



Record of Decision

DEC 21-H113

In the Matter of

Applicant Bruce Power Inc.

Subject Request for Authorization to Restart Bruce Nuclear Generating Station A Unit 4 and Bruce NGS B Units 5, 7 and 8 following future outages

Date of Decision November 12, 2021

Record of Decision Date February 28, 2022

RECORD OF DECISION – DEC 21-H113

Applicant: Bruce Power Inc.

Address/Location: P.O. Box 1540, Building B10, 177 Tie Road, Municipality of Kincardine, Tiverton, Ontario, N0G 2T0

Purpose: Request for Authorization to Restart Bruce Nuclear Generating Station A Unit 4 and Bruce NGS B Units 5, 7 and 8 following future outages

Application received: October 6, 2021

Hearing: Public Hearing in Writing – Notice of Hearing in Writing published on November 4, 2021

Date of decision: November 12, 2021

Panel of Commission: Ms. R. Velshi, President
Dr. M. Lacroix
Ms. I. Maharaj

Decision: Authorization granted to restart Bruce NGS A Unit 4 and Bruce NGS B Units 5, 7, and 8 following any outage

Table of Contents

1.0 INTRODUCTION..... 1
2.0 DECISION..... 2
3.0 ISSUES AND COMMISSION FINDINGS 3

1.0 INTRODUCTION

1. Bruce Power Inc. (Bruce Power) has applied to the Canadian Nuclear Safety Commission¹ (CNSC) for authorization to return Bruce Nuclear Generating Station (NGS) A Unit 4 and Bruce NGS B Units 5, 7, and 8 to service, following any unplanned outage which results in the cooldown of the heat transport system. Bruce NGS Units 4, 5, 7 and 8 are [subject to a CNSC order](#)² that requires the licensee to obtain authorization from the Commission prior to restart following any unit outage that results in the cooldown of the heat transport system. The Bruce NGS A and Bruce NGS B each comprise four Canada Deuterium Uranium (CANDU) reactors (Units 1-4 and Units 5-8) and their associated equipment. Bruce NGS A and B are located on the Bruce Nuclear Power Development site in the Municipality of Kincardine, Ontario and on the traditional territory of the Anishinabek Nation: the peoples of the three fires known as Ojibway, Odawa and Pottawatomie Nations. The Bruce region is also homeland to the Historic Saugeen Métis and to the Métis Nation of Ontario.
2. A CNSC designated officer issued the order to Bruce Power after the discovery of elevated hydrogen equivalent concentration ([Heq]) levels at Bruce NGS A Unit 3 and Bruce NGS B Unit 6. The designated officer considered the discovery to put into question the predictive capability of the model for [Heq] levels in operating reactors which have pressure tubes in extended operation. The Commission confirmed the designated officer order following a proceeding on [September 10, 2021](#).
3. This decision does not consider Bruce NGS A Unit 3. On [October 5, 2021](#), the Commission authorized the restart of Unit 3 following a planned outage but not from future outages. On [December 17, 2021](#), Bruce Power submitted an application to the CNSC for authorization to restart Unit 3 following any future outage. The Commission will consider Bruce Power's application respecting Unit 3 in a separate hearing.

Hearing in writing

4. Pursuant to section 22 of the NSCA, the President of the Commission established a Panel of the Commission over which she would preside, including Commission Members Dr. Marcel Lacroix and Ms. Indra Maharaj, to decide on the request. A [notice of hearing in writing](#) was published on November 4, 2021. The hearing in writing was conducted in accordance with the [Canadian Nuclear Safety Commission Rules of Procedure](#). The Commission considered written submissions from Bruce Power ([CMD 21-H113.1](#), [CMD 21-H113.1A](#), and [CMD 21-H113.1B](#)) and CNSC staff ([CMD 21-H113](#) and [CMD 21-H113.A](#)). The Commission also received a written submission from the Commission's [External Advisory Committee on Pressure Tubes \(EAC\)](#)³ ([CMD 21-H113.2](#)).

¹ The *Canadian Nuclear Safety Commission* is referred to as the "CNSC" when referring to the organization and its staff in general, and as the "Commission" when referring to the tribunal component.

² The Commission confirmed this order on September 22, 2021; refer to the [Record of Decision DEC 21-H11](#), *Review by the Commission of the Designated Officer Orders Issued to Bruce Power and Ontario Power Generation Inc. on July 26-27, 2021*; and *Requests to Restart Reactors subject to the Orders*, November 10, 2021.

³ Established on July 30, 2021, the External Advisory Committee on Pressure Tubes was created by the Commission, under its statutory authority to establish advisory committees, to complement the expertise of

5. The Commission Secretary communicated the Commission's decision to Bruce Power on [November 12, 2021](#).⁴ This *Record of Decision* provides the detailed reasons for that decision.

Issues

6. The Commission must determine whether Bruce Power satisfied the conditions of the order, which provides that:

Prior to the restart of any of Units 3, 4, 5, 7 or 8, following any outage that results in the cooldown of the heat transport system, Bruce Power shall obtain authorization from the Commission to restart.

Prior to seeking such authorization, Bruce Power shall either:

- a. carry out inspection and maintenance activities that demonstrate with a high degree of confidence that pressure tube [Heq] is within Bruce Power's licensing basis, per licence condition G.1, and submit results of such activities to CNSC staff;

or

- b. carry out inspection and maintenance activities that demonstrate with a high degree of confidence that no flaws are present in the region of pressure tubes where the models failed to conservatively predict the elevated [Heq], and submit results of such activities to CNSC staff.

7. The Commission has also considered the application of licence condition 15.3 of Bruce Power's CNSC licence, PROL 18.01/2028, to this request for restart. That condition provides:

Before hydrogen equivalent concentrations exceed 120 ppm (parts per million), the licensee shall demonstrate that pressure tube fracture toughness will be sufficient for safe operation beyond 120 ppm.

2.0 DECISION

8. Based on its consideration of the matter, with respect to the restart of Bruce NGS Units 4, 5, 7 and 8 following any outage that results in the cooldown of the heat transport system, the Commission concludes that Bruce Power has:

- demonstrated a low likelihood of flaws deeper than 0.15 mm in the region of interest of the uninspected pressure tubes of Units 4, 5, 7, and 8 that could lead to crack initiation;

Commission members, and to provide an external perspective for the benefit of Commission members in their role as decision-makers.

⁴ Email from M. Leblanc (CNSC) to J. Scogack, M. Burton and L. Clarke (Bruce Power), *Request for restarts – Bruce Power – Summary decision*, November 12, 2021.

- demonstrated with a high degree of confidence that no flaws that could call into question the fitness for service of Units 4, 5, 7, and 8 pressure tubes are present in the region of pressure tubes where the models failed to conservatively predict the elevated [Heq], satisfying Option (b) of the conditions set in the order; and
- demonstrated, for the purposes of licence condition 15.3 in relation to the restart request, that pressure tube fracture toughness is presently sufficient for safe operation.

The Commission authorizes Bruce Power to restart any of Bruce NGS A Unit 4 and Bruce NGS B Units 5, 7, and 8 from any outage where cooling down the primary heat transport system is necessary, subject to all other pressure tube fitness for service requirements in the licensing basis being satisfied. As a result of this decision, Bruce Power will no longer be required to request authorization to restart Units 4, 5, 7, and 8 pursuant to the order.

3.0 ISSUES AND COMMISSION FINDINGS

9. In conducting this hearing in writing, the Commission invited the EAC to comment on the submissions from Bruce Power, and on the analysis and recommendations of CNSC staff, who were in turn provided an opportunity to respond. In order to obtain additional information in a fair and expeditious manner, the Commission decided to hold a virtual question and answer session via [transcribed](#) videoconference on November 12, 2021, with representatives from Bruce Power, CNSC staff and EAC members in attendance. The responses provided during the virtual question and answer session addressed the Commission's remaining questions.

Conditions of the Order

10. The Commission assessed whether Bruce Power had satisfied the conditions of the order. Prior to seeking authorization to restart Units 4, 5, 7 and 8, Bruce Power was required to satisfy either option (a) or (b) of the order. CNSC staff had previously established the following restart criteria for each option:

Criteria for option (a):

1. Licensee shall demonstrate an understanding of the mechanism leading to high Hydrogen equivalent (Heq) concentration in the region of interest⁵, and are able to conservatively model Heq concentration in this region.

Criteria for option (b):

1. Sufficient inspection data shall be available for the reactor unit to justify, with a high degree of certainty, that no flaws are present in the region of interest greater than 0.15 mm in depth; and

⁵ For the Bruce NGS A and B, CNSC staff defined the “region of interest” as the region of the pressure tubes 75 mm inboard from the outlet burnish mark and 360° of the pressure tube circumference.

2. Corrective actions shall be implemented for tubes containing flaws greater than the specified depth.
11. With respect to defining the region of interest to assess the request for authorization to restart Bruce NGS A and B Units 4, 5, 7, and 8, CNSC staff submitted that an axial length of 75 millimetres (mm) from the outlet burnish mark and 360° of the pressure tube circumference is appropriate. This region of interest bounds the axial position where elevated [Heq] levels were discovered in Bruce NGS A Unit 3 and Bruce NGS B Unit 6 pressure tubes.
12. The Commission notes that the 0.15 mm depth specified in the criteria for option (b) is based on CSA standard N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*⁶, and represents the threshold at which a flaw is considered to be unconditionally acceptable. The Commission understands that the primary mechanisms and characteristics of flaws that would pose a risk to pressure tube integrity are [Heq], flaw depth, and flaw sharpness
13. The Commission is satisfied that the restart criteria established by CNSC staff are appropriate and provide reasonable bases on which to demonstrate that the conditions of the order have been satisfied. The Commission is of the view that compliance with these criteria would demonstrate that the risk associated with elevated [Heq] in the region of interest is low.
14. This decision will focus on the criteria for option (b). Bruce Power submitted that it has met the criteria for option (b) only and the Commission concludes that there is insufficient information to confirm that Bruce Power meets the restart criteria for option (a). Satisfying option (a) would require strengthening the predictive capability of the model that has been called into question. While the Commission acknowledges Bruce Power's progress in its analysis to satisfy this criterion, there is insufficient information to support option (a) at this time.

Option (b), Criterion 1

15. In its CMD, CNSC staff specified that, to satisfy criterion 1 of option (b), the licensee must demonstrate, through an evaluation of the inspection history data and knowledge of the potential flaw formation mechanisms, that in the region of interest, flaws deeper than 0.15 mm are unlikely to exist in the population of pressure tubes in a reactor that have not been inspected. CNSC staff's assessment is that Bruce Power's inspection data and statistical analysis satisfy restart criterion 1 for option (b) of the order.
16. Bruce Power submitted that it has inspected 308 pressure tubes across Units 4, 5, 7, and 8 and has identified no flaws greater than 0.15 mm deep in the region of interest of any inspected tube. Bruce Power submitted that it intends to continue pressure tube inspections on Units 4, 5, 7, and 8 during their next planned maintenance outages and

⁶ CSA N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*, CSA Group, 2020.

communicate technical information to CNSC staff. The Commission notes its agreement with Bruce Power's approach to complete the inspections during planned outages, rather than unplanned outages, to ensure that adequate preparations are made for each inspection campaign.

17. Bruce Power submitted a statistical analysis of the potential existence of dispositionable flaws in the region of interest of uninspected tubes in Units 4, 5, 7, and 8. The analysis estimated that fewer than 1 dispositionable flaw exists within the region of interest of pressure tubes in each of Unit 4, 5, 7, and 8. CNSC staff submitted that this result remains within the safety case for the Bruce NGS, as approved by the Commission.
18. In its submission, the EAC posed questions regarding the methodology and verification of the statistical analysis. Bruce Power provided information on the statistical distributions used in the analysis and explained that it performed sensitivity studies across the region of interest to check the analysis results. CNSC staff stated that it verified the results of the analysis using two different statistical methods. In response to questions from the Commission, Bruce Power submitted CMD 21-H113.1B and CNSC staff submitted CMD 21-H113.A to provide additional information regarding the analysis. The Commission is satisfied that Bruce Power has demonstrated, with a high degree of confidence, that dispositionable flaws are unlikely to exist in the region of interest in the population of uninspected pressure tubes and that CNSC staff performed sufficient analyses to verify Bruce Power's results. The Commission also notes the EAC's comment regarding significant figures and agrees that numerical results need only be provided up to three significant figures.
19. On the creation of flaws, CNSC staff submitted that there are no known mechanisms that can result in the creation of flaws deeper than 0.15 mm in the region of interest during normal operation. Bruce Power submitted that all units at Bruce NGS A and B are equipped with a fuel carrier which prevents flaw formation due to cross flow conditions during fuelling operations. Bruce Power further submitted that the positioning of fuel bundle bearing pads in the pressure tube does not introduce significant drivers for the formation of flaws deeper than 0.15 mm in the region of interest. The Commission asked if pressure tubes aging could have an impact on the creation of flaws. Bruce Power clarified that it is not the aging of a pressure tube that creates flaws but rather that flaws can develop over time due to external factors such as debris.
20. With respect to Bruce NGS A and B, Units 4, 5, 7, and 8, the Commission concludes that Bruce Power has satisfied criterion 1 for Option (b) of the order. The Commission finds that:
 - Bruce Power has identified no flaws in the region of interest of the 308 inspected tubes across Units 4, 5, 7, and 8;
 - Bruce Power has demonstrated, with a high degree of confidence, that flaws deeper than 0.15 mm are unlikely to exist in the region of interest in the population of pressure tubes that have not been inspected; and that
 - pressure tube flaws deeper than 0.15 mm are not likely to develop in the region of interest.

Option (b), Criterion 2

21. The second criterion that CNSC staff set out for satisfying option (b) of the order requires that corrective actions be implemented for pressure tubes containing flaws greater than the specified depth (0.15 mm). Bruce Power submitted that it has not identified any flaws in Units 4, 5, 7, or 8 that would necessitate invoking criterion 2. The Commission therefore concludes that corrective measures are not required, and that Bruce Power has satisfied both criteria for option (b) of the order.

Compliance with Licence Condition 15.3

22. Licence condition 15.3 for PROL 18.01/2028 requires that:

“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 Commission understands that Bruce NGS Units 4, 5, 7, and 8 have not had a pressure tube with measured [Heq] in excess of the licence limit.

CNSC staff submitted that, in satisfying option (b) of the order, Bruce Power has demonstrated that pressure tube fracture toughness will be sufficient for safe operation beyond [Heq] of 120 ppm at Units 4, 5, 7, and 8.

23. The Commission is satisfied that Bruce Power has demonstrated, for the purposes of licence condition 15.3 in relation to this restart request, that pressure tube fracture toughness is sufficient for safe operation.

Scope of Restart Request

24. Bruce Power is seeking authorization to return Bruce NGS A Unit 4 and Bruce NGS B Units 5, 7, and 8 to service following any unplanned outage that results in the cooldown of the heat transport system. CNSC staff recommended that the Commission authorize the restart of Units 4, 5, 7, and 8 following any planned or unplanned outage. The Commission considered the evidence on the record for this hearing as it applies to the restart of the units from both future planned and unplanned outages.
25. CNSC staff submitted that, for a unit that has pressure tubes with potential elevated [Heq] in the region of interest, the risks associated with restarting the unit from a planned outage or an unplanned outage are essentially the same. A Bruce Power representative stated that Bruce Power’s restart request focused on unplanned outages as an operational priority, but that Bruce Power concurred with CNSC staff’s recommendation.

26. The EAC expressed concern regarding potential pressure tube impacts during unit cooldown from unplanned outages. Bruce Power submitted that, following every unit shutdown, it conducts a post-transient review, which includes a review of the cooldown curve, for potential impacts on pressure tube fitness for service. Bruce Power noted that if the cooldown deviates from normal, Bruce Power conducts an assessment to ensure that the pressure tubes remain fit for service. The Commission offered the EAC the opportunity to provide closing remarks and notes that the EAC did not raise additional concerns with regard to the information on the record.
27. The Commission finds that, in satisfying option (b) of the order and Licence Condition 15.3 for Units 4, 5, 7, and 8, Bruce Power has:
- demonstrated with a high degree of confidence that no flaws deeper than 0.15 mm are present within the region of pressure tubes where the models failed to conservatively predict the elevated [Heq] and that no significant mechanisms exist to create flaws deeper than 0.15 mm in that region; and
 - demonstrated that pressure tube fracture toughness will be sufficient for safe operation beyond 120 ppm [Heq].
28. The Commission's view is that, barring unforeseen future pressure tube inspection results outside the licensing basis, it is reasonable to expect that the conditions in the Unit 4, 5, 7, and 8 pressure tubes will not significantly change for the remainder of the operating life of the reactor units. That is, the Commission is satisfied that the Unit 4, 5, 7, and 8 pressure tubes are likely to remain fit for service, within the licensing basis. The Commission therefore authorizes Bruce Power to restart Bruce NGS A Unit 4 and Bruce NGS B Units 5, 7, and 8 from any outage where cooling down the primary heat transport system is necessary, subject to all other pressure tube fitness for service requirements in the licensing basis being satisfied. The Commission notes that Bruce Power's operation of each reactor unit is still subject to standard regulatory oversight activities.
29. As a result of this decision, Bruce Power will no longer be required to request authorization to restart Bruce NGS A Unit 4 and Bruce NGS B Units 5, 7, and 8 pursuant to the order.

**Velshi,
Rumina**



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Rumina Velshi
President,
Canadian Nuclear Safety Commission

February 28, 2022

Date