Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

CMD 21-H110Q

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**UNPROTECTED**

# Questions from Commission Panel Members and External Advisory Committee

In the Matter of

**Request for authorization to return Bruce Nuclear Generating Station (NGS) A Unit 3 to service, following its current planned outage**

Public Hearing - Hearing in writing based on written submissions

**October 2021**

**NON PROTÉGÉ**

# Questions des membres de la formation de la Commission et Comité consultatif externe

À l'égard de

**Demande concernant l'autorisation de la remise en service de la tranche 3 de la centrale nucléaire de Bruce-A à la fin de son arrêt prévu actuel**

Audience Publique - Audience fondée sur des mémoires

**Octobre 2021**

Canada

## INTRODUCTION

The Panel of the Commission, in conducting hearing in writing 2021-H-110[1] to consider a request from Bruce Power for an authorization to return Bruce Nuclear Generating Station (NGS) A Unit 3 to service, following its current planned outage, has reviewed the written submissions provided by CNSC staff and Bruce Power.

Bruce NGS A Unit 3 is subject to a CNSC order that requires the licensee to obtain authorization from the Commission prior to restart following any outage that results in the cooldown of the heat transport system. The Panel of the Commission and the External Advisory Committee require additional information with respect to CMD 21-H110, CMD 21-H110.1, CMD 21-H110.1A and CMD 21-H110.1B.

## QUESTIONS

The External Advisory Committee's questions for Bruce Power and CNSC staff's attention are set out in Table 1.

The Panel of the Commission's questions for Bruce Power and CNSC staff's attention are set out in Table 2.

**Table 1 – CMD 21-H110Q EAC Statements and Bruce Power Responses**

| # | External Advisory Committee Statements |
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| 1. | **Statement:**<br>Bruce Power seeks re-start of Unit 3 based on a high probability of there being no flaws in the region of interest (i.e. Option b).<br><br>**Response:**<br><br>This is correct, with high confidence the number of a dispositionable flaws within the CNSC defined region is < 1.<br><br>Reference: CMD 21-H110.1B - Bruce Power Letter, M. Burton to M. Leblanc and A. Viktorov, "Bruce A and Bruce B: Supplementary Information with Respect to Flaw Probability", September 29, 2021, BP-CORR-00531-02090. Enclosure 1. B-03644.1-29SEP2021, "Updated Flaw Probability in the Region of Interest in the Uninspected Population of Pressure Tubes in Bruce Units 3-8" |

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| 2. | **Statement:**<br>In addition, the submission argues that the high [$H_{eq}$] is unlikely to affect DHC performance or fracture toughness in the region of interest at the outlet end of PT's. However, due to lack of data on PT material, this relies on interpretation of literature data on other Zirconium alloys. This partially but not completely supports Option a.<br><br>**Response:**<br>**This is correct and the normal performance of Zr2.5Nb predictions have been adjusted downward to mimic the poorer known performance of Zr-2 and Zr-4.**<br>Reference: CMD 21-H110.1 - Bruce Power Letter, M. Burton to M. Leblanc and A. Viktorov, "Bruce A Unit 3: Return to Service Additional Information", September 17, 2021, BP-CORR-00531-02033. Enclosure 3. NK21-REP-31100-00219, B2038/RP/009, R00, "Risk-Informed Deterministic Evaluation of Fracture Protection for the Region of Interest in Outlet Rolled Joints in Bruce Unit 3". |
| 3. | **Statement:**<br>Some concerns still exist, however they are not sufficient to prevent approval of re-start of Unit 3, given a) the measures to control the pressure/temperature envelope during return to power and b) provided the R&D program promised by Bruce Power is delivered.<br><br>**Response:**<br>This is correct and the R&D work is on schedule as per Bruce Power's prior formal correspondence.<br><br>Reference: CMD 21-H110.1 - Bruce Power Letter, M. Burton to M. Leblanc and A. Viktorov, "Bruce A Unit 3: Return to Service Additional Information", September 17, 2021, BP-CORR-00531-02033. Enclosure 1. B-31100 LOF NSAS, Revision 000, "Re: Justification for Application of Crack Initiation Models to High Hydrogen Equivalent Concentration Regions in Pressure Tubes". |
| 4. | **Statement:**<br>The R&D activities should include effort to revise the modeling to predict the circumferential migration of [$H_{eq}$] in the outlet end rolled joint region and the region of interest. Attention should be given to the prediction of [$H_{eq}$] migration in the axial inboard direction from the burnish mark due to smaller axial temperature gradients associated with flow bypass resulting from PT circumferential creep. This will improve confidence in the modeling of [$H_{eq}$] distribution in regions of interest. |

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| | **Response:**<br>This is correct and work is underway to further develop the 2-dimensional finite element diffusion model required to provide these predictions. |
| 5. | **Statement:**<br>In addition, it is recommended that PT inspections of acoustically active channels be prioritised in Unit 3, to ensure that the acoustically active channels do not represent a population with a higher probability of flaws in the outlet end region of interest."<br><br>**Response:**<br>There are no acoustically active channels in Bruce A units, only a small number in the outer zone region of Bruce Units 5, 7 & 8. |
| **Comments from CNSC staff on Bruce Power's responses:**<br>CNSC staff have reviewed responses to comments by the EAC as provided by Bruce Power. We conclude that the responses align with the information used by staff in developing recommendations to the Commission. Hence, CNSC staff recommendations regarding request for restart of Bruce NGS Unit 3 do not change. Commitments for further R&D will be tracked through our established mechanisms, such as Action Items and the LCH. | |

**Table 2 – CMD 21-H110Q Questions for CNSC Staff and Bruce Power and Responses**

| # | Panel of the Commission Questions |
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| 1. | **Question for CNSC staff:**<br><br>At p. 6 of Staff's submission (CMD 21-H110), it is stated:<br><br>Based on the information provided by Bruce Power [2-5], CNSC staff conclude that:<br>• Bruce Power has met the restart criteria for Option (b) of the Order since they have demonstrated "*with a high degree of certainty, that no **[service-induced]** flaws greater than 0.15 mm are present in the region of interest"* [7],<br><br>The question is why is there such a caveat? Please provide a rationale and how this may exclude other flaws. |

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| | **Response from CNSC staff:**<br><br>As CNSC staff has noted in CMD 21-H-110, during the latest outage scrape campaign, Bruce Power obtained scrape samples from several pressure tubes at locations where Heq was above 120 ppm. The caveat noted below was added in reference to the resulting scrape marks or flaws, to differentiate from flaws induced during operation due to fretting or other mechanisms (the latter are called "service-induced" flaws).<br><br>Bruce Power completed a stress analysis and concluded that the resulting stress concentration associated with the scrape marks is insufficient to accumulate hydrogen at levels that would lead to crack initiation based on current crack initiation models. It is noted in our CMD that these models are not fully validated at Heq levels above 120 ppm. Additional work is planned to confirm the accuracy of the models for elevated levels of Heq up to 220 ppm that will support continued operation of tubes with scrape marks in locations of elevated Heq. The first of these test results are expected prior to the end of 2021.<br><br>The specific scrape marks or flaws will not impact safe restart and subsequent full power operation following the current outage since there is no mechanism for crack formation while the unit is depressurized or during heat-up as part of the restart process. CNSC staff also recognize that the likelihood of these flaws ever forming cracks is low. The fitness for service of the tubes containing these scrape flaws should be evaluated to support restart from future outages as crack initiation from a flaw is most likely to occur during a reactor cooldown cycle. Hence, it is important that Bruce Power proceed with the completion of the crack initiation testing program in a timely manner to support such evaluations.<br><br>CNSC staff confirm that Unit 3 is safe to restart and is in compliance with the condition of the order. |
| 2. | **Question for CNSC staff and Bruce Power:**<br><br>Can Bruce Power and CNSC staff confirm that they have a high degree of certainty that no flaws greater than 0.15 mm deep exist in the ROI?<br><br>**Response from CNSC staff:**<br><br>CNSC staff has concluded, with a high degree of certainty, that there are no flaws greater than 0.15 mm deep in the region of interest. This excludes the scrape marks that were discussed in staff's previous response. The conclusion is based on the analysis of the historical inspection data, the configuration of the fuel bundles near the outlet burnish mark and the mechanistic understanding of the flaw formation mechanisms. |

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| | **Response from Bruce Power:**<br><br>Thank you for the opportunity to comment on the CNSC staff response and provide a response to the Commission panelists' additional question. Bruce Power notes that the CNSC staff response is accurate and want to re-enforce the fact that the specific assessment of crack initiation has shown that the impact would be low. This includes outage related scrape witness marks which are > 0.15mm in the region of interest. These outage witness marks have geometries which are not susceptible to crack initiation. The assessment is further supported by the testing program, but also stands on its own (Reference 1). The analysis completed by Bruce Power confirms that there is a high degree of confidence that there is less than 1 service induced flaw in the region of interest (i.e. 360 degrees x 75 mm) (Reference 2). In addition no dispositionable service induced flaw > 0.15 has ever been detected in this region of interest (Reference 3).<br><br>Reference 1: CMD 21-H110.1… Bruce Power Letter, M. Burton to M. Leblanc and A. Viktorov, "Bruce A Unit 3: Return to Service Additional Information", September 17, 2021, BP-CORR-00531-02033. Enclosure 1. B-31100 LOF NSAS, Revision 000, "Re: Justification for Application of Crack Initiation Models to High Hydrogen Equivalent Concentration Regions in Pressure Tubes".<br><br>Reference 2: CMD 21-H110.1B… Bruce Power Letter, M. Burton to M. Leblanc and A. Viktorov, "Bruce A and Bruce B: Supplementary Information with Respect to Flaw Probability", September 29, 2021, BP-CORR-00531-02090. Enclosure 1. B-03644.1-29SEP2021, "Updated Flaw Probability in the Region of Interest in the Uninspected Population of Pressure Tubes in Bruce Units 3-8"<br><br>Reference 3: CMD 21-H11.2, Letter, M. Burton to M. Leblanc, "Designated Officer Order to Bruce Power - Unit 3 Planned Outage Restart Authorization", August 13, 2021, BP-PROC-01935. Attachment A. |
| 3. | **Question for CNSC Staff:**<br><br>Can CNSC staff confirm that they are in agreement with Bruce Power's statement that "These outage witness marks have geometries which are not susceptible to crack initiation." and that staff has high confidence that this would be the case for heat-ups and cooldown?<br><br>**Response from CNSC Staff:**<br><br>"CNSC staff and Bruce Power are using different terminology to refer to features that remain in the pressure tubes after scrape samples are taken. CNSC staff has referred to them as "scrape flaws" and Bruce Power as "witness marks". It means the same thing. |

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| | As mentioned in a previous response, CNSC staff conclude the likelihood that the scrape flaws or witness marks will initiate cracks with subsequent operation, including heat-up and cooldown cycles, is low. We consider it important that Bruce Power proceed with tests of material with elevated Heq to fully validate the crack initiation models.” |

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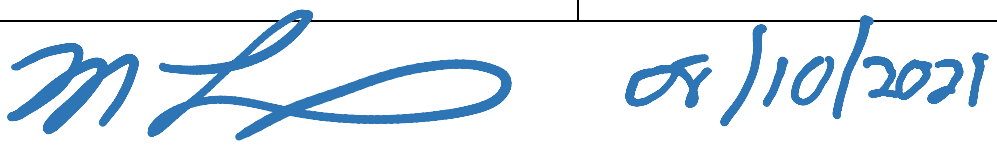
| Name: | Marc Leblanc, Commission Secretary<br>*On behalf of the Panel of the Commission* | Date: 2021-10-08 |
| Signature: |  | |