Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

CMD 21-H112.A
CMD 21-H114.A

File/dossier : 6.01.07
Date : 2021-10-04
e-Docs pdf : 6675308

Supplementary Information

Written submission from CNSC Staff

In the Matter of

Request for authorization to return Pickering Nuclear Generating Station (NGS) Units 6-7-8 and Darlington NGS Units 1 and 4 to service

Public Hearing - Hearing in writing based on written submissions

November 2021

Renseignements supplémentaires

Mémoire du Personnel de la CCSN

À l'égard de

Demande pour obtenir l'autorisation de remettre en service les tranches 6-7-8 de la centrale nucléaire de Pickering et les tranches 1 et 4 de la centrale nucléaire de Darlington

Audience Publique - Audience fondée sur des mémoires

Novembre 2021

Canada

Here are staff's responses to the three comments from the EAC regarding CMD 21-H112 and 21-H114:

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)

   CNSC staff did not intend to imply that restart was considered acceptable because there are safety systems in place to mitigate the consequences of a pressure tube failure. The statement referred to by the EAC was merely intended to demonstrate that assumptions related to the Defence in Depth barriers for a pressure tube failure were not challenged by the results of OPG's statistical evaluations to address the Option (b) restart criteria.

   The recommendation to allow restart is based on the evaluation of pressure tube fitness for service. As described in CMD 21-M4, fitness for service evaluations of pressure tubes are comprised of:

   - Evaluations of inspected pressure tubes to demonstrate that design safety margins are maintained when flaws are detected; and
   - Risk evaluations to demonstrate a low likelihood of failure in tubes that have not been inspected.

   OPG has completed a review and demonstrated a very small population of Pickering pressure tubes with flaws in the Region of Interest that would require dispositioning in accordance with CSA Standard N285.4 based on the depth of the flaws. The majority of the flaws were bearing pad frets arising from cross flow events during fueling operations. These flaws were only marginally deeper than 0.15 mm and had profiles that would not generate stress concentrations sufficient to lead to crack initiation. One other flaw in Pickering Unit 5 pressure tube O05 was classified as a debris fret, but was also very small with a depth of 0.17 mm, a length of 4.6 mm and a width of 1.2 mm. Crack initiation from this flaw was also not considered to be a concern given it did not generate a significant stress concentration. There were no dispositionable flaws detected in any of the inspected Darlington pressure tubes. Based on this review it was determined that the inspected pressure tubes retained their design safety margins in the Pickering and Darlington units.

   CSA Standard N285.8 provides options for evaluating the likelihood of failures of pressure tubes that have not been inspected. Deterministic methods may be used to evaluate the likelihood of failure for a hypothetical through thickness crack of a specified length (typically 20 mm long) and it must be demonstrated that the tubes have sufficient fracture toughness to resist a pressure tube break. Alternatively, probabilistic methods may be used to assess the likelihood of the formation of a crack and a subsequent pressure tube break based on pressure tube fracture toughness.

   Since the fracture toughness estimate depends on the Heq, it is not possible to confidently estimate the fracture toughness of pressure tubes in the Region of Interest at this time. This prevents a licensee from using the methods established by CSA Standard N285.8. As an alternative, the Option (b) restart criteria focuses on the

likelihood of through wall flaws being present in the Region of Interest of the population of tubes that have not been inspected in each unit. The presence of a flaw is a precursor to crack initiation and subsequent growth through the wall thickness. When a licensee can demonstrate that it is unlikely that a flaw exists in the Region of Interest of a pressure tube, they can achieve the objective of the risk evaluations for the uninspected population of pressure tubes, without requiring a full evaluation that requires an estimate of the fracture toughness. When CNSC staff reviewed OPG's submission, the following factors were considered when concluding the that the likelihood of the existence of dispositionable flaws in the region of interest was low:

- The results of the statistical evaluations based on the population of inspected pressure tubes demonstrated that less than 1 flaw was likely to exist in the uninspected population of pressure tubes in each unit.
- The drivers for the formation of significant flaws are not present since, during normal operation, fuel bundle bearing pads do not reside in the Region of Interest.
- There were no dispositionable flaws detected in the Region of Interest in any of the inspected Darlington pressure tubes.
- Flaws arising from cross flow events in Pickering pressure tubes are considered benign. All pressure tubes that have experienced significant cross flow have been inspected and steps have been taken to limit future cross flow conditions in pressure tubes.
- The dispositionable flaw identified in Pickering Unit 5 pressure tube O05 was detected in 1999. The majority of the population of inspected pressure tubes has been inspected after 1999. No similar flaws have been detected in any other tubes since that time, indicating the mechanism that caused that flaw is not common to the Pickering pressure tube population.
- The statistical analysis did not directly account for a significant number of repeat inspections of pressure tubes, which provides additional evidence that conditions that could lead to flaw formation in the Region of Interest have not changed with time.
- The mechanistic understanding of the different flaw formation mechanisms.

It is important to highlight that OPG was successful in satisfying the Option (b) restart criteria because the Region of Interest is close to the outlet burnish mark where conditions result in a low likelihood of flaws. If the Region of Interest was located in a different position along the length of pressure tubes where flaws are more likely to occur, it would have been much more challenging for the licensee to confirm pressure tube fitness for service.

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.

   This was already discussed in more detail in CMD 21-H11. However, a summary is provided below.

The 75 mm axial dimension of the region of interest was originally established by CNSC staff to ensure it would bound the region where Heq could not be fully characterized by past scraping campaigns and provide a buffer for continued operation. It was based on the observation that for many Bruce Power pressure tubes, the first scrapes inboard of the burnish mark were obtained at 65 to 70 mm axially inboard of the outlet rolled join burnish mark. However, OPG has been able to consistently acquire the first inboard scrapes at 50 to 55 mm from the burnish mark in Pickering and Darlington scrape campaigns and have not observed elevated levels of Heq at those locations. Given that the OPG scrapes are generally obtained 10 to 20 mm closer to the burnish mark and the Heq measurements obtained from that location have all been below 120 ppm and consistent with model predictions, it is reasonable to reduce the axial extent of the region of interest for the OPG reactors.

In previous Commission Meetings and Hearings related to the Order, CNSC Staff informed the Commission that the dimensions of the Region of Interest were conservatively established given the developing information related to the elevated Heq findings at the time the Order was issued and would be reviewed by Staff as new information became available. While CNSC Staff has not been satisfied by licensee submissions that the Region of Interest can be restricted to the top 120^{o} of the pressure tube circumference at his time, there was sufficient justification based upon OPG's programs and measurement results to support reducing the length of the region for Pickering and Darlington pressure tubes.

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.

   This was already discussed in more detail in CMD 21-H11. It is also discussed above in the response to EAC Comment 1. The following excerpt is taken from CMD 21-H11.

   > *The sixth flaw, identified as P5O05-IND1, was located in the region of interest in a Pickering Unit 5 pressure tube. It was attributed to debris fretting and is very small, measuring only 0.17 mm deep, 4.6 mm in length and 1.2 degrees in width. In Pickering B reactors, a shield plug extends approximately 85 mm past the outlet burnish mark and supports the last fuel bundle (see Figure A.1 in Attachment A). Therefore, pressure tube flaw formation mechanisms associated with contact between the fuel bundle and pressure tube wall are not active during normal operation in the region of interest. The shield plug configuration is not conducive to trapping debris against the pressure tube wall during normal operation. This limits the potential for the formation of deeper flaws that would be at risk for crack initiation in the region of interest. The location of flaw P5O05-IND1 is covered by the shield plug during normal operation. The flaw was detected and reported to the CNSC in 1999 and no other similar flaws have been detected in any of the other 299 Pickering pressure tubes inspected in Units 1, 4, 5-8. Based on this evidence, it was concluded that this flaw was not due to a mechanism that was likely to be repeated in other pressure tubes Thus, it was also concluded that this flaw could be excluded from the statistical evaluation.*