power Reactor Operating Licence, PROL 18.00/2020 [2], for a period of 10 years, from September 1, 2018 to August 31, 2028. Bruce Power's licence application includes continued operation of all reactor units, and the intent to proceed with major component replacement (MCR) for life extension of the Bruce Power nuclear facility. This EA under the NSCA considers operations, MCR, decommissioning and abandonment; and was conducted to determine whether Bruce Power has made, and will continue to make, adequate provisions for the protection of the environment and the health of persons.

This EA report is based on the latest science available, information submitted by Bruce Power and activities completed by CNSC staff, which includes the following:

- regulatory oversight (section 2)
- CNSC staff review of Bruce Power's 2017 environmental risk assessment (ERA) (sections 2.1.1 and 3.1)
- CNSC staff review of Bruce Power's 2017 predictive environmental assessment (PEA), submitted as part of the ERA (section 3.3)
- CNSC staff review of the recent preliminary decommissioning plan (PDP) to inform an assessment of environmental effects post decommissioning (section 2.1.6)
- CNSC staff review of Bruce Power's EA follow-up program (section 2.2.3)
- Independent Environmental Monitoring Program (IEMP) results (section 4)
- Update on other regional monitoring activities (section 5)

An analysis has been conducted for all components related to the project, but only a selection of topics are presented in detail in this report. Topics were selected as those being of interest to the Commission, members of the public, Indigenous groups, or of regulatory interest. These topics include atmospheric, aquatic, geological, hydrogeological, terrestrial, environments and human health. Topics of regulatory interest include greenhouse gas emissions and regional monitoring conducted by other levels of government.

CNSC staff keep informed of emerging science and applies appropriate evidence-based decision making to assess the environment at every phase of a project and its activities, and will continue to do so until the decommissioning and abandonment of the site. CNSC staff assess potential impacts of the environment and health of persons throughout all phases of a facility's lifecycle. An EA report is prepared prior to licensing to provide transparency to the public and advice to the Commission.

1.2 Background

Bruce Power operates the Bruce Nuclear Power Development Site (Bruce nuclear site), which includes Bruce A and B and lands occupied by Ontario Power Generation (OPG) and Canadian Nuclear Laboratories (CNL).

The Bruce nuclear site is located on the shores of Lake Huron (see figure 1.1 and 1.2), in the Municipality of Kincardine, in the County of Bruce, Ontario. OPG owns Bruce A and B, which Bruce Power has been operating under a lease agreement with OPG since 2001. Bruce A and B produce 6300 MW of electricity in Ontario, as well as cobalt-60, a radioactive substance used in the medical industry for cancer treatment and sterilization of medical devices.

Several support facilities are also located on the Bruce nuclear site, including a sewage processing plant, garages, warehouses, workshops, administrative buildings and the Central Maintenance and Laundry Facility (CMLF). In addition, the Bruce nuclear site contains the Western Waste Management Facility (WWMF), which is owned and operated by OPG and the Douglas Point Waste Management Facility (DPWMF), which is owned by CNL. Both the WWMF and DPWMF are operated under separate CNSC licences.

This EA report includes CNSC staff's assessment of the licence application and documents submitted by Bruce Power for licence renewal of Bruce A and B, and includes continued operation of all reactor units, and the intent to proceed with major component replacement (MCR) for life extension of the Bruce Power nuclear facility. It does not include the other facilities on the Bruce nuclear site, as they operate under separate licences issued by the CNSC.

Figure 1.1: Location of the Bruce Nuclear Generating Stations A and B

Figure 1.2: Aerial view showing Bruce B in foreground and Bruce A in background

1.2.1 Project Overview

Bruce A consists of four 750 megawatt CANDU[1] reactors (Units 1 to 4) which came into service between 1977 and 1979. Bruce B consists of four 822 megawatt CANDU reactors (Units 5 to 8) which came into service between 1984 and 1987. Bruce A units were put in laid-up condition by OPG in 1998. In 2001, Bruce Power took over the operation of the site from OPG, and returned Units 3 and 4 to service in 2003 and 2004, respectively, and entirely refurbished Units 1 and 2 in 2012. As of the fall of 2012, Bruce Power returned the site to its full operational capacity, with all eight units fully operational.

In May 2015, following a two-part hearing, the CNSC renewed the power reactor operating licence for Bruce A and B. The current operating licence (PROL 18.00/2020) is valid from June 1, 2015 until May 31, 2020. In the *Record of Proceedings, Including Reasons for Decisions* [3], and in the issued operating licence there are requirements for the licensee to inform the Commission of any plans to refurbish a reactor or replace major components at the nuclear facility.

On June 30, 2017, Bruce Power submitted an application for the renewal of their operating licence (PROL 18.00/2020) for a 10-year term [1]. As part of the licence renewal application,

[1] CANada Deuterium Uranium

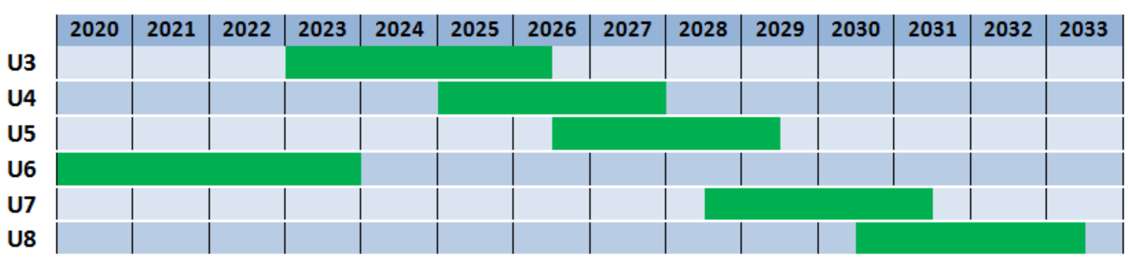
Bruce Power is also applying to extend the operational lives of Units 3 to 8, which includes the replacement of major components through the Major Component Replacement (MCR) project.

During the proposed 10-year licencing period, Bruce Power would continue operation of all eight reactor units at Bruce A and Bruce B. While the scope of the MCR project is included in the Integrated Implementation Plan (IIP), Bruce Power plans to conduct additional work on the units as part of its asset management program. Bruce Power's plan is to complete any required asset management work in normal maintenance outages but, where this is not possible, (e.g., where the work requires significant field time – greater than 90 days, or a defueled/dewatered state) this work will fall within the MCR outages.

The MCR project will be limited in scope to focus on the replacement of key major components, including replacement of steam generators, replacement of feeder tubes, fuel channels and calandria tubes, as well as work related to defueling, dewatering and refueling the reactors. Bruce Power's plan is to complete routine or regularly scheduled maintenance work (work that falls outside of MCR activities) during normal maintenance outages. This approach was developed from lessons learned from the refurbishment of Units 1 and 2 and Bruce Power's life extension activities since 2001 [1].

Bruce Power's proposed MCR activities will not commence before 2020. Once begun, MCR outages will be carried out in a phased approach (i.e., one unit at a time) beginning with Unit 6, and completed over a 13 year period. The life extension program proposed by Bruce Power will extend the operating life units through to 2064, pending approval by the Commission. This time period extends beyond the licensing period being sought. The environmental impact of Bruce A and B will be reviewed annually and at each future licence renewal. For continued operation of Bruce A and B, Bruce Power is be required to apply to the CNSC for subsequent licence renewals to demonstrate continued safe operation and to complete further life extension activities. The proposed schedule is shown in figure 1.3.

Figure 1.3: Bruce Power proposed MCR timelines



In support of the licence application for continued operation of the reactor units, including activities associated with the MCR, Bruce Power submitted an updated environmental risk assessment (ERA) in accordance with accordance with CSA Group Standard N288.6-12, *Environmental risk assessment at class I nuclear facilities and uranium mines and mills* (2012) [4], a Periodic Safety Review (PSR) and IIP in accordance with CNSC Regulatory Document REGDOC-2.3.3, *Periodic Safety Reviews* [5].

The updated ERA is required to demonstrate that Bruce Power has provisions in place to protect the environment and human health and to inform the licensing process for the continued operations of the reactor units, including MCR activities. Bruce Power's ERA evaluates the risk of contaminants and physical stressors to human and ecological receptors, related to Bruce A and B and its activities. Human receptors were defined as those within 20 km of the site. Ecological receptors were those identified on-site, within the immediate area and within the near-field receiving waters. Consistent with expectations outlined in CNSC Regulatory Document REGDOC 2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures* [6], licensees are required to review and revise the ERA every five years or earlier should there be significant changes in either the facility, activity or in the science on which the ERA is based.

Waste Management

Current waste management practices will be utilized during continued operations, including during MCR activities for radioactive and non-radioactive solid, liquid and gaseous waste. The wastes generated during the MCR project includes steam generators, reactor components, piping system, fuel channels and feeder piping. Additional waste management measures during the MCR activities include:

- Reactor retube and feeder replacement waste will be stored in new radiological waste containers on the Bruce nuclear site.
- Existing steam generators will be stored at OPG's WWMF, located on the Bruce nuclear site.
- Pressure, feeder and calandria tubes will be cut and placed in specially designed waste containers, which will be transferred directly to OPG's WWMF.
- Radiological waste (low- and intermediate-level waste) will be sampled, monitored for radioactivity and transferred to a third party contractor.
- Non-radiological conventional and hazardous waste will be sampled, monitored and transferred to a third party contractor.

2.0 REGULATORY OVERSIGHT

The CNSC regulates nuclear facilities and activities in Canada to protect the environment and the health and safety of persons in a manner that is consistent with Canadian environmental policies, acts and regulations and with Canada's international obligations. The CNSC assesses the environmental effects of nuclear facilities and activities at every phase of their lifecycle. This regulatory oversight of environmental protection measures at the Bruce site are elaborated further within section 2.0.

To meet CNSC's regulatory requirements, Bruce Power is responsible for implementing and maintaining environmental protection measures that identify, control and (where necessary) monitor all releases of radiological and non-radiological (hazardous) substances and effects on human health and the environment, from the Bruce nuclear site. These environmental protection measures must comply with, or have implementation plans in place to comply with the regulatory requirements set out in table 2.1.

In addition, as part of CNSC's regulatory oversight, compliance activities of verification, enforcement and reporting are in place to ensure that CNSC licensees are in compliance with CNSC's regulatory framework. Bruce Power is required to submit an annual environmental monitoring report that details the results of the environmental protection measures related to the operations of Bruce A and B. These annual reports are reviewed by CNSC staff and are publicly accessible on Bruce Power's website.

The CNSC also publishes an annual *Regulatory Oversight Report on Canadian Nuclear Power Plants* [7]. This report compiles data collected through various means of inspection, review and oversight conducted by CNSC staff and highlights industry trends. These reports are presented annually to the Commission at a public proceeding.

Table 2.1: Implementation of regulatory requirements

Document Title	Implementation Date
REGDOC-2.9.1 v1.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures* [6]	December 31, 2020
CSA Group Standard N288.1-2014, *Update 2, Guidelines for calculating derive release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* [8]	December 31, 2020
CSA Group Standard N288.4-2010, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills* [9]	December 31, 2018
CSA N288.5-2011, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [10]	December 31, 2018
CSA Group Standard N288.6-2012, *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills* [4]	December 31, 2018
CSA Group Standard N288.7-2015, *Groundwater Protection Programs* [11]	December 31, 2020

The following sections provide information on CNSC's regulatory oversight of environmental protection measures for Bruce Power's operations.

2.1 Environmental Protection Measures

Environmental protection measures identify, control and monitor releases of radiological and non-radiological substances from facilities or activities, and their effects on the environment, to protect the environment and the health of persons. Environmental protection measures are an important component of the overall requirement for licensees to make adequate provision for protection of the environment.

Environmental protection measures may also be referred to as environmental protection programs. Applicants and licensees are not required to update their management system or other documents to reflect the term "environmental protection measures", but they must meet the requirements listed in this section.

The necessary environmental protection measures required for Bruce A and B are described in this section.

2.1.1 Environmental Risk Assessment

An environmental risk assessment (ERA) of nuclear facilities is a systematic process used to identify, quantify and characterize the risk posed by contaminants and physical stressors in the environment on biological receptors, including the magnitude and extent of the potential effects associated with a facility [4]. An ERA must be submitted in accordance with CSA Group Standard N288.6-12, *Environmental risk assessment at class I nuclear facilities and uranium mines and mills*. An ERA is a practice or methodology that can provide science-based information to support decision-making, risk-informed recommendations for improvement of the effluent and environmental monitoring program and risk management, and to prioritize the implementation of mitigation measures.

An ERA:

- identifies and prioritizes the contaminants and physical stressors of concern, their sources or points of release, and the potential human and non-human receptors
- identifies facility or activity-specific characteristics, site-specific environmental characteristics, and interactions between them
- provides an assessment of the receptor exposure to the contaminants and physical stressors
- provides an assessment of the environmental risk to receptors posed by the facility
- identifies and quantifies the uncertainties in the assessment of the environmental risk
- is used to demonstrate protection of the environment and human health under the NSCA, and should be conducted every five-years or when major changes have occurred to the facility, or new scientific information becomes available

In June 2017, Bruce Power submitted a 2017 ERA [12] for Bruce A and B based on effluent and environmental monitoring data for the five year period between 2012 and 2016. In December 2017, Bruce Power provided supplemental information [13] for CNSC staff review. The ERA included an ecological risk assessment (EcoRA) and a human health risk assessment (HHRA) for radiological and non-radiological (hazardous) contaminants of potential concern (COPCs) and physical stressors related to Bruce A and B. The purpose of the 2017 ERA was to update the previous baseline ERA that was submitted by Bruce Power in 2015 [14] and to support the current application for licence renewal.

The 2017 ERA included updated baseline monitoring information, such as:

- addition of a hunter/fisher receptor, representative of Indigenous peoples
- incorporation of recent EA follow-up and aquatic monitoring information, including information on fish impingement and entrainment, aquatic life habitat information and thermal surveys
- additional baseline information for soil quality monitoring, water and sediment quality monitoring, ambient air quality monitoring and noise monitoring

Bruce Power also submitted a predictive environmental assessment (PEA), as part of the ERA submission, which is a predictive assessment to determine whether changes to current conditions during proposed MCR activities would result in additional risk to human and ecological receptors. Overall, the purpose of the ERA and PEA is to demonstrate that Bruce Power has made adequate provision for the protection of the environment and to human health and for current operations, as well as during continued operations and MCR activities that will occur in the future, pending approval by the Commission. Bruce Power has posted the submitted 2017 ERA on its website.

Based on the information provided, CNSC staff concluded that the potential risks from physical stressors and radiological and non-radiological releases to the atmospheric, terrestrial, hydrogeological, aquatic and human environment are low to negligible and the ERA to be consistent with the overall methodology of the CSA Group Standard N288.6-12 [4]. CNSC staff provided comments to Bruce Power with specific recommendations to validate some ERA conclusions, to improve the ERA quality and to reduce uncertainties in future versions of the ERA. The EA report explains the actions for Bruce Power to undertake to confirm these conclusions, based on staff's review of Bruce Power's ERA and related information, as of the end of January 2018.

However, the supplemental information [13] and additional actions identified by CNSC staff do not change any conclusions of the 2017 ERA.

CNSC staff requested the ERA be updated to provide clarification and/or additional information. Specifically, Bruce Power is to provide, through modifications and/or enhancements of their existing environmental monitoring program or through updates to the ERA, the following:

- future monitoring and assessment to address potential risks to aquatic and semi-aquatic receptors utilizing the South Railway Ditch and the former sewage lagoon
- future monitoring of impingement and entrainment to reduce data uncertainties, including entrainment monitoring of Deepwater Sculpin and to refine the conclusions on potential impacts via the cooling water intake
- a winter thermal plume model and action plan to reduce uncertainties related to potential risk to fish species
- future monitoring and assessment to address knowledge and data gaps in bird, plant, invertebrate, fish and wildlife exposure to COPCs, including hazardous contaminants, alpha

emitters, C-14, tritium and organically bound tritium, and other radionuclides to reduce uncertainty in the ecological risk assessment

- further information on beta and gamma emitters in soils and dose due to animal product ingestion to confirm the conservative assumptions used in the human health radiological risk assessment

CNSC staff will track these recommendations through Action Item 2018-07-12218 and through review of the environmental monitoring program reports submitted annually to the CNSC and/or through future revisions of the ERA.

The ERA is required to be reviewed and revised every five years or earlier should there be significant changes in either the facility, activity or in the science on which the ERA is based.

Overall, adverse effects resulting from releases to air and water are unlikely, which is consistent with the overall conclusion of previous EAs completed under the CEAA 1992 and under the NSCA for Bruce A and B. CNSC staff concluded that the overall 2017 ERA provides sufficient evidence that the public and environment are protected. This conclusion is also supported through the CNSC's regulatory oversight of annual environmental monitoring reports, and compliance verification activities (e.g., inspections, audits, and reviews) and the CNSC's IEMP results conducted around the Bruce nuclear site.

Bruce Power's ERA was the primary source of information used to inform the Environmental Effects Assessment for Continued Operations (sections 3.2 – 3.2.5) and the Environmental Effects Assessment for MCR (sections 3.3 - 3.3.5). Additionally, Bruce Power's recent licence application [1] and the 2016 environmental monitoring report [15] inform various sections of this EA report.

Table 2.2: Summary of Bruce Power's 2017 ERA conclusions

Type	Members of the public	Aquatic biota	Terrestrial biota
Radiological	No adverse impacts expected from radiological contaminants of potential concern (COPCs) released from the Bruce site	No adverse impacts expected from radiological COPCs released from the Bruce site	No adverse impacts expected from radiological COPCs released from the Bruce site
Non-Radiological	No adverse impacts expected from non-radiological COPCs released from the Bruce site	No adverse impacts expected from non-radiological COPCs released from the Bruce site	No adverse impacts expected from non-radiological COPCs released from the Bruce site However, low potential risks from exposure to COPCs in soils were identified for a small number of ecological receptors at a limited number of former industrial areas within the site (see section 3.2.2 for more information)

Type	Members of the public	Aquatic biota	Terrestrial biota
Physical Stressors*	No adverse impacts expected from noise	No adverse impacts are expected to aquatic biota from thermal releases to the aquatic environment. No adverse impacts to aquatic biota, at the population level, expected from impingement and entrainment	No adverse impacts are expected to terrestrial biota from noise, road kill, bird strikes, or habitat alteration

* Physical stressors for aquatic receptors include entrainment/impingement of aquatic biota and thermal releases to the aquatic environment. Physical stressors for terrestrial receptors include noise, road kill and habitat alteration.

2.1.2 Environmental Management System

An environmental management system (EMS) refers to the management of an organization's environmental policies, programs and procedures in a comprehensive, systematic, planned and documented manner. It includes the organizational structure, planning and resources for developing, implementing and maintaining policy for environmental protection.

An EMS is the integrated set of documented activities (policies, programs and procedures) that provide a framework for action with respect to environmental protection. An EMS encompasses:

- control measures on releases and wastes to prevent or mitigate environmental effects
- demonstration of the effectiveness of those control measures
- training of personnel
- public information and disclosure

CNSC staff determined that Bruce Power has established and implemented an EMS, integrated into the corporate wide management system, in accordance with REGDOC-2.9.1, *Environmental Protection: Policies, Programs and Procedures* [6] as referenced in Bruce Power's licence.

Bruce Power fully complies with the recently released ISO 14001: 2015 edition. The major themes of which are in the areas of leadership and commitment of management, identification of risks/opportunities related to environmental aspects affecting interested parties, protection of the environment beyond prevention of pollution, continual improvement of environmental performance, adoption of a lifecycle approach when determining environmental aspects, and internal/external communications.

2.1.3 Effluent and Emissions Control and Monitoring

Controls on environmental releases are established to provide protection to the environment and to respect the principles of sustainable development, pollution prevention and continuous improvement. The effluent and emissions preventive and control measures are established on the basis of best industry practice, incorporating the results of an ERA.

CSNC staff determined that Bruce Power has implemented and maintains an effluent monitoring program. Bruce Power's reported radiological and non-radiological releases at the Bruce site during the licensing period have remained below their respective regulatory limits, as detailed below and summarized in section 3.0 of this EA report:

- Radiological releases are in compliance with derived release limits (DRLs) and action levels, approved by the CNSC, to control radiological air and effluent releases from the site. A DRL for a given radionuclide is the quantity that would cause an individual of the most highly exposed group to receive a dose equal to the regulatory annual dose limit of 1 mSv.
- Non-radiological liquid effluent is monitored in accordance with the Provincial Environmental Compliance Approval (ECA) requirements. For COPCs where no criteria is available, toxicity benchmarks are used as screening criteria. COPC's not addressed by the ECA are assessed through the ERA to determine they merit additional regulatory oversight.
- Non-radiological airborne emissions are in compliance with provincial regulation O. Reg. 419/05, which is met by complying with the ECA for Air and Noise. An Emissions Summary and Dispersion Modelling (ESDM) report is used to document and maintain compliance with O.Reg. 419/05.

2.1.4 Environmental Monitoring

Bruce Power's environmental monitoring program (EMP) is designed to sample, measure, analyze, interpret and report on the following in the vicinity of the Bruce site:

- concentration of radiological and non-radiological substances in environmental media
- effect, or lack of effect, on biological organisms or communities if such potential is predicted by the ERA or required by legislation
- intensity of physical stressors (e.g., noise) and their potential effect on human health and the environment
- physical, chemical and biological parameters in the environment considered in the design of the environmental monitoring necessary to support the interpretation of the results
- physical, chemical and biological parameters in the environment considered necessary to support the interpretation of the results of the monitoring program

Based on Bruce Power's EMP, environmental samples from different pathways of the food chain are collected from various offsite locations and analyzed. Data from the program are also used to assess public dose resulting from the routine operation of Bruce A and B, and to verify predictions made in the ERA.

Routine monitoring of the receiving environment associated with Bruce Power's operations is completed under the EMP through a wide range of environmental monitoring activities. As per reporting requirements outlined in the licence and licence conditions handbook (LCH) [2], Bruce Power completes an annual report of their EMP for public posting and submission to the CNSC for review and assessment.

Bruce Power met current regulatory requirements and commits to implementing the revised with CSA Group Standard N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*, by December 31, 2018.

Further, Bruce Power has also committed to implement by December 31, 2020, CSA Group Standard N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* [11]. While the existing environmental and groundwater monitoring programs under the EMP are satisfactory, implementation of these CSA Group Standards will ensure a more standardized approach that will improve compliance.

Based on CNSC staff reviews of the Bruce Power's annual EMP reports, CNSC staff concluded that Bruce Power has adequate measures in place to provide adequate protection of the environment.

2.1.5 Public Dose

Radiological releases to the environment are controlled and monitored by the licensee's effluent and emissions control and environmental monitoring. Results of these programs are used to determine dose to members of the public and ensure that dose to the public remains below the regulatory dose limit of 1 mSv per year.

The *Radiation Protection Regulations* define prescribed dose limits for workers and members of the public, and require doses to be monitored by direct measurement or by estimation of the quantities and concentrations of any nuclear substance released as a result of a proposed activity. The regulations also require Bruce Power to implement a radiation protection program designed to ensure that doses to workers are controlled and do not exceed regulatory limits. Over the licensing period, radiation doses to workers were below the regulatory dose limits established in the radiation protection program.

Bruce Power also ensured the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to a representative member of the public from Bruce nuclear site over the licensing period remained well below the annual public dose limit of 1 mSv per year. The specific dose estimates are provided in table 3.14, of section 3.1.6 which outlines the details of the human health risk assessment (HHRA). The HHRA, a sub-element of the ERA [12] is completed for both radioactive and hazardous substances.

2.1.6 Preliminary Decommissioning Plan

Class 1 facilities, like Bruce A and B, are regulated by the CNSC through a phased licensing process which includes separate licences for site preparation, construction, operation, decommissioning and abandonment. A preliminary decommissioning plan (PDP) must be prepared and submitted to the CNSC for each licence in accordance with CNSC's Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities* [16].

OPG completed a PDP in December 2016, which has been accepted by the Commission. As OPG is the owner of the Bruce site, OPG is responsible for preparing a decommissioning plan and outlining the activities required to decommission the Bruce nuclear facility in a manner that will ensure that the health, safety and security of workers, the public, Indigenous groups and the environment are protected and the site is restored for other uses.

Bruce Power will ultimately return Bruce A and B to OPG (in a defueled and dewatered state) when the lease agreement expires between Bruce Power and OPG. OPG will retain ownership of the site throughout the course of decommissioning and subsequent restoration.

OPG has chosen a deferred decommissioning strategy on the basis of decommissioning planning studies that OPG has undertaken since the 1980's. Deferred decommissioning will require reactors and stations to be stored for approximately 30 years after shutdown to allow radiation levels to decay prior to dismantling and demolition. Decommissioning will proceed according to the following four distinct stages:

- Stage 1 - preparation for safe storage: after permanent shutdown of the nuclear generating stations (including defueling and dewatering), OPG will undertake all necessary modifications to the structures, systems and components to prepare for the safe storage period.
- Stage 2 - safe storage: also referred to as storage with surveillance, allows time for the decay of fission and activation products that remain in structures, systems and components. Fuel transfer from irradiated fuel bays will continue during this stage until all used fuel is transferred to the Western Waste Management Facility.
- Stage 3 - dismantling and demolition: the first reactor will be dismantled and followed in sequence by the remaining reactors while radiological and non-radiological substances and materials are removed from the site and transferred to approved disposal facilities.
- Stage 4 - completion of decommissioning and site restoration: remove and transfer any remaining radioactive material to an approved off-site disposal facility, and dismantle and remove any remaining structures, systems and components.

The site will ultimately be restored to a condition suitable for future OPG use. At that time, OPG will be eligible to submit an application to the CNSC for a Licence to Abandon. Should a licence be issued by the Commission it would release OPG from CNSC regulatory oversight as outlined in CNSC Regulatory Guide G-219: *Decommissioning Planning for Licensed Activities* [16].

It is important to note that decommissioning activities and associated schedules will be addressed in a comprehensive manner, and fully described in a detailed decommissioning plan (DDP). The DDP is submitted to CNSC with an application for a licence to decommission. This licence application would apply for all decommissioning activities including Stage 2, safe storage with surveillance.

2.2 Completed Environmental Assessments

The CNSC has conducted EAs for proposed and ongoing projects at the Bruce nuclear site under the NSCA and the former CEAA 1992. The purpose of an EA is to identify the possible environmental effects of a proposed project, and determine whether these effects can be mitigated before a licence decision can be made. Under the CEAA, a decision must be made which concludes that the project, after implementation of mitigation measures, will not cause significant adverse environmental effects before a project can proceed. Under the NSCA, the assessment of the environment is part of the ongoing lifecycle environmental protection framework. No decision is made on the EA itself, as the information is intended to inform and support the regulatory decision being sought.

To date, three screening-level EAs under the CEAA 1992 have been completed for the Bruce nuclear site as indicated in table 2.3. A short description of the most recent EAs completed under the NSCA and the CEAA 1992 is provided in this section, including further information regarding the ongoing EA follow-up program. Under the CEAA 2012 (and the former CEAA

1992), a follow-up program verifies the accuracy of the predictions of the EA and the effectiveness of the mitigation measures. The CNSC ensures that CEAA follow-up programs within the CNSC's mandate are incorporated within the licensing process.

Table 2.3: EAs completed under the CEAA 1992 for Bruce A and B

Project	Regime	EA start date	EA decision date	CEAA EA follow-up program (status)
Restart of Units 3 and 4 of Bruce A [17]	CEAA 1992	September 2001	Jan. 6, 2003	Yes (complete)
Proposed Use of New Fuel in CANDU Reactors at the Bruce B [18]	CEAA 1992	December 2003	June 17, 2005	No[1]
Bruce A Refurbishment for Life Extension and Continued Operation [19]	CEAA 1992	December 2004	July 5, 2006	Yes (complete)

[1] The Proposed Use of New Fuel in CANDU Reactors at Bruce B project was cancelled in 2009; therefore, no EA follow-up program was required.

2.2.1 Previous EAs Completed Under the CEAA 1992

Bruce A Refurbishment for Life Extension and Continued Operation

In 2004, Bruce Power applied to the CNSC for a licence amendment to return Units 1 and 2 of Bruce A to service. The licence application also considered the refurbishment of Units 3 and 4 at a later date to extend their operational life. The project consisted of the following elements:

- activities required to refuel Bruce A Units 1 and 2
- activities required to allow Units 1 and 2 to be brought to operational status
- activities required to extend the planned operational life of these units to allow continued generation of power by Units 1 and 2 for an extended period to the end of a potential Bruce Power lease in 2043
- activities required for the possible extended operational life of Units 3 and 4 and operation of these units through 2043
- activities required for the potential use of low void reactivity fuel in all four units at Bruce A

No new construction activities were planned for the Bruce A return to service project, and no changes to existing approved waste management practices or systems were proposed.

The project was subject to an EA under the CEAA 1992 and an EA Screening Report was completed. On July 5, 2006, the Commission concluded that Bruce Power's proposed project for the return to service of Units 1 and 2 and the refurbishment for life extension of Bruce A, taking into account the appropriate mitigation measures, was not likely to cause significant adverse environmental effects [20].

The EA process identified the need for an EA follow-up program [19] designed to validate the predicted environmental effects and effectiveness of the mitigation measures during the undertaking of the project.

2.2.2 Previous EAs Completed Under the NSCA

Bruce A and B Nuclear Generating Stations – PROL 15.00/2015 and 16.00/2015 Licence Renewal

In 2014, Bruce Power applied to the CNSC to renew Bruce A and B operating licences, PROL-15.01/2015 and PROL-16.01/2015 [21], both of which expired on May 31, 2015. Bruce Power requested a renewal of the licences for a period of five years to continue with current operations only; MCR activities were not considered in the context of this licensing action.

CNSC staff prepared an EA under the NSCA report for this licence renewal. CNSC staff concluded that Bruce Power had made, and would continue to make, adequate provision for the protection of the environment and the health of persons. A two-part public Commission hearing on the licence application was held on February 5, 2015 and April 13-16, 2015. On May 28, 2015, the Commission renewed the Bruce A and B operating licences as a single licence [2].

2.2.3 EA Follow-up Program

Bruce Power implemented an EA follow-up program [22] between 2007 and 2015 to verify predictions made in the 2006 Bruce A refurbishment for life extension and continued operation EA. As shown in table 2.4, the program consisted of 23 monitoring elements, several of which included assessing the impingement and entrainment of fish species, as well as the thermal effects on potential fish spawning habitat when all four units were back in operation at Bruce A. All of the elements within the follow-up program were previously closed with the exception of element 3.3, which was specific to Deepwater Sculpin and element 3.9, which was specific to substrate temperature.

Based on the information collected through the EA follow-up program for both of these elements, CNSC staff in consultation with Department of Fisheries and Oceans (DFO) and Environment and Climate Change Canada (ECCC) staff concluded that the results were inconclusive to verify the predictions of the EA due to insufficient information being available on the local population levels of Deepwater Sculpin and the difficulty in detecting the increase in substrate temperature (0.1 to 0.3^{o}C in the lake bottom temperature). To achieve the purpose of the EA follow-up program additional work on the overall topics of substrate temperatures and Deepwater Sculpin will be addressed within future ERA updates, EMP and as part of the *Fisheries Act* authorization, as appropriate. Therefore, these elements (elements 3.3 and 3.9) of the EA follow-up monitoring program have been closed.

While the EA follow-up program for these two elements is closed, CNSC and DFO staff recommended additional monitoring for entrainment and substrate temperatures are completed under Bruce Power's EMP. More details are provided in the Aquatic Environment section of this EA report, under Physical Stressors.

Table 2.4: Status of EA follow-up and monitoring elements for Bruce A Refurbishment for Life Extension and Continued Operation

Element	Monitoring element	Reporting period	Status
Radiation and radioactivity			
1.1 Dose to workers	Radiation dose to workers	2007 - 2013	Complete
1.2 Dose to public	Radiation dose to critical group	2007 - 2013	Complete
1.3 Dose to aquatic biota	Radionuclides in fish, sediment, and surface water	2007 - 2015	Complete
1.4 Groundwater quality	Tritium activity in wells	2007 - 2013	Complete
Surface water resources			
2.1 Lake water quality	Discharges from Active Liquid Waste Management System	2013	Complete
2.2 Lake water quality	Discharges from inactive drainage	2013 - 2014	Complete
Aquatic environment			
3.1 Entrainment of Lake Whitefish	Assess local population (if any) and monitor entrainment	2013 – 2014	Complete
3.2 Hydrazine and morpholine	Hydrazine & morpholine during vacuum building outages (VBO)	Only if VBO is taking place from May through June	Complete
3.3 Deepwater Sculpin	Population review and monitor entrainment	2007 – 2015	Complete
3.4 Impingement of Spottail Shiner and Lake Whitefish	Impingement rates	2013 – 2014	Complete
3.5 Creel census	Fishing pressure on Smallmouth Bass	2007 2009 - 2015	Complete
3.6 Smallmouth Bass survey	Smallmouth Bass nesting success	2009 - 2015	Complete
3.7 Aquatic effects	Dissolved oxygen in discharge channel	2013 - 2015	Complete
3.8 Aquatic habitat	Effects of thermal plume	2013	Complete
3.9 Aquatic habitat	Substrate temperature	2013	Complete
Atmospheric environment			
4.1 Air quality	Hydrazine emissions to air	2014	Complete
4.2 Air quality	Fine particulate matter ($PM_{2.5}$)	2007	Complete

Element	Monitoring element	Reporting period	Status
4.3 Air quality	Nitrogen oxide gases (NO_x)	2007	Complete
Geology, hydrogeology and seismicity			
5.1 Groundwater quality	Tritium activity Unit 4 sump	2008 - 2014	Complete
5.2 Groundwater quality	Tritium activity Unit 2 sump	2012 - 2013	Complete
Terrestrial environment			
6.1 Wildlife communities	Collisions with deer	2007 - 2012	Complete
Socio-economic conditions			
7.1 Population & economic	Visitations statistics	2007 - 2015	Complete
	Accommodation survey		Complete
7.2 Residents & communities	Public attitudes	2007, 2013	Complete

2.3 Greenhouse Gas Emissions

Under the federal *Canadian Environmental Protection Act* [23] and the provincial *Climate Change Mitigation and Low-carbon Economy Act* [24], Bruce Power is required to monitor and report on Greenhouse Gas (GHG) emissions at set thresholds.

In 2009, the federal annual reporting threshold of 100,000 tonnes CO_2 equivalent (CO_2e), established in 2004, was reduced to 50,000 tonnes. Ontario provincial reporting requirements are somewhat lower with reporting required for emissions of 10,000 tonnes and verification (certified third party) required for emissions over 25,000 tonnes.

Federally, Bruce Power has reported emissions for 2009 through 2011, though the latter represented voluntary reporting as emissions were just below the reporting threshold (e.g., 49,831 tonnes CO_2e). Emissions have been below the Ontario reporting requirements since 2014. Bruce Power continues to monitor and quantify GHG emissions to confirm they are below threshold values and provides the calculated emissions to the CNSC through their annual report [15].

The GHG emissions resulting from Bruce Power's operations from 2010 – 2016 are shown in table 2.5. The downward trend in GHG releases is attributed to the implementation of the Bruce Steam Plant shutdown strategy.

Table 2.5: Bruce GHG Emissions

Year	2010	2011	2012	2013	2014	2015	2016
GHG (CO_2e tonnes)*	68,463.7	46,488.4	32,310.2	16,215	3,679.6	5,021.1	3,948.4
Reporting Thresholds (CO_2e tonnes)	Federal: 50,000 Provincial: 10,000 and over 25,000 requires verification						

* CO_2e tonnes: A unit of measure used to standardize reporting of various greenhouse gases with differing global warming potential (GWP) to that of CO_2. For example, the GWP potentials for CO_2 is 1 while that of methane is 25 (for a 100 year time horizon). This means that emissions of one metric tonne of methane are equivalent to emissions of 25 metric tonnes of CO_2. In 2013 ECCC modified reporting requirements to incorporate the most recent GWP factors based on the most recent values recognized by the Intergovernmental Panel on Climate Change.

3.0 STATUS OF THE ENVIRONMENT

The following sections of the EA report include summaries of project-environment interactions that were assessed by CNSC staff, and were deemed to be of specific Indigenous, public and/or regulatory interest including radiological releases (to air and water) and protection of human health, groundwater, soil, and aquatic/terrestrial species and habitat. It should be noted that all environmental components are regularly reviewed through annual reporting requirements and CNSC compliance verification activities. These are reported to the Commission, at least annually, in the environmental protection safety and control area of licensing Commission Member Documents, and in CNSC's annual regulatory oversight reports.

3.1 Environmental Effects Assessment – Overview

This section provides a general description of the environment in which the project will be implemented. This characterization of the environment provides baseline or reference information which forms the basis for assessing the projects potential effects on the environment and how the environment and human health is protected and will continue to be protected.

In addition, this environmental effects assessment section presents an overview of the assessment of predicted effects of the project on the environment and the health of persons. The assessment of likely effects of the project was carried out in a step-wise manner as follows:

- Identifying the potential project-environment interactions (see table 3.1)
- Identifying potential environmental and health effects
- Determining whether the environment and health of persons is protected

An analysis was conducted for all components related to the project, but only a selection of topics are presented in detail in this section. Topics were selected by CNSC staff as being of interest for the Commission, members of the public and Indigenous groups, or of regulatory interest.

Table 3.1 identifies the potential interactions between the site and the environment for the continued operation of Bruce A and B, as well as for MCR activities.

Exposure pathways to ecological and human receptors from effluent and emission releases from operation of the Bruce nuclear facility were also assessed. Exposure pathways represent the various routes by which radiological and/or non-radiological contaminates of potential concern (COPCs) could enter the receptor's system and the routes of contaminant dispersion from the source to the receptor location or through the food chain to the receptor. Exposure pathways for human receptors to radiological and/or non-radiological COPCs include inhalation, ingestion and external exposure (e.g., skin contact). Ecological receptors may be exposed to COPCs through direct and indirect pathways. Direct pathways are those where the receptor comes into direct contact with the source of the COPCs (e.g., sediment, soil and surface water ingestion). Indirect exposure pathways are those where the exposure results from secondary media (e.g., ingestion of vegetation and/or prey).

Contaminants of Potential Concern

Bruce A and B emit radiological and non-radiological contaminants to the environment in the normal course of operation. As such, COPCs were selected based on a review of site monitoring data for chemical substances. Each COPC was screened against available guidelines, site-specific regulatory limits and/or background levels in adjacent areas that are protective of environmental and human health. All radiological and non-radiological releases above environmental and human health levels were retained for further analysis. If the concentrations of non-radiological releases were below environmental and human health levels, they were not carried forward for further analysis as the concentration would be less than any concentration known to cause adverse effects to ecological or human receptors. All radiological COCPs were carried forward for assessment. The potential for effects from COPC exposure was assessed by comparing the exposure level to toxicological, radiological and thermal benchmarks.

For non-radiological COPCs, the potential for ecological effects was assessed by comparing exposure levels to toxicological benchmarks and then characterized in terms of a Hazard Quotient (HQ). A HQ less than 1 indicates a negligible risk to the receptor, while a HQ greater than 1 indicates a potential risk to the receptor that warrants further consideration.

For radiological COPCs, the potential for ecological effects was assessed by comparing exposure level to radiation dose benchmarks. A radiation benchmark of 9.6 milligray/day (mGy/d) and 2.4 mGy/d were selected for aquatic and terrestrial biota, respectively, based on CSA Group Standard N288.6-12 [4].

Table 3.1: Conceptual matrix showing potential project-environment interactions

PHYSICAL WORKS AND ACTIVITIES	Atmospheric Environment			Terrestrial Environment		Hydrogeological Environment	Aquatic environment			Human Environment	
	Air	Dust	Noise	Terrestrial biota and habitat	Soil	Groundwater	Aquatic biota and habitat	Surface water	Sediment	Worker	Public
Operating Phase											
Reactor systems	●		●	●	●	●				●	●
Nuclear steam supply systems						●				●	
Cooling water systems				●			●			●	
Fuel and fuel handling				●	●	●				●	
Materials handling systems										●	
On-site management of operational L&ILW and spent fuel				●	●					●	
Major Component Replacement Phase											
Preparation work for MCR		●	●	●	●	●				●	
Reactor re-tube and feeder replacement	●	●	●							●	
Steam Generator replacement	●	●	●		●	●				●	●
New decontamination facility		●	●							●	
Increased traffic and operation of diesel generators associated with MCR	●	●	●	●						●	●
Construction and demolition activities associated with MCR	●			●	●					●	
On-site management of L&ILW associated with MCR	●				●	●				●	●
Returning units to operation	●		●	●	●	●	●	●	●	●	●

● = Project-environment interactions that have been determined to result in potential effects on the environment and health of persons

3.2 Environmental Effects Assessment – Current Operations

As noted in section 2.1.1 of this EA report, Bruce Power submitted an updated ERA to the CNSC, which was used to populate this section of the report. The Environmental Effects Assessment - Current Operations discuss the potential impacts during normal operations and provide CNSC staff's conclusion on whether Bruce Power will continue to make adequate provisions for the protection of the environment and human health, for this phase of the project.

3.2.1 Atmospheric Environment

The Bruce Power nuclear site is located on the shores of Lake Huron. The regional air quality around the site is similar to general air quality for Southern Ontario. Existing noise levels in the area surrounding the Bruce site are reflective of a rural sound environment (sound levels are generally less than 50 dBA), and are typically characterized by the sound of nature.

Atmospheric releases from the Bruce site are monitored through the emission and environmental monitoring programs, which include source and ambient air monitoring.

Radiological Emissions

The main airborne radionuclide emissions from Bruce A and B include tritium, noble gases, iodine (I-131), carbon-14 (C-14), gross alpha and gross beta/gamma (emitters on particulate material). These emissions were compared against derived release limits (DRLs), developed by Bruce Power and approved by the CNSC, to ensure release limits to the environment would not exceed the annual regulatory public dose limit of 1 mSv. Bruce Power submits the results of the radiological airborne emissions on a quarterly and annual basis, in accordance with the operating licence reporting requirements issued by the CNSC. Bruce Power's radiological releases remained well below DRLs for the last licensing period, as indicated in table 3.2 [12].

Bruce Power controls release to the environment through the use of engineered barriers and the routing of contaminated air flows through filters to minimize releases of radionuclides. A combination of high efficiency particulate air (HEPA) filters and high efficiency carbon air (HECA) filters are used to reduce radionuclides released to the environment. Testing of these filters is conducted annually by Bruce Power.

Table 3.2: Bruce A and Bruce B average radiological emissions to air from 2012-2016 and derived release limits (air emission (Bq/yr)

Radiological COPC	Bruce A emissions	Bruce A DRL	Bruce B emissions	Bruce B DRL	Total air emissions from site*
Tritium	$5.95x10^{14}$	$1.98\ x10^{17}$	$3.89\ x10^{14}$	$3.16\ x10^{17}$	$1.05\ x10^{15}$
Noble Gas**	$6.01\ x10^{13}$	$1.12\ x10^{17}$	$3.30\ x10^{13}$	$2.17\ x10^{17}$	$9.32\ x10^{13}$
Iodine -131	$1.43\ x10^{08}$	$1.14\ x10^{12}$	$4.05\ x10^{07}$	$1.35\ x10^{12}$	$1.98\ x10^{08}$
Particulate – Gross Beta/Gamma	$5.27\ x10^{06}$	$1.73\ x10^{12}$	$1.39\ x10^{07}$	$3.61\ x10^{12}$	$1.85\ x10^{07}$
Particulate – Gross Alpha	$6.68\ x10^{05}$	$2.96\ x10^{11}$	$1.51\ x10^{06}$	$5.77\ x10^{11}$	$1.96\ x10^{06}$
Carbon-14	$2.26\ x10^{12}$	$6.34\ x10^{14}$	$1.16\ x10^{12}$	$7.56\ x10^{14}$	$3.43\ x10^{12}$

* Note: Total emissions include releases from Bruce A, Bruce B, CMLF, WWMF and DPWMF

** The unit of DRL for noble gases is Bq-MeV/year.

Non-Radiological Emissions

The main non-radiological emissions from Bruce A and B are from operation of the generators and vehicle traffic on site. These sources release small quantities of nitrogen oxides, carbon dioxide, sulphur dioxide and particulate matter.

Non-radiological air emissions are controlled in accordance with the Ontario Ministry of Environment and Climate Change (MOECC) Environmental Compliance Approval (ECA) for air emissions [25]. Emissions are conservatively estimated to ensure worst case emission rate scenarios are in compliance. Air quality at the fence line met the MOECC air quality limits and these limits have been shown to be protective of human and non-human biota in the surrounding environment.

Ambient Air Monitoring

The air quality outside of the Bruce site perimeter is monitored for wind patterns and concentrations of tritium, external gamma and carbon-14. The objective of the ambient air monitoring is to confirm the effectiveness of emission mitigation measures and evaluate the impact of the facility on the environment and those living and working near the site. As indicated, continual monitoring of airborne radionuclides at the Bruce site demonstrates the public and environment are protected from airborne emissions.

Noise

Bruce Power initiated a noise monitoring program that began in the summer of 2015 and continued from May to October 2016, and again in the winter of 2017, to monitor existing noise levels at the Bruce nuclear site. Physical stressors, such as noise, are relevant both to humans and ecological receptors. The noise monitoring assessment indicated that the sound level of the Bruce nuclear facility complied with the MOECC's ECA for noise limits. Periodic noise level exceedances are likely not affecting wildlife in the area, as they are likely accustomed to the levels.

Conclusion

CNSC staff assessed evaluated the licensee's radiological and non-radiological emissions monitoring program annual results, noise monitoring program and the ERA with respect to air emissions for the licensing period and determined that Bruce Power effectively demonstrated that concentrations in air are below applicable CNSC approved DRLs and the MOECC's ECA for air emissions and noise limits. Bruce Power continues to provide adequate protection of people and the environment from atmospheric releases.

3.2.2 Terrestrial Environment

The Bruce nuclear site rests on a geological setting characterized by glacial sediments (unconsolidated deposits) of varying depths overlying carbonate bedrock (solid rock) laid down on top of the Canadian shield. The overburden consists of sand, gravel, silt, till and clay. Along the Lake Huron shoreline, only a thin layer of glacial sediments exist (beach sand).

Inland, the dominant physiographic feature is the Algonquin Bluff, which is a 30-meter high ridge traversing parallel along the Lake Huron shoreline for several kilometres. The terrain above and inland from the Algonquin Bluff consists of relatively flat clay plains with a network of streams draining westward toward Lake Huron.

General Site Characteristics

The Bruce nuclear site rests on unconsolidated glacial deposits (overburden) of variable thickness, that overlays Paleozoic age sedimentary bedrock to a depth of approximately 850m, which in turn overlay crystalline, Precambrian and Canadian Shield basement rocks. The overburden consists of sand, gravel, till and clay; there are also thin, shoreline-parallel bands of sandy beach deposits. The underlying dolostone bedrock (Devonian age) is exposed along a large portion of the shoreline.

Inland, the dominant physiographic feature is the Algonquin bluff, which is a pronounced ridge that runs parallel to the Lake Huron shoreline for several kilometers. It's the result of wave action within glacial Lake Algonquin (that existed between 12,500 to 10,600 years ago and occupied parts of the Lake Huron and Michigan Basins) that incised a 30m bluff into previously deposited glacial till; those eroded tills were then redeposited on a plain adjacent to Lake Huron. The terrain above and inland from the Algonquin Bluff consists of relatively flat clay plains with a network of streams draining westward to Lake Huron.

Terrestrial Habitat

The most recent assessment of vegetation communities at the Bruce nuclear site was completed in 2016. Additional botanical surveys were conducted in 2017 during the spring growing season.

Onsite vegetation communities have a long-standing history of human use and anthropogenic modification, including logging, farming, recreational use, and the present-day industrial use. Vegetation communities identified within the site include coniferous and mixed forest, agriculture, shrubs, beach, marsh, swamp, and open water.

Bruce County contains a number of large forested areas and wetlands, providing core habitat for a variety of wildlife species. Most of the wildlife habitat occurs at the periphery of the Bruce nuclear site, specifically in Inverhuron Provincial Park, the Baie du Doré Provincially Significant Wetland (PSW) and the conifer forest communities near or along the perimeter fence. For example, wildlife habitats in the PSW and the Lake Huron shoreline provide for a variety of shorebird species (e.g., gulls, waterfowl and Cormorants). Grasslands and meadows support ground nesting bird (e.g., Field Sparrow and Wild Turkey), while conifer woodlands, meadows and grasslands are utilized by small rodents (e.g., Red Squirrel, Meadow Vole). Upland forest communities, dominated by Eastern White Cedar, are important overwintering and feeding sites for White-tailed Deer, as well as for a number of bird species.

Soil Quality

The Bruce nuclear site is home to a number of terrestrial species, including plants, mammals, birds, soil invertebrates, reptiles and amphibians, which have the potential to be exposed to contamination through ingestion, skin contact and inhalation.

Soil quality data have been collected across the Bruce nuclear site over various years, most recently in 2016, as part of baseline environmental monitoring. For the 2017 ERA, soil samples were collected from areas considered to represent suitable ecological habitat within the site. Surficial soil samples were analyzed for non-radiological and radiological COPCs. Areas of elevated soil non-radiological COPCs are mainly associated with industrial activities on the site, such as the construction landfill areas, the Bruce A storage compound, the former fire training facility and the former sewage lagoon and are discussed later in this section.

Terrestrial Biota

The most recent assessment of wildlife habitat and communities at the Bruce nuclear site was completed in 2016. Additional wildlife assessments were conducted in 2017.

The following total numbers of species have been reported on and around the Bruce nuclear site:

- 522 vascular plants, including species of trees, shrubs, vines, ferns, and forbs
- 26 species of small and large mammals
- 186 species of birds, including migrants and local breeders, such as the Canada Goose, Barn Swallow and Mallard Duck
- 11 species of amphibians, including the Northern Leopard Frog and Wood Frog
- 12 species of reptiles, including the Eastern Garter Snake and Midland Painted Turtle

Hunting is a popular activity in the area surrounding the Bruce nuclear site. As well, Indigenous communities identified hunting and trapping of wildlife as part of traditional land use and harvesting activities. As such, Bruce Power conducted a survey in 2016 to determine which households consumed wild meat sourced within Bruce County. Of the 258 households surveyed, 38 (15%) indicated that they consumed wild animals (deer, rabbit, waterfowl, turkey and bear) from within Bruce County.

Terrestrial species that may occur on the Bruce nuclear site that are either listed under the Ontario provincial *Endangered Species Act* (ESA) or the federal *Species at Risk Act* (SARA) are outlined in table 3.3.

Table 3.3: Terrestrial species at risk observed in and around the Bruce nuclear site

Common name	Ontario provincial ESA status	Federal SARA schedule 1 status
Amphibians and reptiles		
Eastern Foxsnake	Endangered	Endangered
Eastern Milksnake	Not listed	Special concern
Eastern Ribbonsnake	Special concern	Special concern
Snapping Turtle	Special concern	Special concern
Birds		
Bald Eagle	Special concern	Not listed
Bank Swallow	Threatened	Not listed
Barn Swallow	Threatened	Not listed
Canada Warbler	Special concern	Threatened
Common Nighthawk	Special concern	Threatened
Eastern Meadowlark	Threatened	Not listed
Eastern Wood-pewee	Special concern	Not listed
Grasshopper Sparrow	Special concern	Not listed
Horned Grebes	Special concern	Not listed
Red-headed Woodpecker	Special concern	Threatened
Short-eared Owl	Special concern	Special concern
Wood Thrush	Special concern	Not listed
Insects		
Monarch Butterfly	Special concern	Not listed
Mammals		
Eastern Small-footed Myotis	Endangered	Not listed
Little Brown Myotis	Endangered	Endangered
Northern Myotis	Endangered	Endangered
Tri-colored Bat	Endangered	Endangered
Plants		

Common name	Ontario provincial ESA status	Federal SARA schedule 1 status
Butternut Tree	Endangered	Endangered
Dwarf Iris	Special concern	Special concern

Radiological Contaminants

The 2017 ERA assessed potential onsite risks to terrestrial life from radionuclides through external exposure pathways such as air immersion, groundshine (external exposure to radiation from radioactive deposits on the ground) and consumption of potentially contaminated soil, vegetation or animals. The dose rate to terrestrial biota was calculated based on the concentration of radionuclides in air (for tritium, carbon-14 and noble gases) and soil (for cobalt-60, plutonium-239 and iodine-131).

For all terrestrial ecological receptors, except deer, the total radiation dose rate was approximately 0.05 mGy/day, and was predominantly a result of the internal radiation from tritium and carbon-14. The measured dose rate for deer, from radioactivity concentrations in tissue, was significantly lower (8 x 10-5 mGy/d). These dose rates were a fraction of the radiological benchmark value defined by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) of 2.4 mGy/day. Therefore, radiological effects associated with normal operations are not a concern to terrestrial biota.

As part of CNSC staff's review of the ERA staff recommended that Bruce Power propose future monitoring and/or assessment to address knowledge gaps in the exposure of wildlife to radiological contaminates, including cardon-14, tritium and organically bound tritium, to reduce uncertainties within the ERA's terrestrial risk assessment.

Non-Radiological Contaminants

The 2017 ERA assessed potential onsite risks to terrestrial life from exposure to non-radiological substances in soil, sediment, surface water and groundwater from current operations. Exposure to terrestrial species at risk was also included in the assessment through the use of a non-species at risk or a generic species of the same feeding guild (e.g., carnivorous bird, reptile that consumes aquatic insects, etc.) to represent the species at risk receptor.

Moderate potential risks to terrestrial mammals, birds and plants from exposure to non-radiological COPCs in soils were identified for a small number of ecological receptors (i.e., American Woodcock, Red Fox, Short-eared Owl, vegetation and soil invertebrates) at a limited number of former industrial areas within the site (e.g., construction landfills, the fire training facility and the Bruce A storage compound). Although some impacts to terrestrial biota could result at these locations, because these areas represent less than 3% of the total area of the site, and given that other nearby areas provide more suitable habitat for terrestrial biota, impacts to mammals, birds, soil invertebrates, or other terrestrial species are likely to be low. Risks to terrestrial life due to COPCs in sediments, drinking water sources, and surface waters onsite and offsite in Lake Huron were estimated to be negligible. However, CNSC expects Bruce Power to propose future monitoring and/or assessment to address knowledge and data gaps in the exposure of invertebrates, plants and birds to existing soil contamination and the former sewage lagoon, to reduce uncertainties in the ERA's terrestrial risk assessment.

Physical Stressors

Terrestrial biota can be impacted by physical stressors such as noise, road kill, bird strikes, and habitat alteration. Noise was not quantitatively assessed as part of the 2017 ERA because of the absence of noise benchmarks that are protective for wildlife populations. Based on the last five years of data (2012 to 2016), a total of 12 vehicle-deer interactions were recorded resulting in five deer fatalities within the site, which was comparable to losses in previous years. As such, the effects of traffic accidents on local wildlife populations, specifically deer, were considered negligible. Surveys on bird strikes and animal-vehicle interaction surveys were started in 2017, and therefore, no information is available to date. With regards to habitat alteration, there has been no significant increase in the footprint of the Bruce nuclear site since operations began, and therefore no additional habitat loss. The stoppage of activities in some areas onsite has, in fact, resulted in the gradual return of these areas to available habitat, with the result that over time some habitat types will increase in size. Overall, the 2017 ERA concluded that risks to terrestrial biota due to physical stressors were negligible.

Conclusion

Based on the review of the 2017 ERA, CNSC staff concluded that potential risks to terrestrial life from non-radiological contaminants in sediment, drinking water and surface water, and from radionuclides through external exposure and consumption of potentially contaminated soil, vegetation or animals are negligible. Additionally, CNSC staff concluded that risks to terrestrial biota due to physical stressors are negligible. As part of CNSC staff's review of the ERA staff recommended Bruce Power to propose future monitoring and/or assessment in the ERA to address minor knowledge and/or data gaps. These are expected to reduce uncertainty but not considered significant enough to alter CNSC staff's conclusion that the terrestrial biota are adequately protected.

3.2.3 Hydrogeological Environment

Groundwater Quantity

In general, overburden groundwater flows toward Lake Huron, with the exception of radial inward flows at Bruce A and B, which are controlled by foundation drains. There appears to be a groundwater divide in the water table within the overburden and shallow bedrock, between the former Bruce Heavy Water Plant and the WWMF: northwest of this divide, shallow groundwater flows towards Lake Huron; southeast of this divide, shallow groundwater flows towards the WWMF. This divide is believed to be related to the presence of the Middle Sand Aquifer underlying the vicinity of the WWMF. The Middle Sand Aquifer in some areas is directly connected to the underlying shallow bedrock and providing a potential conduit for vertical migration of infiltrating groundwater in the vicinity of the WWMF.

Groundwater Quality

Bruce Power has in place a comprehensive groundwater monitoring program to evaluate the groundwater quality and conditions at the site. Based on site-wide evaluations and third party reviews completed in the late 1990s fourteen subject areas within the site were identified as meriting active monitoring. These subject areas include over a 100 monitoring wells monitored at a frequency informed by their potential risks to the environment. Monitoring of groundwater is also conducted from 10 multi-level wells installed into the bedrock and located around Bruce A and B. These wells are sampled on a semi-annual basis for tritium.

Radiological Contaminants

The 2016 groundwater monitoring results indicate that tritium concentrations remained below the Ontario Drinking Water Standard for tritium (7,000 Bq/L), though it should be noted that none of the monitoring wells are a drinking water source. In addition Bruce A and B are hydraulically isolated from public areas around the facilities as groundwater flows into the stations rather than away from them. This is then monitored in the CCW duct (composite sampling) before reaching the Lake Huron. As a result, Lake Huron, which is monitored regularly, is the only off-site receptor for site groundwater.

Non-radiological Contaminants

As result of the groundwater flow paths discussed above, the only relevant onsite groundwater exposure pathways is that of terrestrial plants via root uptake of COPCs associated with the shallow groundwater. The former sewage lagoon is the location at which shallow groundwater has the highest potential to interact with non-human biota (i.e. plant roots, aquatic and semi-aquatic organisms.

Groundwater samples (< 1 m below ground surface) were collected from six monitoring wells around the former sewage lagoon. Samples were analyzed for metals and inorganics, petroleum hydrocarbons, polycyclic aromatic hydrocarbons, and volatile organic compounds. Iron, lithium, tin, titanium, uranium, and phenanthrene were retained as COPCs for further evaluation and compared with selected groundwater benchmarks. All concentrations resulted in hazard quotients (HQ) of less than one, indicating that potential risks for terrestrial plants near the former sewage lagoon from non-radiological COPCs in shallow groundwater are negligible.

Conclusion

CNSC staff concluded that the current groundwater conditions are not negatively impacting terrestrial biota. In December 2017, Bruce Power submitted for CNSC's staff review, a transition plan for the implementation CSA Group Standard N288.7-15 by December 31, 2020. CNSC staff will review the transition plan and the coordination between the ERA and groundwater monitoring as it relates to the relevant CSA Group Standards N288.6-12 and N288.7-15.

3.2.4 Aquatic Environment

The Bruce site and its surroundings have aquatic features of natural, physical and cultural significance. These include the Lake Huron shoreline, Lake Huron commercial, recreational and Aboriginal fisheries (offshore and nearshore), and the Baie du Doré Provincially Significant Wetland (PSW), which is located at the head of Baie du Doré. Baie du Doré is an embayment along the eastern shore of Lake Huron immediately north of the Bruce nuclear site. An overview of physical substrates within and around the Bruce nuclear site and extending into Lake Huron shows that much of the area is comprised of hard substrates including exposed bedrock and bedrock overlain with pebbles, cobbles and boulders. The Baie du Doré and offshore areas also include pockets of sand interspersed among hard substrates [17].

Despite the overall similarity of the substrates, the nearshore areas of Lake Huron within and around the Bruce site contain diverse physical habitats that are determined mainly by depth, temperature and current velocities. These features define habitats that are used by a diversity of invertebrate and fish species through a variety of their life stages [17]. The nearshore area also includes the Bruce A and B discharge channels. Both discharge channels are lined with armour stone and the bottoms are predominantly bedrock. The Bruce A channel contains organic silt and sand bottoms in depositional areas while the Bruce B channel is almost exclusively exposed bedrock.

Other locations that support aquatic life in and around the Bruce site include Stream C and the South Railway Ditch. Stream C is a cool-to-cold water stream that was originally part of the Little Sauble River watershed, which drains into lnverhuron Bay to the south of Bruce B. It presently flows in a constructed channel across the northeast corner of the Bruce site where it enters Baie du Doré immediately north of Bruce A. Approximately 1.5 km of Stream C is located on the site. The lower 800 m of the stream flows outside of the property boundary and discharges into Baie du Doré [29].

The South Railway Ditch is approximately 3 m wide and 1.5 m deep and is wet throughout the year as it intercepts groundwater. The South Railway Ditch has become naturalized over time and contains cattails along its length, which slow water flow such that the cattails are periodically cut back to re-establish a drainage path from the WWMF. In addition to slowing water flow, the thick stands of cattails also minimize erosion and increase the rate of settling for sediments that may enter the ditch system. The ditch flows adjacent to the north end of an on-site wetland that has been repurposed for stormwater management use, although minimal contact exists between these two features. The South Railway Ditch flows to the east and eventually runs through a culvert and into Stream C.

Because the South Railway Ditch was constructed with the intention of controlling stormwater drainage from the WWMF, it does not meet the definition[2] of a water body. However, considering the South Railway Ditch has naturalized over time and provides potential fish habitat, it has been incorporated into the assessment insofar as assessing its downstream contribution to Stream C. Bruce Power asserted that through the assessment of Stream C in the ERA, the upstream contribution of the South Railway Ditch is considered, including any potential contribution of contaminants into the surface water and sediment quality of Stream C. However, CNSC staff expect that the South Railway Ditch sediment, water quality and risks to receptors be included in future versions of the ERA, rather than strictly assessing the risk due to water quality contribution from the Railway Ditch to Stream C.

In general, aquatic communities in the regions discussed above include aquatic vegetation (macrophytes), phytoplankton, zooplankton, benthic invertebrates and fish, which are discussed further in the aquatic biota sub-section below.

Aquatic Biota

Emergent aquatic macrophytes occur only sparsely near the shoreline of the Bruce site, which is consistent with exposed, high energy environments such as the nearshore of Lake Huron. Coarse substrates tend to prevail in high energy (wave action and ice scour) areas such that conditions do not exist for plant growth. However, areas of submerged aquatic vegetation occur in sheltered

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[2] Areas providing aquatic habitat on and around the Bruce site were identified as those that meet the definition of a water body under the Environmental Protection Act, Part XV.1, Ontario Regulation 153/04: "A permanent stream, river or similar watercourse or a pond or lake, but does not include a pond constructed on the property for the purpose of controlling surface water drainage."

portions (i.e., areas of low flow or low velocity water) of the Bruce A and B discharge channels. Both submerged and emergent vegetation is present in small localized patches in sheltered areas at the head of Baie du Doré.

A comparison of Wetland Macrophyte Index (WMI) scores generated in 1998 and 2015 indicate improved health for the Baie du Doré wetland. WMI scores were interpreted as "somewhat impacted" in 1998, but improved to "not impacted" in 2015 [26].

The presence of periphyton along the Lake Huron shoreline in the Bruce area was confirmed in a 2014 algal growth study [27] Baie du Doré hosted higher concentrations because of the warmer water temperatures, limited ice scour and shelter from Lake Huron’s wave action. Phytoplankton also exists in Lake Huron, but density and diversity is generally low because of low nutrient availability. Baie du Doré and similar sheltered areas receiving runoff have phytoplankton in greater quantities than Lake Huron in general.

Dramatic changes in Lake Huron’s zooplankton community (i.e., diversity and abundance significantly reduced) since the early 2000’s have occurred in response to water quality management policies (e.g., policies to reduce nutrient loading) and the emergence of predatory non-native cladoceran (i.e., branchiopod crustacean) and zebra mussels [28]. It is anticipated that the zooplankton community around the Bruce site has also changed reflecting the broader ecosystem patterns that have established in Lake Huron, and these changes will continue to be reflected in the future.

Lake Huron is divided into offshore and nearshore zones from a fish community perspective. The offshore fish community is generally composed of species that use open or deep waters for the majority of their life cycles. These fish make use of the nearshore areas during spawning periods and possibly to feed, but generally prefer cool and deep offshore waters

The nearshore fish community is comprised of those species that prefer shallow, warmer water. Along the shoreline of the main Lake Huron basin, these habitats are located within sheltered, shallow embayments such as Baie du Doré and the discharge channels. Similar to the index score derived for wetland macrophytes, a Wetland Fish Index (WFI) score was derived for the Baie du Doré (3.57), which is classified as "very good". The WFI is considered to reflect the "ecosystem integrity of the wetland".

Stream C supports a resident population of brook trout. Stream C is a cool to coldwater stream and is protected under the Ontario Ministry of Natural Resources and Forestry (MNRF) as critical cold-water habitat, particularly for spawning activity [28]. However, other salmonid species have also been observed in Stream C [29] [30], in addition to various minnow species.

Previous South Railway Ditch habitat assessments and fish surveys have identified a number of warm-water baitfish species common in Ontario, and tolerant to a range of environmental conditions. Crayfish have also been observed, including both aquatic crayfish and burrowing varieties. The CNSC expects Bruce Power to propose monitoring of the South Railways Ditch to confirm its use or non-use as habitat.

Fish species present in and around the different aquatic habitats associated with the Bruce nuclear site are listed in table 3.4.

Table 3.4: Aquatic biota (fish and benthic species) present or observed in and around the Bruce nuclear site

Common name	Water body
Benthic species	
Amphipoda	Lake Huron (nearshore)
Naididae	Bruce A discharge channel
Oligochaete	Bruce B discharge channel (shallow waters)
Chironomidae	Bruce B discharge channel (deeper waters)
Fish species	
Deepwater Sculpin	Lake Huron (offshore)
Round Whitefish	Lake Huron (offshore)
Lake Whitefish	Lake Huron (offshore)
Lake Trout	Lake Huron (offshore)
Rainbow Smelt	Lake Huron (offshore)
Burbot/Ling	Lake Huron (offshore/nearshore)
Gizzard Shad	Lake Huron (off/nearshore)
Longnose Sucker	Lake Huron (nearshore)
Redhorse Sucker	Lake Huron (nearshore)
White Sucker	Lake Huron (nearshore), Stream C
Spottail Shiner	Lake Huron (nearshore)
Smallmouth Bass	Lake Huron (nearshore including Bruce A and B discharge channels and Baie du Doré)
Yellow Perch	Lake Huron (offshore/nearshore)
Rock Bass	Lake Huron (nearshore)
Mimic Shiner	Lake Huron (nearshore)
Non-native Alewife	Baie du Doré

Common name	Water body
Non-native Round Gobie	Baie du Doré
Brook Trout	Stream C
Rainbow Trout	Stream C
Brown Trout	Stream C
Chinook Salmon	Stream C
Coho Salmon	Stream C
Creek Chub (minnow)	Stream C, South Railway Ditch
Brassy Minnow	South Railway Ditch
Brook Stickleback	South Railway Ditch
Central Mud Minnow	South Railway Ditch
Fathead Minnow	South Railway Ditch
Redbelly Dace	South Railway Ditch
Crayfish (both aquatic and burrowing species)	South Railway Ditch

In Ontario, two different pieces of legislation apply to species at risk, the provincial *Endangered Species Act* (ESA) [31], and the federal *Species at Risk Act* (SARA) [32]. Screening for species at risk on and around the Bruce site has previously been completed with one aquatic species at risk identified (Deepwater Sculpin).

Deepwater Sculpin are listed under SARA as Special Concern federally (Schedule 1) but are not listed under the provincial ESA. The Special Concern status is indicative of a species is at risk of becoming threatened or endangered in the future. Under SARA, there is a Management Plan for the Deepwater Sculpin in Canada (Great Lakes – Western St. Lawrence populations). The action-orientated plan identifies the conservation activities and land use measurements needed to ensure, at minimum, that the species does not become threatened or endangered in the future [33]. Deepwater Sculpin are further discussed under the Physical Stressors (impingement and entrainment) sub-section, later in this section.

Radiological Contaminants in Surface Water

As part of Bruce Power's environmental monitoring program, water samples are taken and are routinely monitored for tritium, carbon-14, and gross alpha and gross beta/gamma radiation. Sources of tritium emissions include the active liquid waste management system (ALWMS), condenser cooling water (CCW) discharges, steam generator discharges, and foundation drainage sump discharge. All radionuclide concentrations have remained well below the CNSC approved DRLs. Average radiological emissions to water for the past five years are shown in table 3.5.

Table 3.5: Bruce A and B average radiological emissions (Bq/year) to water during 2012-2016 period

Radiological COPC	Bruce A - releases	Bruce A DRL	Bruce B - releases	Bruce B DRL
Tritium Oxide	$1.97x10^{14}$	$2.30x10^{18}$	$6.76x10^{14}$	$1.84\ x10^{18}$
Gross Beta/Gamma	$8.84x10^{08}$	$4.58x10^{13}$	$2.45x10^{09}$	$5.17x10^{13}$
Gross Alpha	$1.37x10^{06}$	$1.12x10^{14}$	$2.58x10^{06}$	$1.21x10^{14}$
Carbon-14	$1.35x10^{09}$	$1.03x10^{15}$	$5.68x10^{09}$	$1.16x10^{15}$

Dose rates to aquatic biota were calculated based on the concentrations of radionuclides in surface water (Lake Huron) and sediment. The highest concentrations are observed in Baie du Doré, where the following measurements are taken as part of Bruce Power's EMP:

- tritiated water (HTO) in surface water and fish
- organically bound tritium in fish
- carbon-14 in fish
- cobalt-60 in fish and sediment - all measurements were below detection limits
- cesium-134 in fish and sediment - all measurements were below detection limits
- cesium-137 in fish and sediment

Since the measured concentrations of cobalt-60 and cesium-134 in fish and sediment were below detection limits, they were not considered further in the ERA. For each radionuclide considered in the ERA, the radiation dose was calculated for aquatic biota and assessed against radiological dose benchmarks (9.6 mGy/day for aquatic receptors). Total calculated dose rates to aquatic biota are provided in table 3.6, and indicate that dose rates were well below the radiological dose benchmark.

As part of CNSC staff's review of the ERA staff recommended Bruce Power propose future monitoring and/or assessment to address knowledge and data gaps in the exposure of fish to radiological contaminates in Lake Huron to reduce uncertainties within the ERA's aquatic risk assessment [12].

Table 3.6: Calculated total dose rates to aquatic biota on or near the Bruce site compared against benchmark dose rates

Aquatic receptor	Total dose rate (mGy/d)	Exposure Ratio (%)*
Pelagic fish	7.75×10^{-07}	0.000008
Benthic fish	7.78×10^{-06}	0.00008
Freshwater invertebrate	1.88×10^{-05}	0.0002
Insect larvae	2.27×10^{-05}	0.0002
Freshwater plant	2.19×10^{-05}	0.0002

* Compared to the aquatic receptor benchmark dose rate of 9.6 mGy/day

Non-radiological Contaminants in Surface Water

Surface water samples are collected from multiple control points around Bruce A and B, and from ancillary facilities under separate Environmental Compliance Approvals and Effluent Monitoring and Effluent Limit (EMEL) requirements specific to each facility (Bruce A, Bruce B and Centre of Site facilities, which covers numerous ancillary facilities). For the purpose of the ERA, only data pertaining to the CCW discharge points of Bruce A and Bruce B were considered, as they are the end-of-pipe discharge points for the facilities to Lake Huron. Ecological receptors would not be expected to come into contact with surface water discharges within the Bruce nuclear site; therefore, the end-of-pipe is appropriate. For the ERA, five years of data were collected and analyzed and all data met their respective limits, including water quality in the CCW discharge points from Bruce A and B.

A summary of the concentrations reported in the 2012 to 2016 quarterly reports for the Bruce A CCW is provided in table 3.7.

Table 3.7: Bruce A Condensing Cooling Water Discharge Concentrations from 2012 to 2nd quarter of 2016

Non-radiological COPC	Unit	EMEL limit	Minimum recorded concentration	Maximum recorded concentration
Boron	mg/l	5	<0.006	0.06
Ammonia (unionized)	mg/l	<0.02	0.000094	0.004
pH	-	6.0 – 9.5	7.3	8.6
Phosphorus	mg/l	1	<0.01	0.004
Solvent extractables	mg/l	< detection limit	<1	2

Non-radiological COPC	Unit	EMEL limit	Minimum recorded concentration	Maximum recorded concentration
Hydrazine	mg/l	0.1	0.0011	0.0013
Morpholine	mg/l	2.5	<0.02	0.7

Potential risks to aquatic life from exposure to non-radiological COPCs identified in surface water and sediment were assessed on a quantitative basis by calculating HQs. The HQ is the ratio of the concentration of the COPC in the environmental media (i.e., surface water or sediment) to the most conservative toxicological benchmark. A HQ that is ≤1, meaning that the concentration of COPCs in the surface water or sediment are less than or equal to the benchmark, indicates that there is no potential risk to aquatic receptors from exposure. The calculated HQs for surface water are provided in table 3.8.

Table 3.8: Calculated Hazard Quotients for surface water*

Non-radiological COPC	Maximum measured concentration (µg/L)	Toxicological benchmark (µg/L)	Hazard Quotient*
Total dissolved solids	420 000	500 000	0.84
Sulphate	6900	309 000	0.022
Fluoride	0.49	1940	0.00025
Iron	870	1740	0.5
Manganese	170	1000	0.17
Aluminum	330	198	1.7
Barium	24	1102	0.022
Mercury	0.3	0.23	1.3
Strontium	1700	1000	1.7
Toluene	12	9.8	1.2
Xylene	14	30	0.47

* The maximum concentrations of each COPC from all of the sampled locations and sampling dates for which the chemical was identified as a COPC were used as the Exposure Point Concentrations in surface water and sediment for aquatic life. As such, HQs were calculated based on the maximum concentrations of all sampled locations and sampling dates.

The HQs for aluminum, mercury, strontium and toluene were slightly above one, suggesting potential risks to aquatic life from exposure to this COPC in surface water. These potential risks are discussed further below.

Aluminum

The HQ for aluminum was greater than 1 in a single location from a sample collected in 2007 from Stream C (maximum measured concentration: 330 µg/L). HQs were less than 1 at all other locations sampled. Given that samples collected in Stream C since 2007 have had much lower concentrations of aluminum, this measurement is likely an aberration and not representative of actual conditions at the Bruce nuclear site. As no subsequent sampling events identified elevated aluminum concentrations, the risks due to aluminum in surface water were deemed to be negligible for aquatic life in Stream C and all other surface waters.

Mercury

HQs for mercury were greater than 1 in two locations, off Douglas Point and off Bruce B. However, calculated HQs were less than 1 during the May 2007 sampling event and slightly greater than one during the June 2007 sampling event (HQs of 1.3 for both sampling locations). Mercury concentrations around the Bruce nuclear site were below the detection limit (<0.1 µg/L) during the October 2007 sampling event. A sampling event was conducted in October 2016 and the results did not yield mercury concentrations above the benchmark. As such, risks to aquatic life from mercury in surface water were deemed to be negligible for aquatic life at the Douglas Point and Bruce B sampling locations and other surface waters.

Strontium

The HQ for strontium was greater than 1 in a single location (MacPherson Bay). However, the HQ is based on the highest concentration of strontium measured in this location (1,700 µg/L in June 2007). Subsequent concentrations measured at this location (October 2007; and May, September and October 2009) yielded HQs that were less than 1. In addition, the very low activity of gross beta in Baie du Doré (modelled from the radiological emissions) suggests that Sr-90 isotope activity in the receiving environment is negligible. Therefore, risks to aquatic life from exposure to strontium (and its isotopes) in surface water are considered negligible.

Toluene

The HQ for toluene was greater than 1 at one location in Lake Huron in a sampling event carried out in August 2016. However, concentrations of toluene at the same location (McRae Point) in previous sampling events (completed in 2007, May 2016 and November 2016) were below the 9.8 µg/L benchmark and resulting HQs were less than 1. Therefore, this one measurement is not considered representative of typical conditions, and risks to aquatic life from exposure to toluene in surface water during regular operations are considered negligible (i.e., there is no expected risk to aquatic biota due to one above-benchmark measurement of toluene).

Stormwater

Bruce Power monitors stormwater discharge and provides MOECC with an annual report as per the provincial ECA reporting requirements. For the purposes of the ERA, Bruce Power collected stormwater samples from several locations throughout the Bruce site. Using applicable provincial and federal standards for the Tier 1 screening, only chloride concentrations in the samples collected in 2016 (current licensing period) exceeded the short-term exposure guideline of 120 mg/L. No samples exceeded the long-term exposure guideline of 640 mg/L. It is recognized that chloride concentrations are generally several times higher in the stormwater drainage system as a result of road salt in surface runoff parameters.

Non-radiological Contaminants in Sediment

A surface water and sediment quality assessment of both the South Railway Ditch and Stream C was completed in 2009. The assessment identified concentrations of arsenic, cadmium, copper and nickel greater than the provincial sediment standards in the west end of the South Railway Ditch, and elevated concentration of copper only in the east side of the ditch (up gradient outlet through a culvert and into Stream C). However, no sediment exceedances were identified in Stream C.

Aquatic receptors were considered to be exposed to COPCs in sediments in the discharge channels, Stream C, MacPherson Bay and Baie du Doré. HQs for aluminum, iron, manganese, uranium and vanadium were below the target HQ of 1, indicating that there are negligible risks to aquatic life from exposure to these COPCs in sediment[3].

HQs for barium and strontium could not be calculated because toxicity reference values do not exist for these COPCs in sediment. However, the U.S. EPA [34] states that average barium concentration are <20 mg/kg in sediments for non-polluted Great Lakes. This value is intended as a reference value to determine whether elevated levels of barium are present at a site. The maximum measured concentration of barium of 4.6 mg/kg at the Bruce site is well below the U.S. EPA value of < 20 mg/kg. Therefore, barium in sediment is considered to pose negligible risk to aquatic life.

Given the lack of toxicity data for strontium in sediments and the lack of information on typical background levels in Ontario lakes, it cannot be determined whether strontium poses a potential risk to aquatic life. CNSC recommends that Bruce Power collect background sediment samples for comparison of measured strontium concentrations on-site to the background concentrations.

Conclusion

CNSC staff reviewed the 2017 ERA and annual environmental monitoring data results and concluded that Bruce Power made adequate provision for the protection of the environment, and radiological and non-radiological impacts to aquatic biota were negligible.

Calculated dose rates to pelagic fish, freshwater invertebrates and freshwater plants are attributed due to internal radiation from tritium, while dose rates to benthic fish and insect larvae are largely a result of external radiation from radioactive particulate. The ERA identified insect larvae, which is representative of benthic invertebrates in the aquatic environment, as the aquatic species with the highest total radiation dose rate (2.27x10-5 mGy/d). This dose rate is well below the radiation benchmark dose rate of 9.6 mGy/d for aquatic receptors. Therefore, CNSC staff concluded that the radiological risk to aquatic biota resulting from normal operations at the Bruce nuclear site is negligible. CNSC staff recommended that Bruce Power propose future monitoring and/or assessment to address knowledge and data gaps in the exposure of aquatic

[3] Low risks from ingestion of sediment were noted in Stream C to the Water Shrew and the Semipalmated Sandpiper due to aluminum (semi-aquatic biota). Since the results are based on conservative assumptions and only two samples from Stream C (one collected in 2009 and one in 2016), the results are based on high uncertainty, and risks are likely overestimated for these receptors.

organisms to radiological contaminates and strontium in Lake Huron to reduce uncertainties in the aquatic risk assessment.

Additionally, as described above, potential risks to aquatic biota from non-radiological COPCs in surface water and sediment are low. Derived HQs for aluminum, mercury, strontium and toluene were marginally above one, but samples collected with concentrations above benchmark were from isolated sampling events with no recurrence in subsequent sampling events. Therefore, these samples were not considered indicative of actual conditions. CNSC staff concluded that non-radiological risk to aquatic biota resulting from normal operations at the Bruce nuclear site are negligible.

CNSC staff determined that Bruce Power's EMP provided sufficient information demonstrating radiological and non-radiological contaminant concentrations in the aquatic environment surrounding the Bruce nuclear site are generally low and if elevated, the contamination is localized. The CNSC expects Bruce Power to propose monitoring of the South Railway Ditch to confirm its uses or non-use as habitat. If receptors are present, the risk should be addressed in future versions of the ERA.

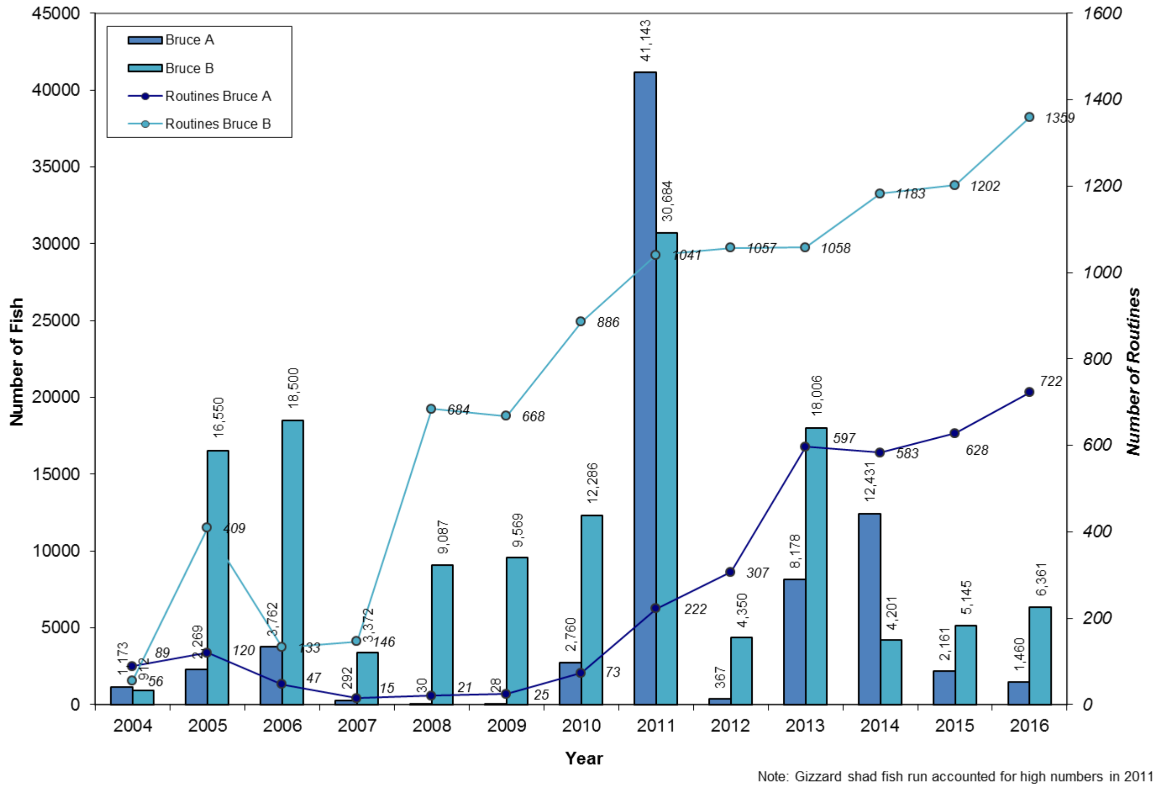
Physical stressors

Impingement and Entrainment

Bruce Power currently operates three offshore intakes that are located several hundred meters beyond the shoreline and that extend well beyond the littoral zone of Lake Huron (Bruce A: 550 m offshore, design flow rate 175 m3/s; Bruce B: 830 m offshore, design flow rate of 193 m3/s; and Centre of Site intake: 820 m offshore, average flow rate 0.037 m3/s) (see figure 3.3 for satellite image of Bruce A and B CCW systems). The intakes for Bruce A and B have low-flow velocity caps that reduce water currents at the edge of the cap to approximately 15 cm/s. This reduces fish impingement as larger fish are able to swim away from the intake due to the reduced flow rate. Further, the Bruce B intake has a chain-rope barrier with the function of guiding schooling fish along the barrier and away from the intake. The Centre of Site intake has a low approach velocity intake (0.011 cm/s) that supplies water to the Bruce Energy Centre and a fire water system. All intakes have Ontario Ministry of Environment and Climate Change (MOECC) Permit to Take Water Approvals.

Bruce Power has monitored fish impingement at both Bruce A and B continuously since 2004. Impingement is the trapping of aquatic organisms that are drawn into the water intake on a physical barrier. Fish that are impinged on the travelling screens are identified to species and the length recorded daily. The number of fish impinged at each Bruce A and Bruce B since 2004 are displayed in figure 3.2, as are the number of "routines" completed each year. "Routines" are the number of sampling events undertaken by Bruce Power operators each year to count the number of fish impinged. The minimum routine or sampling event is once daily. The number of sampling events completed by station operators has increased in recent years, beginning in 2011 at Bruce A and 2008 at Bruce B. Increased sampling events have provided more data and an improved representation of annual fish impingement. The notably higher number of fish impinged in 2011 was due to an increase in frequency of Gizzard Shad runs in that year.

Figure 3.1: Number of fish impinged (bars) and number of routines complete (lines) by year for Bruce A and B



During 2016 impingement monitoring, Bruce Power collected a total of 7,821 fish comprised of 29 species, from both Bruce A and Bruce B. Thirty-four fish could not be identified. Fish species and the number of fish impinged in 2016 monitoring are provided in table 3.9.

Table 3.9: Number of individual fish impinged by station during 2016 impingement monitoring

Species	Number of individuals		
	Bruce A	Bruce B	Total
Alewife	1	65	66
Brown Trout	3	7	10
Bullhead	11	0	11
Burbot/Ling	59	195	254
Carp	3	16	19
Channel Catfish	7	10	17
Chinook Salmon	3	7	10
Coho Salmon	0	6	6
Emerald Shiner	1	25	26
Freshwater Drum	7	13	20
Gizzard Shad	286	356	642
Lake Chub	0	1	1

Species	Number of individuals		
Lake Trout	15	52	67
Lake Whitefish	26	45	71
Longnose Sucker	68	426	494
Rainbow Smelt	196	938	1134
Rainbow Trout	8	16	24
Redhorse Sucker	3	126	129
Rock Bass	16	2	18
Round Goby	446	2296	2742
Round Whitefish	2	1	3
Shiner	2	0	2
Silver Bass	0	1	1
Smallmouth Bass	3	13	16
Three Spine Stickleback	5	0	5
Unknown	29	5	34
Walleye	5	25	30
White Perch	14	12	26
White Sucker	9	91	100
Yellow Perch	232	1611	1843
Total	1460	6361	7821

Entrainment is the taking of aquatic organisms into a facility with cooling water such that they are released to the receiving waterbody through the discharge outlet. These organisms are smaller than the mesh of travelling screens and therefore remain in the cooling water as it moves through the facility. These smaller organisms are typically eggs and larval fish. It is assumed that these organisms will be killed, damaged, or seriously harmed by thermal or mechanical stress while passing through the facility.

The number of fish impinged each year at Bruce A and B is continuously monitored but the entrainment of eggs and larvae is not monitored every year due to the sampling effort required. Bruce Power conducted monitoring in the Bruce A intake channel from 2013 to 2014 to characterize loss of eggs and larvae due to entrainment as part of the Bruce A Refurbishment Follow-up Monitoring Program. Entrainment at Bruce B in 2013 and 2014 was calculated using actual annual flows for Bruce B, assuming the entrainment levels at Bruce B are equal to the entrainment at Bruce A. Because both impingement and entrainment sampling were conducted in 2013 and 2014, these years were selected by Bruce Power to assess the potential impact of impingement and entrainment on fish populations in Lake Huron.

Eggs or larvae of Alewife, Burbot, Chinook Salmon, Lake Whitefish, Longnose Sucker, Redhorse Sucker, Rainbow Smelt, Round Goby, Walleye, White Sucker, Yellow Perch and salmonid species were identified in the entrainment samples from 2013 and 2014. The calculated number of eggs and larvae entrained at Bruce A and B combined ranged from 12,450 Chinook Salmon in 2013 to 6.9 million Burbot in 2014.

Bloater, Cisco and Deepwater Sculpin fish were not impinged in 2013, 2014 or 2016. However, the eggs and larvae of these three species were identified during the 2013 and 2014 entrainment monitoring. Therefore, Bruce Power determined the potential impact to these species is due to the entrainment of eggs and larvae, rather than the impingement of fish. The calculated numbers of Bloater eggs and larvae entrained were 543,680 in 2013 and 547,992 in 2014; the numbers of Cisco eggs and larvae entrained were 647,421 in 2013 and 141,332 in 2014; the numbers of Deepwater Sculpin eggs and larvae entrained were 419,314 in 2013 and 2,577,310 in 2014.

The numbers of eggs and larvae entrained and the number of fish impinged at Bruce A and B in 2013 and 2014 were converted to the number of Age-1 equivalent fish that would have resulted had the eggs, larvae and fish survived, as it is understood that many of the eggs and larvae will die in the natural ecosystem from natural mortality. The Age-1 equivalent biomass of the entrained and impinged fish from 2013 and 2014 was also calculated and the results are displayed in table 3.10. Entrainment accounted for the majority of the biomass of Age-1 Equivalent fish lost due to the cooling water intakes at Bruce Power in 2013 and 2014.

Table 3.10 Annual Biomass of Age-1 Equivalent Fish Entrained and Impinged at Bruce Power (Bruce A and Bruce B combined) in 2013 and 2014

Year	Biomass of Entrained Fish (kg)	Biomass of Entrained Eggs (kg)	Total Biomass Entrained (kg)	Total Biomass Impinged (kg)	Total Annual Biomass Impinged and Entrained (kg)
2013	2,474	10	2,484	219	2,703
2014	1,456	13	1,469	613	2,082
Average	1,965	12	1,977	416	2,393

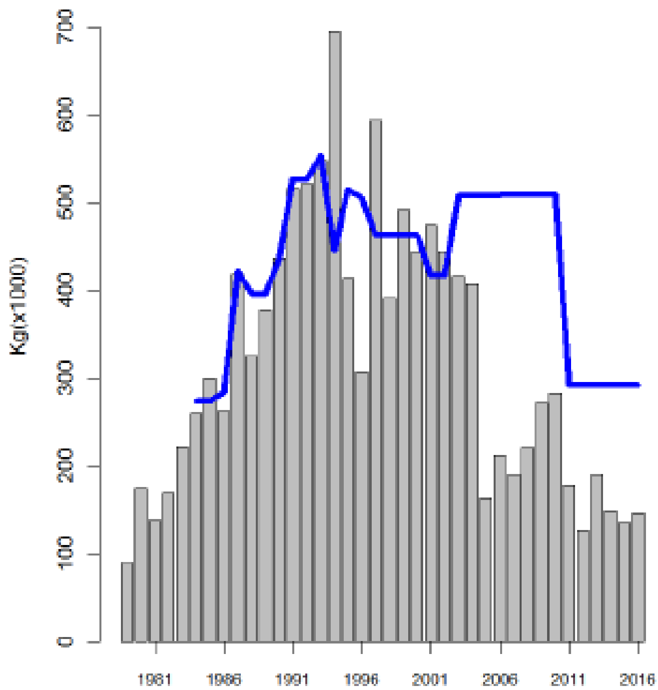
Context to Lake Huron

In the absence of specific information on population structure of fish species in the vicinity of the Bruce site, CNSC staff rely on inputs from the fisheries managers. In the case of the Bruce site, the commercial fishery in the Ontario waters of Lake Huron is managed by the Ontario Ministry of Natural Resources and Forestry (MNRF), Upper Great Lakes Management Unit. The provincial strategy is a practical and strategic approach used to sustainably manage the provinces fisheries resources (fish species, fish communities, commercial, recreational and First Nations and Métis fisheries). The MNRF prepares an annual commercial fishing report, which summarizes the known commercial fishing activities of the year and provides some historical context of the fishery. Licensed commercial fishers on Lake Huron are required to report effort, catch, and harvest information. In addition, Aboriginal commercial fisheries operating under fishing agreements with the province are required to report similar information to the MNRF on an annual basis. These combined data provide the basis for the annual reporting and are also used in stock assessment analyses and are used by the MNRF to set fishery quotas on an annual basis.

The Bruce site is located adjacent to the Zone 1 Quota Management Area in Lake Huron. The only established quota in Zone 1 is for Lake Whitefish which is commercially fished by the Saugeen Ojibway Nation (SON). The annual quota for this species is jointly managed by the SON and MNRF to ensure the sustainability of the population. The commercial quota for Lake

Whitefish and harvest levels in Zone 1 are provided in figure 3.2. The biomass of harvested Lake Whitefish has been less than the quota since 2003.

Figure 3.2: Lake Whitefish quota (line) and harvest (bars) for management area Zone 1 [Ontario Ministry of Natural Resources and Forestry. 2017. Lake Huron Commercial Fishing Summary for 2016. Upper Great Lakes Management Unit Lake Huron Report TR-LHA-2016-01]



The SON has the only commercial fishery in Zone 1 and the SON has the mandate to collect commercial harvest information for their fishery. The SON provides information to the MNRF who summarize the annual fish harvest data for other commercially harvested species (other Coregonid (i.e., Round Whitefish, Cisco, Bloater) species, Lake Trout, Walleye and Yellow Perch) in Zone 1. There are currently no quotas for these species in Zone 1. Were any harvest levels to become a concern from a population sustainability perspective, the SON and the OMNRF would work collaboratively toward establishing a quota. As there are no quotas for these species, the current level of commercial fishing is not impacting the fish populations in Zone 1.

Bruce Power used the used the calculated biomass of impinged and entrained fish in 2013 and 2014 and calculated the foregone fishery yield for fish species that are commercially harvested in Lake Huron. Foregone fishery yield is modelled using the age-specific numbers of fish impinged and entrained, age-specific survival data, fish weight at age data and the age-specific instantaneous mortality rates from both fishing and other impacts. The foregone fishery yield is the biomass of fish (in kg) that would have been available to the fishery had the fish not been impinged or entrained.

The foregone fishery yield was compared with commercial fishing harvest for those years and the results are displayed in table 3.11.

Table 3.11: Commercial harvest in Zone 1 and the annual impingement and entrainment losses based on Foregone Fishery Yield in 2013 and 2014

2013	Commercial Fishing Zone 1		Foregone Fishery Yield Annual Losses		
Common Name	**Harvest (kg)**	**Value of Harvest ($)**	**Biomass (kg)**	**% of Harvest**	**Commercial Value ($)**
Lake Whitefish	191,155	722,040	986	0.52	3,724
Coregonids[1]	191,155	722,040	2,355	1.23	8,895
Lake Trout	29,165	35,632	92	0.32	112
Walleye	2,380	12,784	231	9.71	1,241
Yellow Perch	1,355	5,494	82	6.05	332
TOTAL	**224,055**	**775,950**	**2,760**	**1.23**	**10,580**
2014	**Commercial fishing Zone 1**		**Foregone Fishery Yield Annual Losses**		
Common Name	**Harvest (kg)**	**Value of Harvest ($)**	**Biomass (kg)**	**% of Harvest**	**Commercial Value ($)**
Lake Whitefish	149,275	642,283	443	0.30	1,906
Coregonids[1]	149,275	642,283	443	0.30	1,906
Lake Trout	21,647	22,669	140	0.65	147
Walleye	2,479	12,740	312	12.59	1,603
Yellow Perch	828	3,585	28	3.38	121
TOTAL	**174,229**	**681,277**	**923**	**0.53**	**3,777**

[1]In 2013, not all Coregonids could be identified to the species level. Specimens positively identified as Lake Whitefish were placed into the Lake Whitefish category and the Coregonids category. Totals included values from Coregonids category to remain conservative because some of the unidentified Coregonids may have been Lake Whitefish.

The foregone fishery yield biomass lost from impingement and entrainment in 2013 and 2014 ranged from 0.03% of the commercial harvest of Lake Whitefish to 12.59% of the commercial harvest for Walleye in 2014 for the Zone 1 fish management zone of Lake Huron. In all cases, the foregone fishery yield biomass lost was a fraction of the fish lost from commercial fishing. Commercial fishing is managed by the MNRF to ensure the sustainability of fish populations, and in the case of Lake Whitefish in Zone 1, is jointly managed by the SON and MNRF. It can be surmised that losses of commercial fish in Lake Huron due to the Bruce site in 2013 and 2014 did not have an effect on the population of commercial fish species in Zone 1 of Lake Huron since they were a fraction of the fish loss to commercial harvest.

In its ERA, Bruce Power has focussed on comparing its losses due to impingement and entrainment to the losses of commercially fished species. The losses of other species relative to other fishing metrics have not been provided. CNSC staff expect Bruce Power to address this gap though CNSC staff is of the opinion that it is not expected to change the conclusions of no unreasonable risk to fish populations and will update the Commission at the Part I Hearing.

As stated earlier in this report, the monitoring of the impact of cooling water intake on Deepwater Sculpin was part of the Bruce A Refurbishment EA Follow-up Monitoring Program (element 3.3). The results of follow-up element 3.3 were inconclusive to verify the predictions of the EA due to insufficient information being available on the local population levels of Deepwater Sculpin. The potential impact will continue to be assessed as part of the ERA.

DFO has been consulted on this matter since Deepwater Sculpin is SARA-listed. DFO has advised the CNSC that future monitoring of local Deepwater Sculpin populations appears to be warranted and would allow for a future threshold to be set to support the conclusion of no significant risk.

CNSC staff recommended that additional entrainment monitoring be completed as part of the environmental monitoring program and that Bruce Power engage with DFO to determine reasonable methods that could be used to increase the understanding of the population of Deepwater Sculpin in the local areas surrounding the Bruce site. Continued oversight of this additional assessment will continue through the ERA and the annual reports on the environmental monitoring program.

Conclusion

CNSC staff assessed Bruce Power's analysis and concluded that there is negligible risk to fish populations in Lake Huron from impingement and entrainment, and low risk to fish populations present near the Bruce site. CNSC staff recommended Bruce Power continue to assess the potential uncertainties in their impingement and entrainment numbers and provide means by which they can reduce uncertainties to improve quantification during future monitoring. CNSC further recommended that additional entrainment monitoring of Deepwater Sculpin be completed under the environmental monitoring program and that Bruce Power engages with DFO to determine reasonable methods that could be used to increase the understanding of the population of Deepwater Sculpin in the local area surrounding the Bruce site.

Based on the current available science and information, CNSC staff concluded that potential impacts from the continued operation of Bruce A and B is not causing unreasonable risk to fish populations and that the aquatic environment around the Bruce site remains protected.

Thermal Effects

Bruce A and B both use a once-through CCW system to dissipate excess heat from the steam turbines, and condense steam to water for recycling back to the steam generator. Water intakes (previously discussed in impingement and entrainment section) take water from Lake Huron and that water passes through the condenser and is discharged back to Lake Huron via the CCW duct and discharge channel. At Bruce A, the reinforced CCW duct extends from Unit 4 in the east to the outfall structure, which is the start of the discharge channel that reports to the surface waters of Lake Huron. At Bruce B, the reinforced CCW discharge duct extends from Unit 8 in the northeast to the outfall structure, at the start of the discharge channel that reports to the surface waters of Lake Huron. Both discharge channels are bounded by concrete and rock groynes (see figure 3.3 for satellite image of Bruce A and B CCW systems).

Figure 3.3: Satellite image of Bruce A and B site with Bruce A and Bruce B intake structures, intake channels, forebay channels and discharge channels highlighted in yellow

Five seasons of summer thermal data (2011, 2012, 2014, 2015 and 2016) and three seasons of winter thermal data (2012/2013, 2014/2015 and 2015/2016) were compiled and considered in the preliminary quantitative risk assessment (PQRA) undertaken within the 2017 ERA thermal assessment. For the PQRA, Bruce Power thermal monitoring data was compared to fish thermal criteria (specific to fish species and life stage) [12] using the HQ method outlined in CSA Group Standard N288.6-12 (i.e., calculation of hazard quotients) [4]. Monitoring data used in the PQRA included data collected via data loggers deployed within the surrounding environment, as well as permanent temperature monitors in each discharge channel that measure effluent temperature, which is regulated by MOECC. Ten monitoring sites were chosen within the nearshore region close to the Bruce A and B discharges where there is potential for thermal effects. These sites were chosen based on known fish habitat and consistent logger recovery and data availability. The monitoring area also included Baie du Doré, and Stream C (not a nearshore area).

Five cold-water species, six cool-water species and five warm-water species were selected based on their presence near the Bruce A and B among other considerations including:

- a selection of species encompassing each guild type - cold water, cool water and warm water
- a selection of species representing the taxonomic group of fish (e.g., Chinook Salmon for salmonids)
- species chosen based on the amount of thermal criteria available
- species of socio-economic interest (commercial and recreational species)

- known interest to Indigenous groups
- a selection of species encompassing relevant variations in physiology (i.e., sensitive species) and lifestyle (i.e., water column depth preference, habitat preference [nearshore, offshore, shoals], and trophic level)

Five life stages were evaluated for each species (spawning, egg/incubation, larvae, young-of-the-year/juvenile, and adult). The daily maximum and average temperatures were determined for each period of interest and compared to thermal criteria available to each selected fish species and life stage. Any fish/life-stage/temperature combination identified in the PQRA with an HQ greater than 1 was further assessed using a detailed qualitative risk assessment (DQRA) where the difference between the HQ values (exposure vs reference) was greater than 50%.

Table 3.12: Fish species considered in thermal effluent assessment

Common name	Water type
Chinook Salmon, Lake Trout, Rainbow Trout, Lake Whitefish, Round Whitefish	Cold-water
Emerald Shiner, Gizzard Shad, Smallmouth Bass, Walleye, White Sucker, Yellow Perch	Cool-water
Brown Bullhead, Channel Catfish, Common Carp, Freshwater Drum, White Bass	Warm-water

Using the approach outlined above, no warm-water species were exposed to temperatures above benchmarks.

For cool-water species, for example, Emerald Shiner and its eggs (in Bruce A discharge), White Sucker eggs (in Baie du Doré), Walleye eggs (in Baie du Doré), Yellow Perch spawning stage and eggs (in Baie du Doré) received temperatures above benchmarks. Bruce Power took an interpretative approach to addressing these instances (e.g., limited spatial and/or temporal extent).

Since no scientific basis was provided, CNSC and ECCC do not agree with the arbitrary 50% cut off as well as the interpretative approach to dealing with HQs above 1. As per CSA standard 288.6, an HQ > 1 indicates a potential for direct thermal effects. As such, it is CNSC and ECCC's expectation that Bruce Power address the instances where HQs > 1 (i.e., DQRA) as part of Action Item 2018-07-12218 going forward given these situations generally appeared to be of limited spatial and/or temporal extent.

For cold-water species, only Lake Whitefish larvae and Round Whitefish eggs received temperatures above benchmark. Both were carried forward for DQRAs. Potential acute and chronic effects were considered.

From an acute perspective, for example, maximum temperature change values were observed above 5°C at several sites within all three years, but upon further examination of the frequency of these temperature changes, it was determined that these situations were infrequent and short-lived.

From a chronic perspective, using the Round Whitefish as the indicator cold-water species and the associated temperature benchmark of 6°C, it can be seen that in a very warm winter (e.g., 2015), there is the potential for an elevated risk to Round Whitefish eggs across a number of exposure stations associated with potential spawning habitat.

However, due to the absence of a winter thermal plume model, it is difficult to estimate a spatial extent of the potential elevated risk area.

As such, CNSC and ECCC staff expect Bruce Power to develop a winter thermal plume model in order to address this uncertainty in the risk assessment.

Conclusion

CNSC staff concluded, based on the assessment of the most recent ERA, Bruce Power responses to technical comments, and thermal assessment data, that the current operations at the Bruce site will generally pose a negligible to low thermal risk for warm water and cool water fish species. For cold water species, during warm winters, there is the potential for an elevated risk for Round Whitefish eggs. This potential risk has a number of uncertainties associated with it. As such, CNSC expects Bruce Power to submit an action plan to address these and other uncertainties (e.g., recent research, updated benchmarks, thermal plume modelling, DQRAs for HQ>1). CNSCS staff will provide updates to the Commission and the public on this issue through the CNSC's annual regulatory oversight reporting process.

CNSC staff determined that Bruce Power has provided adequate information concerning the thermal assessment to confirm that thermal effects in the aquatic environment surrounding the Bruce site are not likely posing an unreasonable risk to the environment.

3.2.5 Human Environment

Radiological emissions

Within Bruce Power's ERA, the human health risk assessment section [12] presents the doses to persons living in the vicinity of the site from its operations from 2012 to 2016. The data that served as inputs into the dose calculations are presented in the preceding sections of this report. This section describes how representative persons were selected to ascertain their annual doses, the exposure pathways considered in the assessment and the resulting annual doses.

Representative Persons Determination

Representative persons have the "average characteristics of a group of individuals who, by reason of their location and habits, are likely to receive the highest exposures to a given radionuclide released from a particular source" [8].

Doses were calculated for 18 groups of representative persons, each consisting of adults, children and infants, in proximity to Bruce A and B, and a Bruce Energy Centre Worker, as listed in section 6.1.1.2 (Receptor Description) of the ERA [12]. The locations of these groups are shown in figure 3.4 and the general characteristics of each group can be found in table 3.13 below. The characteristics of each group, including the use of local water supplies and consumption of home grown produce, are based on the Bruce site specific survey. Details of these groups had been provided by Bruce Power [12].

Figure 3.4: Location of Representative Persons for the Bruce Site (Left: local, Right: far-field)

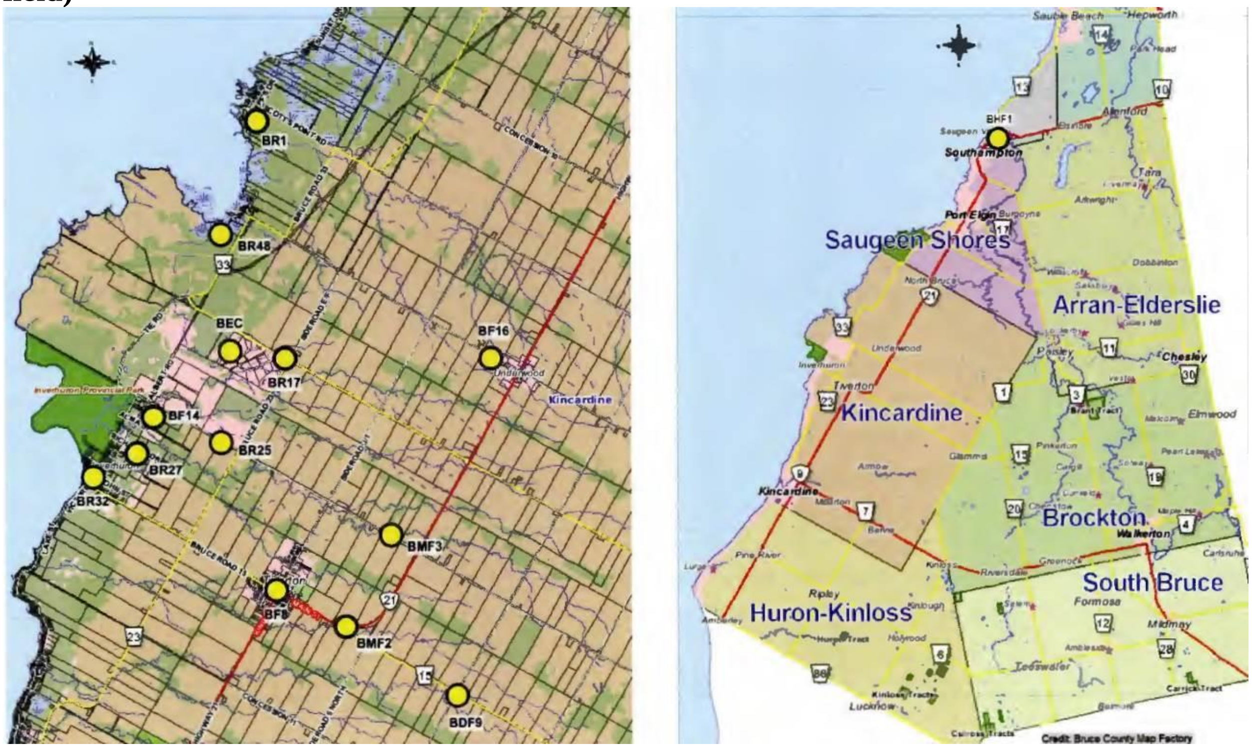


Table 3.13: Identification of Representative Persons

Group name	General characteristics	Approximate distance and direction*	
		Bruce A	Bruce B
BR1	Non-farm resident, Lakeshore, Scott	2 km NE	5 km NE
BR17	Non-farm resident,	4 km SE	5 km E
BR25	Non-farm resident, Inland	5 km S	4 km SE
BR27	Non-farm resident, Inland, Trailer Park	5 km S	3 km SE
BR32	Non-farm resident, Lakeshore, Inverhuron	6 km S	3 km S
BR48	Non-farm resident, Inland, near Baie de Doré	2 km SE	3 km E
BF8	Agricultural, farm resident	8 km S	7 km SE
BF14	Agricultural, farm resident	5 km S	3 km SE
BF16	Agricultural, farm resident	7 km SE	8 km E
BSF2	Agricultural, farm resident (Mennonite)	9 km SE	9 km SE
BSF3	Agricultural, farm resident (Mennonite)	8 km SE	8 km SE
BHF1	Hunter/Fisher	20 km N	20 km N
BDF1	Agricultural, Dairy farm resident	11 km NE	14 km NE
BDF9	Agricultural, Dairy farm resident	13 km SE	12 km SE

Group name	General characteristics	Approximate distance and direction*	
		Bruce A	Bruce B
BDF12	Agricultural, Dairy farm resident	13 km E	15 km NE
BDF13	Agricultural, Dairy farm resident	13 km SE	12 km SE
BDF14	Agricultural, Dairy farm resident	14 km SE	13 km SE
BDF15	Agricultural, Dairy farm resident	13 km SE	12 km SE
BEC	Worker in Bruce Eco-Industrial park worker	4 km SE	4 km E

* E = East; NE = Northeast; S = South; SE = Southeast

As a result of the information accumulated during the site survey, six types of representative persons have been identified:

1) non-farm residents (BR)
2) farm residents (BF)
3) subsistence farm residents (BSF)
4) hunter/ fisher resident (BHF)
5) dairy farm resident (BDF)
6) Bruce eco-industrial park worker (BEC)

The subsistence farm resident is an individual that self-produces more than half of their diet. It represents Mennonite farmers and others whose food consumption is from local sources.

The hunter/fisher catches and consumes wild game and fish. The consumption rates of these foods are greater than that for other individuals, and are representative of local Indigenous people.

Each representative person has dose calculations performed for an adult, child and infant with the exception of the BEC, which is a Bruce eco-industrial park worker.

Exposure Pathways

The Bruce Power environmental qualitative risk assessment describes the pathways by which the representative persons may be exposed to radiological releases from the Bruce site. Annual doses were ascertained for each radionuclide released from the site for the following exposure pathways:

- inhalation
- immersion in air
- water ingestion
- immersion in water
- incidental ingestion of soil
- external exposure from radionuclides deposited in soil
- consumption of terrestrial animal and animal products (e.g., milk)

- consumption of terrestrial plants
- consumption of aquatic animals
- consumption of aquatic plants
- incidental ingestion of sediment
- external exposure from radionuclides deposited in sediment

The above list of exposure pathways are consistent with the pathways recommended in CSA N288.1-14 [8].

Public Dose Results

The annual dose received by members of the public is determined by the degree of exposure to the radionuclides in the various exposure media (e.g., air, drinking water) and the radionuclide-specific and pathway-specific dose conversion factor. Radioactivity measurement data from the Bruce Power Environmental Monitoring Program, collected from 2012 to 2016, were used as inputs into IMPACT software to calculate the dose to each representative person listed in table 3.13. The IMPACT model was developed based on guidance provided in CSA Group Standard N288.1-14 [8]. In some cases, environmental measurements were not available, such as in the case of the hunter/fisher, which is located outside of the boundaries of the Bruce Power Environmental Monitoring Program. In such cases, an IMPACT model was used to model the transport of radionuclides from their point of release to the receptors.

The data indicate that annual dose to the public resulting from Bruce Power site operations continues to be well below the annual allowable dose limit of 1000 µSv (1 mSv) per year. The representative person with the greatest annual dose for the period 2012 to 2016 is the infant at the BSF3 'subsistence farmer' location. Doses for this receptor range from 2.1 µSv/year (0.0021 mSv/year) based on the 5 year annual average (2012-2016) to 4.4 µSv/year (0.0044 mSv/year) for the upper range annual concentrations for the same time period. The breakdown of this upper range dose by radionuclide and pathway are shown in tables 3.16 and table 3.17.

Table 3.14 Upper range dose by radionuclide for BSF3 infant

BSF3 Infant	^{14}C	^{244}Cm	^{60}Co	^{134}Cs	^{137}Cs	HTO	^{131}I	Noble Gases	OBT	^{239}Pu	Total
Dose (µSv/a)	1.31	7.5E-05	0.014	0.008	1.74	0.478	0.61	0.109	1.18E-01	8E-04	4.4
Percent	29.8 %	0%	0.3%	0.2%	39.5%	10.9%	13.9%	2.5%	2.7%	0%	100%

Table 3.15: Upper range dose by pathway for BSF3 infant

BSF3 Infant	Inhalation	Immersion (air)	Soil (external)	Sediment (external)	Aquatic animals	Terrestrial plants	Terrestrial animals	Total
Dose (µSv/a)	0.104	0.109	1.63	0.012	0.031	1.23	1.27	4.4
Percent	2.4%	2.5%	37.0%	0.3%	0.7%	28.0%	28.9%	100.0%

The maximum effective dose represents 4.4 µSv/year represents 0.44% of the dose limit of 1,000 µSv per year. The primary radionuclides contributing to this dose are cesium-137, carbon-14, iodine-131 and tritiated water. Exposure is mainly via external exposure from radionuclides in the soil and the consumption of animal products as well as fruits and vegetables. CNSC staff expect Bruce Power to provide further information on beta and gamma emitters in soils and dose due to animal product ingestion to confirm the conservative assumptions used in the Public Dose Assessment.

Non-radiological (hazardous) contaminants

Bruce Power's data was reviewed and COPCs were selected based on any exceedances of available guidelines and background levels. Where a guideline or background level was exceeded, the chemical was identified as a COPC. Exposures to COPCs were estimated considering the receptor most likely to be exposed in each applicable environmental medium and by each applicable exposure pathway. The estimated exposure was then compared to Toxicity Reference Values (TRV) derived from toxicity data in published scientific studies that would be protective of the receptor under conservative exposure conditions. Where the estimated exposure was less than the TRV, risks were considered to be acceptable.

As a result of the screening process described above, morpholine in surface water was the only chemical identified as a COPC. No other chemicals were identified in surface water or other media including sediment, soil or air. A conservative assessment of potential exposure was conducted for morpholine in the HHRA. Given that the highest concentrations were noted within the discharges from Bruce A and B, exposure of a sensitive receptor (toddler) through incidental ingestion of water while swimming was considered, recognizing that this is a conservative assumption because it is unlikely that a toddler would be exposed within the discharge. The TRV for assessing the potential health effects of morpholine was adopted from Health Canada. The assessment determined that the potential exposure was less than the TRV, and therefore there would be no risks to the receptor.

Conclusion

CNSC staff reviewed estimated annual doses to all human receptor groups considered in the ERA and concluded that human health is adequately protected as they were well below the public dose limit of 1 mSv. CNSC staff expect Bruce Power to provide further information on beta and gamma emitters in soils and dose due to animal product ingestion to confirm the conservative assumptions used in the Public Dose Assessment.

Additionally, there are no risks to human health through exposure to non-radiological substances. Therefore, CNSC staff concluded that Bruce Power have made adequate provision for the health of people surrounding the Bruce site.

3.3 Environmental Effects Assessment – MCR Activities

As part of Bruce Power's licence renewal application, Bruce Power is also applying to extend the operational lives of Units 3 to 8, which includes the replacement of major components through the MCR project. This section presents an overview of the assessment of predicted effects of continued operations and includes MCR activities on the environment and the health of persons. During the proposed 10-year licencing period, Bruce Power would continue operation of all eight reactor units. The MCR project will be limited in scope to focus on the replacement of key major components, including replacement of steam generators, replacement of feeder tubes, fuel channels and calandria tubes, as well as work related to defueling, dewatering and refueling the reactors. While the scope of the MCR project is included in the IIP, Bruce Power plans to conduct additional work on the units as part of its asset management program. Bruce Power's plan is to complete any required asset management work in normal maintenance outages but, where this is not possible, (e.g., where the work requires significant field time – greater than 90 days, or a defueled/dewatered state) this work will fall within the MCR outages. This approach was developed by Bruce Power from the previous refurbishment of Bruce A Units 1 and 2 and lessons learned. An EA under CEAA 1992 report was prepared Bruce A refurbishment for life extension and continued operation [19].

It is proposed that MCR activities will not commence before 2020 and would be carried out in a phased approach (i.e., one unit at a time, beginning with Unit 6) over a 13 year period. As Bruce Power has already executed the refurbishment of two reactors, many of the necessary facilities are already in place. However, additional facilities are needed in support of the MCR project. These include; parking spaces and buildings to house additional people, tools and equipment, and a simulator testing and training facility.

The life extension program proposed by Bruce Power would allow for the continued operation life of Bruce A and B through to 2064, pending approval by the Commission. For the purposes of the EA report, it is assumed that Bruce Power will continue to operate Bruce A and B consistent with its current operations. As such, it is predicted that, the anticipated environmental and radiological effects (e.g., risks to humans and non-human biota from radiological and non-radiological contaminants) will be similar.

However, given the dynamic nature of the Lake Huron ecosystem, it is recognized that in the future, the aquatic species assemblage could change. Likewise, with respect to climate change, water temperatures in Lake Huron are expected to continue to increase. These factors may influence the nature and extent of future impacts to aquatic biota due to impingement, entrainment and thermal discharges.

As the CNSC is a life-cycle regulator, with an established environmental protection framework, such changes to the receiving environment can be addressed through ongoing regulatory oversight. Consistent with expectations outlined in REG DOC 2.9.1, licensees will have an ERA that is to be updated on a 5 year basis, or sooner should there be major changes to the facility, that will help inform effluent and environmental monitoring programs. The cyclical nature of this framework allows for the CNSC to assess and mitigate risks that may arise.

Further, the PSR process will allow for the regular assessment of the current state of the facility and its performance to determine the extent to which the facility conforms to modern codes, standards and practices, and to identify any factors that would limit safe long-term operation. This enables the determination of reasonable and practical modifications or enhancements to operational programs.

Similarly, should Bruce Power receive a *Fisheries Act* authorization, the authorization would have the flexibility to deal with changing circumstances in order to ensure that the serious harm being authorized remains adequately mitigated.

The predicted assessment of likely effects of the project was carried out in a step-wise manner as follows:

- identifying potential project-environment interactions (see table 3.1)
- identifying potential environmental and health effects
- identifying mitigation measures (beyond standard design and operational measures) and monitoring and follow-up requirements
- determining whether the environment and health of persons is protected

A review has been conducted for all activities related to the MCR project, but only a selection of topics are presented in detail in this section. Topics were selected by CNSC staff as being of interest for the Commission, members of the public and Indigenous communities, or of regulatory interest, which include air, water, soil, fish and human health.

3.3.1 Atmospheric Environment

As mentioned previously, the atmospheric releases from the ongoing operations of the site are monitored through air quality monitoring programs. The MCR activities have the potential to increase radiological and non-radiological releases.

While air emissions from Bruce A and B will continue, releases will be reduced as reactors are taken offline for extended periods for MCR. However, there will be alternative releases related to MCR activities. Potential sources of radiological emissions would be from drain and dry activities and steam generator replacement. Bruce Power has committed to conduct a maximum probable emission rate study to calculate the effect of a release through the roof openings.

For conventional airborne emissions related to MCR activities, Bruce Power is held to performance standards stipulated in its Ministry of Environment and Climate Change (MOECC) Environmental Compliance Approval (ECA) [25] which allows Bruce Power to release contaminants up to the maximum point of impingement (POI) concentration limit at its property boundary. Main conventional contaminants include nitrogen oxides, morpholine, hydrazine, carbon dioxide, sulphur dioxide and particulate matter. Bruce Power has demonstrated through its monitoring data that Bruce A and B met applicable MOECC limits.

Predicted Air Quality

All of the above future refurbishment and restart activities listed in section 3.3 are comparable to the refurbishment work carried out for Bruce A Units 1 and 2 that were assessed in a 2006 EA screening report on Bruce A refurbishment for life extension and continued operations [19]. During this past work there was no significant increase in radiological or non-radiological emissions and atmospheric emissions were in-line with air modeling predictions. All emissions related to refurbishment activities are expected to remain well below regulatory limits. Based on this past experience, air emissions for future refurbishment and restart activities are also expected to remain below regulatory limits. Existing environmental monitoring programs will monitor MCR activities to confirm predictions and results will be reported through Bruce's annual EMP findings.

Notwithstanding the above, there was an unplanned worker exposure to airborne alpha contamination in 2009. This event was attributed to the grinding of feeder tubes in the reactor vault of Unit 1 at Bruce A as part of refurbishment activities.

To address this event, Bruce Power has since incorporated alpha monitoring in atmospheric and waterborne emissions and reports gross alpha particulate measurements in emissions in its annual environmental monitoring report. The alpha emitters measured in atmospheric and waterborne emissions over the 2012-2016 monitoring period were used in the ERA to model doses from alpha contamination to human and environmental receptors. The doses to human and environmental receptors due to alpha emissions were negligible and CNSC staff concluded that there is no overall radiological risk to humans and biota. In their review of the ERA, CNSC staff recommended monitoring of key alpha emitters in environmental pathways and receptors to confirm the modelling results. CNSC staff concluded that Bruce Power has adequately incorporated alpha monitoring as part of their normal operations and CNSC staff will be conducting regulatory oversight activities to verify that the environment and human health are protected throughout MCR activities.

For MCR activities, air releases will be directed to existing exhaust systems, where feasible. Exhaust systems are fitted with HEPA and HECA filters to reduce radiological and non-radiological emissions. Additionally, vault vapour recovery systems also minimize tritium releases to the environment and will be used for certain evolutions and activities during MCR. Bruce Power will also install on-site portable air quality monitors as required.

Concerning potential noise concerns, the predicted change in noise levels as a result of MCR activities will not likely be measurable (i.e., not discernible from existing conditions) to off-site receptors locations, as the predicted levels are consistent with current noise conditions.

As previously mentioned, CNSC staff determined that Bruce Power has a robust environmental monitoring program including radiological effluent monitoring programs to capture atmospheric radiological and non-radiological releases from Bruce A and B. These programs monitor ongoing operations and will include activities from the future MCR project.

Conclusion

CNSC staff reviewed the predicted effects of MCR activities and determined that licensee's predictions for change in air quality levels as a result of MCR activities are reasonable. Although the breadth of the activities to be undertaken as part of MCR is not considered routine for the site, this type of work has been carried out in the past with refurbishment of units at Bruce A. CNSC staff's past reviews of monitoring data indicates all future MCR activities are to meet regulatory limits, other CNSC and federal regulations and guidance, plus conventional air emission standards stipulated by MOECC regulations and accepted limits.

3.3.2 Terrestrial Environment

Soil Quality

As discussed in section 3.1.2, areas of elevated soil COPCs exist onsite (e.g., at the construction landfill areas, the distribution facilities, the former sewage lagoon and the fire training facility). However, impacts related to normal operations at the Bruce nuclear site are localized, well characterized, and effectively managed.

Based on Bruce Power's PEA, direct effects to soil from continued operations, including MCR activities, will be limited to the Bruce nuclear site. The majority of the areas that could potentially be impacted have already been disturbed, and to a great extent, have already been gravelled. No future activities were found to have a likely measurable change on soil quality. Therefore, predicted effects to soil quality from future activities are likely to be negligible and of relatively short duration.

Terrestrial Biota and Habitat

As mentioned in section 3.1.2, terrestrial receptors have the potential to be exposed to COPCs in soil, sediment, surface water and groundwater, as well as to radionuclides in air and soil from the ongoing operations of the site. Terrestrial biota can also be impacted by physical stressors such as noise, road kill, bird strikes, and habitat alteration. The 2017 ERA demonstrated that these risks were either negligible or low.

Based on Bruce Power's Predictive Effects Assessment, future operations, including MCR activities, are not expected to result in any significant change to terrestrial habitat on or near the Bruce nuclear site, as current operational conditions are demonstrated to be bounding of predicted changes. However, the following MCR activities were identified as posing potential risks to terrestrial receptors due to changes in vegetation, terrestrial habitat, or wildlife:

- The expansion of the Bruce B parking lot – this activity involves land clearing, including removal of trees, and construction with reclaimed asphalt.
- The construction of the Bruce B simulator – this activity involves land clearing, including removal of trees, installation of foundations and construction of the structure using mechanical equipment.

These potentially affected areas are onsite, and therefore, have previously been disturbed. Furthermore, measures are in place to mitigate the environmental impacts from current and future activities. Some of these mitigation measures include planting trees to replace those that have been removed to build temporary infrastructure, adherence to legislative requirements for fauna and flora protection (e.g., increased awareness of bat habitat, removal of trees outside of the maternal root season, etc.) and strategies to avoid bird-window strikes.

Potential changes are not anticipated to result in residual effects that necessitate additional monitoring or compensatory action. It is predicted, that negative effects are likely to be negligible for the terrestrial environment from current and future operational activities.

Conclusion

CNSC staff reviewed the predicted effects of MCR activities and determined that the terrestrial environment is not anticipated to change substantively during the course of future site activities. Predicted effects to soil quality from MCR activities are likely to be negligible and of short. The expansion of the Bruce B parking lot and the construction of the Bruce B simulator pose potential risks to terrestrial biota, but because measures are in place to mitigate those risks, negative effects are likely to be negligible.

3.3.3 Hydrogeological Environment

Groundwater Quantity

During future activities, including MCR activities, foundation drains and associated sumps and pumps will continue to remain in operation. Therefore, groundwater flow will continue to be controlled by the groundwater collection system. Site preparation activities related to MCR projects could interact with groundwater recharge and flow by temporarily hardening ground surfaces, thus potentially limiting surface recharge to groundwater. However, this is not anticipated to be measurable as variation will not be beyond seasonal variability. Therefore, predicted effects to groundwater quantity from MCR activities are likely to be negligible, of short duration, and reversible.

Groundwater Quality

According to Bruce Power's PEA, the only MCR activity identified as potentially resulting in measurable effects to groundwater quality is the expansion of the Bruce B parking lot. Expanding the parking lot could result in a larger paved area being treated with salt during the winter months to clear the ice and the snow. Runoff from the expanded area could consequently affect groundwater quality in the area surrounding the parking lot.

These results are in line with those presented in the Bruce A Refurbishment for Life Extension EA, which showed limited interactions between refurbishment activities and groundwater quality.

Conclusion

CNSC staff have reviewed the predicted effects of MCR activities and determined that licensee's predictions related to the groundwater flow regime is not anticipated to change substantively during the course of future site activities. The expansion of the Bruce B parking lot is likely to result in effects to groundwater quantity that are negligible, of relatively short duration, and are reversible. Existing processes and infrastructure in place will manage potential negative effects to groundwater quality from increased salt loading during the winter.

3.3.4 Aquatic Environment

Aquatic habitat on and near the Bruce site was previously described in the aquatic environment sub-section within section 3.1: Description of the Environment. Ongoing normal operations on the Bruce site, including MCR activities, are not expected to result in any significant change to aquatic habitat on or near the Bruce site. Therefore, CNSC staff concluded that the previously described aquatic environment at the Bruce site remains accurate for the purposes of the predictive effects assessment for MRC activities.

Liquid Effluent

Aqueous wastes generated on the Bruce site are processed, and the resultant effluent is discharged through the CCW duct, which is a monitored pathway to the environment. No change in operation of the ALWMS collection, handling and treatment system is expected as a result of MCR activities. However, the operating procedures on-site will be expanded to encompass and manage this facility, and emissions are anticipated to be maintained within compliance limits.

The following activities are predicted to interact with lake water quality:

- replacement of CCW and service water motors, pumps and valves
- vault air conditioning
- temporary dehumidifiers
- primary heat transport drain and dry
- moderator drain and dry
- system lay up

As part of MCR, the CCW and service water motors will be replaced. During this short duration activity, feedwater chemical concentrations in the discharge may be higher due to reduced volumes (i.e., dilution) in the CCW duct, though ECA minimum flow requirements and concentration criteria will be met. Draining and drying tasks completed as part of this activity may result in elevated corrosion, scale and hardness in the effluent being discharged. However, liquid emissions were monitored during the Bruce A refurbishment and emissions during MCR are expected to be similar and maintained within compliance limits, based on this previous experience.

Other MCR activities are anticipated to result in an increase in waterborne contaminants being directed to the ALWMS, and subsequently the CCW. These activities are: vault air conditioning, temporary dehumidifiers, and system lay-up. These predicted changes are not anticipated to be measurable. Again, liquid emissions were monitored during the Bruce A refurbishment and emissions during the MCR are expected to be similar and maintained within compliance limits, based on this previous experience.

Radiological Contaminants

Baseline waterborne radiological releases are detailed in the ERA [12], and include: tritium, carbon-14, and gross alpha/beta/gamma. In 2016, Bruce Power's radiological waterborne emissions were well below regulatory limits. In 2014 and 2015, elevated tritium levels were attributable to draining of the emergency water storage tank in preparation of a vacuum outage. In 2007 and 2012, elevated activity levels from steam generators were associated with elevated levels of tritium and gamma emitting radionuclides (americium-241, cesium-137, and uranium-235). However, all radionuclide concentrations remained well below DRLs in those years.

Bruce Power has a number of mitigation measures in place to reduce radionuclide releases to the environment such as engineered barriers, including pre-treatment particle filtration and ion exchange, or reverse osmosis and processing though a limestone bed.

The calculated public dose for the Bruce site continues to remain below 10 μSv/year, which is well below the Canadian effective dose limit of 1 mSv/year (1000 μSv/year). In 2016, Bruce Power’s maximum public dose calculation, including all exposure pathways, was 1.6 μSv/year. The upper-range for the most exposed receptor was 4 μSv/year. CNSC concluded that the public remains protected as the radiation dose to members of the public is less than 1% of the CNSC effective dose limit (1 mSv/year).

Hazardous (Non-Radiological) Contaminants

The Bruce A Refurbishment for Life Extension and Continued Operations Project EA [19] concluded that there would be no residual effects to surface water due to refurbishment activities. In 2014, Bruce Power commissioned a water treatment system to provide additional mitigation against untreated discharge from the re-heater drain sumps, which accept untreated discharge from Units 1 and 2, and are intended to accept discharges from Units 3 and 4 in the future. Monitoring completed in 2014 showed no exceedances of EMEL criteria for any control points. The monitoring confirmed the EA follow-up program prediction of no residual effects to surface water.

Bruce Power concluded that it was not necessary to carry forward any hazardous (non-radiological) COPC with respect to CCW emissions, based on the monitoring data presented in table 3.5, which is located in the aquatic environment sub-section within section 3.1. Because the current operational conditions are demonstrated to be bounding of future activities, including MCR activities, hazardous (non-radiological) effluent is not expected to pose an unreasonable risk to aquatic habitat or biota.

Surface Water Quality

In the ERA, surface water was represented by radiological environmental monitoring program data; where data was not available for certain radionuclides, discharge monitoring data was used. MCR activities that could affect surface water quality directly are discussed further. Specifically, disruptive activities that are predicted to interact with the environment by resulting in an increase in the airborne contaminants directed to active ventilation. The activities that could result in a measurable change are:

- Primary heat transport drain and dry
- Moderator drain and dry
- Roof opening installation and closure

Active exhaust could result in downwash that could affect surface water quality. However, as airborne emissions are not only anticipated to meet compliance limits, but are anticipated to be within conditions experienced at the Bruce site under current operations, the change is not anticipated to be measurable. Therefore, the ERA for current operations is representative of anticipated future conditions, and exposure associated with waterborne emissions, including airborne emission deposition, is not anticipated to increase above current operating conditions as a result of MCR activities.

Stormwater Quality

Activities that are predicted to potentially affect stormwater management as part of MCR are limited to installation of MCR infrastructure, and include establishment of the:

- Bruce B Parking Lot Expansion (likely measurable change)
- Central Storage Facility (likely not measureable change)
- Bruce B Simulator (likely not measureable change)
- Bruce B Protected Area Office Complex (likely not measureable change)
- Decontamination Facility (likely not measureable change)

Ditches, swales, pipes and drains are used to collect and manage stormwater, which is discharged directly to Lake Huron at various locations. Bruce Power employs at-source mitigation measures, including controls such as site design, industry best management practices and solid reduction measures (e.g., slow flow and vegetation establishment) to improve water quality prior to release to the environment. As indicated earlier in this EA report, stormwater volume and quality are monitored to ensure discharges from the site do not exceed established flows and water quality remains acceptable, as per the requirements of Bruce Power's MOECC ECA. The Bruce B Parking Lot Expansion will affect the existing forest to the south-east of the existing parking lot. The establishment of all other facilities will avoid substantial tree clearing and are encompassed by existing disturbed area (e.g., graveled area). Stormwater runoff designs for each new building will be reviewed prior to MCR infrastructure construction to determine if changes to existing stormwater management procedures will be required to accommodate the facility. It is Bruce Power's responsibility to engage MOECC with respect to any potential or necessary ECA amendments that may be required.

Construction dewatering will be discharged to grade, and erosion and sedimentation controls will be in place to manage sediment runoff to waterways. It anticipated that the existing stormwater management system will be expanded to encompass temporary MCR infrastructure. However, if new catch basins or the installation of drainage with swales are required to accommodate the construction of infrastructure for MCR, Bruce Power will obtain the requisite ECA amendments.

Future site activities were predicted to not result in measurable changes on inland surface water quality or water quality in Lake Huron.

Sediment Quality

Sediment samples were collected in 2016 and 2017 from two locations along Stream C (one upstream used to represent background sediment quality in the stream, and one downstream), and at several locations in Lake Huron and the Bruce A and Bruce B discharge channels. The upstream contribution of the South Railway Ditch was considered in the ERA because the South Railway Ditch feeds into Stream C. Therefore, any potential contribution of contaminants from the South Railway Ditch was incorporated into the sediment quality of Stream C. CNSC staff have requested that the sediment quality in the South Railway Ditch be monitored and incorporated into the next iteration of the ERA.

No site-specific limits were available for sediment; therefore, the following provincial and federal standards were used in screening COPCs:

- The MOECC Table 1 Standards for Sediment [35]
- The CCME Interim Sediment Quality Guidelines [36]

The sediment quality standards and guidelines from MOECC and CCME were derived to be protective of aquatic life. The baseline screening was completed using the more stringent of the provincial and federal standards listed above, along with comparison to the MOECC Ontario typical range concentrations where provincial and federal standards were not available. The chemicals, strontium and sulphate were identified as COPCs in at least one sediment sampling location in Stream C.

All other concentrations of chemicals in sediment samples collected from Stream C were either less than their screening value or less than the Stream C upstream concentration. Additionally, further analysis yielded a HQ of less than 1 for sulphate in sediment, which indicates negligible risk to aquatic life from exposure to sulphate in sediment.

In Lake Huron, strontium was identified as COPC in sediment at Scott Point and Southampton. No other Lake Huron locations or samples from the Bruce A or Bruce B discharge channels had COPCs identified in sediment. The chemicals listed above were identified as COPCs in sediment because no standards were available and the chemical exceeded its method detection limit.

Strontium in sediment was discussed previously in the Non-radiological Contaminants in Sediment sub-section within section 3.1.4.

Aquatic Biota

Aquatic receptors were considered to have exposure to surface water in Stream C and adjacent areas of Lake Huron during current operations. However, because water quality in discharge from Bruce A and B meets current regulatory limits, no COPCs were identified in the effluent discharges.

Aquatic receptors were considered to be exposed to COPCs in sediments in the discharge channels, Stream C, onsite ponds, MacPherson Bay and Baie du Doré. There were some marginally elevated HQs identified for semi-aquatic wildlife in direct contact with sediments in Stream C that were discussed previously in the aquatic sub-section within section 3.1: Description of the Environment. No risks were identified for semi-aquatic birds using the on-site lagoons or ornamental pond, or consuming fish along the Lake Huron shoreline of the Bruce site. Risks to aquatic life in Stream C were negligible for all assessed receptors. Hazardous (non-radiological) COPC pose no risk to aquatic biota resulting from normal operations on the site, including MCR activities.

The EA for the Bruce A Units 1 and 2 Refurbishment Project [19] predicted an increase in winter water temperatures at Loscombe Bank, which is a cobble shoal that occurs approximately 2.5 km northwest of the Bruce site. As part of the EA follow up program, monitoring was required to verify predictions that temperatures would be within +/- 2°C of predicted temperatures taking into consideration natural variability. Substrate temperatures collected prior to refurbishment activities (2004-2005) were compared to those collected during the first year of operations (2013), and there were no overall significant differences observed. Thermal effects generally pose a low risk to aquatic biota resulting from normal operations on the site, including MCR activities.

Fish impingement and entrainment monitoring was conducted in 2013 and 2014, when 8 reactor units were running. The annual average age-1 equivalent biomass impinged and entrained at the Bruce site in 2013 and 2014 was 2,393 kg. As previously stated, the majority of the biomass loss was caused by fish entrainment (83%) rather than impingement (17%). The biomass of Lake Whitefish impinged and entrained during site operations in 2013 and 2014 was approximately 0.3 - 0.5% of the commercial harvest in Zone 1. Biomass of other commercially harvested species (Lake Trout, Walleye and Yellow Perch) ranged from 0.3 to 12.6% of the annual harvest in these years. Bruce Power's PEA asserted that the volume and rate of the cooling water intake as Bruce A and B during the proposed licensing period will not be greater than the volume and rate in 2013 and 2014, and therefore the fish impingement and entrainment losses for those years represents a bounding case for future fish loss due to the cooling water intake. Therefore, the predicted loss of fish from cooling water intake at the Bruce site for future operations during the upcoming licensing period is predicted to result in a negligible risk to fish populations in Lake Huron, given the small percentage of biomass lost relative to the size of local fish populations.

Conclusion

CNSC staff reviewed the predicted effects of MCR activities and concluded that Bruce Power will make adequate provision for protection of the aquatic environment on and near the Bruce site during the upcoming licensing period, including protection of aquatic biota.

Any change in waterborne emission as a result of MCR activities will likely result in relatively short durations of measurable effect. Although the breadth of the activities necessary for MCR are not considered routine for the Bruce site, the activities are not new to the site; therefore, periods of monitoring data representative of this future condition exist, and based on that data, all emissions associated with MCR activities are anticipated to meet DRL limits and ECA limits [12].

There is no radiological risk to aquatic biota resulting from normal operations on the site, as current operational conditions are demonstrated to be bounding of future activities, including MCR activities [12]. With respect to non-radiological contaminants, all derived hazard quotients (HQs) are below one (or only marginally above 1); therefore, there is negligible non-radiological risk to aquatic biota resulting from normal operations on the Bruce site, including MCR activities.

With respect to physical stressors (thermal effects and impingement and entrainment), adequate provisions have been made for the protection of fish, given the small percentage of biomass lost relative to the size of local fish populations. Additionally, Bruce Power has conducted several environmental assessments for the Bruce site, and continues to conduct ongoing monitoring that continues to support this conclusion.

3.3.5 Human Environment

Public Exposure – Radiological

This section considers changes to radiological exposures that could occur as a result of MCR, as presented in Bruce Power's predictive environmental assessment [12]. Predicted changes to exposure pathways leading to radiological exposures of members of the public, from MCR activities, have been assessed to be bounded by current operational conditions. These exposure pathways are encompassed in the following assessment topics, discussed previously in this section:

- air quality
- surface water quality and hydrogeology
- geology and soil quantity and quality
- groundwater quality and flow
- effects to aquatic and terrestrial environments

Given that pathways leading to public radiological exposures are not affected by the MCR project presented in Bruce Power's assessment [12], radiological exposures associated with future activities are bounded by the current operational conditions, which has remained below the annual public dose limit of 1 mSv for the last 25 years.

Concerning workers, in 2009 there was an unplanned worker exposure to airborne alpha contamination. This event was attributed to the grinding of feeder tubes in the reactor vault of Unit 1 at Bruce A as part of refurbishment activities. In total, 557 workers were affected by the event. None of these workers exceeded the regulatory annual dose limit of 50 mSv for a nuclear energy worker. However, 45 workers received greater than 2 mSv of unplanned dose from the event. Bruce Power took immediate corrective actions to enhance alpha monitoring and control aspects of its radiation protection program to avoid a re-occurrence. Following this event CNSC staff enhanced monitoring to ensure workers were protected and conducted a focused inspection of worker dose control at Bruce A and B. CNSC staff concluded that all corrective actions were acceptable. The lessons learned from this event have been adequately applied to mitigate any potential alpha exposure during future refurbishment activities.

Non-radiological (hazardous) contaminants

The current operational conditions are demonstrated in the PEA to be bounding of future activities, including MCR activities. No MCR activities are anticipated to have any detrimental effect on human health with the exception of aesthetic concerns due to construction infrastructure and expansion of paved areas (i.e., parking lot). The non-radiological HHRA evaluated the potential for health risks for members of the public, and the potential for health risks due to non-radiological chemicals and physical stressors (i.e., noise) were shown to be negligible considering normal operations at the Bruce site.

Conclusion

Estimated annual doses to all human receptor groups considered in the predicted affects assessment were below the annual public dose limit of 1 mSv. No health effects are expected to be observed at this dose. Additionally, the non-radiological human health risk assessment evaluated the potential for health risks for members of the public, and the potential for health risks due to non-radiological chemicals and physical stressors (i.e., noise) were shown to be negligible considering normal operations at the Bruce site. Therefore, CNSC staff concluded that human health will be adequately protected during MCR activities.

4.0 CNSC Independent Environmental Monitoring Program

The CNSC has implemented its IEMP to verify that the public and the environment around licensed nuclear facilities are protected. It is separate from, but complementary to the CNSC's ongoing compliance verification program. The IEMP involves taking samples from public areas around the facilities, and measuring and analyzing the amount of radiological and non-radiological contaminant substances in those samples. CNSC staff collect the samples and send them to the CNSC's state-of-the-art laboratory for testing and analysis.

4.1 IEMP for the Bruce Nuclear Site

The 2013, 2015 and 2016 IEMP sampling plans for Bruce site focused on radiological and non-radiological contaminants. Site-specific sampling plans were developed based on Bruce Power's approved EMP and the CNSC's regulatory experience with the site. Samples were collected in publicly accessible areas outside the Bruce site perimeter and included air particulate, vegetation, water, soil, sediment, and local food such as milk, meat, and produce from local farms. The site-specific sample plans are reviewed by CNSC staff on an ongoing basis to continuously improve and refine the plans to meet the objectives of the program.

CNSC staff taking a sample of local produce near the Bruce site in 2015.

For future IEMP sampling plans in the Bruce area, the CNSC will collaborate with local Indigenous groups to determine how best to collect samples that will provide meaningful results.

Below provides an overview of IEMP sampling in the vicinity of the Bruce site:

- air (5 locations in 2013, 3 locations in 2015 and 2 locations in 2016)
- water (11 locations in 2013, 7 locations in 2015 and 7 locations in 2016)
- soil (5 locations in 2013, 3 locations in 2015 and 3 locations in 2016)
- sediment (5 locations in 2013, 5 locations in 2015 and 5 locations in 2016)
- vegetation (6 locations in 2013, 4 locations in 2015 and 3 locations in 2016
- local food (16 locations in 2013, 9 locations in 2015 and 9 locations in 2016)

Samples collected were analyzed by qualified laboratory specialists in the CNSC's state-of-the-art laboratory in Ottawa, using appropriate protocols. CNSC staff measured the following:

- radioactive particulates – such as cesium-137, tritiated water, gross alpha and gross beta

Figures 4.1 to 4.3 provide an overview of the Bruce nuclear site sample locations for the 2013, 2015 and 2016 IEMP sampling campaigns.

Figure 4.1: Location overview of the Bruce nuclear site and 2013 sample locations

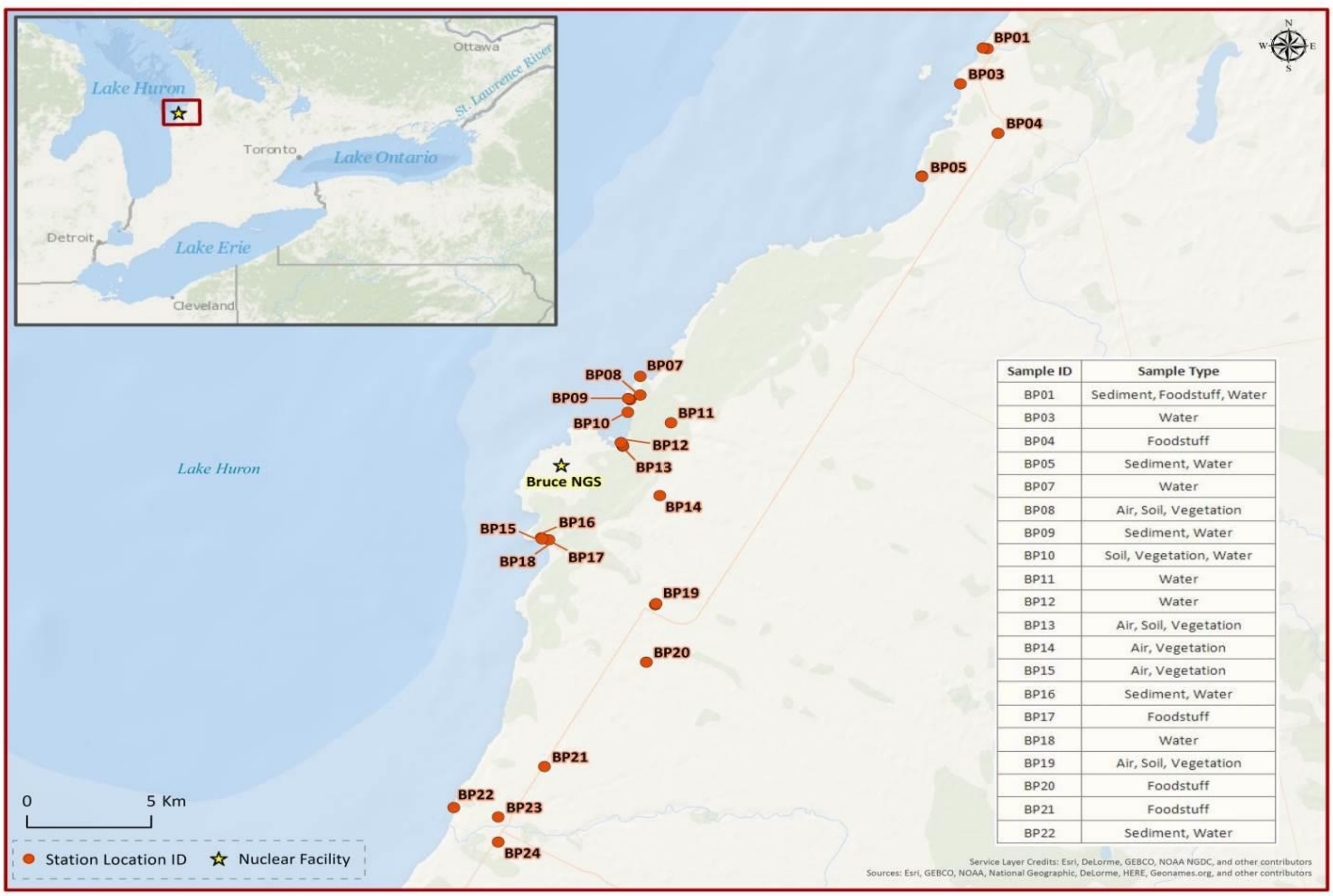


Figure 4.2: Location overview of the Bruce nuclear site and 2015 sample locations

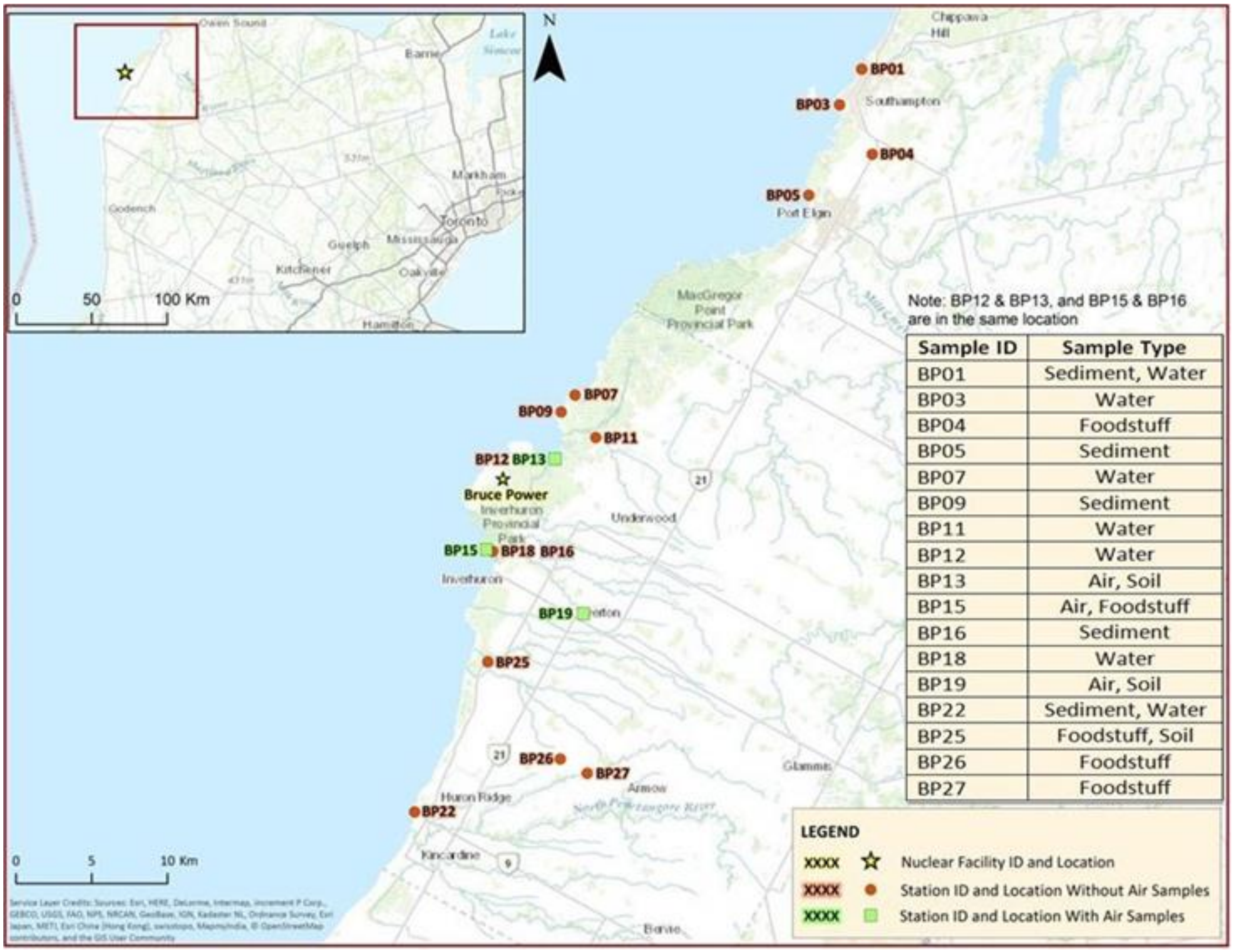
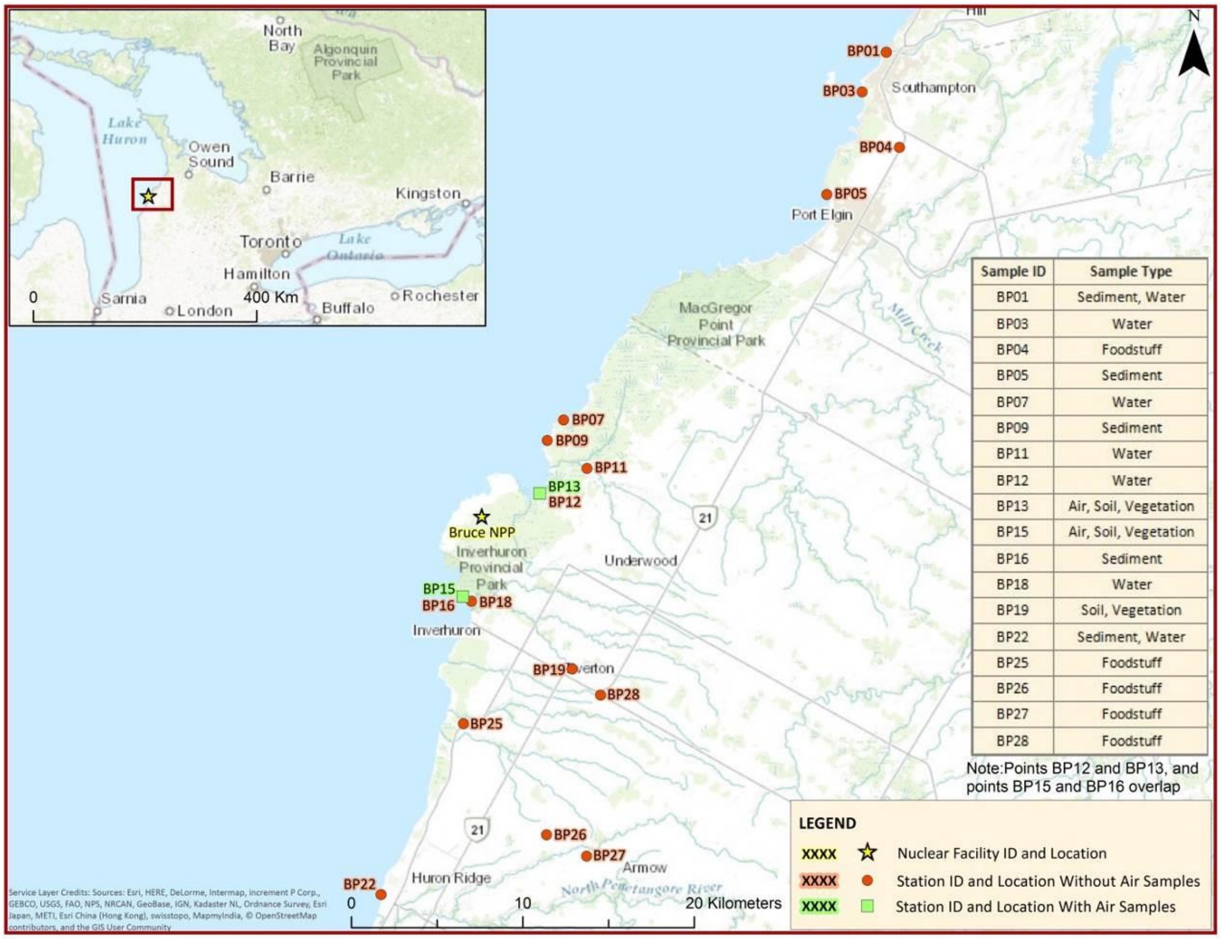


Figure 4.3: Location overview of the Bruce nuclear site and 2016 sample locations



4.2 Results

The measured radioactivity in all samples were below available guidelines and CNSC reference levels. The 2016 results were similar to what was found in 2013 and in 2015. CNSC reference levels are based on conservative assumptions about the exposure that would result in a dose of 0.1 mSv/year.

Appendix 1 provides the range of results from the 2013, 2015 and 2016 IEMP sampling campaigns. The full IEMP results are available through an interactive map on the CNSC website.

The IEMP results confirm that the public and the environment around the Bruce site are protected, and that there are no expected health impacts. These results are consistent with the results submitted by Bruce Power confirming that the licensee’s environmental protection program protects the health of persons and the environment.

5.0 Other Regional Monitoring

There are several regional monitoring programs carried out by other levels of government, which the CNSC has reviewed in order to confirm that the environment and health of persons around the Bruce nuclear site are protected. A summary of the programs' findings are provided below.

Ontario Ministry of Environment and Climate Change's Drinking Water Surveillance Program

The Drinking Water Surveillance Program (DWSP) provides water quality information for selected municipal drinking water supply plants for scientific and research purposes through the monitoring of analytes including organic, inorganic and radiological parameters (i.e., tritium, gross alpha and gross beta) [37]. The DWSP monitors two drinking water plants in the Bruce region. The closest municipal drinking water supply plant to the Bruce nuclear site is the Saugeen Shores water supply plant, approximately 25 km northeast of the Bruce site. This plant services the Saugeen Township, the Saugeen First Nation and the Town of Port Elgin. The second water supply plant is the Goderich plant located approximately 65 km further south along the shores of Lake Huron and services the Town of Goderich.

The most recent dataset from the DWSP is for 2012. Radioactivity levels were measured for both Lake Huron intake waters (raw) and water treated at the drinking water plant (treated water). The 2012 results and the range over the last 10 years ((2003-2012) are presented in table 5.1 for comparison to the provincial water guideline of 7,000 Bq/L for tritium and federal screening levels of 0.5 Bq/L for gross alpha and 1.0 Bq/L for gross beta.

The results show that tritium, gross alpha and gross beta activity levels have all been well below their respective drinking water standard or screening levels. There is a slight tritium signature at the Saugeen Shores plant (range <5.0 to 17 Bq/L), which is not reflected in the gross beta measurements due to tritium being a low beta emitter. Results from the Goderich plant, which is situated twice the distance to the south, indicate that operations at the Bruce site are having little to no influence.

Table 5.1: Drinking water surveillance program results of radionuclide activity in water sampled from stations near Bruce A and B in 2012 and the ten year range (2003 – 2012)

Measured radioactivity levels (Bq/L) in lake intake waters (raw) and treated waters for 2012 and the ten year range (2003-2012)						
Sampling Period	Tritium		Gross alpha		Gross beta	
	Raw	Treated	Raw	Treated	Raw	Treated
Drinking Water Standard(1a) or Screening Level (1b)						
	7000		**0.5**		**1.0**	
Saugeen Shores Drinking Water Supply Plant(2)						
2012[a]	14.0, 17.0	11.0, 17.0	< 0.04, <0.04	< 0.04, <0.04	0.04, 0.04	0.04, 0.04
Ten year range	<5.0 - 17	<5.0 - 17	< 0.04	< 0.04	< 0.04	< 0.04 - 0.05
Goderich Drinking Water Supply Plant(3)						
2012[b]	< 5.0	5.3	< 0.04	<0.04	0.06	0.04
Ten year range	< 5.0 - 7.2	<5.0 - 5.3	< 0.04	< 0.04	< 0.04 - 0.08	< 0.04 - 0.06

(1) a) Ontario Drinking Water Quality Standards Regulation 069/03
b) Health Canada Guideline Technical Document: Radiological Parameters – 2009
(2) Saugeen Shores was sampled twice in 2012.
(3) Goderich was sampled once in 2012.

Ontario Ministry of Labour's Ontario Reactor Surveillance Program

The objective of the Ontario Reactor Surveillance Program (ORSP) is to establish, operate and maintain a radiological surveillance network to assess radiological concentrations around designated major nuclear facilities in the province [38]. The ORSP monitors the air, water and food around nuclear power plants for radioactivity.

The purpose of the ORSP is to assure the public living and working in the vicinity of nuclear facilities that their health, safety, welfare and property is not affected by emissions from nuclear facilities. The most recent ORSP report, produced by the Ontario Ministry of Labour in 2014, concluded that the public in the vicinity of major nuclear facilities in Ontario can be assured that their health, safety, welfare and property are not adversely affected by emissions from the nuclear facilities.

The ORSP's core surveillance focuses on air and drinking water with the most recently posted dataset from 2012. For the Bruce nuclear site, air is monitored at three locations (see figure 5.1). Table 5.2 outlines the 2012 ORSP results for particulates and tritium in air, which are consistent with those observed in previous years. In addition, the results are below the CNSC's IEMP screening levels (see section 4.0 of this EA report).

A derived survey criteria was calculated to represent radioactivity levels in specific media (e.g., water and air) activity levels that would result in a dose at or below 0.1 mSv/year, which is an order of magnitude lower than the regulatory public dose limit of 1 mSv.

Table 5.2 outlines the 2012 ORSP results for particulates in air (gross beta, cesium-137 and iodine-131) and tritium in air (HTO (tritiated water)). These results indicate that particulates and tritium in air are reporting below their respective DSC. In addition, these results consistent with the results obtained through the CNSC's IEMP sampling results, with result below the CNSC's IEMP reference levels (see section 4.0 and Appendix 1).

The 2012 results were consistent with previous years with the particulates and tritium in air consistently reporting below their respective calculated derived survey criteria.

Table 5.2: Summary of the 2012 ORSP median measurements for the particulates and tritium in air

	Particulate in air				Tritium in air	
	No. of Samples[1]	Gross-beta (µBq/m^3)	Cs-137 (µBq/m^3)	I-131 (µBq/m^3)	Sample No.	HTO (Bq/m^3)
Derived survey criteria	---	100,000	1,000,000	600,000	---	700
Bruce	34	860	< 80	<80	33	0.85

[1] Monthly sampling, data not available for every month/station

Water monitoring is part of ORSP is more intensive in frequency and involves more radionuclides than monitoring completed with the DWPS. With the ORSP, there are two water supply plants included in the Bruce region. The Kincardine plant is located 15 km southwest from Bruce B and the previously discussed Southampton[4] (or Saugeen Shores) water supply plant, which is located approximately 25 km northeast of Bruce A.

At each participating water supply plants, daily collections were combined to form a weekly sample for tritium analyses. The ORSP reports the combined median value for the Bruce area (i.e., both stations) as 8.4 Bq/L, with the Kincardine results ranging from <5 Bq/L to 29 Bq/L and the Southampton plant ranging from < 5 Bq/L to 25 Bq/L. All of the water supply plants reported results well below the provincial drinking water standard of 7,000 Bq/L, and consistent with both the DWSP results and the CNSC's IEMP sampling results.

The weekly samples were combined to form quarterly composites for the analyses of gamma emitters (cobalt-60, iodine-131, cesium-134 and cesium-137), as well as for gross alpha and

[4] Note: Southampton water supply plant is identified as the Saugeen Shores water supply plant in the provincial drinking water surveillance program database discussed previously.

gross beta. The ORSP reports the combined median value for the Bruce surveillance area (i.e., both water plants combined) for these analytes, which are summarized in table 5.3. The results indicate that the analyses for gamma emitters and gross alpha and beta are all well below the DSC and consistent with both the DWSP and the CNSC's IEMP sampling results.

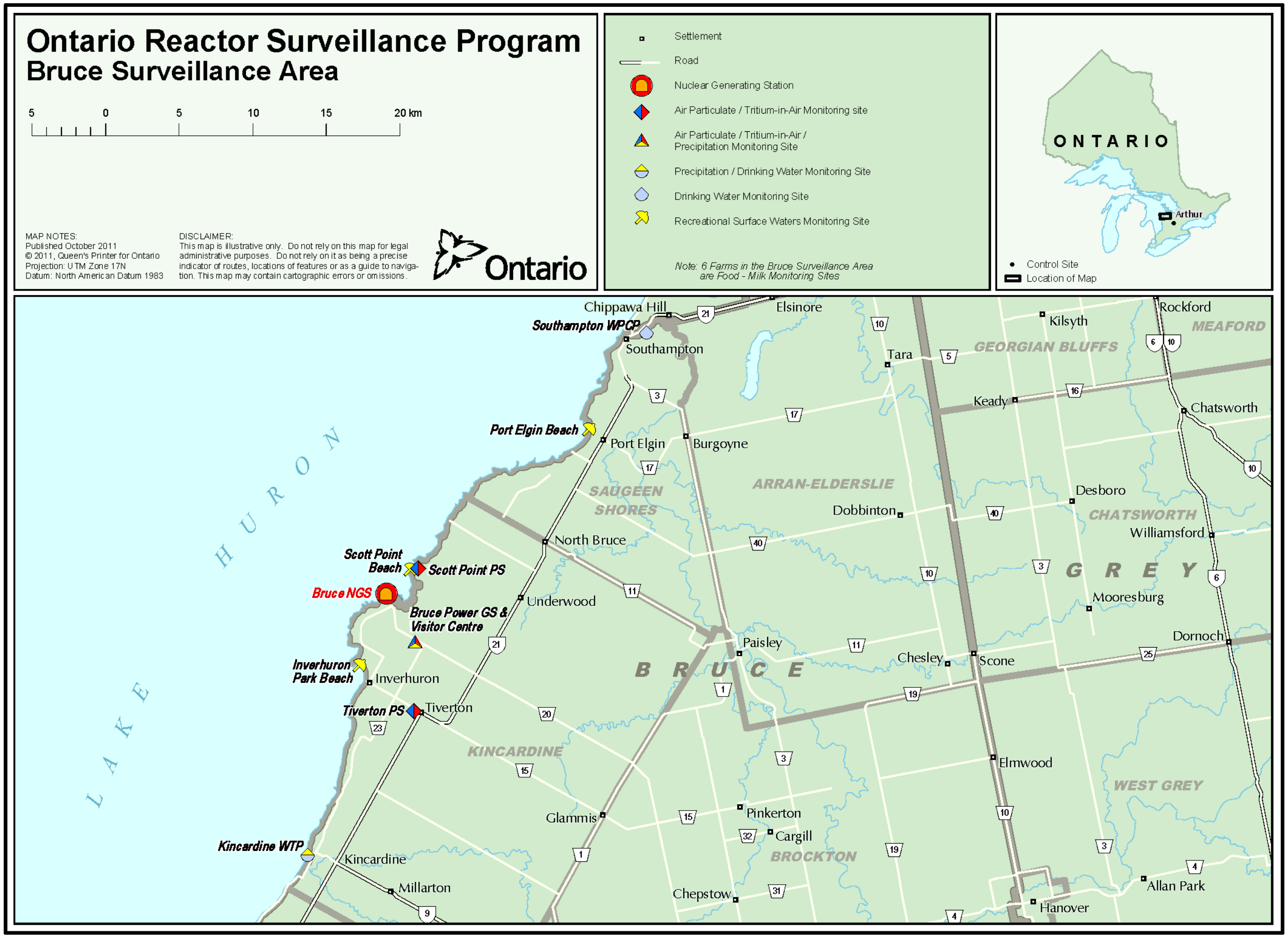
Table 5.3: Summary of 2012 ORSP sampling of drinking water annual median for gamma emitters, gross alpha and gross beta

	No. of samples	Gamma emitters				Gross alpha (Bq/L)	Gross beta (Bq/L)
		Co–60 (Bq/L)	I–131 (Bq/L)	Cs–134 (Bq/L)	Cs–137 (Bq/L)		
Derived surveillance criteria(1)	---	2	6	7	10	0.5	1.0
Bruce	8	< 0.2	< 0.6	< 0.7	< 1.0	< 0.04	0.04

(1) Derived surveillance criteria is for drinking water equal to the Ontario provincial drinking water standards Regulation 069/03 and the Health Canada screening level for gross alpha and beta.

To supplement the core surveillance program associated with air and drinking water the ORSP also monitors precipitation, surface water, milk and vegetation. This data is collected as a baseline for emergency planning, the maintenance of technical and laboratory skills required for emergency response (emergency and post-emergency environmental sampling) and is of value for scientific studies (e.g., precipitation monitoring has been used to develop radionuclide transport models for the Great Lakes and studies of basin hydrology). The results for these parameters were below the minimum detectable concentration of <5 Bq/L.

Figure 5.1: ORSP map of Bruce surveillance area monitoring sites for air and drinking water



Health Canada's Fixed Point Surveillance Program

In 2000, Health Canada complemented the Canadian Radiological Monitoring Network [39] with the Fixed Point Surveillance (FPS) network [40]. The FPS functions as a real-time radiation detection system designed to monitor public dose from radioactive materials in the air, including atmospheric releases associated with nuclear facilities and activities both nationally and internationally. Monitoring stations continuously measure gamma radioactivity levels from ground-deposited (ground-shine) and airborne contaminants.

Health Canada measures the radiation dose rate as Air KERMA (Kinetic Energy Released in unit MAss of Material) reported as nanogray per hour (nGy/h) of absorbed dose. These measurements are conducted every 15 minutes at 79 sites of its FPS network across the country. Air KERMA is also measured for three radioactive noble gases associated with nuclear fission which may escape into the atmosphere during normal operation of nuclear facilities. These three noble gases are Argon-41, Xenon-133 and Xenon-135.

The Health Canada website reports the the external absorbed dose from all gamma sources (natural and artificial) as well as the external gamma dose from the three monitored noble gases as nanoGray per month. CNSC staff worked with Health Canada to convert the absorbed dose rate to an effective dose, reported in millisievert (mSv) per year, which allows for comparison to annual background dose estimates and the regulatory public dose limit (table 5.4).

The 2016 total external gamma dose reported for the FPS network near the Bruce site is similar to the Canadian average for natural background (range 0.007 – 0.027 mSv/year) [41]. These results indicate that total external gamma dose at these stations is not significantly influenced by activities of the Bruce Site. Further evidence of this is provided by the extremely low activity levels reported for the noble gases, as outlined in table 5.4. All of the results are significantly below the public dose limit of 1 mSv.

Table 5.4: Annual external gamma doses (mSv/year1) for 2016 at the Fixed Point Surveillance network monitoring stations associated with Bruce A and B. No data is reported when results were below the minimum detectable dose (---)

Monitoring Stations near Bruce A and B	External Gamma Dose			
	All gamma sources	Monitored Noble Gases (Fission Products)		
		Argon-41	Xenon-133	Xenon-135
Site boundary	0.014	---	---	---
Scott point	0.010	---	---	---
Kincardine	0.011	---	---	---
Inverhuron	0.011	---	---	---
Port Elgin	0.010	---	---	---
Infocentre	0.018	---	---	---

Monitoring Stations near Bruce A and B	External Gamma Dose			
	All gamma sources	Monitored Noble Gases (Fission Products)		
		Argon-41	Xenon-133	Xenon-135
Tiverton	0.014	---	---	---
Shore road	0.010	---	---	---

[1] Assumptions: adult located at monitoring station for 24 hours a day, 365 days per year. Air KERMA in nanoGray corrected. Total Dose: 0.69 Sv for every Gray of absorbed dose measured: Argon-41: 0.74; Xenon-133: 0.75; Xenon-135: 0.67.

6.0 Recommendations and Conclusions

CNSC staff reviewed and assessed Bruce Power's environmental protection measures against regulatory requirements. Furthermore, CNSC staff completed regular compliance verification activities (e.g., inspections, audits, reviews) to ensure Bruce Power's environmental protection measures continued to meet CNSC regulatory requirements.

CNSC staff also reviewed Bruce Power's licence application and the documents submitted in support of the application, including Bruce Power's environmental risk assessment (ERA), associated predictive environmental assessment (PEA), preliminary decommissioning plan (PDP) and annual environmental monitoring reports, as well as the findings of CNSC's Independent Environmental Monitoring Program (IEMP) and past EA reports under CEAA 1992 and the NSCA. CNSC staff concluded that the results of the ERA and PEA provided sufficient evidence that the public and environment are protected and met both the CNSC's regulatory requirements and CSA Group Standard N288.6-12 *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [4].

CNSC staff reviewed the results from other regional monitoring programs conducted by other levels of government, which substantiated CNSC staff's conclusions that the environment and health of persons are protected from operations at the Bruce site. CNSC staff also conducted IEMP sampling around the Bruce site in 2013, 2015 and 2016. Both the regional monitoring results and the IEMP results confirmed that the public and the environment around the Bruce site is protected and that there are no health impacts as a result of facility operations. These results are consistent with the results submitted by Bruce Power, demonstrating that the licensee's environmental programs protect the health of persons and the environment.

This EA under the NSCA focused on items of current public and regulatory interest, including physical stressors, releases to air, groundwater and surface water from ongoing operations and those related to the proposed MCR project for the purpose of extending the operational life of Bruce A and B. CNSC staff concluded that the potential risk from physical stressors and radiological and non-radiological COPCs releases to the atmospheric, terrestrial, hydrogeological, aquatic and human environment are low to negligible. The EA report did identify actions for Bruce Power to undertake to confirm these conclusions, based on staff's review of Bruce Power's ERA and related information, as of the end of January 2018.

CNSC staff requested that future updates to the ERA provide clarification and/or additional information. Specifically, Bruce Power is to provide, through modifications and/or enhancements of their existing environmental monitoring program or through updates to the ERA, the following:

- future monitoring and assessment to address potential risks to aquatic and semi-aquatic receptors utilizing the South Railway Ditch and the former sewage lagoon
- future monitoring of impingement and entrainment to reduce data uncertainties, including entrainment monitoring of Deepwater Sculpin and to refine the conclusions on potential impacts via the cooling water intake
- a winter thermal plume model and action plan to reduce uncertainties related to potential risk to fish species
- future monitoring and assessment to address knowledge and data gaps in bird, plant, invertebrate, fish and wildlife exposure to COPCs, including hazardous contaminants, alpha emitters, C-14, tritium and organically bound tritium, and other radionuclides to reduce uncertainty in the ecological risk assessment
- further information on beta and gamma emitters in soils and dose due to animal product ingestion to confirm the conservative assumptions used in the human health radiological risk assessment

CNSC staff will track these recommendations through Action Item 2018-07-12218 and through review of the environmental monitoring program reports submitted annually to the CNSC and/or through future revisions of the ERA.

CNSC staff, based this EA under the NSCA report, concluded that Bruce Power has and will continue to make adequate provision for the protection of the environment and the health of persons. The implementation of the recommendations outlined above do not affect these conclusions as CNSC staff will continue to verify and ensure that, through ongoing licensing and compliance activities and reviews, the environment and the health of persons are protected and will continue to be protected until the safe state and abandonment of Bruce A and B.

The information provided in this EA report supports the recommendation by CNSC staff to the Commission to renew Bruce Power's power reactor operating licence of Bruce A and B (PROL 18.00/2020) for a period of ten years.

ACRONYMS

Acronym	Term
AL	Action Level
ALARA	As Low As Reasonably Achievable
CEAA, 2012	*Canadian Environmental Assessment Act, 2012*
CEAR	Canadian Environmental Assessment Registry
CEPA	*Canadian Environmental Protection Act*
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
DRL	Derived Release Limit
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMP	Environmental Monitoring Program
EMS	Environmental Management System
ERA	Environmental Risk Assessment
ESA	*Endangered Species Act*
IEMP	Independent Environmental Monitoring Program
LCH	Licence Condition Handbook
MCR	Major Component Replacement
NEW	Nuclear Energy Worker
NGS	Nuclear Generating Station
NSCA	*Nuclear Safety and Control Act*
PEA	Predictive Environmental Assessment
PDP	Preliminary Decommissioning Plan
SARA	*Species at Risk Act*
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WWMF	Western Waste Management Facility

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Appendix 1: Summary of the Bruce nuclear site IEMP results for 2013, 2015 and 2016

Radionuclide	Range of measured radioactivity			Guideline or CNSC reference level(1)
Water (Bq/L)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	<3.0(2) – 55.0	<3.0(2) – 47.2	3.0 – 88.9	7,000(3)
Gross Beta	<0.03(2) – 0.47	<0.07(2) – 0.14	<0.12(2) – 0.27	1(4)
Gross Alpha	N/A(5)	<0.05(2) – <0.07(2)	<0.07(2) – 0.35	0.5(4)
Cesium-137	<0.55(2)	<0.25(2)	<0.26(2)	10.0(3)
Cobalt-60	N/A(5)	<0.28(2)	<0.3(2)	12.1(3)
Air (Bq/m^3)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	<0.2(2) – 3	<1(2) – 9	<2.5(2) – <3(2)	340(1)
Tritiated hydrogen (HT)	0.4 – 5.9	<1(2)	<2.5(2) – <3(2)	5,100,000(1)
Air particulate (cesium-137)	<0.001(2)	<0.0001(2)	<0.00007(2) – <0.00008(2)	2.56(1)
Air particulate (cobalt-60)	N/A(5)	N/A(5)	<0.00008(2) – <0.00009(2)	0.228(1)
Iodine cartridge (iodine-131)	<0.005(2)	<0.001(2)	<0.001(2)	0.228(1)
Soil (Bq/kg dry weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	<1.5(2) – 14.7	N/A(5)	N/A(5)	68,500,000(1)(6)
Cesium-137	1.22 – 20.8	6.3 – 8.4	1.5 – 3.8	58.6(1)
Cobalt-60	N/A(5)	<1(2)	<0.8(2)	14(1)
Sediment (Bq/kg dry weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Cesium-137	<1(2) – 1.7	<0.5(2) – 6.6	<0.4(2) – 6.9	37,300(1)
Cobalt-60	N/A(5)	<1(2)	<0.8(2)	14(1)
Beef (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	<1.5(2)	4.8	6.5	159,000(1)
Organically bound tritium	<2(2)	56.5	<1.5(2)	69,300(1)

(OBT)				
Cesium-137	<1.2[2]	<1[2]	<1.5[2]	246[1]
Cobalt-60	N/A[5]	<1.2[2]	<1.9[2]	1080[1]
Beet (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level[1]**
Tritiated water (HTO)	N/A[5]	N/A[5]	<1.5[2]	104,000[1]
Organically bound tritium (OBT)	N/A[5]	N/A[5]	1.7	45,200[1]
Cesium-137	N/A[5]	N/A[5]	<1.5[2]	160[1]
Cobalt-60	N/A[5]	N/A[5]	<1.9	373[1]
Blueberry (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level[1]**
Tritiated water (HTO)	8.9	N/A[5]	N/A[5]	123,000[1]
Organically bound tritium (OBT)	<2[2]	N/A[5]	N/A[5]	50,300[1]
Cesium-137	<1.2[2]	N/A[5]	N/A[5]	258[1]
Carrot (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level[1]**
Tritiated water (HTO)	5.8	5.1 – 10.2	3.3	104,000[1]
Organically bound tritium (OBT)	<2[2]	<1.5[2]	<1.5[2]	45,200[1]
Cesium-137	<1.2[2]	<1[2]	<1.5[2]	160[1]
Cobalt-60	N/A[5]	<1[2]	<1.9[2]	373[1]
Chicken breast (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level[1]**
Tritiated water (HTO)	N/A[5]	<1.5[2]	3.5	196,000[1]
Organically bound tritium (OBT)	N/A[5]	1.5	<1.5[2]	85,500[1]
Cesium-137	N/A[5]	<0.8[2]	<1.5[2]	303[1]
Cobalt-60	N/A[5]	<1[2]	<1.9[2]	684[1]
Fish – Bass (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level[1]**
Tritiated water (HTO)	21.8	N/A[5]	N/A[5]	488,000[1]
Organically bound tritium (OBT)	1.8	N/A[5]	N/A[5]	212,000[1]

Cesium-137	<1.2[2]	N/A[5]	N/A[5]	1,040[1]
Fish – Lake Trout (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level[1]**
Tritiated water (HTO)	<1.5[2]	N/A[5]	N/A[5]	488,000[1]
Organically bound tritium (OBT)	<2[2]	N/A[5]	N/A[5]	212,000[1]
Cesium-137	2.08	N/A[5]	N/A[5]	1,040[1]
Fish – Whitefish (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level[1]**
Tritiated water (HTO)	<1.5[2]	N/A[5]	N/A[5]	488,000[1]
Organically bound tritium (OBT)	<2[2]	N/A[5]	N/A[5]	212,000[1]
Cesium-137	<1.2[2]	N/A[5]	N/A[5]	1,040[1]
Green Pepper (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level[1]**
Tritiated water (HTO)	7.1	N/A[5]	N/A[5]	123,000[1]
Organically bound tritium (OBT)	<1.5[2]	N/A[5]	N/A[5]	50,300[1]
Cesium-137	<1.5[2]	N/A[5]	N/A[5]	258[1]
Cobalt-60	<1.9[2]	N/A[5]	N/A[5]	242[1]
Kale (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level[1]**
Tritiated water (HTO)	N/A[5]	3.3 – 69.9	3.4 – 6.4	104,000[1]
Organically bound tritium (OBT)	N/A[5]	<1.5[2] – 2	<1.5[2]	45,200[1]
Cesium-137	N/A[5]	<1.8[2]	<1.5[2]	160[1]
Cobalt-60	N/A[5]	<2.1[2]	<1.9[2]	373[1]

Leaf Lettuce (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	5.2	N/A(5)	N/A(5)	104,000(1)
Organically bound tritium (OBT)	<2(2)	N/A(5)	N/A(5)	45,200(1)
Cesium-137	<1.2(2)	N/A(5)	N/A(5)	4,390(1)

Milk (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	N/A(5)	N/A(5)	1.7	5,560(1)
Organically bound tritium (OBT)	N/A(5)	N/A(5)	4.8	2,260(1)
Cesium-137	N/A(5)	N/A(5)	<0.26(2)	24.5(1)
Cobalt-60	N/A(5)	N/A(5)	<0.3(2)	10.9(1)
Iodine-131	N/A(5)	N/A(5)	<0.3(2)	1.64(1)

Pork chop (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	<1.5(2)	3.9	N/A(5)	392,000(1)
Organically bound tritium (OBT)	<2(2)	21	N/A(5)	171,000(1)
Cesium-137	<1.2(2)	<0.8(2)	N/A(5)	606(1)
Cobalt-60	N/A(5)	<1(2)	N/A(5)	1,440(1)

Potatoes (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	<1.5(2) – 4.3	N/A(5)	N/A(5)	279,000(1)
Organically bound tritium (OBT)	<2(2)	N/A(5)	N/A(5)	121,000(1)
Cesium-137	<1.2(2)	N/A(5)	N/A(5)	429(1)

Pumpkin (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	6.7	N/A(5)	N/A(5)	104,000(1)
Organically bound tritium (OBT)	<2(2)	N/A(5)	N/A(5)	45,200(1)
Cesium-137	<1.2(2)	N/A(5)	N/A(5)	4,390(1)
Romaine lettuce (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	4	N/A(5)	N/A(5)	104,000(1)
Organically bound tritium (OBT)	<2(2)	N/A(5)	N/A(5)	45,200(1)
Cesium-137	<1.2(2)	N/A(5)	N/A(5)	4,390(1)
Strawberry (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	10.5	N/A(5)	N/A(5)	123,000(1)
Organically bound tritium (OBT)	<2(2)	N/A(5)	N/A(5)	50,300(1)
Cesium-137	<1.2(2)	N/A(5)	N/A(5)	258(1)
Tomatoes (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	5.6 – 7.2	12.3 – 20.8	6.9	123,000(1)
Organically bound tritium (OBT)	<2(2)	<1.5(2)	<1.5(2)	50,300(1)
Cesium-137	<1.2(2)	<0.8(2)	<1.5(2)	258(1)
Cobalt-60	N/A(5)	<1(2)	<1.9(2)	242(1)

Zucchini (Bq/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	9.3	N/A(5)	N/A(5)	104,000(1)
Organically bound tritium (OBT)	<2(2)	N/A(5)	N/A(5)	45,200(1)
Cesium-137	<1.2(2)	N/A(5)	N/A(5)	4,390(1)
Vegetation (Bg/kg fresh weight)				
Radionuclide	**2013**	**2015**	**2016**	**Guideline or CNSC reference level(1)**
Tritiated water (HTO)	4.2 – 87.5	N/A(5)	7.1 – 17.2	10,900(1)
Organically bound tritium (OBT)	N/A(5)	N/A(5)	1.9 – 14.7	73,000(1)
Cesium-137	<5(2)	<4(2)	<3.5(2)	52(1)
Cobalt-60	N/A(5)	<4(2)	<4(2)	605(1)

(1) The concentration required for a hypothetical person (most exposed member of a critical group) to receive an effective whole body dose of 0.1 mSv/year due to exposure to the given radionuclide. Reference levels calculated based on conservative assumptions using CSA Standard N288.1-14 [8]
(2) The < symbol indicates that a result is below the detection limit for laboratory analysis
(3) Health Canada Guidelines for Canadian Drinking Water Quality [42]
(4) Health Canada Guidelines for Canadian Drinking Water Quality screening level [42]
(5) Samples for this contaminant, radionuclide particulate or iodine not taken this year
(6) Tritiated water concentrations in soil are presented on a fresh-weight basis. This indicates the concentration in bulk soil, for which tritiated water is contained in the soil pore water.

PART TWO

Part Two provides all relevant information pertaining directly to the licence, including:

1. Any proposed changes to the conditions, licensing period, or formatting of an existing licence
2. The proposed licence
3. The proposed licence conditions handbook
4. The current licence

PROPOSED LICENCE CHANGES

Overview

The proposed Bruce A and B Power Reactor Operating Licence (PROL) has been revised from the current PROL to include licence conditions for the Major Component Replacement (MCR), return to service and the consolidation of some of the other licences which have been issued by the CNSC to Bruce Power. Additionally, there have been some minor modifications to licence conditions to improve clarity and consistency.

Licence Conditions

Power Reactor Operating Licence

The new proposed Bruce A and B PROL is based on the standard PROL template developed by CNSC staff. This standard PROL template ensures that standardized licence conditions are used for all CNSC licensees and to provide regulatory consistency. The PROL template is structured to include the following parts:

I) Licence number (PROL 18.00/2028)
II) Licensee (Bruce Power Inc.)
III) Licence period (September 1, 2018 to August 31, 2028)
IV) Licensed activities (what the licence authorizes the licensee to do)
V) Explanatory notes (which provide PROL clarifications and make reference to the LCH)
VI) The licence conditions (LCs) for the 14 SCAs, Nuclear Facility-Specific LCs and Nuclear Substances and Prescribed Equipment LCs

The proposed Bruce Power PROL contains six facility-specific LCs retained from the current licence regarding: the lease agreement, refurbishment, removal of a reactor from commercial operation, booster fuel, the criticality program, and cobalt 60.

With the plans of Bruce Power to conduct a MCR for life extension of Units 3 to 8, CNSC staff proposes a LC for the implementation of the IIP. Additionally, a LC has been proposed to require Bruce Power to obtain approval from the Commission (or a person authorized by the Commission) prior to the removal of established regulatory hold points. Lastly, a specific licence condition is recommended by CNSC staff requiring Bruce Power to maintain pressure tube fracture toughness sufficient for safe operation.

In its application [1], Bruce Power requested the consolidation of other types of licences issued by the CNSC (such as the Class II licence and the Nuclear Substances and Radiation Devices licences) into the PROL. A description of the consolidation of other licences into the PROL is found in section 5.10 of this CMD. Therefore, nuclear facility-specific LCs have been included for the Class II nuclear facility, and nuclear substance and radiation devices.

While many of the licence conditions for the PROL, the Class II nuclear facility licence and the Nuclear Substances and Radiation Devices (NSRD) licences are identical, there are two conditions which are specific to the other (non-PROL) licences. CNSC staff propose to add station-specific conditions to the PROL which ensure the requirements from the other licences are incorporated into the PROL. These conditions are:

- LC 15.10, The licensee shall implement and maintain a program for the operation of the Class II nuclear facility
- LC 15.11, The licensee shall implement and maintain a program for nuclear substances and prescribed equipment

Licence Conditions Handbook

The proposed Bruce A and B Licence Conditions Handbook (LCH) is based on CNSC staff's standard LCH template. It provides regulatory consistency by including the same sections within each SCA. The format for the sections of the LCH which provide explanation of the LCs (General and Sections 1 to 15) includes:

- The licence condition
- The preamble section outlining the legal requirements
- The Compliance Verification Criteria (CVC) section ("shall" statements), including the Licensee documents that require Notification of Change and the Licensing Basis publications
- The Guidance section ("should" statements)

To ensure that Bruce Power operates within the Commission-approved licensing basis, the Bruce A and B LCH contains references to program documents that are programmatic in nature or process documents only when those documents contain limits or control measures. This ensures that changes made to programs, operating limits and control measures undergo regulatory scrutiny, but allows the licensee to manage its programs within the boundaries set by its management system.

The Commission considers the LCH during licence renewal and maintains oversight of it by receiving annual updates of major LCH changes through the NPP Regulatory Oversight Report (ROR) entitled *Regulatory Oversight Report for Canadian Nuclear Power Plants*. The NPP ROR is prepared annually by CNSC staff.

The significant changes in the proposed Bruce A and B PROL are shown in Table 18 and Table 19.

Table 18: Comparison of existing and proposed licence activities

EXISTING PROL	PROPOSED PROL	REASONS FOR CHANGE
(i) operate the Bruce Nuclear Generating Stations A and B (hereinafter “the nuclear facilities”) comprised of reactor units 1 to 4 and 5 to 8 respectively, at the Bruce site located in the County of Bruce in the regional municipality of Kincardine, Province of Ontario.	(i) operate the Bruce Nuclear Generating Stations A and B (hereinafter “Bruce A and B”) comprised of reactor units 1 to 4 and 5 to 8 respectively, at the Bruce site located in the County of Bruce in the regional municipality of Kincardine, Province of Ontario; and, (1) possess, transfer, use, package, manage and store nuclear substances that are required for, associated with, or arise from the activities described in (i), except for booster fuel assemblies; (2) possess, transfer and use prescribed equipment that is required for, associated with, or arises from the activities described in (i); (3) possess and use prescribed information that is required for, associated with, or arises from the activities described in (i);	Reformatted licensed activities due to consolidation of Nuclear Substances and Radiation Devices licences, and the Class II nuclear facility licence into PROL
	(ii) operate a Class II nuclear facility at the Bruce site; and, (1) possess, transfer, use, package, manage and store nuclear substances that are required for, associated with, or arise from the activities described in (ii); (2) possess, transfer and use prescribed equipment that is required for, associated with, or arises from the activities described in (ii);	
	(iii) possess, transfer, use, manage and store nuclear substances and prescribed equipment to perform industrial radiography throughout the Bruce site;	
(ii) possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in (i);	*moved*	Licensed activity found in Proposed (i)(1)
(iii) possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in (i);	*moved*	Licensed activity found in Proposed (i)(2) and (i)(3)
(iv) possess, transfer use, package, manage and store heavy water and the nuclear substances arising from the use of heavy water in the heat transport and moderator systems;	*deleted*	No longer required as per Bruce Power licence application [1] and to align with other Canadian NPP PROLs
	(iv) import and export prescribed equipment and nuclear substances, except controlled nuclear substances, that are required for, associated with, or arise from the activities described in (i), (ii) and (iii);	Per CMD 17-H109. Standard LC introduced to the Darlington and Pickering PROLs
(v) possess, manage and store booster fuel assemblies at Bruce A; and	(v) possess, manage and store booster fuel assemblies at Bruce A; and	No change
(vi) possess, produce, manage, transfer and store Cobalt-60 at Bruce B.	(vi) produce Cobalt-60 at Bruce B.	Possess, manage, transfer and store included in Proposed (i)(1) for nuclear substances, which includes Cobalt 60

Table 19: Comparison of current and proposed Licence Conditions

CURRENT PROL	PROPOSED PROL	REASONS FOR CHANGE
LCs G.1 to G.5	LCs G.1 to G.5	No change
LCs 1.1 to 2.1	LCs 1.1 to 2.1	No change
LC 2.2 The licensee shall implement and maintain the minimum shift complement and control room staffing for the nuclear facilities.	LC 2.2 The licensee shall implement and maintain the minimum shift complement and control room staffing for Bruce A and B.	Due to the addition of LC 15.10 for Class II nuclear facility, cannot refer to Bruce A and B as the nuclear facility in the proposed PROL
LC 2.3 The licensee shall implement and maintain training programs for workers. The certification process and supporting examinations and tests shall be conducted in accordance with CNSC regulatory document RD-204 CERTIFICATION OF PERSONS WORKING AT NUCLEAR POWER PLANTS. Persons appointed to the following positions shall be certified: (i) authorized health physicist; (ii) authorized nuclear operator; (iii) control room shift supervisor; (iv) Unit 0 control room operator; and (v) Shift manager.	LC 2.3 The licensee shall implement and maintain training programs for workers. LC 2.4 The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document RD-204 CERTIFICATION OF PERSONS WORKING AT NUCLEAR POWER PLANTS. Persons appointed to the following positions require certification: (i) authorized health physicist; (ii) authorized nuclear operator; (iii) control room shift supervisor; (iv) Unit 0 control room operator; and (v) shift manager.	Split LC 2.3 into two LCs, 2.3 and 2.4 per the CNSC document "Applicability of the Standard Licence Conditions to Class I Facilities (e-Doc 4658014).
LC 3.1 The licensee shall implement and maintain an operations program, which shall have as components: (i) a safe operating envelope; (ii) a set of operating policies and principles; and (iii) accident management procedures and/or guides for design basis and beyond design basis accidents, including overall strategies for recovery.	LC 3.1 The licensee shall implement and maintain an operations program, which includes a set of operating limits.	Revised per the CNSC standard LC document
LCs 3.2 to 3.3	LCs 3.2 to 3.3	No change
LC 4.1 The licensee shall implement and maintain a deterministic safety analysis program and a probabilistic safety assessment program. LC 4.2 The licensee shall ensure that design and analysis computer codes and software used to support the safe operation of the nuclear facilities are of adequate quality.	Integrated LC 4.2 into LC 4.1 LC 4.1 The licensee shall implement and maintain a safety analysis program.	Integrated per the CNSC standard LC document
LCs 5.1 to 5.2	LCs 5.1 to 5.2	No change
LC 5.3 The licensee shall implement and maintain an environmental qualification program.	LC 5.3 The licensee shall implement and maintain an equipment and structure qualification program.	Revised per the CNSC standard LC document
LC 6.1 The licensee shall implement and maintain programs to ensure fitness for service of systems, structures and components, including an in-service inspection program for the safety significant balance of plant pressure retaining systems and components, and safety-related structures.	LC 6.1 The licensee shall implement and maintain a fitness for service program.	
LCs 7.1 to 8.1	LCs 7.1 to 8.1	No change
LC 9.1 The licensee shall implement and maintain an environmental protection program and undertake specific measures to control releases of nuclear and hazardous substances in accordance with applicable limits and to monitor effluents.	LC 9.1 The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within	Integrated per the CNSC Standard LC document

CURRENT PROL	PROPOSED PROL	REASONS FOR CHANGE
LC 9.2 The licensee shall have a set of environmental action levels for nuclear substances. When the licensee becomes aware that an environmental action level has been reached, the licensee shall notify the Commission within seven days.	seven days.	
LC 10.1 The licensee shall implement and maintain an emergency preparedness program and conduct emergency exercises.	LC 10.1 The licensee shall implement and maintain an emergency preparedness program.	Revised per the CNSC Standard LC document
LCs 10.2 to 15.1	LCs 10.2 to 15.1	No change
	LC 15.2 The licensee shall implement the Integrated Implementation Plan.	**NEW LC** as part of PSR
LC 15.2 The licensee shall inform the Commission of any plan to refurbish a reactor or replace a major component at the nuclear facilities, and shall: (i) prepare and conduct a periodic safety review. (ii) implement and maintain a return-to-service plan; and (iii) provide periodic updates on progress and proposed changes.	LC 15.4 The licensee shall implement a return-to-service plan for Major Component Replacement.	Split the LC for efficiency and to align with other NPP PROLs undergoing MCR activities
	LC 15.6 The licensee shall conduct and implement a periodic safety review.	
	LC 15.3 The licensee shall maintain pressure tube fracture toughness sufficient for safe operation.	**NEW LC** related to demonstrating fitness for service of pressure tubes
	LC 15.5 The licensee shall obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points.	**NEW LC** related to MCR activities
LC 15.3 The licensee shall inform the Commission of any reactor to be removed from commercial operations at the nuclear facilities, and shall provide a plan describing the activities and timeline for transitioning from operations to safe storage.	LC 15.7 The licensee shall inform the Commission of any reactor to be removed from commercial operations at Bruce A and B, and shall provide a plan describing the activities and timeline for transitioning from operations to safe storage.	No significant change in LCs. The LCs were just renumbered
LC 15.4 The licensee shall store and manage booster fuel assemblies at Bruce A in a manner that ensures their physical security.	LC 15.8 The licensee shall store and manage booster fuel assemblies at Bruce A in a manner that ensures their physical security.	
LC 15.5 The licensee shall implement and maintain a nuclear criticality safety program.	LC 15.9 The licensee shall implement and maintain a nuclear criticality safety program.	
LC 15.6 The licensee shall implement and maintain a program for the receipt, storage and handling of the prescribed substance Cobalt-60 at Bruce B.	LC 15.10 The licensee shall implement and maintain a program for the receipt, storage and handling of the prescribed substance Cobalt-60 at Bruce B.	
	LC 15.11 The licensee shall implement and maintain a program for the operation of the Class II nuclear facility.	**NEW LC** due to consolidation of Nuclear Substances licences
	LC 15.12 The licensee shall implement and maintain a program for nuclear substances and prescribed equipment.	**NEW LC** due to consolidation of Class II nuclear facility licence

Licence Period

Bruce Power requested in its licence application [1] the renewal of the PROL 18.00/2020 for Bruce A and B for a period of ten years, from September 1, 2018 to August 31, 2028.

Over the ten year period, Bruce Power plans to complete MCR outages of Units 3 through 8. The licence application incorporated the IIP into the licensing basis. The IIP emerged from a global assessment of all site activities and details specific commitments Bruce Power has made to ensure ongoing operations will remain safe.

PROPOSED LICENCE

DRAFT: February 12, 2018
PDF Ref.: e-Doc 5371084
Word Ref.: e-Doc 5263721
File / Dossier: 2.01

NUCLEAR POWER REACTOR OPERATING LICENCE

BRUCE NUCLEAR GENERATING STATIONS A AND B

I) LICENCE NUMBER: **PROL 18.00/2028**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act* this licence is issued to:

Bruce Power Inc.
P.O. Box 1540, R.R. #2
Building B10, 177 Tie Road
Municipality of Kincardine
Tiverton, Ontario
N0G 2T0

III) LICENCE PERIOD: This licence is valid from September 1, 2018 to August 31, 2028, unless suspended, amended, revoked or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

(i) operate the Bruce Nuclear Generating Stations A and B (hereinafter "Bruce A and B") comprised of reactor units 1 to 4 and 5 to 8 respectively, at the Bruce site located in the County of Bruce in the regional municipality of Kincardine, Province of Ontario; and,

(1) possess, transfer, use, package, manage and store nuclear substances that are required for, associated with, or arise from the activities described in (i), except for booster fuel assemblies;

(2) possess, transfer and use prescribed equipment that is required for, associated with, or arises from the activities described in (i);

(3) possess and use prescribed information that is required for, associated with, or arises from the activities described in (i);

(ii) operate a Class II nuclear facility at the Bruce site; and,

(1) possess, transfer, use, package, manage and store nuclear substances that are required for, associated with, or arise from the activities described in (ii);

(2) possess, transfer and use prescribed equipment that is required for, associated with, or arises from the activities described in (ii);

(iii) possess, transfer, use, manage and store nuclear substances and prescribed equipment to perform industrial radiography throughout the Bruce site;

(iv) import and export prescribed equipment and nuclear substances, except controlled nuclear substances, that are required for, associated with, or arise from the activities described in (i), (ii) and (iii);

(v) possess, manage and store booster fuel assemblies at Bruce A; and

(vi) produce Cobalt-60 at Bruce B.

V) EXPLANATORY NOTES:

(i) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(ii) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* and associated Regulations.

(iii) The BRUCE NGS A AND B LICENCE CONDITIONS HANDBOOK (LCH) provides compliance verification criteria including the Canadian standards and regulatory documents used to verify compliance with the conditions in the licence. The LCH also provides information regarding delegation of authority, applicable versions of documents and non-mandatory recommendations and guidance on how to achieve compliance.

VI) CONDITIONS:

G. **General**

G.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

- (i) the regulatory requirements set out in the applicable laws and regulations;
- (ii) the conditions and safety control measures described in the facilities' licence and the documents directly referenced in that licence;
- (iii) the safety and control measures described in the licence applications and the documents needed to support those licence applications;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (CNSC) (hereinafter "the Commission").

G.2 The licensee shall give written notification of changes to the facilities or their operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

G.3 The licensee shall control the use and occupation of any land within the exclusion zones.

G.4 The licensee shall provide, at the Bruce site and at no expense to the Commission, office space for employees of the Commission who customarily carry out their functions on the premises of Bruce A and B (onsite Commission staff).

G.5 The licensee shall implement and maintain a public information and disclosure program.

1. Management System

1.1 The licensee shall implement and maintain a management system.

2. Human Performance Management

2.1 The licensee shall implement and maintain a human performance program.

2.2 The licensee shall implement and maintain the minimum shift complement and control room staffing for Bruce A and B.

2.3 The licensee shall implement and maintain training programs for workers.

2.4 The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document RD-204 CERTIFICATION OF PERSONS WORKING AT NUCLEAR POWER PLANTS.

Persons appointed to the following positions require certification:

(i) authorized health physicist;
(ii) authorized nuclear operator;
(iii) control room shift supervisor;
(iv) Unit 0 control room operator; and
(v) shift manager.

3. Operating Performance

3.1 The licensee shall implement and maintain an operations program, which includes a set of operating limits.

3.2 The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or prior written consent of a person authorized by the Commission.

3.3 The licensee shall notify and report in accordance with CNSC regulatory document REGDOC-3.1.1 REPORTING REQUIREMENTS FOR NUCLEAR POWER PLANTS.

4. Safety Analysis

4.1 The licensee shall implement and maintain a safety analysis program.

5. Physical Design

5.1 The licensee shall implement and maintain a design program.

5.2 The licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency.

5.3 The licensee shall implement and maintain an equipment and structure qualification program.

6. Fitness for Service

6.1 The licensee shall implement and maintain a fitness for service program.

7. Radiation Protection

7.1 The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

8. Conventional Health and Safety

8.1 The licensee shall implement and maintain a conventional health and safety program.

9. Environmental Protection

9.1 The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

10. Emergency Management and Fire Protection

10.1 The licensee shall implement and maintain an emergency preparedness program.

10.2 The licensee shall implement and maintain a fire protection program.

11. Waste Management

11.1 The licensee shall implement and maintain a waste management program.

11.2 The licensee shall notify the Commission of any changes regarding the obligations of decommissioning and financial guarantees under the Lease Agreement with Ontario Power Generation Inc., as described in 15.1.

12. Security

12.1 The licensee shall implement and maintain a nuclear security program.

13. Safeguards and Non-Proliferation

13.1 The licensee shall implement and maintain a safeguards program.

14. Packaging and Transport

14.1 The licensee shall implement and maintain a packaging and transport program.

15. Nuclear Facility-Specific

15.1 The licensee shall inform the Commission in writing of any amendments to the Amended and Restated Lease Agreement between Ontario Power Generation Inc., Bruce Power L.P., OPG-Huron A Inc./OPG-Huron B Inc./OPG-Huron Common Facilities Inc., British Energy PLC, Cameco Corporation, TransCanada Pipelines Limited, BPC Generation Infrastructure Trust and Ontario Municipal Employees Retirement Board dated February 14, 2003.

15.2 The licensee shall implement the Integrated Implementation Plan.

15.3 The licensee shall maintain pressure tube fracture toughness sufficient for safe operation.

15.4 The licensee shall implement a return-to-service plan for Major Component Replacement.

15.5 The licensee shall obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points.

15.6 The licensee shall conduct and implement a periodic safety review.

15.7 The licensee shall inform the Commission of any reactor to be removed from commercial operations at Bruce A and B, and shall provide a plan describing the activities and timeline for transitioning from operations to safe storage.

15.8 The licensee shall store and manage booster fuel assemblies at Bruce A in a manner that ensures their physical security.

15.9 The licensee shall implement and maintain a nuclear criticality safety program.

15.10 The licensee shall implement and maintain a program for the receipt, storage and handling of the nuclear substance Cobalt-60 at Bruce B.

15.11 The licensee shall implement and maintain a program for the operation of the Class II nuclear facility.

15.12 The licensee shall implement and maintain a program for nuclear substances and prescribed equipment.

SIGNED at OTTAWA ____________________________

____

Michael Binder
President
CANADIAN NUCLEAR SAFETY COMMISSION

PROPOSED LICENCE CONDITIONS HANDBOOK

Canada's Nuclear Regulator

Draft February 12, 2018

e-Doc 5331057 (Word)

e-Doc 5371085 (PDF)

LICENCE CONDITIONS HANDBOOK

LCH-PR-18.00/2028-R000

BRUCE NUCLEAR GENERATING STATIONS A AND B
NUCLEAR POWER REACTOR OPERATING LICENCE
LICENCE # PROL 18.00/2028

DRAFT

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

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Licence Conditions Handbook **Effective: Month day, 2018**

LCH-PR-18.00/2028-R000

Bruce Nuclear Generating Stations A and B

Nuclear Power Reactor Operating Licence

PROL-18.00/2028

SIGNED at OTTAWA this _____th day of _______ 2018

____

Gerry Frappier, Director General

Directorate of Power Reactor Regulation

CANADIAN NUCLEAR SAFETY COMMISSION

Revision History

Effective Date	Revision	Word e-Doc and Version	Description of the Changes	CAF e-Doc
Month day, 2018	0	5331057 v#	Original Document	N/A

TABLE OF CONTENT

INTRODUCTION

The general purpose of the Licence Conditions Handbook (LCH) is to identify and clarify the relevant parts of the licensing basis for each licence condition (LC). This will help ensure that the licensee maintains facility operation in accordance with the licensing basis for the facility and the intent of the licence. The LCH should be read in conjunction with the licence.

The LCH typically has three parts under each LC: the Preamble, Compliance Verification Criteria (CVC), and Guidance. The Preamble explains, as needed, the regulatory context, background, and/or history related to the LC. CVC are criteria used by CNSC staff to verify and oversee compliance with the LC. Guidance is non-mandatory information, including direction, on how to comply with the LC.

Throughout the licence, the statement "or consent of a person authorized by the Commission" reflects to whom the Commission may delegate certain authority (hence "consent") to CNSC staff. Unless otherwise indicated in the CVC of specific LCs in this LCH, the delegation of authority by the Commission to act as a "person authorized by the Commission" is only applied to the incumbents of the following positions (source: Record of Proceedings, Including Reasons for Decision for licence renewal issued Month 20XX, e-Doc XXXXXXX):

- Director, Bruce Regulatory Program Division
- Director General, Directorate of Power Reactor Regulation
- Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch

Interaction between the licensee and CNSC staff that is described in this LCH is governed by the prevailing communication protocol (e-Doc 3565860) between the two.

Current versions of the licensee documents listed in this LCH are recorded in the document "Bruce PROL - Written Notification Documents in LCH" (e-Doc 5356815), which is controlled by the Bruce Regulatory Program Division (BRPD) and is available to the licensee upon request.

The content of this LCH is an input to the compliance program for this facility.

This LCH includes appendices A to E which contain administrative procedures, acronyms, a glossary of terms and lists of LCH-related documents.

More information on the LCH is available in e-Doc 4967591.

GENERAL

G. GENERAL

G.1 Licensing Basis for the Licensed Activities

Licence Condition G.1:

The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

(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;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (CNSC, hereinafter "the Commission").

Preamble:

Licensing Basis

The licensing basis is discussed in CNSC document INFO-0795, *Licensing Basis Objectives and Definitions* (2010).

Licensed Activities

Paragraph 24 (1) of the Nuclear Safety and Control Act (NSCA) states "The Commission may establish classes of licences authorizing the licensee to carry on any activity described in any of paragraphs 26 (a) to (f) that is specified in the licence for the period that is specified in the licence."

Paragraph 26 (a) of the NSCA states "Subject to the regulations, no person shall, except in accordance with a licence,

(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;

(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance;

(c) produce or service prescribed equipment;

(d) operate a dosimetry service for the purposes of this Act;

(e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility; or

(f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada."

Compliance Verification Criteria:

Licensee Documents

Document Title	Document #	Notification
Bruce Power Letter, Frank Saunders to Marc Leblanc, "Application for the Renewal of the Power Reactor Operating Licence for Bruce Nuclear Generating Stations A and B", June 30, 2017, e-Doc 5291208	NK21-CORR-00531-13493	N/A
Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for Renewal of the Power Reactor Operating Licence: Periodic Safety Review Reports (including revised Bruce A and B Global Assessment Report and Integrated Implementation Plan)", July 19, 2017, e-Docs 5303331, 5303343 and 5303344	NK21-CORR-00531-13543	N/A
Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Major Component Replacement Project Execution Plan and Bruce B Unit 6 Return to Service Plan", June 30, 2017, e-Doc 5292343	NK21-CORR-00531-14175	N/A
Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Updated Environmental Risk Assessment that includes Major Component Replacement", June 30, 2017, e-Doc 5291221	NK21-CORR-00531-13620	N/A
Bruce Power Letter, Frank Saunders to Ken Lafrenière, "Bruce A Environmental Assessment Follow-up Monitoring Report, 2015", November 21, 2016, e-Doc 5128322	NK21-CORR-00531-13142	N/A
Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Whitefish Research Review", June 30, 2017, e-Doc 5291210	NK21-CORR-00531-13494	N/A
Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence:	NK21-CORR-00531-13587	N/A

University Research Summary", June 30, 2017, e-Doc 5291217		
Bruce Power Letter, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Security Program Description", June 30, 2017, e-Doc 5291200 **(PROTECTED)**	NK21-CORR-00531-13367 NK29-CORR-00531-13917	N/A
Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Fitness-for-Service of Pressure Tubes", October 13, 2017, e-Doc 5369131	NK21-CORR-00531-13854 NK29-CORR-00531-14517	N/A
Bruce Power Letter, Frank Saunders to Marc Leblanc, "Bruce Power Application for the Renewal of the Power Reactor Operating Licence: Supplemental Requests", February 1, 2018, e-Doc 5451672	NK21-CORR-00531-13890	N/A

Part (i) of the licensing basis includes, but is not limited to, the following:

- *Nuclear Safety and Control Act;*
- *Canadian Environmental Assessment Act;*
- *Canadian Environment Protection Act;*
- *Nuclear Liability and Compensation Act;*
- *Transportation of Dangerous Goods Act;*
- *Radiation Emitting Devices Act;*
- *Access to Information Act; and*
- *Canada/IAEA Safeguards Agreement.*

The safety and control measures mentioned in the LC under Parts (ii) and (iii) of the licensing basis include important aspects of analysis, design, operation, etc. They may be found in high-level, programmatic licensee documents but might also be found in lower-level, supporting documentation. They also include safety and control measures in licensing basis publications (e.g., CNSC regulatory documents or CSA standards) that are cited in the licence, the application, or in the licensee's supporting documentation.

Licensing basis publications are listed in tables in this LCH under the most relevant LC. All "shall" or normative statements in licensing basis publications are considered CVC unless stated otherwise. "Should" or informative statements in licensing basis publications may also be considered CVC when they align with safety and control measures described in the licence application.

The licensee documents in question and relevant licensing basis publications may cite other documents that also contain safety and control measures (i.e., there may be safety and control measures in "nested" references). There is no predetermined limit to the degree of nesting at which relevant safety and control measures may be found.

LC G.1 requires the licensee to implement all the safety and control measures; however, not all details in referenced documents are necessarily considered to be safety and control measures.

- Details that are not directly relevant to safety and control measures for facilities or activities authorized by the licence are excluded from the licensing basis.
- Details that are relevant to a different safety and control area (i.e., not the one associated with the main document) are only part of the licensing basis to the extent they are consistent with the main requirements for both safety and control areas.

In the event of any perceived or real conflict or inconsistency between two elements of the licensing basis, the licensee shall consult CNSC staff to determine the approach to resolve the issue.

In case of a conflict between CSA standards, CNSC will consult with CSA Group before reaching a conclusion on the resolution.

This LC is not intended to unduly inhibit the ongoing management and operation of the facility or the licensee's ability to adapt to changing circumstances and continuously improve, in accordance with its management system. Where the licensing basis refers to specific configurations, methods, solutions, designs, etc., the licensee is free to propose alternate approaches as long as they remain, overall, in accordance with the licensing basis and have a neutral or positive impact on health, safety, the environment, security, and safeguards. However, the licensee shall assess changes to confirm that operations remain in accordance with the licensing basis.

Changes to certain licensee documents require written notification to the CNSC, even if they are in accordance with the licensing basis. Further information on this topic is provided under LC G.2.

For unapproved operation that is not in accordance with the licensing basis, the licensee shall take action as soon as practicable to return to a state consistent with the licensing basis, taking into account the risk significance of the situation.

In the event that the Commission grants approval to operate in a manner that is not in accordance with existing licensing basis, this would effectively revise the licensing basis for the facility. The appropriate changes would be reflected in the CVC of the relevant LC.

Guidance:

When the licensee becomes aware that a proposed change or activity might not be in accordance with the licensing basis, it should first seek direction from CNSC staff regarding the potential acceptability of this change or activity. The licensee should take into account that certain types of proposed changes might require significant lead times before CNSC staff can make recommendations and/or the Commission can properly consider them. Examples of these types of changes are discussed under various LCs in this LCH. Guidance for notifications to the CNSC related to licensee changes are discussed under LC G.2.

G.2 Notification of Changes

Licence Condition G.2:

The licensee shall give written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

Preamble:

CNSC staff records, in e-Doc 5356815, the version history of licensee documents that require notification of change (with the exception of security-related documents).

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Document Management	BP-PROG-03.01	At Implementation

Written notification is a physical or electronic communication from the licensee.

In general, the changes for which the licensee shall notify the CNSC are captured as changes to specific licensee documents. The LCH identifies them under the most relevant LC (see example above). However, the licensee documents identified in the LCH only represent the minimum subset of documents that require notification of change. For any change that is not captured as a change to a document listed in the LCH, the licensee shall provide written notification (WN) of the change if the change negatively impacts designs, operating conditions, policies, programs, methods, or other elements that are integral to the licensing basis. For example, if a licensee document in the CVC refers to another document, including a third-party document, without citing the revision # of that document, if that document changes and the licensee uses the revised version, the licensee shall determine if it is necessary to notify the CNSC of the change.

The documents needed to support the licence application may include documents produced by third parties (e.g., reports prepared by third party contractors). Changes to these documents require written notification to the CNSC only if the new version continues to form part of the licensing basis. That is, if the licensee implements a new version of a document prepared by a third party, it shall inform the CNSC of the change(s), per LC 1.2. On the other hand, if a third party has updated a certain document, but the licensee has not adopted the new version as part of its safety and control measures, the licensee is not required to inform the CNSC that the third party has changed the document.

Licensee documents tabulated in the CVC of the LCH are subdivided into groups having different requirements for notification of change – ones that require prior written notification of changes and those that require written notification only. For the former type, the licensee shall submit the document to the CNSC prior to implementing changes. Typically, the requirement is to submit the proposed changes 30 days prior to planned implementation; however, the licensee shall allow sufficient time for the CNSC to review the change proportionate to its complexity and the importance of the safety and control measures being affected. For the latter type, the licensee need only submit the document at the time of implementation.

Written notifications shall include a summary description of the change, the rationale for the change, expected duration (if not a permanent change), and a summary explanation of how the licensee has concluded that the change remains in accordance with the licensing basis (e.g., an evaluation of the impact on health, safety, security, the environment and Canada's international obligations). A copy of the revised WN document shall accompany the notification. All written notifications shall be transmitted to CNSC per established communication protocols.

The above also applies to a notice of change that requires CNSC staff acceptance, due to some other requirement in the licensing basis.

Changes that are not clearly in the safe direction require further assessment of impact to determine if Commission approval is required in accordance with LC G.1.

The licensee shall notify the CNSC in writing when it plans to implement a new licensing basis publication, including the date by which implementation of the publication will be complete. The notice shall indicate the corresponding changes to licensee documents listed in CVC of the LCH.

Guidance:

A list of criteria that could help determine if a change would be in accordance with the licensing basis is provided in Appendix A of e-Doc 4055483. Such criteria would also be used if the change requires CNSC staff acceptance, due to some other requirement in the licensing basis.

For proposed changes that would not be in accordance with the licensing basis, the Guidance for LC G.1 applies.

G.3 Land Use and Occupation

Licence Condition G.3:

The licensee shall control the use and occupation of any land within the exclusion zone.

Preamble:

The *General Nuclear Safety and Control Regulations* require that a licence application contain a description of the nuclear facility.

The siting guide used at the time of design of all Canadian NPPs stipulated an exclusion zone that extended at least 914 metres from the exterior of any reactor building [Reference: D.G. Hurst and F.C. Boyd, "Reactor Licensing and Safety Requirements, AECB-1059", Paper 72-CNA-102, presented at the 12th Annual Conference of the Canadian Nuclear Association, Ottawa, Canada, 11-14 June 1972, e-Doc 3000249].

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Site Facilities Plan of the Bruce Nuclear Power Development Lots 11 to 28 and Part of 29 and 30	NK37-DRAW-10200-10001	Prior to Implementation
Bruce A Safety Report, Part 1: Plant and Site Description	NK21-SR-01320-00001	Prior to Implementation
Bruce B Safety Report, Part 1: Plant and Site Description	NK29-SR-01320-00001	Prior to Implementation

Bruce Power shall control land use and occupation such that no permanent dwelling (house, residence, abode) is permitted within the exclusion zones at the Bruce site. Permanent dwelling refers to housing that is meant to be fixed. The licensee may erect, for a short time without prior notification, temporary structures required for operational purposes (e.g., a trailer).

The Bruce A nuclear facility is located on the shore of Lake Huron on parts of lots 28, 29 and 30, Lake Range, Municipality of Kincardine, County of Bruce, Province of Ontario. The Bruce B nuclear facility is located on the shore of Lake Huron on parts of lots 12, 13, 14 and 15, Lake Range, Municipality of Kincardine, County of Bruce, Province of Ontario. The location of the exclusion zones and any structures within those zones are found in Ontario Power Generation (OPG) Drawing, “Site Facilities Plan of the Bruce Nuclear Power Development Lots 11 to 28 and Part of 29 and 30”. This drawing is a plan of survey dated May 10, 1999, prepared by Marshall Macklin Monaghan Ontario Limited, Ontario Land Surveyors, and certified by Mr. Roy C. Mayo, O.L.S.

Bruce Power shall ensure that the use and occupancy of land within the exclusion zones do not compromise the safety and control measures in the licensing basis. Specifically, the licensee shall consider emergency preparedness and ALARA with respect to land use within the exclusion zones. This applies to land that Bruce Power occupies as well as to land occupied by others.

Bruce Power shall notify the CNSC of permanent changes to the use and occupation of any land within the exclusion zones. The notice shall be submitted prior to the change, with lead time in proportion to the expected impact of the change on the licensee's safety and control measures.

Guidance:

Not applicable to this LC.

G.4 Office for CNSC Onsite Inspectors

Licence Condition G.4:

The licensee shall provide, at the Bruce site and at no expense to the Commission, suitable office space for employees of the Commission who customarily carry out their functions on the premises of Bruce A and B (onsite Commission staff).

Preamble:

CNSC staff requires suitable office space and equipment at the nuclear facility in order to satisfactorily carry out its regulatory activities.

Compliance Verification Criteria:

Any changes of accommodation or equipment shall be made based on discussion and subsequent agreement between the CNSC and Bruce Power.

Bruce Power shall keep the office space of onsite Commission staff separate from the remainder of the building in which it is located by walls, partitions or other suitable structures.

Guidance:

Not applicable to this LC.

G.5 Public Information and Disclosure

Licence Condition G.5:

The licensee shall implement and maintain a public information and disclosure program.

Preamble:

A Public Information and Disclosure Program (PIDP) is a regulatory requirement, which applies to licence applicants and licensees under the *Class I Nuclear Facilities Regulations* and it requires that an application for a licence to operate a Class I nuclear facility contain a program that includes a disclosure program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects of the licensed facility and its activities on the environment, health and safety of persons, thereby generating an atmosphere of openness, transparency and trust.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Stakeholder Interaction	BP-PROG-09.02	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Public Information and Disclosure	RD/GD-99.3	2012	June 1, 2015

CNSC regulatory document RD/GD-99.3, PUBLIC INFORMATION AND DISCLOSURE outlines the requirements for a public information and disclosure program.

Guidance:

It is recommended that Bruce Power submit annually to CNSC staff a report summarizing the events and developments involving the Bruce nuclear facilities for the purposes of promoting compliance verification.

1 SCA – MANAGEMENT SYSTEM

1.1 Management System Requirements

Licence Condition 1.1:

The licensee shall implement and maintain a management system.

Preamble:

The *General Nuclear Safety and Control Regulations* require that a licence application contain information related to the organizational management structure and responsibilities.

The *Class I Nuclear Facilities Regulations* requires that an application for a licence to prepare site or to construct a Class I nuclear facility contain the proposed quality assurance program for the design of the nuclear facility.

Safe and reliable operation requires a commitment and adherence to a set of management system principles and, consistent with those principles, the establishment and implementation of processes that achieve the expected results. CSA standard N286 contains the requirements for a management system throughout the life cycle of a nuclear power plant and extends to all safety and control areas.

The management system must satisfy the requirements set out in the *NSCA*, regulations made pursuant to the *NSCA*, the licence and the measures necessary to ensure that safety is of paramount consideration in implementation of the management system. An adequately established and implemented management system provides the evidence that the licensing basis remains valid.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Management System Manual	BP-MSM-1	Prior to Implementation
Business Plan Management	BP-PROG-01.01	At Implementation
Bruce Power Management System (BPMS) Management	BP-PROG-01.02	Prior to Implementation
Operating Experience Program	BP-PROG-01.06	At Implementation
Corrective Action	BP-PROG-01.07	At Implementation
Supply Chain	BP-PROG-05.01	At Implementation
Nuclear Oversight Management	BP-PROG-15.01	At Implementation
Project Management and Construction	BP-PROG-14.01	At Implementation
Contractor Management	BP-PROG-14.02	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CSA	Management system requirements for nuclear power plants	N286	2005 including Update No. 1 (2007)	June 1, 2015
CSA	Management system requirements for nuclear facilities	N286	2012	Dec. 31, 2018

Management System

The management and operation of Bruce Power are defined by the programs and their implementing documents, as described by Bruce Power's Management System Manual. Changes to the management system documents, including Bruce Power's programs and procedures listed in the LCH and the processes are to be made in accordance with the Bruce Power document "Management System (BPMS) Management".

Implementation strategy for CSA N286 (2012 Version)

CSA standard N286, MANAGEMENT SYSTEM REQUIREMENTS FOR NUCLEAR POWER PLANT [version 2012 refers to 'Nuclear Facilities' in lieu of 'Nuclear Power Plants' in the title] outlines the requirements for a management system. Bruce Power shall complete the transition to CSA standard N286-12 by December 31, 2018.

During the transition to the 2012 version, CNSC staff will perform compliance activities in accordance with the 2007 version, and when applicable, the 2012 version of CSA N286.

Organization

Bruce Power shall document the organizational structure for safe and reliable conduct of licensed activities and shall include all positions with responsibilities for the management and control of the licensed activity. Any changes to the nuclear organization shall be made in accordance with Bruce Power's "Organizational Structure Change Management".

Safety Culture

Bruce Power shall ensure that management supports the safe conduct of licensed activities at the nuclear facilities.

The Bruce nuclear facilities' operations and performance must ensure that sound nuclear safety is the overriding priority in all activities performed in support of the licensee's nuclear facilities and has clear priority over schedule, cost and production. Bruce Power's Nuclear Oversight Management and Operating Experience Program contribute to the development of a healthy safety culture throughout the oversight of Bruce Power's programs and processes by using internal and external assessments and self-assessments in order to continuously improve performance.

A safety culture self-assessment methodology has been developed by Bruce Power. It is governed by its business assessment process which promotes continuous improvement.

Configuration management

Configuration management, the process that identifies, documents changes and ensure conformance is maintained between design requirements, physical configuration and facility configuration information, is discussed in section 5.1.

Management of Contractors

Bruce Power shall implement and maintain a management of contractors program that will ensure compliance with regulatory requirements.

Business Continuity

Business continuity planning ensures that essential functions can continue to operate safely when affected by adverse physical conditions or following interruptions to normal operation. Bruce Power shall maintain contingency plans to:

- ensure minimal disruptions in the event of a labour dispute or public protest; and
- provide for essential services through a sustained period with significant employee absenteeism (for ex. influenza outbreak).

Guidance:

The management system should be used to promote and support a healthy safety culture. The CNSC recognizes the following characteristics that form the framework for a healthy safety culture:

- safety is a clearly recognized value;
- accountability for safety is clear;
- safety is integrated into all activities;
- a safety leadership process exists; and
- safety culture is learning-driven.

The licensee should conduct self-assessments of safety culture periodically. The assessment method should be documented and the framework should include links to the safety culture characteristics listed above.

CNSC staff encourages senior management at the Bruce nuclear facilities to continue fostering a healthy safety culture so licensee staff understands the influence that safety culture has over all other organizational processes and its role in maintaining and improving safety performance.

The management system documentation should contain sufficient directions for workers to comply with the regulatory requirements. It is recommended that when the Management System Manual is updated and the CNSC is notified, that Bruce Power also submit to the CNSC the associated sheets that provide information on program matrix, approved reference chart authorities and responsibilities, list of applicable governing Acts, Regulations, Codes and Standards, and program summaries.

2 SCA – HUMAN PERFORMANCE MANAGEMENT

2.1 Human Performance Program

Licence Condition 2.1:

The licensee shall implement and maintain a human performance program.

Preamble:

Human performance relates to reducing the likelihood of human error in work activities. It refers to the outcome of human behaviour, functions and actions in a specified environment, reflecting the ability of workers and management to meet the system's defined performance under the conditions in which the system will be employed.

Human factors are factors that influence human performance as it relates to the safety of a nuclear facility or activity over all design and operations phases. These factors may include the characteristics of the person, task, equipment, organization, environment, and training. The consideration of human factors in issues such as interface design, training, procedures, and organization and job design may affect the reliability of humans performing tasks under various conditions.

CNSC regulatory policy P-119, POLICY ON HUMAN FACTORS, describes how the CNSC will take human factors into account during its licensing, compliance and standards-development activities.

For clarification, CNSC regulatory oversight related to hours of work is for the purpose of "nuclear safety" not for the purpose of "worker protection". Worker protection is covered under the SCA "Conventional Health and Safety" (section 8.1).

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Limits to Hours of Work	BP-PROC-00005	Prior to Implementation
Human Performance Program	BP-PROG-00.07	Prior to Implementation
Human Resources Management	BP-PROG-02.01	At Implementation
Fitness For Duty	BP-PROC-00610	At Implementation
Fitness for Duty Considerations for Shift Complement Staff Held Over for More than 13 Hours	GRP-OPS-00055	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Fitness for Duty: Managing Worker Fatigue	REGDOC-2.2.4	2017	Dec. 31, 2018

In order to establish, maintain and improve human performance, Bruce Power shall monitor and control the work hours and shift schedules of nuclear workers, in accordance with BP-PROC-00005, LIMITS TO HOURS OF WORK.

Bruce Power shall also monitor and control the fitness for duty of its workers at all times as per the provisions set out in BP-PROC-00610, FITNESS FOR DUTY. Fitness for duty considerations for shift complement staff held over from their regular shift are contained in GRP-OPS-00055.

Implementation strategy for REGDOC-2.2.4, Managing Worker Fatigue

Bruce Power shall transition to REGDOC-2.2.4 for managing worker fatigue using a graded approach for the transition, commensurate with the risk, by December 31, 2018.

Guidance:

Guidance Publications

Org	Document Title	Document #	Implementation Plan Submission Date	Version
CNSC	Fitness for Duty, Volume II: Managing Alcohol and Drug Use	REGDOC-2.2.4	March 31, 2018	2014

Licensees should implement a program that continuously monitors human performance, takes steps to identify human performance weaknesses, improves human performance, and reduces the likelihood of human performance related causes and root causes of nuclear safety events.

The licensee should address and integrate the range of human factors that influence human performance, which include, but may not be limited to the following:

- The provision of qualified staff
  - Certification and Training
  - Staffing
  - Minimum Shift Complement
  - Fitness for duty (hours of work, fatigue management)
- The reduction of human error
  - Procedures Development
  - Procedural Compliance
  - Work protection and Work Permit Systems
  - Shift Turnover
  - Pre and Post Job Briefings
  - Safe work strategies/practices

- Organizational support for safe work activities
  - Human Actions in Safety Analysis
  - Organizational Performance and Safety culture
- The continuous improvement of human performance

2.2 Minimum Shift Complement and Control Room Staffing

Licence Condition 2.2:

The licensee shall implement and maintain the minimum shift complement and control room staffing for Bruce A and B.

Preamble:

The *General Nuclear Safety and Control Regulations*, require that the licensee ensure the presence of a sufficient number of qualified workers at the nuclear facility to carry out the licensed activity safety and in accordance with the NSCA, the regulations made under the Act and the licence.

The minimum shift complement specifies the numbers of qualified staff that are required to operate and maintain unit(s) safely under all operating states including normal operations, anticipated operational occurrences, design-basis accidents and emergencies.

This licence condition ensures the presence of a sufficient number of qualified workers who must be present at all times to ensure safe operation of the nuclear facility, and to ensure adequate emergency response capability.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Station Shift Complement – Bruce A	DIV-OPA-00001	Prior to Implementation
Station Shift Complement – Bruce B	DIV-OPB-00001	Prior to Implementation

Minimum Shift Complement

Bruce Power's minimum shift complement procedures describe the minimum number of workers with specific qualifications required for the safe operation of the nuclear facilities under all operating states and the measures in place to mitigate the impact of any minimum shift complement violations until minimum complement requirements are restored.

Bruce Power shall operate the nuclear facilities in accordance with these documents and shall monitor and keep records of each shift's complement. The following tables summarize the number of workers located at Bruce A and Bruce B during one shift, as well as additional staff on site and available as call-ins.

A. Number of Workers Present at the Bruce A Nuclear Facility

DESIGNATED POSITION	# of Staff	EMERGENCY RESPONSE ORGANIZATION POSITION
Shift Manager	1	Shift Emergency Controller (SEC)
Control Room Shift Supervisor	1	Back-up SEC
Shift Assistant Technical Support	1	Emergency Shift Assistant
Field Shift Operating Supervisor	1	Out-of-Plant Coordinator for Bruce B
Authorized Nuclear Operator	6	
Supervising Nuclear Operator – Reactor Units	4	Shift Resource Coordinator
Nuclear Operator – Reactor Units	8	
Unit 0 Control Room Operator	2	
Supervising Nuclear Operator – Unit 0	1	
Nuclear Operator – Unit 0	3	
Fuel Handling Control Room Operator	1	Work Control Area Accounting Supervisor
Nuclear Operator – Fuel Handling	1	
Control Maintenance First Line Manager	1	In-plant Coordinator
Control Technician	1	
Chemistry Technician	2	Chemistry Laboratory and Supervisor
Emergency Services Maintainer First Line Manager Assistant – Bruce A	1	Emergency Response Team - Field Command (Bruce A), OSST Captain (Bruce B)
TOTAL	**35**	

B. Number of Workers Present at the Bruce B Nuclear Facility

DESIGNATED POSITION	# of Staff	EMERGENCY RESPONSE ORGANIZATION POSITION
Shift Manager	1	Shift Emergency Controller (SEC)
Control Room Shift Supervisor	1	Back-up SEC
Shift Assistant Technical Support	1	Emergency Shift Assistant
Field Shift Operating Supervisor	1	Out-of-Plant Coordinator for Bruce A
Authorized Nuclear Operator	6	
Supervising Nuclear Operator – Reactor Units	4	
Nuclear Operator – Reactor Units	8	
Unit 0 Control Room Operator	2	
Supervising Nuclear Operator – Unit 0	1	
Nuclear Operator – Unit 0	4	
Fuel Handling Control Room Operator	1	Shift Resource Coordinator
Nuclear Operator – Fuel Handling	1	Work Control Area Accounting Supervisor
Control Maintenance First Line Manager	1	In-plant Coordinator
Control Technician	1	
Mechanical Maintainer	1	
Chemistry Technician	2	Chemistry Laboratory and Supervisor
Emergency Services Maintainer First Line Manager Assistant – Bruce B	1	Emergency Response Team - Field Command (Bruce B), OSST Captain (Bruce A)
TOTAL	**37**	

C. Number of Additional Workers Present at Site in Support of the Bruce A and Bruce B Nuclear Facilities

DESIGNATED POSITION	# of Staff	EMERGENCY RESPONSE ORGANIZATION POSITION
Staff Normally Based at Bruce A		
Control Technician	1	Emergency Entry/Repair Team
Emergency Services Maintainer – Bruce A	2	Emergency Response Team
Staff Normally Based at Bruce B		
Mechanical Maintainer	1	Emergency Entry/Repair Team
Stock Keeper	1	Stores
Emergency Services Maintainer – Bruce B	2	Emergency Response Team
Additional Staff Normally Based on Site		
Shift Emergency Response Manager	1	Emergency Response Coordinator
Emergency Services Maintainer - Dispatcher	1	Dispatcher
Emergency Services Maintainer - First Line Manager(assistant) - Site	1	Emergency Response Team
Emergency Services Maintainer - Site	4	Emergency Response Team
Emergency Services Maintainer - Site	2	In-plant Survey Team
Emergency Services Maintainer - Site	2	Source Term Survey Team
TOTAL	**18**	

D. Number of Call-in Workers in Addition to Station and Site Personnel

DESIGNATED POSITION	# of Staff	EMERGENCY RESPONSE ORGANIZATION POSITION
Call-in Staff		
Security	2	Offsite Survey Team Drivers
Radiation Technician	2	Offsite Survey Team Surveyors
TOTAL	**4**	

Control Room Staffing

Bruce Power shall comply with the minimum certified worker requirements for the nuclear facilities and for the main control rooms. The certified positions are listed in LC 2.3.

In conjunction with the minimum shift complement for the facility, Bruce Power shall maintain adequate control room staffing. The licensee shall, at all times, have the following certified workers:

- at least one shift manager, six authorized nuclear operators, one control room shift supervisor and two Unit 0 control room operators at each nuclear facility (Bruce A and B);
- an authorized nuclear operator in direct attendance at the control panels of each reactor unit in the main control rooms;

- a minimum of one Unit 0 control room operator in the main control room at each nuclear facility (Bruce A and B), except for brief absences to respond to security alerts or to determine the origin of fire alarms.

"In direct attendance" means the certified person is physically in the direct line of sight and in close proximity to the control room panels to continuously monitor, recognize and differentiate panel displays, alarms and indications.

The minimum certified worker requirements for the main control rooms that this condition imposes do not apply where this minimum cannot be met due to emergency conditions that could cause an unwarranted hazard to workers in the main control rooms, in which case Bruce Power shall place the reactor(s) in a safe shutdown state and the nuclear facilities in a safe condition.

A certified person shall be in a position to rapidly respond, in accordance with his/her role, to changing unit conditions, at all times.

Bruce Power shall provide a rolling 5-year staffing profile of certified operators on an annual basis.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CNSC	Ensuring Presence of Sufficient Qualified Staff at Class I Nuclear Facilities - Minimum Staff Complement	G-323	2007
CNSC	Human Factors Verification and Validation Plans	G-278	2003

The adequacy of the minimum shift complement should be determined through a systematic analysis of the most resource-intensive conditions under all operating states, design-basis accidents, and emergencies. The results of the analysis should then be validated to determine the degree to which the minimum shift complement facilitates the achievement of the overall safety goals.

Guidance for the development and validation of the minimum shift complement are provided in the following CNSC guidance documents:

- G-323, ENSURING THE PRESENCE OF SUFFICIENT QUALIFIED STAFF AT CLASS I NUCLEAR FACILITIES – MINIMUM STAFF COMPLEMENT, describes the CNSC recommended approach for defining the minimum shift complement and sets out the key factors that CNSC staff will take into account when assessing whether the licensee has made, or the applicant will make, adequate provision for ensuring the presence of a sufficient number of qualified staff.
- G-278, HUMAN FACTORS VERIFICATION AND VALIDATION PLANS, describes the elements of effective human factors verification and validation planning, including a suggested format for documenting these elements.

2.3 Personnel Training

Licence Condition 2.3:

The licensee shall implement and maintain training programs for workers.

Preamble:

The *General Nuclear Safety and Control Regulations* requires the licensee to train the workers to carry on the licensed activity in accordance with the *NSCA*, the associated regulations and the licence.

The *Class I Nuclear Facilities Regulations* requires that an application for a licence to operate a Class I nuclear facility contains the proposed training program for workers.

This LC provides the regulatory requirements for the development and implementation of training programs for workers.

As defined by the *General Nuclear Safety and Control Regulations*, workers include contractors and temporary employees who perform work that is referred to in the licence. Training requirements apply equally to these types of workers as to the licensees own employees.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Worker Learning and Qualification	BP-PROG-02.02	Prior to Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Personnel Training, Version 2	REGDOC-2.2.2	2016	September 1, 2018

Where REGDOC-2.2.2 (2014) is referenced in Bruce Power governance, it is understood to refer to REGDOC-2.2.2 Version 2 (2016). Bruce Power will update the references in governance through Document Change Requests (DCRs) at the next planned revisions of the governance documents.

Training Programs for Workers

The licensee shall implement and maintain training programs for workers in accordance with REGDOC-2.2.2, *Personnel Training*, Version 2, which defines the requirements regarding the development and implementation of a training system.

REGDOC-2.2.2 also provides the requirements necessary to support initial certification training and renewal of certification training of persons for the positions listed in LC 2.4, and as required by RD-204.

All training programs related to workers in positions where the consequence of human error poses a risk to the environment, the health and safety of persons, or to the security of the nuclear facilities and licensed activities, are evaluated against the criteria for a systematic approach to training (SAT).

Guidance:

Not applicable to this LC.

2.4 Certification and Examination Programs

Licence Condition 2.4:

> **The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document RD-204 CERTIFICATION OF PERSONS WORKING AT NUCLEAR POWER PLANTS.**
>
> **Persons appointed to the following positions require certification:**
>
> **(i) authorized health physicist;**
>
> **(ii) authorized nuclear operator;**
>
> **(iii) control room shift supervisor;**
>
> **(iv) Unit 0 control room operator; and**
>
> **(v) shift manager.**

Preamble:

The *Class I Nuclear Facilities Regulations* requires that:

- an application for a licence to operate a Class I nuclear facility contain the proposed responsibilities of and qualification requirements and training program for workers, including the procedures for the requalification of workers; and
- the licensee submit the necessary information for certification or renewal of certification of the applicable positions.

The licensee's documentation describes the authority and responsibilities of certified positions.

This LC provides the regulatory requirements for the initial certification, the renewal of certification and training of persons for the positions listed in the LC. It also provides the requirements regarding the program and processes necessary to support the certification and training of persons at the nuclear facility.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Bruce A Role Descriptions for Licence-Related Positions	DIV-OPA-00002	Prior to Implementation
Bruce B Role Description for Licence-Related Positions	DIV-OPB-00002	Prior to Implementation
Responsibilities of an Authorized Health Physicist	SEC-RPR-00040	Prior to Implementation
Certification Training Development and Administration of Comprehensive Written and Oral Examinations for Certification Training Programs	BP-PROC-00568	Prior to Implementation

Document Title	Document #	Notification
Certification Training Examinations – Standards for Development and Administration of Closed Reference Multiple Choice Questions for Initial General Certification Written Examinations	B-HBK-09510-00012	Prior to Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Certification of Persons Working at Nuclear Power Plants	RD-204	2008	June 1, 2015

Note*:* Paragraph 13.1.6 of RD-204 will be amended during the next regulatory document revision to align with the written requalification test requirements in CNSC document, REQUIREMENTS FOR THE REQUALIFICATION TESTING OF CERTIFIED SHIFT PERSONNEL AT NUCLEAR POWER PLANTS, Revision 2. In the interim, for RD-204 paragraph 13.1.6, CNSC staff will apply the following compliance criteria: “The person must have successfully completed written requalification tests equivalent in number to those referred to in the NPP licence that the person would have had to take during the period of absence, if the person had continued to work in the position.”

Training and Certification for Staff Appointed to Certified Positions

Bruce Power shall implement and maintain a certification training and examination program in accordance with RD-204, which defines the requirements regarding certification of persons working at NPPs in positions that have a direct impact on nuclear safety.

The senior health physicist referred to in RD-204 is equivalent to the authorized health physicist position at Bruce A and B. The term authorized health physicist, referred to in Bruce Power documentation, and responsible health physicist, have the same meaning and the terms are interchangeable. The plant shift supervisor referred to in RD-204 is equivalent to the shift manager position at Bruce A and B. Any person who holds a certification as shift manager shall also be qualified to act in the control room shift supervisor position. The control room shift supervisor position may also be filled by a certified shift manager.

In an agreement made between CNSC and Bruce Power for paragraphs 25.2.6 and 26.7 of RD-204, the following CVC shall be applied. For RD-204 paragraph 25.2.6, CNSC staff will apply the following compliance criteria: “The person must have performed the duties of the control room shift supervisor under the supervision of a **certified control room shift supervisor or a certified shift manager** for a minimum of 480 hours on shift to confirm and document that the person can perform those duties competently and safely. At least 360 of those hours must have been worked after the person has met the requirements specified in paragraphs 25.2.1 to 25.2.4”. For RD-204 paragraph 26.7, CNSC staff will apply the following compliance criteria: “The person must have performed the duties of the control room shift supervisor under the supervision of a **certified control room shift supervisor or a certified shift manager** for a minimum of 480 hours on shift to confirm and document that the person can perform those duties competently and safely. At least 360 of those hours must have been worked after the person has met the requirements specified in subsections 26.2 to 26.4”.

Bruce Power shall ensure persons appointed to the position of authorized health physicist, shift manager, authorized nuclear operator, control room shift supervisor and Unit 0 control room operator, at the nuclear facilities hold a certification for the position to which they have been appointed, in accordance with the requirements of the *Class I Nuclear Facilities Regulations*.

Bruce Power has a document entitled "Role Descriptions for Licence-Related Positions", which describes the authorities and responsibilities for certified positions referred to in this LC. Certified operating staff will carry out their authorities and responsibilities as per their respective role descriptions.

The authorities and responsibilities of the certified positions listed above are considered safety and control measures. Any changes to them will be reviewed by CNSC staff to confirm they remain within the licensing basis, in consultation with the designated officer to certify and decertify persons referred to in sections 9 and 12 of the *Class I Nuclear Facilities Regulations* and the Director of the Personnel Certification Division. The general criteria for reviewing changes include those described in LC G.1 and G.2. Any changes outside the licensing basis would require prior written approval of the Commission, per LC 1.1.

Conduct of Examinations and Tests for Certified Personnel

Currently, the following three CNSC internal documents contain the requirements for administering the certification examinations and requalification tests required by RD-204:

- CNSC-EG1, Rev.0: Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants,
- CNSC-EG2, Rev.0: Requirements and Guidelines for Simulator-based Certification Examinations for Shift Personnel at Nuclear Power Plants, and
- CNSC document: Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants, Revision 2

As per the CNSC December 19, 2017 letter (e-Doc 5340379) for the General certification examinations specified in CNSC document EG1, the following CVC shall be applied. On a pilot basis, Bruce Power may choose to administer General certification examinations using a Multiple Choice Question (MCQ) format. During this pilot period, the development, conduct and marking of MCQ General certification examinations shall be in accordance with the following Bruce Power documents:

- BP-PROC-00568, and
- B-HBK-09510-00012

Guidance:

Not applicable to this LC.

3 SCA – OPERATING PERFORMANCE

3.1 Operations Program

Licence Condition 3.1:

The licensee shall implement and maintain an operations program, which includes a set of operating limits.

Preamble:

The *Class I Nuclear Facilities Regulations* require that an application for a licence to operate a Class I nuclear facility contain the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility.

The operations program establishes safe operating practices within the nuclear facility, under all operating conditions (routine and non-routine), and provides the ability to ensure the facility is operated in such a manner that:

- applicable regulations, LCs, and standards are followed;
- the requirements of the operating policies and principles are implemented; and
- limits established in accordance with a safe operating envelope (SOE) are not exceeded.

The Operating Policies and Principles (OP&Ps):

- outline the operating rules consistent with the safety analyses and other licensing support documentation within which the station will be operated, maintained and modified, all of which should ensure nuclear safety;
- specify the authorities of the station staff positions to make decisions within the defined boundaries; and
- identify and differentiate between actions where discretion may be applied and where jurisdictional authorization is required.

The safe operating limits are derived from the safety analysis limits. The SOE parameters are currently identified in various station documents, including Operational Safety Requirements (OSR) and Instrument Uncertainty Calculations (IUCs). These limits are monitored through compliance documents such as the Impairments Manual and surveillance documentation.

Power limit specifications set limits on parameters that affect reactor core, channel, and fuel bundle powers, to ensure compliance with limits imposed by the design and safety analysis assumptions. The magnitude of the initial reactor power, channel powers and bundle powers in the reactor prior to an accident are the fundamental parameters governing whether fuel or fuel channel failure will occur during anticipated transients and the postulated Design-Basis Accidents (DBAs).

Accident management provisions are to ensure continuity and prevent any gaps in operating conditions by clearly identifying limiting scenarios between DBAs and Beyond-Design-Basis Accidents (BDBAs).

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Operating Policies and Principles – Bruce B	BP-OPP-00001	Prior to Implementation
Operating Policies and Principles – Bruce A	BP-OPP-00002	Prior to Implementation
Operating Policies and Principles – Central Maintenance and Laundry Facility	BP-OPP-00003	Prior to Implementation
Bruce Power Safeguards Site Plan 2015	NK37-CORR-00531-02784	N/A
Conduct of Plant Operations	BP-PROG-12.01	At Implementation
Operational Safety Requirements for Bruce A Fuel and Reactor Physics	NK21-OSR-31000-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Moderator System	NK21-OSR-32000-00001	Prior to Implementation
Bruce A NGS: Operational Safety Requirements for Heat Transport System	NK21-OSR-33100-00001	Prior to Implementation
Operational Safety Requirements for Bruce A End Shield Cooling System	NK21-OSR-34110-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Containment System	NK21-OSR-34200-00004	Prior to Implementation
Operational Safety Requirements for Bruce A Emergency Coolant Injection System	NK21-OSR-34340-00003	Prior to Implementation
Operational Safety Requirements for Bruce A Powerhouse Emergency Venting System	NK21-OSR-34360-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Shutdown and Maintenance Cooling Systems	NK21-OSR-34700-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Annulus Gas System	NK21-OSR-34980-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Fuel Handling	NK21-OSR-35000-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Main Steam Supply System	NK21-OSR-36100-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Confinement	NK21-OSR-38330/21175-00001	Prior to Implementation

Document Title	Document #	Notification
Operational Safety Requirements for Bruce A Feedwater and Condensate System	NK21-OSR-43200-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Electrical System	NK21-OSR-53000/55000-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Qualified Power Supply System	NK21-OSR-5440-00001	Prior to Implementation
Operational Safety Requirements for Critical Safety Parameter Monitoring	NK21-OSR-66060-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Reactor Regulating System	NK21-OSR-63710-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Shutdown Systems	NK21-OSR-63720-63730-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Service Water Systems	NK21-OSR-71310-00001	Prior to Implementation
Operational Safety Requirements for Bruce A Emergency Boiler Cooling System	NK21-OSR-71910-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Fuel and Reactor Physics	NK29-OSR-31000-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Moderator System	NK29-OSR-32000-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Heat Transport System	NK29-OSR-33000-00001	Prior to Implementation
Operational Safety Requirements for Bruce B End Shield Cooling System	NK29-OSR-34110-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Containment System	NK29-OSR-34200-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Emergency Coolant Injection System	NK29-OSR-34340-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Powerhouse Emergency Venting System	NK29-OSR-34360-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Shutdown and Maintenance Cooling Systems	NK29-OSR-34700-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Annulus Gas System	NK29-OSR-34980-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Fuel Handling	NK29-OSR-35000-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Main Steam Supply System	NK29-OSR-36100-00001	Prior to Implementation

Document Title	Document #	Notification
Operational Safety Requirements for Bruce B Confinement	NK29-OSR-38330-21190-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Feedwater and Condensate System	NK29-OSR-43220-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Electrical System	NK29-OSR-53000-55000-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Emergency Power Supply System	NK29-OSR-54300-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Critical Safety Parameter Monitoring	NK29-OSR-60060-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Reactor Regulating System	NK29-OSR-63710-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Shutdown Systems	NK29-OSR-63720-63730-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Service Water Systems	NK29-OSR-71310-00001	Prior to Implementation
Operational Safety Requirements for Bruce B Emergency Water System	NK29-OSR-71380-00001	Prior to Implementation

<u>Licensing Basis Publications</u>

Org	Document Title	Document #	Revision #	Effective Date
CSA	Requirements for the safe operating envelope for nuclear power plants	N290.15	2010 Update No. 1 (2016)	Feb. 29, 2016
CNSC	Accident Management: Severe Accident Management Programs for Nuclear Reactors	REGDOC-2.3.2	2013	Sep. 30, 2015

The licensee shall implement and maintain operations programs. These programs shall consist of, at a minimum, a safe operating envelope, a set of operating policies and principles, and accident management procedures and/or guides for design-basis and beyond-design-basis accidents, including overall strategies for recovery.

Bruce Power employs a number of programs and other governance to fulfill the objective of this LC. Operation in states not considered in, or not bounded by, the safety analyses is not permitted.

Power Limits

Bruce Power shall operate the reactor within the following limits:

Bruce A		
	Inner Flow Zone	Outer Flow Zone

Total power generated in any one fuel bundle	Shall not exceed 969 kilowatts	Shall not exceed 857 kilowatts
Total power generated in any fuel channel	Shall not exceed 6.84 megawatts under normal steady-state operating conditions	Shall not exceed 6.25 megawatts under normal steady-state operating conditions
Total thermal power from the reactor fuel	Shall not exceed 2619.6 megawatts (92.5% full power) under steady-state operating conditions	

Bruce B		
	Inner Flow Zone	Outer Flow Zone
Total power generated in any one fuel bundle	Shall not exceed 837 kilowatts under normal steady-state operating conditions	
Total power generated in any fuel channel	Shall not exceed 6.70 megawatts in the inner flow zone of the reactor core under normal steady-state operating conditions	Shall not exceed 6.23 megawatts in the outer flow zone of the reactor core under normal steady-state operating conditions
Total thermal power from the reactor fuel	Shall not exceed 2634 megawatts (93% full power) under steady-state operating conditions	

The reactor, channel and bundle power limits are considered safety and control measures. Any changes to them, or planned operations outside of these limits, would require prior written approval by the Commission, per LC G.1.

Operating Policies and Principles

The OP&Ps shall provide direction for operating the nuclear facilities safely and, as a minimum, reflect the safety analyses that have been previously submitted to the Commission, or a person authorized by the Commission.

Bruce Power shall, at all times, maintain and operate the nuclear facilities within the principles of the OP&Ps and the limits of the SOE. If operation outside the operating boundaries specified by the OP&Ps and SOE is discovered, the licensee shall take immediate action to return the facility within the boundaries of safety analyses, in a safe manner as per Bruce Power procedures.

Safe Operating Envelope

CSA standard N290.15, REQUIREMENTS FOR THE SAFE OPERATING ENVELOPE FOR NUCLEAR POWER PLANTS outlines the requirements for a safe operating envelope.

Bruce Power's safe operating limits, conditions and surveillance requirements as well as their bases are documented in station and system specific operational safety requirements (OSRs) documents along with any associated IUCs. The limits and conditions defined in the OSRs, including any requirements for corrective or mitigating actions and action times, are specified in the applicable operations and maintenance tests, procedures and processes to ensure compliance with the SOE.

Bruce Power shall, at all times, maintain and operate the nuclear facilities within the limits of the SOE, as defined by the OSRs and IUCs.

Changes to the SOE that are neutral or in the safe direction require notification prior to implementation, as per the requirements of LC G.2; however, SOE changes that reduce the overall safety margins require Commission approval prior to implementation.

Accident Management and Recovery

CNSC regulatory document REGDOC-2.3.2, ACCIDENT MANAGEMENT: SEVERE ACCIDENT MANAGEMENT PROGRAMS FOR NUCLEAR REACTORS outlines the requirements related to severe accident management programs, which provide additional defence against the consequences of those accidents that fall beyond the scope of events considered in the reactor design basis.

Bruce Power shall implement and maintain operational procedures for operation in all states analyzed in the design basis, including abnormal and emergency states.

Bruce Power's operational procedures ensure that the operation of the facility can be returned to a safe and controlled state should operation deviate from normal operation. Bruce Power shall ensure all abnormal operational scenarios analyzed in the design basis are accounted for in the operational procedures with the purpose of mitigating situations that may arise which cause a deviation from the expected state. These documents are conceived to return the plant to a safe and controlled state and to prevent the further escalation of the abnormal incident into a more serious deviation.

In addition to the operational guidance for abnormal and emergency states, Bruce Power shall implement and maintain a severe accident management program to address residual risks posed by severe accidents. Bruce Power shall also ensure clear instruction is provided directing operations in abnormal scenarios to the appropriate set of procedures or guides, including severe accident management guidelines (SAMGs), if a severe accident is detected.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CSA	Requirements for reactor heat removal capability during outage of nuclear power plants	N290.11	2013
CSA	Requirements for beyond design basis accidents	N290.16	2016
CNSC	Accident Management, Version 2	REGDOC-2.3.2	2015

The licensee should manage all outage heat sink work activities in accordance with CSA standard N290.11, REQUIREMENTS FOR REACTOR HEAT REMOVAL CAPABILITY DURING OUTAGE OF NUCLEAR POWER PLANTS.

The licensee should take into consideration the September 2015 version of CNSC regulatory document REGDOC-2.3.2, Version 2 on accident management.

3.2 Approval to Restart after a Serious Process Failure

Licence Condition 3.2:

The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or the prior written consent of a person authorized by the Commission.

Preamble:

The definition of serious process failure and the associated reporting requirements are provided in REGDOC-3.1.1.

For a serious process failure to occur, an imbalance of heat produced and heat removed from the reactor core must exist. This imbalance can be caused by an increase in reactor power or a decrease in the ability of the primary heat transport system to remove heat from the reactor core. There are mitigating systems such as stepback, setback, auxiliary feedwater, and standby electrical power that can prevent process system failures from becoming serious process failures.

Compliance Verification Criteria:

Where a cause of a trip was found to be a serious process failure or where the determination as to the cause of a trip has proved inconclusive (i.e. a serious process failure cannot be ruled out), a request for restart of the reactor shall be submitted in writing and approval to restart the reactor must be obtained from the CNSC.

If there is sufficient assurance that the cause of the serious process failure has been resolved and it is now safe to return the facility to service, a CNSC authorized person has the authority to give the consent to Bruce Power to proceed with the restart of the reactor.

The written request for restart of the reactor is to include the following information:

- a description of the event;
- the causes of the event;
- the consequences and safety significance of the event;
- a recovery plan including corrective actions, and fitness for service assessment on the systems/components impacted from the failure if applicable. This shall be completed prior to reactor restart;
- a statement regarding plant readiness to resume safe operation. This shall include any conditions that the licensee proposes to impose upon reactor restart and/or subsequent reactor operation to ensure safe operation of the nuclear facilities; and
- an extent of completion of the conditions mentioned in the statement regarding plant readiness to resume safe operation.

Guidance:

In addition to the requirements listed above, the written request to restart a reactor after a serious process failure should also include the following information:

- a statement specifying that an extent of condition has been completed;
- the documentation and communication to licensee staff (including additional training, if necessary); and
- applicable historical operating experience (OPEX) review for comparable events.

3.3 Reporting Requirements

Licence Condition 3.3:

The licensee shall notify and report in accordance with CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

Preamble:

CNSC regulatory document REGDOC-3.1.1 has comprehensive reporting requirements (scheduled and unscheduled) for licensees of NPPs. It describes information that the CNSC needs to evaluate the performance of the facilities it regulates. This document is complementary to the reporting requirements in the *Nuclear Safety and Control Act* and the associated regulations.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Nuclear Regulatory Affairs	BP-PROG-06.01	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Reporting Requirements for Nuclear Power Plants, Version 2	REGDOC-3.1.1	2016	May 2016

1. For REGDOC-3.1.1 Section 3.1, Quarterly report on safety performance indicators:
Bruce Power's quarterly report on Safety Performance Indicators (SPIs) is to include contributions from the licensed support activities at the Central Maintenance and Laundry Facility (CMLF) for SPI 1, Collective Radiation Exposure and SPI 5, Environmental Releases – Radiological.
2. For REGDOC-3.1.1 Section 3.5, Annual report on environmental protection:
Bruce Power is to provide the reporting data with respect to sewage plant radioactivity monitoring in the annual report on environmental protection.

Guidance:

To ensure consistency of reporting across the fleet of Canadian NPPs, CNSC staff have prepared a list (e-Doc 5012344) which provides additional clarification and interpretation of the requirements of REGDOC-3.1.1. The list, which is expected to become a controlled CNSC document, was developed in consultation with industry and should be used as guidance, as appropriate.

Guidance Publications

Org	Document Title	Document #	Version
CNSC	Interpretation of REGDOC-3.1.1, Reporting Requirements for Nuclear Power Plants	N/A	Rev 0, 2015 e-Doc 5012344

4 SCA – SAFETY ANALYSIS

4.1 Safety Analysis Program

Licence Condition 4.1:

The licensee shall implement and maintain a safety analysis program.

Preamble:

The *General Nuclear Safety and Control Regulations* requires that a licence application contain a description and the results of any analyses performed to substantiate the information included in the application.

The *Class I Nuclear Facilities Regulations* require, among other requirements, that an application for a licence to operate a Class I nuclear facility contain a final safety analysis report demonstrating the adequacy of the design of the nuclear facility.

All event sequences which can occur in a NPP must be analyzed to ensure safe operation. A deterministic safety analysis evaluates the NPP's responses to such events by using predetermined rules and assumptions. The objectives of the deterministic safety analysis are stated in REGDOC-2.4.1, DETERMINISTIC SAFETY ANALYSIS.

Probabilistic safety assessment (PSA) is a comprehensive and integrated assessment of the safety of the NPP that, by considering the initial plant state and the probability, progression, and consequences of equipment failures and operator response, derives numerical estimates of a consistent measure of the safety of the design. Such assessments are most useful in assessing the relative level of safety. The objectives of the PSA are stated in REGDOC-2.4.2, PROBABILISTIC SAFETY ASSESSMENT (PSA) FOR NUCLEAR POWER PLANTS.

CSA standard N286.7, QUALITY ASSURANCE OF ANALYTICAL, SCIENTIFIC, AND DESIGN COMPUTER PROGRAMS applies to the design, development, modification and use of computer programs that are used in analytical, scientific and design applications at nuclear power plants.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Bruce A Safety Report, Part 2: Plant Components and Systems	NK21-SR-01320-00002	Prior to Implementation
Bruce B Safety Report, Part 2: Plant Components and Systems	NK29-SR-01320-00001	Prior to Implementation
Bruce A Safety Report, Part 3: Safety Analysis	NK21-SR-01320-00003	Prior to Implementation

Document Title	Document #	Notification
Bruce B Safety Report, Part 3: Safety Analysis	NK29-SR-01320-00002	Prior to Implementation
Updated Emergency Planning Technical Basis for Provincial Nuclear Emergency Response Plan	B-03490-31MAR2017	Prior to Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Deterministic Safety Analysis	REGDOC-2.4.1	2014	Dec. 31, 2017
CNSC	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	S-294	2005	June 1, 2015
CNSC	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	REGDOC-2.4.2	2014	June 30, 2019
CSA	Quality assurance of analytical, scientific, and design computer programs	N286.7	2016	Dec 31, 2016

Deterministic Safety Analysis

CNSC regulatory document REGDOC-2.4.1 outlines the requirements related to safety analysis events, operating modes, acceptance criteria, methods, documentation and review. The closure criteria for implementation include the following elements:

- assessment of the current safety analysis practices against REGDOC-2.4.1 to identify gaps;
- prioritization of the identified gaps using formal methods;
- justification of non-conformances; and
- development and execution of corrective action plans to address the important gaps.

Implementation Strategy for REGDOC-2.4.1

Recognizing that full implementation of REGDOC-2.4.1 may not be possible or provide any additional safety benefit beyond the current safety case, a method of evaluating the significance of gaps (applying a graded approach) against REGDOC-2.4.1 and their importance to safety shall be established and applied on an as-needed basis, providing a means of prioritizing safety analysis to deliver the greatest safety benefit.

COG document COG-13-9035-R00, *Derived Acceptance Criteria for Deterministic Safety Analysis* shall be used by Bruce Power when conducting deterministic safety analysis for the associated accident scenarios.

Bruce Power has completed gap assessments against REGDOC-2.4.1 and gap prioritization using the proper methodology, and submitted a REGDOC-2.4.1 implementation plan. A 3-year Safety Report Improvement (SRI) project was completed in December 2017 to align with the new REGDOC-2.4.1 framework, which also includes a new Safety Report Appendix on Common Mode Events (CME) for both the Bruce A and Bruce B Safety Reports.

CNSC staff have provided comments on the CME analyses with recommended follow-up actions. Bruce Power is expected to consider those comments and recommendations and update this new CME Safety Report section as well as other relevant sections through the Safety Report Update process.

During the licensing period, CNSC staff will follow-up with Bruce Power on the execution of the REGDOC-2.4.1 implementation plan, and its updates.

Bruce Power shall conduct and maintain a deterministic safety analysis as documented in the plant Final Safety Analysis Report. The deterministic safety analysis shall demonstrate that the radiological consequences of the postulated initiating events involving a single process failure and events involving a single process failure in conjunction with failure of one of the special safety systems do not exceed the accident-dependent reference public dose limits specified in the siting guide [see reference in G.3] and reproduced in the following table:

	Individual Dose Limit		Population Dose Limit	
	Thyroid Dose (mSv)	Whole Body Dose (mSv)	Thyroid Dose (Person mSv)	Whole Body Dose (Person mSv)
Single Failure	30	5	10^5	10^5
Dual Failure	2500	250	10^7	10^7

Bruce Power has undertaken an update of the processes and procedures related to the Deterministic Safety Analysis in preparation for executing the SRI activities to ensure safety analyses are geared toward becoming consistent with REGDOC-2.4.1.

Probabilistic Safety Assessment

CNSC regulatory documents S-294 and REGDOC-2.4.2 outline the requirements related to PSA. REGDOC-2.4.2, which was published in 2014 superseded S-294 and includes amendments to reflect he lessons learned from the Fukushima accident. Bruce Power is compliant with S-294 requirements for both Bruce A and Bruce B.

Implementation strategy for REGDOC-2.4.2

Bruce Power shall transition to REGDOC-2.4.2 for PSA over this licensing period. The target date for full compliance to REGDOC-2.4.2 is June 30, 2019.

Bruce Power shall update PSA models every 5 years (the next due date is June 30, 2014) or sooner if there are significant changes in the plant design or operation.

In addition, Bruce Power shall implement internal policy to address if the PSA results are in between the safety limit and the target.

Furthermore, as part of the COG effort to develop a whole-site PSA methodology, Bruce Power should provide a plan for whole-site PSA assessment.

Design and Analysis Computer Codes and Software

CSA standard N286.7 provides the specific requirements related to the development, modification, maintenance and use of computer programs used in analytical, scientific and design applications.

Bruce Power shall demonstrate compliance of computer programs used in analytical, scientific and design applications used to support the safe plant operation in accordance with CSA N286.7.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CSA	Probabilistic safety assessment for nuclear power plants	N290.17	2017
CSA	Wet storage of irradiated fuel and other radioactive materials	N292.1	2016
CSA	Interim dry storage of irradiated fuel	N292.2	2013

Detailed methodologies and derived acceptance criteria for the conduct of deterministic safety analysis are described in the following COG documents:

Document Title	Document #	Revision #
Principles & Guidelines For Deterministic Safety Analysis	COG-09-9030	Rev 3
Guidelines for Application of the Limit of Operating Envelope Methodology to Deterministic Safety Analysis	COG-11-9023	Rev 1
Guidelines for Application of the Best Estimate Analysis and Uncertainty (BEAU) Methodology to Licensing Analysis	COG-06-9012	Rev 1
Principles and Guidelines for NOP/ROP Trip Setpoint Analysis for CANDU Reactors	COG-08-2078	Rev 1
Derived Acceptance Criteria For Deterministic Safety Analysis	COG-13-9035	Rev 0

Updates to deterministic safety analysis should contain a revision summary sheet highlighting the key differences between the existing analyses and updated analysis. The revision summary should include:

- Summary of changes (key differences) such as:
  - in acceptance criteria
  - In event characterization
  - In safety analysis assumptions
  - In methodology, or in elements of a methodology
  - In plant models
  - In use of computer codes and embedded models
  - In trip coverage
- Reasons for updating the analysis and for updating models, assumptions, initial conditions or boundary conditions;
- Significance of changes, and their justification;

- Significant changes in results that may affect the conclusions of the analysis for the design; operational or emergency safety requirements for a particular situation or event; and
- Impact on operating and safety margins.

The licensee should maintain a Safety Report Basis consisting of a listing of Analysis of Record Items and auxiliary documents. The licensee should continue to provide CNSC staff with regular updates of the list indicating the submissions to be included in the next Safety Report update (Part 3).

When the deterministic safety analysis methodology is modified as a result of improved knowledge, or to address emerging issues, the licensee should assess the impact of such a modification on the operating limits, as well as procedural and administrative rules.

The licensee should not credit results obtained with a modified safety analysis methodology to relax operating conditions and/or change safety margins until the modification of the methodology has been reviewed by CNSC staff. If CNSC staff indicate that the modified methodology is appropriate, the licensee must still fulfill any other requirements or criteria associated with the changes to the operating conditions or safety margins, as documented under other LCs such as those in Section 3.

In addition to industry standards, CNSC staff will refer to the applicable industry verification and validation process practices related to computer codes and software used to support the safe plant operation.

Bruce Power should implement a policy to address PSA results that are between the safety limit and the target.

5 SCA – PHYSICAL DESIGN

5.1 Design Program

Licence Condition 5.1:

The licensee shall implement and maintain a design program.

Preamble:

The *Class I Nuclear Facilities Regulations* require that an application for a licence to operate a Class I nuclear facility contain a description of the systems and equipment at the nuclear facility, including their design and their design operating conditions.

A design program ensures that the plant design is managed using a well-defined systematic approach. Implementing and maintaining a design program confirms that safety-related systems, structures and components (SSCs) and any modifications to them, continue to meet their design bases given new information arising over time and taking changes in the external environment into account. It also confirms that SSCs continue to be able to perform their safety functions under all plant states. An important cross-cutting element of a design program is design basis management.

A design program composed of sub-programs that include, but not limited to: pressure boundary design, civil structure design, seismic design, mechanical design, fuel design, core nuclear design, core thermal-hydraulic design, safety system design, fire protection design, electrical power system design, as well as instrument and control system design.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Plant Design Basis Management	BP-PROG-10.01	Prior to Implementation
Engineering Change Control	BP-PROG-10.02	Prior to Implementation
Configuration Management	BP-PROG-10.03	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CSA	Human factors in design for nuclear power plants	N290.12	2014	September 1, 2018

Org	Document Title	Document #	Revision #	Effective Date
CSA	Qualification of pre-developed software for use in safety-related instrumentation and control applications in nuclear power plants	N290.14	2007	September 1, 2018
CSA	Requirements for safety-related structures for CANDU nuclear power plants (see Note)	N291	2015	July 1, 2018

Note: Exception for implementation of CSA N291-15 is Clause 4.3(f)

Bruce Power shall ensure that all SSCs important to safety are designed to perform their required functions under all plant states for which the system must remain available.

Design Basis Management

Bruce Power shall ensure that plant status changes (design modifications) are controlled such that the plant is maintained and modified within the limits prescribed by the design and licensing basis. Aspects of design are considered safety and control measures if changes to them could

- invalidate the limits documented in the operating policies and principles or safe operating envelope referred to in LC 3.1;
- introduce hazards different in nature or greater in probability or consequence than those considered by the safety analyses and probabilistic safety assessment; and/or
- adversely impact other important safety and control measures, such as those related to operations, radiation protection, emergency preparedness, etc.

Bruce Power shall ensure that changes to those aspects of design remain within the licensing basis and shall notify the CNSC when such changes are planned. Changes outside the licensing basis would require prior written approval by the Commission.

Bruce Power shall ensure that plant design and changes to plant design are accurately reflected in the safety analysis (see section 4.1 for licensee documents that contain the facilities descriptions and the final safety analysis reports). Where specific reports (e.g., external third party reviews as required by CSA standard N293, which is cited in LC 10.2) are required by the standards in the licensing basis, these shall be submitted to the CNSC.

Design Sub-programs

See LC 5.2 for compliance verification criteria on pressure boundary design and LC 5.3 for information on equipment and structure qualification.

Bruce Power shall have sub-program elements that address the modification of the special safety systems (Shutdown System 1, Shutdown System 2, Emergency Core Cooling System and Containment). Significant changes to the special safety systems or systems connected to the special safety systems (e.g., change that would impact safety margins) would require prior notification and engagement of CNSC. Changes outside the licensing basis would require prior written approval by the Commission.
Prior notification is not required for changes to items that serve the same functional characteristics of the originally designed item and does not result in a change to operating procedures or safety system testing.

Bruce Power shall have sub-program elements that address the design and modification of concrete containment structures and safety-related structures.

Any changes that have the potential to impact fire protection are assessed for compliance with CSA standard N293 and, if required, an external third party review shall be performed and the results submitted to the CNSC. See LC 10.2 for version control of CSA N293.

The plant electrical power system design shall include the safety classifications of the systems. Its design shall be adequate for all modes of operation under steady-state, voltage and frequency excursion, and transient conditions, as confirmed by electrical analysis. The electrical power systems shall be monitored and tested to demonstrate they comply with the design requirements and to verify the operability for AC systems and DC systems.

Bruce Power shall ensure that the plant overall instrument and control (I&C) system is designed to satisfy the following:

- the safety classification of the I&C system is in compliance with plant level system classification and is justified by analysis;
- I&C system meets separation requirements between the groups and channels;
- safety features for enhancing I&C system reliability and integrity are identified and implemented in the design, for example, fail safe design, redundancy, independence and testing capability;
- I&C system is not vulnerable to common cause failures;
- I&C of safety system meets the requirements of single failure criteria.

The licensee shall demonstrate survivability of the I&C systems and component that are critical to the management of BDBAs, and the availability of power supply to necessary equipment and associated I&C for BDBAs.

Prior to making use of a new fuel bundle/fuel bundle string or fuel assembly design in the reactor, Bruce Power shall perform design verification activities, analyses and testing to demonstrate that design requirements are met. The length and complexities of those activities depend on the novelty of the design.

Bruce Power shall update and maintain the reactor core nuclear design information found in Bruce A and B Safety Reports – Part 2 (WN documents in section 4.1) and supporting design manuals. Core surveillance activities shall be implemented to ensure compliance with reactor core nuclear design and operation within the design envelope. Significant changes to core nuclear design would require prior notification and engagement of CNSC. Changes outside the reactor core nuclear design basis would require prior written approval by the Commission.

Modification to the design of existing safety-related structures and components shall include adequate consideration for human factors. For proposed modifications, modern requirements, that are consistent with the current licensing basis of the plant, shall be applied to the extent practicable.

Bruce Power shall ensure configuration management is aligned with the design and safety analysis and incorporated into purchasing, construction, commissioning, operating and maintenance documentation. Conformance is to be maintained between design requirements, physical configuration and facility configuration information. Bruce Power shall establish a design authority function with the authority to review, verify, approve (or reject), document the design changes and maintain design configuration control.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CNSC	Human Factors Engineering Program Plans	G-276	2003
CNSC	Human Factors Verification and Validation Plans	G-278	2003
CNSC	Design of Reactor Facilities: Nuclear Power Plants	REGDOC-2.5.2	2014
CSA	Configuration management for high energy reactor facilities	N286.10	2016
CSA	General requirements for concrete containment structures for CANDU nuclear power plants	N287.1	2014
CSA	Material requirements for concrete containment structures for CANDU nuclear power plants	N287.2	2008
CSA	Design requirements for concrete containment structures for CANDU nuclear power plants	N287.3	2014
CSA	Construction, fabrication, and installation requirements for concrete containment structures for CANDU nuclear power plants	N287.4	2009
CSA	Examination and testing requirements for Concrete Containment Structures for CANDU Nuclear Power Plants	N287.5	2011
CSA	Pre-operational proof and leakage rate testing requirements for concrete containment structures for CANDU nuclear power plants	N287.6	2011
CSA	General requirements for safety systems of nuclear power plants	N290.0	2011
CSA	Requirements for the shutdown systems of CANDU nuclear power plants	N290.1	2013
CSA	Requirements for emergency core cooling systems of nuclear power plants	N290.2	2011
CSA	Requirements for the containment system of nuclear power plants	N290.3	2016
CSA	Requirements for reactor control systems of nuclear power plants	N290.4	2011
CSA	Requirements for electrical power and instrument air systems of CANDU nuclear power plants	N290.5	2006 (R2011)
CSA	Requirements for monitoring and display of nuclear power plant safety functions in the event of an accident	N290.6	2009 (R2014)

Org	Document Title	Document #	Version
CSA	Qualification of digital hardware and software for use in instrumentation and control applications for nuclear power plants	N290.14	2015
US NRC	Unified Facilities Criteria – Structures to Resist the Effects of Accidental Explosions	UFC 3-340-02	2008

Since Bruce Power's design program spans many other programs and processes not included as a written notification document, a table or roadmap that identifies relevant design basis documents, design sub-programs and processes should be maintained by Bruce Power and made available to CNSC staff.

With regard to modifications, the design basis for the plant should be documented and maintained to reflect design changes to ensure adequate configuration management. The design basis should be maintained to reflect new information, operating experience, safety analyses, and resolution of safety issues or correction of deficiencies. The impacts of the design changes should be fully assessed, addressed and accurately reflected in the safety analyses prior to implementation.

The design program should minimize the potential for human error and promote safe and reliable system performance through the consideration of human factors in the design of facilities, systems, and equipment. Guidance for considering human factors in design programs is provided in CNSC guidance documents G-276, HUMAN FACTORS ENGINEERING PROGRAM PLANS, and G-278, HUMAN FACTORS VERIFICATION AND VALIDATION PLANS.

5.2 Pressure Boundary Program

Licence Condition 5.2:

The licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency.

Preamble:

This LC provides regulatory oversight with regards to the licensee's implementation of a pressure boundary program and holds the licensee responsible for all aspects of pressure boundary registration and inspections.

A pressure boundary program is comprised of the many programs, processes and procedures and associated controls that are required to ensure compliance with CSA standard N285.0, GENERAL REQUIREMENTS FOR PRESSURE RETAINING SYSTEMS AND COMPONENTS IN CANDU NUCLEAR POWER PLANTS which defines the technical requirements for the design, procurement, fabrication, installation, modification, repair, replacement, testing, examination and inspection of pressure-retaining and containment systems, including their components and supports.

This LC also ensures that an Authorized Inspection Agency (AIA) will be subcontracted directly by the licensee. An AIA is an organization recognized by the CNSC as authorized to register designs and procedures, perform inspections, and other functions and activities as defined by CSA N285.0 and its applicable referenced publications (e.g., CSA standard B51, NATIONAL BOARD INSPECTION CODE). The AIA is accredited by the American Society of Mechanical Engineers (ASME) as stipulated by NCA-5121 of the ASME Boiler & Pressure Vessel Code.

The licensee is also responsible for all aspects of pressure boundary registration and inspections.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Pressure Boundary Quality Assurance Program	BP-PROG-00.04	At Implementation
Index to Pressure Boundary Program Elements (CSA N285.0-12 Table N.1)	B-LIST-01900-00001	At Implementation
System and Item Classification	DIV-ENG-00017	Prior to Implementation
Design Registration and Reconciliation	DIV-ENG-00018	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CSA	General requirements for pressure-retaining systems and components in CANDU nuclear power plants	N285.0	2012 Update No. 1 (Sep. 2013) & Update No. 2 (Nov. 2014)	August 31, 2015

General

CSA standard N285.0 outlines the requirements for a pressure boundary program. Bruce Power shall maintain an index of the processes and procedures of the pressure boundary program (governing and implementing documents).

Classification, Registration and Reconciliation Procedures

Licensee procedures describing the classification, registration and reconciliation processes and the associated controls must form a part of the pressure boundary program. Bruce Power shall provide prior notification of any changes to these procedures.

Registration of previously unregistered systems and legacy system design changes has been planned and prioritized. Bruce Power shall provide periodic updates and a prioritization scheme to the CNSC. Bruce Power has committed to having all Bruce B system design registrations (including system classification lists) updated by December 31, 2017. In November 2017 Bruce Power requested approval to extend the commitment to complete the Bruce B Legacy Registration Project. CNSC staff accepted this request subject to conditions of certain notifications be made to CNSC prior to May 31, 2018.

Overpressure Protection Reports

Bruce Power shall provide written notification to CNSC staff, of new or revised overpressure protection reports, after the final registration of the system.

Classification and Registration of Fire Protection Systems

Fire protection systems and associated fittings and components are to be classified at least as Code Class 6, designed to the ASME B31.1 and registered, unless the exemption criteria noted below are met. The requirements of CSA standard N285.0 apply for higher than Code Class 6.

The following fittings and components may be exempt from requiring a Canadian Registration Number provided they meet the following exemption criteria:

a) deluge, fire hose control, pressure control, drain, pre-action, alarm and dry pipe valves and devices, providing they are cUL or ULC listed and suitable for the expected environmental conditions and maximum pressures; or

b) fire and jockey pumps and their controllers which meet the requirements of the National Fire Protection Association (NFPA)-20, if cUL or ULC listed and suitable for the expected environmental conditions and maximum pressures; or

c) sprinkler, nozzles, inductors, proportioners, strainers and other spray and distribution devices, if cUL or ULC listed and suitable for the expected environmental conditions and maximum pressures; or

d) pressurized cylinders and tubes, such as extinguishers, inert gas and foam tanks, which bear Transport Canada approvals and suitable for the expected environmental conditions and maximum pressures; or

e) buried fire protection piping when in compliance with NFPA-24.

Buried fire protection piping may be exempt from the ASME testing requirements if testing is performed to NFPA-24.

Formal Agreement with an Authorized Inspection Agency

The licensee shall always have in place a formal agreement with an AIA to provide services for the pressure boundaries of the nuclear facilities as defined by CSA standard N285.0 and its applicable referenced publications.

Design registration services for pressure boundary shall be provided by an AIA legally entitled under the provincial boilers and pressure vessels acts and regulations to register designs. Registration of piping systems shall be done by the Technical Standards and Safety Authority, who is legally entitled to register designs in Ontario.

A copy of the signed agreement shall be provided to the CNSC. During the licence period, Bruce Power shall notify the CNSC in writing of any change to the terms and conditions of the agreement, including termination of the agreement. This correspondence shall be addressed to the Director of the Bruce Regulatory Program Division.

The licensee shall arrange for the AIA inspectors to have access to all areas of the facility and records, and to the facilities and records of the licensee's pressure boundary contractors and material organizations, as necessary for the purposes of performing inspections and other activities required by the standards. Inspectors of the AIA shall be provided with information, reasonably in advance with notice and time necessary to plan and perform inspections and other activities required by the standards.

For a variance or deviation from the requirements of the CSA N285.0 standard, except as noted below, the licensee must first submit the proposed resolution to the AIA for evaluation, and then to the CNSC for consent. The licensee must demonstrate that meeting the code requirement is impracticable and the proposed resolution will provide adequate safety. Per the agreement with the AIA, the evaluated resolution shall not be implemented without the prior written consent of CNSC staff. A variance or deviation related to Code Edition, Code Classification, and Legacy Registration issues may be submitted directly to the CNSC without prior AIA evaluation. General criteria for obtaining prior written consent/approval for a proposed resolution from the CNSC can be found in LC G.1 and G.2.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
ASME	Boiler and Pressure Vessel Code – Code Cases	N/A	2010 Edition with 2011 Addendum
ASME	Power Piping	B31.1	2010
ASME	Process Piping	B31.3	2010
ASME	Refrigeration Piping and Heat Transfer Components	B31.5	2010
CSA	Boiler, Pressure Vessel and Piping Code	B51	2014
CSA	General requirements for pressure-retaining systems and components in CANDU nuclear power plants	N285.0	2017

Note: Where these standards/codes or portions thereof are required for compliance with a governing standard referenced in the CVC of the LCH, compliance to the referenced standards/codes or portions thereof is required for compliance with the governing standard and the LC.

Bruce Power should arrange for AIA inspectors to have access to all areas of the facilities and records for purposes of performing inspection and other activities required by the standards. Inspection-related information should be provided to the AIA inspectors prior to the inspection within a reasonable time.

The AIA, and its authorized inspectors, should be familiar with and capable of applying the CSA N285.0 provisions to perform their activities as defined by the standard.

5.3 Equipment and Structure Qualification Program

Licence Condition 5.3:

The licensee shall implement and maintain an equipment and structure qualification program.

Preamble:

Environmental qualification (EQ) ensures that all required equipment in a nuclear facility is qualified to perform its safety functions if exposed to harsh environmental conditions resulting from credited Design-Basis Accidents (DBAs) and that this capability is preserved for the life of the plant.

Condition monitoring assesses variables that indicate the physical state of the equipment, and assesses its ability to perform its intended function following the period of observation. Environmental monitoring measures environmental stressors, such as temperature, radiation and operational cycling during normal operating conditions.

Seismic qualification (SQ) ensures that all seismically credited safety-related SSCs in a nuclear power plant are designed, installed and maintained to perform their safety function during and/or after (as needed and pre-defined) a design basis earthquake or site design earthquake and also ensures an adequate margin against review level earthquakes.

Compliance Verification Criteria:

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CSA	General requirements for seismic design and qualification of CANDU nuclear power plants	N289.1	2008	September 1, 2018
CSA	Ground motion determination for seismic qualification of CANDU nuclear power plants	N289.2	2010	September 1, 2018
CSA	Design procedures for seismic qualification of CANDU nuclear power plants	N289.3	2010	September 1, 2018
CSA	Testing procedures for seismic qualification of nuclear power plant structures, systems, and components	N289.4	2012	September 1, 2018
CSA	Seismic instrumentation requirements for nuclear power plants and nuclear facilities	N289.5	2012	September 1, 2018
CSA	Environmental qualification of equipment for CANDU nuclear power plants	N290.13	2005 Reaffirmed 2015	September 1, 2018

CSA standard N290.13, ENVIRONMENTAL QUALIFICATION OF EQUIPMENT FOR CANDU NUCLEAR POWER PLANTS outlines the requirements for an EQ program.

In addition to the criteria set out in CSA N290.13, Bruce Power's EQ program shall include a monitoring program consisting of condition monitoring and environmental monitoring, to measure degradation and failures of qualified equipment, including cables.

CSA standard N289.1, GENERAL REQUIREMENTS FOR SEISMIC DESIGN AND QUALIFICATION OF CANDU NUCLEAR POWER PLANTS is the introduction standard to the CSA N289 series and supplements the standards in this series with current seismic qualification concepts and methodologies.

CSA standard N289.2, GROUND MOTION DETERMINATION FOR SEISMIC QUALIFICATION OF NUCLEAR POWER PLANTS describes the investigations required to obtain the seismological and geological information necessary to determine, for a proposed or existing nuclear power plant site, the seismic ground motion that will be used in seismic qualification of safety-related plant structures and systems, and the potential for seismically induced phenomena that can have a direct or indirect effect on plant safety or operation.

CSA standard N289.3, DESIGN PROCEDURES FOR SEISMIC QUALIFICATION OF CANDU NUCLEAR POWER PLANTS provides design requirements and methods for determining the engineering representation of ground motion, ground response spectra, and floor response spectra for use in the design and seismic qualification of SSCs; and for performing seismic qualification of specified SSCs by analytical methods.

CSA standard N289.4, TESTING PROCEDURES FOR SEISMIC QUALIFICATION OF NUCLEAR POWER PLANT STRUCTURES, SYSTEMS, AND COMPONENTS provides design requirements and methods for seismic qualification of specific components and systems by testing methods.

CSA standard N289.5, SEISMIC INSTRUMENTATION REQUIREMENTS FOR NUCLEAR POWER PLANTS AND NUCLEAR FACILITIES provides requirements for seismic instrumentation systems for nuclear power plants and nuclear facilities to monitor site-specific seismic responses.

Guidance:

The processes and procedures related to the EQ program should meet the requirements of recognized industrial standards.

6 SCA – FITNESS FOR SERVICE

6.1 Fitness for Service Program

Licence Condition 6.1:

The licensee shall implement and maintain a fitness for service program.

Preamble:

The *Class I Nuclear Facilities Regulations* requires that an application for a licence to operate a Class I nuclear facility contain the proposed measures, policies, methods and procedures to maintain the nuclear facility.

A fitness for service program includes the following elements:

- An effective control of plant chemistry to ensure critical plant equipment performs safely and reliably;
- aging management activities to ensure the availability of required safety functions of structures, systems and components (SSCs);
- periodic and in-service inspection programs to ensure that pressure-boundary components, containment structures and components, continue to meet their design requirements;
- in-service inspection of balance of plant to ensure safety significant pressure retaining systems, components and safety-related structures are monitored for degradation; and
- proper reliability program and implementation to ensure that SSCs important to safety continue to meet their performance requirements.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title		Document #	Notification
Plant Maintenance		BP-PROG-11.04	At Implementation
Equipment Reliability		BP-PROG-11.01	At Implementation
N287.7	Periodic Inspection Program for Bruce NGS A Concrete Containment Structures and Appurtenances	NK21-PIP-21100-00001	Prior to Implementation
	Periodic Inspection Program for Bruce NGS A Vacuum Building	NK21-PIP-25100-00001	Prior to Implementation
	Periodic Inspection Program for Bruce NGS B Concrete Containment Structures and Appurtenances	NK29-PIP-21100-00001	Prior to Implementation
	Periodic Inspection Program for Bruce NGS B Vacuum Building	NK29-PIP-25100-00001	Prior to Implementation

Document Title		Document #	Notification
	Visual Inspection of Containment Boundary Components	BP-PROC-00815	Prior to Implementation
N285.4	Bruce A Periodic Inspection Plan for Unit 1	NK21-PIP-03641.2-00001	Prior to Implementation
	Bruce A Periodic Inspection Plan for Unit 2	NK21-PIP-03641.2-00002	Prior to Implementation
	Bruce A Periodic Inspection Plan for Unit 3	NK21-PIP-03641.2-00003	Prior to Implementation
	Bruce A Periodic Inspection Plan for Unit 4	NK21-PIP-03641.2-00004	Prior to Implementation
	Bruce B Periodic Inspection Plan for Unit 5	NK29-PIP-03641.2-00001	Prior to Implementation
	Bruce B Periodic Inspection Plan for Unit 6	NK29-PIP-03641.2-00002	Prior to Implementation
	Bruce B Periodic Inspection Plan for Unit 7	NK29-PIP-03641.2-00003	Prior to Implementation
	Bruce B Periodic Inspection Plan for Unit 8	NK29-PIP-03641.2-00004	Prior to Implementation
	Bruce Nuclear Generating Station Fuel Channel Periodic Inspection Program	B-PIP-31100-00002	Prior to Implementation
N285.5	Bruce A Periodic Inspection Plan for Unit 0 and Units 1 to 4 Containment Components	NK21-PIP-03642-00001	Prior to Implementation
	Bruce B Periodic Inspection Plan for Unit 0 and Units 5 to 8 Containment Components	NK29-PIP-03642-00001	Prior to Implementation
Life Cycle Management Plan for Safety Related Civil Structures		B-LCM-20000-00001	Prior to Implementation
Fuel Channel Life Cycle Management Plan		B-LCM-31100-00001	Prior to Implementation
Steam Generator and Preheater Life Cycle Management Plan		B-PIP-33110-00001	Prior to Implementation
PHT Feeder Piping Periodic Inspection Plan		B-PIP-33126-00001	Prior to Implementation
On-Line Work Management		BP-PROG-11.02	At Implementation
Outage Work Management		BP-PROG-11.03	At Implementation
Chemistry Management		BP-PROG-12.02	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Reliability Programs for Nuclear Power Plants	REGDOC-2.6.1	2017	Sep. 1, 2018
CNSC	Maintenance Programs for Nuclear Power Plants	REGDOC-2.6.2	2017	Sep. 1, 2018
CNSC	Aging Management	REGDOC-2.6.3	2014	Dec. 31, 2016
CSA	Periodic inspection of CANDU nuclear power plant components (see Note 1)	N285.4	2009 Edition Update 2 (June 2011)	Dec. 31, 2017
CSA	Periodic inspection of CANDU nuclear power plant containment components	N285.5	2008	Jun. 1, 2015
CSA	Periodic inspection of CANDU nuclear power plant balance of plant systems and components	N285.7	2015	Mar. 29, 2019
CSA	In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants	N287.7	2008	Jun. 1, 2015
CSA	Requirements for safety-related structures for CANDU nuclear power plants (see Note 2)	N291	2015	Jul. 1, 2018

Notes:
1. Where N285.4 refers to N285.8, Bruce Power shall comply with N285.8-15.
2. Exception for implementation of CSA N291-15 is Clause 4.3(f).

Reliability of Systems Important to Safety

REGDOC-2.6.1, RELIABILITY PROGRAM FOR NUCLEAR POWER PLANTS outlines the requirements for a reliability program. This document has replaced RD/GD-98 in the regulatory framework in 2017.

Given that REGDOC-2.6.1 has no material changes to it, where RD/GD-98 is referenced in Bruce Power governing documents, it shall be taken to mean REGDOC-2.6.1. Bruce Power will update the references in their governance on the regular document review cycle.

Maintenance

A NPP maintenance program consists of policies, processes and procedures that provide direction for maintaining SSCs of the plant. The intent of a maintenance program is to ensure that the SSCs remain capable of performing their function as described in the safety analysis. A maintenance program uses organized activities, both administrative and technical, to keep SSCs in good operating condition, and to ensure that they function as per design.

CNSC regulatory document REGDOC-2.6.2, MAINTENANCE PROGRAMS FOR NUCLEAR POWER PLANTS outlines the requirements for a maintenance program. This document has replaced RD/GD-210 in the regulatory framework in 2017.

Given that REGDOC-2.6.2 has no material changes to it, where RD/GD-210 is referenced in Bruce Power governing documents, it shall be taken to mean REGDOC-2.6.2. Bruce Power will update the references in their governance on the regular document review cycle.

Management of Planned Outages

The maintenance program shall include provisions for the management of planned outages. Bruce Power's program related to management of planned outages is documented in the licensee's procedure "Planned Outages".

Accordingly, Bruce Power shall make outage-related information (including Levels 1 and 2 Outage Plans, detailing all major work on safety related SSCs to be carried out during the planned outage) available to CNSC staff. Levels 1 and 2 outage plans are defined in Appendix B.2 – Definitions.

Planned outages represent a key activity that has a high regulatory significance. Therefore a review is required to ensure proper scoping (of safety-related commitments), planning and execution of the commitments (e.g., for heat sinks, dose control, etc.).

Chemistry Control

The chemistry control program shall specify processes, specifications, overall requirements, parameter monitoring, data trending and evaluation to ensure effective control of plant chemistry during operational and lay-up conditions. Bruce Power shall maintain the implementing documents referenced in their chemistry management program that describe the design basis for chemistry control.

Aging Management

CNSC regulatory document REGDOC-2.6.3, AGING MANAGEMENT outlines the requirements related to aging management. SSC-specific aging management programs (also, in some cases, referred to as Life Cycle Management Plans (LCMPs)), shall be implemented in accordance with the overall integrated aging management program framework, and address the attributes of an effective aging management program as listed in REGDOC-2.6.3. The SSC-specific aging management programs (AMPs) or LCMPs are to include structured, forward looking inspection and maintenance schedules requirements to monitor and trend aging effects and any preventative actions necessary to minimize and control aging degradation of the SSCs.

The SSC-specific AMPs or LCMPs identified as WN documents that were submitted in accordance with LC G.2 are licensing basis documents. As such, any changes to these documents will be reviewed by CNSC staff to confirm that they remain within the licensing basis and include all prior licensee commitments with respect to the inspection scope and other relevant commitments related to the continued operation of the nuclear facilities. Administrative or other such changes to the documents are subject to normal notification requirements as indicated in the WN table for this section.

Periodic Inspection and Testing

CSA standards N285.4, PERIODIC INSPECTION OF CANDU NUCLEAR POWER PLANT COMPONENTS and N285.5, PERIODIC INSPECTION OF CANDU NUCLEAR POWER PLANT CONTAINMENT COMPONENTS outline the requirements related to periodic inspections for nuclear pressure retaining and containment systems and components. CSA standard N287.7, IN-SERVICE EXAMINATION AND TESTING REQUIREMENTS FOR CONCRETE CONTAINMENT STRUCTURES FOR CANDU NUCLEAR POWER PLANTS outlines the requirements for in-service examination and testing.

Bruce Power shall carry out the periodic inspections in accordance with the accepted PIP documents. If a deviation from the accepted PIP program is anticipated during inspection planning activities, the licensee shall obtain CNSC acceptance prior to conducting the affected inspections. However, for any findings, discoveries or deviations from the accepted PIP that are identified during an inspection, Bruce Power shall follow organizational governance to provide justification to CNSC in the inspection report submission, based on OPEX and Best Industry Practices. For permanently required exemptions to the requirements of CSA PIP standards, the licensee shall document these exemptions in a revised PIP document and submit to the CNSC for acceptance.

When PIP requirements are addressed exclusively within an aging management or LCMP document, only those elements of the document which directly address the PIP requirements of the governing CSA standard require acceptance from CNSC staff prior to implementation.

As indicated in the Bruce Design Manuals, the fuel channels were designed to meet the intent of section III of ASME Boiler and Pressure Vessel Code. As a planning assumption, the fuel channels were designed and assembled to satisfy function and economic life requirements for at least the equivalent of 210,000 hours of full power operation (i.e., 30 years at a capacity factor of 80%). Demonstration that fuel channels continue to meet the intent of section III of ASME Boiler and Pressure Vessel Code is part of the design basis, which in turn is part of the licensing basis. For operation beyond 210,000 equivalent full power hours (EFPH), the licensee shall provide evidence to demonstrate that the predicted condition of pressure tubes continues to be sufficient to support safe operation. Bruce Power provided this evidence as part of the 2015 licence renewal and requested operation of all units up to 247,000 EFPH. The Commission approved in 2015 operation of all 8 units up to 247,000 EFPH.

*** PARAGRAPH(s) WILL BE NEEDED HERE TO GIVE THE COMMISSION'S DECISION REGARDING THE REQUEST FROM BRUCE POWER TO OPERATE UP TO 300,000 EFPH ***

Specific requirements related to the validation of fracture toughness models to support fuel channel evaluations can be found in section 15.3.

Personnel conducting nondestructive examinations shall be certified in accordance with the edition of CAN/CGSB 48.9712/ISO 9712 currently adopted for use by the National Certification Body (NCB) of Natural Resources Canada for the appropriate examination method. If the NCB does not offer certification for a specific inspection method, the relevant alternate requirements of Clause 5 of CSA N285.4 or Clause 6 of N285.5 shall apply to ensure that personnel are appropriately trained and qualified.

Inspection of Balance of Plant

Bruce Power shall have adequate knowledge of the current state of balance-of-plant (BOP) pressure retaining systems, components and safety-related structures to ensure that they are capable of operating within their design intent and perform required safety functions if called upon. Bruce Power shall implement and maintain inspection program(s) and LCMPs for these systems in keeping with industry best practices.

Specifically, Bruce Power shall develop:

a) an inspection program and LCMPs for safety-significant BOP pressure retaining systems and components; and
b) an inspection program and LCMPs for BOP safety-related structures.

Implementation strategy for CSA N285.7

CSA standard N285.7, PERIODIC INSPECTION OF CANDU NUCLEAR POWER PLANT BALANCE OF PLANT SYSTEMS AND COMPONENTS outlines the requirements related to in-service inspection of balance of plant pressure retaining systems and components. Bruce Power shall submit an implementation plan to transition to a program complying with CSA N285.7-15 by March 29, 2019. Bruce Power is expected to perform detailed assessments to determine the extent of the inspection in accordance with the pre-screening process identified in the CSA standard.

Station Containment Outage and Vacuum Building Outage

CSA standard N287.7 permits a performance-based option to specify the frequency of the Vacuum Building (VB) leakage rate testing in lieu of a prescriptive 12-year testing interval. Under the licensee's periodic inspection program for CSA N287.7, if a performance-based methodology (acceptable to CNSC) to justify the frequency of the VB pressure test is not developed by industry, then Bruce Power is to carry out a test to measure the leakage rate at full design pressure of the VB and inspect the vacuum building concrete structure and components once every twelve (12) years.

Bruce Power is to carry out a test to measure the leakage rate at full design pressure of station containment and inspect the associated concrete structures and components once every six (6) years.

The table below provides the dates for the previous Station Containment Outage (SCO) and Vacuum Building Outage (VBO); the next scheduled dates for SCO/VBO shall not be later than those stated below.

Station	Previous SCO	Next Scheduled SCO	Previous VBO	Next Scheduled VBO
Bruce A	2016 (May) including positive pressure test	2022	2009 (September) including positive pressure test	2021
Bruce B	2015 (April) including positive pressure test	2021	2015 (April) including positive pressure test	2027

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CSA	Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors	N285.8	2015
CSA	Aging management for concrete containment structures for nuclear power plants	N287.8	2015
COG	Interim Implementation Guidelines for CANDU Nuclear Plant Reliability Programs	COG-05-9011	2006

Org	Document Title	Document #	Implementation Plan Submission Date	Version
CSA	Periodic inspection of CANDU nuclear power plant components	N285.4	December 31, 2018	2014
CSA	Periodic inspection of CANDU nuclear power plant containment components	N285.5	December 31, 2018	2013

Reliability of Systems Important to Safety

The licensee should establish a program that includes setting reliability targets, performing reliability assessments, testing and monitoring, and reporting for plant systems whose failure affect the risk of a release of radioactive or hazardous material.

Outage Management

The outage program should have designated criteria that the licensee will follow to confirm that planned and discovery work has been satisfactorily completed during the planned outage, and that all safety-significant SSCs are available to ensure the continued safe operation of the facilities.

CNSC staff located at licensees' site offices should be invited to the restart meetings in order to verify that all appropriate sign-offs for restart of the reactor have occurred.

Aging Management

Bruce Power should maintain a roadmap outlining the programs and procedures that ensure a well-documented overall integrated aging management framework exists.

The licensee should have an adequate knowledge of the current state of the SSCs and should document the knowledge in the SSC-specific AMP or LCMPs. The AMPs and/or LCMPs may include in-service inspections and preventative actions to minimize and limit the effects of aging on the operational reliability and the fitness for service of the SSCs and to effectively manage and maintain the SSCs to meet its intended design function until the end of life.

Whenever a revision to the AMP, SSC-specific AMP or LCMP is submitted to CNSC for review, the licensee should identify whether the revision(s), affects the previously planned inspection and maintenance activities, with supporting technical basis for the change.

Inspection Programs for Balance of Plant

The licensee should document the current status of all of the safety-significant LCMP for BOP pressure-retaining components and an AMP for safety-related structures in the form of AMPs or LCMPs following regulatory requirements. The licensee may elect to use alternative approaches, provided the elements identified in CNSC regulatory document REGDOC-2.6.3 are addressed in an equivalent manner, and are demonstrated to be effective in managing aging. The plans should apply a systematic and integrated approach to establish, implement and improve programs to manage aging and obsolescence of SSCs. SSC-specific LCMPs and AMPs should be implemented in accordance with the licensee's overall integrated AMP framework.

7 SCA – RADIATION PROTECTION

7.1 Radiation Protection Program and Action Levels

Licence Condition 7.1:

The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

Preamble:

The *Radiation Protection Regulations* require that the licensee implement a radiation protection program and also ascertain and record doses for each person who perform any duties in connection with any activity that is authorized by the NSCA or is present at a place where that activity is carried on. This program must ensure that doses to workers do not exceed prescribed dose limits and are kept As Low As Reasonably Achievable (the ALARA principle), social and economic factors being taken into account. Also, the program shall ensure that occupational exposures are ascertained and recorded in accordance with the *Radiation Protection Regulations* through the establishment of dosimetry requirements.

Note that the regulatory dose limits to workers and the general public are explicitly provided in the *Radiation Protection Regulations*.

Action Levels (ALs) relate to the parameters of dose to workers and surface contamination levels. ALs are designed to alert licensees before regulatory dose limits are reached. By definition, if an AL referred to in a licence is reached, a loss of control of some part of the associated radiation protection program may have occurred, and specific action is required, as defined in the *Radiation Protection Regulations* and the licence. ALs are not intended to be static and are to reflect operating conditions in the station.

Administrative Dose Limits (ADLs) are the licensee's internal dose limits designed to ensure individuals do not exceed regulatory dose limits. ADLs that are exceeded without prior approval from the designated licensee authority are reported as AL exceedances in accordance with the *Radiation Protection Regulations*.

The *Radiation Protection Regulations* specify the requirements related to ALs and indicate that the licence will be used to identify their notification timeframes. For this licence, the ALs are provided in the CVC below.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Radiation Protection Program	BP-PROG-12.05	Prior to Implementation
ALARA Program	BP-RPP-00044	At Implementation

Document Title	Document #	Notification
Dosimetry Requirements	BP-PROC-00280	Prior to Implementation
Dose Limits and Exposure Control	BP-RPP-00009	Prior to Implementation

The current ALs and ADLs for Bruce A and B (including the CMLF) are summarized in the tables below for convenience.

The ALs shown in the following table are taken from the "Actions Levels" appendix of Bruce Power's document "Radiation Protection Program":

Bruce Power Action Levels				
Description	**Bruce A and B**	**CMLF and Class II Nuclear Facility**	**Nuclear Substances and Radiation Devices**	**Notes**
Unplanned External Exposure	2 mSv (200 mrem) or more above planned dose	250µSv (25 mrem) or more above planned dose	2 mSv (200 mrem) or more above planned dose	Unplanned external exposure is per shift and above the value of the Dose Control Device back-out level. For an individual that is not working on a Radiation Exposure Permit (i.e. a back-out limit has not been established), the back-out level is considered to be 0 millisieverts (0 millirem).
Unplanned Internal Exposure – Tritium	Unplanned committed effective dose* of 2 mSv (200 mrem) or more	n/a	n/a	Unplanned internal exposure from Tritium is per shift and above the planned tritium dose level. For an individual that is not working on a Radiation Exposure Permit, the planned dose level is considered to be 0 millisieverts (0 millirem).
Unplanned Internal Exposure – Non-Tritium	Unplanned committed effective dose* of 2 mSv (200 mrem) or more	n/a	n/a	Internal exposure - Non-Tritium encompasses all other nuclear substances (e.g. fission products, activation products, transuranics) taken into the body that result in committed effective doses above the recordable level. Unplanned internal exposure - Non-Tritium is the total dose above an approved planned level during a 1 year dosimetry period. If a planned dose is not established in an approved Radiation Exposure Permit then the back-out level is considered to be 0 millisieverts (0 millirem). Both unplanned acute and unplanned chronic low level uptakes that exceed 2 mSv/y above an approved planned level are considered AL exceedances (e.g. four unplanned exceedances within a calendar year with a committed effective dose assignment 0.5 mSv/each would be considered an AL exceedance).

Accumulated Dose	Exceeding an ADL without prior approval			Internal exposure - Non-Tritium encompasses all other nuclear substances (e.g. fission products, activation products, transuranics) taken into the body that result in committed effective doses above the recordable level. Accumulated doses that are to be compared with the ADLs include doses received at all places of employment during the dose period as defined in the table below. ADLs are defined in the Bruce Power document BP-RPP-00009, Dose Limits and Exposure Control.
Beta-Gamma surface Contamination in Zone 1	Total: Greater than 3.7 Bq/cm^2	n/a	n/a	Beta-gamma contamination that exceeds 3.7 Bq/cm^2 normally calculated over a 100 cm^2 reference area on any surface in those areas deemed equivalent to the public domain (e.g. Zone 1) within the licensed facility.
Alpha Surface Contamination in Zone 1	Total : Greater than 0.05 Bq/cm^2	n/a	n/a	Alpha contamination that exceeds 0.05 Bq/cm^2 (300 dpm/100 cm^2) normally calculated over a 100 cm^2 reference area on any surface in those areas deemed equivalent to the public domain (e.g. Zone 1) within the licensed facility.

* *Committed Effective Dose is calculated from the time of intake.*

The ADLs shown in the following table are taken from the Bruce Power document BP-RPP-00009, Dose Limits and Exposure Control:

Administrative Dose Limits (ADL)			
Category of Worker	**Dose Period**	**Employees**	**Contractors**
Nuclear Energy Worker (NEW)	One-year dosimetry period	20 mSv	40 mSv
	Five-year dosimetry period	50 mSv	90 mSv
Pregnant NEW	Balance of pregnancy	0.5 mSv	0.5 mSv
Non-NEW	One calendar year	0.5 mSv	0.5 mSv

Estimated Dose to Public

The *Radiation Protection Regulations* prescribe the radiation dose limits for the general public of 1 mSv per calendar year. The licensee reports the estimated dose to the public from the Pickering site annually, in accordance with REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* (See LC 3.3), in the Environmental Protection report.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CNSC	Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable (ALARA)"	G-129	2004
CNSC	Developing and Using Action Levels	G-228	2001

CNSC guidance document G-129, KEEPING RADIATION EXPOSURES AND DOSES "AS LOW AS REASONABLY ACHIEVABLE (ALARA)" provides the licensee guidance for developing, implementing and maintaining a radiation protection program to ensure that exposures will be ALARA.

CNSC guidance document G-228, DEVELOPING AND USING ACTION LEVELS provides the licensees guidance for developing ALs in accordance with the *General Nuclear Safety and Control Regulations* and section 6 of the *Radiation Protection Regulations*.

The licensee should conduct a documented review and, if necessary, revise the ALs specified above at least once per licence period in order to validate their effectiveness. The results of such reviews should be provided to CNSC staff.

8 SCA – CONVENTIONAL HEALTH AND SAFETY

8.1 Conventional Health and Safety Program

Licence Condition 8.1:

The licensee shall implement and maintain a conventional health and safety program.

Preamble:

The *Class I Nuclear Facilities Regulations* requires that an application for a licence to operate a Class I nuclear facility contain the proposed worker health and safety policies and procedures.

NPPs in Ontario are regulated by the *Ontario Occupational Health and Safety Act* and the *Labour Relations Act*.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Health and Safety Management	BP-PROG-00.06	At Implementation

Bruce Power's "Health and Safety Management Program", a licensee document listed in the written notification table, describes the occupational health and safety practices at the Bruce site. The *Ontario Occupational Health and Safety Act* contains the detailed regulatory requirements for workplace health and safety in Ontario.

Guidance:

Not applicable to this LC.

9 SCA – ENVIRONMENTAL PROTECTION

9.1 Environmental Protection Program

Licence Condition 9.1:

The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

Preamble:

The *Class I Nuclear Facilities Regulations* set out requirements related to environmental protection that must be met by the applicant for a licence to operate a Class I nuclear facility.

The *General Nuclear Safety and Control Regulations* require every licensee to take all reasonable precautions to protect the environment and to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity.

The *Radiation Protection Regulations* prescribe radiation dose limits for the general public of 1 mSv per calendar year.

Derived Release Limits (DRLs) are calculated or derived using environmental transfer modeling that describes transfer of radioactive materials through environmental pathways to humans. DRLs are required for the purpose of protecting members of the public from unreasonable risk resulting from releases of radionuclides into the environment from the normal operation of the licensed facility.

Licensees set Environmental Action Levels (EAL) and related parameters, so as to provide early warnings of any actual or potential losses of control of the Environmental Protection Program. EALs are precautionary levels and are set far below the actual DRLs. EALs are designed to alert licensees before DRLs are reached. They are required by regulations to be specific doses of radiation or other parameter that, if reached, may indicate a loss of control of the licensee's Environmental Protection Program.

The *Radiation Protection Regulations* specify requirements related to "Action Levels" and indicate that the licence will be used to identify the action levels and the notification timeframes.

The release of hazardous substances is regulated by both the Ministry of Environment and Climate Change (MOECC) and Environment Canada and Climate Change (ECCC) through various acts and regulations, as well as the CNSC.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Environmental Management	BP-PROG-00.02	Prior to Implementation
Derived Release Limits and Action Levels for Bruce Nuclear Generating Station A	NK21-REP-03482-00002	Prior to Implementation
Derived Release Limits and Action Levels for Bruce Nuclear Generating Station B	NK29-REP-03482-00003	Prior to Implementation
Derived Release Limits and Action Levels for Central Maintenance and Laundry Facility	NK37-REP-03482-00001	Prior to Implementation
Radiological Emissions Limits and Action Levels	BP-PROC-00171	Prior to Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Environmental Protection: Environmental Principles, Assessments and Protection Measures	REGDOC-2.9.1, Version 1.1	2017	Dec. 31, 2020
CSA	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	N288.1	2014 Update No. 2 (Nov. 2017)	Dec. 31, 2020
CSA	Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills	N288.4	2010	Dec. 31, 2018
CSA	Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills	N288.5	2011	Dec. 31, 2018
CSA	Environmental risk assessment at Class I nuclear facilities and uranium mines and mills	N288.6	2012	Dec.31, 2018
CSA	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	N288.7	2015	Dec.31, 2020

Environmental Management System (EMS)

The objective of the environmental protection policies, programs and procedures is to establish adequate provision for protection of the environment at Class I nuclear facilities and uranium mines and mills. This shall be accomplished through an integrated set of documented activities that are typical of an environmental management system (EMS).

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

CNSC regulatory document REGDOC-2.9.1, ENVIRONMENTAL PROTECTION: ENVIRONMENTAL PRINCIPLES, ASSESSMENTS AND PROTECTIVE MEASURES outlines the requirements related for an environmental protection program. Bruce Power's governing document "Environmental Management" is the key document of the environmental protection program.

Bruce Power is proceeding with the implementation REGDOC 2.9.1, Version 1.1 in accordance with the implementation plan below.

Bruce Power is in compliance with all requirements of REGDOC 2.9.1, Version 1.1 with two exceptions:

1) There is currently no industry "best practice" for the assessment of risks related to non-human biota and there are gaps in Bruce Power's Environmental Management System (EMS) in this regard. These gaps will be addressed with implementation of the CSA N288 series.
2) Administrative documentation updates are required.

Implementation strategy for REGDOC-2.9.1, Version 1.1

Bruce Power plans to be in full compliance with REGDOC-2.9.1, Version 1.1 by December 31, 2020.

Assessment and Monitoring

CSA standard N288.4, ENVIRONMENTAL MONITORING PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS outlines the requirements for an environmental monitoring program. This document was revised in May 2010 to include radioactive and hazardous substances, physical stressors, potential biological effects, and pathways for both human and non-human biota.

An EMP consists of a risk-informed set of integrated and documented activities to sample, measure, analyze, interpret, and report the following:

- the concentration of hazardous and/or nuclear substances in environmental media to assess one or both of
    - exposure of receptors to those substances; and
    - the potential effects on human health, safety, and the environment;
- the intensity of physical stressors and/or their potential effect on human health and the environment; and
- the physical, chemical, and biological parameters of the environment normally considered in design of the EMP.

Bruce Power's Environmental Monitoring Program shall ensure compliance with CSA N288.4, in accordance with the implementation plan below.

Implementation strategy for CSA N288.4

Bruce Power is currently targeting December 31, 2018 to be in full compliance with CSA N288.4, ENVIRONMENTAL MONITORING PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS.

CSA standard N288.7, GROUNDWATER PROTECTION PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS provides requirements and guidance which facilitate groundwater protection at Class I nuclear facilities and uranium mines and mills. Compliance with N288.7 will allow facilities to demonstrate that they will not pose an unreasonable risk to the environment or the health and safety of humans and non-human biota from groundwater. N288.7 addresses the design, implementation, and management of a groundwater protection program that incorporates best practices in Canada and internationally.

Bruce Power shall ensure compliance with CSA N288.7 in accordance with the implementation plan below.

Implementation strategy for CSA N288.7

Bruce Power submitted an implementation plan in December 2017 and will be in full compliance with CSA N288.7, GROUNDWATER PROTECTION PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS by Dec 31, 2020.

Effluent and Emissions Control (Releases)

The licensee shall ensure effluent monitoring for nuclear and hazardous substances is designed, implemented and managed to respect applicable laws and to incorporate best practices. The effluent monitoring program shall incorporate airborne and waterborne effluents.

CSA standard N288.5, EFFLUENT MONITORING PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS outlines the requirements for an effluent monitoring program. Bruce Power shall ensure effluent monitoring sub-program for nuclear and hazardous substances is designed, implemented and managed to respect applicable laws and to incorporate best practices. The effluent monitoring program shall incorporate airborne and waterborne effluents. Effluent monitoring is a risk-informed activity that is to quantify or estimate the nuclear and hazardous substances being released into the environment.

Bruce Power's Effluent Monitoring Program shall ensure compliance with CSA N288.5 in accordance with the implementation plan below.

Implementation strategy for CSA N288.5

Bruce Power is targeting to be in full compliance with N288.5, EFFLUENT MONITORING PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS by December 31, 2018.

<u>Nuclear Substances – Derived Release Limits (DRLs)</u>

Bruce Power shall control radiological emissions to ALARA, within the Derived Release Limits (DRLs), and take action to investigate cause(s) and correct the cause(s) of increased emissions.

CSA standard N288.1, GUIDELINES FOR CALCULATING DERIVED RELEASE LIMITS FOR RADIOACTIVE MATERIAL IN AIRBORNE AND LIQUID EFFLUENTS FOR NORMAL OPERATION OF NUCLEAR FACILITIES outlines the requirements related to DRLs. Bruce Power shall ensure compliance with CSA N288.1 in accordance with the implementation plan below.

Implementation strategy for CSA N288.1

Bruce Power will be in full compliance with CSA N288.1 (2014, Update No. 2, Nov. 2017) by December 31, 2020.

The DRLs are considered part of the licensing basis. Changes to these limits are subject to LC G.1. The DRLs for Bruce A and Bruce B nuclear facilities and the Central Maintenance and Laundry Facility (CMLF) are summarized in the table below. In the event of a discrepancy between these tables below and the licensee documentation upon which they are based, the licensee documentation shall be considered the authoritative source (assuming that the licensee has followed its own change control process).

Derived Release Limits				
		Bruce A	**Bruce B**	**CMLF**
Release Category	Radionuclide/Radionuclide Group[1]	DRL(Becquerel/year)		
Air	Tritium	1.98E+17	3.16E+17	2.45E+17
	Carbon-14	6.34E+14	7.56E+14	n/a
	Iodine (mixed fission products)	1.14E+12	1.35E+12	1.31E+12
	Noble Gases[2]	1.12E+17	2.17E+17	n/a
	Particulate (Alpha)	2.96E+11	5.77E+11	4.40E+11
	Particulate (Beta/Gamma)	1.73E+12	3.61E+12	3.03E+12
Water[3, 4]	Tritium	2.30E+18	1.84E+18	n/a
	Carbon-14	1.03E+15	1.16E+15	n/a
	Gross Alpha	1.12E+14	1.21E+14	n/a
	Gross Beta/Gamma	4.58E+13	5.17E+13	n/a

Notes:
[1] Individual DRLs are calculated for about 118 radionuclides and isotopes. Only the significant radionuclide groups which are given in the table are monitored and reported to the CNSC.
[2] The unit DRL for Noble gases is in Bq-MeV/year
[3] The Bruce A waterborne DRLs are based on the flow rate of 156 m^3/s condenser cooling water (CCW).
[4] The Bruce B waterborne DRLs are based on the flow rate of 168 m^3/s CCW, representing 12 pump design flow.

These DRLs for radionuclides and radionuclide groups account for the most significant releases and are the focus of monitoring and reporting requirements.

Hazardous Substances

Bruce Power shall control hazardous substances releases according to the limits defined in the licensing basis in accordance with the applicable environmental compliance approvals and take action to investigate and correct the cause(s) of increased emissions. Under the jurisdiction of MOECC and ECCC, Bruce Power prepares routine environmental reports at different frequencies.

Environmental Action Levels

The current Environmental Action Levels (EALs) for the licensed facility for both the Bruce A and B nuclear facilities (including the CMLF) are given in the following table:

Environmental Action Levels

Release Category	Radionuclide	**Bruce A Gaseous** releases (Becquerel/week)	**Bruce B Gaseous** releases (Becquerel/week)	**CMLF Gaseous** releases (Becquerel/week)
Air	Tritium (HTO)	3.97E+14	6.32E+14	4.89E+14
	Iodine (mfp)	2.27E+09	2.71E+09	2.62E+09
	Carbon-14	1.27E+12	1.51E+12	n/a
	Noble Gases*	2.23E+14	4.34E+14	n/a
	Particulate – Gross Beta – Gamma	3.46E+09	7.22E+09	6.06E+09
	Particulate – Gross Alpha	5.92E+08	1.15E+09	8.81E+08
Release Category	Radionuclide	**Liquid** releases (Becquerel/month per kg/month of CCW)	**Liquid** releases (Becquerel/month per kg/month of CCW)	**Liquid** releases (Becquerel/month per kg/month of CCW)
Water	Tritium (HTO)	4.48E+04	3.33E+04	n/a
	Carbon-14	2.01E+01	2.10E+01	n/a
	Gross Alpha	2.18E+00	2.19E+00	n/a
	Gross Beta-Gamma	8.94E-01	9.37E-01	

** Units for noble gas action level are Bq-MeV/week*

The established EALs are based on a uniform public dose level of 2 µSv/week and 8µSv/month for each monitored airborne and waterborne radionuclide/group emission respectively. The EALs are considered safety and control measures.

Environmental Risk Assessment

CSA standard N288.6, ENVIRONMENTAL RISK ASSESSMENT AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS outlines the requirements for an environmental risk assessment. This specific area provides assessment of environmental risks associated with contaminants and physical stressors in the environment relevant to nuclear facilities, and to the short-term and long-term safety of human health and the environment.

The ERA provides the basis for the environmental monitoring program (CSA standard N288.4) and also the effluent monitoring program (CSA standard N288.5), including Radiological Environmental Monitoring Programs. The ERA shall be updated periodically with the results from the environmental and effluent monitoring programs in order to confirm the effectiveness of any additional mitigation measures needed.

Implementation strategy for CSA N288.6

Bruce Power submitted an Environmental Risk Assessment (ERA) in 2015 and a revised ERA in 2017 as a supplement to its licence application which was consistent with the requirements of CSA N288.6. Bruce Power will use the ERA findings to develop and implement compliance plans for CSA N288.4 and N288.5.

Bruce Power plans to be in full compliance with CSA N288.6 by December 31, 2018.

Protection of the public

See LCH Section 7.1, Radiation Protection under the sub-title Estimated Dose to the Public.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CSA	Establishing and implementing action levels for releases to the environment from nuclear facilities	N288.8	2017

10 SCA – EMERGENCY MANAGEMENT AND FIRE PROTECTION

10.1 Emergency Preparedness Program

Licence Condition 10.1:

The licensee shall implement and maintain an emergency preparedness program.

Preamble:

Paragraph 6(k) of the *Class I Nuclear Facilities Regulations* requires that an application for a licence to operate a Class I nuclear facility contain information on the licensee's proposed mitigating measures for onsite and offsite events. This includes measures to prevent or mitigate the effects of accidental releases of nuclear and hazardous substances to the environment, to protect the health and safety of persons, to ensure the maintenance of national security, as well as measures to assist offsite planning authorities regarding an accidental release for:

- planning and preparing to limit the effects;
- notification;
- reporting of information during and after;
- assisting offsite authorities with dealing with effects; and
- testing the implementation of the measures to prevent or mitigate the effects.

In addition to the nuclear emergency plan, the licensee maintains a set of emergency operating procedures and abnormal plant operating procedures. This aspect is covered under LC 3.1.

A security response to malevolent acts is governed by a separate plan under the licensee's Nuclear Security program (LC 12.1) but provisions of the licensee's site security report apply to any associated potential threat of release of radioactive material - for example, the need for offsite notification, situation updates and confirmation of any radioactive releases.

Liquid emission response and radioactive materials transportation emergency response are also governed by separate plans (LCs 9.1 and 14.1).

CNSC regulatory document REGDOC-2.10.1, NUCLEAR EMERGENCY PREPAREDNESS AND RESPONSE replaced CNSC regulatory document RD-353, TESTING AND IMPLEMENTATION OF EMERGENCY MEASURES and CNSC regulatory guide G-225, EMERGENCY PLANNING AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES in October 2014.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Bruce Power Nuclear Emergency Response Plan	BP-PLAN-00001	Prior to Implementation
Radioactive Materials Transportation Emergency Response Plan	BP-PLAN-00005	At Implementation
Emergency Management Program	BP-PROG-08.01	At Implementation
Updated Emergency Planning Technical Basis for Provincial Nuclear Emergency Response Plan	B-03490-31MAR2017	Prior to Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Nuclear Emergency Preparedness and Response	REGDOC-2.10.1	2014	Aug. 31, 2018

CNSC regulatory document REGDOC-2.10.1 outlines the requirements for an emergency preparedness program.

Clause 2.2.6(4) of REGDOC-2.10.1 is satisfied by the current location of Bruce Power's Emergency Management Centre with supporting procedures on security and communications arrangements as described in the clause.

The emergency preparedness program is documented in Bruce Power's Nuclear Emergency Response Plan. Bruce Power shall maintain equipment, procedures and staff to support offsite response activities for an accidental release. Infrastructures defined within may be used in planning and response to virtually all emergencies. Bruce Power's Nuclear Emergency Response Plan also represents a basis for controlling changes and modifications to the emergency preparedness program.

In accordance with section 2.3.3 of REGDOC-2.10.1, the licensee shall test all requirements listed in this REGDOC over a five-year period, with a full-scale integrated emergency testing exercise at least once every three years involving, at a minimum, regional and provincial offsite authorities. To meet this requirement, Bruce Power shall conduct emergency exercises and drills as described in their Nuclear Emergency Response Plan. In most areas, drills and/or exercises are required at least annually. A corporate exercise is held annually at either the Bruce A or B nuclear facility. A "site evacuation" is held every three years and alternates between the two nuclear facilities. Annual exercises are also conducted at other facilities, such as hospitals and offsite centres by mutual agreement. Participation by municipal and provincial emergency response groups is also scheduled by mutual agreement.

In accordance with section 2.1 of REGDOC-2.10.1, the licensee is required to provide regional and provincial offsite authorities with the necessary information to allow for effective emergency planning policies and procedures to be established and modified, if needed or on a periodic basis. This information to include an estimate of the associated radiological consequences, including isotopic release quantities (source term), possible release start time and duration and the geographical area potentially affected. See LCH Section 4.1 for more information on severe accident analysis.

The CNSC will update federal authorities of updates to the licensee's Emergency Planning Technical Basis.

The licensee shall implement and maintain an automated (collected and posted without human intervention) data sharing system for the CNSC EOC, with near real-time (at 15 minute interval or less) posting of a set of pre-determined plant data, with web-based access for viewing and trending, including the ability to download to support CNSC response mandate.

Implementation Strategy for REGDOC-2.10.1

Bruce Power provided a gap analyses and submitted an implementation plan to the CNSC on June 29, 2015. The target date for full compliance to REGDOC-2.10.1 is August 31, 2018.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CNSC	Accident Management, Version 2	REGDOC-2.3.2	2015
CNSC	Nuclear Emergency Preparedness and Response, Version 2	REGDOC-2.10.1	2016
CSA	General requirements for nuclear emergency management programs	N1600	2016

The licensee should provide emergency communications outlining what surrounding community residents need to know and do before, during and after a nuclear emergency. Information should be in plain language, readily accessible and include the following:

- how the public is notified of an emergency;
- what protective actions may be required during an emergency;
- what the public is expected to do, and why, when directed to take protective actions;
- what the public can do now to be better prepared for an emergency;
- where can the public get more information on emergency plans.

10.2 Fire Protection Program

Licence Condition 10.2:

The licensee shall implement and maintain a fire protection program.

Preamble:

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

Fire protection provisions are applicable to all work related to the design, construction, operation, and maintenance of the nuclear facility, including systems, structures and components (SSCs) that directly support the plant and the protected area. External events such as an aircraft crash or threats are dealt under LC 12.1.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Fire Safety Management	BP-PLAN-00008	At Implementation
Conventional Emergency Plan	BP-PLAN-00006	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CSA	Fire protection for CANDU nuclear power plants	N293	2012	June 1, 2015

CSA standard N293, FIRE PROTECTION FOR CANDU NUCLEAR POWER PLANTS outlines the requirements for a fire protection program.

An implementation strategy for CSA N293-12 is not required since Bruce Power is compliant with the programmatic and operational requirements of CSA N293-12. The requirements for a revised Code Compliance Review, Fire Hazard Assessment and Fire Safety Shutdown Analysis did not change from CSA N293-07 to N293-12; N293-12 simply provided additional clarification on the requirements.

Due to the date of construction of the Bruce facilities versus the date of issuance of the codes (1970's vs. 2012) a number of historical design related non-conformances were identified. Bruce Power has submitted a revised Code Compliance Review, Fire Hazard Assessment and Fire Safety Shutdown

Analysis to the CNSC, as well as implementation dates for the remaining plant upgrades to address these design non-conformances. The implementation plan to complete this work was submitted to CNSC staff in October 2014 and has been accepted by CNSC staff. Bruce Power shall provide CNSC staff with annual updates until such time as the implementation plan is completed and this is being tracked under Action Item 1207-3890.

CNSC staff have accepted Bruce Power's Integrated Implementation Project (IIP), which includes details of the Fire Protection Capital Project. Updates to the Fire Protection Capital Project will be provided as a part of IIP communication.

Bruce Power shall arrange for third party audits of one industrial fire brigade fire drill once every two years, alternating between stations on an annual cycle. The purpose of a Third Party Audit is to provide an in-depth analysis of the Industrial Fire Brigade's (IFB) fire response performance against applicable regulatory criteria. A fire response is a planned, coordinated and controlled activity to provide emergency response to a fire. The audit is to analyze and ensure competencies of the IFB against CSA standard N293. The resulting audit report shall be submitted to CNSC staff for review.

An independent third party auditor is required to be an expert in their discipline, normally fire-fighting and qualified through specific education and relevant experience. The third party auditor is required to be independent or at "arm's length" from the facility to ensure total impartiality. The review shall be of sufficient depth and detail that the reviewer can attest with reasonable confidence on the competencies of the IFB at the facility.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
NEI	Guidance for Post Fire Safe Shutdown Circuit Analysis	NEI 00-01	Rev. 2 (2009)

The Nuclear Energy Institute NEI 00-01 "Guidance for Post Fire Safe Shutdown Circuit Analysis" is used by CNSC staff to help determine the adequacy of safe shutdown electrical circuit analysis.

Expectation for the Third Party Audit Report

The results of the audits will typically consist of reports that compare the requirements of the applicable codes and standards with the implementation of the Fire Protection Program and the Fire Response exercised. The report should identify any non-compliance and formulate a conclusion if the licensee's program and IFB meet the requirements of the standards referenced in the facilities licence. The format of the submission is not specified and can be tailored to the facility. However, as a guideline the following suggestions for the content and format of the written report are provided as follows:

1. Cover page with the name of the facility, date and signature of the authors;
2. Name, address, phone number, of the preparing agency or organization;
3. Names of review team members, including brief descriptions of experience and education;
4. Name, address, and phone number of licensee;
5. Title of report, date, and document number;
6. Introduction briefly describing the area of interest that is audited;

7. Statement of review scope specifically listing any exclusions;
8. Objectives of the review;
9. A list of applicable codes and standards;
10. Summary of the review methodology, including areas and documents reviewed;
11. Detailed observations with relation to standard requirements against the observed response;
12. Conclusions, including a statement that the program or the IFB response meet the requirements of the applicable standards, achieves their objectives, and a summary of any non-compliances;
13. Recommendations (if any); and
14. An issues tracking table.

11 SCA – WASTE MANAGEMENT

11.1 Waste Management Program

Licence Condition 11.1:

The licensee shall implement and maintain a waste management program.

Preamble:

The *General Nuclear Safety and Control Regulations* require that a licence application contain information related to the in-plant management of radioactive waste or hazardous waste resulting from the licensed activities.

The *Class I Nuclear Facilities Regulations* require that an application for a licence to operate a Class I nuclear facility contain the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances.

This LC covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. Topics include waste management, waste characterization, waste minimization and waste management practices.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Nuclear Fuel Management	BP-PROG-12.03	At Implementation

Bruce Power's Radioactive Waste Management Procedure contains the safety and control measures. The procedure expands on program-level requirements by describing the requirements and processes governing segregation, collection, processing, packaging, transport, storage and handling of irradiated fuel, or transfer to dry storage containers or licensed waste management facility for storage, which are safety and control measures addressed by Bruce Power's Fuel Handling Procedure.

Bruce Power shall:

- characterize its waste streams and minimize the production of all wastes taking into consideration the health and safety of workers and the environment;
- integrate waste management programs as a key element of the facility's safety culture; and
- audit on a regular basis its program to maximize its efficiency.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CSA	General principles for the management of radioactive waste and irradiated fuel	N292.0	2014
CSA	Interim dry storage of irradiated fuel	N292.2	2013
CSA	Guideline for the exemption of clearance from regulatory control of materials that contain, or potentially contain, nuclear substances	N292.5	2011

Org	Document Title	Document #	Implementation Plan Submission Date	Version
CSA	Management of low- and intermediate-level radioactive waste	N292.3	September 1, 2018	2014

With respect to the storage and management of spent nuclear fuel, it should reflect the fundamental safety concerns related to criticality, exposure, heat control, containment and retrievability. Namely, the systems that are designed and operated should assure subcriticality, control of radiation exposure, assure heat removal, assure containment and allow retrievability.

11.2 Decommissioning and Financial Guarantees

Licence Condition 11.2:

The licensee shall notify the Commission of any changes regarding the obligations of decommissioning and financial guarantees under the Lease Agreement with Ontario Power Generation Inc. as described in 15.1.

Preamble:

The *Class I Nuclear Facilities Regulations* require that an application for a licence to operate a Class I nuclear facility contain the proposed plan for decommissioning of the nuclear facility. The decommissioning plan includes strategies for the management of low and intermediate level waste, reactor and waste storage facility decommissioning, and the used fuel arising from the operation of the nuclear facility.

The *General Nuclear Safety and Control Regulations* requires that a licence application contain a description of any proposed financial guarantee relating to the activity to be licensed.

Compliance Verification Criteria:

Ontario Power Generation Inc. (OPG) is responsible for the decommissioning plan and strategies of the Bruce nuclear facilities; however, Bruce Power shall provide a status update with the licence renewal application.

OPG is also responsible for all costs of decommissioning of the Bruce nuclear facilities. All such costs are included in the Decommissioning Cost Estimates and are covered by OPG's consolidated financial guarantee for decommissioning.

In terms of operational financial guarantees, Bruce Power Limited Partnership maintains an Investment Grade Credit Rating for the operation of the Bruce nuclear facilities. Bruce Power shall inform CNSC staff in writing **within forty-five days** of any changes to this credit rating.

Guidance:

Not applicable to this LC.

12 SCA – SECURITY

12.1 Nuclear Security Program

Licence Condition 12.1:

The licensee shall implement and maintain a security program.

Preamble:

The *General Nuclear Safety and Control Regulations* require that an application for a licence to operate a Class I nuclear facility contain information related to site access control and measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information.

The *Class I Nuclear Facilities Regulations* require that an application for a licence to operate a Class I nuclear facility contain the proposed measures to prevent acts of sabotage or attempted sabotage at the nuclear facility.

The *Nuclear Security Regulations* require that a licence application contain specific information related to nuclear security, stipulates the requirements for high-security sites, and contains specific requirements pertaining to the transportation of Category I, II or III nuclear material.

The *Nuclear Security Regulations* require that a licensee of a high security site:

- maintain at all times a qualified onsite nuclear response force;
- obtain the applicable certifications, before issuing an authorization to a nuclear security officer;
- prevent and detect unauthorized entry into a protected area or inner area; and
- prevent unauthorized entry of weapons and explosive substances into a protected area or inner area.

The *Nuclear Security Regulations* require every licensee to: conduct, at least once every 12 months, a threat and risk assessment specific to a facility where it carries on licensed activities in order to determine the adequacy of its physical protection system; make modifications to its physical protection system, as necessary, to counter any credible threat identified as a result of the threat and risk assessment; keep a written record of each threat and risk assessment that it conducts and provide a copy of the written record, together with a statement of actions taken as a result of the threat and risk assessment, to the Commission upon request (within 60 days) after completion of the assessment.

CNSC regulatory document REGDOC-2.12.1 describes how, when required by a CNSC licence or order, a trained and equipped onsite nuclear response force shall be established and deployed at a nuclear facility.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Nuclear Security	BP-PROG-08.02	Prior to Implementation
Cybersecurity	BP-PROC-00784	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	High Security Sites: Nuclear Response Force	REGDOC-2.12.1	2013	June 1, 2015
CNSC	Site Access Security Clearance	REGDOC-2.12.2	2013	June 1, 2015
CNSC	Security of Nuclear Substances: Sealed Sources	REGDOC-2.12.3	2013	Sep. 1, 2018
CNSC	Nuclear Security Officer Medical, Physical, and Psychological Fitness	RD-363	2008	June 1, 2015
CNSC	Criteria for Physical Protection Systems and Devices at High-Security Sites	RD-321	2010	June 1, 2015
CNSC	Criteria for Explosive Substance Detection, X-Ray Imaging and Metal Detection Devices at High-Security Sites	RD-361	2010	June 1, 2015
CSA	Cyber security for nuclear power plants and small reactor facilities	N290.7	2014	Dec. 31, 2020

Nuclear Security Program

CNSC regulatory documents REGDOC-2.12.1, RD-363, RD-321 and RD-361 outline the requirements related to a nuclear security program.

Bruce Power shall ensure the identified vital areas within the nuclear facilities are protected against design basis threats and any other credible threat identified in their Threat and Risk Assessment documentation. The prime functions that must be maintained to prevent unacceptable radiological consequences are those of control, cool, and contain.

Bruce Power shall maintain the operation, design and analysis provisions credited in the above assessments required to ensure adequate engineered safety barriers for the protection against malevolent acts. The provisions for the protection against malevolent acts shall be documented as part of a managed program or process within the management system. Bruce Power shall summarize changes in design, analysis or operational procedures which are credited for the protection against malevolent acts in the annual threat and risk assessment, and submit a copy to the Commission 60 days after completion of the assessment.

All detection devices shall be installed, operated and maintained in accordance with manufacturers' specifications and meet the criteria in RD-321 and RD-361.

Bruce Power shall implement measures for the purpose of preventing and detecting unauthorized entry into a protected area or inner area at a high-security site, including:

- vehicle barriers and vehicle access control points;
- intrusion detection systems and devices;
- closed-circuit video systems/devices for applications in a protected area or inner area;
- the design and functioning of security monitoring rooms; and
- the security monitoring room systems and devices.

CNSC staff will assess the changes to the site security program to determine if a recommendation to update the Station Security Reports would be required.

The licensee shall meet the security measures for sealed sources as set out in Regulatory Document REGDOC-2.12.3, *Security of Nuclear Substances: Sealed Sources*, as amended from time to time.

Cybersecurity Program

Bruce Power's cybersecurity program shall be implemented and maintained to protect the cyber-critical assets for nuclear safety, physical protection and emergency preparedness functions from cyber-attacks. CSA standard N290.7, CYBER SECURITY FOR NUCLEAR POWER PLANTS AND SMALL REACTOR FACILITIES outlines the requirements for a cybersecurity program. Bruce Power shall transition to the 2014 version of CSA standard N290.7 by December 31, 2020.

The cybersecurity program includes the following elements:

- roles and responsibilities;
- policies and procedures;
- staff training and awareness;
- overall approach to cybersecurity;
- configuration management;
- incident response and recovery;
- periodic self-assessments;
- security controls;
- identification and classification of cyber-critical assets.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CNSC	Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities	G-274	2003
CNSC	Transportation security Plans for Category I, II or III Nuclear Material	G-208	2003
IAEA	Engineering Safety Aspects of the Protection of Nuclear Power Plants Against Sabotage	IAEA Nuclear Security Series No. 4 Technical Guidance	2007
IAEA	Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5)	IAEA Nuclear Security Series No. 13	2011
IAEA	Computer Security at Nuclear Facilities	IAEA Nuclear Security Series No. 17 Technical Guidance	2011

CNSC guidance document G-274, SECURITY PROGRAMS FOR CATEGORY I OR II NUCLEAR MATERIAL OR CERTAIN NUCLEAR FACILITIES provides guidance for preparing, submitting and revising the Station Security Report. CNSC guidance document G-208, TRANSPORTATION SECURITY PLANS FOR CATEGORIES I, II, OR III NUCLEAR MATERIAL provides guidance to licensee on how to prepare and submit a "written transportation security plan".

Guidance may be obtained in the IAEA Nuclear Security Series No. 4, Technical Guidance "Engineering Safety Aspects of the Protection of Nuclear Power Plants Against Sabotage" and IAEA Nuclear Security Series No. 13 "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5)" for developing and maintaining a security program.

Guidance may be obtained in the IAEA Nuclear Security Series No. 17, Technical Guidance "Computer Security at Nuclear Facilities" for developing and maintaining a cybersecurity program.

13 SCA – SAFEGUARDS AND NON-PROLIFERATION

13.1 Safeguards Program

Licence Condition 13.1:

The licensee shall implement and maintain a safeguards program.

Preamble:

Safeguards is a system of inspection and other verification activities undertaken by the International Atomic Energy Agency (IAEA) in order to evaluate a Member State's compliance with its obligations pursuant to its safeguards agreements with the IAEA.

The *General Nuclear Safety and Control Regulations* require the licensee to take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement, and defines reporting requirements for safeguards events.

The *Class I Nuclear Facilities Regulations* require that an application for a licence to operate a Class I nuclear facility contain information on the licensee's proposed measures to facilitate Canada's compliance with any applicable safeguards agreement.

Canada has entered into a Safeguards Agreement and an Additional Protocol (hereinafter referred to as "safeguards agreements") with the IAEA pursuant to its obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons* (INFCIRC/140). The objective of the Canada-IAEA Safeguards Agreement is for the IAEA to provide assurance on an annual basis to Canada and to the international community that all declared nuclear materials are in peaceful, non-explosive uses and that there is no indication of undeclared nuclear materials or activities. This conclusion confirms that Canada is in compliance with its obligations under the following Canada-IAEA Safeguards Agreement:

- *Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons;* and
- *Protocol Additional to the Agreement Between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*.

These are reproduced in information circulars INFCIRC/164, and INFCIRC/164/Add. 1.

CNSC regulatory document RD-336, ACCOUNTING AND REPORTING OF NUCLEAR MATERIAL replaced AECB-1049 Rev 2, REPORTING REQUIREMENTS FOR FISSIONABLE AND FERTILE SUBSTANCES on January 1, 2011.

The scope of the non-proliferation program for the PROL is limited to the tracking and reporting of foreign obligations and origins of nuclear material. In addition, the import and export of controlled nuclear substances, equipment and information identified in the *Nuclear Non-proliferation Import and*

Export Control Regulations require separate authorization from the CNSC, consistent with section 3(2) of the *General Nuclear Safety and Control Regulations*.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Safeguards Operating Manual	NK21-OM-35370	At Implementation
Safeguards Operating Manual	NK29-OM-35370	At Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Accounting and Reporting of Nuclear Material	RD-336	000	June 1, 2015

The licensee shall ensure that accounting and reporting of nuclear materials is carried out in accordance with CNSC regulatory document RD-336, ACCOUNTING AND REPORTING OF NUCLEAR MATERIAL.

To ensure the safeguards program enables Canada to meet its international safeguards obligations, Bruce Power shall:

- Provide the IAEA, an IAEA inspector, or a person acting on behalf of the IAEA, with such reasonable services and assistance as are required to enable the IAEA to carry out its duties and functions pursuant to a safeguards agreement.
- Grant prompt access at all reasonable times to all locations at the nuclear facilities to an IAEA inspector, or to a person acting on behalf of the IAEA, where such access is required for the purposes of carrying on an activity pursuant to a safeguards agreement. In granting access, the licensee will provide health and safety services and escorts as required in order to facilitate activities pursuant to a safeguards agreement.
- Disclose to the Commission, to the IAEA, or to an IAEA inspector, any records that are required to be kept or any reports that are required to be made under a safeguards agreement.
- Provide such reasonable assistance to an IAEA inspector, or to a person acting on behalf of the IAEA, as is required to enable sampling and removal or shipment of samples required pursuant to a safeguards agreement.
- Provide such reasonable assistance to an IAEA inspector, or to a person acting on behalf of the IAEA, as is required to enable measurements, tests and removal or shipment of equipment required pursuant to a safeguards agreement.
- At the request of the Commission, or CNSC staff recognized by the Commission, install safeguards equipment at the nuclear facilities.
- Permit an IAEA inspector, or a person acting on behalf of the IAEA, to service safeguards equipment at the nuclear facilities.

- Operate safeguards equipment at the nuclear facilities in accordance with the methods and procedures specified by the IAEA.
- Provide the services required for the operation of the safeguards equipment at the nuclear facilities, in accordance with the specifications of the IAEA.
- Not interfere with or interrupt the operation of safeguards equipment at the nuclear facilities, or alter, deface or break a safeguards seal, except pursuant to a safeguards agreement.
- Implement measures to prevent damage to, or the theft, loss or sabotage of safeguards equipment or samples collected pursuant to a safeguards agreement or the illegal use, possession, operation or removal of such equipment or samples.
- Make and submit reports to the Commission on the inventory and transfer of fissionable and fertile substances in accordance with CNSC regulatory document RD-336, ACCOUNTING AND REPORTING OF NUCLEAR MATERIAL.
- Make such reports and provide such information to the Commission as are required to facilitate Canada's compliance with any applicable safeguards agreement.

According to sections 6.4.1 and 6.5.1 of RD-336, Bruce Power shall submit to the CNSC both a List of Inventory Items (LII) and a Physical Key Measurement Point Inventory Summary (P-KMPIS) within seven business days of a Physical Inventory Taking. However, based on initial experience, it has been determined that while the P-KMPIS will continue to be a mandatory document as per RD-336, LIIs will only be required upon request.

Some additional reporting requirements in RD-336 can be immediately relaxed.

The following changes are effective immediately:

- Bruce Power is no longer required to submit monthly General Ledgers for months in which no inventory changes occur. Note that this does not remove the requirement to create and retain General Ledgers, and to provide them at CNSC or IAEA request.
- Bruce Power is no longer required to create or submit Summary of Inventory Change reports.
- Bruce Power is no longer required to create or submit Obligated Materials Information Summary (OMIS) reports for years in which there was no inventory of foreign-obligated materials in their possession. An OMIS must still be submitted for any year in which the foreign obligated material inventory is not zero for the entirety of the year.

Bruce Power shall not make changes to operation, equipment or procedures that would affect the implementation of safeguards measures, except with the prior written approval of the Commission or CNSC staff as follows:

- Director, International Safeguards Division
- Director General, Directorate of Security and Safeguards
- Vice-President, Technical Support Branch

With respect to the implementation of safeguards measures, changes made by the licensee to the operation, equipment or procedures as a result of the agreement between Bruce Power, the CNSC and the IAEA are considered routine.

If a requested change would adversely impact Canada's compliance with the agreement, CNSC staff do not have the authority to give the approval, as this would violate the obligations arising from the Canada-IAEA safeguards agreement.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CNSC	Import and Export	REGDOC-2.13.2	2016
CNSC	Guidance for Accounting and Reporting of Nuclear Material	GD-336	2010

Guidance may be obtained from CNSC regulatory document REGDOC-2.13.2, IMPORT AND EXPORT and CNSC guidance document GD-336, GUIDANCE FOR ACCOUNTING AND REPORTING OF NUCLEAR MATERIAL.

14 SCA – PACKAGING AND TRANSPORT

14.1 Packaging and Transport Program

Licence Condition 14.1:

The licensee shall implement and maintain a packaging and transport program.

Preamble:

The *Class I Nuclear Facilities Regulations* require that an application for a licence to operate a Class I nuclear facility contain information on the proposed procedures for transporting nuclear substances.

Every person who transports radioactive material, or requires it to be transported, shall act in accordance with the requirements of the *Transportation of Dangerous Goods Regulations* (TDGR) and the *Packaging and Transport of Nuclear Substances Regulations, 2015* (PTNSR).

The TDGR and PTNSR provide specific requirements for the design of transport packages, the packaging, marking and labeling of packages and the handling and transport of nuclear substances.

Compliance Verification Criteria:

Bruce Power shall implement and maintain a packaging and transport program that will ensure compliance with the requirements set out in the TDGR and PTNSR for all shipments of nuclear substances to and from the Bruce site. Shipments of nuclear substances within the nuclear facility where access to the property is controlled are exempted from the application of TDGR and PTNSR.

Guidance:

Not applicable to this LC.

15 NUCLEAR FACILITY-SPECIFIC

15.1 Lease Agreement

Licence Condition 15.1:

The licensee shall inform the Commission in writing of any amendments to the Amended and Restated Lease Agreement between Ontario Power Generation Inc., Bruce Power L.P., OPG-Huron A Inc./OPG-Huron B Inc./OPG-Huron Common Facilities Inc., British Energy PLC, Cameco Corporation, TransCanada Pipelines Limited, BPC Generation Infrastructure Trust and Ontario Municipal Employees Retirement Board dated February 14, 2003.

Preamble:

Bruce Power leases the Bruce A and B nuclear facilities from Ontario Power Generation Inc. (OPG).

Compliance Verification Criteria:

Bruce Power is responsible for informing the Commission of any change in the lease agreement with OPG. Bruce Power shall inform the Commission in writing no **later than 30 days** after the execution of any such amendments.

Bruce Power and OPG have consolidated and superseded all prior amendments to the lease into a Second Amended (February 14, 2003) and Restated Lease Agreement dated October 11, 2016.

Guidance:

Not applicable to this LC.

15.2 Integrated Implementation Plan

Licence Condition 15.2:

The licensee shall implement the Integrated Implementation Plan.

Preamble:

The Integrated Implementation Plan (IIP) contains commitments, including the timeframes for implementation, from the Bruce A and B Periodic Safety Reviews (PSRs).

Compliance Verification Criteria:

In implementing the commitments identified in the IIP (Bruce A and B Global Assessment Report and Integrated Implementation Plan, B-GAR-09701-00001 R002 – e-Doc 5303331), Bruce Power committed to submitting to CNSC staff formal progress reports on the status of all IIP commitments on an annual basis by March 31st of each year during the licence period. Any proposed non-intent changes to the IIP shall be subject to the licensee's change control process as documented in BP-PROC-00058, "CNSC Commitment Management".

Guidance:

Not applicable to this LC.

15.3 Pressure Tube Fracture Toughness

Licence Condition 15.3:

The licensee shall maintain pressure tube fracture toughness sufficient for safe operation.

Preamble:

Bruce Power submits assessments for fuel channel components to support safe operation and satisfy compliance verification criteria in CSA N285.4-09 Update 2 and CSA N285.8-10 as outlined in Section 6.1. These assessments rely on models that conservatively represent the current and future conditions of fuel channel components. Fracture toughness models are used to assess risk of pressure tube failure from postulated flaws in uninspected pressure tubes. The current model for fracture toughness in CSA N285.8 has an upper bound for Hydrogen equivalent concentration, [Heq], in pressure tubes of 120 ppm. To reach Major Component Replacement target dates, Bruce Power currently predicts that some pressure tubes will operate with [Heq] in excess of 120 ppm and has proposed the development and validation of new fracture toughness models to satisfy the requirement of this licence condition. To meet compliance verification criteria for pressure tube evaluations a fracture toughness model for pressure tubes with [Heq] greater than 120 ppm, hereafter referred to as the Fracture Toughness Model, needs to be developed and accepted by CNSC staff for use.

Compliance Verification Criteria:

1. For continued operation of units containing pressure tubes with a [H_{eq}] exceeding 120 ppm between the inlet and outlet burnish marks:
   a. Bruce Power shall obtain prior written approval of the CNSC before operating any pressure tube with a measured [H_{eq}] greater than 120 ppm, or beyond the time any pressure tube is predicted to have a [H_{eq}] greater than 120 ppm,
      i. Predictions of maximum [H_{eq}] shall be determined utilizing the Hydrogen prediction model applied to the unit in the most recent report submitted to the CNSC under CSA N285.4, Clause 12.3.6.2. Revisions to the Hydrogen prediction model used in the most recent report shall be accepted by the CNSC.
   b. Bruce Power shall submit annual reports by July 1 of each year indicating when each unit is predicted to reach a maximum [H_{eq}] of 120 ppm

2. Criteria for the development of the Fracture Toughness Model:

   By June 1, 2019, Bruce Power shall submit to CNSC a technical basis document for the Fracture Toughness Model including a schedule for any remaining activities to complete model development and validation.

   Until the Fracture Toughness Model is accepted for use, Bruce Power shall report, on a semi-annual basis, the following:

   a. status updates on the validation of the Fracture Toughness Model,
   b. a quantitative assessment of uncertainties for the Fracture Toughness Model as new test data is added; and
   c. updates to the test plan, which includes:
      i. status of findings and outcomes from previous fracture toughness tests;
      ii. additions and changes to the test plan i.e. schedule of fracture toughness tests;
      iii. changes to the Test Strategy; and
      iv. results of fracture toughness tests including, as a minimum, material tested, test conditions, the results, whether the test objective has been met, and the tests planned for the next six months.

Guidance:

Attributes for an acceptable fracture toughness model

To support the licensing application of the updated model(s), the licensee should demonstrate that the model can:

i. explicitly account for actual hydride orientation;
ii. account for the variation in hydride morphology from pressure tube inlet to outlet;
iii. predict hydride fracture, as a function of hydride length and temperature;
iv. predict the transition-to-upper shelf temperature;
v. account for hydride length and orientation (using improved fracture path and ligament rupture models);
vi. explicitly model the fissures initiating at Zirconium-Chlorine-Carbon precipitates; and
vii. make use of the conventional traction-separation rule applied to finite-element cohesive-zone analyses.

Uncertainty Analysis

To support the licensing application of the Fracture Toughness Model, a quantitative assessment of uncertainties should be conducted. The assessment should utilize the approach in sections A.1, A.2 and A.5 of Appendix A to COG-JP-4491-V197, “Fuel Channel Life Management: Third Party Review of Probabilistic Fracture Protection Evaluation Methodology and Acceptance Criteria”, e-Doc 5230291.

Predicted maximum Hydrogen equivalent concentration

The predicted [H_{eq}] at the inlet and outlet burnish marks at the end of the evaluation period should be determined through a station or unit-specific model. The initial Hydrogen concentration should be from off-cut measurements and be channel-specific, the unit-specific bounding value, or the station-specific bounding value. Operating conditions such as temperature and fast flux, where applicable to the model or its components, should be channel-specific, the unit-specific bounding combination, or the station-specific bounding combination. If any inputs are sampled from a distribution, the inputs as well as their percentiles should be justified. For a probabilistic Monte Carlo approach, the upper-bound percentile for the [H_{eq}] prediction at the end of the evaluation period should be justified. In accordance with Clauses 12.3.4.6 and 12.4.4.6 of CSA N285.4, Bruce Power should report all of the parametric data used in the determination and prediction of the [H_{eq}] values.

15.4 Return-to-Service Plan

Licence Condition 15.4:

The licensee shall implement a return-to-service plan for Major Component Replacement.

Preamble:

Return to service (RTS) involves returning the reactor and associated nuclear and non-nuclear systems to commercial operation. The licensee must demonstrate that all regulatory requirements have been met and that the associated work has been done to the satisfaction of the CNSC.

Compliance Verification Criteria:

Licensee Documents

Document Title	Document #	Notification
Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Major Component Replacement Project Execution Plan and Bruce B Unit 6 Return to Service Plan", June 30, 2017, e-Doc 5292343	NK21-CORR-00531-14175	N/A

Bruce Power has notified CNSC of its intention to extend the operational lives of Bruce A Units 3 and 4 and Bruce B Units 5-8 including the replacement of major components. Bruce Power shall carry out any outstanding work related to the EA Follow-up Monitoring Program for the Bruce A refurbishment of Units 1 and 2.

Bruce Power shall develop and implement a project execution plan and a return-to-service plan for any refurbishment activities.

Guidance:

Not applicable to this LC.

15.5 Regulatory Hold Points for Return to Service and Continued Operation

Licence Condition 15.5:

The licensee shall obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points.

Preamble:

CNSC have identified four (4) regulatory hold points for the return to service of each unit undergoing a Major Component Replacement (MCR) outage for which CNSC approval will be sought prior to proceeding to the subsequent commissioning phase. These hold points require regulatory verification to confirm operational readiness of the plant safety systems to satisfy regulatory requirements for staged progress through the commissioning phases up to full power operation. These regulatory hold points are consistent with the regulatory approach described in REGDOC-2.3.1, *Conduct of Licensed Activity: Construction and Commissioning.*

Compliance Verification Criteria:

The licensee shall seek approval of the Commission or consent of a person authorized by the Commission prior to the removal of the following regulatory hold points for the return to service of each unit. The regulatory hold points that mark the completion of the commissioning phases are as follows:

1. Prior to **Fuel Load - Phase A**
2. Prior to removal of **Guaranteed Shutdown State - Phase B**
3. Prior to exceeding **1% Full Power - Phase C**
4. Prior to exceeding **35% Full Power - Phase D**

For each of the regulatory hold points, the licensee shall submit Completion Assurance Documents (CAD). In addition to these CAD's, the licensee shall submit CADs following sustained operation at 100% full power that will specify activities that were completed between 35% and 100% full power. Each CAD shall present evidence that all pre-established conditions for removal have been met.

Prior to GSS removal, all plant personnel who work on the reactor that has undergone major component replacement shall have completed update training appropriate to the knowledge and skill requirements of the applicable position covering the changes to facility systems, equipment and procedures made during the Major Component Replacement outages.

For each ANO, CRSS and SM this includes, at a minimum:

- Principles of reactor operation with a pre-equilibrium core;
- Principles of nuclear safety relevant to the operation of the reactor unit with a pre-equilibrium core;
- Operating constraints and limits associated with the operation of the reactor unit with a pre-equilibrium core;

- The initial approach to criticality and power increase until control by the reactor regulating system is established, including the systems and equipment required and their operation; and
- Changes in fuel composition and core reactivity until reaching equilibrium fuel conditions.

This training shall include formal knowledge and performance evaluations that confirm and document that, at the time of GSS removal, the person has the required knowledge and skills to perform the duties of the applicable position.

Low power testing (Phase C) shall be carried out at the lowest possible power level, with a maximum of 1% of full power.

Prior to release of a regulatory hold point, CNSC staff will verify compliance of the licensee to the pre-requisites for release of a hold point and provide a report to the Commission or person authorized by the Commission. Based on the results of the review of this report, the CNSC's Regulatory Operations Branch will issue a record of decision.

Pre-requisites for Release of Hold Points:

<u>Pre-requisites for Fuel Load</u>

1. All IIP commitments required prior to fuel load are complete;
2. All SSCs required for safe operation beyond fuel load are available for service;
3. Staffing levels to safely operate the unit are adequate;
4. Specified operating procedures for fuel load have been formally validated;
5. Specified training for fuel load is complete and staff qualified;
6. Specified SSCs meet the quality and completion requirements of CSA N286;
7. All non-conformances and open items identified as a pre-requisite to fuel load are addressed; and
8. Verification by CNSC staff that all construction, commissioning, re-start, and available for service activities required prior to fuel load have been successfully completed.

With respect to pre-requisite #3: Staffing levels refers to a sufficient number of qualified workers present at all times to ensure the safe operation of the nuclear facility and to ensure adequate emergency response capability. The licensee should have adequate staff available such that absences due to vacation, sick leave and training do not cause violations of the minimum shift complement levels.

<u>Pre-requisites for GSS Removal</u>

1. All IIP commitments required prior to GSS removal are complete;
2. All SSCs required for safe operation beyond GSS removal are available for service;
3. Specified operating procedures for GSS removal have been formally validated;
4. Specified training for GSS removal is complete and staff qualified;
5. All non-conformances and open items identified as a pre-requisite to GSS removal are addressed;
6. Specified SSCs meet the quality and completion requirements of CSA N286; and
7. Verification by CNSC staff that all construction, commissioning, re-start, and available for service activities required prior to GSS removal have been successfully completed.

<u>Pre-requisites for Reactor Power Increases Prior to exceeding 1% Full Power</u>

1. All IIP commitments required prior to increasing reactor power are complete;

2. All SSCs required for safe operation are available for service;
3. Specified operating procedures have been formally validated;
4. Specified training is complete and staff qualified;
5. All non-conformances and open items identified as a pre-requisite to reactor power increases above 1% power are addressed;
6. Specified SSCs meet the quality and completion requirements of CSA N286; and
7. Verification by CNSC staff that all construction, commissioning, re-start, and available for service activities required prior to increasing reactor power have been successfully completed.

Pre-requisites for Reactor Power Increases Prior to exceeding 35% Full Power

1. All IIP commitments required prior to normal operation are complete;
2. All SSCs required for safe operation are available for service;
3. Specified operating procedures have been formally validated;
4. Specified training is complete and staff qualified;
5. All non-conformances and open items identified as a pre-requisite to reactor power increases above 35% power are addressed;
6. Specified SSCs meet the quality and completion requirements of CSA N286; and
7. Verification by CNSC staff that all construction, commissioning, re-start, and available for service activities required prior to increasing reactor power have been successfully completed.

Guidance:

Not applicable to this LC.

15.6 Periodic Safety Review

Licence Condition 15.6:

The licensee shall conduct and implement a periodic safety review.

Preamble:

A periodic safety review (PSR) is a comprehensive evaluation of the design, condition and operation of a nuclear power plant. It is an effective way to obtain an overall view of actual plant safety and the quality of the safety documentation, and to determine reasonable and practical improvements to ensure safety until the next PSR or, where appropriate, until the end of commercial operation.

This licence condition pertains to the next PSR that Bruce Power shall submit during the licence period.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Bruce A Refurbishment for Life Extension Follow-up Monitoring Program	NK21-CORR-00531-06668	N/A

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Periodic Safety Reviews	REGDOC-2.3.3	2015	June 1, 2015

The licensee shall conduct a PSR to obtain an overall view of actual plant safety and the quality of safety documentation and to determine reasonable and practical improvements to ensure safety. The PSR shall be conducted in accordance with CNSC regulatory document REGDOC-2.3.3, PERIODIC SAFETY REVIEWS.

Bruce Power shall submit the next PSR to CNSC staff for review approximately 18 months prior to the next licence application.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
IAEA	Commissioning for Nuclear Power Plants	Specific Safety Guide Series No. SSG-28	2014
IAEA	Safety of Nuclear Power Plants: Commissioning and Operation	Specific Safety Requirements Series No. SSR-2/2	2011

15.7 End of Commercial Operations

Licence Condition 15.7:

The licensee shall inform the Commission of any reactor to be removed from commercial operation at Bruce A and B, and shall provide a plan describing the activities and timeline for transitioning from operations to safe storage.

Preamble:

Given that Bruce Power leases the Bruce A and Bruce B facilities, there is a need to ensure that when Bruce Power plans to take a reactor unit out of commercial service that there are adequate plans to ensure the safe transition from an operating unit into safe storage and the eventual transfer of the facility back to Ontario Power Generation.

Compliance Verification Criteria:

For any reactor that is to be removed from commercial operation, Bruce Power shall produce a strategy and plan of activities to manage and execute a safe process for removal from commercial service of a reactor unit at the nuclear facility. This plan shall cover:

- safe operation until end of commercial operation;
- transition to safe storage;
- staffing profiles;
- any required changes to Bruce Power programs covered in the operating licence;
- transition of the facility back to the owner for decommissioning.

Guidance:

The licensee should consider all units at a facility when developing the required plan. This is to take into consideration that units are likely to be removed from commercial service in a staggered approach such that the plan may need to cover several years.

15.8 Booster Fuel

Licence Condition 15.8:

The licensee shall store and manage booster fuel assemblies at Bruce A in a manner that ensures their physical security.

Preamble:

This LC is required for Bruce A due to the booster fuel assemblies.

Compliance Verification Criteria:

Bruce Power shall ensure the inner areas within the nuclear facility at Bruce A are protected in accordance with section 14 of the *Nuclear Security Regulations* against design basis threats and any other credible threat identified in the Threat and Risk Assessment documentation.

Guidance:

Not applicable to this LC.

15.9 Criticality Program

Licence Condition 15.9:

The licensee shall implement and maintain a nuclear criticality safety program.

Preamble:

This LC is required for Bruce A due to the booster fuel assemblies and for Bruce B due to the Low Void Reactivity Fuel (LVRF) Demonstration Irradiation. The booster fuel assemblies and LVRF bundles are currently in storage and only relevant sections of RD-327, NUCLEAR CRITICALITY SAFETY are applicable. The other sections would apply only if Bruce Power proposes a change to the storage conditions.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Nuclear Criticality Safety Management	BP-PROC-00324	Prior to Implementation

Licensing Basis Publications

Org	Document Title	Document #	Revision #	Effective Date
CNSC	Nuclear Criticality Safety	RD-327	0	May 31, 2016

Bruce Power is to maintain their nuclear criticality safety program in accordance with certain sections of CNSC regulatory document RD-327. Due to the presence of fissionable materials (as defined in section 2.3.1.3 of RD-327) in the booster fuel assemblies at Bruce A and the LVRF bundles at Bruce B, several of the requirements listed in RD-327 have been assessed as being applicable. The applicable requirements are:

Subject	Section
Nuclear criticality safety program relative to categorization	2.3.1.3, 2.3.1.4 , 12.8
Responsibilities	2.3.2.1, 12.3.1, 12.3.2, 12.3.3
Quality Management program and procedures	2.3.2.3, 2.3.2.6
Materials control	2.3.2.4 , 12.6
Operational control	2.3.2.7
Emergency procedures	2.3.2.9, 12.7
Nuclear criticality safety in the storage of fissile materials	6.0
Nuclear criticality safety training	13.0

Bruce Power is to maintain their nuclear criticality safety program in accordance with the Nuclear Criticality Safety Management procedure such that Upper Subcritical Limits established by the program will not be exceeded under both normal and credible abnormal conditions of operations with fissionable materials outside the reactors.

BP-PROC-00324 has been updated to meet the requirements of CSA standard N286-12.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CNSC	Guidance for Nuclear Criticality Safety	GD-327	2010

15.10 Cobalt 60

Licence Condition 15.10:

The licensee shall implement and maintain a program for the receipt, storage and handling of the nuclear substance Cobalt-60 at Bruce B.

Preamble:

Bruce Power harvests Cobalt-60 during the removal of Cobalt adjusters from each of the Bruce B reactors. These cobalt rods are processed into cobalt bundles that are placed in sealed containers and transported to Nordion Inc. who reprocess the bundles into sealed sources. Due to decay, the Cobalt-60 sealed sources cannot be used for commercial use after many years and are shipped back to Bruce Power. The sealed sources are stored in the Secondary Irradiated Fuel Bay at Bruce B NGS and upon decommissioning; they will be placed in permanent dry storage. This LC provides adequate regulatory oversight with regards to the reporting requirements related to the licensed activity associated with Cobalt-60 sealed sources.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Cobalt Handling	BP-PROC-00003	Prior to Implementation

The Bruce licence supports the possession of Cobalt-60 in both sealed and unsealed forms at the Bruce B nuclear facility. Bruce Power shall ensure that handling, processing and accounting of Cobalt is in accordance with Bruce Power's procedure for Cobalt Handling.

The written report, which shall be submitted to the CNSC via the Sealed Source Tracking System within 48 hours of any receipt of Cobalt-60 sealed sources (as required by CNSC regulatory document REGDOC-3.1.1), shall include:

(i) the date of receipt of a transfer;
(ii) the name of the shipper and licence number;
(iii) the address of the shipper's authorized location;
(iv) the nuclear substance;
(v) activity (radioactivity) (Bq) per source on the reference date;
(vi) the reference date;
(vii) the number of sealed source(s);
(viii) the aggregate activity (Bq);
(ix) sealed source unique identifiers (if available).

Guidance:

Not applicable to this LC.

15.11 Class II Nuclear Facility

<u>Licence Condition 15.11:</u>

The licensee shall implement and maintain a program for the operation of the Class II nuclear facility.

<u>Preamble:</u>

Bruce Power possesses Class II prescribed equipment and associated nuclear substances for the Class II nuclear facility as listed and at the locations given in table 15.11.1.

Table 15.11.1: List of Prescribed Equipment and Associated Nuclear Substances and their Locations for the Class II Nuclear Facility at the Bruce site

<u>a) Prescribed Equipment Containing Sealed Sources</u>

Item	Equipment Make and Model	Nuclear Substance	Maximum Quantity Per Machine	Location in Bruce B NGS	
				Use/ Operation	Storage
1	J.L. Shepherd 81-12 and 81-12B	Cesium 137	37 TBq	[redacted]	
2	J.L. Shepherd 81-12 and 81-12B	Cesium 137	37 TBq		

Prescribed Information

<u>Compliance Verification Criteria:</u>

<u>Licensee Documents that Require Notification of Change</u>

Document Title	Document #	Notification
Management of Class II Nuclear Facilities	BP-PROC-00817	At Implementation
Leak Testing Program	BP-PROC-00143	At Implementation
Radiation Calibration Facility Safety Interlock Checks and Operation	NK29-CMP-67880-00001	At Implementation
Plans and Design of the Calibration Facility	NK29-CORR-00531-01343	N/A
Shielding Calculations for the Calibration Facility	NK29-CORR-00531-04839	N/A
Safety System Layout for the Calibration Facility	NK29-DRAW-67880-10001 Rev. 2006/08/03	At Implementation
Safety System Diagram for the Calibration Facility	NK29-DRAW-67880-10003 Rev. 2006/08/03	At Implementation

Sealed Source Tracking
Unless otherwise permitted by the prior written approval of the Commission or a person authorized by the Commission the licensee shall, in respect of a radioactive nuclear substance set out:

i) in column 1 of the table below, report in writing to the Commission or a person authorized by the Commission any transfer, receipt, export, or import of a sealed source whose corresponding activity is equal to or greater than the value set out in column 2 of the table; or

ii) in table 15.10.1 of this LCH, reporting in writing to the Commission or a person authorized by the Commission any transfer, receipt, import or export of any sealed source:

(a) at least 7 days before any transfer or export, and
(b) within 48 hours of any receipt of a transfer or import.

Column 1 Nuclear Substance	Column 2 (TBq)
Americium 241	0.6
Americium 241/Beryllium	0.6
Californium 252	0.2
Curium 244	0.5
Cobalt 60	0.3
Cesium 137	1
Gadolinium 153	10
Iridium 192	0.8
Promethium 147	400
Plutonium 238	0.6
Plutonium 239/Beryllium	0.6
Radium 226	0.4
Selenium 75	2
Strontium 90 (Yttrium 90)	10
Thulium 170	200
Ytterbium 169	3

The written report shall be in a form acceptable to the Commission that includes:
(a) on transfer or export of a sealed source(s),
- (i) the date of transfer or export,
- (ii) the export licence number (where applicable),
- (iii) the name of the recipient and licence number or the name of the importer,
- (iv) the address of the recipient's or importer's authorized location,
- (v) the nuclear substance (radionuclide),
- (vi) activity (radioactivity) (Bq) per sealed source on the reference date,
- (vii) the reference date,
- (viii) the number of sealed source(s),
- (ix) the aggregate activity (Bq),
- (x) the sealed source unique identifiers (if available), and
- (xi) where the sealed source is incorporated in a prescribed equipment,
  - (1) the name and model number of the equipment, and
  - (2) the equipment serial number (if available)

(b) on receipt or import of a sealed source(s),
- (i) the date of receipt of a transfer or import,
- (ii) the name of the shipper and licence number or the name of the exporter,
- (iii) the address of the shipper's or exporter's authorized location,
- (iv) the nuclear substance (radionuclide),
- (v) activity (radioactivity) (Bq) per sealed source on the reference date,
- (vi) the reference date,
- (vii) the number of sealed source(s),

(viii) the aggregate activity (Bq),
(ix) sealed source unique identifiers (if available), and
(x) where the sealed source is incorporated in a prescribed equipment,
  (1) the name and model number of the equipment, and
  (2) the equipment serial number (if available)

Annual Compliance Report for a Class II Nuclear Facility
The licensee shall, by January 31 of each year, submit to the Commission a written annual compliance report for a Class II nuclear facility and prescribed equipment in the form specified at www.nuclearsafety.gc.ca/acr (Number 535).

Guidance:

Not applicable to this LC.

15.12 Nuclear Substances and Prescribed Equipment

Licence Condition 15.12:

The licensee shall implement and maintain a program for nuclear substances and prescribed equipment.

Preamble:

Bruce Power has been authorized to use the types of nuclear substances and prescribed equipment listed in tables 15.12.1, 15.12.2 and 15.12.3 of this section.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Title	Document #	Notification
Management of Nuclear Substances and Radiation Generating Equipment	BP-RPP-00043	At Implementation
Bruce Power Inc. Control Maintenance Procedure, Hopewell Designs BX-3-2600 Box Calibrator Pre-Use Operational and Safety Interlock Checks	NK21-CMP-67870-00002	At Implementation
Hopewell Designs Inc. Model BX3 Gamma Irradiator Operations & Maintenance Manual (Version 1)	N/A	At Implementation
Hopewell Designs, Inc. Stand-Alone Irradiator Calibrator 3347-R2 User Manual	N/A	At Implementation
Instructions for the Removal/Replacement of Kinectrics KIN-FLS400 Sealed Source Assembly	N/A	At Implementation
Conduct of Radiography	BP-PROC-00036	At Implementation
Radiography Emergency Procedures	BP-PROC-00798	At Implementation
Leak Testing Program	BP-PROC-00143	At Implementation

The licensee shall implement and maintain a nuclear substances and prescribed equipment program.

The licensee main support process document which describes the program for nuclear substances and prescribed equipment is BP-RPP-00043, *Management of Nuclear Substances and Radiation Generating Equipment*.

The licensee is authorized to conduct licensed activities with the nuclear substances and the prescribed equipment listed in tables 15.12.1, 15.12.2 and 15.12.3.

Nuclear substances and prescribed equipment are used throughout the Bruce site, subject to the requirements of the program for nuclear substances and prescribed equipment.

Table 15.12.1 - Unsealed and Sealed Sources

ITEM	NUCLEAR SUBSTANCE	UNSEALED SOURCE MAXIMUM TOTAL QUANTITY IN POSSESSION	MAXIMUM QUANTITY PER SEALED SOURCE
1	Americium 241	200 MBq	200 MBq
2	Americium 241/ Beryllium	N/A	400 GBq
3	Barium 133	200 GBq	200 GBq
4	Cadmium 109	200 GBq	200 GBq
5	Carbon 14	185 MBq	200 GBq
6	Cerium 139	200 GBq	200 GBq
7	Cesium 134	200 GBq	200 GBq
8	Cesium 137	200 GBq	200 GBq
9	Chlorine 36	200 GBq	200 GBq
10	Cobalt 57	200 GBq	200 GBq
11	Cobalt 60	200 GBq	400 GBq
12	Curium 244	10 kBq	N/A
13	Depleted Uranium	4 kg	N/A
14	Deuterium	100 kg	N/A
15	Europium 152	N/A	200 GBq
16	Europium 155	N/A	200 GBq
17	Highly enriched Uranium (> 20%)	N/A	10 kBq
18	Hydrogen 3	370 GBq	N/A
19	Iron 55	200 GBq	200 GBq
20	Krypton 85	N/A	200 GBq
21	Manganese 54	N/A	200 GBq
22	Mercury 203	200 GBq	200 GBq
23	Nickel 63	200 GBq	200 GBq
24	Plutonium 239	10 kBq	200 MBq
25	Plutonium 239/ Beryllium	N/A	37 GBq
26	Radium 226	N/A	200 GBq
27	Sodium 22	N/A	200 GBq
28	Strontium 85	200 GBq	200 GBq
29	Strontium 90	200 GBq	200 GBq
30	Technetium 99	N/A	200 GBq
31	Thorium 230	N/A	200 MBq
32	Tin 113	200 GBq	200 GBq
33	Tritium	N/A	4.5 TBq
34	Yttrium 88	200 GBq	200 GBq
35	Yttrium 90	N/A	200 GBq

Table 15.12.2 - Radiation Devices

ITEM	NUCLEAR SUBSTANCE	MAXIMUM QUANTITY PER RADIATION DEVICE	EQUIPMENT MAKE AND MODEL
36	Americium 241/ Beryllium	7,400 MBq	Thermo Fisher Scientific 5020
37	Americium 241/ Beryllium	185 GBq	J.L. Shepherd Neutron Detector, Model 149
38	Americium 241/ Beryllium	37 GBq	Scintrex Neutron Snoopy Checker, Model 316
39	Americium 241	1,110 MBq	Niton XL, XLII, Xli, XLp,XL3p Series
	Cadmium 109	1,850 MBq	
40	Americium 241	3,700 MBq	Siemens EPD Auto-Irradiator (IRR-2)
	Chlorine 36	100 kBq	
41	Barium 133	56 MBq	Harshaw Containment Activity Monitor – CAM II
42	Barium 133	333 kBq	General Atomic Particulate and Iodine Stack Monitor Model 0332-1801
	Chlorine 36	333 kBq	
43	Barium 133	333 kBq	Sorrento Electronics Stack Monitor 02810730-001
	Cesium 137	330 kBq	
	Chlorine 36	3,700 kBq	
44	Carbon 14	185 kBq	Saint-Gobain Crystals and Detectors 8800
	Strontium 90	18,500 kBq	
45	Cesium 137	3,700 kBq	Amersham PARM Calibrator
46	Cesium 137	266 kBq	Amersham Stack Monitor Calibrator, Model QCRK 2392
47	Cesium 137	3,700 MBq	Saint-Gobain Crystals and Detectors 6610
48	Cesium 137	2.22 MBq	Bot Engineering Model RM-AC-20u
49	Cesium 137	592 MBq	Bot Engineering TR-1 Universal Gamma Checker
50	Cesium 137	370 MBq	Bot Engineering TR-1A Universal Gamma Checker
51	Cesium 137	7,400 kBq	Bruce Power General Atomic High Range Fixed Area Gamma Monitor RD-21 modified by Bruce Power
52	Cesium 137	104 TBq	Hopewell Designs Models: BX3-1-12, BX3-2-12, BX3-1-360, BX3-2-360, BX3-1-2600, BX3-2-2600
53	Cesium 137	5 TBq	J.L. Shepherd 78-2M Calibrator
54	Cesium 137	5.5 TBq	J.L. Shepherd 89 Calibrator
55	Cesium 137	370 kBq	Kinectrics KIN-FLS400 and KIN-FLS400V1
56	Cesium 137	74 kBq	Labserco Liquid Effluent Monitoring System Model NK21RG 678775-00

ITEM	NUCLEAR SUBSTANCE	MAXIMUM QUANTITY PER RADIATION DEVICE	EQUIPMENT MAKE AND MODEL
57	Cesium 137	370 MBq	Mirion Technologies IRD 2000
58	Cesium 137	42 MBq	New England Nuclear FAGM Checker Model NEN-FAGM
59	Cesium 137	381 MBq	OHN Alnor PAD Checker, Model AP
60	Cesium 137	2,072 MBq	OPG DRD Checker Series
61	Cesium 137	370 GBq	Scintrex Emergency/High Range Gamma Checker, Model 006101
62	Cesium 137	1,850 MBq	Scintrex Medium Range Gamma Checker, Model 006100
63	Cesium 137	330 kBq	Sentry Equipment Recovery Monitor Model 1010020
64	Cesium 137	370 MBq	Sorrento Electronics General Atomic Area Monitor Calibrator, Model RT-10
65	Cesium 137	111 kBq	Eberline DA1-4CS/DA1-8CS Detector Assembly
	Strontium 90	37 kBq	
66	Chlorine 36	37 kBq	Sorrento Electronics General Atomic Area Monitor Detector, Model RD-1
67	Cobalt 60	19 MBq	Ginge 62A02
68	Enriched Uranium 235	370 kBq	Bot Engineering Model RM-VIFM-CDM
69	Enriched Uranium 235	4 kBq	IST Corporation Fission Chamber Detector, Model #WX-33073
70	Nickel 63	700 MBq	[redacted]
71	Nickel 63	370 MBq	Valco Instruments Co. Model 140 Series Detector
72	Strontium 90	3,700 MBq	Hopewell Designs Beta-100Chp
73	Strontium 90	185 MBq	OHN Extremity TLD Irradiator, Model 4212
74	Strontium 90	18,500 kBq	Thermo Electron Model 2210 TLD
75	Strontium 90/ Yttrium 90	1,480 MBq	R-Metrics Beta Meter Checker
76	Strontium 90/Yttrium 90	37 GBq	J.L. Shepherd Model 492 Beta Calibrator

Prescribed Information

Table 15.12.3 – Industrial Radiography Radiation Devices

ITEM	NUCLEAR SUBSTANCE	MAXIMUM QUANTITY PER RADIATION DEVICE	EQUIPMENT MAKE AND MODEL	SEALED SOURCE ASSEMBLY
77	Cobalt 60	12.21 TBq	QSA Global Model Sentry 330	QSA Global A424-13
78	Cobalt 60	12.21 TBq	Replacement source for: QSA Global Model Sentry 330	QSA Global A424-13
79	Depleted Uranium	Unlimited	Contained as an integral part of any exposure device	As integral part of each device
80	Selenium 75	3 TBq	QSA Global 1075 SCARPro	QSA Global A425-6
81	Selenium 75	3 TBq	Replacement source for: QSA Global 1075 SCARPro	QSA Global A425-6
82	Selenium 75	5,550 GBq	QSA Global Models 880 Delta, 880 Sigma and 880 Elite	AEA Technology A424-25W
	Iridium 192	5,550 GBq		AEA Technology (Delta) A424-9
83	Selenium 75	5,550 GBq	Replacement source for: QSA Global Models 880 Delta, 880 Sigma and 880 Elite	AEA Technology A424-25W
	Iridium 192	5,550 GBq		AEA Technology (Delta) A424-9

Prohibition of Human Use
The licensee is not authorized by the licence to conduct activities related to nuclear medicine and therefore it is prohibited to use nuclear substances in or on human beings.

CNSC staff will verify by whatever means available that the licensee is not using radioactive prescribed substances in or on humans.

Laboratory Lists
The licensee shall maintain a list of all areas, rooms and enclosures in which more than one exemption quantity of a nuclear substance is used or stored. The allowable maximum quantities of radionuclides as given previously in tables 15.12.1 and 15.12.2.

Laboratory Procedures
The licensee shall post and keep posted, in a readily visible location in the areas, rooms or enclosures where nuclear substances are handled, a radioisotope safety poster approved by the Commission or a person authorized by the Commission, which corresponds to the classification of the area, room or enclosure.

Storage

The licensee shall:

(a) ensure that when in storage radioactive nuclear substances or radiation devices are accessible only to persons authorized by the licensee;

(b) ensure that the dose rate at any occupied location outside the storage area, room or enclosure resulting from the substances or devices in storage does not exceed 2.5 microSv/h; and

(c) have measures in place that the dose limits in the Radiation Protection Regulations are not exceeded as a result of the substances or devices in storage.

Area Classification

The licensee shall classify each room, area or enclosure where more than one exemption quantity of an unsealed nuclear substance is used at a single time as:

(a) basic-level if the quantity does not exceed 5 Annual Limit on Intake (ALI),

(b) intermediate-level if the quantity used does not exceed 50 ALI,

(c) high-level if the quantity does not exceed 500 ALI,

(d) containment-level if the quantity exceeds 500 ALI; or

(e) special purpose if approved in writing by the Commission or a person authorized by the Commission.

Except for the basic-level classification, the licensee shall not use unsealed nuclear substances in these rooms, areas or enclosures without written approval of the Commission or a person authorized by the Commission.

Contamination Meter Requirements

The licensee shall make available to workers at all times at the site of the licensed activity a properly functioning portable contamination meter.

Survey Meter Requirements

The licensee shall provide at all times where nuclear substances, except for Hydrogen-3 and Nickel-63, are handled or stored a radiation survey meter.

Contamination Criteria

The licensee shall ensure that for nuclear substances listed in table 15.11.4, Classes of Radionuclides, given below:

(a) non-fixed contamination in all areas, rooms or enclosures where unsealed nuclear substances are used or stored does not exceed:

(i) 3 becquerels per square centimetre for all Class A radionuclides;

(ii) 30 becquerels per square centimetre for all Class B radionuclides; or

(iii) 300 becquerels per square centimetre for all Class C radionuclides; averaged over an area not exceeding 100 square centimetres; and

(b) non-fixed contamination in all other areas does not exceed:

(i) 0.3 becquerels per square centimetre for all Class A radionuclides;

(ii) 3 becquerels per square centimetre for all Class B radionuclides; or

(iii) 30 becquerels per square centimetre for all Class C radionuclides; averaged over an area not exceeding 100 square centimetres.

Table 15.12.4 – Classes of Radionuclides

The most commonly licensed radionuclides have been grouped into Class A, Class B and Class C, based upon their radiological properties as shown in the table below.

Class	Radionuclide				
Class A	All alpha emitters and their daughter isotopes				
	Ag-110m	Bi-210	Co-56	Co-60	Cs-134
	Cs-137	I-124	Lu-177m	Mn-52	Na-22
	Po-210	Pu-238	Pu-239	Pu-240	Sb-124
	Sc-46	Sr-82	U-234	U-235	U-238
	V-48	Zn-65			
Class B	Au-198	Ba-133	Br-82	Ce-143	Co-58
	Cu-67	Fe-59	Hg-194	Hg-203	I-131
	Ir-192	La-140	Mo-99	Nb-95	Pa-233
	Ra-223	Re-186	Re-188	Ru-103	Sb-122
	Sm-153	Sr-90	Xe-127	Y-86	Y-90
	Yb-169	Zr-89	Zr-95		
Class C	C-11	C-14	Ca-45	Cd-109	Ce-141
	Cl-36	Co-57	Cr-51	Cu-60	Cu-61
	Cu-64	F-18	Fe-55	Ga-67	Ga-68
	Ge-68	H-3	I-123	I-125	In-111
	In-113m	In-114	K-42	Kr-85	Lu-177
	Mn-52m	Mn-56	N-13	Na-24	Nb-98
	Ni-63	O-15	P-32	P-33	Pd-103
	Pr-144	Pu-241	Rh-106	S-35	Sc-44
	Sn-113	Sr-89	Tc-94m	Tc-99	Tc-99m
	Te-127	Tl-201	V-49	W-181	W-188
	Xe-133	Zn-63			

When using more than one radionuclide in a room, the radionuclide with the lowest contamination limit must be used to determine the limit, Class A, Class B or Class C that applies to the room.

Extremity Dosimetry – Beta Emitters

The licensee shall ensure that any person who handles a container which contains more than 50 MBq of phosphorus 32, strontium 89, yttrium 90, samarium 153 or rhenium 186 wears a ring dosimeter. The dosimeters must be supplied and read by a dosimetry service licensed by the Commission.

Internal Authorization

The licensee shall ensure that:

(a) internal authorizations are issued in accordance with the licensee's internal authorization policies and procedures approved by the Commission or a person authorized by the Commission;

(b) internal authorization forms are posted in a readily visible location in or near each room, area or enclosure where nuclear substances and radiation devices are used or stored; and

(c) the licensed activity is conducted in accordance with the terms and conditions of the internal authorization.

Project Approval

The licensee shall obtain written approval from the Commission or a person authorized by the Commission before starting any work requiring the use of more than 10,000 exemption quantities of a nuclear substance at a single time.

Disposal (General)
When disposing of unsealed nuclear substances set out in column 1 of table 15.12.5, Disposal Limits to municipal waste, to sewer systems or to atmosphere, the licensee shall ensure that the concentration limit set out for each nuclear substance is not exceeded.
(a) The concentration limits set out in column 2 apply to quantities of solid waste of less than three tonnes per building per year. Nuclear substances released to the municipal garbage system must be in solid form and uniformly distributed in the waste with a concentration that is less than the limits in column 2. Where more than one nuclear substance is disposed of at one time, the sum of the quotients obtained by dividing the quantity of each substance by its corresponding limit in column 2 shall not exceed one.
(b) The limits set out in Column 3 apply to the water soluble liquid form of each nuclear substance which may be disposed of per building per year. Where more than one nuclear substance is disposed of at one time, the sum of the quotients obtained by dividing the quantity of each substance by its corresponding limit in column 3 shall not exceed one.
(c) The concentration limits set out in Column 4 may be averaged over a one-week period and apply to releases of less than 3 million cubic metres per year. Where more than one nuclear substance is disposed of at one time, the sum of the quotients obtained by dividing the quantity of each substance by its corresponding limit in column 4 shall not exceed one.

Table 15.12.5 – Disposal Limits

Column 1	Column 2	Column 3	Column 4
Nuclear Substance	Solids to Municipal Garbage System (Qty per kg)	Liquids (Water Soluble) to Municipal Sewer System (Qty per year)	Gases to Atmosphere (Qty per cubic metre)
Americium 241	0.001 MBq	10 MBq	0.03 Bq
Barium 133	0.037 MBq	1 MBq	n/a
Cadmium 109	0.37 MBq	10 MBq	n/a
Carbon 14	3.7 MBq	10000 MBq	n/a
Cerium 139	0.1 MBq	1 MBq	30 Bq
Cesium 134	0.01 MBq	0.1 MBq	n/a
Cesium 137	0.01 MBq	1 MBq	n/a
Chlorine 36	0.37 MBq	10000 MBq	n/a
Cobalt 57	0.37 MBq	1000 MBq	n/a
Cobalt 60	0.01 MBq	0.1 MBq	0.3 Bq
Hydrogen 3	37 MBq	1 TBq	37 kBq
Iron 55	3.7 MBq	10000 MBq	n/a
Mercury 203	0.1 MBq	10 MBq	n/a
Nickel 63	0.1 MBq	10000 MBq	n/a
Strontium 85	0.1 MBq	1 MBq	n/a
Strontium 90	0.1 MBq	1 MBq	0.3 Bq
Tin 113	1 MBq	n/a	n/a
Yttrium 88	0.01 MBq	0.1 MBq	3 Bq

Decommissioning
The licensee shall ensure that prior to decommissioning any area, room or enclosure where the licensed activity has been conducted:
(a) the non-fixed contamination for nuclear substances listed in the licence application guide table titled "Classification of Radionuclides" does not exceed:
(i) 0.3 becquerels per square centimetre for all Class A radionuclides;
(ii) 3 becquerels per square centimetre for all Class B radionuclides; and

(iii) 30 becquerels per square centimetre for all Class C radionuclides; averaged over an area not exceeding 100 square centimetres;
(b) the release of any area, room or enclosure containing fixed contamination, is approved in writing by the Commission or person authorized by the Commission;
(c) all nuclear substances and radiation devices have been transferred in accordance with the conditions of this licence; and
(d) all radiation warning signs have been removed or defaced.

Sealed Source Tracking
Unless otherwise permitted by the prior written approval of the Commission or a person authorized by the Commission the licensee shall, in respect of a radioactive nuclear substance set out:

i) in column 1 of the table below, report in writing to the Commission or a person authorized by the Commission any transfer, receipt, export, or import of a sealed source whose corresponding activity is equal to or greater than the value set out in column 2 of the table; or
ii) in table 15.11.3 of this LCH, reporting in writing to the Commission or a person authorized by the Commission any transfer, receipt, import or export of any sealed source:

(a) at least 7 days before any transfer or export, and
(b) within 48 hours of any receipt of a transfer or import.

Column 1 Nuclear Substance	Column 2 (TBq)
Americium 241	0.6
Americium 241/Beryllium	0.6
Californium 252	0.2
Curium 244	0.5
Cobalt 60	0.3
Cesium 137	1
Gadolinium 153	10
Iridium 192	0.8
Promethium 147	400
Plutonium 238	0.6
Plutonium 239/Beryllium	0.6
Radium 226	0.4
Selenium 75	2
Strontium 90 (Yttrium 90)	10
Thulium 170	200
Ytterbium 169	3

The written report shall be in a form acceptable to the Commission that includes:
(a) on transfer or export of a sealed source(s),

(i) the date of transfer or export,
(ii) the export licence number (where applicable),
(iii) the name of the recipient and licence number or the name of the importer,
(iv) the address of the recipient's or importer's authorized location,
(v) the nuclear substance (radionuclide),
(vi) activity (radioactivity) (Bq) per sealed source on the reference date,

(vii) the reference date,
(viii) the number of sealed source(s),
(ix) the aggregate activity (Bq),
(x) the sealed source unique identifiers (if available), and
(xi) where the sealed source is incorporated in a prescribed equipment,
(1) the name and model number of the equipment, and
(2) the equipment serial number (if available)

(b) on receipt or import of a sealed source(s),
(i) the date of receipt of a transfer or import,
(ii) the name of the shipper and licence number or the name of the exporter,
(iii) the address of the shipper's or exporter's authorized location,
(iv) the nuclear substance (radionuclide),
(v) activity (radioactivity) (Bq) per sealed source on the reference date,
(vi) the reference date,
(vii) the number of sealed source(s),
(viii) the aggregate activity (Bq),
(ix) sealed source unique identifiers (if available), and
(x) where the sealed source is incorporated in a prescribed equipment,
(1) the name and model number of the equipment, and
(2) the equipment serial number (if available)

Annual Compliance Reports for Nuclear Substances and Radiation Devices
The licensee shall, by February 28 of each year, submit to the Commission two written annual compliance reports for nuclear substances and radiation devices in the form specified at www.nuclearsafety.gc.ca/acr (Numbers 812 and 815).

Import and Export Restriction
The licensee shall not import or export the following items as described in the schedule, Parts A and B, to the *Nuclear Non-proliferation Import and Export Control Regulations*, subject to any restrictions or exemptions as noted in each paragraph of the schedule:

1. Special fissionable material, as described in paragraph A.1.1:
   - Plutonium;
   - Uranium 233; and
   - Uranium enriched in Uranium 233 or Uranium 235.
2. Source material, as described in paragraph A.1.2:
   - Uranium, containing the mixture of isotopes that occurs in nature;
   - Uranium, depleted in the isotope Uranium 235; and
   - Thorium.
3. Deuterium and heavy water, as described in paragraph A.1.3.
4. Tritium, as described in paragraph A.1.5.
5. Alpha-emitting nuclear substances, as described in paragraph B.1.1.1, including but not limited to:
   - Actinium 225, 227;
   - Californium 248, 250, 252, 253, 254;
   - Curium 240, 241, 242, 243, 244;
   - Einsteinium 252, 253, 254, 255;
   - Fermium 257;

- Gadolinium 148;
- Mendelevium 258, 260;
- Neptunium 235;
- Polonium 208, 209, 210; and
- Radium 223.

6. Radium-226, as described in paragraph B.1.1.16.

The licensee shall not import or export any of the nuclear substances listed above without a valid import/export licence issued by the CNSC. The import or export licence issued by the CNSC includes licence conditions to verify compliance with the *Nuclear Non-proliferation Import and Export Control Regulations*. CNSC inspectors can verify compliance by reviewing shipping documents pertaining to imports and exports.

Export Limitations – Sealed Sources
The licence does not authorize the licensee, in respect of a radioactive nuclear substance set out in column 1 of the table below, to export a sealed source whose corresponding activity is equal to or greater than the value set out in column 2 of table 15.12.6.

Table 15.12.6 – Export Limitations

Column 1	Column 2
Nuclear Substance	TBq
Americium 241	0.6
Americium 241/Beryllium	0.6
Californium 252	0.2
Curium 244	0.5
Cobalt 60	0.3
Cesium 137	1
Gadolinium 153	10
Iridium 192	0.8
Promethium 147	400
Plutonium 238	0.6
Plutonium 239/Beryllium	0.6
Radium 226	0.4
Selenium 75	2
Strontium 90 (Yttrium 90)	10
Thulium 170	200
Ytterbium 169	3

Location Notification
The licensee shall, for any site where licensed activities are to be conducted for more than 90 consecutive days, notify the Commission in writing of the site within 7 days of starting to conduct the activities at the site. The licensee shall notify the Commission in writing within 7 days of the discontinuance of licensed activities at any site. The continuity of consecutive days is not broken during off site use or off site temporary storage.

Device Use Restrictions
The licensee shall not transfer the following devices without prior written consent of the Commission or a person authorized by the Commission; for disposal to a licensed nuclear waste facility:
(1) Amersham PARM Calibrator (CNSC Device No 219-0002);

(2) Amersham Stack Monitor Calibrator, Model QCRK 2392 (CNSC Device No 219-0001);
(3) BOT Engineering TR-1 Universal Gamma Checker (CNSC Device No 414-0013);
(4) Harshaw Containment Activity Monitor - CAM II (CNSC Device No 379-0002);
(5) J.L. Shepherd Neutron Detector, Model 149 (CNSC Device No 179-0002);
(6) New England Nuclear FAGM Checker Model NEN-FAGM (CNSC Device No 077-0001);
(7) OHN Alnor PAD Checker, Model AP (CNSC Device No 212-0002);
(8) OHN Extremity TLD Irradiator Model 4212, (CNSC Device No 212-0001);
(9) OPG DRD Checker Series (CNSC Device No 198-0001);
(10) Scintrex Medium Range Gamma Checker Model 006100 (CNSC Device No 204-0021);
(11) Scintrex Neutron Snoopy Checker Model 316 (CNSC Device No 204-0019);
(12) Sorrento Electronics General Atomic Area Monitor Calibrator Model RT-10 (CNSC Device No 199-0003);
(13) Sorrento Electronics General Atomic Area Monitor Detector Model RD-1 (CNSC Device No 199-0002);
(14) Sorrento Electronics Stack Monitor 02810730-001 (CNSC Device No 199-0004);
(15) General Atomics Particulate & Iodine Stack Monitor 0332-1801 (CNSC Device No 339-0001);
(16) R-Metrics Beta Meter Checker (CNSC Device No 276-0001);
(17) Sentry Equipment Recovery Monitor Model 1010020 (CNSC Device No 183-0002); and
(18) Bruce Power General Atomic High Range Fixed Area Gamma Monitor RD-21 (CNSC Device No 496-0001).

Maintenance Limitations
The licence authorizes the cleaning and lubrication of the radiation devices listed in this section, in accordance with the manufacturer's operating manual.

The continuity of consecutive days is not broken during off site use or off site temporary storage.

Safeguards
The licensee shall:
(a) Take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement;
(b) Provide the International Atomic Energy Agency, an International Atomic Energy Agency inspector, or a person acting on behalf of the International Atomic Energy Agency with such reasonable services and assistance as are required to enable the International Atomic Energy Agency to carry out its duties and functions pursuant to a safeguards agreement;
(c) Grant prompt access at all reasonable times to all locations at the facility to an International Atomic Energy Agency inspector, or to a person acting on behalf of the International Atomic Energy Agency, where such access is required for the purposes of carrying on an activity pursuant to a safeguards agreement. In granting access, the
licensee shall provide health and safety services and escorts as required in order to facilitate activities pursuant to a safeguards agreement;
(d) Disclose to the Commission, to the International Atomic Energy Agency or to an International Atomic Energy Agency inspector, any records that are required to be kept or any reports that are required to be made under a safeguards agreement;
(e) Provide such reasonable assistance to an International Atomic Energy Agency inspector or to a person acting on behalf of the International Atomic Energy Agency, as is required to enable sampling and removal or shipment of samples required pursuant to a safeguards agreement;

(f) Provide such reasonable assistance to an International Atomic Energy Agency inspector or to a person acting on behalf of the International Atomic Energy Agency, as is required to enable measurements, tests and removal or shipment of equipment required pursuant to a safeguards agreement;
(g) Not alter, deface or break a safeguards seal, except pursuant to a safeguards agreement;
(h) Implement measures to prevent damage to or the theft, loss or sabotage of samples collected pursuant to a safeguards agreement or the illegal use, possession or removal of such samples;
(i) Make such reports and provide such information to the Commission as are required to facilitate Canada's compliance with any applicable safeguards agreement; and
(j) Make and submit reports to the Commission in accordance with the RD-336, *Accounting and Reporting of Nuclear Material*, on the inventory and transfer of fissionable and fertile substances, or as otherwise stipulated in any regulatory document that replaces RD-336.

Guidance:

Guidance Publications

Org	Document Title	Document #	Version
CNSC	Import and Export	REGDOC-2.13.2	2016

APPENDIX A – Acronyms and Definitions

A.1 Acronyms

The following is the list of acronyms used in the LCH:

ADL	Administrative Dose Limits
AIA	Authorized Inspection Agency
AL	Action Levels
ALARA	As Low As Reasonably Achievable
AMP	Aging Management Plan
ASME	American Society of Mechanical Engineers
BDBA	Beyond-Design-Basis Accident
BOP	Balance of Plant
BPMS	Bruce Power Management System
BRPD	Bruce Regulatory Program Division
CANDU	Canadian Deuterium Uranium
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
CVC	Compliance Verification Criteria
CCW	Condenser Cooling Water
DBA	Design-Basis Accident
DCR	Document Change Request
DG	Director General
DPRR	Directorate of Power Reactor Regulation
DRL	Derived Release Limits
EAL	Environmental Action Levels
ECCC	Environment and Climate Change Canada
EFPH	Equivalent Full Power Hours
EMS	Environmental Management System
EQ	Environmental Qualification
ERA	Environmental Risk Assessment
FFSG	Fitness for Service Guidelines
$[H_{eq}]$	Hydrogen Equivalent Concentration
HTO	Hydrogenated Tritium Oxide (Tritium)
IAEA	International Atomic Energy Agency
IFB	Industrial Fire Brigade
IIP	Integrated Implementation Plan
IUCs	Instrument Uncertainty Calculations
LC	Licence Condition
LCH	Licence Conditions Handbook
LCMP	Life Cycle Management Plans
LII	List of Inventory Items
LVRF	Low Void Reactivity Fuel
mfp	Mixed Fission Products
NDE	Non-destructive Examination
NEW	Nuclear Energy Worker
NFPA	National Fire Protection Association
NGS	Nuclear Generating Station

NPP	Nuclear Power Plant
NSCA	*Nuclear Safety and Control Act*
MOECC	Ministry of Environment and Climate Change
OP&P	Operating Policies and Principles
OPEX	Operating Experience
OPG	Ontario Power Generation Inc.
OSRs	Operational Safety Requirements
PBQA	Pressure Boundary Quality Assurance
PIDP	Public Information and Disclosure Program
PIP	Periodic Inspection Program
PRA	Probabilistic Risk Assessment
PRLCID	Power Reactor Licensing and Compliance Integration Division
PROL	Nuclear Power Reactor Operating Licence
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
RPD	Regulatory Program Division
SAMGs	Severe Accident Management Guidelines
SAT	Systematic Approach to Training
SCA	Safety and Control Area
SCO	Station Containment Outage
SOE	Safe Operating Envelope
SPOC	Single Point of Contact
SQ	Seismic Qualification
SSCs	Systems, structures and components
VB	Vacuum Building
WN	Written Notification [document]

A.2 Definitions

The following is a list of definitions of words or expressions used in the LCH that may need clarification. Unless a reference source is provided in parenthesis, the words or expressions have been defined for the purpose of the LCH. Additional definitions could be found in REGDOC-3.6, *Glossary of CNSC Terminology*.

Accept/ed/able/ance

Meet regulatory requirements, which mean it is in compliance with regulatory documents or technical standards referenced in the licence.

Approval

Commission's permission to proceed, for situations or changes where the licensee would be:

- not compliant with a regulatory requirements set out in applicable laws and regulations; or
- not compliant with a licence condition; or
- not in the safe direction but the objective of the licensing basis is met.

Boundary conditions (context differs from REGDOC-3.6)

Procedural, administrative rules and operating limits for ensuring safe operation of the facility based on safety analysis. It also includes any applicable regulatory requirements.

Certified staff

Trained licensee staff, certified by the Commission to be competent in completing tasks identified in their respective roles.

Compliance verification criteria

Criteria used by CNSC staff to verify compliance with a licence condition. CVC provides the licensee and CNSC staff with detailed information to clarify regulatory requirements for compliance purposes.

Consent

Written permission to proceed, given by CNSC delegated authority, for situations or changes where the licensee would:

- comply with a regulatory requirements set out in applicable laws and regulations;
- comply with a licence condition; and
- not adversely impact the licensing basis.

Effective date

The date that a given document becomes incorporated into the licensing basis within the licensing period.

Extent of condition

Means an evaluation to determine if an issue has potential or actual applicability to other activities, processes, equipment, programs, facilities, operations or organizations.

Graduated enforcement

A process for escalating enforcement action. If initial enforcement action does not result in timely compliance, gradually more severe enforcement actions may need to be used. It takes into account such things as:

- the risk significance of the non-compliance with respect to health, safety, security, the environment and international obligations;
- the circumstances that lead to the non-compliance (including acts of willfulness);
- previous compliance record; and
- operational and legal constraints (for example, Directive on the Health of Canadians)
- industry specific strategies.

[CNSC process document: Assure Compliance-"Select and Apply Enforcement Tools"]

Levels 1 and 2 Outage Plans

A level 1 outage plan is a schedule which identifies the key components of the finalized critical path, major projects and programs. A level 2 outage plan is a schedule which identifies the system windows with durations.

Program(s)

A documented group of planned activities, procedures, processes, standards and instructions coordinated to meet a specific purpose.

Qualified staff

Trained licensee staff, deemed competent and qualified to carry out tasks associated to their respective positions.

Guidance

These are non-mandatory suggestions on how to comply with the licence condition. Guidance may include regulatory advice and/or recommended industry best practices to guide the licensee towards a higher level of safety and/or fully satisfactory performance/implementation of its programs.

Restart of the reactor

Removal of the Guaranteed Shutdown State.

Safe direction

Means changes in plant safety levels which would not result in:

- a reduction in safety margins,
- a breakdown of barrier,
- an increase (in certain parameters) above accepted limits,
- an increase in risk,
- impairment(s) of special safety systems,
- an increase in the risk of radioactive releases or spills of hazardous substances,
- injuries to workers or members of the public,
- introduction of a new hazard,

- reduction of the defense-in-depth provisions,
- reducing the capability to control, cool and contain the reactor while retaining the adequacy thereof, and
- causing hazards or risks different in nature or greater in probability or magnitude than those stated in the safety analysis of the nuclear facility.

Safety and control measures

Criteria used in assessing the compliance of a licence application with regulatory requirements. These measures or provisions demonstrate that the applicant:

(i) is qualified to carry on the licensed activities, and

(ii) has made adequate provision for the protection of the environment, the health and safety of persons, the maintenance of national security and any measures required to implement international obligations to which Canada has agreed.

Shall

Is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the licence.

Written Notification

A physical or electronic communication that follows established communication protocols.

APPENDIX B – List of All Version-Controlled Documents

B.1 – All Canadian Standards Association (CSA) documents

Document #	Document Title	Issue Date	L.C.
N286	Management system requirements for nuclear power plants	2005	1.1
N286	Management system requirements for nuclear facilities	2012	1.1
N290.15	Requirements for the safe operating envelope for nuclear power plants	2010 Update 1 2016	3.1
N286.7	Quality assurance of analytical, scientific, and design computer programs	2016	4.1
N290.12	Human factors in design for nuclear power plants	2014	5.1
N290.14	Qualification of pre-developed software for use in safety-related instrumentation and control applications in nuclear power plants	2007	5.1
N291	Requirements for safety-related structures for CANDU nuclear power plants (2015)	2015	5.1, 6.1
N285.0	General requirements for pressure-retaining systems and components in CANDU nuclear power plants	2012 Update No. 1 (Sep. 2013) & Update No. 2 (Nov. 2014)	5.2
N289.1	General requirements for seismic design and qualification of CANDU nuclear power plants	2008	5.3
N289.2	Ground motion determination for seismic qualification of CANDU nuclear power plants	2010	5.3
N289.3	Design procedures for seismic qualification of CANDU nuclear power plants	2010	5.3
N289.4	Testing procedures for seismic qualification of nuclear power plant structures, systems, and components	2012	5.3
N289.5	Seismic instrumentation requirements for nuclear power plants and nuclear facilities	2012	5.3
N290.13	Environmental qualification of equipment for CANDU nuclear power plants	Reaffirmed 2015	5.3
N285.4	Periodic inspection of CANDU nuclear power plant components	2009 Edition Update 2 (June 2011)	6.1
N285.5	Periodic inspection of CANDU nuclear power plant containment components	2008	6.1
N285.7	Periodic inspection of CANDU nuclear power plant balance of plant systems and components	2015	6.1
N287.7	In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plant components	2008	6.1
N288.1	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	2014 Update No. 2 (Nov. 2017)	9.1

Document #	Document Title	Issue Date	L.C.
N288.4	Environmental monitoring program at Class I nuclear facilities and uranium mines and mills	2010	9.1
N288.5	Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills	2011	9.1
N288.6	Environmental risk assessments at Class I nuclear facilities and uranium mines and mills	2012	9.1
N288.7	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	2015	9.1
N290.7	Cyber security for nuclear power plants and small reactor facilities	2014	12.1
N293	Fire protection for CANDU nuclear power plants	2012	10.2

CSA standards are the proprietary of the Canadian Standards Association (CSA Group) and are covered by copyright law. The CNSC has an online subscription (licence agreement) with the CSA Group for CNSC staff to access the nuclear standards ("my subscription"). The public has read-only access through the following platform:

https://community.csagroup.org/community/nuclear

CNSC staff may access standards and codes via e-Access – folder #4021465 – maintained by the Regulatory Framework Division.

B.2 – All Canadian Nuclear Safety Commission (CNSC) documents

Document #	Document Title	Issue Date	L.C.
RD/GD-99.3	Public Information and Disclosure	March 2012	G.5
REGDOC-2.2.4	Fitness for Duty: Managing Worker Fatigue	March 2017	2.1
RD-204	Certifications of Persons Working at Nuclear Power Plants	Feb. 2008	2.2
REGDOC-2.2.2	Personnel Training, Version 2	Dec. 2016	2.3
REGDOC-2.3.2	Accident Management: Severe Accident Management Programs for Nuclear Reactors	Sep. 2013	3.1
REGDOC-3.1.1	Reporting Requirements: Nuclear Power Plants, Version 2	April 2016	3.3
REGDOC-2.4.1	Deterministic Safety Analysis	May 2014	4.1
S-294	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	April 2005	4.1
REGDOC-2.4.2	Probabilistic Safety Assessment (PSA) For Nuclear Power Plants	May 2014	4.1
REGDOC-2.6.1	Reliability Programs for Nuclear Power Plants	August 2017	6.1
REGDOC-2.6.2	Maintenance Programs for Nuclear Power Plants	August 2017	6.1
REGDOC-2.6.3	Aging Management	March 2014	6.1
REGDOC-2.9.1	Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.1	Apr. 2017	9.1

Document #	Document Title	Issue Date	L.C.
REGDOC-2.10.1	Nuclear Emergency Preparedness and Response	Oct. 2014	10.1
REGDOC-2.12.1	High Security Sites: Nuclear Response Force	Oct. 2013	12.1
REGDOC-2.12.2	Site Access Security Clearance	April 2013	12.1
REGDOC-2.12.3	Security of Nuclear Substances: Sealed Sources	May 2013	12.1
RD-363	Nuclear Security Officer Medical, Physical and Psychological Fitness	Oct. 2008	12.1
RD-321	Criteria for Physical Protection Systems and Devices at High Security Sites	Dec. 2010	12.1
RD-361	Criteria for Explosive Substance Detection, X-Ray Imaging and Metal Detection at High Security Sites	Dec. 2010	12.1
RD-336	Accounting and Reporting of Nuclear Material	June 2010	13.1
REGDOC-2.3.3	Periodic Safety Reviews	April 2015	15.6
RD-327	Nuclear Criticality Safety	Dec. 2010	15.9

ALL CNSC REGULATORY DOCUMENTS CAN BE FOUND ON THE CNSC WEBSITE: http://www.nuclearsafety.gc.ca

Any superseded regulatory document may be requested through the email account: cnsc.consultation.ccsn@canada.ca

In addition, the following documents are referenced in the LCH under CVC:

Document #	Document Title	Date	L.C.	eDocs
EG1	Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants	July 2005	2.3	3402702
EG2	Requirements and Guidelines for Simulator-based Certification Examinations for Shift Personnel at Nuclear Power Plants	June 2004	2.3	3402705
N/A	Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants	May 2009	2.3	3436327

APPENDIX C – List of Documents used as Guidance

C.1 – Other Codes or Standards to be used as guidance

Document #	Document Title	L.C.
CSA N290.11	Requirements for heat removal capability during outage of nuclear power plants (2013)	3.1
CSA N290.16	Requirements for beyond design basis accidents (2016)	3.1
CSA N290.17	Probabilistic safety assessment for nuclear power plants (2017)	4.1
CSA N292.1	Wet storage of irradiated fuel and other radioactive materials (2016)	4.1
CSA N292.2	Interim dry storage of irradiated fuel (2013)	4.1
COG-09-9030	Principles & Guidelines For Deterministic Safety Analysis	4.1
COG-11-9023	Guidelines for Application of the Limit of Operating Envelope Methodology to Deterministic Safety Analysis	4.1
COG-06-9012	Guidelines for Application of the Best Estimate Analysis and Uncertainty (BEAU) Methodology to Licensing Analysis	4.1
COG-08-2078	Principles and Guidelines for NOP/ROP Trip Setpoint Analysis for CANDU Reactors	4.1
COG-13-9035	Derived Acceptance Criteria For Deterministic Safety Analysis	4.1
CSA N286.10	Configuration management for high energy reactor facilities (2016)	5.1
CSA N287.1	General requirements for concrete containment structures for CANDU nuclear power plants (2014)	5.1
CSA N287.2	Material requirements for concrete containment structures for CANDU nuclear power plants (2008)	5.1
CSA N287.3	Design requirements for concrete containment structures for CANDU nuclear power plants (2014)	5.1
CSA N287.4	Construction, fabrication, and installation requirements for concrete containment structures for CANDU nuclear power plants (2009)	5.1
CSA N287.5	Examination and testing requirements for concrete containment structures for CANDU nuclear power plants (2011)	5.1
CSA N287.6	Pre-operational proof and leakage rate testing requirements for concrete containment structures for CANDU nuclear power plants (2011)	5.1
CSA N290.0	General requirements for safety systems of nuclear power plants (2011)	5.1
CSA N290.1	Requirements for the shutdown systems of CANDU nuclear power plants (2013)	5.1
CSA N290.2	Requirements for emergency core cooling systems of nuclear power plants (2011)	5.1
CSA N290.3	Requirements for the containment system of nuclear power plants (2016)	5.1
CSA N290.4	Requirements for reactor control systems of nuclear power plants (2011)	5.1
CSA N290.5	Requirements for electrical power and instrument air systems of CANDU nuclear power plants (2006, R2011)	5.1
CSA N290.6	Requirements for monitoring and display of nuclear power plant safety functions in the event of an accident (2009, R2014)	5.1
CSA N290.14	Qualification of digital hardware and software for use in instrumentation and control applications for nuclear power plants (2015)	5.1
(USNRC) UFC-3-340-02	Unified Facilities Criteria – Structures to Resist the Effects of Accidental Explosions	5.1

Document #	Document Title	L.C.
ASME B31.1	Power Piping	5.2
ASME B31.3	Process Piping	5.2
ASME B31.5	Refrigeration Piping and Heat Transfer Components	5.2
ASME	Boiler and Pressure Vessel Code – Code Cases	5.2
CSA B51	Boiler, Pressure Vessel and Piping Code	5.2
CSA N285.0	General requirements for pressure-retaining systems and components in CANDU nuclear power plants (2017)	5.2
COG-05-9011	Interim Implementation Guidelines for CANDU Nuclear Plant Reliability Programs	6.1
CSA N285.4	Construction, fabrication, and installation requirements for concrete containment structures for CANDU nuclear power plants (2014)	6.1
CSA N285.5	Examination and testing requirements for concrete containment structures for CANDU nuclear power plants (2013)	6.1
CSA N285.8	Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors (2015)	6.1
CSA N287.8	Aging management for concrete containment structures for nuclear power plants (2015)	6.1
CSA N288.8	Establishing and implementing action levels for releases to the environment from nuclear facilities (2017)	9.1
CSA N1600	General requirements for nuclear emergency management programs (2016)	10.1
NEI 00-01	Guidance for Post Fire Safe Shutdown Circuit Analysis	10.2
CSA N292.0	General principles for the management of radioactive waste and irradiated fuel (2014)	11.1
CSA N292.2	Interim dry storage of irradiated fuel	11.1
CSA N292.3	Management of low- and intermediate-level radioactive waste (2014)	11.1
CSA N292.5	Guideline for the exemption of clearance from regulatory control of materials that contain, or potentially contain, nuclear substances (2011)	11.1
IAEA	IAEA Nuclear Security Series No. 4 Technical Guidance: Engineering Safety Aspects of the Protection of Nuclear Power Plants Against Sabotage	12.1
IAEA	IAEA Nuclear Security Series No. 13 Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5)	12.1
IAEA	IAEA Nuclear Security Series No. 17 Technical Guidance: Computer Security at Nuclear Facilities	12.1
IAEA	Specific Safety Guide Series No. SSG-28 Commissioning for Nuclear Power Plants	15.6
IAEA	Specific Safety Requirements Series No. SSR-2/2 Safety of Nuclear Power Plants: Commissioning and Operation	15.6

Canadian standards/codes and international documents can be found on the internet under the organization’s website. CNSC staff may access standards and codes via e-Access folder #4021465 – maintained by the Regulatory Framework Division.

C.2 – Other CNSC documents referenced in the LCH

Document #	Document Title	L.C.
P-299	Regulatory Fundamentals (2005)	N/A
P-242	Considering Cost-benefit Information (2000)	N/A
INFO-0795	Licensing Basis Objective and Definition	G.1
P-119	Policy on Human Factors	2.1
REGDOC-2.2.4	Fitness for Duty, Volume II: Managing Alcohol and Drug Use (2017)	2.1
G-323	Ensuring the Presence of Sufficiently Qualified Staff at Class I Nuclear Facilities - Minimum Shift Complement (2007)	2.2
G-278	Human Factors Verification and Validation Plans (2003)	2.2, 5.1
REGDOC-2.2.2	Personnel Training, Version 2 (2016)	2.3
REGDOC-2.3.2	Accident Management, Version 2 (2015)	3.1, 10.1
N/A	Interpretation of REGDOC-3.1.1, Reporting Requirements for Nuclear Power Plants, Revision 0 (2015)	3.3
G-276	Human Factors Engineering Program Plans (2003)	5.1
REGDOC-2.5.2	Design of Reactor Facilities: Nuclear Power Plants (2014)	5.1
G-129	Keeping Radiation Exposures and Doses “As Low As Reasonably Achievable (ALARA)” (2004)	7.1
G-228	Developing and Using Action Levels (2001)	7.1
REGDOC-2.10.1	Nuclear Emergency Preparedness and Response, Version 2 (2016)	10.1
G-274	Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities (2003)	12.1
G-208	Transportation Security Plans for Category I, II or III Nuclear Material (2003)	12.1
GD-336	Guidance for Accounting and Reporting of Nuclear Material (2010)	13.1
GD-327	Guidance for Nuclear Criticality Safety (2010)	15.9
REGDOC-2.13.2	Import and Export	13.1 15.12

ALL CNSC REGULATORY DOCUMENTS CAN BE FOUND ON THE CNSC WEBSITE: http://www.nuclearsafety.gc.ca

APPENDIX D – List of Licensee Documents Requiring Written Notification

Document #	Document Title	Notification Requirements	L.C.
GENERAL			
NK21-CORR-00531-13493	Bruce Power Letter, Frank Saunders to Marc Leblanc, "Application for the Renewal of the Power Reactor Operating Licence for Bruce Nuclear Generating Stations A and B", June 30, 2017	N/A	G.1
NK21-CORR-00531-13543	Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for Renewal of the Power Reactor Operating Licence: Periodic Safety Review Reports (including revised Bruce A and B Global Assessment Report and Integrated Implementation Plan)", July 19, 2017	N/A	G.1
NK21-CORR-00531-14175	Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Major Component Replacement Project Execution Plan and Bruce B Unit 6 Return to Service Plan", June 30, 2017	N/A	G.1
NK21-CORR-00531-13620	Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Updated Environmental Risk Assessment that includes Major Component Replacement", June 30, 2017	N/A	G.1
NK21-CORR-00531-13142	Bruce Power Letter, Frank Saunders to Ken Lafrenière, "Bruce A Environmental Assessment Follow-up Monitoring Report, 2015", November 21, 2016	N/A	G.1
NK21-CORR-00531-13494	Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Whitefish Research Review", June 30, 2017	N/A	G.1
NK21-CORR-00531-13587	Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: University Research Summary", June 30, 2017	N/A	G.1

Document #	Document Title	Notification Requirements	L.C.
NK21-CORR-00531-13367 NK29-CORR-00531-13917	Bruce Power Letter, “Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Security Program Description”, June 30, 2017 **(PROTECTED)**	N/A	G.1
NK21-CORR-00531-13854 NK29-CORR-00531-14517	Bruce Power Letter, Frank Saunders to Marc Leblanc, “Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Fitness-for-Service of Pressure Tubes”, October 13, 2017	N/A	G.1
NK21-CORR-00531-13890	Bruce Power Letter, Frank Saunders to Marc Leblanc, “Bruce Power Application for the Renewal of the Power Reactor Operating Licence: Supplemental Requests”, February 1, 2018	N/A	G.1
BP-PROG-03.01	Document Management	At Implementation	G.2
NK37-DRAW-10200-10001	Site Facilities Plan of the Bruce Nuclear Power Development Lots 11 to 28 and Part of 29 and 30	Prior to Implementation	G.3
NK21-SR-01320-00001	Bruce A Safety Report, Part 1: Plant and Site Description	Prior to Implementation	G.3
NK29-SR-01320-00001	Bruce B Safety Report, Part 1: Plant and Site Description	Prior to Implementation	G.3
BP-PROG-09.02	Stakeholder Interaction	At Implementation	G.5
MANAGEMENT SYSTEM			
BP-MSM-1	Management System Manual	Prior to Implementation	1.1
BP-PROG-01.01	Business Plan Management	At Implementation	1.1
BP-PROG-01.02	Bruce Power Management System (BPMS) Management	Prior to Implementation	1.1
BP-PROG-01.06	Operating Experience Program	At Implementation	1.1
BP-PROG-01.07	Corrective Action	At Implementation	1.1
BP-PROG-05.01	Supply Chain	At Implementation	1.1
BP-PROG-15.01	Nuclear Oversight Management	At Implementation	1.1
BP-PROG-14.01	Project Management and Construction	At Implementation	1.1
BP-PROG-14.02	Contractor Management	At Implementation	1.1
HUMAN PERFORMANCE MANAGEMENT			
BP-PROC-00005	Limits to Hours of Work	Prior to Implementation	2.1
BP-PROG-00.07	Human Performance Program	Prior to Implementation	2.1
BP-PROC-00610	Fitness For Duty	At Implementation	2.1
GRP-OPS-00055	Fitness for Duty Considerations for Shift Complement Staff Held Over for More than 13 Hours	At Implementation	2.1

Document #	Document Title	Notification Requirements	L.C.
DIV-OPA-00001	Station Shift Complement – Bruce A	Prior to Implementation	2.2
DIV-OPB-00001	Station Shift Complement – Bruce B	Prior to Implementation	2.2
BP-PROG-02.01	Human Resources Management	At Implementation	2.1
BP-PROG-02.02	Worker Learning and Qualification	Prior to Implementation	2.3
DIV-OPA-00002	Bruce A Role Descriptions for Licence-Related Positions	Prior to Implementation	2.4
DIV-OPB-00002	Bruce B Role Description for Licence-Related Positions	Prior to Implementation	2.4
SEC-RPR-00040	Responsibilities of an Authorized Health Physicist	Prior to Implementation	2.4
BP-PROC-00568	Certification Training Development and Administration of Comprehensive Written and Oral Examinations for Certification Training Programs	Prior to Implementation	2.4
B-HBK-09510-00012	Certification Training Examinations – Standards for Development and Administration of Closed Reference Multiple Choice Questions for Initial General Certification Written Examinations	Prior to Implementation	2.4
OPERATING PERFORMANCE			
BP-OPP-00001	Operating Policies and Principles – Bruce B	Prior to Implementation	3.1
BP-OPP-00002	Operating Policies and Principles – Bruce A	Prior to Implementation	3.1
BP-OPP-00003	Operating Policies and Principles – Central Maintenance and Laundry Facility	Prior to Implementation	3.1
NK37-CORR-00531-02784	Bruce Power Safeguards Site Plan 2015	N/A	3.1
BP-PROG-12.01	Conduct of Plant Operations	At Implementation	3.1
NK21-OSR-31000-00001	Operational Safety Requirements for Bruce A Fuel and Reactor Physics	Prior to Implementation	3.1
NK21-OSR-32000-00001	Operational Safety Requirements for Bruce A Moderator System	Prior to Implementation	3.1
NK21-OSR-33100-00001	Bruce A NGS: Operational Safety Requirements for Heat Transport System	Prior to Implementation	3.1
NK21-OSR-34110-00001	Operational Safety Requirements for Bruce A End Shield Cooling System	Prior to Implementation	3.1
NK21-OSR-34200-00004	Operational Safety Requirements for Bruce A Containment System	Prior to Implementation	3.1
NK21-OSR-34340-00003	Operational Safety Requirements for Bruce A Emergency Coolant Injection System	Prior to Implementation	3.1

Document #	Document Title	Notification Requirements	L.C.
NK21-OSR-34360-00001	Operational Safety Requirements for Bruce A Powerhouse Emergency Venting System	Prior to Implementation	3.1
NK21-OSR-34700-00001	Operational Safety Requirements for Bruce A Shutdown and Maintenance Cooling Systems	Prior to Implementation	3.1
NK21-OSR-34980-00001	Operational Safety Requirements for Bruce A Annulus Gas System	Prior to Implementation	3.1
NK21-OSR-35000-00001	Operational Safety Requirements for Bruce A Fuel Handling	Prior to Implementation	3.1
NK21-OSR-36100-00001	Operational Safety Requirements for Bruce A Main Steam Supply System	Prior to Implementation	3.1
NK21-OSR-38330/21175-00001	Operational Safety Requirements for Bruce A Confinement	Prior to Implementation	3.1
NK21-OSR-43200-00001	Operational Safety Requirements for Bruce A Feedwater and Condensate System	Prior to Implementation	3.1
NK21-OSR-53000/55000-00001	Operational Safety Requirements for Bruce A Electrical System	Prior to Implementation	3.1
NK21-OSR-5440-00001	Operational Safety Requirements for Bruce A Qualified Power Supply System	Prior to Implementation	3.1
NK21-OSR-66060-00001	Operational Safety Requirements for Critical Safety Parameter Monitoring	Prior to Implementation	3.1
NK21-OSR-63710-00001	Operational Safety Requirements for Bruce A Reactor Regulating System	Prior to Implementation	3.1
NK21-OSR-63720-63730-00001	Operational Safety Requirements for Bruce A Shutdown Systems	Prior to Implementation	3.1
NK21-OSR-71310-00001	Operational Safety Requirements for Bruce A Service Water Systems	Prior to Implementation	3.1
NK21-OSR-71910-00001	Operational Safety Requirements for Bruce A Emergency Boiler Cooling System	Prior to Implementation	3.1
NK29-OSR-31000-00001	Operational Safety Requirements for Bruce B Fuel and Reactor Physics	Prior to Implementation	3.1
NK29-OSR-32000-00001	Operational Safety Requirements for Bruce B Moderator System	Prior to Implementation	3.1
NK29-OSR-33000-00001	Operational Safety Requirements for Bruce B Heat Transport System	Prior to Implementation	3.1
NK29-OSR-34110-00001	Operational Safety Requirements for Bruce B End Shield Cooling System	Prior to Implementation	3.1
NK29-OSR-34200-00001	Operational Safety Requirements for Bruce B Containment System	Prior to Implementation	3.1
NK29-OSR-34340-00001	Operational Safety Requirements for Bruce B Emergency Coolant Injection System	Prior to Implementation	3.1

Document #	Document Title	Notification Requirements	L.C.
NK29-OSR-34360-00001	Operational Safety Requirements for Bruce B Powerhouse Emergency Venting System	Prior to Implementation	3.1
NK29-OSR-34700-00001	Operational Safety Requirements for Bruce B Shutdown and Maintenance Cooling Systems	Prior to Implementation	3.1
NK29-OSR-34980-00001	Operational Safety Requirements for Bruce B Annulus Gas System	Prior to Implementation	3.1
NK29-OSR-35000-00001	Operational Safety Requirements for Bruce B Fuel Handling	Prior to Implementation	3.1
NK29-OSR-36100-00001	Operational Safety Requirements for Bruce B Main Steam Supply System	Prior to Implementation	3.1
NK29-OSR-38330-21190-00001	Operational Safety Requirements for Bruce B Confinement	Prior to Implementation	3.1
NK29-OSR-43220-00001	Operational Safety Requirements for Bruce B Feedwater and Condensate System	Prior to Implementation	3.1
NK29-OSR-53000-55000-00001	Operational Safety Requirements for Bruce B Electrical System	Prior to Implementation	3.1
NK29-OSR-54300-00001	Operational Safety Requirements for Bruce B Emergency Power Supply System	Prior to Implementation	3.1
NK29-OSR-60060-00001	Operational Safety Requirements for Bruce B Critical Safety Parameter Monitoring	Prior to Implementation	3.1
NK29-OSR-63710-00001	Operational Safety Requirements for Bruce B Reactor Regulating System	Prior to Implementation	3.1
NK29-OSR-63720-63730-00001	Operational Safety Requirements for Bruce B Shutdown Systems	Prior to Implementation	3.1
NK29-OSR-71310-00001	Operational Safety Requirements for Bruce B Service Water Systems	Prior to Implementation	3.1
NK29-OSR-71380-00001	Operational Safety Requirements for Bruce B Emergency Water System	Prior to Implementation	3.1
BP-PROG-06.01	Nuclear Regulatory Affairs	At Implementation	3.3
SAFETY ANALYSIS			
NK21-SR-01320-00002	Bruce A Safety Report, Part 2: Plant Components and Systems	Prior to Implementation	4.1
NK29-SR-01320-00001	Bruce B Safety Report, Part 2: Plant Components and Systems	Prior to Implementation	4.1
NK21-SR-01320-00003	Bruce A Safety Report, Part 3: Safety Analysis	Prior to Implementation	4.1
NK29-SR-01320-00002	Bruce B Safety Report, Part 3: Safety Analysis	Prior to Implementation	4.1
B-03490-31MAR2017	Updated Emergency Planning Technical Basis for Provincial Nuclear Emergency Response Plan	Prior to Implementation	4.1

Document #	Document Title		Notification Requirements	L.C.
PHYSICAL DESIGN				
BP-PROG-10.01	Plant Design Basis Management		Prior to Implementation	5.1
BP-PROG-10.02	Engineering Change Control		Prior to Implementation	5.1
BP-PROG-10.03	Configuration Management		At Implementation	5.1
BP-PROG-00.04	Pressure Boundary Quality Assurance Program		At Implementation	5.2
B-LIST-01900-00001	Index to Pressure Boundary Program Elements (CSA N285.0-12 Table N.1)		At Implementation	5.2
DIV-ENG-00017	System and Item Classification		Prior to Implementation	5.2
DIV-ENG-00018	Design Registration and Reconciliation		At Implementation	5.2
FITNESS FOR SERVICE				
BP-PROG-11.04	Plant Maintenance		At Implementation	6.1
BP-PROG-11.01	Equipment Reliability		At Implementation	6.1
NK21-PIP-21100-00001		Periodic Inspection Program for Bruce NGS A Concrete Containment Structures and Appurtenances	Prior to Implementation	6.1
NK21-PIP-25100-00001		Periodic Inspection Program for Bruce NGS A Vacuum Building	Prior to Implementation	6.1
NK29-PIP-21100-00001	N287.7	Periodic Inspection Program for Bruce NGS B Concrete Containment Structures and Appurtenances	Prior to Implementation	6.1
NK29-PIP-25100-00001		Periodic Inspection Program for Bruce NGS B Vacuum Building	Prior to Implementation	6.1
BP-PROC-00815		Visual Inspection of Containment Boundary Components	Prior to Implementation	6.1
NK21-PIP-03641.2-00001		Bruce A Periodic Inspection Plan for Unit 1	Prior to Implementation	6.1
NK21-PIP-03641.2-00002		Bruce A Periodic Inspection Plan for Unit 2	Prior to Implementation	6.1
NK21-PIP-03641.2-00003		Bruce A Periodic Inspection Plan for Unit 3	Prior to Implementation	6.1
NK21-PIP-03641.2-00004	N285.4	Bruce A Periodic Inspection Plan for Unit 4	Prior to Implementation	6.1
NK29-PIP-03641.2-00001		Bruce B Periodic Inspection Plan for Unit 5	Prior to Implementation	6.1
NK29-PIP-03641.2-00002		Bruce B Periodic Inspection Plan for Unit 6	Prior to Implementation	6.1

<table>
<tr><th>Document #</th><th colspan="2">Document Title</th><th>Notification Requirements</th><th>L.C.</th></tr>
<tr><td>NK29-PIP-03641.2-00003</td><td rowspan="3"></td><td>Bruce B Periodic Inspection Plan for Unit 7</td><td>Prior to Implementation</td><td>6.1</td></tr>
<tr><td>NK29-PIP-03641.2-00004</td><td>Bruce B Periodic Inspection Plan for Unit 8</td><td>Prior to Implementation</td><td>6.1</td></tr>
<tr><td>B-PIP-31100-00002</td><td>Bruce Nuclear Generating Station Fuel Channel Periodic Inspection Program</td><td>Prior to Implementation</td><td>6.1</td></tr>
<tr><td>NK21-PIP-03642-00001</td><td rowspan="2">N285.5</td><td>Bruce A Periodic Inspection Plan for Unit 0 and Units 1 to 4 Containment Components</td><td>Prior to Implementation</td><td>6.1</td></tr>
<tr><td>NK29-PIP-03642-00001</td><td>Bruce B Periodic Inspection Plan for Unit 0 and Units 5 to 8 Containment Components</td><td>Prior to Implementation</td><td>6.1</td></tr>
<tr><td>B-LCM-20000-00001</td><td colspan="2">Life Cycle Management Plan for Safety Related Civil Structures</td><td>Prior to Implementation</td><td>6.1</td></tr>
<tr><td>B-PIP-33110-00001</td><td colspan="2">Steam Generator and Preheater Life Cycle Management Plan</td><td>Prior to Implementation</td><td>6.1</td></tr>
<tr><td>B-PIP-33126-00001</td><td colspan="2">PHT Feeder Piping Periodic Inspection Plan</td><td>Prior to Implementation</td><td>6.1</td></tr>
<tr><td>BP-PROG-11.02</td><td colspan="2">On-Line Work Management</td><td>At Implementation</td><td>6.1</td></tr>
<tr><td>BP-PROG-11.03</td><td colspan="2">Outage Work Management</td><td>At Implementation</td><td>6.1</td></tr>
<tr><td>BP-PROG-12.02</td><td colspan="2">Chemistry Management</td><td>At Implementation</td><td>6.1</td></tr>
<tr><th colspan="5">RADIATION PROTECTION</th></tr>
<tr><td>BP-PROG-12.05</td><td colspan="2">Radiation Protection Program</td><td>Prior to Implementation</td><td>7.1</td></tr>
<tr><td>BP-RPP-00044</td><td colspan="2">ALARA Program</td><td>At Implementation</td><td>7.1</td></tr>
<tr><td>BP-PROC-00280</td><td colspan="2">Dosimetry Requirements</td><td>Prior to Implementation</td><td>7.1</td></tr>
<tr><td>BP-RPP-00009</td><td colspan="2">Dose Limits and Exposure Control</td><td>Prior to Implementation</td><td>7.1</td></tr>
<tr><th colspan="5">CONVENTIONAL HEALTH AND SAFETY</th></tr>
<tr><td>BP-PROG-00.06</td><td colspan="2">Health and Safety Management</td><td>At Implementation</td><td>8.1</td></tr>
<tr><th colspan="5">ENVIRONMENTAL PROTECTION</th></tr>
<tr><td>BP-PROG-00.02</td><td colspan="2">Environmental Management</td><td>Prior to Implementation</td><td>9.1</td></tr>
<tr><td>NK21-REP-03482-00002</td><td colspan="2">Derived Release Limits and Action Levels for Bruce Nuclear Generating Station A</td><td>Prior to Implementation</td><td>9.1</td></tr>
<tr><td>NK37-REP-03482-00003</td><td colspan="2">Derived Release Limits and Action Levels for Bruce Nuclear Generating Station B</td><td>Prior to Implementation</td><td>9.1</td></tr>
</table>

Document #	Document Title	Notification Requirements	L.C.
NK37-REP-03482-00001	Derived Release Limits and Action Levels for Central Maintenance and Laundry Facility	Prior to Implementation	9.1
BP-PROC-00171	Radiological Emissions Limits and Action Levels	Prior to Implementation	9.1
EMERGENCY MANAGEMENT AND FIRE PROTECTION			
BP-PLAN-00001	Bruce Power Nuclear Emergency Response Plan	Prior to Implementation	10.1
BP-PLAN-00005	Radioactive Materials Transportation Emergency Response Plan	At Implementation	10.1
BP-PROG-08.01	Emergency Management Program	At Implementation	10.1
B-03490-31MAR2017	Updated Emergency Planning Technical Basis for Provincial Nuclear Emergency Response Plan	Prior to Implementation	10.1
BP-PLAN-00008	Fire Safety Management	At Implementation	10.2
BP-PLAN-00006	Conventional Emergency Plan	At Implementation	10.2
WASTE MANAGEMENT			
BP-PROG-12.03	Nuclear Fuel Management	At Implementation	11.1
SECURITY			
BP-PROG-08.02	Nuclear Security	Prior to Implementation	12.1
BP-PROC-00784	Cybersecurity	At Implementation	12.1
SAFEGUARDS			
NK21-OM-35370	Safeguards Operating Manual	At Implementation	13.1
NK29-OM-35370	Safeguards Operating Manual	At Implementation	13.1
PACKAGING AND TRANSPORT			
N/A			
NUCLEAR FACILITY-SPECIFIC			
NK21-CORR-00531-14175	Bruce Power Letter, Frank Saunders to Marc Leblanc, "Supplement to the Application for the Renewal of the Power Reactor Operating Licence: Major Component Replacement Project Execution Plan and Bruce B Unit 6 Return to Service Plan", June 30, 2017, e-Doc 5292343	N/A	15.4
BP-PROC-00324	Nuclear Criticality Safety Management	Prior to Implementation	15.9
BP-PROC-00003	Cobalt Handling	Prior to Implementation	15.10

Document #	Document Title	Notification Requirements	L.C.
BP-PROC-00817	Management of Class II Nuclear Facilities	At Implementation	15.11
BP-PROC-00143	Leak Testing Program	At Implementation	15.11, 15.12
NK29-CMP-67880-00001	Radiation Calibration Facility Safety Interlock Checks and Operation	At Implementation	15.11
NK29-CORR-00531-01343	Plans and Design of the Nuclear Facility	N/A	15.11
NK29-CORR-00531-04839	Shielding Calculations	N/A	15.11
NK29-DRAW-67880-10001 Rev. 2006/08/03	Safety System Layout	At Implementation	15.11
NK29-DRAW-67880-10003 Rev. 2006/08/03	Safety System Diagram	At Implementation	15.11
BP-RPP-00043	Management of Nuclear Substances and Radiation Generating Equipment	At Implementation	15.12
NK21-CMP-67870-00002	Bruce Power Inc. Control Maintenance Procedure, Hopewell Designs BX-3-2600 Box Calibrator Pre-Use Operational and Safety Interlock Checks	At Implementation	15.12
BP-PROC-00036	Conduct of Radiography	At Implementation	15.12
BP-PROC-00798	Radiography Emergency Procedures	At Implementation	15.12

CURRENT LICENCE

PDF Ref.: e-Doc 4723908
Word Ref.: e-Doc 4648308
File / Dossier: 2.01

NUCLEAR POWER REACTOR OPERATING LICENCE

BRUCE NUCLEAR GENERATING STATIONS A AND B

I) LICENCE NUMBER: **PROL 18.00/2020**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act* this licence is issued to:

Bruce Power Inc.
P.0. Box 1540, R.R. #2
Building B10, 177 Tie Road
Municipality of Kincardine
Tiverton, Ontario
N0G 2T0

III) LICENCE PERIOD: This licence is valid from June 1, 2015 to May 31, 2020, unless suspended, amended, revoked or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

(i) operate the Bruce Nuclear Generating Stations A and B (hereinafter “the nuclear facilities”) comprised of reactor units 1 to 4 and 5 to 8 respectively, at the Bruce site located in the County of Bruce in the regional municipality of Kincardine, Province of Ontario.

(ii) possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in (i);

(iii) possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in (i);

(iv) possess, transfer use, package, manage and store heavy water and the nuclear substances arising from the use of heavy water in the heat transport and moderator systems;

(v) possess, manage and store booster fuel assemblies at Bruce A; and

(vi) possess, produce, manage, transfer and store Cobalt-60 at Bruce B.

V) EXPLANATORY NOTES:

(i) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(ii) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* and associated Regulations.

(iii) The BRUCE NGS A AND B LICENCE CONDITIONS HANDBOOK (LCH) provides compliance verification criteria including the Canadian standards and regulatory documents used to verify compliance with the conditions in the licence. The LCH also provides information regarding delegation of authority, applicable versions of documents and non-mandatory recommendations and guidance on how to achieve compliance.

VI) CONDITIONS:

G. **General**

G.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

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

(ii) the conditions and safety control measures described in the facilities' licence and the documents directly referenced in that licence;

(iii) the safety and control measures described in the licence applications and the documents needed to support those licence applications;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (CNSC) (hereinafter "the Commission").

G.2 The licensee shall give written notification of changes to the facilities or their operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

G.3 The licensee shall control the use and occupation of any land within the exclusion zones.

G.4 The licensee shall provide, at the Bruce site and at no expense to the Commission, office space for employees of the Commission who customarily carry out their functions on the premises of the nuclear facilities (onsite Commission staff).

G.5 The licensee shall implement and maintain a public information and disclosure program.

1. Management System

1.1 The licensee shall implement and maintain a management system.

2. Human Performance Management

2.1 The licensee shall implement and maintain a human performance program.

2.2 The licensee shall implement and maintain the minimum shift complement and control room staffing for the nuclear facilities.

2.3 The licensee shall implement and maintain training programs for workers. The certification process and supporting examinations and tests shall be conducted in accordance with CNSC regulatory document RD-204 CERTIFICATION OF PERSONS WORKING AT NUCLEAR POWER PLANTS.

Persons appointed to the following positions shall be certified:

(i) authorized health physicist;

(ii) authorized nuclear operator;

(iii) control room shift supervisor;

(iv) Unit 0 control room operator; and

(v) Shift manager.

3. Operating Performance

3.1 The licensee shall implement and maintain an operations program, which shall have as components:

(i) a safe operating envelope;

(ii) a set of operating policies and principles; and

(iii) accident management procedures and/or guides for design basis and beyond design basis accidents, including overall strategies for recovery.

3.2 The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or prior written consent of a person authorized by the Commission.

3.3 The licensee shall notify and report in accordance with CNSC regulatory document REGDOC-3.1.1 REPORTING REQUIREMENTS: NUCLEAR POWER PLANTS.

4. Safety Analysis

4.1 The licensee shall implement and maintain a deterministic safety analysis program and a probabilistic safety assessment program.

4.2 The licensee shall ensure that design and analysis computer codes and software used to support the safe operation of the nuclear facilities are of adequate quality.

5. Physical Design

5.1 The licensee shall implement and maintain a design program.

5.2 The licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency.

5.3 The licensee shall implement and maintain an environmental qualification program.

6. Fitness for Service

6.1 The licensee shall implement and maintain programs to ensure fitness for service of systems, structures and components, including an in-service inspection program for the safety significant balance of plant pressure retaining systems and components, and safety-related structures.

7. Radiation Protection

7.1 The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

8. Conventional Health and Safety

8.1 The licensee shall implement and maintain a conventional health and safety program.

9. Environmental Protection

9.1 The licensee shall implement and maintain an environmental protection program and undertake specific measures to control releases of nuclear and hazardous substances in accordance with applicable limits and to monitor effluents.

9.2 The licensee shall have a set of environmental action levels for nuclear substances. When the licensee becomes aware that an environmental action level has been reached, the licensee shall notify the Commission within seven days.

10. Emergency Management and Fire Protection

10.1 The licensee shall implement and maintain an emergency preparedness program and conduct emergency exercises.

10.2 The licensee shall implement and maintain a fire protection program.

11. Waste Management

11.1 The licensee shall implement and maintain a waste management program.

11.2 The licensee shall notify the Commission of any changes regarding the obligations of decommissioning and financial guarantees under the Lease Agreement with Ontario Power Generation Inc., as described in 15.1.

12. Security

12.1 The licensee shall implement and maintain a nuclear security program.

13. Safeguards and Non-Proliferation

13.1 The licensee shall implement and maintain a safeguards program.

14. Packaging and Transport

14.1 The licensee shall implement and maintain a packaging and transport program.

15. Nuclear Facility-Specific

15.1 The licensee shall inform the Commission in writing of any amendments to the Amended and Restated Lease Agreement between Ontario Power Generation Inc., Bruce Power L.P., OPG-Huron A Inc./OPG-Huron B Inc./OPG-Huron Common Facilities Inc., British Energy PLC, Cameco Corporation, TransCanada Pipelines Limited, BPC Generation Infrastructure Trust and Ontario Municipal Employees Retirement Board dated February 14, 2003.

15.2 The licensee shall inform the Commission of any plan to refurbish a reactor or replace a major component at the nuclear facilities, and shall:

(i) prepare and conduct a periodic safety review.

(ii) implement and maintain a return-to-service plan; and

(iii) provide periodic updates on progress and proposed changes.

15.3 The licensee shall inform the Commission of any reactor to be removed from commercial operations at the nuclear facilities, and shall provide a plan describing the activities and timeline for transitioning from operations to safe storage.

15.4 The licensee shall store and manage booster fuel assemblies at Bruce A in a manner that ensures their physical security.

15.5 The licensee shall implement and maintain a nuclear criticality safety program.

15.6 The licensee shall implement and maintain a program for the receipt, storage and handling of the prescribed substance Cobalt-60 at Bruce B.

SIGNED at OTTAWA MAY 2 7 2015

Michael Binder
President
CANADIAN NUCLEAR SAFETY COMMISSION