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**Written submission from  
NB Power**

**Mémoire d'  
Énergie NB**

**CNSC staff update on elevated  
hydrogen equivalent concentration  
discovery events in the pressure  
tubes of reactors in extended  
operation**

**Mise à jour du personnel de la  
CCSN sur les événements liés aux  
découvertes de concentrations  
élevées d'hydrogène équivalent dans  
les tubes de forces de réacteurs en  
exploitation prolongée**

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Responses from NB Power to the  
request from the Commission for an  
update

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Réponses d'Énergie NB à la demande  
de la Commission pour une mise à  
jour

Commission Meeting

Réunion de la Commission

November 3, 2022

Le 3 novembre 2022



Point Lepreau Nuclear Generating Station  
PO Box 600, Lepreau, NB  
E5J 2S6

**TU 06374**  
**PICA 22-2617**  
**AI 221204-23135**

July 20, 2022

Mr. Denis Saumure, Commission Registrar  
Legal and Commission Affairs Branch  
Canadian Nuclear Safety Commission  
P.O. Box 1046, Station B  
Ottawa, Ontario  
K1P 5S9

Dr. Alexandre Viktorov, Director General  
Directorate of Power Reactor Regulation  
Canadian Nuclear Safety Commission  
P.O. Box 1046, Station B  
Ottawa, Ontario  
K1P 5S9

Dear Mr. Denis Saumure, Dr. Alexandre Viktorov:

**Subject: Point Lepreau NGS: Request for an Update to the Commission on Activities Related to the Discovery of Elevated Hydrogen Equivalent Concentration (Heq) – New Action Item 221204-23135**

The purpose of this letter is for New Brunswick Power (NBP) to provide a report to CNSC staff, and the Commission as requested under (Reference 1), in relation to activities undertaken by NBP associated with pressure tube fitness for service upon the discovery of elevated hydrogen equivalent concentration ([Heq]) since the Fall of 2021.

The attached report, *Summary of PLNGS Activities Related to Elevated Hydrogen Equivalent Concentration OPEX Undertaken Since Fall of 2021* (Attachment 1), provides background information regarding the discovery of elevated [Heq] in the region of interest in late-life pressure tubes, details the original request to NBP from the CNSC (Reference 2), and provides an update regarding activities performed by NBP in response to the OPEX since the Fall of 2021. NBP concludes that the pressure tubes installed at PLNGS continue to be compliant with the licensing basis as defined under PROL 22.00/2032, Licence Condition Handbook section 6.1 and continues to ensure high levels of safety to the public.

NBP looks forward to supporting the Commission meeting set for November 1-3, 2022, and requests closure of Action Item 221201-231135 with the submission of this report.

If you require additional information, please contact Nick Reicker at 506-659-7324 or [nreicker@nbpower.com](mailto:nreicker@nbpower.com).

Sincerely,



Mark Power  
Site Vice President

MP/NR/bb

- cc.** Anupama Bulkan, Solly Karivelil, Tiffany Dunbar, Stephen Eckstein, Elnara Nasimi, Alexander Mawhinney, Andrew Daley, Samuel Gyepi-Garbrah, Ailan Holbrook (CNSC Ottawa)  
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Brett Plummer, Nick Reicker, Amanda Gardner, Alex Bardsley, Kathleen Duguay, Jennifer Lennox, Keith Sproul, Michael Briggs, Brendan Boyle (NBP)

References:

1. Letter: to M. Power, from A. Viktorov, "Point Lepreau NGS: Request for an Update to the Commission on Activities Related to the Discovery of Elevated Hydrogen Equivalent Concentration (Heq) – New Action Item 221204-23135", April 28, 2022, e-Doc 6783069
2. Letter: to M. Power, from A. Viktorov, "PLNGS: 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 6604246

Attachment:

1. Summary of PLNGS Activities Related to Elevated Hydrogen Equivalent Concentration OPEX Undertaken Since Fall of 2021, B. Boyle, July 20, 2022.

## **Attachment 1**

### **Summary of PLNGS Activities Related to Elevated Hydrogen Equivalent Concentration OPEX Undertaken Since Fall of 2021**

## 1.0 Executive Summary

Point Lepreau Nuclear Generating Station (PLNGS) pressure tubes were replaced during a planned refurbishment maintenance outage between 2008 and 2012. As such, the pressure tubes at PLNGS have been in service for a low number of effective full power hours (EFPH) (67,460 EFPH as of 2022-04-11, less than one third of end-of-design life of 210,000 EFPH), which corresponds to low levels of hydrogen uptake, and low levels of age-related degradation.

In July 2021, NB Power received a formal request from the CNSC, pursuant to subsection 12(2) of the *General Nuclear Safety and Control Regulations* in letter dated 2021-07-13 [1]. The request was based on information reported to the Canadian Nuclear Safety Commission (CNSC) by another Canadian licensee, in relation to analysis of pressure tube sampling, which initially suggested that the models used at the time may under-predict the maximum hydrogen equivalent concentration ([Heq]) in pressure tubes of CANDU reactors.

Taking into consideration all PLNGS post-refurbishment fuel channel inspections, the results from assessments completed to date indicate that material property trends are bounded by the models. There exists adequate margin to acceptance standard limits and the fuel channels continue to meet their fitness-for-service requirements. [2]

CNSC staff confirmed (in letter dated 2021-09-15 [3], in response to NB Power letter dated 2021-07-30 [2]) that there has been no evidence of highly elevated [Heq] in any scrape or surveillance pressure tube investigation for pressure tubes operating up to 210,000 EFPH and PLNGS would not approach this operational target for many years. In letter dated 2021-09-15 [3], CNSC staff concurred with NB Power's conclusion in letter dated 2021-07-30 [2] that there

is a very low risk that regions of elevated [Heq] are currently present in the PLNGS pressure tubes.

## **2.0 Initial Regulatory Correspondence**

Based on industry operating experience (OPEX) shared related to the elevated [Heq] measured at the outlets of pressure tubes installed at another Canadian nuclear power plant, the CNSC issued correspondence [1] to PLNGS requesting immediate short-term actions be undertaken to confirm that PLNGS remained within its licensing basis.

NB Power determined that pressure tubes remained fit-for-service and that PLNGS continues to operate within its licensing basis. This conclusion was based on the highly localized area of interest identified by the industry OPEX, the late-life initiation of the phenomenon/mechanism, significant conservatism in fitness-for-service assessments, and adequate margins to CSA N285.4 [Heq] acceptance standards and CSA N285.8 fracture toughness validity limits. This demonstrates continued compliance with the licensing basis as defined under Power Reactor Operating Licence (PROL) 17.01/2022, License Condition Handbook section 6.1, and ensures high levels of safety to the public.

## **2.1 Path Forward Established by NB Power**

In letter dated 2021-07-30 [2], NB Power established a path forward to ensure there was an appropriate response to the industry OPEX. The path forward included: consideration of scope adjustments to and completion of the 2022 [Heq] inspection campaign; and the reassessment of [Heq] model validity using data gathered from the inspection campaign.

## **2.2 Progress to Date on Path Forward Established by NB Power**

The hydrogen equivalent concentration [Heq] determination inspection was completed as scheduled during the 2022 planned maintenance outage. The inspection campaign was completed using the wet axial scrape tooling in the body of tube, and damp circumferential scrape tooling in the rolled joint region of the pressure tubes.

Damp Circumferential Scrape tooling was determined to be capable of sampling at the region of interest, but sampling at the region of interest was determined to be of limited value due to the low number of effective full power hours of the PLNGS pressure tubes, and the understanding that pressure tubes early in life do not exhibit the behavior seen in the OPEX. This provides an opportunity for conducting future measurements in the region of interest at higher effective full power hours.

Scrape samples have been analyzed and the preliminary results indicate that [Heq] measured in all samples are below the maximum [Heq], predicted conservatively, in the tensile region of the pressure tube. The model validity will be reassessed and submitted to the CNSC as part of the 120-day report submission required by clause 12.3.6.2 of CSA N285.4-19.

Evaluations completed to date do not challenge existing fuel channel fitness-for-service assessments. Additionally, CNSC staff confirmed in letter dated 2021-09-15 [3] “that there has been no evidence of highly elevated [Heq] in any scrape or removed tube investigations for pressure tubes operating up to 210,000 EFPH and that Point Lepreau Nuclear Generating Station (PLNGS) will not approach this operational target for many years. CNSC staff concur that there is a very low risk that regions of elevated [Heq] are currently present in the PLNGS pressure

tubes”. Inspections and related analyses completed to date at PLNGS (including the 2022 scrape campaign) support the position of CNSC staff in letter dated 2021-09-15 [3].

### **3.0 PLNGS Industry Involvement**

PLNGS actively participated in the industry root cause investigation related to this OPEX.

PLNGS provided input to the root cause investigation and collaborated with Canadian utilities to understand the cause of the OPEX.

PLNGS is an active member in industry groups including CSA Technical Committee and Sub-Committees, Candu Owners Group (COG) fuel channels research and development technical committee, working groups, joint projects, and [Heq] modelling roadmap.

### **4.0 PLNGS Fuel Channel Program Management**

PLNGS maintains regular communication with the CNSC in compliance with the PROL and Licence Condition Handbook (LCH) documents such as the fuel channels management plan (FCMP) and CSA N285.8 compliance plan. Additionally, the FCMP has been updated since the reporting of elevated [Heq], and now specifically addresses this industry OPEX.

The FCMP specifies that the fuel channel program specialist is responsible for incorporating OPEX into the FCMP, and that any OPEX event related to fuel channel integrity, either internal or external, is evaluated for applicability and potential impact to PLNGS pressure tubes.

PLNGS’s Fuel Channel Aging Management Program complies with OPEX feedback and feedback of research and development results (the eighth attribute of effective aging management) as documented in Appendix A of REGDOC 2.6.3.



Procedures and methods specific to inspections in compliance with CSA N285.4 are submitted to the CNSC for acceptance prior to use, which ensures communication between NB Power and the CNSC prior to fuel channel inspections. Furthermore, any findings from inspections requiring disposition are sent to the CNSC for acceptance.

## **5.0 Conclusions**

The pressure tubes replaced during the planned maintenance refurbishment outage (2008-2012) at PLNGS are early in their design-operating life, which corresponds to low levels of age-related degradation. NB Power continues to hold safety as the highest priority and has demonstrated pressure tube fitness-for-service. There exists adequate margin to acceptance standards and the fuel channels continue to meet their fitness-for-service requirements. The CNSC has confirmed that there has been no evidence of highly elevated [Heq] for pressure tubes operating up to 210,000 EFPH and that Point Lepreau Nuclear Generating Station (PLNGS) will not approach this operational target for many years [3].

NB Power is actively engaged in the industry and will assess industry research and OPEX as it evolves.

The fitness-for-service assessments of the PLNGS pressure tubes have sufficient conservatism and result in adequate margins to acceptance standards such that there is no concern of the OPEX of elevated [Heq] having an immediate impact on PLNGS fuel channel fitness-for-service.

PLNGS pressure tubes have low time in service, and fuel channel health is monitored as per the FCMP. NB Power is committed to meeting the requirements of relevant CSA standards to ensure public safety is maintained as the highest priority.

## 6.0 References

1. Letter: to M. Power, from A. Viktorov, “PLNGS: 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 6604246.
2. Letter: to M. Leblanc and A. Viktorov, from M. Power, “Request pursuant to Subsection 12(2) of the General Nuclear Safety and Control Regulations: Issues Relating to Measurements of Hydrogen Equivalent Concentration in Pressure Tubes”, July 30, 2021, e-Doc 6616141.
3. Letter: to M. Power, from A. Viktorov, “PLNGS: Closure of the 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”, September 15, 2021, e-Doc 6626762.