# Minutes of the Canadian Nuclear Safety Commission (CNSC) Meeting held on September 3, 2021

September 3, 2021

Minutes of the Canadian Nuclear Safety Commission (CNSC) meeting held over a virtual platform on September 3, 2021 beginning at 1:00 p.m. The meeting was webcast live via the CNSC website, and video archives are available on the CNSC's website.

Present:

R. Velshi, President
T. Berube
S. Demeter
M. Lacroix
S. McKinnon
I. Maharaj
R. Kahgee

M. Leblanc, Secretary
L. Thiele, Senior General Counsel
M. McMillan, Recording Secretary

CNSC staff advisors were: A. Viktorov, R. Jammal, V. Tavasoli, B. Carroll, M. Gerrish and J. Sigetich

Other contributors were:

- Bruce Power: J. Scongack, S. Mudrick and G. Newman
- NB Power: J. Nouwens, B. Plummer and J. Lennox
- Ontario Power Generation: M. Knutson, J. Vecchiarelli and S. Granville
- External Advisory Committee: M. R. Daymond, J. Luxat and P. Spekkens

Constitution

1. With the notice of meeting Commission member document (CMD) 21-M30 having been properly given and all permanent Commission members being present, the meeting was declared to be properly constituted.

2. Since the Commission meeting held on June 8, 2021, CMD 21-M37 to CMD 21-M39 were distributed to members. These documents are further detailed in Appendix A of these minutes

Adoption of the Agenda

3. The agenda, CMD 21-M31, was adopted as presented.

Chair and Secretary

4. The President chaired the meeting of the Commission, assisted by M. Leblanc, Secretary and M. McMillan, Recording Secretary.

INFORMATION ITEMS

Impact on Canadian Nuclear Power Plants of Bruce Units 3 and 6 Licence Limit Exceedance of Hydrogen Equivalent Concentration in Pressure Tubes

5. On July 5, 2021 Bruce Power informed the CNSC that measurements obtained from a Bruce Nuclear Generating Station (NGS) Unit 6 pressure tube showed a hydrogen equivalent concentration ([Heq]) in exceedance of the licence limit of 120 parts per million (ppm).[1] On July 8, 2021 Bruce Power informed CNSC staff that a pressure tube from Bruce NGS Unit 3 also showed [Heq] in exceedance of the licence limit. Pursuant to subsection 12(2) of the *General Nuclear Safety and Control Regulations* (GNSCR), CNSC staff took regulatory action on July 13, 2021 requiring Bruce Power, Ontario Power Generation (OPG) and New Brunswick (NB) Power to report on pressure tube fitness for service and any other measures taken in response to this event.

6. The purpose of this Commission meeting was to discuss CNSC staff's July 16, 2021 Event Initial Report (EIR, CMD 21-M39) and submissions from the licensees in response to the requests made under subsection 12(2) of the GNSCR. The members of the Commission's External Advisory Committee on Pressure Tubes also attended.[2]

[1] The amount of hydrogen absorbed in a pressure tube during operation is quantified as the hydrogen equivalent concentration ([Heq]).
[2] The Commission established the External Advisory Committee on Pressure Tubes on July 30, 2021, under its statutory authority to establish advisory committees. The Committee is meant to provide an external perspective for the benefit of the Commission Members in their role as decision-makers.

7. With reference to CMD 21-M37, CMD 21-M37.A, and CMD 21-M39, CNSC staff presented an update regarding the discovery of the Bruce A Unit 3 and Bruce B Unit 6 licence limit exceedances, the GNSCR subsection 12(2) requests, the impact of the discovery on the safe operation of Canadian nuclear power plants (NPP), and the next steps for NPP licensees. CNSC staff reported that NPP licensees adequately responded to the discovery and regulatory actions. CNSC staff's view is that the continued operation of reactors does not pose an unreasonable risk, and that existing safety analyses remain valid.

8. Bruce Power (CMD 21-M37.1, CMD 21-M37.1A), OPG (CMD 21-M37.2, CMD 21-M37.2A), and NB Power (CMD 21-M37.3, CMD 21-M37.3A) presented information in response to CNSC staff's requests under subsection 12(2) of the GNSCR. All three licensees stated that they continue to maintain pressure tube fitness for service and the ability to operate safely.

Discussion

9. The Commission asked CNSC staff to elaborate on the impact of high [Heq] on pressure tubes during normal operation. CNSC staff stated that high [Heq] does not impact pressure tube fracture toughness at normal operating temperatures, and that CNSC staff considers the continued operation of reactors in extended operation to be safe until their next outage.[3] CNSC staff explained that high [Heq] reduces pressure tube fracture toughness at temperatures lower than the normal operating temperature.[4] A pressure tube rupture could occur during reactor heat up or cool down if a flaw that has the characteristics to initiate a crack is present in the area of high [Heq]. If it can be demonstrated that no flaws with the potential to initiate a crack exist in the area of high [Heq], then there is not an immediate pressure tube fitness for service concern.

10. The Commission sought more information on the location of the elevated [Heq]. A Bruce Power representative stated that [Heq] in exceedance of the licence limit was localized to a specific "region of interest" in the analyzed pressure tubes from Bruce NGS Unit 3 and Unit 6. The region of interest is located at the top of the pressure tube, near the outlet end fitting. The Bruce Power representative suggested that a flow-related temperature gradient is the likely cause of high [Heq] in the region of interest, as hydrogen tends to migrate to the coldest region of the tube, though the method by which the pressure tube was manufactured may also

[3] Extended operation of pressure tubes refers to operation beyond 210,000 equivalent full power hours.
[4] Fracture toughness characterizes the ability of a pressure tube to resist failure if a crack is present. If fracture toughness at the location of a crack is not adequate, the pressure tube could fail suddenly. If fracture toughness is adequate, the crack would first lead to a leak that could be detected.

play a role, the representative opined. CNSC staff stated that the root cause of the elevated [Heq] had not yet been verified and that the CNSC expects the licensees to determine the cause.

11. On whether the discovery is applicable to other NPPs, an OPG representative stated that elevated [Heq] had been observed in the region of interest of some pressure tubes in OPG reactors, however, not to the extent detected at the Bruce NGS. The OPG representative opined that the difference could be due to several factors, including lower equivalent full power hours of operation, operating temperature and neutron flux.

12. Asked if the pressure tubes from Bruce NGS Unit 3 and Unit 6 had been inspected prior to this event, a Bruce Power representative said that both of the tubes in question had been previously inspected. The Bruce Power representative explained that whenever a pressure tube inspection identifies [Heq] near the upper limit, the tube is revisited as part of Bruce Power's lifecycle management program. It is for this reason that the specific Unit 3 and Unit 6 tubes were selected for inspection. The Bruce Power representative stated that Bruce Power had performed inspections on additional pressure tubes since this event but had not submitted the results to CNSC staff at the time of this meeting.

13. With regard to the origin of pressure tube flaws, CNSC staff stated that flaws are predominately caused by contact between fuel bundles and the interior of a pressure tube. A Bruce Power representative stated that Bruce Power has not identified, and does not expect to identify, any flaws in the region of interest. Due to the design of the Bruce NGS pressure tubes, fuel bundles do not contact the top of the tube. An OPG representative stated that, similar to the Bruce NGS, OPG has not identified, and does not expect to identify, any flaws in the region of interest of Darlington NGS pressure tubes. The OPG representative stated that while known flaws exist in the region of interest of certain Pickering NGS Unit 5 pressure tubes, OPG has analyzed the flaws and determined that they do not have the geometry to pose a risk of crack initiation. CNSC staff stated that it had not yet verified OPG's analysis.

14. The Commission asked for clarification on the difference between a flaw and a crack. CNSC staff explained that CSA Group standard N285.4, *Periodic inspection of CANDU nuclear power plant components*, has a limit on flaw depth of 0.15 millimetres.[5] Flaws beyond that depth require further analysis. If a pressure tube has a flaw that is determined to be at risk of cracking, the pressure tube is not acceptable for continued service. A Bruce Power

[5] N285.4, *Periodic inspection of CANDU nuclear power plant components*, CSA Group, 2019

representative stated that Bruce Power plans to further validate its crack initiation models; information pertaining to this validation had not been formally submitted to the CNSC at the time of this meeting.

15. The Commission sought more information on pressure tube inspections. CNSC staff provided details on the technologies used to sample pressure tubes and to identify flaws, including scrape sampling, burst testing and ultrasound. The Bruce Power representative explained that Bruce Power modified its scrape tool to be able to retrieve samples from the region of interest, and noted that Bruce Power has made this modification available to the other NPP licensees.

16. The Commission asked CNSC staff to address the issue of the validity of the fracture toughness model.[6] CNSC staff acknowledged that the current fracture toughness model has shown good agreement with data in the majority of the pressure tube body, apart from the region of interest. CNSC staff noted the regulatory expectation that the licensees will improve the fracture toughness model to account for the phenomena that resulted in elevated [Heq] in the region of interest.

17. On the topic of the current licence limit of 120 ppm [Heq], CNSC staff explained that the licence limit was based on the limits of the fracture toughness model at the time that the licence was issued. CNSC staff noted that the industry intends to validate the model for higher [Heq], and although burst testing has been completed up to 200 ppm [Heq], the discovery at Bruce Power occurred prior to the model being updated.

18. The Commission asked about public engagement related to the [Heq] licence limit exceedance. CNSC staff explained that the CNSC had engaged with local Indigenous and public community leaders to provide information on the discovery. CNSC staff have also made information available on the CNSC website and engaged with interested members of the media. The Bruce Power representative stated that Bruce Power had also discussed the discovery with local community leaders, created a webpage on pressure tube integrity, and distributed information to its mailing list of over 10,000 subscribers. All three NPP licensees stated that they had not received any concerns from the public specific to this event.

[6] The CNSC requires licensees to have a model that predicts the fracture toughness of pressure tubes during start-up and shutdown conditions, taking temperature and [Heq] into account.

19. The Commission highlighted the importance of making information available to the public, particularly given the complexity of the subject matter, and commended the licensees and CNSC staff on their efforts to date in this regard. Representatives from Bruce Power, OPG and NB Power affirmed their commitment to transparency.

20. The External Advisory Committee was offered the opportunity to comment, but opted to reserve its comments for future public proceedings on the matter.

21. The Commission intends to hold a follow-up public Commission meeting on this topic in late Winter or early Spring 2022 following the CNSC's receipt of further hydrogen uptake model validity analyses from the licensees, per the GNSCR subsection 12(2) requests. Licensee responses are due by mid-January 2022. It is intended that Indigenous groups and members of the public will be invited to participate in the meeting.

Closure of the Public Meeting

22. The public meeting closed at 4:53 p.m.

McMillan Megan — Digitally signed by McMillan, Megan … I am the author of this document … Ottawa, ON … 2021-11-09 07:51:40 … Reader Version: 9.7.1

Recording Secretary — November 9, 2021 — Date

Leblanc Marc — Digitally signed by Leblanc, Marc … I am the author of this document … your signing location here … 2021-11-17 15:49:55 … Reader Version: 9.7.1

Secretary — November 17, 2021 — Date

APPENDIX A

| CMD | Date | e-Docs No. |
|---|---|---|
| 21-M30 | 2021-07-30 | 6613782 |
| Notice of Virtual Meeting of the Commission on September 3, 2021 | | |
| 21-M31 | 2021-08-26 | 6613784 |
| Agenda of the Meeting of the Canadian Nuclear Safety Commission (CNSC) to be held remotely on September 3, 2021 | | |
| 21-M39 | 2021-07-16 | 660088 |
| Information Items<br><br>Event Initial Report<br><br>Hydrogen Equivalent Concentration in Pressure Tubes for Nuclear Power Plants<br><br>Submission from CNSC Staff | | |
| 21-M37 | 2021-08-20 | 6626971 |
| Information Items<br><br>Hydrogen Equivalent Concentration in Pressure Tubes for Nuclear Power Plants<br><br>Presentation from CNSC staff | | |
| 21-M37.A | 2021-08-20 | 6626937 |
| Information Items<br><br>Hydrogen Equivalent Concentration in Pressure Tubes for Nuclear Power Plants<br><br>Supplementary submission from CNSC staff | | |
| 21-M37.1 | 2021-08-20 | 6622363 |
| Information Items<br><br>Hydrogen Equivalent Concentration in Pressure Tubes for Nuclear Power Plants<br><br>Submission from Bruce Power | | |
| 21-M37.1A | 2021-08-25 | 6628824 |
| Information Items<br><br>Hydrogen Equivalent Concentration in Pressure Tubes for Nuclear Power Plants<br><br>Presentation from Bruce Power | | |

| | | |
|---|---|---|
| 21-M37.2 | 2021-08-20 | 6622504 |
| Information Items<br><br>Hydrogen Equivalent Concentration in Pressure Tubes for Nuclear Power Plants<br><br>Submission from Ontario Power Generation | | |
| 21-M37.2A | 2021-08-25 | 6628827 |
| Information Items<br><br>Hydrogen Equivalent Concentration in Pressure Tubes for Nuclear Power Plants<br><br>Presentation from Ontario Power Generation | | |
| 21-M37.3 | 2021-08-20 | 6622555 |
| Information Items<br><br>Hydrogen Equivalent Concentration in Pressure Tubes for Nuclear Power Plants<br><br>Submission from NB Power | | |
| 21-M37.3A | 2021-08-25 | 6628830 |
| Information Items<br><br>Hydrogen Equivalent Concentration in Pressure Tubes for Nuclear Power Plants<br><br>Presentation from NB Power | | |