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Written submission from the Canadian Association of Nuclear Host Communities

Mémoire de la Canadian Association of Nuclear Host Communities

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

Commission Meeting

Réunion de la Commission

November 3, 2022

Le 3 novembre 2022

Canada

THE CANADIAN ASSOCIATION OF
NUCLEAR HOST
COMMUNITIES

Participant Funding Program Administrator
Canadian Nuclear Safety Commission
280 Slater Street
Ottawa, Ontario
K1P 5S9

October 18, 2022

To the Commission,

Herein, please find the Canadian Association of Nuclear Host Communities (CANAC) review and feedback on the Canadian Nuclear Safety Commission's (CNSC) report, and related reports from the utilities, on the **CNSC Staff Update on the Discovery of Elevated Hydrogen Concentration Equivalent in the Pressure Tubes of Reactors in Extended Operation**.

The Brilliant Energy Institute (BEI) at Ontario Tech University provided analysis, including a technical report by Dr. Glenn Harvel (enclosed).

Dr. Harvel spent more than 11 years as a design engineer at Atomic Energy Canada Ltd. before joining Ontario Tech University in 2006, within the Faculty of Energy Systems and Nuclear Engineering and Science (now Department of Energy and Nuclear Engineering).

The purpose of the CANHC review was to gain an understanding and obtain an objective perspective of the elevated hydrogen concentration equivalent issue and to assess related risks it might pose to the CANHC member communities and the public.

We have considered the issue, potential consequences, and public communication, through the specific lens of the CANHC communities and have provided conclusions and recommendations at the bottom of this report, which we respectfully submit to the Commission.

…/2

Summary of the findings

With respect to the goal of gaining a layman's understanding and an objective perspective of the issue, Dr. Harvel's report outlined the technical challenge and associated risks related to a buildup of Deuterium in CANDU pressure tubes over time, and especially toward the end of a unit's full power hours. It is our understanding that if left unchecked, this buildup can cause blistering, cracking and potentially, failure of the tube, resulting in necessary shutdown of the unit.

As explained on the CNSC's website, CANDU power reactors are comprised of several hundred fuel channels, each with a pressure tube, calandria tube, end fittings and spacers. Pressure tubes are "the heart of the reactor" designed to contain the fuel bundles and the primary coolant (water) in a reactor.

During regular plant operation, pressure tubes are exposed to high temperatures, high pressure, and intense radiation, all of which can cause deterioration as they age.

Original CANDU pressure tubes were made of Zircaloy-2, which was susceptible to blistering and cracking and did result in failure. This was addressed decades ago through replacement of the tubes with a new material (Zircaloy-2.5Nb), which is resistant to these effects.

Since the replacement material was adopted, the pressure tubes in all reactor units that have reached full power hours have successfully completed service without a failure (Point Lepreau, Gentilly-2, Wolsung-1, Embalse, Darlington 2 and 3, and Bruce 6).

However, inspection and management of aging pressure tubes remains a high priority. With regulatory oversight and within regulations, the utilities continue to routinely monitor select pressure tubes to validate that the tubes are aging as predicted and are showing no signs of wear that could signal premature failure. These tests are completed to ensure the pressure tubes are performing within the model expectations and hence 'fit' for service until the end of life.

Concern arose in 2021 after an inspection of select pressure tubes, performed during an outage showed higher levels of Deuterium than was anticipated given the age of the tubes.

The measurements in this round of testing were taken near the rolled joint of the tube. Following investigation, it was concluded the specific characteristics of that location caused the elevated reading. A new model is currently being developed as an outcome of this finding and is expected to be completed in 2026.

…/3

Dr. Harvel’s review of CNSC staff and industry documents indicates that even in a worst-case scenario, should a pressure tube fail, this is not a safety event but is a significant operational event with lost production time and financial cost for the utility.

From a purely technical perspective, the Bruce Power written submission indicates the phenomena is understood and can be modelled and the Ontario Power Generation (OPG) concurs. This suggests that the technical aspect of the Heq issue is well controlled and supports the request for the CNSC staff decision to close the Action Item.

Implications for the nuclear host communities

Units with recent refurbishments, such as those at Point Lepreau as well as some units at both Darlington and Bruce Power are at significantly lower risk of being affected by this issue because the pressure tubes are in the early period of full power hours of operation. It is the units closer to completion of their full power hours equivalent (a calculation based on how many hours the units have run and at what percentage of capacity) that are of most relevance.

By 2023, all Darlington units will have undergone pressure tube replacements so, like Point Lepreau, will not be potentially affected by this issue for many years.

Post 2023, four of the eight Bruce units pressure tubes will be replaced while another four will still be using older pressure tubes, as they await refurbishment. The first of those four units will be replaced in 2025 with the last unit operating until 2030. Bruce Power has done significant work to demonstrate full power hour fitness to 300,000 hours. This research and testing have allowed Ontario to sequence its refurbishments in a manner that contributes to more low-carbon electricity availability.

Pickering Nuclear was originally scheduled to complete operation at the end of 2024. The two oldest Pickering Units 1 and 4 will end operation then. The Ontario government recently announced that OPG, the plant operator, will look to extend operation of Pickering Nuclear Units 5-8 until 2026. To do so, OPG must undergo an additional license hearing, at which time, the question of fitness for service and demonstrated full power hours capability is expected to be fully explored.

In total, that leaves four Bruce Power and four Pickering units with aging pressure tubes operating post 2023 until Pickering ends operation no later than 2026 and the four Bruce units undergo tube replacement in 2025, 2026, 2028 and 2030, respectively.

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What was not stated in the report, was the action that would be taken by the CNSC if a pressure tube were to fail. Would the regulator require only that this single unit be removed from service for investigation, inspection and repair or would the regulator require all units approaching full power hours to be shut down?

It has been determined this is an operational issue, where the potential effects on these communities would be related to any ripple effect should there be temporary layoffs due to shutdowns. Given the low probability of failure and given other existing economic opportunities in those communities (Pickering's proximity within the Greater Toronto Area and the other four newer units that could continue to operate at Bruce Power), this appears to be a very low economic risk for the communities.

The number of reactors already refurbished and operating with new pressure tubes buffers the most significant community economic risks. However, if Pickering and the four Bruce units were shut down in a regulatory action, due to one pressure tubes failure, this could create energy security issues for the province, and the replacement power would likely be more carbon intensive.

Reputation considerations

An additional consideration is that if there was a pressure tube failure, which prompted a broader regulatory action, this could create a reputation issue, which in turn could have a ripple effect on the current nuclear host communities. It could also impact the social license of nuclear more broadly and thus the prospect for future nuclear new build in greenfield communities. The reputation of nuclear is more critical now than ever before given its important role in helping Canada, and the world, meet net zero targets.

Communications on the Issue

The CANHC members appreciate the public communication that was done on this issue by both the CNSC and the utilities. We appreciate the opportunity to receive intervention funding to allow us to further investigate and thus knowledgably communicate on this issue to our constituencies.

As an example, Bruce Power provided a detailed explanation on its website of the role of pressure tubes and included on the same page, its presentations to the CNSC on this issue. The pressure tube explainer page on the CNSC website was also helpful.

A further step more generally on these types of issues, would be communication more specifically outlining the implications for communities and the province to help quantify aspects such as risk to safety, community economic impact and energy security. In other words, what it means to us as communities and citizens.

…/5

Conclusion and recommendations

CANHC appreciates the opportunity for intervenor funding, which has helped us provide a community-specific lens to the technical issue that is before the CNSC.

We believe the management and research conducted to validate and extend full power hours and on the implications for pressure tube fitness for service has well-served communities, and Ontarians, more broadly, to date. This work has allowed all Ontarians to benefit from sequencing of refurbishment projects in a manner that has contributed greatly to clean and plentiful low-carbon electricity in Ontario. In many respects, our electricity sector is the envy of the world, in large part thanks to the work of our nuclear assets and the people who run them.

We also recognize the safety related issues, and their management are well understood and that this is primarily an operational issue.

However, it is not clear to us, if, in the highly unlikely event of one pressure tube failure, what the regulatory response would be and whether it could possibly trigger a shutdown for all units with pressure tubes approaching end of full power hours. If this were to happen, we wonder about the consequence for energy security and potential reputational impact.

Therefore, we would ask the CNSC to consider sharing with the communities proactively, what their approach would be in this scenario so the utilities, regulator and the communities could proactively consider it and prepare for it.

Given the potential reputational consequence, we also ask the utilities to maintain their conservatism in monitoring and management of the pressure tubes as they move closer to the end of full power hours, especially where they have been extended (recognizing fully the work that has gone into validating the safety case to do so).

A further recommendation to the CNSC and the utilities is to continue to develop relevant, specific, and clear communications to help nuclear host communities to understand the implications for them when issues like this arise. This allows us to quantify risk and communicate the issue with our constituencies in a way that is understandable and meaningful to them. This is critical to maintaining the public trust and community support that will allow all of us to strengthen the important role of nuclear in our net zero energy systems.

…/6

Sincerely,

Mayor Adrian Foster, Municipality of Clarington
Chair, Canadian Association of Nuclear Host Communities

40 Temperance Street, Bowmanville, ON L1C 3A6
905-623-3379 ext. 2005
mayor@clarington.net

Attachment: Report by Dr. Glenn Harvel, Brilliant Energy Institute

cc: Dr. Glenn Harvel, Brilliant Energy Institute
Jacquie Hoornweg, Executive Director, Brilliant Energy Institute

Review of CMD Submissions regarding Heq concentrations in pressure tubes and the potential impact on local communities

NDL-COM-REP-001 R1

October 17th, 2022

Prepared By:

Dr. Glenn Harvel

Project Purpose

The purpose of this document is to provide support to CANHC as part of their preparation for an intervention. The issue to be address is related to the Hydrogen/Deuterium pickup (Heq) in pressure tubes and the recent discovery at Bruce Power of elevated levels near the rolled joint region.

The work is to review the material submitted by the utilities to (a) prepare a layperson guide regarding the issue and (b) identify the possible impact on communities that neighbour the power plants. The work will not provide a technical expertise review nor make critical expert judgements on the submissions.

Background

The CANDU type nuclear power plant uses Zirconium alloy pressure tubes to separate the fuel from the remainder of the reactor core. The pressure tubes are an integral part of the fuel channel. They are thick enough to serve as a pressure boundary yet thin enough not to significant impact the neutronics of the core.

The pressure tubes age due to neutron irradiation which causes them to elongate, sag, and increase in diameter. Neutron impact on a Zirconium atom causes a dislocation and creates a space in the pressure tube known as interstitial space. The dislocated atom pushes the other atoms which causes the elongation and the diametral expansion of the pressure tube. The phenomena is very slow, on the order of years, which is why the term creep is used. The phenomena requires high pressure (hoop stress), and high temperature to create the stresses that allow the atoms to move as well as a high neutron flux to cause the dislocations. The term Effective Full Power Hours (EFPH) is used to relate the time the pressure tube observes the equivalent of the neutron flux at full power. For this reason, a pressure tube at full power will age faster than a pressure tube at 50% power. Figure 1 shows an array of Zirconium atoms where an interstitial space has been created due to a dislocation of one of the Zirconium atoms.

In addition, the pressure tubes can pick up Deuterium from the coolant directly into the zirconium matrix. The Deuterium is liberated from the heavy water either due to chemistry or radiolysis effects. Essentially, a small percentage of the heavy water (D2O) is dissociated into Deuterium ions (D+) and a deuterium hydroxyl (OD-). This is the same phenomena that occurs in natural water where the concentration of the Hydrogen Ions (H+) is related to the pH of the water. Essentially Deuterium is behaving exactly like Hydrogen and is just a heavier isotope of Hydrogen (1 proton and 1 neutron instead of just 1 proton). For this reason, we refer to Hydrogen equivalence (Heq) in a pressure tube as both Hydrogen and Deuterium could be present and the behaviour is expected to be the same.

Deuterium, like Hydrogen, can diffuse through metals. It is very difficult to stop Hydrogen from migrating. Thus it is normal for Deuterium and Hydrogen to enter the Zirconium matrix of the pressure tube. Figure 1 also shows the Deuterium atoms separate from the heavy water and diffusing into the Zirconium matrix. Note that they can concentrate in the larger spaces such as the interstitial sites and build up an internal pressure.

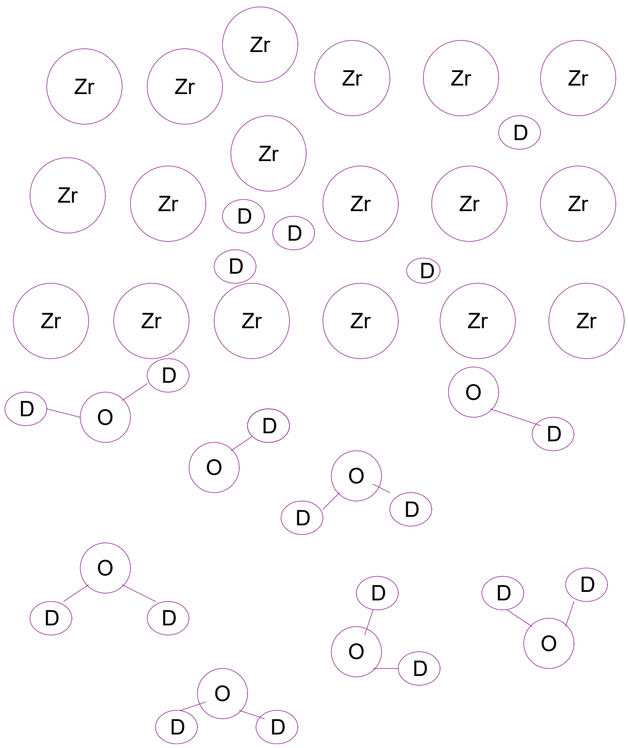

Figure 1: A Zirconium array with heavy water near the surface. Deuterium atoms diffuse into the array and enter the interstitial space

The Deuterium inside the pressure tube can lead to formation of ZrH_2 (Zirconium hydride) and possible the formation of hydride blisters. Under certain conditions, a small crack in the pressure tube, with blisters present, could grow along the length of the pressure tube and burst the pressure tube. Such a burst occurred previously at Pickering NGS and the Bruce NGS station which led to the discovery of hydride blisters and their role in crack propagation.

A burst is the end point of the phenomena. It represents a large crack failure along the length of the pressure tube. Before the burst, a small crack would exist and would allow the coolant to enter into the Annulus Gas System. The moisture added to the Annulus Gas System would be detected and alarm in the control room allowing for the safe shutdown of the plant. If the crack grew large enough to actually burst the pressure tube, there would be an additional reduction in the pressure in the primary heat transport system that will result in a trip of the reactor. Thus, while a burst sounds horrible, the reactor control systems are capable of safely shutting down the plant and the net result is the fuel channel needs replacement before the reactor could restart.

This issue was addressed by changing the material from Zircaloy-2 to Zr-2.5Nb. The presence of 2.5% Niobium in the Zirconium matrix significantly reduced Deuterium pickup in the pressure tube and thus reduced the likelihood of blister formation. Note that all CANDU reactors in the world currently use the Zr-2.5Nb pressure tubes. Several reactors have already successfully made it to the end of the operational life with the current pressure tube design (Point Lepreau, Gentilly-2, Wolsung-1, Embalse, Darlington 2 and 3, and Bruce 6). This design of pressure tube has not failed in service to date.

The reason why no pressure tube has failed is that the life of a pressure tube in a reactor is limited in the number of effective full power hours such that blister formation is unlikely to threaten the integrity of the pressure tube. Inspection of select pressure tubes is performed during an outage to monitor the ingress of deuterium into the pressure tube material to ensure that the pressure tubes are performing within the model expectations and hence 'fit' for service until the end of life.

Recently, a new location for measurements was taken for monitoring of the deuterium uptake. The new location was close to the rolled joint at both the inlet and outlet of the pressure tube. The rolled joint is the location where the pressure tube is sealed into the end fitting. Figure 2 shows the pressure tube and rolled joint locations.

The measurements resulted in higher numbers (>120 ppm) than at the previous measured location which introduced questions related to the accuracy of the existing models and the assurance related to the safety margin.

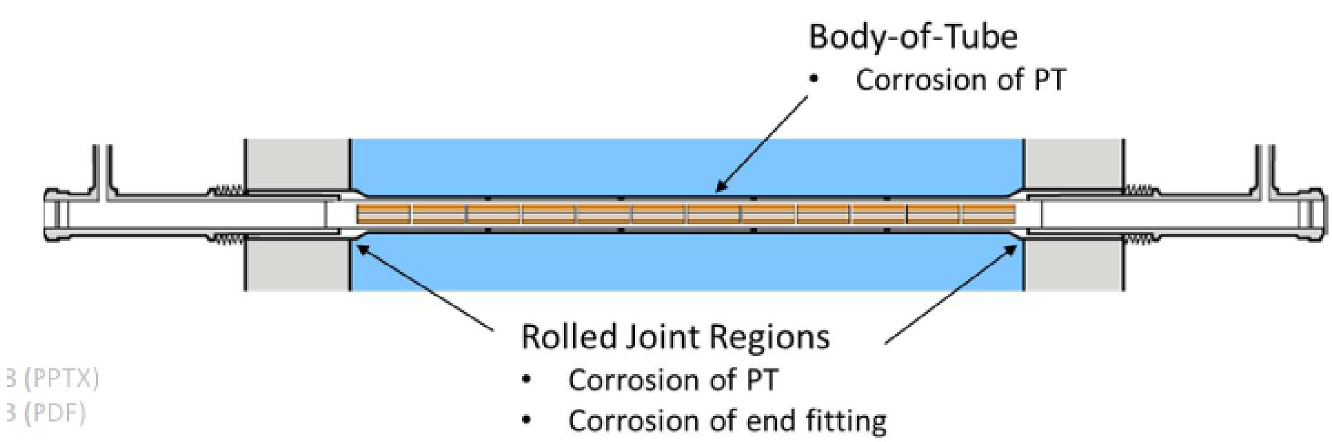

Figure 2: A CANDU type fuel channel showing the location of the pressure tube and the location of the rolled joints [4]

The Deuterium pickup is related to a diffusion process. Therefore, Deuterium will move away from the heavy water where there is a high concentration of Deuterium into the Zirconium matrix. The diffusion process is also enhanced by temperature gradients and thus the Hydrogen will diffuse towards colder locations on the pressure tube.

Figure 3 shows the deuterium concentration of a typical pressure tube from inlet to outlet. The inlet end is attached to the inlet end fitting which is the coldest region of the fuel channel. Typical inlet temperature is around 263 C. The inlet end thus sees a significant increase in the Deuterium concentration because of the colder temperatures. The pressure tube is rolled into the end fitting (rolled joint) which will remain at the cold temperature. The region near the rolled joint (dashed region) will see low concentration as it slightly warmer.

As heat is generated by the fuel increasing the temperature of the coolant, this warms the pressure tube. The deuterium concentration is lower as the deuterium will migrate along the pressure tube towards the colder ends. Figure 3 shows an increase in the deuterium in the pressure tube as we move towards the end of the reactor core.

The outlet end also sees higher concentrations for several reasons. One is an increase in the Deuterium concentration in the heavy water due to radiolysis, another is that the end fitting is cooler, and the third is that the pressure tube is warmer which allows for a faster diffusion process. Thus, it is not surprising that near the rolled joint region, shown in the black dashed circles of Figure 3, are locations of increased Deuterium pickup.

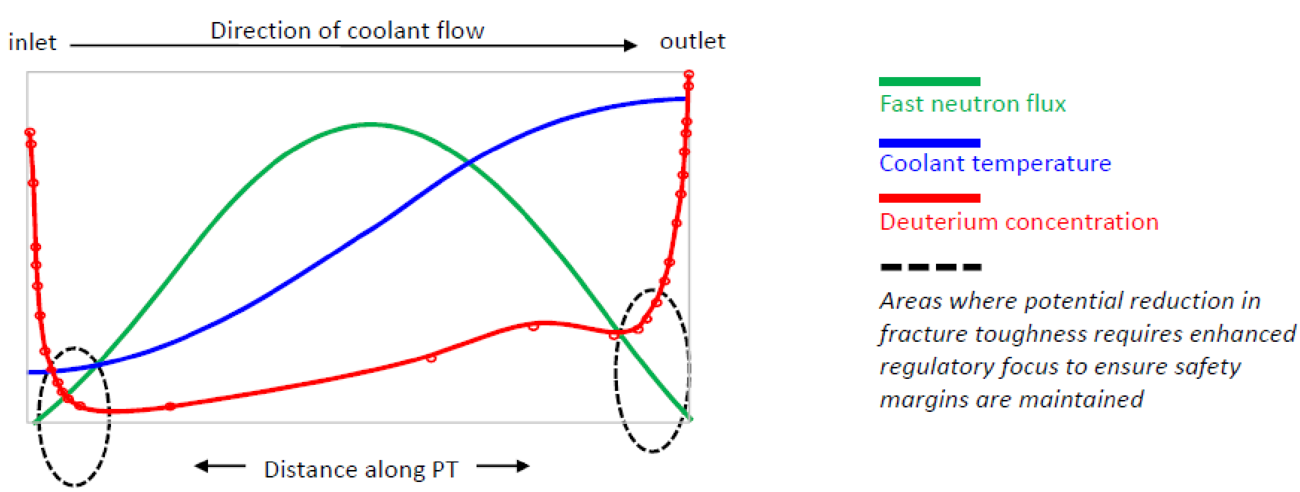

Figure 3: Expected Deuterium pickup in a pressure tube [4]

In summary, the Deuterium pickup in the rolled joint region is not necessarily surprising but is in an area which was not measured before. Thus, it was deemed prudent to investigate the phenomena and ensure that (a) the integrity of the pressure tube is not threatened, and (b) that the phenomena can be modelled and is consistent with the expectations on pressure tube ageing behaviour.

Review Findings

Each utility submitted a written response updating the pressure tube situation at their respective reactors. In general, the responses are very similar and support the positions of the other utilities.

NB Power

NB Power stated in their submission that their pressure tubes remain compliant with the licensing basis and that they have high levels of safety margin [2]. The main reason for this is that the pressure tubes were replaced in the refurbishment process and thus are all quite young. The current life of the NB Power pressure tubes is approximately 67,460 EFPH while the licensed design limit is 210,000 EFPH. As the current Heq issue is more a concern aft 210,000 EFPH operation, NB Power will not violate their license. The Heq issue will not have an impact for many years, long after the current model issues have been addressed and only if NB Power elects to extend the life of their tubes similar to what Bruce Power and OPG have done. Since the operating experience at NB Power has clearly shown they can operate the pressure tubes for the full life of 210,000E EFPH, then there is no impact expected on their local community from this issue.

Ontario Power Generation (OPG)

OPG stated in their submission the status of the pressure tubes at Pickering and Darlington, a summary of the observations taken at the stations, the status of the model development for prediction of Heq in the rolled joint region, and a request to close Action Item 2022-OPG-23135 [1]. It is clear in the OPG submission that they have collaborated with Bruce Power and shared their observations on pressure tubes as well as participated in further improving their models for prediction of Heq.

Some of the key points raised in the submission are as follows:

- Confirmation that elevated Deuterium has been observed in the rolled joints at OPG stations;
- OPG measurements are consistent with the observations on Bruce Power units supporting that the phenomena is real;
- Identification of a ‘blip’ phenomena at the inlet rolled joint which is considered to be when the phenomena is first observed;
- Confirmation that the existing model remains valid for Deuterium pickup in the regions other than the rolled joint;
- Crack growth modelling shows that the behaviour of crack growth would remain consistent with previous knowledge;
- Burst test results remain above model predictions suggesting that the model remains conservative.

OPG remains committed to further development of the model for prediction of Heq in pressure tubes. The completion of the model is targeted for 2026.

From a purely technical perspective, the OPG written submission indicates that the phenomena are understood and can be modelled. This suggests that the technical aspect of the Heq issue is well controlled and supports the decision to close the Action Item.

The written submission does not include any comments related to operational impact or community impact. For example, there is no discussion or comment on actions that might be taken should there be an outlier pressure tube that bursts before the reactors reach their refurbishment date.

Bruce Power (BP)

BP stated in their submission the status of the pressure tubes at Bruce A and Bruce B, a summary of the observations taken at the stations, the status of the model development for prediction of Heq in the rolled joint region, and a request to close Action Item 2022-07-23135 [3.] It is clear in their submission that Bruce Power has taken a lead role in addressing the issue and has also collaborated with OPG and others in the technical study of the issue.

Some of the key points raised in their submission are:

- The on-going surveillance continues to show consistent behaviour with respect to elevated [Heq] findings;
- Model development activities have demonstrated the capability to explain the elevated [Heq] observations;
- The validity of the existing crack initiation models and the current fracture toughness model for elevated [Heq] is confirmed; and
- Pressure tube fitness for service assessments have been completed to support the evaluation of elevated [Heq[impacts and confirmation of the [Heq] model validity.

The Bruce Power submission clearly shows an extensive amount of work has been done but it is also clearly a summary with many of the details not presented. Based upon review of some other documents [4,5], it appears that much of the technical detail has already been presented either at previous meetings or at workshops dedicated to the problem. Bruce Power has already submitted significant technical evidence [5] as part of their request last year to return Bruce A Unit 3 to service.

At the end of their submission, Bruce Power provides the same industry roadmap as OPG for the completion of a more advanced model. The new model is expected to address the blip; phenomena that Bruce Power and OPG have observed as well as the development of a comprehensive model for predicting [Heq] concentrations in a pressure tube. The modelling work has already begun with an expected completion date of mid-2026. Note that most of the units will have started refurbishment by the time that the model is complete and only two units at Bruce with still be operating with aged pressure tubes when the model is complete.

From a purely technical perspective, the Bruce Power written submission indicates that the phenomena are understood and can be modelled. This suggests that the technical aspect of the Heq issue is well controlled and supports the decision to close the Action Item.

The written submission does not include any comments related operational impact or community impact. For example, there is no discussion or comment on actions that might be taken should there be an outlier pressure tube that bursts before the reactors reach their refurbishment date.

Canadian Nuclear Safety Commission – Staff (CNSC)

The CNSC staff did not provide a written submission for this meeting. The External Advisory Committee on Pressure Tubes did not provide a written submission in advance for this meeting. Both will be providing updates. The CNSC has however provided a detailed review of the issue and presented their findings in a January 21, 2022 meeting [4]. This presentation provides a good perspective on the technical aspects of the issue and some of that information is used in the background to provide the layperson explanation of the issue.

The presentation is very clear that the CNSC staff are in alignment with the facts presented by NB Power, OPG, and Bruce Power and suggests that they are supportive of the work being performed and the model being developed. The CNSC staff are also very clear in their position that a pressure tube rupture is unlikely and that the issue is not a significant safety concern.

Assessment of Technical Findings

Note that this assessment is not an expert technical assessment of the phenomena involved. It is a summary of the findings and their relative implications.

First, the fact that the pressure tubes regardless of station are showing consistent results means that this is real phenomena and it is possible to predict that phenomena once it is fully understood.

The identification that the phenomena occur near both rolled joints is consistent with the expectations of Deuterium pick up in pressure tubes and the identification of the blip phenomena indicates an onset identification is possible to help identify when the phenomena starts.

The amount of data that has been collected is significant in volume and thus forms a good base of data for model development and validation [2,3,5].

The elements of the model that the industry is currently developing are appropriate and respect the physical phenomena involved (materials, diffusion, temperature gradients, etc.). The only question with the model is that it will take at least 3 years to fully complete. During that time, pressure tubes will age at approximately 8000 EFPH per year and might achieve an additional 32000 EFPH by the time the model is complete. It is expected that the stations are planning to replace the pressure tubes before they achieve the approved life of their pressure tubes.

The Fitness for Service evaluations are being kept current by the utilities and monitored by the CNSC staff [4] ensuring that the units are kept in good shape.

Table 1 indicates the planned target dates for replacement of the pressure tubes. Five units already have their pressure tubes replaced and thus have no immediate concern. The model being developed will be useful as they approach the end of the second pressure tube life. One unit is currently replacing pressure tubes and three more units will start pressure tube replacement within 1 year.

Table 1: Current planned years for PT removal or plant shutdown

Unit	Planned PT Removal
Point Lepreau	Replaced in 2012
Pickering 1	2024 Shutdown
Pickering 4	2024 Shutdown
Pickering 5	2024+ Shutdown
Pickering 6	2024+ Shutdown
Pickering 7	2024+ Shutdown
Pickering 8	2024+ Shutdown
Darlington 1	2022
Darlington 2	Replaced by 2020
Darlington 3	Replaced by 2022
Darlington 4	2023
Bruce 1	Replaced by 2012
Bruce 2	Replaced by 2012
Bruce 3	2023
Bruce 4	2025
Bruce 5	2026
Bruce 6	Underway
Bruce 7	2028
Bruce 8	2030

Potential Community Impacts

Based upon the review of material available for the upcoming hearing, the technical side of the [Heq] issue near the rolled joint is under control. Several measurements have been taken and they are showing a consistent behaviour regardless of the reactor unit/type the measurements are taken from. As such, it is reasonable to have confidence in the technical activities related to this issue.

While the likelihood of a pressure tube failure is very low, should a failure occur, it would very likely be an isolated incident and represent an outlier of the general pressure tube population. As the utilities and the CNSC staff have not discussed what action would be taken in such a scenario, there remains a potential but low probability that they could shut down more than the affected unit, which in turn could potentially impact the community. This is not a safety impact but rather a question of impact on energy security and potentially reputation for the nuclear fleet.

A failure of one tube has been demonstrated in the past to result in a temporary shutdown of the affected unit to effect repairs (PT replacement). In the current scenarios, the PT are close to the end of their life so such a failure may cause an early refurbishment of the unit. Such an event would have financial and workflow impacts for the utility, which in turn, could potentially have a small, short term economic ripple effect impact the local community.

The previous statement assumes that the utilities and the CNSC would follow previous practice in such an event. Alternatively, the CNSC may request that all common units be shutdown because of the event which would have a much larger financial and workflow impact on the station. This in turn could cause a larger impact on the community, depending how closely the communities' economy is tied to the station's operations and the severity of the impact on station employees.

The question then is related to the regulatory risk that remains unclear should such an event occur, and it may be worthwhile to ask the utilities and the CNSC to explain what actions they would take in the unlikely event that a pressure tube was to fail.

A second question is with respect to the fact the model will not be complete until 2026. What is the risk to continued plant operation and hence the community should the model development deviate from the expected results over the next 4 years? Some units will still not have been refurbished by that time.

Note: this impact may have been discussed in previous CNSC meetings but is not reflected in the latest discussion.

To reiterate, the technical concerns are well covered, such that the community should not be concerned about a safety impact. An operational impact is unlikely, but should it occur, if the regulatory action was to shutdown additional units as a precaution, this could have implications for electricity supply or a potential impact on nuclear reputation, which in turn could create a risk to host community economies. Those concerns appear to not have been discussed.

In the case of Pickering NGS, with the recent announcement of a possible extension of operation, at the time of the extended license renewal hearing, the full power hours and the condition of pressure tubes would be part of the discussion. It would be worth hearing how a failure of a pressure tube would be treated (i.e., would other units be shutdown). Again, the impact to the community would not be safety, but what, if any, ripple effect there might be on the community's economy from the shutdown.

References

1. OPG written submission, 'CNSC staff update on elevated hydrogen equivalent concentration discovery events in the pressure tubes of reactors in extended operation', CMD 22-M37.1, 2022-08-25.
2. NB Power written submission, 'CNSC staff update on elevated hydrogen equivalent concentration discovery events in the pressure tubes of reactors in extended operation', CMD 22-M37.2, 2022-08-25.
3. Bruce Power written submission, 'CNSC staff update on elevated hydrogen equivalent concentration discovery events in the pressure tubes of reactors in extended operation', CMD 22-M37.3, 2022-08-25.
4. CNSC Staff Presentation, Status update: Condition of pressure tubes in operating CANDU Reactors in Canada', CMD 21-M4, January 21, 2021.
5. Bruce Power written submission, 'Request for authorization to return Bruce Nuclear Generating Station (NGS) A Unit 3 to service, following its current planned outage', CMD 21-H110.1, 2021-09-17