<u>External Advisory Committee on Pressure Tubes: Final Report</u>

July 4, 2023

1.Introduction

Established by the Commission on July 30, 2021, the External Advisory Committee (EAC) on Pressure Tubes was created to provide Commission members with objective and impartial expert advice in technical matters related to pressure tubes, notably the hydrogen equivalent concentration [H_{eq}] in different locations of the zirconium alloy tube. The EAC's mandate and function are defined in the EAC Terms of Reference shown on the CNSC Website at *http://cnsc.gc.ca/eng/the-commission/external-advisory-committee-pressure-tubes-terms-of-reference.cfm#EAC%20Membership*.

The EAC consists of three members:

- John Luxat, McMaster University - Chair of the EAC*
- Mark Daymond, Queen's University
- Paul Spekkens, retired from Ontario Power Generation

* For health reasons, Dr. Luxat withdrew from the EAC on 22nd Jan 2023. The EAC completed its mandate with the two remaining members.

The full resumés of the members can be found at the CNSC Website at *https://nuclearsafety.gc.ca/eng/the-commission/external-advisory-committee-pressure-tubes.cfm*.

At the November 3, 2022 Commission meeting to discuss the elevated [H_{eq}] in pressure tubes, the Commission directed the EAC to prepare a report summarizing its work to date. This report will satisfy the reporting requirement defined in section 8.a. of the Terms of Reference: "the EAC will provide an annual report to the Commission on progress achieved or work performed". The purpose of the report is to fulfill the EAC's mandate and provide the Commission with the EAC's up-to-date expert advice related to elevated [H_{eq}] in CANDU pressure tubes. The report will consider all information provided to the Commission to date – including at the September 3, 2021 meeting of the Commission – related to the assessment of the elevated [H_{eq}] matter, as well as the work conducted and proposed to address it.

2.Summary of EAC Work to Date

This section and Attachment A summarize, for the public record, the work that the EAC has performed in providing advice to the Commission. The EAC carried out the following activities for the Commission meetings we attended:

- Review submissions (if any) from licensees, CNSC staff, and intervenors.

- Provide written questions and comments to the Commission based on the submissions reviewed and on un-resolved points from previous meetings.
- Offer comments and questions during hearings at the request of the Commission.
- Provide clarification and advice to the Commission as requested during meetings.

Attachment A "**Hearing-by-Hearing Summary of EAC Activities"** tabulates the Commission meetings and hearings attended by one or more members of the EAC. The meetings are listed in chronological order. In each case, the written documentation provided to the Commission is shown in the table.

In some cases, responses provided by the licensees are also shown in the same column as the "EAC Activities" to provide a more complete picture of the issues raised.

In one case, for the January 25, 2023 meeting, the EAC was asked to evaluate the responses provided by the licensees and the CNSC staff to a set of questions previously posed by the EAC. The assessments are shown in the Table in Attachment A.

In the most recent activity in April 2023, the EAC was asked to provide comments on the ten CMDs submitted for a meeting on April 25, 2023. The report prepared by the CNSC is embedded in the Table.

3. EAC Assessment of Industry Response

During the period of September 2021 to April 2023, the EAC had the opportunity to read and review approximately three dozen CMDs from licensees and from the CNSC staff, and to listen to many hours of presentations, as well as participate in question-and-answer sessions. In the CMDs and presentations in the last 12 months, the EAC agreed with virtually all the conclusions presented by the licensees and by the CNSC staff. Overall, this represents a good outcome from the point of view of the industry and of the public. The final 12 months of the campaign is singled out in the above statement because more and more certain information became available, which allowed questions to be answered factually and definitively. While there remains a great deal of work to be done to fully understand the phenomena that produce blips and other regions of high Heq, enough can be said definitively to provide assurance that the plants can operate safely while the additional work is completed.

There are, however, some lessons that can be learned. These would have allowed the issue to be managed in a more orderly fashion. The EAC would like to point out the following observations and suggestions.

1) In the first few meetings and hearings in the Fall of 2021, it was difficult to distinguish fact from hypothesis from opinion. There was relatively little definitive information

available at that time. This is generally the case, and is indeed to be expected, when a new and surprising observation has been made in the field. It was not helpful when the new information was characterized as "this is not surprising, because…". If it was not surprising, why was the industry participating in a meeting on the Friday afternoon before a long weekend (September 3, 2021) to discuss "not surprising" information. If it was known that the Heq at the 12 o'clock position would be higher than lower locations in the tube, why was there no scrape sampling at the 12 o'clock position. It was perhaps perceived as more reassuring to characterize new information as "not surprising". However, the fact is that nowhere had it been suggested ahead of time that anomalously high Heq values might exist at the top of pressure tubes near the inlet and outlet rolled joints. This was a double surprise, once at the outlet, and once at the inlet.

2) There is an obligation to characterize information in terms that make it clear to the audience what the basis is for the statements made or the conclusions drawn. For example, in one of early presentations to the Commission, there was a colourful image of a "heat map" which showed diffusion of Heq from the rolled joint to the top of the pressure tube beyond the burnish mark. This was presented as being the mechanism by which the observed elevated levels of Heq were formed. But as later investigations and reports would show, this was closer to a hypothesis or an opinion than to a fact.
3) In the opinion of the EAC, fitness for service of CANDU pressure tubes was preserved throughout this event. However, the communication of how it was preserved was not always clear. The determination of fitness for service of CANDU pressure tubes has historically been based on a multi-layer defence-in-depth approach. The main layers are the following:
    a. Layer 1: there is no active cracking mechanism currently observed in any CANDU pressure tubes. Historically, cracking has only been observed due to incorrectly fabricated rolled joints and due to severe contact between pressure tubes and calandria tubes due to complete absence of garter springs in their design positions. Neither of these conditions exists in modern fuel channels.
    b. Layer 2: if we are wrong about layer 1 and a cracking condition exists somewhere in a fuel channel, the CSA standard N285.8 requires that a successful Leak-Before-Break assessment and a Fracture Protection assessment showing the required safety factor be demonstrated as part of the Fitness for Service assessment. This ensures that should a crack develop in a pressure tube, the tube will not rupture.
    c. Layer 3: if we are wrong about Layer 2 and a crack is formed that progresses to the critical crack length before the reactor can be shut down and depressurized, the pressure tube would rupture. However, safety systems in the CANDU reactor design would maintain adequate fuel cooling and containment integrity to prevent any significant impacts on the population closest to the plant. In other words, managing a single fuel channel rupture with no impacts on the public is part of the design basis of the CANDU reactor.

In the case of the tubes with high Heq in the region of interest, Level 1 can arguably be maintained as the conditions under which cracks are most likely to develop (i.e., from sharp flaws in the pressure tube ID which serve as stress risers and initiate cracking) are absent or of low probability in the region of interest (depending on the specific reactor design).

The 2nd layer is more problematic. By definition, a Leak-Before-Break assessment or a Fracture Protection assessment starts with the assumption that there *is* a crack in the most unfavourable location in the PT. For tubes with anomalously high Heq in the region of interest, the flaws would be assumed to be in the region of interest. Work is still ongoing by the Licensees to demonstrate that the Fracture Protection Assessment remains valid at the anomalously high Heq. However, it has already been established that there are no flaws in the region of interest, which means that an assessment which starts with an assumed crack is considered not relevant for the observed regions of interest.

The 3rd layer of defence still exists. Historically, licensees were required to demonstrate Fitness for Service per the requirements of CSA N285.8, i.e., Layers 1 and 2. The CNSC was insistent that the 3rd layer is their defence-in-depth, which the licensees were not allowed to invoke.

In the current high Heq issue, it has been somewhat surprising to the EAC that the licensees, the CNSC staff, and even some of the intervenors seemed to readily cite Layer 3 as the ultimate safety factor that protects the public and makes the reactors fit to operate. How do we reconcile the assumption of all this with the requirements in the 2nd layer that are apparently un-met, suggesting that the Power Reactor Operating Licence requirements are similarly un-met? CSA provides a solution, in that Clause D.13.2.3.1.3 of CSA285.8 allows alternative arguments for reactor operability to be submitted to the regulator for acceptance in non-standard situations. This is the basis for the declaration that the reactors meet the requirements of CSA N285.8 and are therefore fit for service.

It would however be useful if the licensees had clearly and concisely stated the “alternative” case that they were making to meet the CSA standard requirements, and the CNSC staff expressing their acceptance of the case and the basis for doing so.

4. Part of the rationale by which the CNSC staff assessed the acceptability of operating the reactors was a Risk Informed Decision Making (RIDM) process. The EAC concurs with the resulting recommendation that the CNSC staff made on operability of the units. However, the description of how the RIDM was conducted was relatively vague. There was no explanation of the specific time interval of operability, i.e., the basis for the numerical value of 2-3 years is unclear. The EAC asked this question in the package of questions which it prepared for the November 2022 meeting, question p.12 for CMD-M37. The reply was still vague (see ratings of answers to EAC questions in the January 2023 section of the Table in Attachment A).

5. In several CMDs by licensees, CNSC staff and some intervenors, risks are characterized vaguely, for instance using words like “low”, “insignificant”, “tolerable”, etc. However, “low” could mean 10^{-2} or it could mean 10^{-8} or any other number depending on circumstance and viewpoint. Just describing a risk as “low” (or any similar word) is essentially meaningless. Vagueness in the explanation of how assessments were conducted and in the description of the results can cause significant confusion and misunderstanding if readers assign values that are vastly different from what the authors actually meant.

6. When the EAC reviewed CMD 23-H103.1, we encountered the following text on page 1 para 5 of the letter: *“Bruce Power has provided….a finite element analysis of hydrogen diffusion in the rolled joint region of the pressure tube (Reference 4)…*”: and in **the attachment entitled Application to Amend PROL 18.01/2028:** “*… Bruce Power shall follow the requirements of N285.4 and N285.8 to demonstrate fitness for service in the inlet region of interest. This is based on the Finite Element Diffusion Analysis of High Hydrogen Level in Rolled Joint Region with Postulated Flaw (Reference A4) results which demonstrate that the high [H]eq does not impact on the inner diameter of the tube where a flaw may occur…”.* We concluded from this text (and particularly from the second one) that the document cited in Ref 4 (and Ref 4A which is identical to it) was critical to the demonstration of Fitness for Service of pressure tubes with high Heq in the Regions of Interest. In fact, we felt that if this new methodology of Finite Element Diffusion Analysis was to be cited as the principal basis of the Fitness for Service conclusion, it should be subjected to an expert 3rd party review to provide additional confidence that the methodology was sound.

However, when we received a copy of the Executive Summary of Ref 4/4A, we found the following statement: "… (the) *focus of the evaluation was on the high levels of Heq at the blip and the potential impact on the hydrided region at the tip of a postulated axial blunt flaw. It was not intended to establish a comprehensive industry methodology for simulating the distribution of Heq in the entire rolled joint region. R&D work to predict the levels of Heq in the entire rolled joint region is ongoing. The simulation results of the through-wall distribution of Heq at the blip are not intended to be used in an evaluation of other surveillance pressure tubes or in a fitness-for-service evaluation.*"

The yellow highlighted areas (our highlighting) explain that

- this document presents only preliminary results on the hydrogen distribution.
- it is not intended to establish a new comprehensive industry methodology for simulating the distribution of Heq in the rolled joint region.
- the simulation results are not to be used in a fitness-for-service evaluation.

What we had assumed would be a definitive new methodology for predicting the distribution of Heq in the rolled joint region in fact turned out to be a preliminary piece of work which was not appropriate to demonstrate Fitness for Service.

It is important to be clear on the "pedigree" of reference documents, so that a reader will not form an incorrect impression of the degree of confidence in the document and of the uses of the document. In **Section 5.** 2. b. below, we make a recommendation on how to avoid such a misconception in future.

7. The EAC generally agrees with the elements of the R&D program that are described in various places. We would prefer to see a single compendium of all the actions that will be carried out to better understand elevated Heq regions (see **Section 5.** 1.) However, as described in the EAC input to the November 2022 Commission meeting, the 4-year completion date for the R&D actions means that the majority of the Canadian CANDU fleet will be retired or refurbished by then. We understand that modelling and verification/validation of models can take a long time. However, as noted in the same meeting, some activities, for example a feasibility study for a conventional loop experiment, should not take 8 months.

4.EAC Assessment of Interventions

This section presents the EAC's assessment of interventions provided at the November 2022 and April 2023 Commission proceedings. Five and seven interventions, respectively, were received.

Most interventions were essentially non-technical. Rather, they presented statements of confidence (or lack of confidence) in the nuclear operators and/or the CNSC staff. Some raised issues of economic or reputational impacts on operators and host communities should there be a significant unexpected event involving a pressure tube failure. Some reported that communications from the licensee or the CNC staff were perceived as inadequate. While these non-technical concerns are outside the purview of the EAC, attention should be paid to specific issues being reported, as they may be the result of a genuine misunderstanding.

Four of the interventions were technical. Two issues raised in the technical interventions should be evaluated further. The first was the observation that data in the CMDs from Bruce Power were not consistent with the assertion that the high Heq regions were entirely due to redistribution of the existing Heq, and not to an increasing rate of Heq uptake, as was reported by Bruce Power during the September 10, 2021 hearing. The second was the observation that the ratio of Protium to Deuterium was relatively invariant with aging, which is not consistent with the conventional assumption that the only source of Protium is that which is contained in the pressure tube following its manufacture. The intervenor's interpretation of the data suggested that there was an additional source of Protium entering the pressure tubes, which could significantly influence the projected Heq level at the end of life of the pressure tube. The analyses of these two points presented in the intervenor CMDs should be reviewed in detail to determine whether their conclusions are correct.

These two challenges are useful in that they present a perspective on the field data that may not have surfaced otherwise. However, the two CMDs were relatively lengthy (74 and 33 pages) and very detailed. Long, complex reports are carefully read by fewer of the reviewers than shorter reports. As such, the likelihood that challenges and alternate interpretations will be recognized as useful ideas is lower. To improve the accessibility of good ideas in long complex reports, the EAC recommends that:

- *it should be mandated that CMDs or any other submissions longer than 10 pages must have an Executive Summary which presents all the main ideas and conclusions from the document.*
- *for documents 10-30 pages in length (i.e., excluding the Title page, Table of contents, Acknowledgements, References and Attachments/Appendices), the Executive summary can be up to 1 page in length. For documents longer than 30 pages, it can be up to 2 pages in length.*

5. Additional Opinions and Recommendations

The EAC offers the following additional observations and recommendations:

1. The issue of the Heq levels in pressure tubes is complex, and many actions are being undertaken simultaneously by the licensees, consultants and the CNSC staff. It is difficult for all these actions to be tracked without a written document. The industry has had good experience with the establishment of a protocol document that sets out the commitments made by all the parties to the protocol, i.e., one or more licensees and the CNSC staff. These commitments include specific "what, by when, by who" statements of R&D, operational, inspection and safety assessment activities with enough specificity to avoid misunderstandings. Updating against the Protocol commitments provides a standard and unambiguous means of demonstrating compliance with the committed work program. This also provides a means of providing assurance to the non-technical stakeholders that the needed work is progressing as planned.
2. The main challenge for the EAC was to obtain all the important technical information that was not explicitly shown in the CMD documents. In several cases, issues being raised by the EAC had already been addressed in one of the references in a CMD or in interim reports that had been sent from the licensee to the CNSC staff but of which the EAC was unaware. The downside of this situation is that the EAC failed to provide the most useful input to the Commissioners because of an incomplete awareness of the work that has already been done. The following is recommended for future EAC activities:
    a. A process should be put in place whereby communications of interim technical activities which are germane to the scope of an EAC be forwarded to the EAC when they are received by the CNSC staff.
    b. An attachment should be mandated for CMD documents which would show the Executive Summary and Conclusions sections of each reference used in the CMD. This would help avoid a misunderstanding of the significance of a reference, as described in section 3 above.

3. Some of the first-of-a-kind work carried out during the investigation of the elevated Heq phenomenon will become industry-standard methods of modelling or of assessing Heq behaviour. An example is the Finite Element Diffusion Analysis discussed in section 3 above. Given the significant potential impact of unrecognized weaknesses in the new industry-standard methods, it is recommended that when they are ready to be confirmed as standard methods, they be subjected to an independent review by individual(s) with world-class expertise in the subject matter. The individual(s) must not have been involved in the development of the material nor have any vested interest in the outcome of the review. Reviewers should be experts recognized and accepted by licensees and regulators. This practice has been carried out several times in the industry in instances where newly developed industry-standard methods were proposed. Examples are the Fitness for Service Guidelines developed for critical CANDU components such as feeders and steam generator tubes.

6. Conclusions

As detailed in the preceding sections, the EAC reviewed multiple submissions by licensees, CNSC staff and intervenors during the period August 2021 to April 2023. The process followed and observations made by the EAC have been discussed and here we report the most pertinent conclusions.

1. In the opinion of the EAC, fitness for service of CANDU pressure tubes was preserved throughout the process. While there remains much work to be done to fully understand the phenomena that produce regions of high Heq, enough has been done by the licensees to definitively provide assurance that the plants can operate safely while the additional work is completed.

2. Some factors could have improved the process of discovery, especially but not exclusively in the first 6-9 months when the phenomena were first being investigated. Communication was sometimes vague or focussed on reassurance regarding the new information. Risks were characterized vaguely, for instance using words like “low”, “insignificant”, “tolerable”, etc. rather than numerically which could then be related to the CSA Standard. There is an obligation to characterize information in terms that make it clear to the audience what the basis for conclusions drawn or statements is. Vagueness and lack of clarity in the explanation of how assessments were conducted and in the description of the results can cause significant confusion and misunderstanding and should be avoided in the future.

3. In terms of the process by which the EAC operated, the EAC has some suggestions for improvements.

a. Information was not always available between meetings, with interim reports provided only after request. It would have been beneficial if the information could flow to CNSC staff, and then if identified as relevant to the EAC's mandate by CNSC staff, immediately flow to the EAC.

b. While full technical documents are not expected, where references are made to technical documents in the CMDs that are provided to the EAC, the executive summary and conclusions of said technical documents should also be provided to the EAC. This would help avoid a misunderstanding of the significance of a reference.

c. For future significant advisory committees, we recommend that the Commission consider if 4 rather than 3 members is an appropriate size, such that the loss of a member to illness is not felt so hard.

Attachment A –

Hearing by Hearing Summary of EAC Activities

Date	Commission meeting or Hearing	EAC Activity
Sep 3, 2021	Commission meeting to initially discuss the [H_{eq}] pressure tubes.	• 1st meeting attended: arguments noted some possible anomalies in CMDs: • How is compliance achieved with deterministic Leak-before-break and Fracture Protection if "no flaws" is credited. By definition, Leak before Break and Fracture Protection analyses are based on the presence of a flaw in the most unfavourable location. Unclear how the assessment was done here. • TOE: p.3 If it was known all along that top of pressure tube was hotter and accumulating D faster than 3,6 and 9 o'clock, why was this such a surprise? • COPT risk is "negligible"- very qualitative statement

Sep10, 2021	Licensee Opportunity to be Heard regarding Orders	Very large volume of written material was submitted for EAC review. EAC members offered comments on the submissions and answered questions.
		Concerns were expressed about:
		• clarity over material in CMDs or presentations at the Commission being
		  ○ verifiable facts,
		  ○ preliminary results, or
		  ○ opinions with no corroboration yet
		There were examples of material which was hypothetical but seemed to be interpreted as preliminary or factual. Examples: the heat maps of H/D/T concentrations which were later abandoned; the projection of [Heq]
		quoted to 3 significant figures when the actual variability of the model is much greater. Is it the contention of OPG that the modelled result of 119 ppm is significantly different from the limit of 120 ppm?
		• Question asked about the realism of the Darlington projection of 119 ppm for D1 at ends of life, when the highest valued found to date is 75 ppm [Heq] and the unit has only 5 months of operation until re-tubing.

Oct 05, 2021	Commission hearing in writing on Bruce Power Unit 3 (single restart)	*Significant volume of material was reviewed for the October 5 hearing. The 5 following comments were submitted for the Commission's consideration during the" hearing in writing". Bruce Power provided responses to the comments along with references with additional information. The EAC comments are shown in italics in black, Bruce Power's* ***responses are shown in red*** *and the* ***additional references in blue****:* 1. *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).* ***This is correct, with high confidence the number of a dispositionable flaws within the CNSC defined region is < 1.*** ***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"*** 2. *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*

Date	Commission meeting or Hearing	EAC Activity
		Option a. ***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.*** ***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. *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*. **This is correct and the R&D work is on schedule as per Bruce Power's prior formal correspondence. 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. *The R&D activities should include an 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*. **This is correct and work is underway to further develop the 2-dimensional finite element diffusion model required to provide these predictions.** 5. *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."* **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.**
Oct 12, 2021	Commission hearing in writing on OPG Pickering Unit 5 (future restarts)	EAC reviewed OPG documents re Pickering B units as well as a CMD from the CNSC Staff, and commented on the impact on the P5 restart request. The EAC comments are shown in italics in point form below: • *We find the arguments for re-start approval for P5 to be compelling.* • *The end-of-life levels of Rolled Joint Heq at Pickering are projected to be well below the 120 ppm projected for Darlington and measurements (scrape and removed tubes show consistently lower values). Temperatures at Pickering are significantly lower and an Arrhenius-controlled corrosion reaction rate or diffusion rate would be expected to be halved for a 10 degree C temperature difference.* • *Given the lower operating neutron flux, plus lower pressure and temperature in Pickering channels it is expected that lower PT circumferential creep would occur, resulting in lower flow*

Date	Commission meeting or Hearing	EAC Activity
		bypassing. In turn, there would be less circumferential redistribution of Heq in the outlet rolled joint region of Pickering channels. *The OPG answers to the CNSC staff questions are more realistic than some of the discussions at the earlier meetings. They acknowledge that debris frets can be formed even in unlikely locations. However, their number is few (based on all the inspections carried out by the Canadian licensees) and their depth and shape are not crack-like.* • *The assertion that the number of debris frets in Pickering B is small is a bit of a stretch. Typically, Pickering B has more fretting indications than any other OPG units for historical reasons (related to debris produced during initial fuelling of the reactors after hot conditioning). Some of these flaws have historically caused Pickering B units to be cycle-limited (a cycle is unit heat up or cool-down). The cycle limits were cleared before 2016.* • *Re-inspections have historically very seldom (if ever) shown debris frets to grow between inspections. This makes sense as the fuel is removed for inspections to be performed. It is highly unlikely that another piece of debris would be located at exactly the same location and propagate the fret (this not the case for bearing pad frets where coincident location of bearing pads from different bundles have been observed).* • *No crack has ever been found to have developed from a fretting flaw (anywhere in the Canadian fleet to our knowledge). This is why the first line of defence against pressure tube rupture is "there are no active cracking mechanisms". Leak-before-break and fracture protection are defence-in-depth barriers should a cracking mechanism unexpectedly develop.* Commentary on the CNSC staff CMD. *While we agree with the overall conclusion of recommending restart, the assessment "muddies the water" on flaws of concern.* • *while the order quotes any flaw deeper than 0.15 mm as being of concern, a flaw 0.17 mm is described as a "very small" flaw. It is excluded from the statistical analysis, even though its origin is unknown.* • *this suggests that the criterion of >0.15 mm is really "shorthand" for " flaws that are not very small", where the attributes of a "very small flaw" are not specified* • *Subjectivity in the criterion is not ideal.* The EAC also answered a question during the hearing on the important features of flaws and development of cracks with respect to Delayed Hydride Cracking behaviour.
Nov 5, 2021	Commission hearing in writing on	The Commission hearings on restart of Pickering 6, 7 and 8 and of Darlington 1 and 4 were both held on November 5,2021. The EAC provided a single set of comments (in italics) that addressed the Pickering and Darlington hearings:

Date	Commission meeting or Hearing	EAC Activity
	OPG Pickering Units 6,7,8 and Darlington Units 1 and 4 (future restarts)	*As discussed in the previous hearings in early October, the case for allowing Darlington to restart from a forced outage is compelling. However, the information presented in this submission is un-convincing in a few areas:* 1. *Enclosure 1 is a statistical assessment of the possible numbers of flaws in the ROI of Darlington Unit 1 and 4. The claim is the made that "*Enclosure 1 quantitatively demonstrates that no flaws which pose any challenge to pressure tube fitness for service are present in the ROI*". Claiming without any qualifiers that this analysis concludes that there is zero risk of challenging Fitness for Service seems like a stretch for a statistical analysis done at a 95% confidence level.* 2. *Repeat comment from last hearing: a base case which blends Darlington data (where the use of a fuel carrier greatly reduces the risk of flaws in the ROI) with Pickering B data will present a risk for Pickering B which is shifted in the non-conservative direction.* There is insufficient justification for blending Darlington flaw data with Pickering flaw data since the fuel and fuel channel designs for the two stations are significantly different. 3. *Enclosure 2 seems like a long (mathematical) way of saying that "*FC failure is within the design basis so we don't need to worry about it*". This argument has historically not been accepted by the CNSC as the principal basis for demonstrating operability. Rather, operability has been demonstrated by analysis and inspection, with "fuel channel failure as a design basis event" being used as the last line of defence. Relying heavily on the "design basis event" argument seems to weaken the principle of "defence in depth".* 4. *Enclosure 3 provides an estimated frequency of occurrence of two independent, concurrent pressure tube (PT) failures. As expected, the frequency is the square of the frequency for a single PT failure. What is not assessed anywhere is the more difficult question of whether a PT failure (which can be a violent event resulting in calandria tube failure and end fitting ejection) can cause a second neighbouring weakened PT to fail or any other design basis failure to occur. Consequential failures from a design-basis event are not allowed.* 5. *The results of full-scale fuel channel burst tests at Stern Laboratories in the 1990's are not addressed in the deterministic safety assessment. The test rig contained an array of neighbouring simulated fuel channels and the results demonstrated that the only observable damage was collapse of the calandria tubes onto their pressure tubes with resultant compressive loading on the inner pressure tubes. The magnitude of a fuel channel failure.at power will be limited by potential crack arrest due to the high fracture toughness at upper shelf conditions.* ***OPG CMD Doc # CMD 21-H112.1 - Pickering 6-7-8 Restart*** *This document is virtually identical to OPG Document CD# NK38-CORR-00531-22869 (reviewed above). The comments on the Darlington CMD apply to the Pickering 5-8 CMD also.*

Date	Commission meeting or Hearing	EAC Activity
		CNSC Staff CMD: 21-H112, 21-H114 *This CMD is quite short and agrees with OPG's contention that its Darlington and Pickering units meet Condition b of the Order.* *Specific Comments:* *1. This CNSC decision is based to a surprising extent on the ability of the plant to suffer a major FC failure and mitigate the impacts through other plant design features, in other words, "FC failure is a design basis event" (see Section 3.3 of the CMD) (also see Bullet 2 above)* *2. Insufficient supporting justification is presented for reducing the ROI to 60 mm inboard of the burnish mark from the previous value of 75 mm. While this may indeed be a reasonable change, the documentation does not provide any supporting justification.* *3. The logic by which a flaw observed in a channel was dispositioned as "not plausible as a future flaw" was not explained in the CMD. Rather it referenced an OPG document as the source for this conclusion. It is unusual to exclude even a cryptic explanation from the CMD.* The EAC also answered some questions during the hearings.
Nov 12, 2021	Commission hearing in writing on Bruce Power Units 4 ,5 ,7 & 8 (future restarts)	The EAC reviewed the Bruce Power and CNSC CMD's. The EAC's comments are shown in black, and the Bruce Power responses in red: **CMD_21H113_CNSC_staff_assessment_of_supplemental_information……** 1. Generally agree with the overall recommendations 2. Section 4, last paragraph:" *Pressure tubes are most at risk of crack initiation and failure during heatup or cooldown of the reactor; it is irrelevant whether the heatup or cooldown cycle occurs as a result of a planned or unplanned outage*." This comment is valid for heat-ups, as these are planned events which are carried out under predictable conditions. Similarly, cooldowns during planned outages are carried out under predictable conditions. However, cooldowns during forced outages can be very challenging for the operators because of the sudden nature of the failure causing the outage and the possibility of unusual conditions in the reactor due to the failure. The risk of crack initiation may be higher during challenging cooldown activities. Bruce Power Response: Bruce Power conducts a post-transient review for any shutdown (planned or unplanned). As part of this review, the cooldown curve is reviewed for potential impacts on pressure tube fitness for service. In the event that the cooldown deviates from normal, an assessment is conducted to ensure that the pressure tubes remain fit for service. **E-DOCS-#6668418-v1-CMD_21-H113_1-Submission_from_Bruce_Power_Units_4-5-7-8**

Date	Commission meeting or Hearing	EAC Activity
		3. I think that there is general agreement that it is unwise to carry out extensive, un-planned inspections during forced outages. It should not be necessary to continue to provide lengthy explanations of how carefully work is planned for a forced outage. Bruce Power Response: Agreed. 4. In previous submission CMD 21-H11.2A (File / dossier: 6.01.07; Date: 2021-09-02; Edocs: 6633418) Bruce Power appears to be arguing that they meet the requirements of both Option A and Option B. In this submission, Bruce Power is providing information only in support of Option B. Does Bruce Power believe that it also meets the conditions for Option A.? If so, this represents a difference of opinion from that of the CNSC. Is there an intention to resolve this difference of opinion if it still exists? Bruce Power Response: At this time Bruce Power confirms that it has fully met the requirements of Option B only. 5. **Attachment A**, page 1, para1 states: *“All inspections completed on Unit 4 have demonstrated there were no elevated levels of hydrogen above licensing requirements in the inspected area of the tubes”.* This comment is repeated several times in the Attachment. However, it is not possible to judge the relevance of this statement to the issue at hand, i.e. the observation of anomalously high Heq in the ROI, without knowing whether any of these inspections included any parts of the region of Interest. Did any do so? Bruce Power Response: All inspections completed to date in Units 4, 5, 7 and 8 have not indicated any elevated hydrogen concentrations. Traditionally, Bruce Power has performed scrape measurements in the Rolled Joint (RJ) region (inlet or outlet) at 4 axial locations: two in compressive zone and two in the tensile region. The first location from tensile region is in the region of interest (ROI) at either 54 mm (BM+54 mm) or 62 mm (BM+62 mm) from the Burnish Mark (BM). In the compressive zone the scrapes have been performed 25 mm before the BM (BM-25 mm), and the results from this location will be the first to indicate an elevated [Heq]. It should be noted that the elevated [Heq] was first detected in Unit 3 during the A2131 outage with these standard scrape locations. Bruce Power will be pursuing inspections in the ROI in the next planned outage for each unit. 6. In Attachment A regarding unitized inspection findings, the number of flaws in the inboard 100 mm of the outlet BM (OBM) are reported for each of units 4, 5, 7 and 8. ➢ What about data from Units 3 and 6? ➢ Why is the axial length 100 mm when Enclosure 1 uses 75 mm for the axial inboard length to define the region of interest? Bruce Power Response: The data for Unit 3 and Unit 6 were provided in the Enclosures of CMD 21-H113.1. The results for Units 3 and 6 are consistent with the results for Units 4, 5, 7 and 8. The data for Unit 3 was also previously provided in support of the Unit 3 return to service in

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		Enclosure 1 of CMD 21-H110.1B. Unit 6 is currently undergoing its Major Component Replacement (MCR) outage where all pressure tubes will be removed and replaced and for this reason was not subject to the order. 100 mm from the outlet burnish mark was originally used as a convenient and conservative range for examining flaw incidence in the vicinity of the region of interest. The 75 mm axial range for the region of interest was defined by CNSC after this information was generated. Note that the selection of 75 mm or 100 mm does not impact the numbers reported in the tables (i.e., there are no reportable flaws between 75 mm and 100 mm). We realize that we are missing some detail in the methodology, but we are unable to find the description in prior updates of supplemental information from BP. As noted at the November 5 hearing, it would be much easier for the readers and particularly the decision-makers to understand the arguments if the text of the CMD presents the information necessary to understand the argument without needing to dig through previous submissions on the subject. 7. **Enclosure 1**: In section 4.0, para 2, the statement is made: "*It was judged that the product of these two probabilities would be virtually unaffected by increasing the axial extent of the database*." A judgement decision would be more acceptable if there were some sensitivity cases run to confirm that the two terms do indeed cancel each other out. Bruce Power Response: Sensitivities relating to this assumption about the axial extent considered were not deemed necessary given confidence that the assumption was reasonable. The dataset considering an axial extent up to the end of the first bundle has a large number of flaws, and that region is closest to the region of interest and as such is considered to be most relevant. 8. Section 5.1 on page 20 of 37 begins with the statement: "*This probability is assumed to follow a Poisson distribution* ". Is there any physical evidence to confirm that this assumption is valid? What would be the consequence if it wasn't? Validating assumptions is an important part of any engineering assessment. Bruce Power Response: For sets of randomly occurring, discrete observations the Poisson distribution is most commonly used, and was deemed to be appropriate for this application. The mean incidence rate (λ) was based on actual detection of flaws obtained in-reactor. While other distributions could be considered for this exercise, they would not be any more valid than the Poisson distribution. 9. In Section 5.2 and 5.4, results are given to 5 significant figures. For example in Section5.2 "*…that a flaw is present is estimated to be 0.011606* ". What is the basis for the surprisingly large number of significant figures reported in these sections of the report? Bruce Power Response: It is a calculated value, which is only considered meaningful up to 3 significant figures (as reported in the tables).

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		10. **Enclosure 2**: In the last sentence of the Results Section (on p.35 of 37), the following statement is made:" *the estimated number of flaws in the uninspected population was …~1.9-2.0. The updated, more refined analysis … indicate a more realistic value of 0.6 dispositionable flaws …*". What is the basis for stating that 0.6 is more realistic than 2. It is more favourable (which is why the conservatism was removed), but how was it concluded that the lower figure is more realistic? Bruce Power Response: It is more realistic because the flaws of concern for pressure tube integrity are dispositionable flaws. The observation of a proportion of all flaws being dispositionable (i.e., roughly 1/3 based observations outside the region of interest) is not apparent in the region of interest, where there have been zero dispositionable flaws in the inspected tubes. This is consistent with the understanding that debris flaws tend to be both more numerous and more severe around fuel bundle bearing pads where debris can get trapped against the pressure tube surface. Since fuel bundle bearing pads have not resided in the region of interest to trap debris and form flaws in this manner, the observation of less severe fretting flaws in that region is consistent with expectations. 11. In addition, the argument is that there were 6 real flaws, and it was assumed that 1/3 would be dispositionable, i.e. there would be 2 dispositionables. In fact, there were 0 dispositionable flaws. Saying that this shows the assumption is conservative seems a bit weak. If we calculate how often in a population you would get you get 0 dispositionable items if you had a 1/3 dispositionable population …. we think it is just (2/3)^6 which means that 9% of the time, that is the result you would expect. It seems inappropriate to discard the 1.9 expected flaws when it is expected that 9% of the time that is indeed the number you expect. Bruce Power Response: The expected number of flaws was presented using different approaches in Tables 2, 3 & 4 of Enclosure #2; none of the approaches were discarded. However, per the response to comment #10 above, it is believed that the approach based on dispositionable flaws is more representative and better aligned with the physical understanding of the formation of debris fretting flaws. In addition, the EAC provided a clarification during the meeting of the difference between degradation for which you have a reliable model (like the formation of new flaws in the region of interest) and that for which you don't have a reliable model (like the location of elevated level of Heq).
Feb 22, 2022	Commission hearing in writing on Bruce Power Unit 3 (future restarts)	The EAC provided the following comments and questions (in italics) on Bruce Power CMD 22-H100.1 and CNSC Staff CMD 22-H100. (Responses from Bruce Power were provided in CMD 22-H100.1A and from CNSC Staff in CMD 22-H100.1A) *The EAC unanimously agrees with the CNSC Staff recommendation that the Commission close the Order for Bruce Power Unit 3 and return the authority to approve restart Unit 3 from planned and unplanned outages to CNSC staff.* · *The EAC found the Bruce Power case compelling.*

Date	Commission meeting or Hearing	EAC Activity
		· The technical arguments presented in Enclosure 1 from Kinectrics are sound. The results from the two approaches used to assess the margin to crack initiation from scrape marks demonstrate consistent high margins. *The EAC has the following specific comments/questions* *1. Attachment A, Table A1.* *Based on the failure frequency it appears that the Applied KEFF for ST-EH-2 and ST-EH-3 may have been switched - should they be 7.5 and 7.0, not 7.0 and 7.5?* *2. There continues to be a discrepancy between the definition of the Region of Interest (ROI) in the CMD and in the Bruce Power submission. The former includes the full 360 degrees of the pressure tube near the burnish mark (CMD p.3), whereas the Bruce Power submission defines it as "…The axial and radial extents of the high levels of Heq inboard of the outlet rolled joint burnish mark have been found to be confined to a localized region with a central tendency about the top of the pressure tube. This localized region inboard of the outlet rolled joint burnish mark with a central tendency about the top of the pressure tube that has high levels of Heq is referred to as the region of interest" (Enclosure 1, p.64). This needs to be resolved now, not at a later point in the future as the CMD suggests (p.5, bullet 4). The difference in this case is significant. Bruce Power argues (correctly, in our view) that the high levels of H are limited to a region on the top side of the pressure tube, an area where the design of the plant prevents the formation of significant flaws. The CNSC definition includes the lower half of the pressure tube. It is not reasonable to argue that flaws are impossible in areas where trapping of debris under a fuel bearing pad can (and has) produced significant flaw in many CANDU units. The difficulty is that the CNSC recommends approval of the Bruce Power submission while the arguments are likely not valid for the CNSC-defined ROI.* *3. The summary of the CMD is not fully consistent with the text of the CMD. The CMD states following in the summary:* *" …Commission authorize Unit 3 restart following any outage and close the Order for all Bruce Power units".* *However, the text of the CMD does not recommend closing the order for "all Bruce Power units", nor does the Bruce Power submission request this. This is not a big point, but it is an inconsistency that can surprise the reader and detract from the real message that is only focused on Unit 3* *4. There continue to be acronyms used in the material that an audience that doesn't work in these assessments regularly would have difficulty understanding. But we want to start with kudos to Doug Scarth and his co-authors of Enclosure 1: their glossary was exemplary and made their complex paper easier to read. This issue has been discussed before: many authors forget to define some of their acronyms or use different acronyms for a single meaning, e.g. KIH and K_{1h}. A suggestion is the development of a Global Glossary of Acronyms that includes all the acronyms being used by licensees, intervenors and CNSC staff. This will grow to be a long list, many pages long. But in the virtual world, attaching the Global Glossary to each Notice of Meeting is trivially easy. And if there is an easy way to add, deduct or revise*

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		acronyms (through a process that CNSC would control), this would be a very useful "live" tool to make the job of the Commissioners and the readers easier.
Mar 24, 2022	Commission meeting to discuss inlet end elevated Heq	One member of the EAC attended this meeting. The following preliminary questions and comments were submitted shortly after the meeting. *1. The elevated Heq at the inlet end was 10mm inboard of the burnish mark on the OD surface of the PT and was the location of the through-wall punch sample at the 12 o'clock position?* *2. Was the pressure tube installed with the front end of the tube at the inlet?* *3. Is the creep/sag deformation profile in PT B6S13 as measured during in-service inspection outages(i.e. prior to removal) available? If so, may we obtain a copy?* Comment: *A note regarding the difference in the hydraulic behaviour between inlet and outlet ends of the channel. The inlet coolant temperature is pretty uniform and issues from the shield plug as 3 turbulent jets, whereas at the outlet end the PT creep bypass flow causes colder coolant temperatures at the top and hotter coolant at the bottom of the fuel bundles, with major turbulent mixing occurring at the outboard region of the rolled joint and in the shield plug. Therefore, it is not surprising that the outlet Heq behaviour may well be significantly different than the inlet Heq behaviour.* The following additional questions were submitted following a review of the final transcript of the meeting. *1. What is the frequency of high [Heq]patches at the inlet in a Bruce core, ie. how many tubes of the 480 in the core display more than 100 ppm at the inlet end.* *2. How is the [Heq] distributed across the channels, for example inner zone vs outer zone. (Note: Bruce units have two distinct zones in the reactor, the inner zone which corresponds to higher power channels and where the inlet flow is pre-cooled before it enters the core so that the outlet temperatures are more uniform across the core.)* *3. On p.4 of the transcript, a limit in Heq is quoted for the inlet pressure tubes. What is the technical basis for this limit?* *4. Are all the tubes installed in this unit with the front end at the inlet (FEI) or at the outlet(FEO). What is the PT configuration in the re-tubed units (B1,2,6?)* *5. You have calculated a small impact on* CDF...what number of high [Heq] inlets have you assumed? What is the highest [Heq] you have assumed. 6. How many instances exist (statistically or by inspection) where a high [Heq] inlet pressure tube has a neighbouring tube with high [Heq] at the outlet. Is there a risk that a failure at one of the pressure tubes

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		of the two will trigger a consequential failure in the neighbouring weakened tube (which is not allowed in the design basis. Only a single spontaneous pressure tube failure is within the design basis)? 7. It is stated in the transcript that the high [Heq] at the inlet end is caused by the upper side of the pressure tube touching the end fitting , producing *a cold spot where hydrogen from the end fitting can migrate into the pressure tube. How can rapid diametral expansion happen in this area of the pressure tube. Is this contact mechanism something that has been observed or postulated previously? Wouldn't the distortion in the wall of the tube also be observable from the ID.* *8. The comment is made in the transcript that the high Heq is limited to the OD of the tube. Is the mechanism that the hydrogen diffuses axially along the tube surface without diffusing from the outer surface to the inner surface of the pressure tube? How fast can diffusion happen at the low temperature of the PT surface cooled by the annulus gas?* *9. Is there an NDE technique that will detect these high Heq patches on the OD of the pressure tubes. If not, how will you determine how high the Heq value can be in these OD patches*
Nov 3, 2022	Commission meeting follow-up to Sep 3 and March 24 meetings to discuss Heq matter with intervenors	The EAC submitted the following questions before the hearing based on a review of the CMDs submitted by OPG, Bruce Power, NBPower, CNSC Staff and some intervenors. **CMD 22-M37.1 OPG** *p.2 of 18 Why have two slightly different ROI circumferential extents (see items I and ii). This adds unnecessary complexity. Comment at previous meeting to standardize ROI's between OPG, Bruce Power and CNSC not acted upon.* *p.10 of 18 Modelling predicts that bearing contact will shift from Bottom Dead Center to Top Dead Center at end of life: a) Does every channel at Darlington and Pickering undergo this shift or is only a few at random? b) Is the Bearing Contact Point shifted at power, at shut down but at high temperature, or even at low temperature? c) What is the impact of this shift on units which are life-limited by bearing travel? d) How does this shifted Bearing Contact Point affect the loading on the garter springs? If a and b are predictable and cover all the lead channels, this could provide a new strategy for extending units in c). d) is bad if it imposes loads on IX750 garter springs, or if it reduces loads on P5-8 garter springs and causes them to shift to un- favourable places. May cause extra Pressure tube /Calandria tube contacts or at least extra SLAR needs.* *p.9 of 18 What difference in temperature between the top of the pressure tube and the bottom (i.e. "delta T) do your models predict? Some intervenors have found that the required delta T to cause the observed levels of hydrogen migration is unrealistic. Without access to the quantitative results, we cannot determine why there is a difference in the modelled delta T's.* *Appendix 1, starting on p. 9 of 18 2C, 2G: Findings and conclusions are presented in vague, qualitative terms. How can the CNSC get a sense of the remaining margins is there are no quantitative data*

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		3A: Is "low likelihood" 10E-2, 10E-3, 10E-4, 10E-5,10E-6? 3F: Two independent pressure tube failures are "very unlikely". But has the possibility of the pressure surge accompanying a catastrophic pressure tube failure causing another weakened pressure tube to fail been considered. Consequential pressure failures are outside the design basis and are not allowed. *4D: It is difficult to understand why a feasibility study would take up to 8 months, i.e., end of Q2, 2023. Work which relies on reactor data takes time because the time between outages is long. But an assessment of whether a non-active laboratory experiment is feasible should not take 8 months.* *5: 4 years is a long time for a model to be completed, especially when the earlier sections in this CMD seem to say that the current models can reproduce the observed field observation desn't this make it a little pointless? All Darlington units and most Bruce units will be through or in their MCR campaign. Even if a one-year extension of Pickering B were feasible, it would also be over by 2026.* **CMD 22-M37.2 NBPower** *No comments or questions. Their pressure tubes are young, and they are participating in the industry OPEX and R&D programs.* **CMD 22-M37.3 Bruce Power** *While this CMD presents some numerical results of the assessments (which is better than the OPG CMD), all the comments on the OPG CMD above also apply to the Bruce CMD.* *General Question: You have postulated that there are different mechanisms of hydrogen behaviour at the inlet and the outlet ends of the pressure tube. Is it possible that the process which produces the blip operates at both ends of the vulnerable pressure tubes but that the blip is hidden in the large amount of hydrogen that moves into the ROI due to the delta T?* *General Question: the intervenors have asked questions about the ratio of H to D in the samples. There may be another mechanism at work to increase the H concentration. Do you have any comments on this and do you intend to review the H/D question?* **CMD 22-M37 CNSC Staff** *This CMD is well written and gives a very thorough history of these issues.* *p.20 last para: "probabilistic evaluations..(of fracture protection and leak-before-break) …lack of evidence that…appropriate for all PTs". Is the use of probabilistic assessments by the licensees in their current CMDs consistent the Staff concern on in-applicability See fore example OPG p. 12 item 3E.*

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p.22 When the Risk Significance level is judged to be tolerable for 2-3 years, is that based on the projected rates of flaw and [Heq] progression, or is it a “time at risk” argument? “Time at risk” arguments are fraught with problems.
p.23 Point 2 “Material surveillance ….by removing…pressure to provide a statistically significant sample size” . What is the statistical level that must be met, and how many pressure tubes would be needed to satisfy this level. Representing a population of several hundred pressure tubes in a unit requires a large number of samples, a major impact on the MCR or refurb.
p.23 Section 3 When is the RIDM report going to be issued?
p.23 Section 4 “...industry’s R&D plans are in the right direction…”. But are the expected completion dates acceptable? Completion dates are after most units have reached end of life.
p.25 The restriction on “front end” of tubes is 100 ppm if at the outlet and 80 ppm if at the inlet. The licensee CMDs quote the 120 ppm limit, but not the more restrictive “front end” limits. What is the number (estimated or measured) of tubes which fail to meet these tighter limits.
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<tr><td>Jan 25, 2023</td><td>Commission meeting to consider the updates to the Heq matter secretarially.</td><td>
The Commission asked the EAC to evaluate the responses provided by the licensees and the CNSC staff to the questions posed by the EAC in CMD22-M37.8 (October 31, 2022). The responses were provided in the following documents:
CNSC staff: e-Doc6912934 (Nov 24,2022) and CMD 23-M3.A (Jan 19, 2023)
OPG: CD# N-CORR-00531-23498 (Dec 6, 2022)
Bruce Power: BP-CORR-00531-03565 (Dec 9, 2022)
The EAC assessment of the responses is summarised below:
Assessment of responses to EAC questions in CMD 22-M37.8
January 20, 2023; Rev 2
Responses are characterised as Satisfactory (S), Partially satisfactory but incomplete (P), and Needing Further Work (FW) (and No Comment provided (NC))
<table>
<tr><th>Question #</th><th>Bruce Power</th><th>CNSC Staff</th><th>OPG</th><th>Comment</th></tr>
<tr><td>1</td><td>S</td><td>NC</td><td>S</td><td>Good OPG/BP intent to harmonize Blip ROI. Is CNSC still an outlier on ROI definitions?</td></tr>
<tr><td>2</td><td>S</td><td>NC</td><td>S</td><td>Is there a reference for OPG FM report?</td></tr>
<tr><td>3</td><td>S</td><td>NC</td><td>S</td><td>Good</td></tr>
<tr><td>4</td><td>P</td><td>NC</td><td>P</td><td>The intent of the question was ”would commission members know how to interpret vague terms”</td></tr>
<tr><td>5- 3A</td><td>S</td><td>NC</td><td>S</td><td>Does a probability of 0.5% (5x10E-3) at Bruce mean that there are expected to be ~10 or so tubes with flaws in the 2400 tubes in U3,4,5,7,8?</td></tr>
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<tr><td>5-3F</td><td>P</td><td>NC</td><td>P</td><td>Were Stern tests carried out with high [H] patches in the ROI?</td></tr>
<tr><td>6-4D</td><td>S</td><td>NC</td><td>S</td><td>Good to see effort to improve</td></tr>
<tr><td>7-5</td><td>S</td><td>NC</td><td>S</td><td>Good to see interim model usable in 2023.</td></tr>
<tr><td>8</td><td>S</td><td>NC</td><td>S</td><td>Good</td></tr>
<tr><td>9</td><td>P</td><td>NC</td><td>P</td><td>The information about the known H profile was good. The question was more focused on the possible issue of there being more H in the Pressure Tube than was present during installation.</td></tr>
<tr><td>10(cnscQ1)</td><td>P</td><td>S</td><td>NC</td><td>BP/CNSC answers seem to be somewhat at odds with each other, but acceptable.</td></tr>
<tr><td>11(cnscQ2)</td><td>P</td><td>P</td><td>NC</td><td>We would be interested to hear more details of the analyses carried out to understand how time-dependent terms in the assessment are arrived at.</td></tr>
<tr><td>12(cnscQ3)</td><td>S</td><td>S</td><td>S</td><td>Good</td></tr>
<tr><td>13(cnscQ4)</td><td>NC</td><td>S</td><td>NC</td><td>Good</td></tr>
<tr><td>14 (cnscQ5)</td><td>S</td><td>S</td><td>S</td><td>Good</td></tr>
<tr><td>15 (cnscQ6)</td><td>FW</td><td>FW</td><td>FW</td><td>The utilities and CNSC cite different limits. CNSC notes 100ppm for FE material in all circumstances. However, Utilities note 100ppm for inlet and 140ppm for outlet, but it seems that this is only true if FE is at Inlet. Please clarify.
BP doesn't answer the "how many?" question</td></tr>
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<tr><td>April 2023</td><td>Commission hearing in writing to amend the Bruce Power Licence</td><td>On April 19,2023 CNSC requested an assessment and recommendations from the EAC regarding a licence amendment application from Bruce Power. Bruce Power has asked to amend the licence for Bruce A and B by removing licence condition LC 15.3. EAC reviewed ten CMDs and produced the attached report on its findings, "External Advisory Committee (EAC) Review of License Condition Changes" by Mark Daymond and Paul Spekkens, April 26, 2023.

PDF
EAC report on LC 15.3 Rev 4.pdf</td></tr>
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