



Canadian Nuclear
Safety Commission

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Bruce Power Mid-term Update of Licensed Activities



Commission Meeting
September 20, 2023
CMD 23-M27.A

CNSC Staff Presentation - Revised

e-Doc 7099125 (pptx)
e-Doc 7111426 (pdf)



Executive Summary and Context

- The Commission directed Bruce Power to provide update at mid-point of licence period
- Through this presentation, CNSC staff are providing highlights of the regulatory oversight on select topics
- CNSC staff provide a comprehensive annual update on Bruce Power's regulatory performance in its annual Regulatory Oversight Report (ROR)
 - The 2022 ROR will be presented to the Commission in December 2023

This mid-term update does not replace the annual ROR; it provides an opportunity for Indigenous Nations and communities, members of the public and stakeholders to take part in proceedings specific to Bruce Power's licensed activities



Outline

- **Licensing Update**
- **Major Component Replacement (MCR)**
- **Elevated Hydrogen Equivalent (H_{eq}) Concentration in Pressure Tubes of Reactors in Extended Operation**
- **CNSC Oversight of Other Bruce Power Projects**
- **Indigenous Engagement Activities**
- **Emergency Preparedness**
- **Closing Remarks**
- Appendix A: Licence Conditions Handbook (LCH) Updates since 2018 Licence Renewal
- Appendix B: Elevated H_{eq} Concentration in Pressure Tubes References
- Appendix C: Review of Interventions on Bruce Power Mid-term Update



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LICENSING UPDATE



2018 Licence Renewal

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- The Power Reactor Operating Licence (PROL) for Bruce NGS A and B was **renewed by the Commission for a period of 10 years**
- The licence is valid from October 1, 2018, to **September 30, 2028**
- Licence renewal encompassed Bruce Power's **existing operations**, as well as activities related to the **Major Component Replacement (MCR) project**
 - Started in 2020 at Unit 6
 - Followed in 2023 by Unit 3



Source: Bruce Power

Throughout the current licence period, Bruce Power's regulatory performance has been rated as satisfactory or fully satisfactory in all safety and control areas (SCAs)



PROL Amendments

The Bruce
NGS A and B
Power Reactor
Operating Licence
PROL 18.00/2028
came into effect
on October 1,
2018

PROL Version	Amendment
PROL 18.01/2028 (April 9, 2020)	This PROL amendment was to replace RD-204, Certification of Persons Working at Nuclear Power Plants, with REGDOC-2.2.3, Personnel Certification, Volume III: Certification of Persons Working at Nuclear Power Plants , as per Record of Decision DEC 20-H100.
PROL 18.02/2028 (September 24, 2021)	This PROL amendment was to allow for the production of Lutetium-177 with the addition of Licence Condition 15.10, as per Record of Decision DEC 21-H100.



Integrated Implementation Plan (IIP)

- Bruce Power's Integrated Implementation Plan (IIP) is the final output of Periodic Safety Review (PSR)
- Bruce Power has committed to implementing IIP actions identified through the PSR
 - The IIP encompasses a total of 191 items
 - 58 of the 191 IIP items (30 %) have been completed
 - Many of the remaining IIP items are linked to current, or future Major Component Replacement (MCR) projects, and require their corresponding MCR outage to be completed



Source: Bruce Power

Bruce NGS A turbine interior

Bruce Power is
completing its IIP as
required by the PROL



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MAJOR COMPONENT REPLACEMENT (MCR)



CNSC Regulatory Hold Points: Unit 6 MCR

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- The PROL includes four Regulatory Hold Points:
 1. Fuel load – Removed on May 10, 2023
 2. Removal of guaranteed shutdown state (GSS) – Removed on August 2, 2023
 3. Increasing above 1% full power – Removed on September 1, 2023
 4. Increasing above 35% full power
- Pre-requisites for each hold point must be met before they are released
 - The Commission authorized the CNSC's Executive Vice-President and Chief Regulatory Operations Officer to consent to the removal of the hold points



Source: Bruce Power
CNSC staff attending a demonstration of MCR fuel loading procedures

CNSC uses regulatory hold points to ensure that licensees meet requirements before conducting certain activities



CNSC Compliance Verification Activities

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CNSC staff's Compliance Verification Plan for MCR projects:

- developed using a risk-informed approach
- covers all safety and control areas (SCAs)
- linked to various MCR-related activities

CNSC staff completed the following compliance verification activities for Unit 6 MCR:

- 25 Type II Inspections
- 67 Field Inspections
- 7 Desktop Inspections

Inspections demonstrated that Bruce Power conducted Unit 6 MCR activities in accordance with requirements

- Unit 3 MCR is progressing on schedule with CNSC staff conducting compliance verification activities to verify compliance of Bruce Power's work



Source: CNSC

CNSC inspector taking smear samples from steam drum

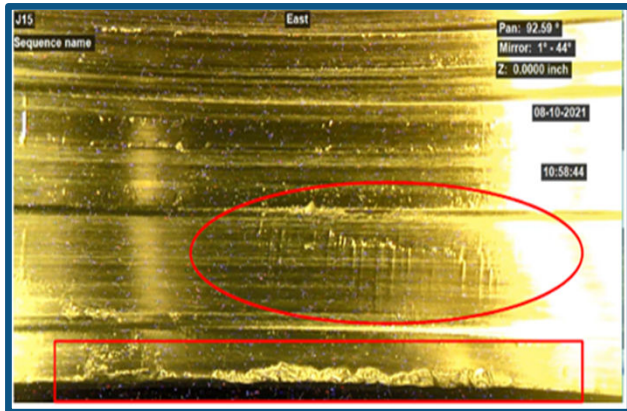
CNSC staff verifies compliance throughout the MCR project



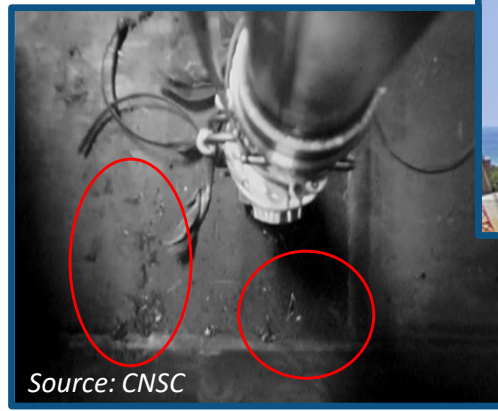
CNSC Oversight: Unit 6 MCR

Areas of focus for CNSC inspections included:

- contractor management
- calandria tube sheet bore (CTSB) remediation
- inadequate control of quarantined items



CTSB with scratches and material build-up
Source: Bruce Power



Source: CNSC
The removal of foreign material from the calandria



Left: Steam generator being removed
Bottom: Fuel channel installation activities



Source for both images above: CNSC

CNSC staff compliance verification activities have shown that Bruce Power has addressed these areas of focus

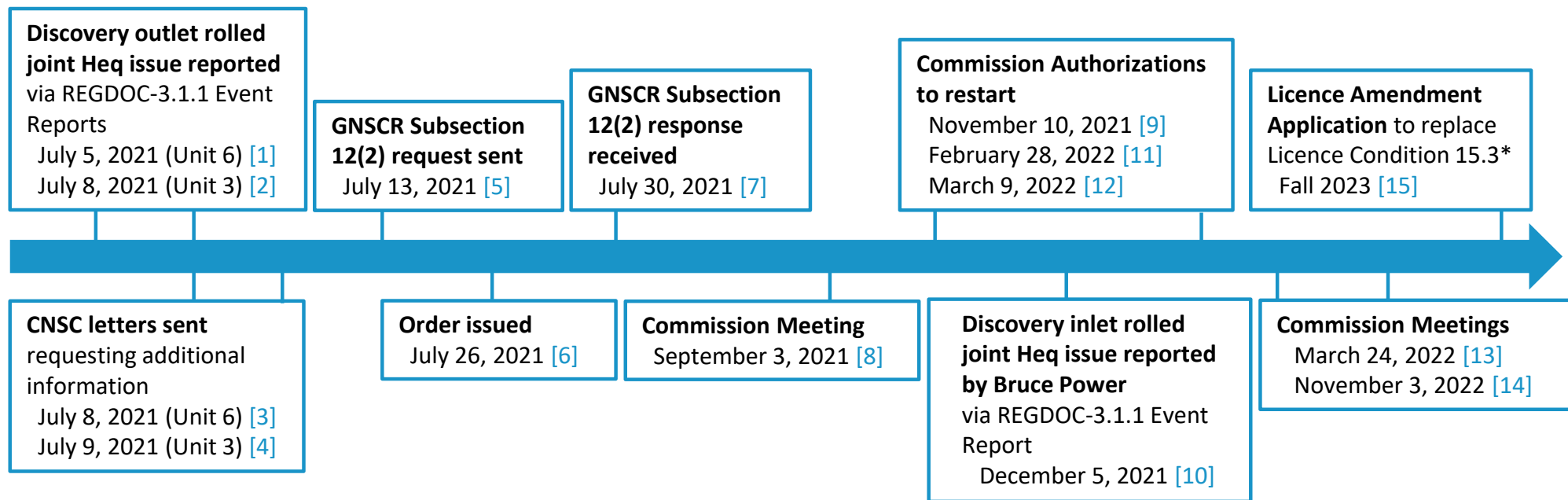


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ELEVATED H_{EQ} CONCENTRATION IN PRESSURE TUBES OF REACTORS IN EXTENDED OPERATION



Timeline of Events: Elevated H_{eq} Concentration in Pressure Tubes



*Currently under deliberation by the Commission

References can be found in Appendix B



Corrective Actions: Elevated H_{eq} Concentration in Pressure Tubes

To address the findings at the rolled joints, Bruce Power has:

- undertaken additional material surveillance and scrape campaigns
- introduced operational changes and training for operators
- undertaken research and development (R&D) activities

**CNSC compliance verification activities have demonstrated that
Bruce Power pressure tubes remain fit for service**



CNSC Staff Update: Elevated H_{eq} Concentration in Pressure Tubes

- Based on previous Commission decisions and CNSC compliance verification activities, the CNSC is satisfied that the continued operation of Bruce Power's reactors does not pose unreasonable risk
 - existing safety analyses remain valid
 - CNSC staff continue to follow up on the resolution of key issues
- Next detailed update to the Commission will be presented in December 2023 during the Commission meeting for the 2022 NPP ROR

Risk-informed decision making has demonstrated that Bruce Power's elevated H_{eq} events have no impact on the safety analysis and the risk to safe operation remains low



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CNSC OVERSIGHT OF OTHER BRUCE POWER PROJECTS



Lutetium-177 Isotope Production

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IPS Target Interface Skid (TIS)
Source: CNSC

- **October 2019** - CNSC staff were informed of Bruce Power's intent to produce Lu-177
- **November 2020** - Bruce Power submitted an application requesting to amend the PROL to produce Lu-177
- **April 2021** - CNSC staff submitted CMD 21-H100 recommending Commission amends the PROL, with a Regulatory Hold Point prior to Bruce Power commencing commercial production of Lu-177
- **September 2021** - The Commission amended Bruce Power's PROL
- **October 2022** - CNSC staff administered the removal of the hold point allowing Bruce Power to begin commercial production of Lu-177

CNSC staff performed compliance verification activities throughout Bruce Power's Lu-177 project



Bruce Power's Project 2030

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- CNSC staff are conducting regulatory reviews of Bruce Power's submissions for Project 2030, which aims to recover power from their refurbished units by the year 2030
- Prior to implementing any changes to power limits, Bruce Power will have to obtain authorization from the Commission



Source: CNSC



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INDIGENOUS ENGAGEMENT ACTIVITIES



Indigenous Engagement Activities

- Since 2018, CNSC staff have continued to build their relationships with the Saugeen Ojibway Nation (SON), Historic Saugeen Métis (HSM) and Métis Nation of Ontario (MNO) Region 7
- The CNSC's Participant Funding Program (PFP) provided funding to support the development and implementation of Terms of References and work plans with the SON, HSM, and MNO Region 7
- CNSC staff conduct oversight of Bruce Power's engagement and communication efforts with the SON, HSM, and MNO Region 7, and are satisfied with Bruce Power's efforts and engagement program

CNSC staff are committed to building relationships and trust with Indigenous Nations and communities



Saugeen Ojibway Nation (SON)



CNSC staff with the SON at local community events
Source of all images: CNSC

- Terms of Reference signed in May 2019
- Meetings with CNSC staff:
 - Monthly with the SON environment office
 - Three times per year with SON steering committee
- Detailed work plan developed that includes:
 - Collaboration on environmental reviews
 - Participation in the CNSC's Independent Environmental Monitoring Program (IEMP)
 - Mitigation measures study
 - Sharing of information from CNSC inspections
 - Outreach and mutual learning



Historic Saugeen Métis (HSM)

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- Terms of Reference signed in April 2019
- Meetings with CNSC staff occur twice per year, or more as needed
- HSM participated in the CNSC's IEMP sampling campaigns in the Bruce region, most recently in July 2022
- CNSC staff and HSM collaborate on annual engagement updates for the annual ROR
- Open learning sessions / webinars



Heritage walk with HSM at MacGregor Point
Provincial Park
Source: CNSC



Métis Nation of Ontario Region 7 (MNO)

- Terms of Reference signed in December 2019
- Meetings with CNSC staff twice per year, or more as needed
- Region 7 work plan developed
- MNO participated in IEMP sampling campaigns in the Bruce region, most recently in July 2022
- CNSC staff and MNO collaborate on annual engagement updates for the annual ROR



CNSC staff attending Nuclear Safety Open House, hosted by the Métis Nation of Ontario Region 7 in May 2023

Source: CNSC



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EMERGENCY PREPAREDNESS



Full-Scale Emergency Exercises (1/2)



Source: Bruce
Power



Source: Owen Sound Sun Times

Bruce Power Emergency Management
Centre (EMC)

- Bruce Power executed two full-scale emergency exercises at Bruce A and B NGS:
 - Huron Resilience (October 2019)
 - Huron Endeavor (October 2022)
- The exercises lasted three days and involved municipal, provincial and federal agencies
- CNSC staff conducted verification activities during the exercises

CNSC staff concluded that Bruce Power demonstrated the ability to adequately respond to an emergency while ensuring the safety and protection of on-site personnel, the public and the environment



Full-Scale Emergency Exercises (2/2)

CNSC staff:

- Participated in the Bruce Power full-scale exercises in 2019 and 2022
- Established exercise objectives that assessed the CNSC Emergency Operations Centre (EOC)'s ability to effectively respond to a nuclear emergency

CNSC staff's response during the exercises

demonstrated that CNSC was able to fulfill the dual role of:

- Maintaining regulatory oversight of licensee nuclear emergency activities
- Participating in Canada's whole-of-government response to a nuclear emergency



Source: CNSC

CNSC Emergency Operations Centre (EOC)



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CLOSING REMARKS



Interventions: Bruce Power Mid-term Update

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A total of 29 interventions were submitted; 18 written only, and 11 written and oral.

CNSC staff identified the following key themes in the interventions submitted:

- Indigenous Engagement
- Environmental Protection
- Public Information and Disclosure
- Elevated Hydrogen Equivalent Concentration in Pressure Tubes

CNSC staff are prepared to answer any questions the Commission may have related to these topics



Closing Remarks

- Throughout the first half of this licence period, CNSC oversight has shown that:
 - Bruce Power's safety performance has remained stable, and Bruce Power has conducted licensed activities in accordance with regulatory requirements
 - Bruce Power has continued to protect the health and safety of the public and the environment near the Bruce NGS
 - Bruce Power implemented appropriate measures and operated safely when faced with COVID-19 pandemic challenges
 - Bruce Power's engagement and communication efforts with the SON, HSM, and MNO Region 7 have met CNSC staff's expectations
- CNSC staff are committed to continue its regulatory oversight and to grow engagement activities to build trust and relationships with Indigenous Nations and communities in the vicinity of the Bruce NGS



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Appendix A: LCH Updates since 2018 Licence Renewal (1/2)

LCH Revision	Updates
<p>Revision 1: LCH-PR-18.00/2028-R001 (April 1, 2019)</p>	<ul style="list-style-type: none"> No significant changes made to Compliance Verification Criteria (CVC) or Guidance documents. Minor clarifications to text and editorial changes made.
<p>Revision 2: LCH-PR-18.01/2028-R002 (May 25, 2020)</p>	<ul style="list-style-type: none"> The following documents became CVC: <ul style="list-style-type: none"> REGDOC-2.1.2, <i>Safety Culture</i> <ul style="list-style-type: none"> REGDOC-2.12.1, <i>High-Security Facilities, Vol. I: Nuclear Response Force, Version 2</i> REGDOC-2.2.4, <i>Fitness for Duty, Vol. III: Nuclear Security Officer Medical, Physical, and Psychological Fitness</i> REGDOC-2.2.3, <i>Personnel Certification, Volume III: Certification of Persons Working at Nuclear Power Plants (Superseded RD-204)</i> The following documents became Guidance: <ul style="list-style-type: none"> REGDOC-2.2.1, <i>Human Factors</i> REGDOC-2.5.1, <i>General Design Considerations: Human Factors</i> REGDOC-2.2.5, <i>Minimum Shift Complement</i> REGDOC-2.1.1, <i>Management System</i> REGDOC-2.8.1, <i>Conventional Health and Safety</i> CSA N292.1-16, <i>Wet storage of irradiated fuel and other radioactive materials</i> CSA N290.9-19, <i>Reliability and maintenance programs for nuclear power plants</i> Updated text in Section 10.1 for automated data sharing during a nuclear emergency



Appendix A: LCH Updates since 2018 Licence Renewal (2/2)

LCH Revision	Updates
<p>Revision 3: LCH-PR-18.02/2028-R003 (September 28, 2021)</p>	<ul style="list-style-type: none"> • Licence Condition 15.10 was added to allow for the production of Lutetium-177. • The following documents became CVC: <ul style="list-style-type: none"> • REGDOC-3.2.1, <i>Public Information and Disclosure</i> • REGDOC-2.12.1, <i>High-Security Facilities, Vol. II: Criteria for Nuclear Security Systems and Devices</i> • CSA N288.8-17, <i>Establishing and implementing action levels for releases to the environment from nuclear facilities</i> • The following documents became Guidance: <ul style="list-style-type: none"> • REGDOC-2.12.3, <i>Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1</i> • REGDOC-2.14.1, <i>Packaging and Transport: Information Incorporated by reference in Canada’s Packaging and Transport of Nuclear Substances Regulations, 2015, Volume I, Version 2</i> • REGDOC-2.7.1, <i>Radiation Protection</i> • REGDOC-2.7.2, <i>Ascertaining Occupational Dose, Volume I</i> • CSA N288.9-18, <i>Guideline for design of fish impingement and entrainment programs at nuclear facilities</i> • CSA N293-12, <i>Fire protection for nuclear power plants</i> • IAEA Nuclear Security Series No. 33-T, Technical Guidance, “Computer Security of Instrumentation and Control Systems at Nuclear Facilities” for developing and maintaining a cyber security program • Updated text in Section 6.1 related to current status of pressure tube fracture toughness assessments, and fracture toughness model



Appendix B: Elevated H_{eq} Concentration in Pressure Tubes References (1/2)

- [1] Bruce Power Detailed Event Report, “REGDOC-3.1.1 Report B-2021-98077 DR – Pressure Tube Surveillance Hydrogen Equivalent Concentration measurements on unit Shutdown for Major Component Replacement”, June 30, 2021, e-Doc 6601668 (CMD 21-M37.1).
- [2] Bruce Power Detailed Event Report, “REGDOC-3.1.1 Report B-2021-93819 DR – A2131 Outage Scrape Campaign Hydrogen Equivalent Concentration Measurements”, June 15, 2021, e-Doc 6597908 (CMD 21-M37.1)
- [3] CNSC Letter, L. Sigouin to M. Burton, “Bruce A and B: CNSC Review of REGDOC-3.1.1 Event Report B-2021-98077 DR on Pressure Tube Surveillance Hydrogen Equivalent Concentration Measurements on Unit Shutdown for Major Component Replacement – New Action Item 2021-07-23406”, July 8, 2021, e-Doc 6600766 (CMD 21-M37.A)
- [4] CNSC Letter, L. Sigouin to M. Burton, “Bruce A: CNSC Review of REGDOC-3.1.1 Event Report B-2021-93819 on A2131 Outage Scrape Campaign Hydrogen Equivalent Concentration Measurements – New Action Item 2021-07-23424”, July 9, 2021, e-Doc 6603183 (CMD 21-M37.A)
- [5] CNSC Letter, A. Viktorov to M. Burton, “Bruce A and B: Request pursuant to Subsection 12(2) of the General Nuclear Safety and Control Regulations: Issues Relating to Measurement of Hydrogen Equivalent Concentration in Pressure Tubes”, July 13, 2021, e-Doc 6603948 (EN, FR)
- [6] Designated Officer Order, R. Jammal to Bruce Power, “Order by a Designated Officer Under Paragraph 37(2)(f) and Subsection 35(1) of the Nuclear Safety and Control Act”, July 26, 2021, e-Doc 6612405 (EN, FR)
- [7] Bruce Power Letter, M. Burton to M. Leblanc and A. Viktorov, “Bruce A and B: Response to Subsection 12(2) of the General Nuclear Safety and Control Regulations: Measurement of Hydrogen Equivalent Concentration in Pressure Tubes”, July 30, 2021, BP-CORR-00531-01884, e-Doc 6616619 (CMD 21- M37.1)
- [8] CMD 21-M37, “Presentation – Impact on NPPs of Bruce Unit 3 and 6 Licence Limit Exceedance of Hydrogen Equivalent Concentration in Pressure Tubes”, September 3, 2021, e-Doc 6626961



Appendix B: Elevated H_{eq} Concentration in Pressure Tubes References (2/2)

- [9] Record of Decision, DEC 21-H110, "In the Matter of Bruce Power Inc. – Request for Authorization to Restart Bruce Nuclear Generating Station A Unit 3 following its current planned outage", November 10, 2021, e-Doc 6672394
- [10] Bruce Power Detailed Event Report, "REGDOC-3.1.1 Report B-2021-135624 DR – Industry Pressure Tube (PT) Surveillance Program – Inlet Hydrogen Equivalent Concentration Measurements on PT from Unit Shutdown for Major Component Replacement", November 19, 2021, e-Doc 6699742 (CMD 22-M16).
- [11] Record of Decision, DEC 21-H113, "In the Matter of Bruce Power Inc. – Request for Authorization to Restart Bruce Nuclear Generating Station A Unit 4 and Bruce NGS B Units 5, 7 and 8 following future outages", February 28, 2022, e-Doc 6746710
- [12] Record of Decision, DEC 22-H100, "In the Matter of Bruce Power Inc. – Request for Authorization to Restart Bruce Nuclear Generating Station A Unit 3 following future outages", March 9, 2022, e-Doc 6752596
- [13] CMD 22-M16, "Event Initial Report – Bruce Power - Elevated Hydrogen Equivalent Concentration (H_{eq}) in the Inlet Rolled Joint of a Bruce Pressure Tube Removed from Service", March 11, 2022, e-Doc 6754276
- [14] CMD 22-M37, "CNSC staff update on elevated hydrogen equivalent concentration discovery events in the pressure tubes of reactors in extended operation", August 22, 2022, e-Doc 6848197
- [15] Record of Decision, DEC 23-H103, Summer 2023



Appendix C: Review of Interventions on Bruce Power Mid-term Update (1/4)

Intervention Themes	CNCS Staff Review
Theme: Indigenous Engagement	<p>CMD 23-M27.20, Métis Nation of Ontario (MNO) Region 7</p> <p>Progress has been made during the last 5 years on several initiatives important to MNO Region 7, including environmental monitoring. CNCS staff looking forward to expanding on this in the future to include other topics of interest to the MNO, including emergency preparedness.</p>
	<p>CMD 23-M27.21, Historic Saugeen Métis (HSM)</p> <p>CNCS staff appreciate the efforts by the HSM to share their history and culture and look forward to continuing to engage with them to ensure that they remain informed and are provided with opportunities to share and provide input into various regulatory matters.</p>
	<p>CMD 23-M27.30, Saugeen Ojibway Nation (SON)</p> <p>While it is acknowledged that concerns still exist in certain areas of the Bruce nuclear power plant operation, the working relationship between SON and CNCS staff have improved in the last 5 years. CNCS staff agree that we will continue to share information, improve transparency, and look to address remaining concerns and for opportunities to work closer together in the future.</p>



Appendix C: Review of Interventions on Bruce Power Mid-term Update (2/4)

Intervention Themes	CNSC Staff Review
Theme: Environmental Protection	CNSC staff acknowledge the environmental protection observations shared by intervenors. CNSC staff have conducted various performance and compliance verification assessments on Bruce Power’s environmental protection programs and concluded that Bruce Power has developed and implemented an adequate Environmental Protection Program that provides for the protection of the public and the environment. Bruce Power met the applicable regulatory requirements and the expectations of CNSC staff for Environmental Protection at the Bruce NGS during the first half of the licence period.
Theme: Public Information and Disclosure	CNSC staff concluded that Bruce Power complied with REGDOC-3.2.1, <i>Public Information and Disclosure</i> throughout the first half of the licence period. In the past 5 years, Bruce Power publicly communicated information on a variety of topics, including but not limited to: COVID-19 pandemic response, elevated Heq concentration in pressure tubes, the Major Component Replacement project, and the Mid-term Update. While compliant overall, CNSC staff acknowledge the observations shared by intervenors and suggest that Bruce Power consider certain updates to the PIDP. In particular, target audiences could be refined to be more inclusive of not-for profit agencies; clarity on the public inquiry process could be outlined; and, updates to the PIDP should be noted for public information. CNSC staff encourages Bruce Power to review and update their PIDP on an annual basis. If updates are made, licensees must send revisions of their public disclosure protocols to the CNSC, indicating the changes and the reasons for them, as per section 2.3.1 of REGDOC-3.2.1.



Appendix C: Review of Interventions on Bruce Power Mid-term Update (3/4)

Intervention Themes	CNSC Staff Review
<p>Theme: Elevated Hydrogen Equivalent Concentration in Pressure Tubes</p>	<p>CMD 23-M27.5, Dr. Frank Greening</p> <p>Concerning comments related to changing the estimates for the time to reach 120 ppm reported by Bruce Power, many of the changes since the 2018 Licence Renewal are due to refinements in Heq predictions. Bruce Power can provide further comment on that. CNSC staff’s primary reason for requesting this information was to determine that pressure tubes were not operated with Heq values in excess of 120 ppm before the fracture toughness model was revised. With the exception of localized regions near the inlet and outlet rolled joints in the Bruce A Unit 3 and Bruce B Unit 6 pressure tubes in 2021, that continues to be the case, while the validity limit for the fracture toughness model was accepted to 140 ppm in 2022. The 2021 events have been addressed in previous Commission Hearings and Meetings and is the subject of a specific industry R&D project. Alternate criteria for evaluating safe operation have been established in the interim until the R&D project is completed.</p> <p>With respect to concerns regarding the equivalent full power hours (EFPH) calculations and their accuracy, these values are produced by industry; therefore, the responsibility to provide clarification would be on Bruce Power.</p>



Appendix C: Review of Interventions on Bruce Power Mid-term Update (4/4)

Intervention Themes	CNSC Staff Review
<p>Theme: Elevated Hydrogen Equivalent Concentration in Pressure Tubes</p>	<p>CMD 23-M27.11, Paul Sedran, RESD Inc.</p> <p>With respect to thermal diffusion and the hydrogen/deuterium concentration gradient, the intervenor recognized an omission of the phenomenon of hydride precipitation from the analysis presented in their intervention for the Commission Meeting in November 2022. In doing so, the Heq gradient observed in the B6S13 pressure tube measurements could not be reproduced, which led to the conclusion that additional ingress may have been required to generate the Heq gradient. The analysis has been revised in the most recent intervention, which concluded that when precipitation effects were taken into account, the temperature gradient due to flow bypass could explain the Heq gradient as proposed by Bruce Power. Industry’s ongoing R&D project will address the phenomenon in more detail.</p> <p>Regarding the inadequacy of the existing rolled joint deuterium ingress model, CNSC staff has informed Bruce Power that it will be necessary to address the intervenors’ comments related to the potential inadequacy of the rolled joint deuterium ingress model in the R&D project. This intervenor has retracted their previous assertion that an additional ingress source at the top of the pressure tube would be required to explain the elevated Heq near the outlet rolled joint of the Bruce Unit 6 pressure tube, B6S13.</p>