Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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SUPPLEMENTAL/ SUPPLÉMENTAIRE

CMD: 18-H4.B

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A Licence Renewal

Bruce Power Inc.

Bruce Nuclear Generating Stations A and B

Commission Public Hearing – Part 2

Scheduled for:

28-31 May 2018

Submitted by:

CNSC Staff

Un renouvellement de permis

Bruce Power Inc.

Centrales nucléaires de Bruce A et B

Audience publique de la Commission – Partie 2

Prévue pour :

28-31 Mai 2018

Soumise par :

Le personnel de la CCSN

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Summary

This supplemental CMD presents updated information with respect to Bruce Power Inc. on:

- renewal of the Power Reactor Operating Licence (PROL) for the Bruce Nuclear Generating Stations (NGS) A and B
- relevant safety and control areas, specifically the following regulatory focus areas:
  - human performance management
  - safety analysis
  - fitness for service
  - radiation protection
  - environmental protection
  - emergency management and fire protection
  - waste management
  - other matters of regulatory interest

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)
  - demonstrate pressure tube fracture toughness sufficient for safe operation beyond 120 ppm
  - implement a return to service plan for Major Component Replacement

Résumé

Le présent CMD supplémentaire présente de l'information à jour sur les questions suivantes concernant Bruce Power Inc.:

- le renouvellement du permis d'exploitation d'un réacteur de puissance (PERP) des centrales nucléaires de Bruce A et B
- les domaines de sûreté et de réglementation pertinents, plus particulièrement les domaines d'intérêt réglementaire suivants :
  - Gestion de la performance humaine
  - Analyse de la sûreté
  - Aptitude fonctionnelle
  - Radioprotection
  - Protection de l'environnement
  - Gestion des urgences et protection-incendie
  - Gestion des déchets
  - autres questions d'intérêt réglementaire

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 intégré d'amélioration découlant du bilan périodique de la sûreté (BPS)
  - démontre que la résistance aux fractures des tubes de force est adéquate pour l'exploitation sûre au-delà de 120 ppm
  - mette en œuvre un plan de remise en service pour les activités de

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
- direct CNSC staff and Bruce Power, to work with Indigenous groups to address their areas of concerns as identified in this CMD

- 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 Hours
- delegate authority as set out in CMD 18-H4
- 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

The following items are attached:

- CMD 18-M4, *Technical update on fuel*

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 avant le renouvellement du prochain permis
- demander au personnel de la CCSN et à Bruce Power de travailler avec les groupes autochtones afin de répondre à leurs préoccupations, qui sont mentionnées dans le présent CMD

- modifier le PERP afin d'y regrouper les permis précis (catégorie II et substances nucléaires et appareils à rayonnement) indiqués 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 un maximum de 300 000 heures équivalentes pleine puissance
- déléguer l'autorité comme il est décrit dans le CMD 18-H4
- 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, qui serait valide pour une période de 10 ans, soit du 1er septembre 2018 au 31 août 2028

Les pièces suivantes sont jointes :

- CMD 18-M4, *Technical update on fuel*

channel fitness-for-service in Canadian nuclear power plants

- CNSC staff response to Saugeen Ojibway Nation's technical appendices in CMD 18-H4.146
- Summary of key issues raised by Aboriginal peoples including CNSC staff and Bruce Power responses
- The updated proposed PROL 18.00/2028

channel fitness-for-service in Canadian nuclear power plants

- Réponse du personnel de la CCSN aux annexes techniques de la Nation Saugeen Ojibway dans le CMD 18-H4.146
- Résumé des enjeux clés soulevés par les peuples autochtones, ainsi que les réponses du personnel de la CCSN et de Bruce Power
- Le permis proposé mis à jour – PERP 18.00/2028

Signed/signé le

16 May, 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

In June 2017, Bruce Power submitted an application requesting licence renewal two years prior to expiry of the current licence in order to obtain the Commission's approval needed to refurbish its units. Bruce Power has requested a renewal licence period of ten (10) years which encompasses operation as well as activities related to refurbishment (which Bruce Power refers to as Major Component Replacement[1] or MCR) of Units 3 to 8, which is planned to begin in 2020. The current Bruce A and B power reactor operating licence, PROL 18.00/2020 expires on May 31, 2020.

In this supplemental Commission Member Document (CMD), CNSC staff present updates since March 14, 2018 (date of Part 1 hearing) including:

- Human Performance Management: Implementation plan for REGDOC-2.2.4 (Volume II), *Fitness for Duty: Managing Alcohol and Drug Use*
- Safety Analysis: Probabilistic Safety Assessment for Large Release Frequency
- Fitness for Service: Operation up to 300,000 Equivalent Full Power Hours (EFPH)
- Radiation Protection: Biological mechanisms acting at low doses of radiation
- Environmental Protection: Environmental Risk Assessment, effluent and environmental monitoring programs, tritium studies synthesis report
- Emergency Management Fire Protection: 2017 Provincial Nuclear Emergency Response Plan update
- Waste Management
- Other Matters of Regulatory Interests:
    - Fukushima Action Items
    - *Fisheries Act* authorization
    - Aboriginal consultation and engagement activities
    - Participant Funding Program
    - Previous commitments raised by the Commission
- Updates to the proposed Licence

CNSC staff conclude 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.

As stated in Part 1 CMD 18-H4 and as updated for Part 2 hearing, 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 Integrated Improvement Plan (IIP) resulting from the current Periodic Safety Review (PSR)

[1] 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.

  - LC 15.3, before hydrogen equivalent concentrations exceed 120 ppm, the licensee shall demonstrate that pressure tube fracture toughness will be sufficient for safe operation beyond 120 ppm
  - 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
- direct CNSC staff and Bruce Power, to work with Indigenous groups to address their areas of concerns as identified in Section 4.3 of this CMD
- 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 Hours
- delegate authority as set out in CMD 18-H4
- issue, pursuant to section 24 of the Nuclear Safety and Control Act (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.

This CMD is presented in two parts. Updates to the general assessment of SCAs since Part 1 hearing (including an overview of the matters being presented, and overall recommendations and conclusions) are presented in Part One of this CMD.

Updates to the proposed PROL and Licence Conditions Handbook are presented in Part Two of this CMD.

Material that complements Part One and Part Two of this CMD is provided in the Addendum section.

PART ONE

Part One includes:

1. An overview of the matter being presented
2. Overall conclusions and overall recommendations
3. Updates to the general assessment of SCAs since Part 1 Hearing
4. Updates to other matters of regulatory interest since Part 1 Hearing

1. OVERVIEW

1.1 Highlights

In the Ontario Long-Term Energy Plan [1] (first issued in 2010 with updates in 2013 and 2017), the Government of Ontario, through the Minister of Energy, concluded that it would refurbish the nuclear generating stations. In developing the Long-Term Energy Plan, the Province of Ontario stated that they have consulted with the public as well as Aboriginal peoples.

Subsequently, Bruce Power entered into a long-term agreement with the Independent Electricity System Operator (IESO) to refurbish six nuclear units at the Bruce Nuclear Generating Station. The decision to undertake the refurbishment of the Bruce units falls outside the mandate of the Canadian Nuclear Safety Commission (CNSC). The CNSC mandate is regulate the use of nuclear energy and materials to protect health, safety, security and the environment.

In June 2017, Bruce Power submitted an application, including supplemental information [2-14], for the renewal of its Bruce A and B Power Reactor Operating Licence (PROL). The current PROL expires on May 31, 2020. Bruce Power is seeking to renew the licence two years prior to expiry of the current licence in order to obtain the Commission's approval needed to refurbish its units. Bruce Power has requested a renewal licence period of ten (10) years which encompasses operation as well as activities related to refurbishment (which Bruce Power refers to as Major Component Replacement[2] 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 and prescribed equipment, except controlled nuclear substances and controlled nuclear equipment, that are required for, are associated with, or arise from the three (3) activities listed above
- possess, manage and store Cobalt-60 at Bruce B
- possess, manage and store booster fuel assemblies at Bruce A

Once the Commission has granted a licence, the role of CNSC staff is to provide regulatory oversight in order to ensure that the licensee is operating the licensed facility in a safe manner, in compliance with the requirements of the Nuclear

[2] 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.

Safety and Control Act (NSCA) and its regulations, as well as the Commission approved licence conditions.

The Bruce A and B nuclear generating stations have very good safety records. Bruce Power continued to implement safety improvements throughout the current licensing period to ensure that regulatory requirements and performance objectives were met or exceeded. There are currently no safety concerns and no impediments to renew the operating licence for Bruce A and B.

1.2 Overall Conclusions

The updates provided in this supplemental CMD do not change the overall CNSC staff conclusions from CMD 18-H4.

CNSC staff 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.

1.3 Overall Recommendations

As presented in Part 1 CMD 18-H4, CNSC staff's overall recommendations to the Commission have not changed. The recommendations include:

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[3], before hydrogen equivalent concentrations exceed 120 ppm, the licensee shall demonstrate that pressure tube fracture toughness will be sufficient for safe operation beyond 120 ppm
   - 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. direct CNSC staff and Bruce Power, to work with Indigenous groups to address their areas of concerns as identified in Section 4.3 of this CMD
3. 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
4. authorize Bruce Power to operate Bruce A and B up to a maximum of 300,000 Equivalent Full Power Hour
5. delegate authority as set out in CMD 18-H4
6. 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 rationale behind CNSC staff's recommendation for a 10-year licence is provided in Section 4.6 of this CMD.

The proposed PROL is presented in Part 2 of this CMD.

[3] The recommendations for LC 15.3 have not changed. The condition was strengthened based on feedback by the Commission during the Part 1 hearing.

2. MATTERS FOR CONSIDERATION

2.1 Safety and Control Areas (SCAs)

As presented in Part 1 CMD 18-H4, the plant safety performance ratings for the fourteen (14) SCAs were provided from 2014 to 2016. Table 1 below includes the ratings for 2017, which shows no changes from 2016. In summary, 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 dose limits. Risk to the public and Bruce Power workers has been kept as low as reasonably achievable (ALARA) and, in CNSC staff's opinion, should remain so over the recommended 10-year licensing period.

Table 1: Plant Safety Performance Ratings 2015-2017

Safety and Control Area (SCA)	2015		2016		2017	
	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	FS	FS	FS	FS	FS	FS
Safety Analysis	SA	SA	FS	FS	FS	FS
Physical Design	SA	SA	SA	SA	SA	SA
Fitness for Service	SA	SA	SA	SA	SA	SA
Radiation Protection	SA	SA	FS	FS	FS	FS
Conventional Health and Safety	FS	FS	FS	SA	FS	SA
Environmental Protection	SA	SA	SA	SA	SA	SA
Emergency Management and Fire Protection	SA	SA	SA	SA	SA	SA
Waste Management	FS	FS	FS	FS	FS	FS
Security	FS	FS	SA	SA	SA	SA
Safeguards and Non-proliferation	SA	SA	SA	SA	SA	SA
Packaging and Transport	SA	SA	SA	SA	SA	SA
Integrated Plant Rating	FS	FS	FS	SA	FS	SA

Note: FS = fully satisfactory SA = satisfactory

Note: *Plant safety performance ratings for 2017 will be presented to the Commission in late 2018*

3. GENERAL ASSESSMENT OF SCAS

The following Safety and Control Area (SCA) sections contain updates since the Part 1 hearing on March 14, 2018.

3.1 Management System

There are no requests from the Commission or updates from staff since the Part 1 CMD.

The conclusion for the Management System SCA remains the same as previously reported:

> 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.

3.2 Human Performance Management

As reported in Part 1 CMD 18-H4, Bruce Power was to submit an implementation plan for REGDOC-2.2.4 (Volume II), *Fitness for Duty: Managing Alcohol and Drug Use* by March 2018. This commitment was met by Bruce Power.

As part of the implementation effort, Bruce Power met with a third-party administrator and a qualified laboratory to discuss the collection, verification and performance of lab analysis on samples for alcohol and drug testing. Bruce Power plans to implement REGDOC-2.2.4 by July 1, 2019 except the requirements for random alcohol and drug testing, which will be implemented by December 1, 2019.

Bruce Power identified that the implementation dates may be impacted by legal challenges, particularly in respect to random alcohol and drug testing, and will inform CNSC staff if the dates could not be met. CNSC staff is currently in the process of reviewing the implementation plan.

This update does not affect CNSC staff's conclusion for the Human Performance Management SCA:

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

3.3 Operating Performance

There are no requests from the Commission or updates from staff since the Part 1 CMD.

The conclusion for the Operating Performance SCA remains the same as previously reported:

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

3.4 Safety Analysis

During the 2015 licence renewal, the Commission recommended Bruce Power to develop a policy and formal document stipulating that enhancements to Bruce A and B will be considered if Probabilistic Safety Assessment (PSA) results are in between the safety goal limit and the safety goal target.

As presented during the Part 1 hearing in CMD 18-H4.A, Bruce Power submitted the policy in March 2018. CNSC staff performed a review of the policy document and determined that the process is consistent with the Canadian nuclear industry's practice and meets CNSC expectations. As stated in Part 1 CMD 18-H4, Bruce Power submitted Bruce A and B PSA reports in 2014. The PSA reports are updated on a five-year frequency and the next update is expected by June 2019.

In the licence application, Bruce Power provided a list of some of the planned enhancements (such as installation of the containment filtered venting system and upgrades to very early smoke detection apparatus) that have been made to address lessons learned from Fukushima. Bruce Power performed additional analysis using the planned enhancements. The new analysis showed improved PSA results for Large Release Frequency (LRF). CNSC staff will conduct a comprehensive regulatory review of the PSA results that will incorporate the planned enhancements as part of the next PSA update, which will be submitted in June 2019. CNSC staff conclude that Bruce Power continued to implement and maintain an effective PSA program. Implementation of REGDOC-2.4.2, *Probabilistic Safety Assessment for Nuclear Power Plants* has begun and full implementation is expected by June 2019.

During the Part 1 hearing, the Commission requested CNSC staff to provide graphs showing LRF results for the 2014 PSA and the estimated data with planned improvements. These are provided in Figure 1 and Figure 2.

This update does not affect CNSC staff's conclusion for the Safety Analysis:

> 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.

Figure 1: LRF Results based on 2014 PSA

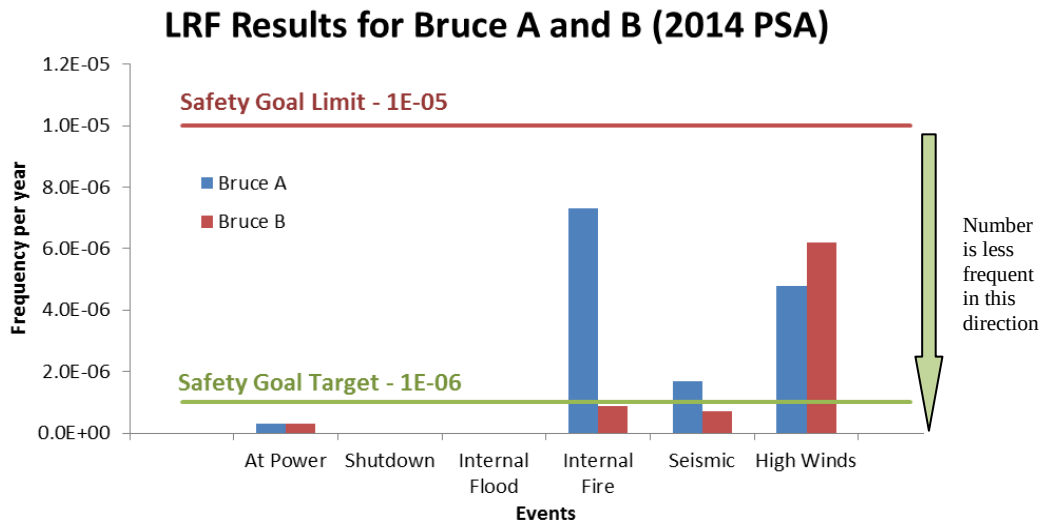
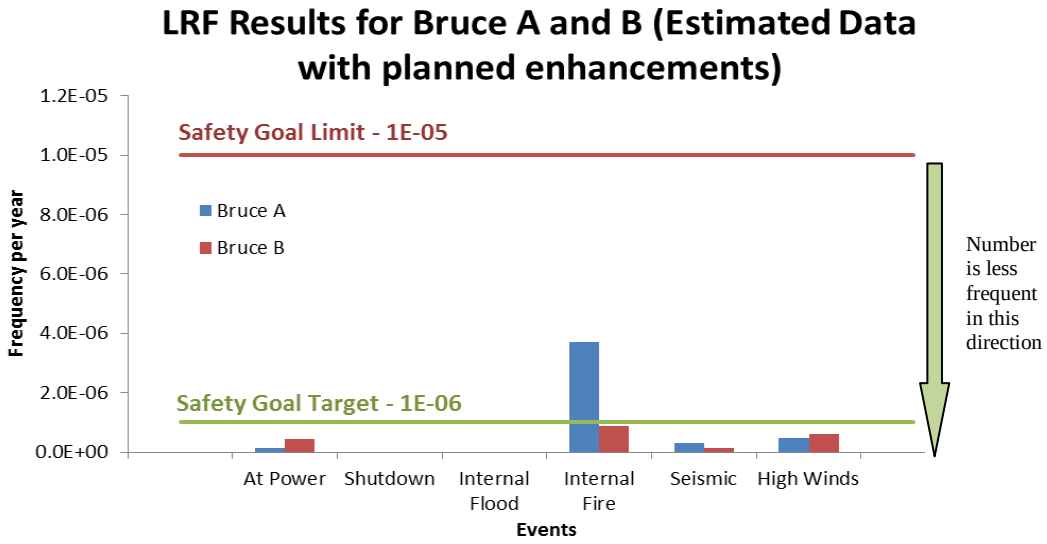


Figure 2: LRF Results based on estimated data with planned enhancements



3.5 Physical Design

There are no requests from the Commission or updates from staff since the Part 1 CMD.

The conclusion for the Physical Design SCA remains the same as previously reported:

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

3.6 Fitness for Service

As presented in CNSC staff's Part 1 CMD 18-H4 and CMD 18-H4.A, Bruce Power is seeking Commission approval to operate Bruce A and B up to a

maximum of 300,000 Equivalent Full Power Hours (EFPH). This is the maximum operational time expected for the units before they enter a refurbishment outage, during which the major components, including pressure tubes, will be replaced. Bruce Power is currently authorized to operate the units up to 247,000 EFPH.

For operation up to 300,000 EFPH, Bruce Power estimates that Hydrogen Equivalent Concentration (HEQ) for some pressure tubes could reach as high as ~150 ppm. HEQ is known to have an impact on the fracture resistance of pressure tubes. As previously discussed in Part 1 CMD 18-H4, to demonstrate safe operation using reactor core assessments, Bruce Power is currently working with the Canadian nuclear industry to develop a fracture toughness model applicable to HEQ levels in excess of 120 ppm. In January 2018, CNSC staff provided a technical update to the Commission in CMD 18-M4 (See Addendum A) on fuel channel evaluations for Canadian NPPs, specifically addressing the pressure tube fitness-for-service requirements and evaluation methodologies that are established in Canadian Standards Association (CSA) standards.

Once the new model has been developed and validated, Bruce Power plans to work with the CSA standards committee, to update the HEQ validity range for the fracture toughness model contained in CSA N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*, to allow assessments to be performed up to 160 ppm. Bruce Power expects to complete this by June 2019.

It is CNSC staff's view that the existing regulatory process, which was used to support acceptance of model up to HEQ of 120 ppm, is adequate for the continued oversight of fitness for service evaluations of pressure tubes, including the determination of the acceptability of the model up to HEQ of 160 ppm.

In summary, CNSC staff are imposing two requirements on Bruce Power:

1. Bruce A and B shall not operate beyond 300,000 EFPH without prior approval by the Commission
2. Bruce A and B shall not operate beyond HEQ of 120 ppm until Bruce Power has demonstrated that pressure tube fracture toughness is sufficient for safe operation

The second requirement is the basis for the Compliance Verification Criteria for Licence Condition 6.1 that addresses requirements for Fitness for Service. As Bruce Power is still currently developing the fracture toughness model up to 160 ppm to support continued operation up to 300,000 EFPH, CNSC staff recommended Licence Condition 15.3 to ensure both requirements are met.

In addition, as requested by the Commission during the Part 1 hearing, CNSC staff strengthened Licence Condition 15.3 as follows:

Old Proposed Licence Condition 15.3	New Proposed Licence Condition 15.3
The licensee shall maintain pressure tube fracture toughness sufficient for safe operation.	Before hydrogen equivalent concentrations exceed 120 ppm, the licensee shall demonstrate that pressure tube fracture toughness will be sufficient for safe operation beyond 120 ppm.

The associated compliance verification criteria have also been strengthened to add clarity with respect to regulatory expectations. The criteria incorporate the following key elements:

- requirements for the development of a pressure tube fracture toughness model covering the range of HEQ expected for the units up to 300,000 EFPH
- provide CNSC staff with semi-annual updates on the status of the fracture toughness tests and model validation activities
- submit to CNSC staff the technical basis for the fracture toughness model by June 2019
- complete a reactor core assessment for each unit, using the updated fracture toughness model, that demonstrates the fracture protection and leak-before-break assessment requirements of CSA Standard N285.8 are met before exceeding HEQ of 120 ppm

CNSC staff will report to the Commission on the status of the licensee's activities towards satisfying the compliance verification criteria through the annual Regulatory Oversight Report for Canadian Nuclear Power Generating Sites (formerly the ROR for Canadian Nuclear Power Plants) or on an as-needed basis.

This update does not affect CNSC staff's conclusion for the Fitness for Service SCA:

> 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.

3.7 Radiation Protection

In recent years, several intervenors have raised their concerns to the Commission regarding the potential health risks associated with exposure to low doses of radiation. Some intervenors are concerned that risks are being underestimated while others are concerned they are being overestimated. In November 2017, CNSC staff presented in CMD 17-M46 [15] on the topic of biological mechanisms acting at low doses of radiation (below 100 mSv). The CMD presented CNSC staff's work resulting from a Commission-directed initiative (started in April 2016) to provide an update on the current scientific understanding of the health risks from exposure to low doses of radiation.

CNSC staff summarized that there is no epidemiological or medical evidence of a measureable effect from exposure to low doses of radiation. The scientific community's view is that if there was any increased risk of cancer at low doses of radiation, the risks would be small as they are not observable. CNSC staff explained that any additional unknown risks to cancer are further minimized with the application of the As Low As Reasonably Achievable (ALARA) principle.

In addition, CNSC staff concluded that the current Canadian radiation protection regulatory requirements framework is robust, and protects workers and the public. This framework is informed by a radiation dose-response model known as the linear-non-threshold (LNT) model. The LNT model remains the best model on which to base the dose limits defined in the *Radiation Protection Regulations* as it is consistent with epidemiological data over a wide dose range and provides a conservative estimate of risk. The intention of the LNT model is not to explain all biological responses to radiation, nor should it be used in cancer risk assessment.

The Commission agreed with CNSC staff's assessment as presented in CMD 17-M46, and expects the information to be formally published.

This update does not affect CNSC staff's conclusion for the Radiation Protection SCA:

> 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 and is applying the ALARA principle. In 2016, Bruce Power has exceeded CNSC requirements and expectations and received a "fully satisfactory" rating.

3.8 Conventional Health and Safety

There are no requests from the Commission or updates from CNSC staff since the Part 1 CMD.

The conclusion for the Conventional Health and Safety SCA remains the same as previously reported:

> 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.

3.9 Environmental Protection

During the Part 1 hearing, the Commission requested clarification on the differences with the Derived Release Limits (DRLs) for Bruce A and B.

The DRLs are calculated following the guidance and methodology specified in CSA Standard N288.1-08, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*. The calculations incorporate results of site specific survey, as well as meteorological data.

The calculations produced specific different DRLs for Bruce A and B based on the following reasons:

- Location – Bruce A and B units are located two kilometres apart, and therefore the distance from the sources to the receptors are not the same
- Design – Bruce A and B units differ slightly in their design. For example, some of the air and liquid source characteristics inputted into the model such as the stack exit velocities and flow rates are different for Bruce A and Bruce B.

The following subsections provide updates and additional details in the areas of:

- Environmental Assessment: NSCA and CEAA (Section 3.9.1)
- Environmental Assessment under the NSCA (Section 3.9.2)
- Bruce Power Environmental Risk Assessment (Section 3.9.3)
- CNSC staff's responses to concerns on potential environment impacts of Bruce A and B (Section 3.9.4)
- Tritium studies project (Section 3.9.5)

This update does not affect CNSC staff's conclusion for the Environmental Protection 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.

3.9.1 Environmental Assessment: NSCA and CEAA

The CNSC has a strong science based environmental protection framework in place. Under the NSCA, the CNSC has a legislated mandate to ensure the protection of the environment and the health and safety of persons. As part of its mandate, the CNSC regulates all environmental stressors including radionuclides, non-radiological contaminant, and physical stressors. The CNSC ensures an Environmental Assessment (EA) is done, regardless if a project falls outside the definitions under Canadian Environmental Assessment Act (CEAA) such as this licence renewal. The CNSC undertakes a robust EA under the NSCA. **The core scientific basis used in the NSCA EA is equivalent to those of CEAA 2012 EAs.**

An EA under the NSCA is generally conducted for projects or activities that have either previously been assessed under CEAA, or for existing facilities. For this reason, the *cumulative effects assessments* and *alternative means assessments* found in EA under CEAA are not part of the EA under the NSCA. However, an assessment of existing regional data is used to support the EA under the NSCA and, where more thorough regional assessments are conducted, these are included in the analysis.

An added benefit of EAs under the NSCA is that they are part of the ongoing regulatory and environmental oversight of all nuclear facilities, and in this way, can incorporate new knowledge and allow for adaptive management.

In all cases, whether under CEAA 2012 or under the NSCA, the environmental protection measures are commensurate with the scale and complexity of the environmental risks associated with the nuclear facility or activity.

3.9.2 Environmental Assessment under the NSCA

As presented in Part 1 CMD 18-H4, CNSC staff performed an EA under the NSCA and 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. The EA Report considered the following sources of information:

- Bruce Power environmental protection measures
- Annual compliance reports
- Results from CNSC's Independent Environmental Monitoring Program (IEMP)
- Updated ERA, including the PEA
- Preliminary Decommissioning Plan (PDP)
- Other regional monitoring

The EA under the NSCA concluded that Bruce Power has and will continue to make adequate provision for the protection of the environment and the health of persons. As a lifecycle regulator, CNSC staff will continue to verify and ensure that, the environment and the health of persons are protected and will continue to be protected until the safe state and abandonment.

3.9.3 Bruce Power Environmental Risk Assessment

Bruce Power's Environmental Risk Assessment (ERA) and Predictive Environmental Risk Assessment (PEA) were carried out in accordance with CNSC's regulatory requirements. Bruce Power made significant progress in the implementation of CSA N288.6-12, *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills* and will be in full compliance by December 31, 2018.

Bruce Power's ERA used conservative assumptions to screen physical, chemical and/or radiological releases into the assessment, using conservative environmental transfer factors and exposure estimates and effects benchmarks to assess potential effects. The ERA also included a thermal risk assessment (see Section 3.9.4.4 of this CMD).

CNSC staff expect that in preparation for the next ERA, updated environmental monitoring data will be compared to the conservative predictions of the potential effects in the current ERA, to confirm that the assumptions used are valid and sufficiently conservative. Where potential effects have been identified, Bruce Power will develop an approach that could include the following:

- risk management actions including additional mitigation solutions
- further refinement of parameter values and data to provide more realistic assumptions
- supplementary studies to address data gaps or verify potential effects

The ERA updates are to be performed on a five year basis. Revisions to the ERA are informed by the accumulated site knowledge derived from operational experience, effluent and environmental monitoring results, special investigations, advances in scientific knowledge and Indigenous traditional knowledge when available.

3.9.4 CNSC staff's responses to concerns on the potential environmental impacts of Bruce A and B

As identified in CMD 18-H4.146, CNSC staff recognize that Saugeen Ojibway Nation (SON) has long-standing concerns related to the potential environmental impacts of Bruce A and B, specifically on the topics of:

- scientific uncertainties
- impacts to fish from impingement and entrainment
- effluent and environmental monitoring programs
- thermal risk assessment

CMD 18-H4.146, including its technical appendices (comprised of technical reviews of the identified topics), contain information that CNSC staff were previously aware of. The technical information provided highlighted aspects that have been the focus of the ongoing dialogue between CNSC staff and SON, and does not change CNSC staff's conclusion regarding the protection of the environment and human health.

CNSC, as a life cycle regulator, will continue to work with the Indigenous groups to address any technical concerns they may have. The information provided in CMD 18-H4.146 will help inform the continued dialogue moving forward. Section 4.3 of this CMD provides additional details on how CNSC staff will work with the Indigenous groups in dealing with the identified interests or concerns. CNSC staff's dispositions of the information contained in SON's technical appendices are provided in Addendum B of this CMD.

The following subsections provide CNSC staff's technical review on the four identified topics.

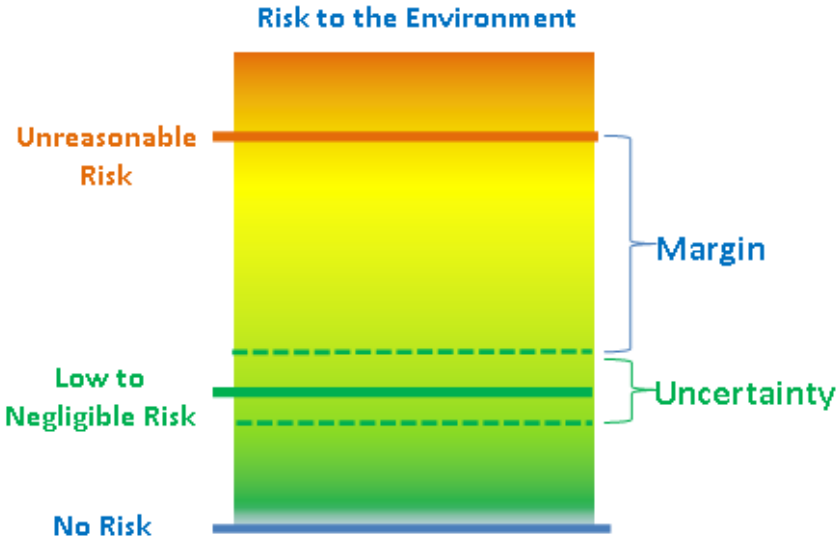
3.9.4.1 Scientific Uncertainties

SON is of the opinion that significant uncertainties exist with regard to the adverse impacts on the environment caused by the Bruce A and B, and that in the absence of more certainty, measures should be taken on a precautionary basis to ensure that the environment is protected.

It is CNSC staff's views that there are sufficient evidence to conclude that the environment is being adequately protected now, and that it will be protected into the future. CNSC staff agree that there are some areas of uncertainty which would benefit from additional monitoring and/or assessment to increase accuracy. For example, additional monitoring on the potential impacts to fish from impingement/entrainment and thermal effluent to reduce uncertainties. Sufficient safety margins are in place to prevent unreasonable risk to the environment, that the level of uncertainty is not significant, and risk to the environment is low to

negligible (see Figure 3). If, in the future, the potential for unreasonable risk is anticipated or detected through on-going environmental monitoring or scientific studies, the CNSC, as a life-cycle regulator and science-based organization, will ensure that additional mitigation measures are implemented.

Figure 3: Sufficient margins to prevent unreasonable risk to the environment



3.9.4.2 Impacts to fish from impingement and entrainment

As presented in Part 1 CMD 18-H4, CNSC staff concluded that impingement and entrainment (I&E) of fish did not result in population-level effects on fish populations in Lake Huron.

Bruce Power's 2011 I&E monitoring program was developed as part of the Follow-up Monitoring Program for the Bruce A (Units 1 and 2) Refurbishment Environmental Assessment. CNSC staff determined that the 2011 I&E monitoring program was sufficient to verify predictions in the Bruce A Refurbishment Environmental Assessment.

Since 2011, CNSC staff have been working with Bruce Power and SON to address the concerns SON has identified in its review of the I&E program. The discussions between CNSC staff, SON and Bruce Power are summarized below.

In 2011, SON identified 296 comments [18] in its review of the I&E monitoring program. In April 2012, Bruce Power provided a revised I&E program which incorporated CNSC staff and SON feedback where appropriate. When CNSC staff learned that SON was not satisfied with how their feedback was incorporated by Bruce Power, CNSC staff requested Bruce Power to provide a detailed disposition to all 296 comments [19].

In 2014, SON was not satisfied with the I&E program despite the detailed disposition of the comments by Bruce Power. SON preferred to continue the discussions with CNSC staff rather than with Bruce Power, and suggested that a workshop be held to determine the actions that would be required to address outstanding issues. Due to the large volume of material, CNSC staff requested

that the comments be categorized and refined, as well as indicating issues where SON was satisfied with Bruce Power's dispositions. SON provided a database with the comments categorized. However, SON did not identify any satisfactory areas to the CNSC.

In December 2015, CNSC staff reviewed the database and provided SON with a disposition of all 296 comments from a regulatory perspective [20]. At this point, SON indicated that the workshop would only proceed if an independent facilitator was used. CNSC staff and SON worked together to develop a Terms of Reference for the workshop and agreed on the selection of a facilitator.

In May 2017, the first workshop on the I&E monitoring program was held, facilitated by Dr. Scott Findlay from the University of Ottawa. The workshop led to a number of suggested topics which warranted further discussion [21]. SON used those topics to develop a series of questions related to understanding the role of science in decision making, and how the CNSC considers cumulative effects. CNSC staff provided SON with an information package [22] which summarized CNSC staff's perspective on each of their questions.

In January 2018 [23] and February 2018 [24], two additional workshops were held, facilitated by Dr. Nicholas Mandrak from the University of Toronto. While the discussions at these workshops did not focus on the 296 comments specifically, there were good discussions which led to a common understanding of SON and CNSC perspectives on various subjects. In particular, the discussions focused on CNSC staff's assessment of the results of the I&E monitoring program, how uncertainties identified by SON could be addressed in Bruce Power's analysis of the data, and modifications to future I&E monitoring programs.

It is CNSC staff's view that Bruce Power is making and will continue to make adequate provision for the protection of the environment. CNSC staff determined that the data collected through the I&E monitoring program in 2013 and 2014 were sufficient in supporting the regulatory decisions under the NSCA.

Bruce Power's revised I&E monitoring plan is submitted as part of the *Fisheries Act* authorization application, which is further discussed in Section 4.2 of this CMD.

3.9.4.3 Effluent and environmental monitoring programs

The purpose of this section is to distinguish the differences between CNSC staff's and Bruce Power's roles and responsibilities in the effluent and environmental monitoring programs, which has been clarified to the Indigenous groups during past discussions.

CNSC is responsible for establishing the regulatory requirements for effluent and environmental monitoring programs at nuclear facilities. Bruce Power is responsible for the design, development and implementation of effluent and environmental monitoring programs associated with the Bruce site according to CNSC regulatory requirements. CNSC staff are responsible for the review of

effluent and environmental monitoring program to determine compliance with CNSC regulatory requirements.

Bruce Power collects and analyzes the effluent and environmental monitoring data according to the program design and reports the data to the CNSC on a quarterly or annual basis. CNSC staff review the effluent and environmental data collected to confirm compliance with the program designs, including quality assurance and quality control of the data collected. CNSC staff do not collect data for Bruce Power's environmental monitoring program.

CNSC staff conduct compliance inspections of the effluent and environmental monitoring programs to confirm that Bruce Power staff and contractors adhere to the procedures included in the design and implementation of the program.

In addition to the Bruce Power effluent and environmental monitoring program, the CNSC has its own program: the Independent Environmental Monitoring Program (IEMP). CNSC staff are responsible for the design, development, and implementation of the CNSC's IEMP. CNSC staff collect, analyze and report the IEMP environmental monitoring data, and where feasible seek opportunities to incorporate Indigenous knowledge to support monitoring priorities.

3.9.4.4 Thermal Risk Assessment

Bruce Power's ERA included a thermal risk assessment to assess the potential effect of the discharge of cooling water to fish. Environment and Climate Change Canada (ECCC) and CNSC staff reviewed the thermal risk assessment and requested further analysis to address uncertainties in the thermal risk assessment. Bruce Power also committed to consider additional assessment or planned monitoring to address these uncertainties by December 2018. As previously stated in Section 3.9.4.1 on scientific uncertainties, sufficient safety margins are in place to prevent unreasonable risk to the environment, that the level of uncertainty is not significant, and risk to the environment is low to negligible.

In CMD 18-H4.146, SON raised concerns with potential thermal effects due to cooling water discharge, specifically on Bruce Power's request to the Ontario Ministry of Environment and Climate Change (MOECC) to modify the current permit (Environmental Compliance Approval or ECA) to allow for "operational flexibility" in effluent temperature. Bruce Power requested to temporarily increase the cooling water discharge (effluent) maximum limit of 32.2^{o}C to 34.5^{o}C, between June 15 to September 30 for a maximum of 30 days and only 15 of which may be consecutive. Bruce Power made the request as a result of the increasing trend in the overall temperature of the lake during the summer months, which may result in an increase in water discharge temperature.

In February 2018, ECCC and CNSC staff reviewed [16] Bruce Power's updated assessment [17] of the risk due to the increased effluent discharge temperature and requested additional assessment. ECCC and CNSC staff concluded [25] that the "operational flexibility" application to allow for a temporary increase in the temperature of the thermal effluent will likely not pose an unreasonable risk to the environment. The results of the review have been communicated to the

Indigenous groups, Bruce Power and MOECC. The request to modify the current permit to allow for "operational flexibility" in effluent temperature is separate from that of relicensing and is not an impediment to licence renewal.

MOECC is currently reviewing Bruce Power's ECA application. The public comment period has ended; MOECC is expected to render its decision end of June 2018.

3.9.5 Tritium studies project

In June 2010, CNSC staff presented in CMD 17-M48 [26] on the progress made in the implementation of the recommendations of the Tritium Studies Project Synthesis Report. The recommendations presented by staff were endorsed by the Commission. The project, initiated in June 2007, was a Commission-directed initiative to enhance the information available to guide the regulatory oversight of tritium processing facilities and tritium releases in Canada.

Based on the work that has been performed to date, CNSC staff concluded that adequate provisions have been made through existing regulatory mechanisms for the protection of Canadians from exposure to tritium releases. The results support the conclusion that the dose to a member of the public due to exposure from tritium releases is a small fraction of the regulatory dose limit and levels known to cause health effects. The Commission concluded that the project objectives had been met.

CNSC staff will continue to ensure that the latest developments in tritium science are integrated, as appropriate, in regulating tritium-emitting nuclear facilities.

3.10 Emergency Management and Fire Protection

On April 4, 2018, the Office of the Fire Marshal and Emergency Management (OFMEM) provided an update in CMD 18-M21 [27] on emergency management in Ontario and the 2017 Provincial Nuclear Emergency Response Plan (PNERP). The CMD provided some highlights on the 2017 PNERP master plan and implementing plan, which included updates to:

- Contingency Planning Zone, clarifying how local protective actions could be implemented if needed
- descriptions of accident scenarios, including severe accidents
- descriptions of key emergency response activities for various accident scenarios
- requirements to regularly review the plan, and complete public consultation
- guidelines for protective actions, roles and responsibilities for stakeholder organizations, and updated training and exercise requirements consistent with national and international standards
- a more detailed rationale behind key features of the plan, including planning zone sizes

As of April 30, 2018, the 2017 PNERP implementing plan for the Bruce Nuclear Generating Station is available on the OFMEM website. The implementing plans apply the principles, concepts and policies contained in the master plan, in order

to provide detailed guidance and direction for dealing with emergencies at the Bruce site. The following subsections provide the work that Bruce Power and the municipalities are performing to meet the requirements of the 2017 PNERP master plan and implementing plan.

This update does not affect CNSC staff's conclusion for the Emergency Management and Fire Protection SCA:

> Bruce Power continued to implement and maintain an emergency management and fire protection program at Bruce A and B that met CNSC requirements.

3.10.1 Updates on Bruce Power's emergency plans

CNSC staff determined that Bruce Power is currently meeting all the requirements from the 2017 PNERP master plan. As stated in Part 1 CMD 18-H4, the 2017 PNERP master plan did not impose any additional requirements on Bruce Power as the requirements for Potassium Iodine (KI) tablets, public alerting and communications, or the designation of emergency response centres.

Bruce Power performed a gap analysis to identify potential changes to its emergency plans and programs in regards to the 2017 PNERP implementing plan. No significant changes are expected to the Bruce Power's emergency plan, as a result of this implementing plan. Bruce Power will perform minor updates to its plans and programs to reference the new 2017 PNERP as part of its document update process.

Bruce Power continues to provide support to offsite authorities. Of note, Bruce Power is evaluating further development of mobile decontamination capabilities to help support the Municipalities.

3.10.2 Updates on the Municipal emergency plans

The Municipal plans have been revised to meet the 2017 PNERP and are currently undergoing consultation. The updated municipal plans are expected to be in place by May 2019.

Impact to the Municipal plans is expected be incremental, primarily seen as continuous improvement to the current plans. The existing plans remain in effect and are adequate to protect the Municipal residents, including the local schools in Saugeen Shores and Municipality of Kincardine as well as the local hospitals.

Currently, the municipalities are identifying alternate facilities that have potential to be utilized beyond the 20 km radius of the site as Emergency Worker Centers and Reception Centers.

The Province will continue to maintain oversight of the municipal arrangements to ensure that provincial emergency management requirements are being met and the emergency plans are being kept up to date.

3.11 Waste Management

In April 2018, Northwatch submitted an intervention in CMD 18-H4.103 [28] and identified the following concerns:

- completeness of licence application
- tracking of import and export of waste
- waste streams and volumes of waste generated as a result of refurbishment

It is CNSC staff's view that Bruce Power's submitted application [2-14] was complete. CNSC staff's detailed analyses of Northwatch's intervention are provided in the following subsections.

This update does not affect CNSC staff's conclusion for the Waste Management SCA:

> 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 Preliminary Decommissioning Plan submitted by Ontario Power Generation (OPG) regarding Bruce A and B is acceptable to CNSC staff.

3.11.1 Completeness of licence application

Northwatch stated in CMD 18-H4.103 that Bruce Power has not provided a basis for approval of their application request. Specifically, Northwatch is of the opinion that the application submitted by Bruce Power fails to meet subparagraph 3(1)(j) of the *General Nuclear Safety and Control Regulations* (GNSCR), which states that:

> *"1) An application for a licence shall contain the following information: […]*
>
> *(j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed, or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;"*

CNSC staff concluded that Bruce Power met the requirement of subparagraph 3(1)(j) of the GNSCR through the submitted application, including the ERA and PERA. Bruce Power has incorporated, by reference, the following documents which are summarized below:

- Preliminary Decommission Plan (PDP)
- annual compliance reports
- waste management program documents

In addition, under the lease agreement between Bruce Power and OPG, OPG retains the responsibility for decommissioning. OPG provides the CNSC with a consolidated Financial Guarantee that covers both decommissioning of the Bruce reactors and long-term waste management. All operational waste is transferred to OPG's Western Waste Management Facility (on the Bruce site) under a fee-for-

service agreement. Regardless of this agreement, Bruce Power remains responsible for providing the CNSC with the necessary assurances in accordance with the NSCA that acceptable arrangements remaining in place for decommissioning and safe management of the waste. Bruce Power does this by referencing the current OPG consolidated decommissioning plan in its application. As noted in CMD 18-H4, the current plan meets CNSC's requirements.

Furthermore, a Licence Condition (LC 11.2 in the proposed licence) has been in place for many years requiring Bruce Power to inform the CNSC of any changes to the Lease Agreement so that CNSC staff can confirm that appropriate Decommissioning Plans and Financial Guarantees remain in place.

Preliminary Decommissioning Plan (PDP)

This document provides the name, quantity, form, origin and volume of waste generated through the operation of the site for the lifetime of the site. The PDP provides bounding estimates and limitations on the types of nuclear waste generated and managed at the site throughout its lifetime. The PDP itself fulfills the requirements of subparagraph 3(1)(j) of the GNSCR. The PDP for the Bruce Nuclear Generating Station and the Western Waste Management Facility (WWMF) is publicly available on the OPG website. As stated in Part 1 CMD 18-H4, CNSC staff determined that the PDP submitted by OPG regarding Bruce A and B met regulatory requirements.

Annual compliance reports

Annually, Bruce Power provides the name, quantity, form, origin and volume of waste generated as a result of its operations that year. The annual reports provide information on many of the same topics as the PDP. CNSC staff perform an annual review of the compliance reports and determined that Bruce Power met the reporting requirements. Bruce Power's annual compliance reports are not made available publicly as they may contain commercial and sensitive material. However, the CNSC report on the inventory of radioactive waste through the Canadian National Report for the Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management. The sixth report was issued in October 2017 and is available publicly on CNSC's website (www.nuclearsafety.gc.ca).

Waste management program documents

Bruce Power's waste management program documents provide the methods for managing waste at the Bruce site. Bruce Power's procedure BP-PROC-00878, *Radioactive Waste Management* contains the safety and control measures, and 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.

3.11.2 Tracking of import and export of waste

In CMD 18-H4.103, Northwatch recommended the CNSC to:

- direct Bruce Power to provide a detailed inventory of waste transfers into and out of Bruce Nuclear Generating Stations, including transfers from other operations in Canada, and transfers from the U.S. into Canada
- establish a publicly accessible registry of waste transfers between operations/sites in Canada, and transfers in and out of Canada

As stated in Part 1 CMD, CNSC staff determined that Bruce Power meets all CNSC regulatory requirements for waste management. There are programs and procedures in place to ensure that wastes transferred into and out of the Bruce site are managed. Most of the waste processing and handling at Bruce site are performed by OPG, who is licensed by the CNSC. The following subsection addresses Northwatch's two recommended actions.

Detailed inventory of waste transfers into and out of Bruce Site

It is CNSC staff's views that the inventory of waste transfers into and out of Bruce site is being adequately managed, records are kept up-to-date, and the information should be protected.

Bruce Power tracks and records any transfers of radioactive waste or any other type of radioactive substances to other licence holders. These records are maintained by the licensee, as required by the regulations, and are accessible to CNSC staff upon request. Through regular compliance oversight activities, CNSC staff verified that Bruce Power only transferred radioactive substances (including waste) to authorized licence holders and that the material is appropriately tracked and recorded.

The Canadian regulatory approach only licenses the shipment of controlled nuclear substances contained in waste such as uranium, plutonium or thorium, subject to the *Nuclear Non-proliferation Import and Export Control Regulations*. For security reasons, the CNSC does not disclose the inventories associated with the shipments of controlled nuclear substances contained in waste nor does the CNSC post export and import licences on its website.

With regards to tracking of nuclear material, the CNSC does track nuclear material that has either been made subject to a Nuclear Cooperation Agreement, or is safeguarded and required to be reported to the International Atomic Energy Agency (IAEA). Other nuclear substances or controlled items are tracked using reports submitted pursuant to the Licence.

Finally, Bruce Power, along with other Canadian licensees, send waste to off-site providers (who may be in Canada or elsewhere) such as Energy*Solutions* Canada for processing. This is consistent with the Reduce, Reuse, Recycle principle that underpins the waste management programs implemented by CNSC licensees. Some waste is incinerated and the resulting ashes are packaged and returned to the originator for long-term management. This is an internationally used practice that achieves a high ratio of volume reduction (up to 95%). In other cases, metallic contaminated components may be melted and cast into parts that are

reused within the nuclear industry. Any remaining waste from the melting that cannot be reused would be returned to the originator for long-term management.

This practice is also described in the written submission from Energy*Solutions* Canada in CMD 18-H4.97 [29].

Establish a publicly accessible registry of waste transfer

It is CNSC staff's views that Northwatch inaccurately described the purpose of the US Nuclear Regulatory Commission (NRC)'s Agency-wide Documents Access and Management System (ADAMS) recordkeeping system.

In CMD 18-H4.103, Northwatch stated that:

- *ADAMS [has] more information … about the radiological contamination of the seacan container than Bruce Power has provided in its entire suite of application and supporting documents about the refurbishment wastes that will be generated through their proposed Major Component Replacement campaign*
- *ADAMS registry strongly indicate that, during previous refurbishment campaigns, Bruce Power's waste management approach included exporting large volumes of refurbishment wastes across an international border for "processing" in the United States*

With respect to the US NRC's ADAMS registry, the documents that are found on the registry consist of licensing related documentation. Licences to import and export found on the registry provide bounding quantities for shipments and are typically valid for several years. The ADAMS registry does not track transfers between Canada and the US; it is the repository of publicly available US NRC records.

As an example, some of the licences found on the registry state that:

> *"All materials … shall be returned to such entities pursuant to a NRC export licence for appropriate disposition in Canada. No materials imported pursuant to this licence will remain in, or be disposed of in the United States"*

In those cases, the waste generated at the Bruce site is not exported to the United States. The transferred waste are processed in the United States and returned to Bruce Power with a reduction in volume.

3.11.3 Waste streams and volumes of waste generated as a result of refurbishment

In April 2018, Saugeen Ojibway Nation submitted in CMD 18-H4.146 [30] stating that "the application submitted by Bruce Power does not consider the environmental or rights impacts of the refurbishment project caused by increased nuclear waste generation" and further defines the wastes that will result from the project as "novel".

In Canada, all radioactive waste is classified into one of four categories: uranium mine and mill waste, low-level radioactive waste, intermediate-level radioactive

waste or high-level radioactive waste. This classification, with the exception of uranium mine and mill waste, is independent of how or where the waste was generated. Waste that arises from refurbishment activities and continued operations will be classified into one of the four existing classes and does not constitute a unique, new or novel type of waste.

SON stated in CMD 18-H4.146 that "in terms of volume, the refurbishment waste [as a result of Bruce refurbishment] alone would comprise as much as 12% of the total waste in OPG's proposed Deep Geological Repository (DGR) Project". The number referenced in the SON submission is based on calculations using "as shipped" volumes (based on the outer volume of the storage containers) from the *Bruce A Refurbishment Environmental Assessment Study Report* (2005), and a total waste emplacement volume for the DGR of 100,000 m^3. In fact, volumes may be further reduced at the time of emplacement in the DGR, for instance, by removing external packaging which may no longer be required at the time of disposal due to lower external doses following radioactive decay.

The Reduce, Reuse, Recycle principle underpins the waste management programs implemented by CNSC licensees. Waste minimization and volume reduction are central components of the licensees' waste management programs. In the case of Bruce Power, many of the volume reduction activities, including incineration and compaction, occur at OPG's WWMF, which is adjacent to the station. Larger components, such as pressure tubes, may also be sectioned or compacted before being placed into storage containers in order to minimize the volume of the waste that requires long term management.

As per the *Reference Low and Intermediate Level Waste Inventory for the Deep Geologic Repository* (2010), the total volume of waste estimated to be emplaced in the DGR is 203,995 m^3, which includes both the waste arising from operations and from decommissioning activities. The inventory volume was calculated assuming refurbishment of all reactor units (except for Pickering A) and extended operations for a further nominal 30 calendar years per refurbished unit. To allow for uncertainties in future waste volumes, the possibility of increasing the waste capacity to a disposal volume up to 400,000 m^3, double the reference inventory, was set as a project requirement and factored in the DGR safety case. Table 2 shows OPG's projections for operational L&ILW and reactor refurbishment waste.

Table 2: OPG's forecasts for operational L&ILW and wastes resulting from refurbishment to be stored in DGR

	Emplaced volume (m^3)	Percent of total emplaced volume (%)
Operational L&ILW	182,310	89
Refurbishment waste forecast	21,685	11
Emplaced volume	203,995	100

The total volume of waste resulting from the refurbishment of all OPG owned units (Pickering, Darlington and Bruce) was estimated at approximately 11% of the total volume of waste, not the 12% as stated by SON for the Bruce units alone. Therefore, the volume of waste as a result of refurbishment activity at Bruce site was already accounted for and does not increase the total waste volume for the DGR project.

In addition, the waste volumes resulting from the proposed major component replacement activities at Bruce Power, as well as the operational waste that will be generated, were also anticipated and taken into account in the proposed storage capacity for the licence renewal [31] of OPG's WWMF which took place in 2017. Table 4 shows the maximum storage capacity of the WWMF, with the construction of additional storage buildings as captured by the safety case and approved by the Commission in 2017.

Table 3: WWMF Maximum Storage Capacity

Type of waste	Maximum Storage Capacity
Low-level waste	178,253 m^3
Intermediate-level waste	58,186 m^3
Used Nuclear Fuel	1,536,000 bundles

Northwatch submitted in CMD 18-H4.103 that the Bruce Power estimate of 8 m^3 of intermediate-level radioactive waste (ILW) from the refurbishment of Unit 6 as stated in their application is "questionable in terms of its validity". CNSC staff reviewed all of the information submitted in support of the application and concur with the intervener that this number appears to be low. As updated for the Part 2 Hearing, Bruce Power has identified a number of corrections to the reported numbers (see Table 3), specifically:

- in the licence application, retube waste was incorrectly included in the LLW volume (0 m^3 vs 334 m^3)
- the PERA waste volumes have been updated to their correct number

Table 3: Corrected values for L&ILW from Bruce Unit 6 refurbishment

	Licence application	PERA (initial submission)	PERA (corrected values)	Expected Volume	Expected Volume (after processing)
Total LLW	11,000 m^3	9451 m^3	9785 m^3	3273 m^3	770 m^3
ILW (non-retube waste)	8 m^3	421 m^3	8 m^3	10 m^3	10 m^3
ILW (retube waste)	included in LLW	334 m^3	421 m^3	427 m^3	427 m^3
Total ILW	8 m^3	755 m^3	429 m^3	437 m^3	437 m^3

However, CNSC staff reviewed the calculations that Northwatch provided, comparing the ILW that will be generated from the refurbishment of Bruce Unit 6 to what was generated from the refurbishment of Pickering A, and concluded that there were some inaccuracies with Northwatch's calculations.

The ILW values for Pickering and Bruce cannot be directly compared without performing additional calculations. As a result of the refurbishment of Pickering A (4 units), 1,012 m^3 of ILW was generated (or 253 m^3 per unit). However, the reported number for Pickering does not include the volume of the containers in which the waste is currently stored, while the reported numbers for Bruce do include the volume of the containers. Using package dimensions and assumptions from the Bruce A Refurbishment EA Study Report, and the expected external volume of ILW of 427 m^3 as provided by Bruce Power, CNSC staff calculate that there will be approximately 86 m^3 of ILW generated from the refurbishment of Bruce Unit 6 (i.e., 86 m^3/unit of ILW from Bruce vs 253 m^3/unit of ILW from Pickering). Comparing those results, the refurbishment of Unit 6 will generate 66% less ILW than a single unit from Pickering A, or approximately 3 times less waste. As the refurbishment of Pickering A was conducted more than two decades ago, waste minimization practices have improved since that time, as demonstrated through these calculations.

Finally, CNSC staff reviewed the corrected numbers and determined that they are in-line with estimates from the Darlington refurbishment project. The volume of low-level radioactive waste that will be generated as a result of refurbishment is also expected to be much lower than the corrected PERA values as a result of the Reduce, Reuse and Recycle principles that Bruce Power will apply for waste minimization. CNSC staff are satisfied that OPG's WWMF has sufficient capacity to handle and store the L&ILW from Bruce's refurbishment project with the construction of additional storage buildings as captured by the safety case and approved by the Commission in 2017.

Furthermore, the PDP for the Bruce A and B also incorporated these waste volumes. The costs associated with the long term management of all of the waste, including the used fuel, was factored into the OPG's Consolidated Financial Guarantee, which was accepted by the Commission [32] following a public hearing in October 2017.

3.12 Security

There are no requests from the Commission or updates from staff since the Part 1 CMD. The conclusion for the Security SCA remains the same as previously reported:

> 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.

3.13 Safeguards and Non-Proliferation

There are no requests from the Commission or updates from staff since the Part 1 CMD. The conclusion for the Safeguards and Non-Proliferation SCA remains the same as previously reported:

> The overall performance for the Safeguards and Non-Proliferation SCA is "satisfactory" and that Bruce Power is qualified to carry out the authorized activities in this SCA.

3.14 Packaging and Transport

There are no requests from the Commission or updates from staff since the Part 1 CMD. The conclusion for the Packaging and Transport SCA remains the same as previously reported:

> Bruce Power met all applicable regulatory requirements in the Packaging and Transport SCA.

4. OTHER MATTERS OF REGULATORY INTEREST

Other Matters of Regulatory Interest provides updates on the following topics:

- Fukushima action items
- *Fisheries Act* authorization
- Aboriginal consultation and engagement activities
- Participant Funding Program
- Previous commitments raised by the Commission
- CNSC staff's recommendation for a 10-year licence

4.1 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 Structures, Systems and Components, 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 10 station specific action items. In June 2017, Bruce Power submitted progress report No. 10 on the FAI.

As presented during the Part 1 hearing in CMD 18-H4.A, CMD 18-H4 should be corrected to state that only 3 of the 13 station specific action items remain open (instead of 4 which was previously reported).

Bruce Power completed the action to perform a site-specific hazard assessment in accordance with CNSC S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*.

The three remaining station specific action items include:

- Shield Tank Overpressure Protection (STOP)
- Containment Filtered Venting System (CFVS)
- coolant makeup

For the STOP, Bruce Power has completed its detailed design which will be installed in all Bruce A and B units by end of 2019. Installation of the STOP can only be performed during a unit's planned outage.

For the CFVS, Bruce Power provided a plan and schedule for the design and installation of the selected CFVS in early 2018. Installation of the CFVS can only be performed during a Station Containment Outage (SCO) or Vacuum Building Outage (VBO), typically occurring once every 6 years and once every 12 years respectively.

Finally, for coolant makeup, Severe Accident Management Guidelines (SAMG) connections points have been made to the primary heat transport system, moderator system and shield tank. Bruce Power is installing additional Emergency Management Equipment (EME) connection points to those systems, which are further enhancements as they provide quicker connections compared to

the SAMG connections. Installation of EME connections will be completed by mid-2019 as the work can only be completed during a unit's planned outage.

Significant effort has been made for the design and procurement of these plant enhancements to address FAIs. As stated, the installation of these systems can only be performed during a unit's planned maintenance outage (typically once every 2-3 years) or during a SCO or VBO. Bruce Power is required to report annually on the status of the work through the ROR for Nuclear Power Generating Sites. CNSC staff are satisfied with the progress of the work completed to date and will oversee the licensee's performance to ensure that the remaining actions are completed as per schedule.

4.2 Fisheries Act Authorization

As presented inthe Part 1 CMD 18-H4, the *Fisheries Act* was revised in 2012 with the requirement that projects that cause serious harm to fish must be authorized by the Minister of Fisheries and Oceans Canada (DFO). While there is no specific timeline for the completion of a Fisheries Act authorization application, CNSC staff have been working to ensure that Bruce Power comes into compliance with the *Fisheries Act* as soon as reasonably possible.

To ensure that the Bruce Power's *Fisheries Act* authorization application is complete, and to expedite CNSC and DFO staff's review time, CNSC staff have provided Bruce Power with comments since May 2017. Discussions were carried out with Bruce Power to allow CNSC and DFO staff to provide feedback on the application. CNSC and DFO staff have also reviewed and provided comments on iterations of Bruce Power's revised offset plan ahead of Bruce Power submitting the final application.

As stated in Section 3.9.4 of this CMD, over the current licensing period, SON made extensive comments (296 comments total) to CNSC staff on the Bruce Power I&E monitoring program. CNSC has requested that Bruce Power include a revised I&E monitoring plan in the *Fisheries Act* authorization application and that the revised plan addresses the uncertainties identified by the CNSC in their review of the application as well as the applicable comments raised by SON previously.

Bruce Power is on track to submit a revised *Fisheries Act* authorization application to CNSC by June 2018.

4.3 Consultation and Engagement Activities with Indigenous Groups

4.3.1 Duty to consult

As CNSC staff noted in Part 1 CMD 18-H4, Bruce Power's 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 Commission's task under the NSCA is not to decide

whether continued operation of the Bruce facility should be undertaken; this is an energy planning decision that was made by the province. Rather, since that decision was made, the Commission's mandate is to authorize that continued operation only if it can be done in a way that is adequately protective of health, safety, the environment, national security and Canada's international obligations. In making that decision, the Commission must reflect fair dealing and reconciliation with Indigenous peoples in Canada whose interests may be adversely affected by the decision.

As reflected in SON's intervention in CMD 18-H4.146 [29], SON and CNSC staff do not see in the same way in the guidance on the duty that the Supreme Court of Canada gave in the case *Rio Tinto Alcan Inc. v. Carrier Sekani Tribal Council* (2010 SCC 43) (Rio Tinto). CNSC staff view the authorization for continued operation of the Bruce facility, and the activities to be undertaken to ensure that continued operation will be safe, as not posing any novel adverse impacts to the rights of Indigenous groups. CNSC staff disagree with the interpretation that "novel" simply means "new"; as defined in the Merriam-Webster dictionary online, "novel" does not mean simply "new", it means "new and not resembling something formerly known or used" (https://www.merriam-webster.com/dictionary/novel). It is CNSC staff's view that the continuation of impacts of an existing facility, such as the Bruce facility, would not be novel.

It is in recognition of the longstanding interest and involvement of the Indigenous groups in the operation of the Bruce facility, and their particular concerns about the effects of the facility on the lake and its fish, that CNSC staff have undertaken engagement with the Indigenous groups in the past, and this engagement and consultation have continued respecting this renewal. Regardless of any disagreements as to the legal interpretation of the duty to consult, what is important from the perspective of the Crown is that significant efforts have been and are being made by CNSC staff to meet with the Indigenous groups, to understand their concerns, and to address those concerns.

This CMD will outline CNSC staff's proposals for addressing Indigenous group's concerns. CNSC staff view the ongoing discussions with the Indigenous groups, and the proposals that staff are making to the Commission, together with the public hearing process for this licence renewal, as upholding the honour of the Crown, and discharging the obligations upon the Crown in this matter. Furthermore, CNSC staff will continue to meet with the Indigenous groups, and work to both understand and to meaningfully address their concerns in the future.

CNSC staff recognize that meaningful consultation may in some cases oblige the CNSC to make changes to its proposed actions based on information obtained through consultation. However, CNSC staff note that the duty to consult does not amount to a duty to reach an agreement, nor does the duty amount to a veto for Aboriginal groups (*Haida Nation v. British Columbia (Minister of Forests)*, 2004 SCC 73, para 48). Any duty owed to the Aboriginal groups in this matter could not, in law, amount to a veto on the project moving ahead. What the duty requires is a meaningful process of consultation in good faith. In the case of this continued operation of the Bruce facility, CNSC staff have undertaken this process in a spirit

of fair dealing and reconciliation, and in a way that acknowledges that the facility already exists and has been in operation for decades.

In response to concerns that have been raised in discussions with the Indigenous groups, CNSC staff are proposing to the Commission some measures that are within the remedial authority of the Commission under licensing. These measures seek to preserve the Indigenous groups' rights and interests.

Specifically, whereas SON suggests that the duty to consult would require that its concerns be addressed in advance of a Commission decision to renew the operating licence and authorize refurbishment activities, it is CNSC staff's view that any potential adverse impacts posed by a renewal could be addressed through the CNSC's hearing process, and over the licensing period that would follow.

4.3.2 Licensee engagement efforts

Bruce Power included, in its supplemental CMD [11], Community Interest Reports on SON, the Métis Nation of Ontario (MNO) and the Historic Saugeen Métis (HSM). The purpose of these reports was to demonstrate Bruce Power's active engagement with SON, the MNO and the HSM over many years, including the work Bruce Power has performed to date and the discussions that were carried out (such as on the licence renewal application). Each respective report was shared with SON, the MNO and the HSM for review and comment. Bruce Power also continued to hold regular meetings with CNSC staff to confirm and consider approaches to resolve issues raised by SON and the MNO.

Bruce Power's engagement activities and work have substantially contributed, in many instances, to the activities and work CNSC staff have conducted with SON, the MNO and the HSM, including validating the issues and concerns raised. This has allowed CNSC staff to work with Bruce Power, SON, the MNO and the HSM to resolve, or identify ways to resolve, those issues and concerns.

Bruce Power demonstrated its commitment to engaging and continuing to work with SON, the MNO and HSM to try and address unresolved issues and concerns, include welcoming potential involvement by SON, the MNO and the HSM in the monitoring and oversight activities at the Bruce site.

4.3.3 CNSC staff engagement efforts

As reported in Part 1 CMD 18-H4, CNSC staff actively engaged with SON, the MNO and the HSM. A summary of some of the key issues raised by SON, the MNO and the HSM including CNSC staff's and Bruce Power's responses to those issues are provided in the Addendum C. A brief summary of discussions, including updates since the Part 1 CMD 18-H4, with each of the Indigenous Groups is provided below.

CNSC staff value its relationship with all Indigenous peoples, and would like to continue to work together on building trust in the operation and regulatory oversight of the Bruce Nuclear generating facility.

Discussions with the HSM

As reported in Part 1 CMD 18-H4, CNSC staff met with HSM representatives on February 27, 2018 to discuss issues related to the Bruce licence renewal application. The HSM stated that they were satisfied with the level of engagement efforts and have a good working relationship with Bruce Power. CNSC staff and the HSM have previously agreed to continue to meet on a regular basis to share information and build the relationship.

Discussions with the MNO

As reported in Part 1 CMD 18-H4, CNSC staff met with the MNO on January 17, 2018 to discuss the CNSC's Independent Environmental Monitoring Program (IEMP), the status of the *Fisheries Act* authorization application, and the status of the Bruce Power licence renewal application.

The MNO stated that they have a positive relationship with Bruce Power and that, while they still have some outstanding concerns, Bruce Power is working with the MNO to resolve them. CNSC staff and the MNO have previously committed to continue to meet to share information and build the relationship.

Discussions with SON

While the CNSC has engaged extensively with SON over the past years, CNSC staff and SON met on March 20, 2018 to develop areas of collaboration to address their concerns such as those related to the 2018 licensing hearing. While there remains a difference of opinion between CNSC staff and SON on the impacts the Bruce facility is having on the environment, both parties are committed to working together. In areas where agreement has not been reached, CNSC staff has encouraged SON to bring their concerns directly to the Commission for consideration.

Section 3.9.4 of this CMD provided details on the discussions between CNSC staff, SON and Bruce Power on impingement and entrainment of fish.

Section 4.3.4 of this CMD provides details and recommendations on how CNSC staff will work with SON in dealing with the identified interests or concerns.

4.3.4 CNSC staff collaboration with SON

On April 6, 2018, CNSC staff proposed in a letter to SON [33] to collaborate on the issues that are of particular interest to SON. On April 16, 2018 a response was provided by SON and indicated general agreement with the approach proposed by CNSC staff [34]. SON provides additional information on the proposed approach in their CMD 18-H4.146. The following sub-sections provide a summary of issues that are of particular interest to SON, categorized into the following areas:

- developing a study and analysis program
- SON participation in environmental monitoring
- study of available mitigation measures
- additional collaboration

4.3.4.1 Developing a study and analysis program

SON stated that a study and analysis program based on sound scientific principles and SON traditional knowledge should be developed to reduce uncertainties and to generate a credible and reliable understanding of potential impacts, specifically on fish populations.

In the April 6, 2018 letter, CNSC staff proposed that SON and CNSC staff collaborate on the development of a study and analysis program to further strengthen the understanding of the potential impacts from cooling water intake and discharge from the Bruce facility on the aquatic environment and fish populations. The program would be focused on thermal effluent, and impingement and entrainment, which were previously identified by SON as topics of interest and concern.

In their response [34], SON acknowledged their interest in working with CNSC staff to develop a mutually agreeable study and analysis program. SON did request clarification on the development and implementation of the program, particularly, SON's role in: the design of the program; implementation of the program (data collection); establishment of evaluation criteria; and analysis and interpretation of the data.

CNSC staff will request SON's input in the development of Bruce Power's program, recognizing that Bruce Power is responsible for the design development and implementation of environmental monitoring programs, as well as collecting and analyzing data. CNSC staff, along with SON, will perform a review of the program once it has been updated to ensure that SON's concerns have been addressed to the extent practicable.

CNSC staff encourage SON to discuss with Bruce Power on how SON will be able to participate in the environmental monitoring program data collection and analysis. In addition, CNSC staff will request SON to participate in the review of environmental data collected to confirm compliance with the monitoring program designs, including quality assurance and quality control of the data collected. Thermal effluent, and impingement and entrainment, which were previously identified by SON as topics of interest and concern, are to be the focus of these studies.

- The focus of the thermal effluent study and analysis program will be on enhancements to the environmental monitoring to support the development of a winter plume model. This challenge could potentially be overcome with advice on new technology from Environment and Climate Change Canada (ECCC). CNSC staff will ensure that SON participates in the discussions on future thermal monitoring with Bruce Power and ECCC, expected to begin in summer 2018.
- The focus of the fish impingement and entrainment study and analysis program is on enhancements to Bruce Power's impingement and entrainment monitoring plan, expected to be submitted as part of the *Fisheries Act* authorization application. The enhancements include reducing uncertainties in the data collected. CNSC staff will request SON to review the enhanced

monitoring plan to ensure that SON's concerns are addressed to the extent practicable.

To respond to SON's concerns over limitations on participation, CNSC staff proposed to continue to work with SON representatives to develop the study objectives, review updates on SON/Bruce Power collaboration on data collection, establish evaluation criteria, and review analyses of the data. Regular updates on the progress of this work would be provided in the annual Regulatory Oversight Report (ROR) for Canadian Nuclear Power Generating Sites.

In its letter of April 16, 2018, SON expressed concern that annual progress reports through the ROR for Canadian Nuclear Power Generating Sites may not provide a sufficient opportunity for participation. SON has the opportunity to intervene in the proceedings and provide its views on the progress of these activities. SON may also present to the Commission during Commission meetings as required.

To respond to SON's concerns over limitations on participation, CNSC staff recommend the creation of a steering committee comprised of CNSC staff and SON representatives. The steering committee would develop the study objectives, receive updates on SON and Bruce Power collaboration on data collection, establish evaluation criteria, and review analyses of the data. The steering committee would meet on a periodic basis, or on a more frequent basis when required, that could include the use of video or teleconference technologies. Regular updates on the progress of this work would be provided in the ROR for Canadian Nuclear Power Generating Sites. SON would have the option to intervene in those proceedings and provide their views on the progress of these activities. Updates on the work of the steering committee and progress on the program could also be presented during Commission meetings.

CNSC staff recommend to create a steering committee with SON representatives to collaborate on a study and analysis program.

4.3.4.2 SON participation in environmental monitoring

CNSC staff welcome SON involvement in the CNSC's IEMP to ensure any traditional foods, medicines or other environmental aspects of significance to SON are included in the program. This involvement could include SON assistance in gathering samples to be monitored. The next sampling campaign around the Bruce site is in 2019 and sample planning is scheduled to begin in fall 2018. In its April 16, 2018 letter [34], SON welcomes participation in the development and implementation of the CNSC's IEMP.

However, SON notes that its specific concerns are with the credibility of monitoring related to activities carried out by Bruce Power, especially in relation to the monitoring of thermal effluent and entrainment and impingement. As stated in Section 4.3.3.1, Bruce Power is responsible for conducting environmental monitoring data collection and analysis. CNSC staff encourage SON to discuss with Bruce Power directly on how SON may participate in the environmental monitoring program data collection and analysis. CNSC staff will also continue

to share with SON the results of CNSC routine inspections of Bruce Power's environmental program.

CNSC staff recommend to work with SON regarding participation in the CNSC's IEMP around the Bruce site. CNSC staff also recommend Bruce Power to include SON participation in its monitoring activities, including data collection, where appropriate.

4.3.4.3 Study of Available Mitigation Measures

As reported in the Part 1 CMD 18-H4, CNSC staff concluded that Bruce Power has and will continue to make adequate provision for the protection of the environment. CNSC staff acknowledged that SON requested that a study of available mitigation measures be performed, which takes into account not only cost-benefit assessment, but also precautionary principles and SON values.

In the April 6, 2018 letter, CNSC staff did not recommend additional mitigation measures because it is CNSC staff's views that there are no unreasonable risks requiring further mitigation. However, CNSC staff recognize the value in conducting a review of mitigation measures in case the level of risk changes in the future, due to either changing environmental conditions or in light of new science becoming available. As a life-cycle regulator, the CNSC has the ability to require design modifications in the future if warranted. And to be clear, the Commission can, at any time on its own initiative, require Bruce Power to undertake additional actions.

In its April 16, 2018 letter [34], SON clarified its position that a credible mitigation measures plan is required to address significant uncertainties regarding the impacts from the Bruce facility. SON considers a study of available mitigation measures as a necessary first step, but agreement is needed on how to assess the study and to ensure implementation of viable mitigation mechanisms that maybe identified through the assessment. SON further requested clarity on how:

- SON will participate in establishing criteria or expectations for the study
- SON and CNSC staff will carry out an assessment of mitigation measures that reflects SON values and protects SON rights and interests
- the assessment outcomes will be implemented through ongoing regulatory activities

As the operator of the facility, Bruce Power has conducted similar reviews in the past, some of which have been provided to SON, and is best positioned to conduct updates to these reviews. CNSC staff have introduced criteria in the proposed Section 9.1 of the Licence Conditions Handbook (LCH) that Bruce Power conducts a review of feasible mitigation measures for thermal effluent and impingement/entrainment and that the review be completed by December 31, 2019. After the review has been submitted, CNSC staff will work with SON to determine the next steps. CNSC staff will ensure SON values are considered during this process. Updates on the results of this review, including CNSC staff and SON collaboration, would be provided to the Commission via the subsequent

ROR for Canadian Nuclear Power Generating Sites. Updates could also be presented to the Commission during Commission meetings if requested.

CNSC staff recommend to work with SON to identify any feasible mitigation measures for thermal effluent and impingement/entrainment from Bruce Power's review of feasible mitigation measures.

4.3.4.4 Additional Collaboration

In the April 6, 2018 letter to SON, CNSC staff proposed additional activities for collaboration with SON in the interest of strengthening the relationship and building trust in the regulatory oversight of the Bruce site. In its April 16, 2018 response letter, SON stated appreciation for the suggestions and a commitment to work with CNSC staff to define and implement the proposed activities below.

CNSC staff outreach in SON communities

As part of the mandate of the CNSC to disseminate scientific, technical and regulatory information, CNSC staff would like to visit SON communities in order to present findings, hear concerns and answer questions that community members may have. CNSC staff would like to work with SON to determine the best method to implement this proposal.

Sharing of results of environmental inspections

In response to concerns regarding impingement data, CNSC staff conducted an inspection on Bruce Power's impingement monitoring program. The inspection concluded that Bruce Power met regulatory requirements. CNSC identified only issues of low risk significance, such as procedural adherence, which were communicated to Bruce Power for actions. The inspection report was shared with SON and CNSC staff has committed to repeat this inspection annually and share subsequent reports with SON. In addition, CNSC staff also commit to sharing results of other environmental inspections which take place as part of Bruce Power's compliance plan.

Identifying Federal, Provincial and Municipal decision-making Agencies

CNSC staff commit to continuing to work with SON to identify responsible federal, provincial or municipal agencies involved in decisions related to nuclear matters at the Bruce site, such as the Ontario Ministry of Energy for energy policy decisions or the Nuclear Waste Management Organization for long-term disposal for Canada's used nuclear fuel.

Coordinating Meetings with Crown Agencies

CNSC staff commit to explore with SON, where appropriate, opportunities to coordinate meetings with Crown agencies involved in oversight and/or decision making on nuclear matters in SON territory. For example, CNSC staff have ensured ECCC and DFO participation at facilitated workshops with SON, in response to SON's areas of interest.

4.3.5 Overall Conclusion

CNSC staff value the relationships they have with SON, the MNO and the HSM, and are committed to maintaining and strengthening those relationships. CNSC staff will continue to work and collaborate with SON, the MNO and the HSM on common issues of interest or concern including:

- CNSC's Independent Environmental Monitoring Program
- *Fisheries Act* authorization application
- Bruce Power's environmental monitoring program

In addition, CNSC staff will work with the MNO and the HSM to determine their interests in participating in the proposals made by CNSC staff to SON, as detailed in Section 4.3.4.

4.4 Participant Funding Program

As reported in the Part 1 CMD 18-H4, under the CNSC's Participant Funding Program (PFP) $100,000 was made available to the public, other stakeholders and Indigenous peoples to support participation in the relicensing process. Eight (8) applicants were awarded PFP funds for the Bruce licence renewal application to the amount of $76,500, including $32,385 to the MNO.

Additional funding was provided to SON and the MNO through the PFP under general matters of regulatory interest. $78,750 was provided to SON and $24,470 was provided to the MNO to support the costs associated with meetings and workshops with CNSC staff, including facilitator costs, on regulatory matters such as the licence renewal, environmental impacts (including impacts to fish), and refurbishment.

4.5 Previous Commitments Raised by the Commission

As presented in the Part 1 CMD 18-H4, CNSC staff have addressed at previous licensing hearings and meetings the comments raised in Dr. Nijhawan's interventions related to technical issues associated with the CANDU design, such as:

- severe accidents are not considered in the design process
- measures to address lessons learned from Fukushima event are inadequate
- existing systems and containment structures ineffective in dealing with accident progression
- Passive Autocatalytic Recombiners (PARS) are ineffective in hydrogen mitigation as a result of severe accident
- inadequate relief capacity for Primary Heat Transport System

The intervenor has been raising the same and similar issues since 2001. In particular, he raised the same issues in his submissions at the Bruce relicensing hearing in 2015, the Darlington relicensing hearing in 2015 and at the Pt. Lepreau relicensing hearing in 2017.

To address the concerns raised, a joint CANDU Owners Group (COG) project team was formed to evaluate the generic safety issues associated with CANDU reactors. In October 2016, a final COG report was issued which included dispositions of all the intervenor's issues. CNSC staff considered this file closed given that the CANDU safety issues have been evaluated and the COG Research and Development (R&D) report has been submitted.

An update on this issue was presented at the March 8, 2017 Commission meeting. The minutes of the meeting [35] state that the Commission was "satisfied with the methodical approach by the industry, COG and CNSC staff in addressing [the intervenor's] issues and concerns, as well as with reported results of the review of these issues." The Commission also noted the rigour of the evidence that was presented by CNSC staff, third party experts and the Canadian nuclear industry. The Commission concluded that there remain no outstanding issues that would require further attention. Finally, the Commission was satisfied with the approach taken by CNSC staff in the categorization of CANDU Safety Issues.

In April 2018, Dr. Nijhawan submitted an intervention in CMD 18-H4.144 [36] opposing the Bruce relicensing in 2015 as well as the current 2018 relicensing hearing. CMD 18-H4.144 is effectively the same as presented in 2015 and it does not contain any new material nor does it give consideration of the work that was completed by CNSC staff, third party experts and the Canadian nuclear industry since then. As no new material have been presented, CNSC staff recommend that the Commission continue to accept the conclusions from the March 8, 2017 Commission meeting as stated above.

4.6 CNSC staff's Rationale for Recommending a 10-year Licence

CNSC staff are recommending a 10-year operating licences for the operation of Bruce A and B for the following reasons:

- The Commission approved criteria for licence period length have been met
- Licence period length is consistent with international best practices
- Bruce Power conducted a comprehensive Periodic Safety Review (PSR)

CMD 02-M12, *New Staff Approach to Recommending Licence Periods* sets out the criteria in determining the length of a licence period. The objective of CMD 02-M12 was to provide a consistent, rational basis which recognizes the relative risk posed by the facility, activity or equipment being licensed, the time required for CNSC staff to conduct a thorough review, and the need for transparency. CMD 02-M12 was approved for use by the Commission. CNSC staff reviewed Bruce Power's licence application, including assessment of Bruce Power's past performance, and determined that:

- the recommended duration of the licence is commensurate with the licensed activity
- the hazards associated with the licensed activity are well characterized and their impacts well predicted, and are within the scope considered in the environmental safety case

- Bruce Power has in place a management system, to provide assurance that its safety-related activities are effected and maintained
- effective compliance programs are in place on the part of both Bruce Power and the CNSC
- Bruce Power has shown as consistent and good history of operating experience and compliance in carrying out the licensed activity

In 2002, the Organisation for Economic Co-operation and Development (OECD) issued a report [37] on international practices with respect to licence periods/terms for nuclear facilities in Nuclear Energy Agency (NEA) member countries. The CNSC is consistent with 14 of the 16 NEA member countries for requiring a PSR to be conducted on a 10-year frequency. In addition, 14 out of 16 countries surveyed issue long fixed term (10-20 years) or lifetime licences (30 years+). Table 4 provides several examples from the OECD report.

Table 4: International Licence periods and PSR requirements

Country	Licence Period Approach	PSR Frequency
Finland	Fixed term (10-20 years), with first licence for 5 years	Every 10 years
France	Lifetime	Every 10 years
United Kingdom	Lifetime	Every 10 years
United States	Fixed term (40 years, with 20-year renewal option)	None Required

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. In CMD 18-H4, CNSC staff determined that Bruce Power's PSR systematically reviewed modern standards and practices, and identified practical improvements to Bruce A and B over the next licensing period.

CNSC staff's recommendation for a 10-year licence is consistent with international practices for PSR frequency and licence period.

Finally, CNSC staff report annually on the performance of licensees through the ROR for Canadian Nuclear Generating Stations. Members of the public, as well as Indigenous groups, are encouraged to participate during the Commission meetings to identify any concerns they may have with the licensees through the Commission intervention process.

5. OVERALL CONCLUSIONS AND RECOMMENDATIONS

The updates provided in this supplemental CMD do not change the overall CNSC staff conclusions from CMD 18-H4.

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

As presented in CMD 18-H4, CNSC staff's overall recommendations to the Commission have not changed. The recommendations include:

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[4], before hydrogen equivalent concentrations exceed 120 ppm, the licensee shall demonstrate that pressure tube fracture toughness will be sufficient for safe operation beyond 120 ppm
   - 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. direct CNSC staff and Bruce Power, to work with Indigenous groups to address their areas of concerns as identified in Section 4.3 of this CMD
3. 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
4. authorize Bruce Power to operate Bruce A and B up to a maximum of 300,000 Equivalent Full Power Hour

[4] The recommendations for LC 15.3 have not changed. The condition was strengthened based on feedback by the Commission during the Part 1 hearing.

5. delegate authority as set out in CMD 18-H4
6. 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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15. CMD 17-M46, “The biological mechanisms acting at low doses of radiation”, November 9, 2017, eDocs 5333211.

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17. Bruce Power Letter, F. Saunders to L. Sigouin, “Bruce NGS A and B: Bruce Power Environmental Risk Assessment”, February 1, 2018, eDocs 5451083.

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25. CNSC Letter, L. Sigouin to F. Saunders, “Action Item 2017-07-12218: Response to Environmental Risk Assessment: Requirements for Additional Assessment and/or Future Environmental Monitoring”, May 14, 2018, eDocs 5524404.

26. CMD 17-M48, “Update on the implementation of recommendations from the Tritium Studies Synthesis Report”, November 9, 2017, eDocs 5341317.

27. CMD 18-M21, “Update on Emergency Management in Ontario and the Provincial Nuclear Emergency Response Plan (PNERP)”, April 4, 2018, eDocs 5491292.

28. CMD 18-H4.103, Intervention submitted by Northwatch, April 16, 2018, eDocs 5510781.

29. CMD 18-H4.97, “Written submission from Energy*Solutions* Canada”, April 16, 2018, eDocs 5510578.

30. CMD 18-H4.146, Intervention submitted by Saugeen Ojibway Nation, April 23, 2017, eDocs 5514442.
31. CMD 17-H5, "Ontario Power Generation Inc. – Pickering Waste Management Facility", April 12, 2017, eDocs 5186356.
32. CMD 17-H11, "Ontario Power Generation Inc.'s Consolidated Financial Guarantee", October 11, 2017, eDocs 5306917.
33. CNSC Letter, L. Sigouin to K. Ryan, "SON-CNSC staff engagement on Bruce Power's licence renewal application", April 6, 2018, eDocs 5492751.
34. SON Letter, K. Ryan to L. Sigouin, "SON-CNSC staff engagement on Bruce Power's licence renewal application and refurbishment project", April 16, 2018, eDocs 5509680.
35. Minutes of Canadian Nuclear Safety Commission (CNSC) meeting held on March 8, 2017, eDocs 5232103.
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GLOSSARY

Acronym	Term
ALARA	As Low As Reasonable Achievable
BDBA	Beyond Design Basis Accident
CEAA	Canadian Environmental Assessment Act
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
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
EFPH	Equivalent Full Power Hour
ERA	Environmental Risk Assessment
HSM	Historic Saugeen Métis
IEMP	Independent Environmental Monitoring Program
IIP	Integrated Implementation Plan
LC	Licence Condition
LCH	Licence Conditions Handbook
LRF	Large Release Frequency
MCR	Major Component Replacement
MNO	Métis Nation of Ontario
MOECC	Ministry of Environment and Climate Change
NGS	Nuclear Generating Station
NSCA	Nuclear Safety and Control Act
PERA	Predictive Environmental Risk Assessment
PROL	Power Reactor Operating Licence
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review

SCA	Safety and Control Areas
SON	Saugeen Ojibway Nation
SSC	Structures, Systems and Components

PART TWO

Part Two provides all relevant information pertaining directly to the licence and LCH, including:

1. Any proposed changes to the licence activities and conditions, LCH and implementation of regulatory documents
2. The proposed licence

PROPOSED CHANGES TO THE PROL AND LCH - UPDATES

Overview

The reasons for the proposed changes to the Bruce A and B Power Reactor Operating Licence (PROL) and Licence Conditions Handbook (LCH) were provided in CMD 18-H4. This section provides updates on changes made since March 14, 2018 (date of Part 1 hearing). The proposed PROL, including changes since the Part 1 hearing, is provided in the Addendum D.

Proposed changes to the PROL

Revision to licensed activity (iv)

Licensed activity (iv) has been revised to exclude controlled nuclear equipment. This change is necessary as the activity is authorized under the *Nuclear Non-proliferation Import and Export Control Regulations*. In addition, minor editorial changes were made to this licensed activity.

Current Wording	Proposed Wording
(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);	(iv) import and export nuclear substances and prescribed equipment, except controlled nuclear substances and controlled nuclear equipment, that are required for, associated with, or arise from the activities described in (i), (ii) and (iii);

Revision to Licence Condition 15.3

As recommended by the Commission during the Part 1 hearing, CNSC staff revised Licence Condition 15.3 (station specific condition) related to the pressure tube fracture toughness model to strengthen the condition. The reasons for the change were provided in Section 3.6 (fitness for service) of this CMD.

Current Wording	Proposed Change
The licensee shall maintain pressure tube fracture toughness sufficient for safe operation.	Before hydrogen equivalent concentrations exceed 120 ppm, the licensee shall demonstrate that pressure tube fracture toughness will be sufficient for safe operation beyond 120 ppm.

Deviations from Standardized Licence Condition Text

With the consolidation of other licences (such as Class II and nuclear substances and radiation devices licences) into the Bruce A and B PROL 18.00/2028, as explained in section 5.10 of CMD 18-H4, it was necessary to deviate from the standardized text for two LCs (LC G.4 and LC 2.2) due to the fact that the term “nuclear facility” used in these two LCs would need additional information to distinguish between whether one was referring to the “Class I nuclear facilities” (Bruce Nuclear Generating Stations A and B) or the “Class II nuclear facility” (calibration irradiator facility).

CNSC staff decided that, to be clear, the term “Bruce Nuclear Generating Stations A and B” would be defined as “Bruce A and B” and used in place of “nuclear facilities” throughout the proposed PROL.

LC	Standardized Text	Proposed Text
G.4	The licensee shall provide, at the nuclear facility 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 that nuclear facility (onsite Commission staff).	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).
2.2	The licensee shall implement and maintain the minimum shift complement and control room staffing for the nuclear facility.	The licensee shall implement and maintain the minimum shift complement and control room staffing for Bruce A and B.

Proposed changes to the LCH

The LCH will continue to be updated and improved throughout the life of the PROL and approval to revisions of the LCH will be delegated to the Director General of the Directorate of Power Reactor Regulation. This is the standard process that is followed by all LCHs for NPPs regulated by the CNSC. An update on the revisions to the LCH will be given annually to the Commission via the Regulatory Oversight Report for Canadian Nuclear Power Generating Sites. The following are some of the proposed improvements to the LCH since the Part 1 hearing:

Section of LCH	**Proposed improvements to the LCH since the Part 1 CMD**
2.1 Human Performance Program	Addition of the implementation strategy for REGDOC-2.2.4, Volume II: *Managing Alcohol and Drug Use*, Version 2.
6.1 Fitness for Service Program	Addition of CVC and guidance for pressure tube fracture toughness assessments to support the continued use of Revision 1 of the Cohesive Zone Model.
9.1 Environmental Protection Plan	Addition of CVC for assessment of feasible mitigation measures for thermal effluent and impingement/entrainment.
13.1 Safeguards Program	Addition as a guidance publication CNSC regulatory document REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy*, with a submission date for the implementation plan of July 1, 2018.
15.3 Pressure Tube Fracture Toughness	Addition of CVC for demonstration of sufficient pressure tube fracture toughness and guidance for performing Leak-Before-Break assessments.

Updates to Implementation of CNSC REGDOCs and CSA Standards

During the upcoming licence period, new or revised Canadian Standards Association (CSA) standards and CNSC regulatory documents (REGDOCs) will form part of the licensing basis. In some cases, full compliance is not expected to be implemented by Bruce Power upon issuance of the licence, since transitioning requires completion of gap analyses, updates to Bruce Power's governance, and submission of transition plans. The following changes have been made to the list of CNSC REGDOCs since they were presented in CMD 18-H4.

Existing Doc. Identifier	Proposed Doc. Identifier	Title	Date
N/A	REGDOC-2.2.4 Volume II	Managing Alcohol and Drug Use, Version 2	Implement by December 1, 2019
RD-336, GD-336	REGDOC-2.13.1	Safeguards and Nuclear Material Accountancy	Submit implementation plan by July 1, 2018

ADDENDUM

Addendum materials that complement Part One and Part Two of this CMD include:

A. CMD 18-M4, *Technical Update on Fuel Channel Fitness-for-Service in Canadian Nuclear Power Plants*, eDocs 5422679.

B. CNSC staff response to SON's technical appendices included in CMD 18-H4.146, eDocs 5528957.

C. Summary of key issues raised by SON, the MNO and the HSM including CNSC and Bruce Power responses, eDocs 5508881.

D. Proposed Licence, eDocs 5371084.

Addendum A

CMD 18-M4, Technical Update on Fuel Channel Fitness-for-Service in Canadian Nuclear Power Plants

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

Canada

Technical Update on Fuel Channel Fitness-For-Service in Canadian Nuclear Power Plants

Commission Meeting, January 23 2018

CMD 18-M4

CNSC Staff Presentation

Purpose

In relation to aging management of existing operating facilities, CNSC staff presents the science behind fuel channel fitness-for-service assessments in support of technical information for Regulatory recommendations.

Previous CMDs

Pressure tubes have been mentioned during several NPP Re-Licensing Hearings; the following is a list of CMDs that provided detailed technical information:

- CMD 13-H2.A: Supplemental CNSC staff submission recommending Hold Point for OPG-Pickering (in connection with request to operate beyond 210,000 EFPH)
- CMD 14-H2: CNSC staff submission regarding OPG-Pickering request to remove 210,000 EFPH Hold Point
- CMD 14-M15: OPG/BP technical briefing regarding PT fitness-for-service
- CMD 14-M15.1: CNSC staff submission regarding PT fitness-for-service
- CMD 17-M12: CNSC staff submission (follow-up) regarding Commission Meeting Item: CANDU Safety Issues

Outline

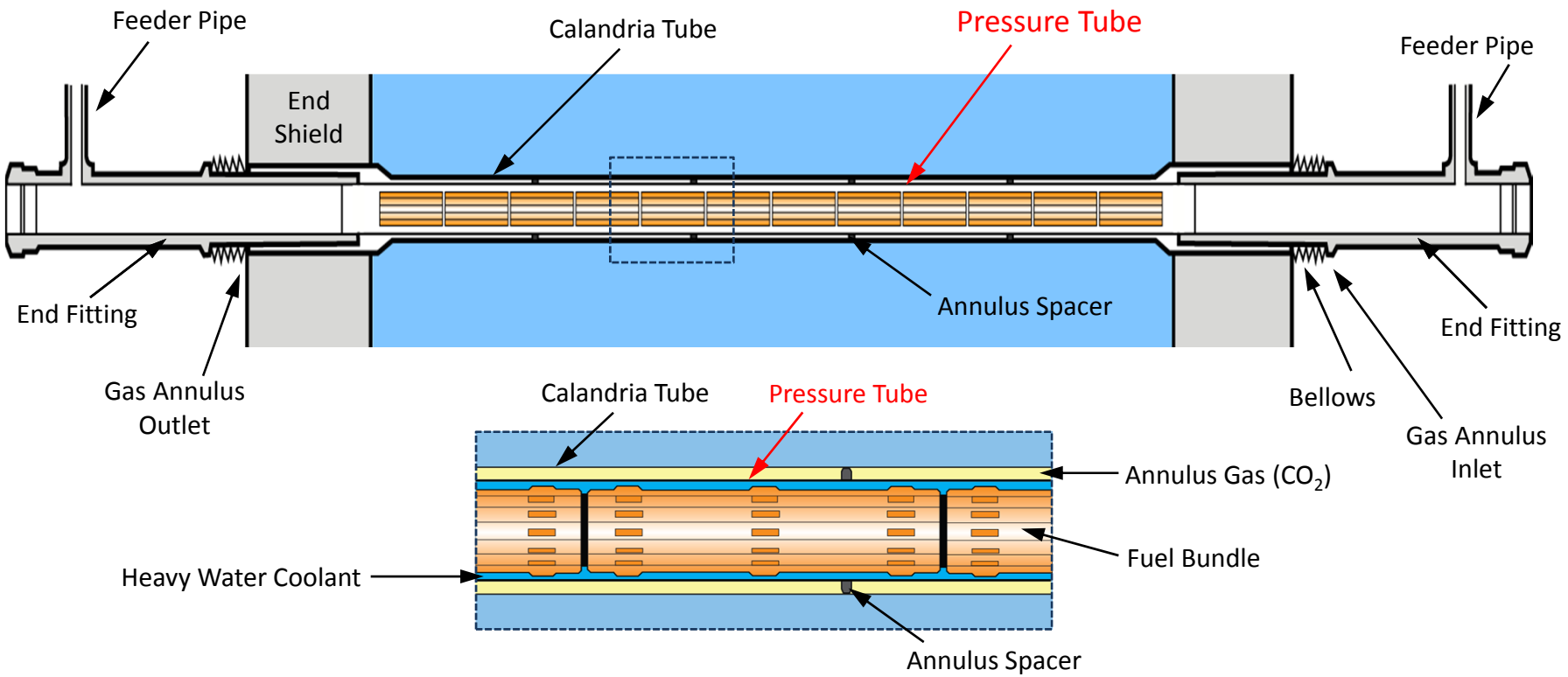
- Overview of the CANDU fuel channel
- Some useful concepts
- Degradation of pressure tubes (“PT”)
- Regulatory oversight of PT degradation
  - Example 1 - PT flaws
  - Example 2 - reduced PT fracture toughness
- CNSC evaluation of requests for extended PT operation
  - Timeline of licensee requests for extended operation
  - Operation beyond 247,000 EFPH: area of regulatory focus
- Summary

Commission Meeting, January 23 2018
CMD 18-M4

OVERVIEW OF THE CANDU FUEL CHANNEL

e-Docs #5422679 (PPTX)
e-Docs #5436079 PDF

CANDU Fuel Channel (FC)



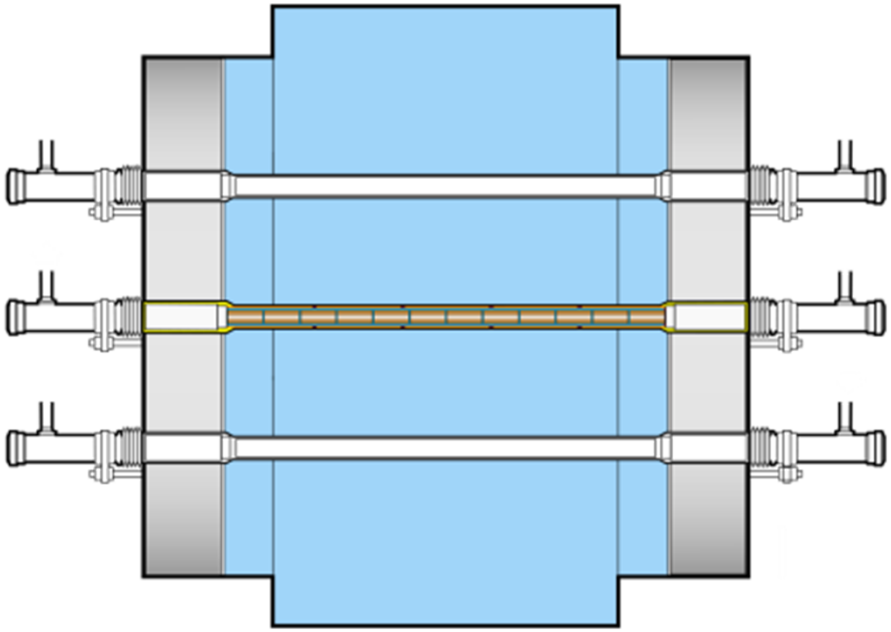
CANDU Fuel Channels (2 of 2)

Pressure Tubes

- 380 to 480 per core
- Horizontal orientation
- Zirconium-2.5 wt.% Niobium
- Dimensions
  - 5.94 m in length
  - Inside diameter 103.4 mm
  - 4.2 mm wall thickness

Normal Operating Conditions

- ≈250°C (inlet) to ≈310°C (outlet)
- ≈11 MPa (inlet) to ≈10 MPa (outlet)



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CMD 18-M4

THECHNICAL CONCEPTS

e-Docs #5422679 (PPTX)
e-Docs #5436079 PDF

Some Technical Concepts

Before describing the basis for pressure tube (PT) assessments, it is useful to review a few concepts:

1. Fitness-for-Service of pressure tubes
2. Hydrogen/deuterium in pressure tubes
3. Units for reactor operating time

Concept #1
Fitness-for-Service of PTs (1 of 2)

- Pressure tubes form part of the pressure boundary of the Primary Heat Transport System
- Structural integrity of the Heat Transport System is an important element of CANDU safety case
  - Under Normal Operating Conditions, PTs contain the high-pressure, high-temperature primary coolant
  - During (postulated) Design Basis Accidents, PTs keep the fuel cool

Concept #1
Fitness-for-Service of PTs (2 of 2)

- For these reasons, PT design must support an extremely low probability of failure under all reactor operating conditions:
  - Pressure tubes are designed not to leak
  - Pressure tubes are designed to resist propagation of a through-wall crack to the point of PT rupture

Goal of fitness-for-service: ensure PTs continue to meet the design intent

Concept #1
Pressure Tube Evaluations

CNSC requirement:

Licensee must demonstrate acceptable performance of 100% of pressure tubes over future period

Fitness-for-Service assessments based on results from periodic inspections — **30%** of pressure tubes

+

Risk assessments* based on CNSC-accepted Models — **70%** of pressure tubes

✓ **100% of PTs assessed against defined acceptance criteria**

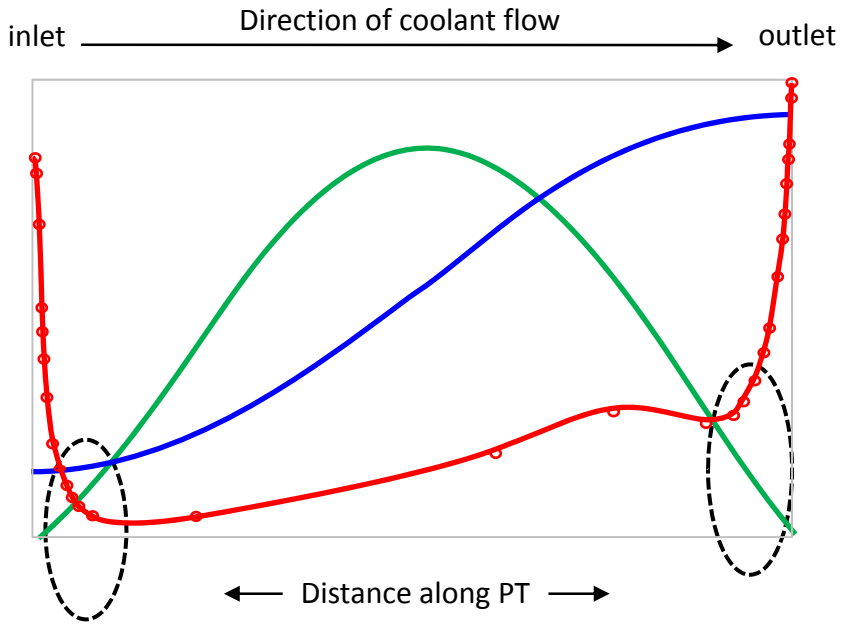
* Examples: Leak-Before-Break (Slide 22) and fracture protection (Slide 28)

Concept #2
Hydrogen/Deuterium

- While three hydrogen isotopes are important to CANDU operation, only two affect PTs
- Every PT contains some **hydrogen (H)**, originating from its manufacture
- In the presence of hot heavy water coolant, PTs corrode to form zirconium oxide. This releases **deuterium (D),** a fraction of which is absorbed by the tube
- By convention, H and D concentrations are reported as milligrams per kilogram of PT material (or parts-per-million, PPM)
- Every PT contains both H and D. The two are often combined and reported as a single value: hydrogen-equivalent (Heq) concentration
  - For convenience, the term “Heq” will be used throughout this CMD

Concept #2

Factors Influencing Heq Level Along a PT



Fast neutron flux

Coolant temperature

Deuterium concentration

Areas where potential reduction in fracture toughness requires enhanced regulatory focus to ensure safety margins are maintained

Concept #3
Units for Reactor Operating Time

- Reactor operating time is described in two ways:
  - ***Hot Hours*** (HH) – includes all periods when the Heat Transport System exceeds ≈200°C
    - Since PTs corrode at these temperatures, Hot Hours is a useful metric for comparing Heq levels
  - ***Effective Full Power Hours*** (EFPH) – captures only those periods when fuel is undergoing fission
    - Since PTs irradiated by fast neutrons during such periods, EFPH useful for tracking degradation arising from neutron damage e.g. PT elongation
- Example: 1 calendar year = 8760 Hot Hours ≈ 7890 EFPH*

* Varies by station, and operating circumstances

Commission Meeting, January 23 2018
CMD 18-M4

DEGRADATION OF PRESSURE TUBES

e-Docs #5422679 (PPTX)
e-Docs #5436079 PDF

Degradation of Pressure Tubes due to aging

- PTs located in reactor core are exposed to high temperatures, high pressure and intense radiation fields
- Leads to in-service degradation

1. PT deformation

- Elongation
- Reduction in wall thickness
- Increase in diameter
- PT sag

2. Calandria tube-to-LISS contact

3. PT corrosion

4. PT flaws

5. Degradation of annulus spacers

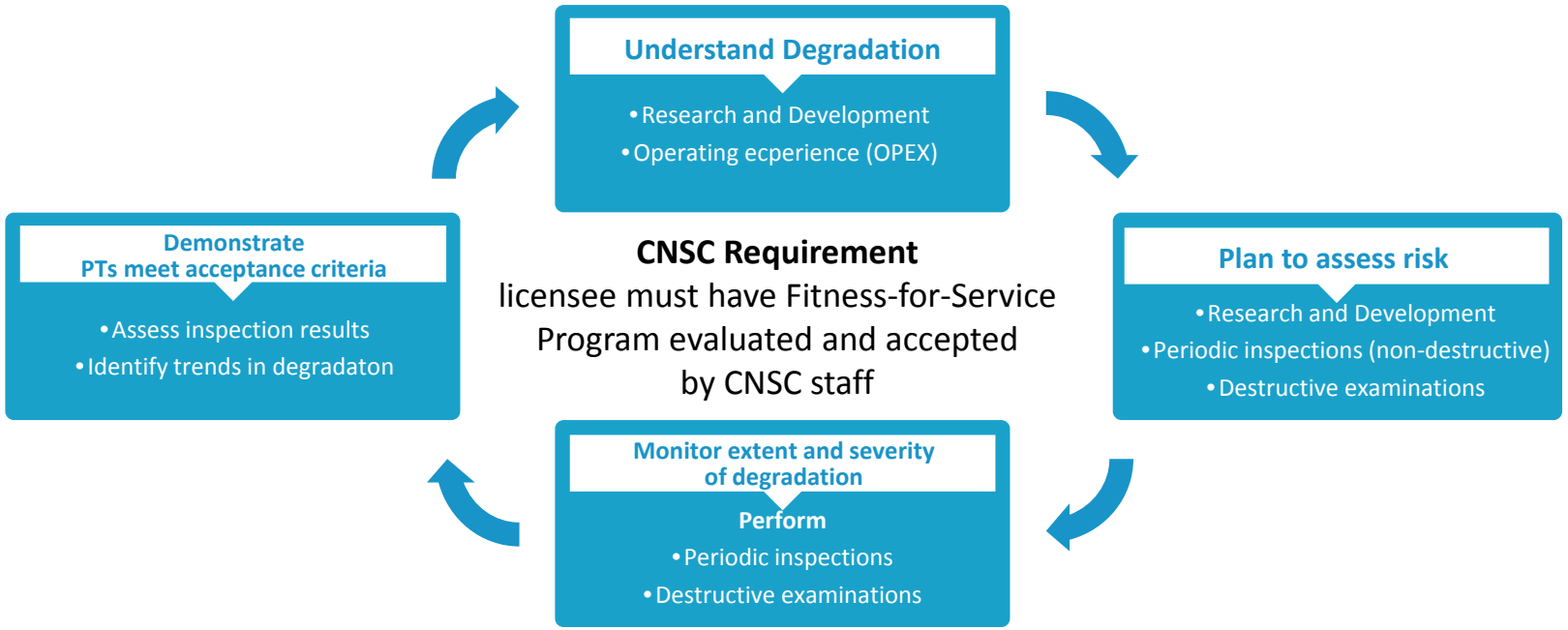
6. Changes in PT material properties
(fracture toughness of particular interest)

Commission Meeting, January 23 2018
CMD 18-M4

REGULATORY OVERSIGHT

e-Docs #5422679 (PPTX)
e-Docs #5436079 PDF

Regulatory Oversight of PT Degradation



CNSC Staff's Management of Risk – Two Examples

Two examples of staff's regulatory oversight of PT degradation:

- Flaws in PTs
- Declining PT fracture toughness

Example 1

PT Flaws (1 of 3)

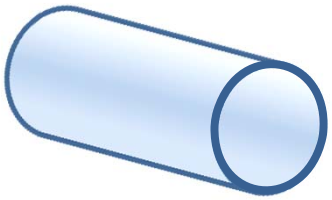
Progression of flaw degradation:

- Flaw initiated in pressure tube
- Flaw develops into crack (e.g. Delayed Hydride Cracking)
- Crack propagates through the PT wall -> primary coolant leakage
- Crack extends axially along PT ***(predictable rate, by design)***
  - **Leak-Before-Break:** reactor cooled and shut-down before PT crack reaches "Critical Length" (point of instability)
  - **Break-Before-Leak:** crack reaches Critical Length before reactor can be shut-down

Example 1

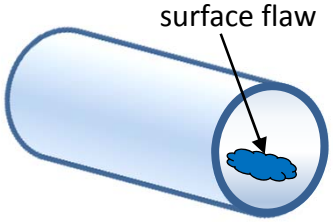
Safety Case for PTs (2 of 3)

Barrier #1 – must pass inaugural inspection (CSA N285.4)



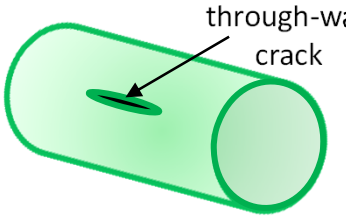
As-installed pressure tube

Barrier #2 – detected flaw must not initiate crack (CSA N285.8)



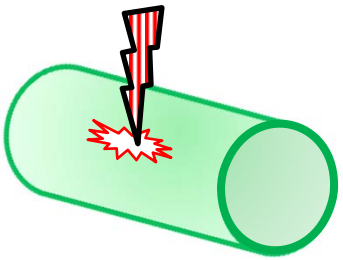
Inspected pressure tube

Barrier #3 – must demonstrate Leak-Before-Break (CSA N285.8)



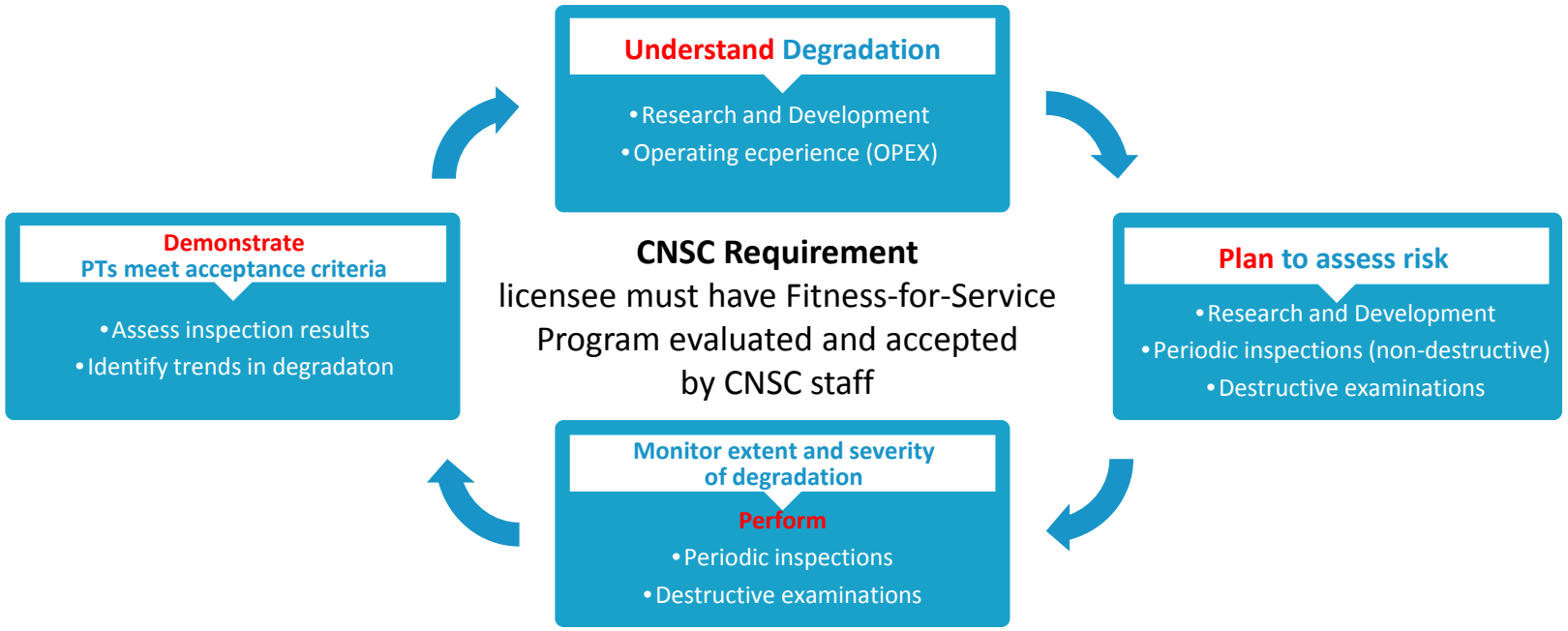
Uninspected pressure tube

pressure tube rupture (Break-Before-Leak)



Uninspected pressure tube

Recalling Slide 20



Example 1

PT Flaws (3 of 3)

Requirement	Regulations	Licensee actions to address requirements
Understand	REGDOC-2.6.3	Industry research and development; fuel channel Condition Assessments
Plan	CSA N285.4 (per licence Condition Handbook)	Periodic Inspection Program (PIP); fuel channel Life-Cycle Management Plan
Perform	CSA N285.4, CSA N285.8 (per licence Condition Handbook)	Periodic inspections; PT material surveillance; research and development
Demonstrate acceptance criteria met	CSA N285.4, CSA N285.8, REGDOC-2.6.3 (per licence Condition Handbook)	Fitness-for-service assessments; follow-up inspections; research and development

Example 2

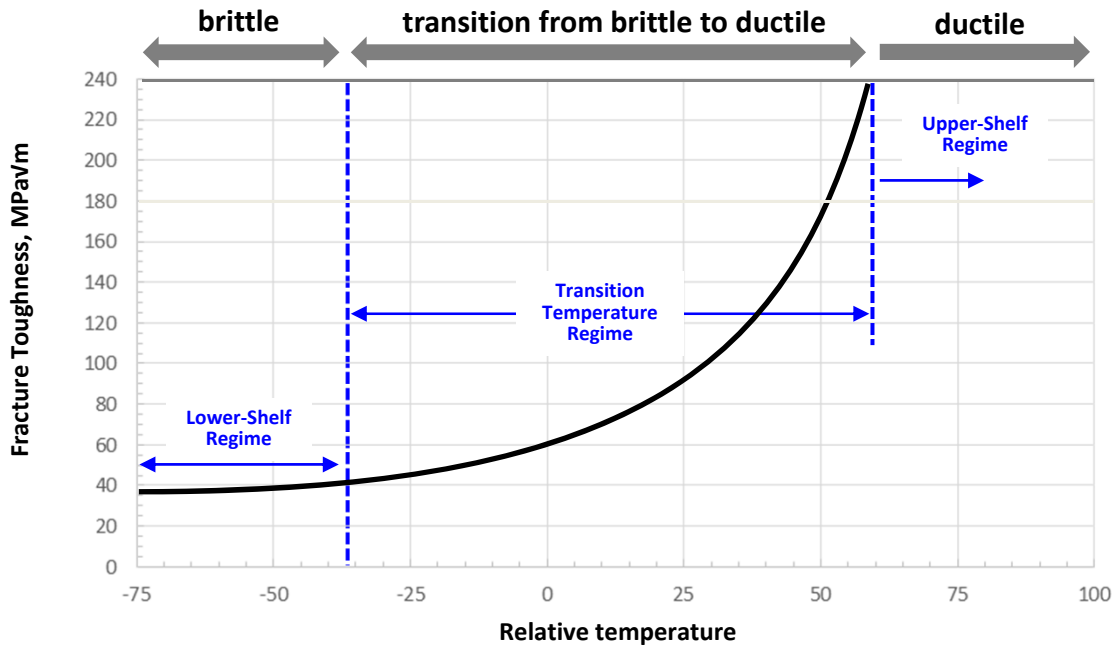
Fracture Toughness (1 of 5)

Definition* - resistance a material will offer to a growing crack

- Fracture toughness vital for quantifying risk posed by postulated PT cracks (uninspected PTs)
- Unique situation
  - Unlike PT flaws (which can be identified and monitored in-situ), fracture toughness cannot be measured in in-service pressure tubes
  - Can only confirm toughness of a tube once it has been removed
  - **To predict behavior of operating pressure tubes, licensees must rely on models**
- Industry relies on two forward-looking toughness Models
  - Statistical upper-shelf model: predicts PT toughness at $\geq 250^{o}C$
  - **Cohesive Zone-based Model**: predicts toughness for lower-shelf and transition regimes

* Carter & Paul, ***Materials Science & Engineering*** ASM International, © 1991

Example 2
Fracture Toughness (2 of 5)



- Relationship between lower-bound toughness and temperature
- Based on destructive tests of irradiated samples of LWR pressure vessel steel
- Three regimes of fracture behavior

Example 2

Fracture Toughness (3 of 5)

- Periodic (destructive) examination of PTs has confirmed adequate fracture toughness over the near-term i.e. successful demonstration of Leak-Before-Break
- However, research and development has demonstrated that PT toughness has, and will continue to decline as Heq levels increase
- To ensure PTs can perform their design function
  - Under Normal Operating Conditions ($\geq 250^{o}C$) PTs must be ***fully ductile*** to respond to anticipated loads under (postulated) Design Basis Accidents. That is, 100% of the pressure tubes in a core must exhibit upper-shelf behavior
  - During reactor heat-up/ cool-down ($35^{o}C$ to $250^{o}C$), transition behavior of PTs must be known, and fracture toughness must be adequate

See Slide 26

- Impact of decreased toughness during heat-up/cool-down is addressed in the following Slide

Example 2

Fracture Toughness (4 of 5)

Heat Transport System heat-up/cool-down envelope*

- ***Regulatory requirement*** – licensee must operate the Heat Transport System (HTS) so as to maintain integrity of pressure-boundary components
  - To address this for pressure tubes, licensees establish a "envelope" within which operators must maneuver pressure and temperature during reactor start-ups and shut-downs
- The upper-bound of the envelope is defined using a ***PT fracture protection assessment***. Assuming a through-wall crack in an uninspected PT, the assessment calculates the maximum operating pressure beyond which the crack would be unstable
- Fracture toughness is a key input
  - Until recently, Heq levels were low enough that PT toughness remained high. This ensured a reasonable safety margin between the heat-up/ cool-down envelope and the maximum allowable Heat Transport System pressure
  - However, PT toughness has decreased as Heq levels increased. licensees can adjust their heat-up/cool-down envelopes to stay below revised maximum pressure values, but safety margins must be demonstrated as adequate
- Since PT toughness is affected by Heq levels only when temperatures fall within the heat-up/cool-down range, ample safety margins are expected to exist under Normal Operating Conditions (i.e. PT temperature >250^{o}C)

* see Appendix

Example 2

Fracture Toughness (5 of 5)

- Regulatory requirements similar to Slide 24

✓ licensee activities involve similar level of effort and focus compared to those devoted to fitness-for-service assessments (e.g. PT flaws)

Commission Meeting, January 23 2018
CMD 18-M4

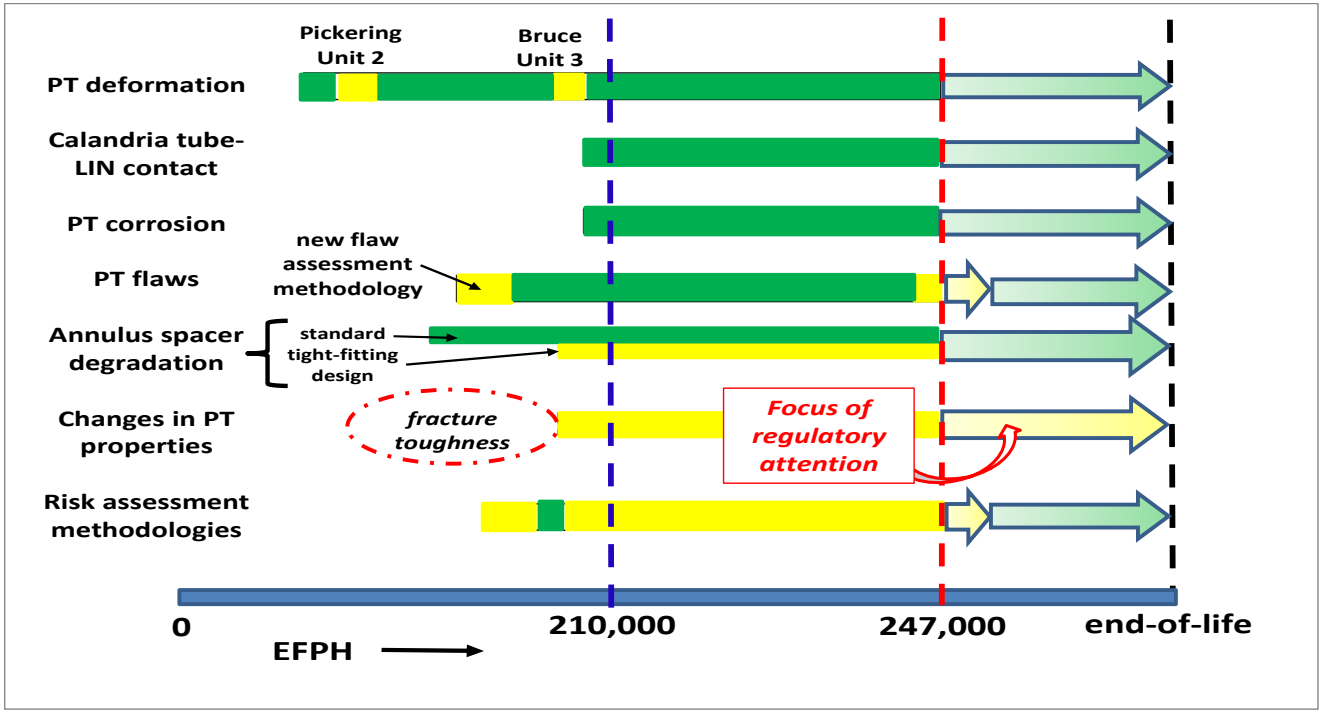
CNSC EVALUATION OF EXTENDED PT OPERATION

e-Docs #5422679 (PPTX)
e-Docs #5436079 PDF

CNSC Evaluation of Proposals for Extended PT Operation (1 of 2)

Existing PROL
licensee provisions satisfactory
Enhanced regulatory scrutiny required

Requested PROL
Staff anticipates satisfactory licensee performance
Staff anticipates continued need for enhanced scrutiny



CNSC Evaluation of Proposals for Extended PT Operation (2 of 2)

Operation beyond 247,000 EFPH ?

- CNSC staff evaluating licensee progress on outstanding issues from Slide 31

Issue	Status in 2014 (prior to 210,000 EFPH)	Current status
Degradation of tight-fitting annulus spacers	Limited data; modest understanding of degradation phenomena	***Additional data collected; improved understanding of phenomena; FFS guidelines have been drafted***
Methodologies for PT risk assessments	New methodologies proposed; limited practical experience	***Two methodologies accepted for use; regulatory decision on third is pending***
Fracture toughness	Limited validation of, and limited experience using two new Models	***Development and validation of new Model? handling of uncertainties?***

Commission Meeting, January 23 2018
CMD 18-M4

SUMMARY

Summary (1of 2)

PT degradation mechanisms

- ***CNSC expectation*** **-** licensees must have an in-depth understanding of PT degradation phenomena, based on extensive research and development and an effective OPEX program
- ***CNSC requirement*** – licensees must routinely inspect PTs to monitor the incidence and severity of known (and emerging) degradation mechanisms
- ***Comprehensive and effective regulatory oversight***
  - Reviews of licensee fitness-for-service assessments, risk assessments, Type II inspections, periodic reviews of the state of industry technical knowledge
  - Clear, well-documented expectations (REGDOC-2.6.3, N285.8 Compliance Plans)
  - Effective Compliance Verification Criteria (CVC) in the Licence Conditions Handbook
  - Regular updates to the Commission (Annual Regulatory Oversight Report)

Summary (2 of 2)

Reduction in fracture toughness

- On-going, dedicated industry research and development program
- ***Regulatory expectations have not changed***: licensees must demonstrate PTs are, and will remain capable of meeting the design intent (*extremely low probability of failure*)
- For acceptance by CNSC staff, models must conservatively predict PT toughness over range of EFPH and Heq concentration shown in the Appendix

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APPENDIX

e-Docs #5422679 (PPTX)
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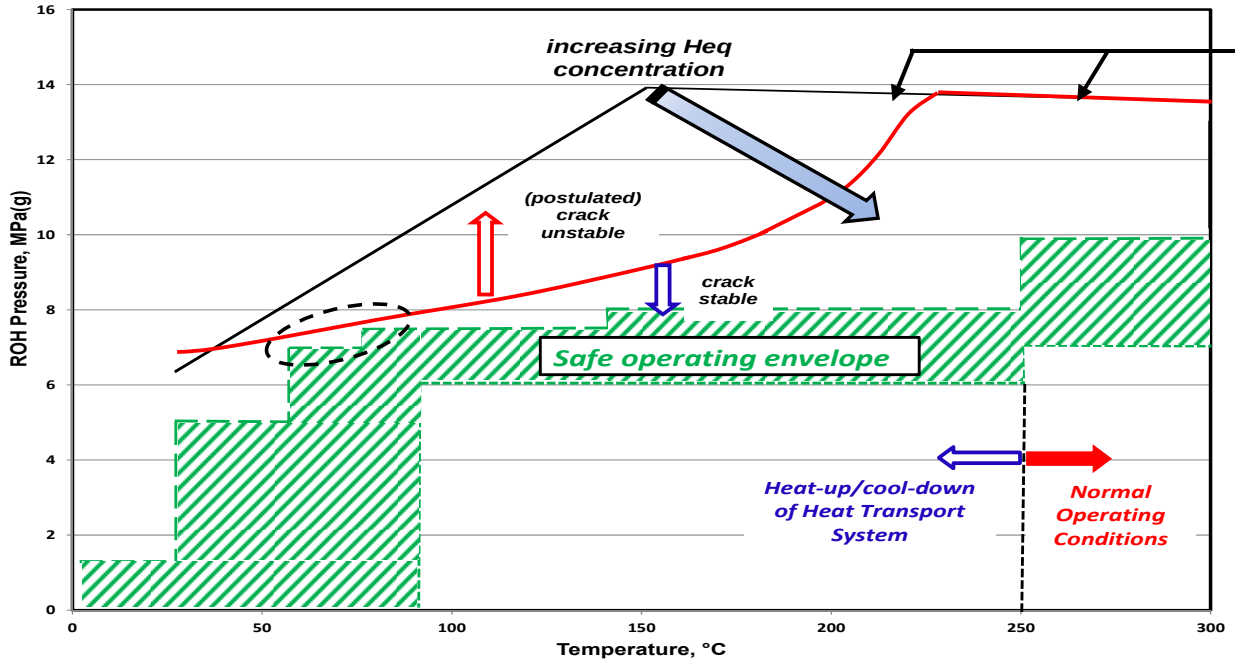
APPENDIX
Typical Heat Transport System Heat-Up/Cool-Down Envelope



Maximum allowable Heat Transport System pressure

APPENDIX

Canada's Pressure Tube Population

Station	Number of fuel channels	Existing cores		Refurbished cores	
		Original PTs began service	EFPH (as of Dec. 2017)	New PTs began service	EFPH (as of Dec. 2017)
Pickering Units 1 & 4	390	(1983), (1993)	134,000		
Pickering Units 5 - 8	380	1982 – 1985	237,000		
Darlington Units 1, 3, 4	480	1990 – 1993	196,000		
Bruce Units 1 & 2	480			Fall 2012	35,000
Bruce Units 3 & 4	480	1977 – 1978	211,000		
Bruce Units 5 - 8	480	1984 - 1987	233,000		
Point Lepreau	380			Fall 2012	35,000

APPENDIX

In-Service Degradation of Fuel Channels (1 of 2)

Type of degradation	Potential risk	How do licensees manage the risk
PT deformation		
• Elongation	Potential for inadequate fuel channel support (*e.g. postulated earthquake)*	Periodic inspections. Fuel channel maintenance
• Reduction in wall thickness	Potential reduction in margin-to-rupture (*postulated design basis accident)*	Periodic inspections
• Increase in diameter	Potential reduction in margin to fuel dry-out (*postulated design basis accident*)	Periodic inspections. Ensure adequate provisions for avoidance of fuel dry-out
• PT sag	Potential contact between pressure tube and calandria tube (CT)	Periodic inspections. Shift annulus spacers (as required)

APPENDIX

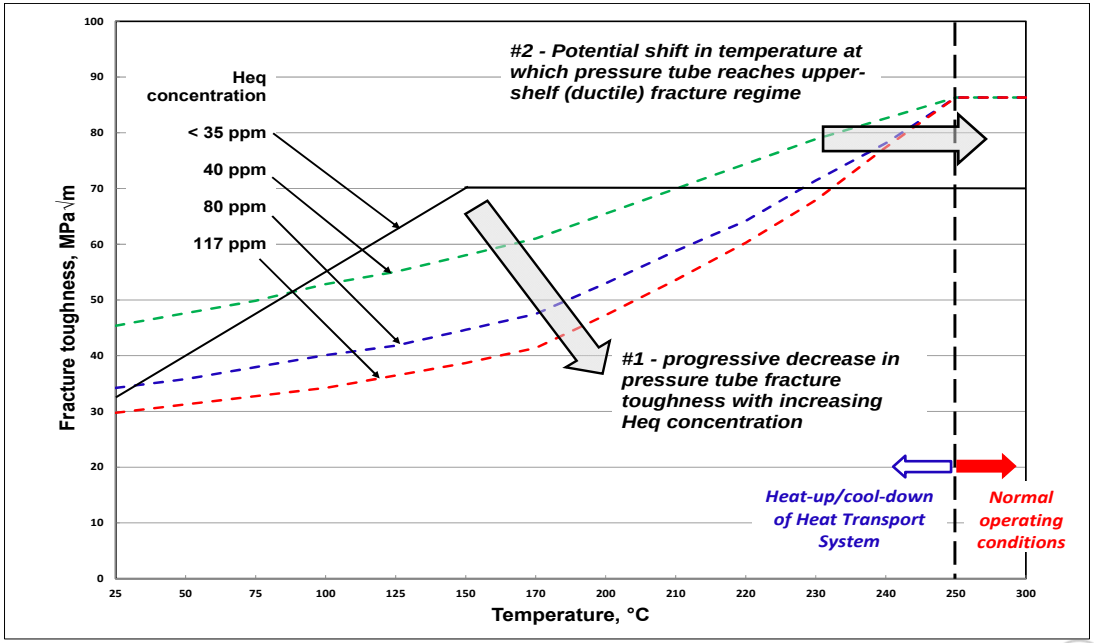
In-Service Degradation of Fuel Channels (2 of 2)

Type of degradation	Potential risk	How do licensees manage the risk
Fuel channel sag	Potential contact between CT and liquid (poison) injection nozzles	Periodic inspections. Re-positioning nozzles
PT corrosion	Reduction in PT wall thickness	Periodic inspections
PT flaws	Delayed Hydride Cracking (DHC) can initiate at flaws	Periodic inspections. Assess risk of DHC initiation
Degradation of annulus spacers	Potential contact between PT and calandria tube	Periodic inspections (gap). Periodic material surveillance
Changes in PT material properties	Key mechanical properties (e.g. fracture toughness) diverge from values assumed in PT safety case	Periodic removal of PTs for destructive examination

APPENDIX

Impact of Increasing Heq Concentration on PT Fracture Toughness

(Lower-Shelf & Transition Temperature Regimes)



APPENDIX

Projected Heq Concentrations for Ontario PTs: Near-Inlet

Station	Projections		
		June 2018	Target Service-life
Pickering-B	EFPH	234,680	289,000
	Heq, ppm	**38**	**55-60**
Darlington Units 1, 3, 4	EFPH	192,790	234,000
	Heq, ppm	**45**	**66**
Bruce-A (Units 3, 4)	EFPH	215,035	255,000
	Heq, ppm	**50**	(unknown)
Bruce-B	EFPH	229,260	298,000
	Heq, ppm	**40**	**70**

APPENDIX

Projected Heq Concentrations for Ontario PTs: Near-Outlet

Station	Projections		
		June 2018	Target Service-life
Pickering-B	EFPH	234,680	289,000
	Heq, ppm	55	82
Darlington Units 1, 3, 4	EFPH	192,790	234,000
	Heq, ppm	52	127
Bruce-A (Units 3, 4)	EFPH	215,035	255,000
	Heq, ppm	71	105
Bruce-B	EFPH	229,260	298,000
	Heq, ppm	90	160

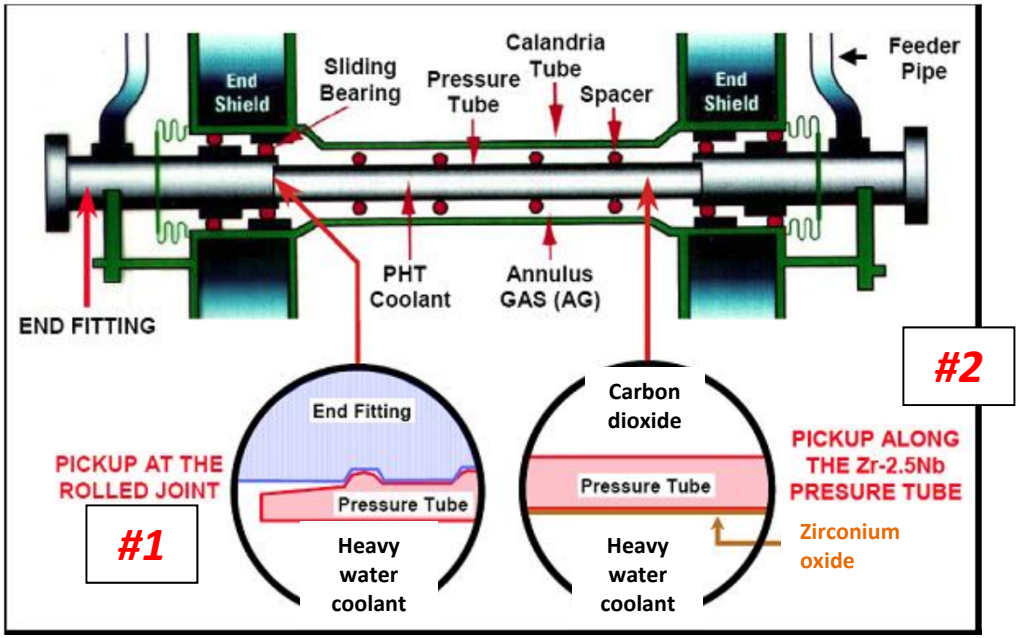
APPENDIX

Attributes of an Acceptable Model

1. The model should (preferably) be founded on a mechanistic understanding of the phenomenon, and/or based on experimental evidence
2. The model must be verified and its predictions validated prior to use
3. Model inputs and assumptions must be identified and justified
4. Model uncertainties must be quantified
5. To focus improvements to the model, a sensitivity analysis is invaluable
6. Forward-looking models must be periodically re-validated

APPENDIX

Sources of Deuterium Uptake



APPENDIX

Sources of PT data

Periodic (CSA-mandated) / In-Service Inspection programs (licensee-initiated, part of Licensing Basis)

- Frequency: typically 2 to 3-year intervals (planned outages)
- Scope: 10 PTs (CSA minimum); mix of uninspected and previously inspected tubes
- Non-destructive examinations include PT dimensions, PT-CT gap, flaws etc.
- Heq concentration

Material surveillance (CSA requirement)

- Frequency: typically 2 to 4-year intervals
- Remove one PT (plus annulus spacers if possible)
- Destructive examinations: Heq, PT material properties (e.g. fracture toughness)

Research and Development

- 35+ years of dedicated effort that continues within Canadian industry

Addendum B

CNSC staff response to SON's technical appendices included in CMD 18-H4.146

Addendum B CNSC Staff Response to SON Technical Appendices included in Saugeen Ojibway Nation (SON) CMD 18-H4.146	
Appendix	**CNSC Disposition**
A – Chris Tollefson, *Implementing the CNSC's Mandate to Ensure Respect for the Precautionary Principle: Bruce Power's Application to Refurbish the Bruce Nuclear Generating Station* (prepared for the Saugeen Ojibway Nation, April 20, 2018)	This appendix outlines a suggested approach to applying the precautionary principle. Precaution is inherent to the Environmental Protection Framework and regulatory oversight of the CNSC. For instance, in the context of REGDOC 2.9.1 Environmental Protection: Environmental Principles, Assessments and Protection Measures, and CSA N288.6 on Environmental Risk Assessment and associated effluent and environmental monitoring standards, predictions are made using conservative assumptions. Where licence action limits are put in place they are established several magnitudes below expected impacts, so that licensees are forced to verify that there are no systems issues of concern when an action level is exceeded. Licence limits are set at levels that pose no unreasonable risk to the environment or the public, in this way, even if an actual limit is approached, the CNSC does not anticipate adverse effects, but would then require the licensee to take corrective actions. This is a form of adaptive management to ensure that there are no adverse impacts. The 5 year cycle of the Environmental Risk Assessment ensures that changes to the environment, new science and traditional knowledge can continuously be factored into the risk assessment predictions, which allows the regulator to be adaptive to any changes and to close the gaps on scientific uncertainties. An example of where science has been used to confirm risk assessment predictions is research has been completed over the years with Bruce Power's support to determine whether population effects are occurring and to discern whether there are local populations of Lake Whitefish. Results to date indicates there is not a distinct local population of Lake Whitefish in the vicinity of the Bruce site, but rather that Lake Whitefish in the vicinity are part of a larger Lake Huron population. This appendix does not present information that changes CNSC staff's conclusion.

B – Marc W. Cadotte, *External review of Bruce Power environmental risk assessments* (University of Toronto, April 20, 2018)	This appendix provides a review of the robustness of Bruce Power's ERA and PERA. Bruce Power completed their Environmental Risk Assessment in accordance with CSA 288.6-12 *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills.* The standard was developed in consideration of Canadian and US Environmental Protection Agency guidance for conducting Environmental Risk Assessments. CNSC staff reviewed the October 2017 updated ERA and concluded that it is consistent with the CSA methodology and that risks to the environment or public health for the continued operation and life extension of Bruce A and B are low to negligible. CSA 288.6-12 indicates that the information used in preparing an ERA can be affected by uncertainties due to, for example, incomplete information about a parameter or value, variability among organisms within population or across time and space, limited data for some species, life stages, or endpoints of interest, and combined effects of multiple contaminants or physical stressors. The updated ERA adequately identified and discussed the important uncertainties associated with the models and data used for each stage of the risk assessment including those associated with the models and data used that are important to the risk result. CNSC staff identified uncertainties that can be reduced in the next iteration of the ERA through additional assessment and/or planned monitoring to confirm the overall conclusions of low to negligible risks to the environment and human health. Aspects of cumulative effects are captured through environmental monitoring, regional monitoring initiatives and research. The Bruce Power Predictive Environmental Risk Assessment (PERA) is based on the Environmental Risk Assessment (ERA) prepared following the guidance in CSA N288.6-12 *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* to demonstrate consideration of environmental protection during future site activities, including the MCR project. The PERA is a tool which takes into account current conditions at the site, including baseline information and impacts from current activities, the ERA, and using models with conservative assumptions to estimate changes and potential risks from future activities at the site.

	The PERA is not a conclusive assessment; rather it is a planning tool and as such, the PERA and ongoing monitoring activities can inform further work, including revisions to the ERA, as appropriate. Through a number of regulatory tools available to the CNSC, such as adaptive management, further adjustments to monitoring programs, special studies and mitigation measures can be made to ensure that people and the environment will continue to be protected in the future. This appendix does not present information that changes CNSC staff's conclusion.
C – Philip H. Byer, *Review of Consideration of Climate Change in Bruce Power Predictive Effects Assessment of Aquatic Environment* (University of Toronto, April 9, 2018)	This appendix examines climate change and the Predictive Environmental Risk Assessment. As a lifecycle regulator, CNSC uses an adaptive management approach to deal with difficult to predict future conditions (such as climate change) that could impact conclusions regarding risk to the environment and human health. Bruce Power has monitored thermal emissions for many years and will continue to do so as part of ongoing regulatory compliance. CNSC and Environment and Climate Change Canada staff have identified some uncertainties that must be addressed within the context of the Environmental Risk Assessment for thermal matters. Bruce Power will continue to assess ongoing and predicted future operations, to ensure that changes in climate will be incorporated. Bruce Power is partnering with the Council of the Great Lakes Region to conduct a climate change study and SON may have traditional knowledge that could be valuable and aid in informing the climate change study. This appendix does not present information that changes CNSC staff's conclusion; however, this information may help inform Bruce Power's planned climate change study.
D – Kathleen Ryan, *Thermal Effects Report* (SON Environment Office, October 9, 2017)	This appendix provides an assessment of Bruce Power's environmental risk assessment due to physical stressors (cooling water intake and discharge) and radiological ecological risk assessment.

	Cooling Water Intake (Impingement and Entrainment) CNSC staff has determined that the existing mitigation on the cooling water intake (offshore intake, velocity cap) is effective and fish losses due to impingement and entrainment is not resulting in population level effects to fish and therefore no additional mitigation is required at this time. *Cooling Water Discharge (Thermal Risk Assessment)* Thermal monitoring will continue during the proposed licensing period. The thermal risk assessment assessed the risk to the thermal guilds of fish species (cool-water, warm-water and cold-water species). Environment and Climate Change Canada (ECCC) and CNSC staff have concluded that the overall risk due to thermal discharge is low, given the results of the risk assessment. CNSC and ECCC staff has made several comments on the thermal risk assessment that are to be addressed in order to reduce uncertainties in the thermal risk assessment by December 31, 2018. The main area of focus is to develop a winter thermal plume model, as there have been challenges based on the ability of water temperature monitoring equipment to survive winter conditions on Lake Huron. ECCC has indicated to CNSC staff that new technology may be available to increase success of data collection. CNSC staff will work with Bruce Power, ECCC and SON to discuss future thermal monitoring. CNSC and ECCC staff have concluded that the "operational flexibility" application that has been submitted to the Ontario Ministry of Environment and Climate Change (MOECC) to allow for a temporary increase in the temperature of the thermal effluent between June and September is not likely to pose an unreasonable risk to the environment. This has been communicated to the Indigenous Communities, Bruce Power and the MOECC. CNSC staff has introduced criteria in Section 9.1 of the proposed Licence Conditions Handbook that Bruce Power conducts a review of feasible mitigation measures for thermal effluent and

	impingement/entrainment by December 31, 2019. After the review is submitted, CNSC staff will work with SON to determine next steps. CNSC staff will ensure SON values are considered during this process. Appendix B – Dr. Michael Nichols, Chesapeake Nuclear Services – Review of Ecological Impacts for the Bruce Power Major Component Replacement 2. Radiological Ecological Risk Assessment: CNSC staff reviewed the Environmental Risk Assessment and confirmed that modelling of radionuclide activity levels into the environment were based on maximum releases. The maximum release activities of radionuclides to the environment are low, due to Bruce Power's control of releases. All modelled dose rates to environmental and human receptors were below the benchmarks, even with this high degree of conservatism. Tissue samples were collected from roadkill deer on site and confirmed the conservatism of the modelled data used in the ERA. CNSC staff have requested Bruce Power propose monitoring of additional terrestrial and aquatic biota to confirm the low modelled radionuclide activities and to address uncertainties and assumptions in the exposure assessment for terrestrial and aquatic biota in the next iteration of the ERA. Tritium activity in the municipal drinking water of communities near Bruce Power are well below the Health Canada guideline and the Province of Ontario's legal limit of 7,000 Bq/L and the Ontario Drinking Water Advisory Committee proposed limit of 20 Bq/L. CNSC staff reviewed the data tables associated with gaseous and waterborne emissions and the associated comments on the request for providing uncertainties in the measured data as well as the inconsistent use of detection limits when summing or averaging data. The intervenor makes several recommendations regarding these issues and suggests following various documents including the "CSA Standard N288.4-10 (2015) Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills". CNSC staff notes that Bruce Power provides a summary of their QA/QC program in Section 8 of the annual reports and notes that the Bruce Power Health Physics Laboratory has a

	comprehensive QA program in accordance with ISO 17025. CNSC staff have noted these inconsistencies and is satisfied that these minor inconsistencies in reporting does not have a significant impact on the results, however CNSC staff expects and Bruce Power has committed to be in full compliance with the CSA Standard N288.4-10 (2015) by December 31, 2018 which includes the provision of uncertainties in measurements as well as acceptance of detection limits and other data reporting requirements. This appendix does not present information that changes CNSC staff's conclusion on the thermal risk assessment or the radiological risk assessment.
E – Richard Ferch, *Assessment of Radioactive Waste and Operational Risk Factors Related to Bruce NGS Relicensing and the Major Component Replacement Plan* (Chesapeake Nuclear Services, Inc., April 12, 2018)	This appendix discusses the cumulative risk as the result of MCR (life extension of reactors for another 25 years), claiming that the risk accumulated from additional 25 year's operation is not acceptable. (Page 274-276) It is an international practice that the average annual risk, (core damage frequency or large release frequency per year) cannot be simply extrapolated to estimate the cumulative risk overtime. Safety goals for existing NPPs (core damage frequency less than 1 in 10,000 years and large release frequency less than 1 in 100,000 years) are established internationally for an average design life of 50 years. Long term operation or life extension is granted on the basis of a comprehensive periodic safety review that includes the PSA that shows that the risk has decreased as a result of all incorporated safety improvements. CNSC Staff concludes that Safety Goals used by Canadian industry are in line with International practices.
F – C. Scott Findlay, *Workshop Follow-Up Report for Saugeen Ojibway Nation—Canadian Nuclear Safety Commission Science Facilitation Workshop* (University of Ottawa, September 19, 2017)	CNSC staff participated in the May 2017 Workshop and provided comments on this Workshop Follow-up Report contained in this Appendix. The initial impetus for the Workshop was to resolve SON's outstanding issues on the methods used by Bruce Power to collect fish impingement and entrainment data (originally submitted as Appendix G – Stephen Crawford, Daniel Gillis, Robert Hanner, Andrew Binns, *Saugeen Ojibway Nation-Bruce Power (SON-BP) Collaborative Lake Whitefish Research Program: University of Guelph Team Analysis of Bruce*

	Power Responses to University of Guelph Team Comments on "Bruce A Refurbishment for Life Extension and Continued Operations Environmental Assessment Follow-up Program Draft Operations Phase Impingement and Entrainment Monitoring Plan" (Golder Associates, July 2011) (University of Guelph, August 7, 2012). The terms of reference for the May 2017 Workshop were developed collaboratively with the SON, and as a result of the Part 1 Workshop reported on in this appendix, the issues expanded beyond actions to resolve SON's outstanding issues on the fish impingement and entrainment monitoring plan to understanding the role of science and uncertainty and adaptive management in CNSC regulatory decision making and cumulative effects in both environmental decisions and the *Fisheries Act* Authorization. Part 2 of the Workshop was held in January and February 2018 with an information package from the CNSC being provided in advance. These workshops have led to a greater understanding and appreciation of the SON's views on the CNSC's use of science, regulatory decision making and how uncertainty is addressed. The CNSC and DFO requested that Bruce Power include a revision to their impingement and entrainment monitoring plan in their final Fisheries Act Authorization Application. The revised impingement and entrainment monitoring plan will address many of the unresolved uncertainties identified by the SON in their original 296 comments on the 2011 monitoring plan. CNSC will consult with SON on the revised impingement and entrainment monitoring plan that has been included in the *Fisheries Act* Authorization Application.
G – Stephen Crawford, Daniel Gillis, Robert Hanner, Andrew Binns, *Saugeen Ojibway Nation-Bruce Power (SON-BP) Collaborative Lake Whitefish Research Program: University of Guelph Team Analysis of Bruce Power Responses to University of Guelph Team Comments on "Bruce A Refurbishment for Life Extension and Continued Operations Environmental Assessment Follow-up Program Draft*	This appendix is the same information that was submitted by the SON in CMD 15-H2.118 as part of the 2015 Bruce Power relicensing hearing. CNSC staff has been working toward resolving these original '296' comments on the 2011 impingement and entrainment monitoring plan. Bruce Power created a revised impingement and entrainment monitoring plan in 2012 where they incorporated aspects of the 296 comments or recommendations. CNSC staff reviewed the 2011 impingement and entrainment monitoring plan against best practices of the time (guidance from the U.S. Electrical Power Research Institute) and concluded the methods were sufficient to verify the predictions of the Bruce A Refurbishment

Operations Phase Impingement and Entrainment Monitoring Plan" (Golder Associates, July 2011) (University of Guelph, August 7, 2012)	Environmental Assessment Efforts to date to resolve these matters include numerous meetings, three facilitated workshops and commitments to work with the SON on future monitoring and analysis related to impingement and entrainment. This appendix does not present information that changes CNSC staff's conclusion; however, updates on progress on resolving these matters have been and will continue to be part of the Regulatory Oversight Report for Canadian Nuclear Power Generating Sites.

Addendum C

Summary of key issues raised by SON, the MNO and the HSM including CNSC and Bruce Power responses

ADDENDUM C : SUMMARY OF KEY ISSUES RAISED BY INDIGENOUS GROUPS AND RESPONSES FROM BRUCE POWER AND CNSC STAFF		
ISSUE/CONCERN RAISED	**BRUCE POWER'S RESPONSE**	**CNSC STAFF'S RESPONSE**
Saugeen Ojibway Nation (SON) **(Saugeen First Nation & Chippewas of Nawash Unceded First Nation)**		
Develop a Mutually Agreeable Study and Analysis Program SON have expressed interest in working with CNSC staff to develop an environmental monitoring program based on sound scientific principles and SON knowledge to reduce uncertainties and generate a credible and reliable understanding of the potential impacts of the nuclear power plant on the environment, specifically on fish populations. SON requested clarification on the development and implementation of the program, particularly, SON's role in: • designing the program; • implementing the program (data collection); • establishing evaluation criteria; and • analyzing and interpreting the data.		• In a letter dated April 6, 2018, CNSC staff proposed to collaborate on the development of a study and analysis program to further strengthen the understanding of the potential impacts from cooling water intake and discharge from of the Bruce site facility on the aquatic environment and fish populations. • The program will be focused on thermal effluent, and impingement and entrainment, which were previously identified by SON as topics of interest and concern. • CNSC staff will request SON's input to provide enhancements to Bruce Power's program, recognizing that Bruce Power is responsible for the design development and implementation of environmental monitoring programs, as well as collecting and analyzing data. • CNSC staff will perform a review of the program once it has been updated to ensure that SON's concerns have been addressed to the extent practicable. • CNSC staff encourage SON to discuss with Bruce Power on how SON will be able to participate in the environmental monitoring program data collection and analysis. • CNSC staff will request SON to participate in the review of environmental data collected to confirm compliance with the monitoring program designs, including quality assurance and quality control of the data collected.

Thermal Effluent SON raised issues and concerns with potential thermal effects due to cooling water discharge, particularly Bruce Power's request to the Ontario Ministry of Environment and Climate Change (MOECC) to modify the current permit to allow for "operational flexibility" in effluent temperature.	• Bruce Power conducted a thermal risk assessment as part of the Environmental Risk Assessment (ERA) and concluded that there is minimal risk to fish as a result of cooling water thermal effluent. • Research supported by Bruce Power was used to inform the thermal risk assessment. • Bruce Power has applied to the MOECC for a change to the effluent temperature permitted in the Environmental Compliance Approval (ECA) during the summer months. • Bruce Power monitors water temperature and will continue to do so in the future as part of monitoring under the *Nuclear Safety and Control Act* and for the thermal ECA from the MOECC. • Bruce Power undertook or supported additional studies to assess the impacts of cooling water discharge on Lake Whitefish and Round Whitefish specifically and Lake Huron generally. • Bruce Power advised that research concluded: ○ The direct impact of the thermal discharge on the survival of Lake Whitefish embryos and juveniles is likely to be limited with no additional effects caused by chemical and radiation exposure at the very low levels that result from Bruce Power operations.	• Thermal monitoring is expected to continue during the proposed licensing period. • The main area of focus is to develop a winter thermal plume model, as there have been challenges based on the ability of water temperature monitoring equipment to survive winter conditions on Lake Huron. • Environment and Climate Change Canada (ECCC) has indicated to CNSC staff that new technology may be available to increase success of data collection. CNSC staff will work with Bruce Power, ECCC and SON to discuss future thermal monitoring. • CNSC and ECCC staff have concluded that the proposed "operational flexibility" is unlikely to pose unreasonable risk to the environment and this has been communicated to Bruce Power and the MOECC • CNSC and ECCC staff have made several comments on the thermal risk assessment that are be addressed in order to reduce uncertainties in the thermal risk assessment by December 31, 2018.

Impingement and Entrainment
 	
SON raised issues and concerns with methods used to collect impingement and entrainment data.
	• Bruce Power completed the Bruce A Environmental Assessment Follow-Up Monitoring Program and completed or supported additional studies to assess the impacts on Lake Whitefish specifically and Lake Huron generally.
	• Bruce Power advised that monitoring and research demonstrates, among other things:
	  ○ Lake Whitefish near the Site are members of a larger genetic and ecological group;
	  ○ Impingement and entrainment of fish by the facility's operations has a minimal effect on the Lake Whitefish population, particularly relative to SON's commercial fishing quota for Lake Whitefish.
		• CNSC staff reviewed the Bruce A Environmental Assessment Follow-Up Monitoring Program impingement and entrainment monitoring study design and concluded it met accepted best practices at that time.
		• As part of their review of Bruce Power's *Fisheries Act* Authorization application, CNSC staff provided comments to Bruce Power on the methods used to collect and analyze the impingement & entrainment data that could be improved in order to reduce uncertainties in the impingement & entrainment numbers.
		• CNSC and Fisheries and Oceans Canada staff have requested that a revised impingement and

	• Bruce Power reviewed SON concerns (296 comments) on the impingement and entrainment monitoring plan as part of the Bruce A Environmental Assessment Follow-Up Monitoring Program. Comments were dispositioned and incorporated into the plan and data analysis where applicable. Final dispositions were provided to SON. • Bruce Power has also documented how it has addressed SON's concerns in its draft *Fisheries Act* Authorization application.	entrainment monitoring plan be submitted by Bruce Power with the final version of the *Fisheries Act* Authorization application that addresses best practices and uncertainties, including, to the degree possible, those raised by SON in their review of the Bruce A Environmental Assessment Follow-up Monitoring Program impingement and entrainment monitoring program. • CNSC staff will involve SON in the development and review of the impingement and entrainment plan that is expected to be submitted by Bruce Power with the *Fisheries Act* Authorization application to ensure that SON concerns are addressed to the extent practicable. • Impingement and entrainment monitoring will be repeated during the *Fisheries Ac*t Authorization period. • CNSC staff conducted an inspection of the impingement monitoring program at the Bruce site in February 2018; results of the inspection were shared with SON on March 15, 2018. CNSC staff is looking at repeating this inspection annually.
Participation in Monitoring Programs SON requested that monitoring program enhancements be considered with SON participation to allow collection of reliable data and increase SON confidence in the monitoring. SON raised concerns with the credibility of monitoring related to activities carried out by Bruce Power, especially in relation to the monitoring of thermal effluent and impingement and entrainment.	• Bruce Power has stated that it is willing to work with SON on future monitoring programs.	• CNSC staff offered to have SON involvement in the CNSC Independent Environmental Monitoring Program (IEMP). A sampling campaign around the Bruce site is planned for 2019, and CNSC staff will reach out to SON in fall 2018 for input. • CNSC staff would like to understand if there are any traditional foods, medicines or other environmental aspects of significance that could be included in the program. • CNSC staff would also appreciate SON assistance in gathering samples, where appropriate. • CNSC staff inspectors conduct routine inspections of Bruce Power's environmental monitoring program and activities. CSNC staff will continue to share results of the CNSC

		inspections with SON. • CNSC staff will recommend Bruce Power include SON participation in its monitoring activities, where appropriate.
Study of Available Mitigation Measures SON have requested a study of available mitigation measures be performed, which takes into account cost-benefit assessment and precautionary principles and SON values. SON considers a study of available mitigation measures as a necessary first step, and would like to come to an agreement on how to assess the study and ensure implementation of viable mitigation mechanisms that may be identified through the assessment. SON further requested clarity on how: ▪ SON will participate in establishing criteria or expectations for the study ▪ SON and CNSC staff will carry out an assessment of mitigation measures that reflects SON values and protects SON rights and interests ▪ the assessment outcomes will be implemented through ongoing regulatory activities	• Bruce Power has advised CNSC staff that it is currently using the best information and technology available for mitigating impacts to fish including a velocity cap. • Bruce Power is currently conducting a review of mitigation options for cooling water intake and discharge.	• CNSC staff concluded that Bruce Power has and will continue to make adequate provision for protection of the environment. • CNSC confirm that the intake structures were designed to mitigate impacts, including velocity caps and being located deep offshore. • It is CNSC's view that there are no unreasonable risks from current or foreseeable future operations that require further mitigation measures, therefore CNSC staff is not recommending additional mitigation measures at this time. • CNSC staff recognize the value in conducting a review of mitigation measures in case the level of risk changes in the future, due to a changing environment or light of new science becoming available. • Bruce Power has conducted similar reviews in the past and is best positioned to conduct updates to the reviews. • CNSC staff has introduced criteria in Section 9.1 of the proposed Licence Conditions Handbook that Bruce Power conducts a review of feasible mitigation measures for thermal effluent and impingement/entrainment and that review be completed by December 31, 2019. • After the review has been submitted, CNSC staff will work with SON to determine next steps. • CNSC staff will ensure SON values are considered during this process. • Updates on the results of this review, including CNSC staff and SON collaboration, would be provided to the Commission via the subsequent Regulatory Oversight Report for Canadian Nuclear Power Generating Sites.

		• Updates could also be presented to the Commission during Commission meetings, if requested.
Identification and coordination of federal, provincial and municipal decision-making agencies related to nuclear to matters.	• N/A	• CNSC staff committed to work with SON to identify responsible federal, provincial, and municipal agencies involved in decisions related to nuclear matters at the Bruce site. • CNSC staff committed to SON, where appropriate, to explore the opportunities to coordinate meetings with Crown agencies involved in oversight and/or decision-making on nuclear matters within SON territory.

Predictive Effects Assessment
 	
SON raised concerns with the absence of a specific template or methodology for the Predictive Effects Assessment (PEA). SON would like to see more prescriptive instructions for evaluations.
	• Bruce Power advised CNSC staff that it follows the applicable CNSC REGDOC and CSA Standard (REGDOC 2.9.1 - *Environmental Principles, Assessments and Protections Measures,* CSA N288.6-12 - *Environmental Risk Assessments at Class 1 Nuclear Facilities and Uranium Mines and Mills*)	• CNSC and Environment and Climate Change Canada (ECCC) staff reviewed Bruce Power's ERA and PEA.
		• CNSC and ECCC staff reviews of the ERA and PEA identified areas that would benefit from further clarification and/or additional information to reduce uncertainties.
		• CNSC and ECCC staff reviews concluded that the potential risk from physical stressors and radiological and non-radiological releases due to current operations depicted in the ERA and predicted future operations included in the PEA to human health and the environment are generally low to negligible.
		• CNSC and ECCC staff have recommended that higher priority uncertainties be addressed in two phases:
		  ○ additional assessment in order to address the proposed thermal increase submitted to Ontario Ministry of Environment and Climate Change (OMECC) was submitted to the CNSC on May 2, 2018 to facilitate CNSC and ECCC comments to the OMECC process.
		  ○ additional assessment in order to reduce uncertainties in the thermal risk

		assessment must be submitted to the CNSC by December 31, 2018. • CNSC staff will review the implementation of these recommendations through the review of Bruce Power's environmental monitoring program reports and through revisions of the ERA • Any remaining comments must be addressed either through the revision of the current ERA/PEA or in the next iteration of the ERA (in five years or sooner if major changes to the facility operation occur). • The Environmental Risk Assessments are updated every 5 years so the risk to the environment is continually being re-evaluated through existing processes.
Cumulative Effects SON raised questions regarding the process for assessing cumulative effects in the ERA.	• Bruce Power's Predictive Effects Assessment (PEA) includes a cumulative effects assessment, which considers the cumulative effects of the refurbishment and continued operation of the Site with other facilities on the Site, including the Western Waste Management Facility (WWMF), Canadian Nuclear Laboratories, Hydro One, and the Ontario Power Generation (OPG) Deep Geological Repository (DGR). o This assessment concluded that cumulative influence of the WWMF, Canadian Nuclear Laboratories facilities, and Hydro One facilities were already included and assessed within the ERA and PEA and that no adverse cumulative effects are likely between the DGR project and the continued operations at the Site including Major Component Replacement (MCR). • Cumulative effects were also considered in prior environmental assessments approved by the Commission relating to the site and the assessments identified no significant adverse cumulative effects.	• Cumulative effects were consideration in a prior Commission-approved environmental assessments under the *Canadian Environmental Assessment Act* • A cumulative effects assessment as defined by Canadian Environmental Assessment Agency's guidance is not required for this project proposal • CNSC staff did not identify any concerns with the site wide effects assessment undertaken in Bruce Power's ERA and PEA. • As a lifecycle regulator, CNSC evaluates site wide ERAs on a cyclical basis and considers inputs from other sources of data at the regional level to ensure that the temporal and spatial effects are considered and applies adaptive management measures if and when necessary. • An Information Package provided to the SON by the CNSC staff to facilitate discussions of various issues was provided to the MNO on January 17 2018 and included CNSC's approach to the assessment of site wide effects including the additive effects of the proposed activities and ongoing environmental protection, compliance and verification – which have provided the CNSC with a longitudinal assessment of emissions from

		Bruce Power Nuclear Power Plant • There are various regional monitoring programs conducted by the Province and Health Canada that assess the releases to the environment. The results of these programs combined with the CNSC's Independent Environmental Monitoring Program results confirm that radiological contaminants are not having an impact on human health and the environment. • Regional Assessments that consider cumulative impacts are a key government of Canada priority as indicated in Bill C-69 on Impact Assessment. This priority requires the input from more than a single regulator, and will require collaboration across jurisdictions, and Indigenous communities.
Climate Change SON raised concerns that climate change is causing changes to Lake Huron and that the impacts of the Bruce facility will tip the balance and cause harm to the environment.	• Bruce Power believes that the current monitoring programs will detect any changes to the environment and that any impacts to biota will not be a result of the nuclear power plants.	• CNSC staff has concluded that there are adequate provisions for the protection of the environment for the current climate conditions. • CNSC staff agrees that climate change will likely continue to have an impact on Lake Huron. • There are existing monitoring programs which continuously monitor for changes to the environment or the impact from the facility. • The Environmental Risk Assessments are updated every 5 years, including new science, so the risk to the environment is continually being re-evaluated through existing processes. • Should the level of risk change, CNSC staff can impose additional mitigation measures in the future as required.
Timelines for Engagement SON raised concerns with timelines and has stated that there is not enough time built in to the licensing process to be adequately consulted.	• Bruce Power provided SON their application and draft engagement plan on July 26, 2017. • Bruce Power offered to meet with SON regarding the licence renewal application and tried to set up a series meetings. • Bruce Power provided a 5-year look ahead in 2015 which identified upcoming regulatory	• The Commission considers the hearing dates as set to be reasonable and fair, and to provide sufficient time for all participants, including the SON, to prepare. The request to adjourn the hearing dates of March 14, 2018 and May 30-31, 2018 is denied. • CNSC staff notified SON on September 8, 2017

	activities, including licence renewal and Major Component Replacement (MCR). The 5-year look ahead was provided annually, with updates to the dates as they were refined.
	• Bruce Power provided SON with the 2017 annual capacity funding at a December 21, 2017 meeting and the 2018 annual capacity funding at an April 17, 2018 meeting as part of the SON/Bruce Power Protocol Agreement. The annual capacity funding was provided to ensure continued progress of the community with respect to the analysis of the renewal application; furthermore, Bruce Power is currently in discussion with SON on additional regulatory top-up capacity funding beyond the annual Protocol Agreement capacity funding.
	• Bruce Power submitted to the CNSC and shared with SON, Community Interest Documents to show the history of engagement on issues and concerns between Bruce Power and SON.
		of the licence renewal application, including information on the MCR, availability of participant funding, and CNSC staff contact information, and confirmed that work was underway to organize a meeting to discuss the licence renewal and other topics of interest to SON.
		• CNSC staff held several meetings and workshops with the SON between February 27, 2014 and February 7, 2018, to discuss concerns and issues related to the Bruce site, which were summarized in Appendix F of CMD 18-H4.
		• CNSC staff continued discussions with SON on their issues and concerns related to the Bruce site since February 7, 2018.
		  ○ On February 20, 2018, CNSC staff and SON met via teleconference to discuss engagement on the licence renewal application.
		  ○ On March 20, 2018, CNSC staff and SON met in Toronto to develop areas of collaboration to address their concerns such as those related to the 2018 licensing hearing
		  ○ On March 22, 2018, CNSC, Department of Fisheries and Oceans and Bruce Power staff included the SON to discuss offset monitoring.
		  ○ CNSC staff also corresponded with the SON several times, via letters and emails, including an April 6, 2018 letter with proposed measures to address remaining SON concerns.
		• SON requested a one-week extension to the intervention submission deadline, a request that was granted by the Commission Secretariat.

Métis Nation of Ontario (MNO)		
Use of Traditional Knowledge and Land Use Information The MNO has expressed that traditional knowledge and land use information contained in the 2017 Métis Nation of Ontario Valued Components Monitoring Report (MNO VC Report) should be incorporated into CNSC's and Bruce Power's processes.	• Bruce Power has met with the MNO at quarterly meetings throughout 2015, 2016, 2017, and 2018 as part of the MNO/Bruce Power Relationship Agreement. During these meetings, discussions have taken place on incorporating the Métis way of life and working jointly with Bruce Power to develop a work plan in order to accomplish this goal. • Bruce Power will continue to discuss how VCs might be able to be addressed. • Bruce Power included species of importance to the MNO in the revised ERA and PEA and assessed potential impacts.	• CNSC staff considered the MNO Valued Components (VCs) in their review of the ERA and PEA to ensure species of importance to the MNO were effectively addressed. • CNSC staff met with the MNO on January 17, 2018 to discuss the MNO VC Report. • CNSC staff noted that the VC Report provides a good high level summary which could be used to inform future monitoring. • CNSC staff remain open to discussing valued components, including psycho/social, but need to respect the CNSC mandate.
Contaminants levels and health of wildlife within the fenced area of the site and surrounding the site The MNO raised specific concerns about health of and contaminants levels in deer flesh, turkey, and fish.	• Bruce Power has assessed risks to biological receptors, including wildlife, due to current and future operations in the ERA and PEA. • The assessments concluded that there is negligible risk to wildlife due to exposure to radiological and non-radiological contaminants.	• CNSC staff stated that they have no concerns about contamination / health of wildlife in meetings with the MNO. • CNSC staff reviewed the ERA with respect to contamination / health of wildlife, and confirm that radiological dose to deer was well below levels that would cause health effects to either this species or to humans consuming deer. • Contaminants are measured and assessed for other species such as fish as part of the ERA. There is no expected impact to wildlife or human health from exposure to the contaminants measured/assessed.
Monitoring/Sampling Analysis The MNO raised concerns that species of fish that are important to the Métis Nation of Ontario are left out of monitoring. The MNO had concerns regarding the process for harvesting and analysis of samples.	• Bruce Power is working with the MNO to develop an annual monitoring program in addition to the existing monitoring programs. • Bruce Power, along with OPG, provided funding for an MNO commissioned study that developed Métis specific valued components for future monitoring.	• CNSC staff met with the MNO on January 17, 2018 to discuss the MNO Valued Components Monitoring Report, the *Fisheries Act* Application authorization, and the Bruce licence renewal application. • CNSC staff sent the MNO a letter on March 20, 2018 and offered to have the MNO participate in

		the CNSC Independent Environmental Monitoring Program (IEMP). • A sampling campaign around the Bruce site is planned for 2019.
Thermal Effects The MNO raised concerns with the effects of thermal plume on water temperatures and on fish populations, including Bruce Power's request to the Ontario Ministry of Environment and Climate Change to modify the current permit to allow for "operational flexibility" in effluent temperature	• Bruce Power conducted a thermal risk assessment as part of the ERA and concluded that there is minimal risk to fish as a result of cooling water thermal effluent. Research supported by Bruce Power was used to inform the thermal risk assessment. • Bruce Power has applied to the Ontario Ministry of Environment and Climate Change (MOECC) for a change to the effluent temperature permitted in the Environmental Compliance Approval (ECA) during the summer months. • Bruce Power monitors water temperature and will continue to do so in the future as part of monitoring under the *Nuclear Safety and Control Act* and for the thermal ECA from the MOECC • Bruce Power undertook or supported additional studies to assess the impacts of cooling water discharge on Lake Whitefish and Round Whitefish specifically and Lake Huron generally. • Bruce Power advised that research concluded: • The direct impact of the thermal discharge on the survival of Lake Whitefish embryos and juveniles is likely to be limited with no additional effects caused by chemical and radiation exposure at the very low levels that result from Bruce Power operations.	• Thermal monitoring is expected to continue during the proposed licensing period. • The main area of focus is to develop a winter thermal plume model, as there have been challenges based on the ability of water temperature monitoring equipment to survive winter conditions on Lake Huron. • Environment and Climate Change Canada (ECCC) has indicated to CNSC staff that new technology may be available to increase success of data collection. CNSC staff will work with Bruce Power, ECCC and SON to discuss future thermal monitoring. • CNSC and ECCC staff have concluded that the proposed "operational flexibility" is unlikely to pose unreasonable risk to the environment and this has been communicated to Bruce Power and the MOECC • CNSC and ECCC staff have made several comments on the thermal risk assessment that are be addressed in order to reduce uncertainties in the thermal risk assessment by December 31, 2018.
Impingement and Entrainment The MNO raised concerns with impacts on fish populations.	• Bruce Power included an assessment of the risk to fish populations due to cooling water intake (fish impingement and entrainment) in the Environmental Risk Assessment (ERA). • The future production of fish lost due to the fish impinged and entrained by the cooling was compared to fishing harvest statistics and data collected from fishing surveys.	• CNSC staff agreed with the ERA conclusion of negligible risk to Lake Huron fish populations due to impingement and entrainment, however, additional assessment was recommended to reduce the uncertainty of impacts of entrainment to Deepwater Sculpin. • As part of their review of Bruce Power's *Fisheries Act* Authorization application, CNSC staff

	• The ERA concluded that there is negligible risk to fish populations in Lake Huron from impingement and entrainment.	provided comments to Bruce Power on uncertainties regarding impingement and entrainment matters. • CNSC and Fisheries and Oceans Canada staff have requested that a revised impingement and entrainment monitoring plan be submitted by Bruce Power with the final version of the *Fisheries Act* Authorization application that addresses best practices and uncertainties, including, to the degree possible, those raised by the MNO in their review of the Bruce A Environmental Assessment Follow-up Monitoring Program impingement and entrainment monitoring program.
Cumulative Effects The MNO raised concerns with cumulative effects impacts on fisheries.	• Bruce Power's PEA includes a cumulative effects assessment, which considers the cumulative effects of the refurbishment and continued operation of the Site with other facilities on the Site, including the Western Waste Management Facility (WWMF), Canadian Nuclear Laboratories, Hydro One, and the Ontario Power Generation (OPG) Deep Geological Repository (DGR). o This assessment concluded that cumulative influence of the WWMF, Canadian Nuclear Laboratories facilities, and Hydro One facilities were already included and assessed within the ERA and PEA and that no adverse cumulative effects are likely between the DGR project and the continued operations at the Site including Major Component Replacement (MCR). • Cumulative effects were also considered in prior environmental assessments approved by the Commission relating to the site and the assessments identified no significant adverse cumulative effects.	• Cumulative effects were consideration in a prior Commission-approved environmental assessments under the Canadian Environmental Assessment Act • A cumulative effects assessment as defined by Canadian Environmental Assessment Agency's guidance is not required for this project proposal • CNSC staff did not identify any concerns with the site wide effects assessment undertaken in Bruce Power's ERA and PEA. • As a lifecycle regulator, CNSC evaluates site wide ERAs on a cyclical basis and considers inputs from other sources of data at the regional level to ensure that the temporal and spatial effects are considered and applies adaptive management measures if and when necessary. • An Information Package provided by the CNSC staff to facilitate discussions of various issues was provided to the MNO on January 17 2018 and included CNSC's approach to the assessment of site wide effects including the additive effects of the proposed activities and ongoing environmental protection, compliance and verification – which have provided the CNSC with a longitudinal assessment of emissions from Bruce Power Nuclear Power Plant.

		• There are various regional monitoring programs conducted by the Province and Health Canada that assess the releases to the environment. The results of these programs combined with the CNSC's Independent Environmental Monitoring Program results confirm that radiological contaminants are not having an impact on human health and the environment. • Regional Assessments that consider cumulative impacts are a key government of Canada priority as indicated in Bill C-69 on Impact Assessment. This priority requires the input from more than a single regulator, and will require collaboration across jurisdictions, and Indigenous communities.
Perceptions The MNO raised concerns regarding impacts on medicines and related perceptions of contamination. The MNO raised issues related to perceptions on the change in land or water which leads to avoidance behaviours.	• Bruce Power met with the MNO to discuss issues related to perceptions.	• CNSC staff offered to help address the science and evidence of no contamination. • CNSC staff and the MNO recognize that changing spiritual perceptions is a challenge, however, CNSC staff offered opportunities to talk to community members on science and monitoring to try to respond to concerns) • MNO participation in the Independent Environmental Monitoring Program (IEMP) will hopefully help to reduce negative perceptions and avoidance behaviours.
***Fisheries Act* Authorization Offsets** MNO has raised concerns regarding consultation by Bruce Power	• Bruce Power has been engaging on the selection of the projects themselves and they remain open to hearing about environmental initiatives regardless of whether it is part of a potential *Fisheries Act* Authorization. • For specific projects Bruce Power has contracted other third-parties to perform all of the necessary work, including permitting. • Any consultation required for the projects will be conducted through the permitting process(es). • The Truax Dam removal project has not yet	• CNSC staff spoke with Bruce Power regarding the engagement with the MNO on the offset projects, as they are responsible for this. • Bruce Power indicated to CNSC staff that since the concern was raised, they have spoken with MNO regarding the projects. Bruce Power has also had the contractor performing the work (GSS Consulting) discuss the work with the MNO. • In addition, Bruce Power has offered for the MNO to have a tour of the project site. CNSC staff sent MNO a letter requesting feedback on the

	gotten to the point where permits have been applied for, hence any necessary consultation is still to be conducted. • Bruce Power has scheduled a tour of Truax Dam project site on May 29, 2018 with the MNO.	offsetting plan and has followed up several times. • No feedback has been received as of May 7, 2018.
Emergency Response Plans In the event of an emergency, the MNO would like to be notified to ensure relevant information is passed on to the Métis harvesters in the region. MNO is suggesting that a formal notification/communication protocol and procedure be included in these plans.	• Bruce Power is willing to initiate a discussion between Office of the Fire Marshal and Emergency Management (OFMEM) and the MNO to ensure all are aware of the protocols in place.	• CNSC staff became aware of this request through the Métis Nation Ontario CMD 18-H4.57. • CNSC staff encourages Bruce Power to work all interested Indigenous communities to ensure they are aware of protocols in place.
Historic Saugeen Métis (HSM)		
Traditional Harvesting practices, rights and interests	• Bruce Power has advised that the applications, previous assessments and monitoring programs demonstrate that there will be no novel adverse impact on rights. • Ongoing monitoring will continue to assess impacts and any changes over time that require additional mitigation measures.	• CNSC has offered for the HSM to participate in the Independent Environmental Monitoring Program (IEMP), including during a February 27, 2018 meeting.
Storage, management, and transportation of waste	• Storage of waste is expected to continue as per current practices and no change is expected from the MCR project work and continued operations. • No interaction with the terrestrial or aquatic environment is predicted.	• CNSC staff offered to have specific workshops/meetings with the HSM and CNSC waste management specialists.
FAA Offsets (Dam Removal)	• Bruce Power provided the HSM a tour of Truax Dam project site in April 24, 2018.	• During a February 27, 2018 meeting, the HSM expressed an interest in the Truax Dam removal project and expressed an interest in touring the project.
Employment	• Bruce Power's Supply Chain program welcomes the participation of Indigenous suppliers.	• The availability of a Supply Chain program is outside of the CNSC's mandate, but the CNSC recognizes Bruce Power's inclusion of Indigenous suppliers in its Supply Chain program as a good practice.

A clear, timely, and effective process for information sharing during engagement and consultation.	• Bruce Power has an existing relationship agreement with the HSM that has and will continue to facilitate sharing of information and engagement on issues and concerns. • A meeting took place between Bruce and HSM on December 12, 2017.	• CNSC has met with HSM to discuss any issues and concerns they may have. • A meeting took place Feb 27, 2018 to discuss any issues or concerns. • HSM indicated they were comfortable with the processes and have a good working relationship with Bruce Power.

Addendum D
Proposed Licence

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

DRAFT: May 16, 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 nuclear substances and prescribed equipment, except controlled nuclear substances and controlled nuclear equipment, 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 Before hydrogen equivalent concentrations exceed 120 ppm, the licensee shall demonstrate that pressure tube fracture toughness will be sufficient for safe operation beyond 120 ppm.

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