Canadian Nuclear Safety Commission

Commission canadienne de sûreté nucléaire

Public hearing

Audience publique

September 10th, 2021

Le 10 septembre 2021

Public Hearing Room
14th floor
280 Slater Street
Ottawa, Ontario

Salle des audiences publiques
14^{e} étage
280, rue Slater
Ottawa (Ontario)

via videoconference

par vidéoconférence

Commission Members present

Ms. Rumina Velshi
Dr. Marcel Lacroix
Ms. Indra Maharaj

Commissaires présents

M^{me} Rumina Velshi
M. Marcel Lacroix
M^{me} Indra Maharaj

Secretary:

Mr. Marc Leblanc

Secrétaire:

M^{e} Marc Leblanc

Senior General Counsel:

Ms. Lisa Thiele

Avocate-générale principale :

M^{e} Lisa Thiele

TABLE OF CONTENTS

by videoconference / par videoconference

--- Upon commencing on Friday, September 10, 2021 at 2:00 p.m. / L'audience débute le vendredi 10 septembre 2021 à 14 h 00

Opening Remarks

THE PRESIDENT: Good afternoon and and welcome to this public hearing of the Canadian Nuclear Safety Commission.

Mon nom est Rumina Velshi. Je suis la présidente de la Commission canadienne de sûreté nucléaire.

I would like to begin by recognizing that our participants today are located in many different parts of the country. I will pause for a few seconds in silence so that each of us can acknowledge the Treaty and/or traditional territory for our locations. Please take this time to provide your gratitude and acknowledgment for the land.

Je vous souhaite la bienvenue and welcome to all those joining us via Zoom or webcast.

I would like to introduce the Members of the Commission that are with us today remotely.

Under my authority to do so in section 22 of the *Nuclear Safety and Control Act*, I established a three-Member Panel of the Commission to conduct this hearing. I will preside over the hearing and I have with me on the Panel Dr. Marcel Lacroix and Ms. Indra Maharaj, who are, like me, present remotely for this virtual hearing.

Also joining us today, to be available for questions, are the Members of the External Advisory Committee on Pressure Tubes: Dr. John C. Luxat, Chair of the EAC; Dr. Mark R. Daymond; and Dr. Paul Spekkens.

Ms. Lisa Thiele, Senior General Counsel to the Commission, and Marc Leblanc, Commission Secretary, are also joining us remotely.

The public hearing today is for the Commission to review the CNSC Order issued to Bruce Power for the Bruce Nuclear Generating Stations and the two Orders issued to OPG for the Darlington and Pickering Nuclear Generating Stations.

The Commission is required by law to review these Orders and will make a decision to confirm, amend, revoke or replace each of them following today's hearing.

Bruce Power and OPG were provided with an opportunity to be heard on the review of the Orders and have chosen to avail themselves of this opportunity.

Bruce Power and OPG have also made

requests, pursuant to the terms of the Order, for Commission authorization to restart reactors if certain conditions are met.

As the subject matter of the Orders is the same, the Commission has determined that it would be fair and expeditious to review the Orders in a single proceeding where it will hear both from the licensees subject to the Order and from CNSC staff.

In addition, the review of the three Orders will consider the licensees' requests made pursuant to the terms of those Orders.

In reviewing the Orders, the Commission will consider the information that was before the Designated Officer at the time he issued them, as well as developments and new information that is relevant to the issues and before us today. The Commission will have the benefit of the External Advisory Committee on Pressure Tubes in this hearing, and the licensees that are subject to the Orders will have the opportunity to address any views expressed by the EAC in this transparent forum.

As always, I would like to begin today's Commission Meeting with a Safety Moment.

My safety moment today is on Zoom fatigue. Here are two tips I have found useful in reducing virtual fatigue:

- One, stretch often. Get up from the computer often and walk around.

- And, two, take care of your eyes. Practise the 20/20/20 Rule. After 20 minutes of screen time, look away at a distance of 20 feet for 20 seconds. So if we see you step away from your screen for 30 seconds or staring into the distance, we will understand.

With that, I will now turn the floor to Mr. Leblanc for a few opening remarks.

Marc, over to you.

M. LEBLANC : Merci, Madame la Présidente.

Bonjour, Mesdames et Messieurs. J'aimerais aborder certains aspects touchant le déroulement de cette audience publique.

During today's business we have simultaneous interpretation. Please keep the pace of your speech relatively slow so that the interpreters have a chance to keep up.

L'audience est enregistrée et transcrite textuellement, et les transcriptions se font dans l'une ou l'autre des langues officielles.

To make the transcripts as meaningful as possible, we would ask everyone to identify themselves before speaking.

The transcripts should be available in a week or so.

I would also like to note that this proceeding is being video webcast live and that the proceeding is also archived on our website for a three-month period after the closure of the hearing.

As a courtesy to others, please mute yourself if you are not presenting or answering a question.

As usual, the President will be coordinating the questions to avoid having two people talking at the same time. During the question period, if you wish to provide an answer or add a comment, please use the Raise Hand function.

Madame la Présidente...?

THE PRESIDENT: Thank you, Marc.

CMD 21-H10.A

Adoption of Agenda

THE PRESIDENT: With this information, I would now like to call for the adoption of the revised Agenda by the Commission Members, as outlined in Commission Member Document 21-H10.A that was posted yesterday.

Do I have concurrence?

For the record, the Agenda is adopted.

We will now proceed with the public

hearing.

I would like to start the hearing by calling on the presentation from Bruce Power, as outlined in CMDs 21-H11.2, 21-H11.2A and 21-H11.2B.

I will turn to Mr. Scongack for this presentation.

Mr. Scongack...?

CMD 21-H11.2/21-H11.2A/21-H11.2B

Oral presentation by Bruce Power

MR. SCONGACK: Great. Thank you very much, Madam Velshi.

We will start with the first slide to make sure I follow the order here.

We will go to the next one, please.

Thank you very much.

Good afternoon, Members of the Commission. For the record, my name is James Scongack and I am the Chief Development Officer and EVP Operational Services here at Bruce Power.

Also representing Bruce Power today before the Commission is Chris Mudrick, Executive Vice President and Chief Nuclear Officer; Gary Newman, Chief Engineer and Senior Vice President, Engineering; and Maury Burton, Chief

Regulatory Officer.

Before we begin today's presentation we would like to recognize the Bruce Power Site is located on the Traditional Territories of the Saugeen Ojibway Nation and the Traditional Harvesting Territories of the Métis Nation of Ontario and the Historic Saugeen Métis.

Bruce Power appreciates the opportunity to present before the Commission today in this public forum to provide information and answer questions regarding our request to return Unit 3 to service and return Units 4, 5, 7 and 8 from an unplanned outage.

We have posted today's presentation and the associated materials on our website and proactively released the correspondence provided to the Commission on September 9th as well. This is all available on our website, along with a new portion of the site we have established on this topic, for any member of the public watching today who is interested in more information.

Next slide, please.

The requests before the Commission today are compliant with the Order we received in July. In addition, through the supplementary information provided and confirmatory submissions we have committed to provide in the short term, this will be further reinforced and also demonstrates fitness for service and operational safety margin more broadly.

Our presentation today will demonstrate a number of key elements core to these requests. Overall hydrogen uptake is not increasing in the pressure tubes beyond the predicted rate. What we have observed is a redistribution of hydrogen concentrations to the top of the tube. This is a limited region of interest that can conservatively be bounded to a total tube volume of less than half a percent. In the balance of the tube, hydrogen concentrations are consistent with our predictive models and below licensing limits. The apparent cause evaluation completed by Bruce Power, identified through two independent sources, for this observed redistribution validates this. While additional activities progress for further verification, Bruce Power is proposing a conservative region of interest be applied at this time.

Based on the evidence from additional inspections recently completed, hundreds of previous inspections and re-inspections, no flaws have been identified in this region of interest. This is key to the integrity of pressure tubes and will be further verified during future planned outages.

You will hear in this presentation the term "consistently no flaws in the region of interest". For clarity, this statement means there are no flaws that are dispositionable, consistent with existing CSA standards and associated regulatory requirements.

Due to the pressure tube and bundle configuration on the Bruce units, no flaws are ever expected to occur in this region of interest. It is not surprising after hundreds of inspections and re-inspections that no flaws are present in the region as the design itself prevents them from occurring in the first place.

There is only a limited amount of time of reactor operation during heatup and cooldown, which we estimate conservatively as less than 3 percent of operating hours, where overpressure conditions can occur. This is well understood and core to our operation today. We are taking additional measurers within the operation to further build safety margin in this window.

Finally, safety and pressure tube integrity continue to be maintained and the core requirements around fitness for service and our defence in depth philosophy remain strong.

Next slide, please.

We are providing the public an overview of our upcoming planned inspection outages. This demonstrates that all operating units have undergone inspections to confirm pressure tube integrity over the last 18 months. Additionally, we have a well-advanced strategy to carry out planned inspections over the next 18 months on all operating units for further verification of pressure tube integrity. These are activities are coordinated and managed sequentially, consistent with our Periodic Inspection Program which is outlined in our *Licence Condition Handbook*.

In the case of Unit 3, the pressure tubes will be replaced when the Unit undergoes its Major Component Replacement starting in the first quarter of 2023. The integrity of these pressure tubes has been verified consistent with the Order.

In Units 4, 5, 7 and 8, pressure tubes in all of these units are also compliant with the Order and as such can safely be returned to service from an unplanned outage.

Next slide, please.

These requests are consistent with the Order and will be further supported through additional submissions that will provide further verification and meet fitness for service requirements.

As noted in our September 9th supplemental submission, we have a clear timetable to provide this additional verification information. This will include unitized analysis, evidence from expanded inspections and outputs, including independent work on our apparent cause.

Specifically, we believe this additional information will further confirm a conservative yet targeted region of interest for hydrogen concentrations and demonstrate no flaws in this region.

Our Chief Nuclear Officer Chris Mudrick will present defence in depth, layers of safety and the inspection regime to provide a clear overview of overall safety.

Our Chief Engineer Gary Newman will present the technical basis for the return to service and review the evidence, analysis and verification outlining how we will ensure safety and align with accepted standards, fitness for service requirements and the licensing basis.

I would now like to turn the presentation over to Chris Mudrick, our Chief Nuclear Officer.

Next slide, please.

MR. MUDRICK: Thanks, James.

For the record, my name is Chris Mudrick, Executive Vice President and Chief Nuclear Officer for Bruce Power.

Next slide, please.

I am going to start by explaining the concept of defence in depth, which is an overall safety philosophy that encompasses the entire lifetime of a nuclear power plant and that philosophy has evolved to further enhance safety.

The original foundation was to ensure multiple physical barriers are in place that protect against releases of radioactive materials. Today defence in depth is enhanced using a combination of barriers and complementary measures that provide consecutive and independent levels of protection.

Safety margin and defence in depth at Bruce Power remain strong.

Next slide, please.

As it relates to pressure tube integrity, the concept of defence in depth is applied through a broad variety of safety measures, including operational, organizational, behavioural and plant design, to ensure that the risk of accidents meets CNSC requirements with required safety margins.

Following the discovery of elevated hydrogen concentrations, operating guidance was issued at both stations here at Bruce Power to limit the likelihood of a cooldown as we worked to understand the hydrogen equivalency issue. The guidance specifies additional programmatic controls, including work screening, management challenges of workplans, and oversight of activities that lead directly to a cooldown or that could increase the likelihood of a cooldown. All work in this category requires Senior Operations Authority approval.

Work of this nature continues to be screened through our High-Risk Evolution Challenge sessions as appropriate, and work with increased risk of leading to a cooldown is challenged cross-functionally with approval from the Senior Operations Authority and concurrence from our Plant Managers.

In addition, an operating memo was issued to provide instructions to limit the likelihood of a cold overpressure transient should a cooldown be required. For example, this includes guidance to:

- establish protected pathways around all equipment which supports heat transport solid mode pressure control;
- it includes performing an infrequently performed test or evolution briefing for any planned cooldown or transfer to solid mode pressure control;
- it provides for a dedicated Authorized Nuclear Operator for a cooldown or solid mode transfer; and
- we mitigate any pressure excursion by shutting down the heat transport system feed pumps.

We completed just-in-time training with certified staff with respect to elevated hydrogen in the pressure tubes and our actions to minimize the likelihood of a cold overpressure transient.

Site operating experience was reviewed for the last 10 years. Pressure transient events were looked at and lessons learned were summarized and included in that just-in-time training package.

From an operational perspective, the overall risk to pressure tube integrity, given the redistribution of hydrogen in the small area of interest in the pressure tube, is negligible.

The risk is limited to certain temperature and pressure conditions in an operational envelope, including heatup and cooldown, which is entered at less than 3 percent of the time of the full operating envelope; and 3 percent is conservatively high as an estimate.

In addition to the steps that we have already taken:

- we are also reviewing and will modify procedures to improve margins during the cooldown and heatup;

- we are reviewing our surveillance tests which are performed in this envelope during planned outages to see if we can relocate these tests to different regions of operation and thus minimize the time at risk to cold overpressure transients; and

- we are also pursuing design changes for

Unit 3, and will be evaluating the other Bruce units also, to provide for automatic shutoffs of our heat transport feed pumps at certain conditions to limit the potential for overpressure. For now, we have established interim guidance for operators to take manual action with regard to the pumps.

Together, these actions provide additional operational margin during heatup and cooldown and reduce the time spent in the operational condition where an overpressure transient could occur.

Given the comprehensiveness of the safety measures and the additional levels of protection, the risk of the cold overpressure transient continues to be within the overall safety case described in the Safety Analysis Report.

Moreover, in a highly unlikely event of a pressure tube rupture, the radiological releases would be lower than acceptance criteria established for design basis accidents, ensuring protection of workers, the public and the environment.

It is important to note that a single pressure tube failure is assumed to be within a design basis accident for CANDU nuclear plants and there are safety systems in place to mitigate the consequences of a pressure tube failure. For example, our annulus gas system is designed to detect leakage at the lowest level in order to take action to mitigate consequences.

We understand these elements and this is why we can be confident in our defence in depth approach, including the risk control measures we have taken to increase safety margins, and in our inspection programs to maintain pressure tube integrity.

We are aligned with the CNSC staff overall conclusions shared during last week's Commission meeting that continued reactor operation does not pose unreasonable risk and existing safety analysis remains valid.

We have complied with the conditions of the CNSC Order and provided additional assurance of pressure tube fitness for service, and we have been responsive to the discovery and to regulatory actions taken.

Next slide, please.

As presented last week and as we provided through our public information program, Bruce Power performs extensive inspection activities on all units during planned outages to ensure safety and compliance with the licensing basis. We plan extensively to deploy tooling, complete rigorous analysis and execute the work safely.

Fundamentally, our inspections verify

pressure tube integrity, examining all the factors that contribute to this, consistent with our periodic inspection program. We have planned inspections scheduled sequentially on all of our operating units over the next 18 months, starting with Unit 7 in November.

In particular, I call your attention to the circumferential wet scrape tool, we call CWEST, that takes pressure tube scrape samples to determine the hydrogen concentration so that it can be compared to model predictions, and ANDE, the advanced non-destructive evaluation tool, with which we confirm there are no flaws.

The results from these inspections are used to demonstrate safety and pressure tube integrity.

Next slide, please.

Bruce Power's inspection program is designed to look for evidence of changes in pressure tubes so that further analysis and corrective actions can be taken to ensure safety. This includes communicating such findings to the CNSC as part of their regulatory oversight role. The inspection results and knowledge we gather through every inspection campaign is applied to continuously improve our future inspections, surveillance and maintenance activities, just as we have demonstrated on Unit 3.

Upon discovery of elevated hydrogen

concentrations, Bruce Power proactively expanded the Unit 3 planned outage inspection scope to collect additional results to ensure a sufficient dataset to be bounding for all operating units. In addition to increasing the number of inspections performed on Unit 3, we modified the inspection tooling to collect samples closer to the region of interest to enable the most accurate results. This is why we have a high degree of certainty on the region of interest.

As Gary Newman will explain later, we have expanded the region of interest beyond what the inspection results would require to ensure conservatism.

Our inspections have also demonstrated that overall we do not have higher hydrogen uptake in the pressure tubes. What we have is a redistribution of the hydrogen concentration to the top of the tube.

Inspections on Unit 3 and hundreds of inspections and re-inspections have demonstrated that this is not a risk to the integrity of the pressure tubes because no flaws have been detected in this region of the tube. The information gathered from Unit 3, which is bounding for all Bruce units, is being used to inform updates to the fracture protection modelling and to further validate conclusions.

At current, Bruce Power has collected the most accurate and extensive sampling of hydrogen concentrations of any CANDU unit.

Through this we have demonstrated compliance with the Order in both of our requests and through additional measures have maintained extensive defence in depth in our operation.

I will now turn the presentation over to our Chief Engineer, Gary Newman.

MR. NEWMAN: Thanks, Chris.

For the record, my name is Gary Newman. I am the Chief Engineer and Senior Vice President of Engineering at Bruce Power.

Next slide, please.

High hydrogen concentrations alone do not impact pressure tube integrity. This is why we evaluate, as does the Order, the combination of both hydrogen concentration and flaws. As Chris noted, it is also only during very specific operating conditions during heatup and cooldown that this risk applies. Furthermore, while we inspect to confirm no flaws exist in the region of interest, there are no flaws in the region as this is how both the fuel bundle and the pressure tubes at Bruce Power are designed.

Outside of the region of interest which we have conservatively established, we are confident hydrogen equivalent model predictions are valid for fitness for service evaluations and below licensing requirements.

Next slide please.

During the original Unit 3 CWEST inspection scope, which included eight pressure tubes, results for three pressure tubes identified elevated hydrogen concentrations compared to the predicted values in a narrow region of interest at the top of the tube. In 99.5 per cent of the tube, hydrogen concentrations were below limits, and overall prediction for hydrogen in the tube was consistent with the predictive model.

As mentioned earlier, Bruce Power proactively expanded the inspection campaign to collect a large population of additional CWEST scrape samples from 42 unique pressure tubes in order to confirm the region of interest and hydrogen concentration levels. We also performed ANDE inspections for all of these channels to confirm there are no flaws in the region of interest where elevated hydrogen concentrations are observed.

This is one of the largest inspection campaigns ever done on a CANDU unit. This is not only beneficial in the case of Unit 3, but for all units at Bruce Power, as it was designed to be proactive and further bound the remaining units and complement existing evidence from historic unit-specific inspections.

The results of the enhanced Unit 3 fuel channel inspection campaign identified a circumferential variation of hydrogen concentration in only a subset of the tubes inspected, which is consistently localized to a small region in the upper half of the tube. Consistent with our periodic inspection program, we modified our tooling to sample in this very specific and targeted region.

As a part of the industry surveillance program, pressure tubes removed from Bruce Unit 6 during the MCR outage were selected mainly due to high circumferential variability. Results were found to be similar to the narrow region of interest as observed in Unit 3.

As opposed to random selection, pressure tubes are specifically selected for inspection and surveillance using conservative criteria and considerations that ensure results gathered are representative and bounding of all unit conditions. Next slide, please.

This figure illustrates this region of interest to put it in perspective.

The region of interest was determined based on extensive hydrogen measurements from Unit 3, using enhanced scrape locations both axially and circumferentially through tooling enhancements as well as punch specimens for Unit 6 at multiple clock positions. As such, these are the most accurate results collected during any in-service inspection on any CANDU unit to date.

Narrowing down the region of interest using evidence from sample measurements is important for a number of reasons. It allows us to confirm we do not have elevated hydrogen concentrations in the balance of the tube and also forms a region where we can use a large population of inspections for flaws on the Bruce units and confirm no flaws exist in this area.

Bruce Power appreciates the CNSC staff rationale for defining a more conservative region of interest as this was based upon information received at that time. We understand the CNSC-defined region of interest to be the full circumference of the pressure tube and up to 75 millimetres inboard of the outlet burnish mark. This was an appropriate position based on the information we had provided at that time.

Aligned with the CNSC staff CMD, which states new information may justify revision of the restart criteria, Bruce Power continues to formally provide surveillance evidence to CNSC staff to further inform the definition of the region of interest. This will all be completed by September 17th and builds on evidence provided over the last two months, starting with the response to the 12(2) letter.

Refining a conservative region of interest based on evidence is essential to ensuring the accuracy of fitness for service assessments and to ensure Bruce Power focuses our efforts on the right areas to continuously improve safety and demonstrate integrity of pressure tubes. Next slide, please.

As outlined in this illustration, the scrape results presented in both of the figures represents the hydrogen equivalent concentration: in the left figure, for the front-end outlet channels at the burnish mark plus 20 millimetres, and in the right figure, back-end outlets also at the burnish mark plus 20 millimetres within this 120-degree region of interest. These figures represent the axial location given where we postulate a 20-millimetre undetected through wall flaw to deterministically demonstrate that pressure tube fracture protection continues to be maintained. This is consistent with the requirements within CSA N285.8. Next slide, please.

Similarly, for Unit 6, surveillance pressure tube Sierra-13, this figure represents the burnish mark plus 20 millimetres, also showing the hydrogen equivalent around the various clock positions, all within the 120-degree region of interest, which we have conservatively been able to define. As illustrated in the figure, hydrogen concentrations outside of this region are well within licensing limits.

With this conservative region of interest clear, we can focus on inspections and analysis for flaws within this region. Next slide.

This figure illustrates the evidence of no flaws in the light grey region of interest. What you are looking at is a planar 360-degree view of the outlet end of the pressure tube. So if you were to close it back up, the light grey at the top and bottom of the illustration would come together at the top of the tube. This is the region of interest where elevated hydrogen concentrations are consistently observed.

There are no flaws in the region of interest where the elevated hydrogen concentrations are observed on any Bruce unit. This means there is no driver for crack initiation. Next slide, please.

There is a large population of evidence to confirm the lack of flaws in the region of interest. Bruce Power has performed inspections in 448 unique pressure tubes in Units 3, 4, 5, 6, 7, and 8, equivalent to nearly one full reactor core, which is 480 channels.

We also revisit channels, which would increase this number to 728. This is done on a routine basis as normal practice for planned outages to confirm these conclusions remain bounding. Further planned inspections will continue to verify this. Next slide, please.

The apparent cause for the observed redistribution of hydrogen is due to the temperature gradient, with the top of the pressure tube cooler than the bottom. This was identified through two independent sources, including critical heat flux mock-up experiments completed in recent years at STERN labs in support of fuel bundle sheath temperature distributions, and separately through two-dimensional finite element modelling work. This work demonstrates the progression of the region of interest as a function of operating years.

As we have established through inspection evidence, higher hydrogen concentrations are encountered in some pressure tubes and are consistently found at the top of tube in a narrow region of interest. In these affected pressure tubes, the hydrogen concentration measurements in areas outside the region of interest at top of the tube are significantly lower and remain within traditional modelling predictions.

The higher hydrogen concentrations at the top of the tube is caused by hydrogen redistribution due to a temperature gradient at outlet ends. This is not an overall increase in the amount of hydrogen in the pressure tube, but rather a redistribution to the aforementioned region of interest. Next slide, please.

This slide illustrates our understanding of the mechanism in our apparent cause evaluation. The targeted region where we have measured higher hydrogen concentrations is due to progression of total hydrogen concentration. It is not an increase in the overall hydrogen pickup in the pressure tube. Bruce Power has demonstrated the existing predictive model for hydrogen concentration continues to provide bounding predictions outside this targeted region of interest that remain below licensing limits.

These four figures show the newly developed two-dimensional model, which is 12:00 to 6:00 on the vertical axis and axial position on the horizontal axis. In addition, this is reflected of four different time intervals, namely five years, 10 years, 20 years, and 30 years of operation. And you can see how this region of interest develops over this time period.

Our analysis indicates the high concentrations of hydrogen exist at the upper portion of the tube due to a temperature gradient as a result of flows within the channel. Higher hydrogen concentrations are limited to this region of interest, which is at the top of the tube near the outlet burnish mark. We have conservatively identified this region. Next slide, please.

From a fitness for service perspective, our key assessments remain valid. This includes our existing flaw assessments on all units.

The existing pressure tube to calandria tube contact dispositions remain valid and are not impacted by elevated hydrogen concentration in the region of interest. No pressure tube to calandria tube contact in the region of interest is physically possible.

The existing fuel channel elongation assessments remain valid and are not impacted by elevated hydrogen concentration in the region of interest. Elevated hydrogen concentration in the region of interest is not expected to have a significant effect on the probabilistic core assessment, including the leak-before-break analysis.

As such, Bruce Power is confident fitness for service will be maintained for Unit 3 and all other units. Next slide, please.

The discovery of elevated hydrogen equivalent concentrations has put into question the predictive capability of the model for hydrogen equivalent levels in operating reactors with pressure tubes in extended operation. We've talked about the proactive steps taken to collect information and work currently underway to update our predictive models as part of our longer-term effort.

I want to emphasize the fact that the current fracture protection assessments of record demonstrating compliance with CSA N285.8 remain valid for the entire length of the pressure tube, with the only exception being the limited region of interest at the top of the pressure tube that represents less than 0.5 per cent of the total volume of the tube. These fracture protection assessments were completed using the Rev 1 of the fracture toughness model, which is the model currently approved for use by the CNSC.

Elevated hydrogen concentrations in the region of interest is being addressed in our fracture protection assessment. Bruce Power has completed initial laboratory testing with favourable results at higher hydrogen equivalent levels, and additional testing is planned later this year. The outcome of this test and associated analysis is to be submitted to the CNSC staff in the near future to request an update to the fracture toughness models.

In the interim, a risk-informed approach has been developed to take consideration of the lack of flaws in the region of interest; as defence in depth, low probability of pressure tube failure due to crack initiation and growth from a flaw; and conservatism in the fracture toughness model.

As discussed earlier, risk control measures are also being implemented. Modifications to the heat-up and cool-down profile in Unit 3 are currently being evaluated in parallel via the engineering change control process to demonstrate compliance with required safety factors.

Similarly, improvements are being made to minimize potential for cold over-pressure transients through logic changes and plant operational protocols to prevent a pressure excursion in the heat transport system during cold conditions.

Technical justification, including verification by testing, is being conducted to demonstrate the crack initial model accurately accounts for flaws in areas of higher hydrogen concentration and will be submitted, as noted in our recent correspondence to the Commission. Next slide, please.

Our probabilistic core assessment will be updated to reflect the change in prediction of hydrogen concentration in the region of interest. We expect this will not materially impact the conservative safety margin in place due to the fact that no flaws have been detected in the region of interest. The probabilistic fracture protection assessment will also be updated to address channels that have not been inspected. For the same reason, this too is expected to be insignificant and not materially impact the conservative safety margin. Next slide, please.

In summary, there are four key points I want to leave you with.

1. The elevated hydrogen concentrations are localized, yet represented by a conservative region of interest, and there are no flaws in this area.

2. The methodology applied to flaw analysis, pressure tube to calandria tube contact, and fuel channel elongation measurements remain valid and are not impacted.

3. Strong fracture protection will continue to be demonstrated, including deterministic analysis.

4. Probabilistic assessments will be updated and will not materially impact the conservative safety margin in place.

These collective elements demonstrate both compliance with the order and pressure tube integrity in the proposals to return Unit 3 to service and the unplanned outage framework before the Commission for consideration.

I will now turn it back to Chris Mudrick for closing remarks. Next slide, please.

MR. MUDRICK: Thanks, Gary.

And for the record, this is Chris Mudrick, executive vice-president and chief nuclear officer at Bruce Power. Next slide, please.

I want to leave the Commission with three concluding points today.

1. The two Bruce Power proposals before the Commission are compliant with the CNSC order, demonstrating high hydrogen concentrations are limited to a conservatively identified and narrow region of the pressure tube where no flaws exist. Bruce Power will provide additional confirmatory information for further verification and demonstrate fitness for service. Pressure tube integrity is assured.

2. High levels of safety margin and defence in depth are maintained. During our less than three per cent of operating hours, including heat-up and cool-down, operational measures are in place to further enhance safety margins, including pressure tube integrity.

3. We have sequentially planned outages on all operating units, starting with Unit 7 in November and over the next 18 months, for inspections to further verify pressure tube integrity. Next slide, please.

In closing, we respectfully request approval of the Commission on these two proposals. We are committed to providing all of the verification items and fitness for service submissions noted in our correspondence from September the 9th, and we will continue to work with the CNSC staff to provide any additional information as required.

We agree with the Commission on the importance of this issue and appreciate the opportunity to present these two requests in the public forum today.

Thanks for your time. And our team is pleased to engage on any questions from the Commission.

THE PRESIDENT: Thank you very much, Mr. Mudrick, Mr. Newman, and Mr. Scongack for the presentation.

We'll now to move Ontario Power Generation for their presentation as outlined in CMDs 21-H11.1, 11.1A, and 11.1B.

Dr. Vecchiarelli, the floor is yours.

CMD 21-H11.1/21-H11.1A/21-H11.1B

Oral presentation by Ontario Power Generation

DR. VECCHIARELLI: Good afternoon President Velshi, Members of the Commission, and the External Advisory Committee.

For the record, my name is Jack Vecchiarelli. I am the vice-president of Nuclear

Regulatory Affairs for Ontario Power Generation.

Thank you for this opportunity to be heard on the matter of the designated officer orders relating to the measurement of hydrogen concentration in pressure tubes.

I would also like to take a brief moment to acknowledge that all of OPG's facilities across Ontario are located on treaty and traditional territories of Indigenous people. Next slide, please.

With me today are several members of the OPG team, including Sean Granville, chief operations officers and chief nuclear officer; Mark Knutson, senior vice-president Enterprise Engineering and chief nuclear engineer; and the licence holders for the Pickering and Darlington nuclear generating stations, namely, Senior Vice-Presidents Jon Franke and Steve Gregoris, respectively, to whom the orders are addressed.

We are before the Commission today to present OPG's perspective on the orders and to summarize the evidence and rationale in support of our formal written request made to the Commission. This includes an outline of our pressure tube fitness for service assessments, enhancements planned for future pressure tube inspections, and modelling of hydrogen equivalent concentration, or Heq, as well as the operational safety and defence in depth provisions that are in place to assure that the risk of a pressure tube failure is low. Next slide, please.

For OPG, there are two designated officer orders that are currently in effect, and we appreciate the opportunity to be heard with respect to both orders today.

As written, the order for the Pickering Nuclear Generating Station is applicable to Units 1, 4, and 5 to 8, while the order for the Darlington Nuclear Generating Station applies to Units 1 and 4.

We fully understand that under the orders, OPG requires prior authorization from the Commission to restart these units following any outage that results in the cool-down of the heat transport system. Next slide, please.

As shown in this slide, the orders allow two options by which OPG can make its case in seeking authorization. As highlighted here, these hinge on demonstrating with a high degree of confidence that the pressure tube Heq is within the licensing basis or that there is high confidence of no pressure tube flaws in the region of interest.

OPG has chosen to address both options, and per the orders, the supporting inspection and maintenance activities have been carried out over the course of many years to date, that is, through the execution of our robust fitness for service program which is in accordance with licence condition 6.1.

Furthermore, per the orders, the results of such activities have been submitted to CNSC staff on a routine basis, that is, programmatically and in accordance with OPG governance. The results are summarized in our recent submissions related to the orders, as noted later in this presentation.

It should also be noted that we have most recently made a supplemental submission on September 8th to provide additional information, free of redactions, in support of our response to the orders.

And for reference, the extra slides to this presentation also show some key elements of the licensing basis that are pertinent to the Heq matter. Next slide, please, slide 5.

While continuing to comply with the orders, OPG has carefully considered the recent Bruce Power information on Heq together with our own knowledge base that supports a good understanding of Heq behaviour in OPG pressure tubes, and we maintain that there is no undue risk from the restart of Pickering and Darlington units following any outage.

Regarding this second point on the slide, and as you will hear during the course of this presentation, our supporting case is multi-layered. I would like to take a moment to elaborate on this point so as to outline the thrust of our supporting case, which encompasses a diverse range of considerations. My intent here is to put this issue into a broader perspective holistically and from an overall risk-informed point of view.

Firstly, we have high confidence that Heq is within the licensing basis, including in the region of interest.

Regardless, we also have high confidence that there are no flaws in the region of interest for units in extended operation with the exception of two minor flaws in Pickering Unit 5. Nonetheless, we have high confidence that any such flaws are safe and dispositioned in accordance with the licensing basis, even at postulated high Heq conditions, and that they cannot lead to the formation of cracks.

Nevertheless, we have high confidence any postulated crack will not grow through the wall of the pressure tube. And this is further mitigated by our highly effective leak detection capability, which would detect leaks in a timely manner and facilitate a safe reactor shutdown. And hence, we have high confidence that pressure tubes will not fail.

Moreover, we have high confidence in the safety systems that are designed to mitigate the unlikely event of a pressure tube failure, as demonstrated to be effective by comprehensive safety analysis documented in the station safety reports.

And lastly, probabilistic safety analyses for various modes of reactor operation confirm that such an event is a relatively small contributor to the overall low plant risk, as indicated, for instance, in terms of the very low frequency of large off-site releases.

And thus, for all these reasons, the risk of a pressure tube failure is low.

In the meantime, and in advance of any planned or unplanned outage, OPG has proactively responded to the orders by substantiating, based on both options therein, that we unconditionally meet the requirements of the orders for the Pickering and Darlington units.

OPG has also considered the CNSC Staff criteria and determined to have met those, too.

As such, on the basis of the complete and supporting information provided to the Commission, OPG respectfully requests an expedited decision to pre-authorize the restart of the Pickering and Darlington units in advance of any planned or unplanned outage with cooldown of the heat transport system.

We also request to close the Orders for both Pickering and Darlington stations.

Next slide, please.

And I will now turn it over to Jon Franke.

MR. FRANKE: Thank you, Jack.

Good afternoon, President Velshi, Members of the Commission and members of the External Advisory Committee.

For the record, my name is Jon Franke. I am the Senior Vice-President of the Pickering Nuclear Generating Station.

As stewards of both nuclear technology our community, the OPG and Pickering team has always held safety of the station and the public as our highest principle. I wish to assure the Commission that there is no condition under which we would intentionally operate outside the bounds of our licensing margins.

In recognition of that commitment to safety, Pickering Nuclear received a WANO Excellence Award, the highest level of achievement recognized in the nuclear industry, as a testament to the high standards to which we adhere.

Before I turn the presentation over to Mr. Knutson, I would like to highlight some key points as it pertains to Pickering’s pressure tube fitness for service assessment starting with Pickering Units 1 and 4.

Pickering -- next slide. Thank you.

Pickering Units 1 and 4 have the youngest operating pressure tubes at the Pickering Station. Pressure tubes in Units 1 and 4 were replaced in 1987 and 1993, respectively, during refurbishment.

As a result, Units 1 and 4 are not in extended operations and will not exceed 210,000 Equivalent Full Power Hours at the end of commercial operation. As a result of stringent manufacturing specification requirements and exposure to lower temperature and flux, it is expected that these pressure tubes will exhibit low Heq levels to the end of life.

We continue to have a high degree of confidence that the pressure tube Heq at Pickering Units 1 and 4 will remain well within OPG's licensing basis.

Next slide, please.

At Pickering Units 5 to 8, we have performed scrape and punch samples, exceeding requirements of the CSA Standard N285.4. Sampling was performed both axially and circumferentially in the body of the tube as well as in both inlet and outlet rolled joints.

As a result, OPG has developed a good understanding of Heq behavior in Pickering pressure tubes.

In addition, at Pickering Units 5 to 8, we have completed hundreds of unique full length pressure tube inspections.

There are two minor flaws in Pickering Unit 5 in the region of interest. This is the same region where high Heq was observed at Bruce Power. And the cause of these flaws is well understood.

We know which specific operational events led to their formation and have instituted a change to prevent more flaws from occurring.

Since 2015, corrective actions have been put in place to prevent reoccurrence of flaw formation. As a result of these corrective actions, no new flaws have been created in the region of interest.

In response to the Bruce Power experience, we have performed sensitivity analysis for these flaws to determine that they are fit for service even at postulated high Heq values up to and beyond 350 ppm.

I would like to conclude by confirming my commitment to continued safe operation of the Pickering Nuclear Generating Station. We have a high degree of confidence that Pickering pressure tube Heq is within OPG's operating basis and that no new flaws will occur in the region of interest.

I will now turn it over to Mark Knutson.

Next slide, please.

MR. KNUTSON: Thank you, Jon.

Good afternoon, President Velshi and Members of the Commission.

For the record, my name is Mark Knutson. I am the Senior Vice-President of Enterprise Engineering and the Chief Nuclear Engineer of Ontario Power Generation.

In the next few slides, I will be presenting a summary of our technical assessment for Pickering Units 1 and 4 as well as Pickering Units 5 to 8.

Next slide, please.

As Jon mentioned, Pickering Units 1 and 4 have the youngest pressure tubes at the Pickering Station. In comparison to Bruce Power’s pressure tubes in Units 3 and 6, Pickering Units 1 and 4 have lower hot hours of operation, and hot hours are a measure of time spent with the heat transport system "hot" and influences deuterium ingress into the pressure tubes.

Pickering Units 1 and 4 will be approximately 70,000 hot hours younger, which is equivalent to eight to nine years, at the target end of life when compared to present hot hours for Bruce Power Units 3 and 6, assuming 100 percent operation until end of life for the Pickering Units.

In addition, Pickering Units 1 and 4 have a smaller reactor core and operate at lower flux and temperature in comparison to Bruce Power Units 3 and 6. Flux and temperature also influences deuterium ingress into the pressure tubes.

Next slide, please.

Pickering Units 1 and 4 have been performing scrape measurements in the body of tube, along with inlet and outlet rolled joints to track Heq pick-up. The current predicted upper bound outlet rolled joint Heq value is 73 ppm for Unit 1, with the estimated value at end of life of Heq to be 86 ppm.

Similarly, the current predicted upper bound rolled joint Heq value is 57 for Pickering Unit 4, with an estimated value at end of life for Heq to be 65 ppm. The highest measured value through our inspection program for both Pickering 1 and 4 in this region is 29 ppm.

Pickering Units 1 and 4 are not in extended operation, the pressure tube Heq values are well within licensing limits, and expected to remain well within licensing limits.

Next slide, please.

Now, I will be presenting a summary of our technical assessment for Pickering Units 5 to 8.

Next slide, please.

Although at similar hot hours in

comparison to Bruce Units 3 and 6, Pickering Units 5 to 8 pressure tubes operate in a lower temperature and flux and have experienced lower deuterium uptake rates than the Bruce Power pressure tubes.

OPG has performed hundreds of scrapes and punch sampling on Pickering Units 5 to 8. Since 2017, OPG has programmatically performed punch samples on pressure tubes removed from the reactor to develop a better understanding of Heq variability.

Before a pressure tube is removed from the core for punch sampling, OPG performs scrape samples in the selected pressure tube and then performs punch samples at these locations in the lab as a confirmatory check that both methods are producing suitable results, and we have seen good agreement between both of these methods.

Punch samples are performed circumferentially at all clock positions and axially, along the length of the pressure tube, including at the burnish mark. Furthermore, these samples are obtained from the inlet and outlet rolled joint areas as well as the body of the pressure tube.

It’s because of these programs that OPG has a good understanding of Heq in Pickering Units 5 to 8.

Next slide, please.

The current predicted upper bound rolled joint Heq values for Pickering Units 5 to 8 is below 90 ppm, with the estimated value at end of life for Heq to be below 100 ppm. The highest measured value in this region through our inspection program is 62 ppm.

We have been performing scrape measurements and punch sampling in the outlet rolled joints, including the area of Bruce Unit 3 OPEX, and Unit 6, to track Heq pickup. Based on the inspection results we have received, OPG is confident in the Heq models used, and does not expect Pickering Units 5 to 8 to exceed licence limits by end of life.

Next slide, please.

As part of ensuring that our models conservatively predict Heq in the outlet rolled joint at Pickering Units 5 to 8, OPG utilizes a predictive versus measured model to ensure conservative decisions are being made with respect to the forward-looking assessments that depend on pressure tube Heq as an input. The figures here show our most recent Pickering Unit 5-8 outlet rolled joint Heq model and that the measurements are lower than the conservative predictions.

OPG's robust fuel-channel inspection program, meeting and exceeding CSA Standard N285.4 and supported by a long-standing research and development program allowed us to develop a good understanding of hydrogen behaviour in pressure tubes, including in the region of interest relating to Bruce Power's data. We have high confidence that Heq values at Pickering Units 5-8 are within licensing limits.

Next slide, please.

Across Pickering Units 5 to 8, we have performed over 226 unique, full-length pressure tube inspections. The purpose of these inspections is to look for flaws present in the pressure tubes. The total number of inspected channels is higher if you include repeat channel visits.

After extensive inspections, we found two flaws present, each in different pressure tubes, and at Pickering Unit 5 in the region of interest.

The root cause of these flaws is well understood. These flaws are characterized as bearing pad frets and were caused by fuel in the crossflow.

While infrequent, a crossflow event occurs when a fuel bundle transitions from the reactor during refueling and remains over the flow holes in the liner tube for an extended period of time. If the fuel bundle remains in this position for an extended period of time, it can cause bearing frets in the fuel bundle or against the pressure tube.

Since 2015, OPG has implemented corrective action, specifically an operational procedural change that restricts the allowable time for a fuel bundle to remain in this crossflow condition. If the bundle is not removed from this condition, the reactor is required to be shut down. OPG performs ultrasonic inspections on the pressure tube that experienced a crossflow event, and these inspection results confirm that no new flaws have formed since implementation of these corrective actions.

The two flaws in the region of interest have been dispositioned, the dispositions were accepted by the CNSC, and the pressure tubes are fit for service.

In fact, OPG has performed a sensitivity assessment on these flaws with postulated Heq in excess of 350 ppm, well beyond the licensing limit and the observed high Heq observations at Bruce Power. The results confirm that the flaws still meet minimum allowable safety factors against crack initiation and would be fit for service to the target operating life of Pickering Units 5 to 8.

In summary, we have high confidence that pressure tubes are fit for service at Pickering 5-8 and expected to remain well within licensing limits.

Now I will turn it over to Steve Gregoris.

Next slide, please.

MR. GREGORIS: Thank you, Mark.

Good afternoon, President Velshi and

Members of the Commission.

For the record, my name is Steve Gregoris, and I am the Senior Vice-President of the Darlington Nuclear Generating Station.

I am responsible for ensuring all activities at the Darlington station, including activities associated with the refurbishment project, comply with our operating licence and regulatory requirements, maintaining safety as our top priority.

Consistent with Pickering and OPG as a whole, the Darlington team holds safety of its workers, the public and the environment as its highest priority. All decisions related to station operation are made with this fundamental responsibility front of mind.

I am confident that Darlington's pressure tubes are fit for service, and my confidence is based on our operating experience, extensive research and development, in-service inspections, as well as the use of predictive models and component condition assessments.

I would like to highlight some key points as it pertains to the Darlington Units 1 and 4 pressure tube fitness for service assessment.

Next slide, please.

OPG recognizes that fitness for service requirements must continue to be met at all times, and regular monitoring and inspection are required to confirm fuel channel components are bounded by predicted conditions.

Like Pickering units, Darlington Units 1 and 4 have a robust inspection program which includes both scrape and punch samples. These inspections confirm that Heq is within the licensing basis for Darlington Units 1 and 4 and are not experiencing similar Heq levels as observed in Bruce Power Units 3 and 6.

Please note that Darlington Unit 2 was recently refurbished with new pressure tubes. Unit 3 is currently shut down for its refurbishment, and Unit 1 will be shut down for its refurbishment in early 2022.

OPG has performed hundreds of unique full-length pressure tube inspections, including the region of interest. There are no flaws located within the region of interest at Darlington Units 1 and 4.

I would like to conclude by confirming my commitment to the continued safe operation of the Darlington Nuclear Generating Station. I, along with the OPG team, have high confidence in the fitness for service of pressure tubes in Darlington Units 1 and 4, and our reactors are operated within the licensing basis and with safety as the overriding priority.

I will now turn it over to Mark Knutson.

Next slide, please.

MR. KNUTSON: Thank you, Steve.

For the record, Mark Knutson.

In the next few slides, I will be presenting a summary of our technical assessment for Darlington Units 1 and 4.

Next slide, please.

In comparison to Bruce Power’s pressure tubes in Units 3 and 6, Darlington Units 1 and 4 will be approximately 39,000 hot hours lower, equivalent to four to five years less, at the target end of life, when compared to the present hot hours for Bruce Power Units 3 and 6. Recall that time spent with the heat transport system "hot" influences deuterium ingress into the pressure tubes.

OPG has performed hundreds of scrapes and punch samples on the Darlington Units 1 and 4 pressure tubes.

Punch samples were taken from actual pressure tubes removed from the reactors at all clock positions circumferentially and along the body of the pressure tube axially, including at the burnish mark.

As mentioned before, we obtain scrape samples from the pressure tube being removed to allow for a comparative punch sample to be taken in this region to ensure alignment of these two measurement techniques. OPG has seen good agreement with these techniques.

It's because of these inspections that OPG has a good understanding of Heq at Darlington units 1 and 4.

Next slide, please.

The current predicted upper bound outlet rolled joint Heq value is 119 ppm for Unit 1, with the end-of-life estimated value of Heq to be 120 ppm. As noted, Darlington Unit 1 will undergo refurbishment starting in February 2022, and this will include the replacement of pressure tubes with new pressure tubes of very low initial hydrogen.

The current predicted upper bound outlet rolled joint Heq value is 108 for Unit 4, with an estimated value at end of life Heq to be 113 ppm.

Remember, though, that the highest measured value for these units via our inspection program has been 75 ppm.

These results show that the Darlington Units 1 and 4 are within their licensing basis and adhere to the conservative model predictions.

Next slide, please.

This slide shows the measured Heq versus predicted Heq.

As part of ensuring that our models

conservatively predict Heq in the outlet rolled joint area, Darlington also utilizes a predictive versus measured model to ensure conservative decisions are being made with respect to forward-looking assessments that depend on pressure tube Heq as an input. The figure here shows our most recent Darlington outlet rolled joint Heq model and that measurements are lower than the conservative predictions.

Next slide, please.

Based on our hydrogen equivalent punch sample program, we have compared recent pressure tubes removed through our surveillance program against the hydrogen values seen in the Bruce Power Unit 6 surveillance tubes. It is clear through the samples obtained in the 12 o’clock top dead centre position of these pressure tubes that no similar high Heq values exist. The focus is on the right side of the burnish mark on this figure, as this is the region of the pressure tube where flaws are susceptible to crack initiation in the presence of elevated hydrides.

Next slide, please.

We have performed over 131 unique, full-length pressure tube inspections between Darlington Units 1 and 4. In fact, the total number of inspected channels is higher if you include repeat channel visits and inspections in Unit 2 and Unit 3.

After extensive inspections, we found no flaws are present at Darlington Units 1 and 4 in the region of interest.

Due to design differences in the fueling machines, bearing pad frets created by crossflow at Pickering cannot happen at Darlington units. This is due to a fueling sleeve that is utilized to protect the fuel and the pressure tube through the fueling cycle.

For these reasons, we have high confidence that no flaws will be created in the region of interest.

Next slide, please.

At this point, I would like to recap the pressure tube fitness for service case for the Pickering and Darlington units.

Our extensive inspections, measurements, detailed review of safety and fitness for service assessments, as well as sensitivity studies, have concluded the following.

High Heq values as reported for Bruce Power Units 3 and 6 have not been observed throughout hundreds of scrape and punch samples performed at Pickering Units 1-4, 5-8 and Darlington Units 1 and 4. We have high confidence the OPG units are within their licensing basis.

Pickering Units 1 and 4 have the youngest operating pressure tubes at the Pickering Station and are not in extended operation. The pressure tubes at Pickering Units 1 and 4 will be approximately a decade younger at the end of commercial operation compared to Bruce Power Units 3 and 6. As such, Pickering Units 1 and 4 will have low Heq until the end of commercial operation.

We have high confidence that no flaws of significance will occur in the region of interest. At Pickering, flaws in the region of interest have been confirmed to be initiated due to known operating configurations. The flaws are well understood, dispositioned, corrective actions have been put in place since 2015 to prevent the creation of any new flaws in this region because of crossflow events.

A sensitivity study has shown that these flaws with postulated Heq in excess of the Bruce Power high Heq OPEX meet the minimum allowable safety factors against crack initiation and would be fit for service to the target operating life of Pickering 5-8.

There are no flaws in the region of interest at Darlington Units 1 and 4.

In the next slide, I will discuss the causes of OPG flaws in the region of interest.

Next slide, please.

Flaws at Pickering Units 5-8 in the region of interest are well understood, analyzed, dispositioned, and are not random in nature.

The root cause of these flaws is due to crossflow. As mentioned, crossflow flaws occur when a fuel bundle is transitioned through the reactor during refueling and passes over the flow holes in the liner tube. Damage to the fuel bundle and/or pressure tube can occur when it remains in this position for an extended period of time.

Corrective actions have been put in place since 2015 to mitigate the risk of additional flaws being formed and have been shown to be effective with eliminating flaw formations.

In order for a flaw to fail in service, two things are required: a sufficient amount of hydrogen in the area of the flaw, and a flaw with sufficient stress concentrations, in other words, sharp features, that hydrides will accumulate and initiate into a flaw growth.

Based on OPG's memo included in the supplemental submission sent to the CNSC on September 8th, the flaws in the region of interest do not have sharp features and, therefore, no failure is predicted even with hydrogen levels greatly exceeding the OPEX observed in Bruce Units 3 and 6. And our sensitivity case shows up to 350 ppm has been looked at.

At Darlington, there are no flaws in this region, as the fuel handling system contains a fuel carrier which is designed to support the fuel bundles preventing damage to the pressure tubes due to this crossflow.

I will now briefly summarize our technical submission to support our technical assessments.

Next slide, please.

OPG has provided a number of technical submissions in response to Bruce Power's high Heq OPEX event. On July 27th, we provided a preliminary Discovery Issue Resolution Process risk assessment showing minimal risk to continued pressure tube fitness for service.

On July 30th, we provided an updated risk assessment showing no impact to continued pressure tube fitness for service. Accompanying this risk assessment was a sensitivity assessment showing that fracture protection and flaw assessments would be within the CSA N285.8 standard requirements even with elevated hydrogen levels.

In a submission dated August 6th, OPG provided a response to the Designated Officer Order which highlighted our confidence in our Heq models and conservative upper bound predictions, the small number of flaws in the region of interest, and a conservative sensitivity assessment for our probabilistic core assessment and leak before break assessment, showing they remain valid with elevated Heq.

Most recently on September 8th, OPG

provided the Commission an overview of the technical basis for flaw formation in the region of interest and showed that the flaws remain fit for service with postulated Heq levels exceeding the Bruce Power OPEX.

Next slide, please.

I will now provide an overview of the enhancements to our inspection and analysis program that OPG is undertaking in response to the Bruce Power OPEX event.

Next slide, please.

In line with the messaging we have heard from the CNSC staff at the Commission Meeting on September 3rd, since receiving the OPEX from Bruce Power, OPG has highlighted a number of enhancements that are in progress to satisfy the short-term deliverables expected from the CNSC.

These include:

- future scrapes at top dead centre in the area of interest from the Bruce Power OPEX, and

- accelerating the processing of scrape samples for interim reporting as soon as practicable, post-inspection campaign.

OPG has committed to executing these enhancement inspections in the fall outages for Pickering Unit 7 and Darlington Unit 4, respectively. We feel this will satisfy the CNSC's medium-term expectations for carrying out the enhanced inspections.

To satisfy the long-term expectations from the CNSC of additional material surveillance measurements, OPG has plans to perform extensive punch samples of four rolled joint sections removed from the Darlington Unit 3 refurbishment campaign, one Pickering Unit 8 tube removed during this last outage campaign, and one Pickering Unit 5 tube which will be removed in the spring of 2022.

In addition to this, OPG is working with industry to implement Heq modelling enhancements, including use of 3D finite element analysis considering fuel channel geometries, local temperatures, location-specific Heq and material stress states.

Next slide, please.

I will now go over our operational safety and defence in depth strategy.

Next slide.

We control the temperature and pressure of our heat transport system very strictly, including at unit heatup and cooldown conditions.

To further reduce stress on pressure tubes, we proactively modified our operating procedures and implemented physical design changes. These changes result in lower pressure limit set points and reduced pressures during these evolutions.

After each unit cooldown the exact pressure-temperature profile of the cooldown is analyzed against procedural requirements to ensure continued pressure tube fitness for service. In the unlikely event that the pressure-temperature envelope could not be adhered to, OPG will look at the impact to fitness for service to ensure that the impact is understood before the unit is returned to service.

Next slide, please.

OPG has a robust fitness for service program for pressure tubes that relies on a defence in depth strategy.

To elaborate on the pillars shown in the diagram below:

One, OPG implements and participates with industry in an extensive and robust research and development program which executes tests to show continued pressure tube fitness for service at the advanced aged stages beyond planned unit end of life.

Two, we monitor progression of pressure tube conditions through our extensive inspection program, as discussed earlier today.

Three, following these inspections, we ensure the data are reflected in our model to ensure margin exists in our fitness for service assessments moving forward.

Four, we mitigate the effects of aging with how we operate the plant. A good example of this is the pressure-temperature envelope changes we proactively implemented in 2014, as explained on a previous slide.

Five, we have defence in depth with our fuel channel design. In the unlikely event that high hydrogen and a flaw of significance occurs in a fuel channel, we have demonstrated leak before break for our flaws, which means in the unlikely event that the crack is initiated from a flaw and grows through wall, a leak will occur before a rupture of the pressure tube. In such a case, our annulus gas system will detect the early onset of the pressure tube leak and trigger a safe shutdown of the reactor, thereby precluding the pressure tube rupture.

Six and lastly, we have redundant safety systems like the emergency coolant injection system and containment which are designed to keep the fuel cool and radioactivity contained under accident scenarios, ensuring that the public, workers and the environment are protected.

Before I turn the presentation over to Sean, I would like to leave you with the following three points.

Number one, operation of all OPG reactors is confirmed to be within their licensing basis. High Heq on the order of the Bruce Power data has not been observed in any OPG unit.

Number two, OPG has high confidence that the pressure tubes are fit for service at Pickering and Darlington stations. In the unlikely event of a high Heq existing in the region of interest, OPG is confident that no pressure tube flaws exist therein or they are dispositioned as safe in accordance with CSA standards.

And number three, OPG's future planned outages will be informed by industry Heq OPEX. OPG is engaged with industry partners on work to further understand the mechanism behind the Bruce Power OPEX and on the associated Heq modeling enhancements.

Next slide, please.

I will now turn it over to Sean Granville.

THE PRESIDENT: Mr. Granville, you are on mute.

--- Pause

MR. KNUTSON: President Velshi, Mark Knutson here, for the record. Maybe I will speak for Sean then.

MR. GRANVILLE: Can you hear me now?

THE PRESIDENT: Yes, we can hear you now.

MR. GRANVILLE: I apologize for that.

Just give me a second.

Thank you, Mark. And good afternoon, President Velshi and Members of the Commission.

For the record, my name is Sean Granville. I am the Chief Operations Officer and Chief Nuclear Officer for Ontario Power Generation.

Next slide, please.

Today, the OPG Team has laid out in more detail how OPG proactively responded to the Designated Officer Orders.

Commissioners, in closing out this presentation I would like to reinforce some key points.

We have high confidence that Heq values are significantly lower at Pickering and Darlington units and are confirmed to be within the licensing basis.

We also have high confidence there are no flaws in the region of interest for units in extended operation, with the exception of the two minor flaws in Pickering Unit 5.

We have completed sensitivity studies at postulated high Heq values to demonstrate the robustness of the safety case for these flaws. These flaws are safe and cannot lead to the formation of a crack.

OPG considers to have unconditionally met the requirements of the Orders for both Pickering and

Darlington units.

We respectfully request an expedited decision to pre-authorize the restart of the Pickering and Darlington units in advance of any planned or unplanned outage with cooldown of the heat transport system.

We also request closure of both Orders for OPG.

Thank you and we look forward to your questions.

THE PRESIDENT: Thank you very much, Mr. Granville, Mr. Gregoris, Jack Vecchiarelli and Mark Knutson for your presentation.

We will now move to the CNSC staff for their presentation, as outlined in CMDs 21-H11 and 21-H11.A.

Mr. Jammal, I will turn the floor to you, please.

CMD 21-H11/21-H11.A

Oral presentation by CNSC staff

M. JAMMAL : Bonjour, Madame la Présidente et Membres de la Commission. Pour le verbatim, mon nom est Ramzi Jammal. I am before you today in my capacity as the Designated Officer who issued the Orders requesting the licensees to obtain Commission approval prior to any restart from a planned or unplanned outage.

Joining me to deliver the presentation is Dr. Alex Viktorov, who is the Director General of the Directorate of Power Reactor Regulation. We are supported by CNSC staff who are the subject matter experts from the Technical Support Branch and other branches within the CNSC.

Slide number two, please. Next slide.

In this presentation the following information will be presented to the Commission.

My recommendations as DO regarding the Orders will be followed by CNSC staff's conclusions and recommendations arising from their assessment criteria used to evaluate the previously submitted requests by the licensees in order to verify their compliance with the conditions of the Order.

Next slide, please.

The discovery of elevated hydrogen equivalent concentrations at Bruce Units 3 and 6 put into question the following: the predictive capability of the model for the Heq levels in operating reactors with pressure tubes in extended operation.

CNSC staff still requires submissions from the licensees to determine the root cause of the Heq uptake and the presence of flaws in the region of interest.

In order to ensure that operating reactors remain in compliance with the licensing basis as established by the Commission, I issued the Designated Officer Orders to Bruce Power and Ontario Power Generation under paragraph 37(2)(f) and subsection 35(1) of the *Nuclear Safety and Control Act*.

Next slide, please.

For the purpose of the hearing pertaining to the review of the Order, I request that the Commission accept my proposal for the amendment to the Order issued to OPG, Pickering NGS, or Nuclear Generating Station, by removing Units 1 and 4 from the Order. This proposal is based on CNSC staff recommendations and conclusions as outlined in CMD 21-H11 and slide 13 of this presentation.

In summary, Units 1 and 4 at the Pickering Nuclear Generating Station units are operating within the licensing basis as established by the Commission.

I also request that the Commission confirm the Orders issued to Bruce Power, Bruce NGS A and B, and OPG Darlington.

This request is also founded on CNSC staff's conclusions as outlined in CMD 21-H11 and slides 9 to 11 in this presentation.

I will now pass the presentation to

Dr. Viktorov.

Dr. Viktorov, the floor is yours.

DR. VIKTOROV: Thank you, Mr. Jammal.

For the record, my name is Alex Viktorov, Director General of Power Reactor Regulation. Good afternoon.

On September 3rd, CNSC staff presented to the Commission assessment criteria for reactor restart, as outlined in CMD 21-M37.

Two options for assessment criteria were developed by CNSC staff: Option (a) focusing on understanding of the cause for elevated Heq; and Option (b) is related to flaws in the region of interest.

These two options will be discussed further in the subsequent slides.

Under Option (a), CNSC staff question the model's ability to predict Heq in the region of interest and require that licensees assess the mechanism that impacted Bruce Unit 3 and Unit 6 pressure tubes. However, since this action is expected to require a longer time to be completed, CNSC staff provided a second shorter term option, as discussed in the next slide.

We know that outside of the region of interest CNSC staff have assessed that Heq model predictions are valid for the pressure tube fitness for service evaluations.

Under Option (b), licensees are required to meet the following assessment criteria:

- sufficient inspection data shall be available for the reactor units to justify with a high degree of certainty that no flaws greater than 0.15 mm in depth are present in the region of interest; and

- corrective actions shall be implemented for tubes containing flaws greater than the specified depths.

Specifically, in order to meet Option (b), Bruce Power and OPG shall:

- provide a methodology to quantify the likelihood of flaws in the CNSC defined region of interest with elevated Heq; and

- submit unit-specific evaluations to demonstrate that safety analysis assumptions related to the likelihood of pressure tube failures are not invalidated;

- as well as implement corrective actions for units that do not satisfy the above criteria.

In order to remove the 0.15 mm flaw depth restriction, licensees need to perform additional crack initiation testing at Heq levels based on Bruce Power observations. This is required to demonstrate that the crack initiation models remain valid for flaw assessments.

Previous submissions from Bruce Power and OPG, including the CMDs and presentations submitted by Bruce Power and OPG for the September 3rd Commission Meeting, have been thoroughly reviewed by CNSC staff. At this time CNSC staff conclude that these submissions do not fully address CNSC staff criteria for restart.

Additional clarification was provided in CMD 21-H11.

New submissions were received from OPG and Bruce Power on September 8th and 9th, respectively. A preliminary review of the submissions concluded that both OPG and Bruce Power plan to provide additional evidence to satisfy Option (b) of the Order. CNSC staff will be in a position to provide an update to the Commission upon completion of a review of the licensees' latest submissions.

I would like to make a few remarks regarding confirmation of Heq in the region of interest.

It is important to keep in mind that no tubes were expected to exceed 120 parts per million near the outlet prior to the Bruce Unit 3 and Unit 6 discoveries. This expectation was based on past measurements and Heq modeling.

The cause of elevated Heq in outlet end of the pressure tubes has not yet been identified. Therefore, it cannot be confirmed if pressure tubes of highest likelihood of elevated Heq were selected for inspections and surveillance activities.

The region of elevated Heq is highly localized. We know that scrape specimens cannot be obtained at the burnish mark, so Heq cannot be directly measured near the burnish mark in in-service pressure tubes.

That is all to say further understanding of the elevated Heq phenomenon is required to support Heq projections in the region of interest.

The criteria for Option (b) in fact do not rely on Heq estimations. In other words, if flaws at risk of cracking do not exist in the region of interest, pressure tubes are safe to operate.

CNSC staff are awaiting Bruce Power and OPG quantitative estimates for likelihood of flaws in reactors in extended operation based on a sample size of inspected tubes. Only qualitative assessments have been provided to date.

CNSC staff are also proposing a slightly larger region of interest while factors resulting in elevated Heq are still being investigated.

The criteria for Option (b) if shown to be satisfied will support safe operation in the short to medium term but require additional unit-specific analysis from licensees.

Based on available information assessed to date regarding restart requests, CNSC staff recommend the following to the Commission:

- if the Commission agrees and amends the Order issued to Pickering NGS, there will be no need to approve restart of Pickering Units 1 and 4 following either a planned or unplanned shutdown; and

- deny requests for blanket approval for restart of Bruce NGS Unit 3, Bruce B Units 4, 5, 7 and 8, and Darlington Units 1 and 4, as well as Pickering Units 5, 6, 7 and 8 until Bruce Power and OPG have provided supplemental quantitative analyses to support restart requests.

CNSC staff conclude that:

- the current pressure tube Heq levels in Pickering Units 1 and 4 are relatively low and there is substantial operating experience and data available to provide confidence that Heq at the outlet rolled joint will not exceed 120 ppm prior to permanent shutdown of these units. CNSC staff confirm there is a high degree of confidence that pressure tube Heq in Pickering Units 1 and 4 is within the licensing basis;

- Bruce Power and OPG must provide

supplemental quantitative analyses, as outlined in CMD 21-H11 and slide 8, to support the requests for approval for restart of other units in extended operation.

Depending on the outcome of this proceeding, CNSC staff expect licensees to resubmit to the Commission applications for restart authorization for units prior to their restart.

In the long term, licensees are expected to:

- undertake a root cause analysis for elevated Heq in the region of interest, and

- ensure adequate predictability of the model for Heq uptakes for fitness for service evaluations.

CNSC staff will develop recommendations for revisiting and revising the licensing basis as the new information becomes available to us.

Thank you for your attention. We are now available to answer any questions you may have.

THE PRESIDENT: Thank you very much, Dr. Viktorov and Mr. Jammal.

We will take a 15-minute break and we will resume with questions from the Commission.

So we will see you at 10 to 4:00.

Thank you.

--- Upon recessing at 3:34 p.m. /
Suspension à 15 h 34
--- Upon resuming at 3:50 p.m. /
Reprise à 15 h 50

THE PRESIDENT: Welcome back.

Mr. Scongack, I understand Bruce Power would like to make a point of clarification. I'll turn the floor over to you, please.

MR. SCONGACK: Thank you, Madam Velshi.

Can you hear me? I just want to make sure I came off mute okay.

Thank you very much, Madam Velshi.

For the record, James Scongack, for the record.

Madam Velshi, Members of the Commission, there's just one clarifying point that Bruce Power would like to make. We want to make sure it was clearly articulated in our presentation, and we recognize there have been a lot of moving pieces with respect to this file.

Bruce Power has in fact made two requests to the Commission. The first request we made to the Commission was dated August 13th, and that request was regarding the return to service of Unit 3 from its planned outage. And in that request to the Commission, we requested -- we indicated we were happy to provide additional information required by either the External Advisory Committee, the Commission itself, or CNSC staff. And just for clarity purposes, yesterday we issued a letter on the time table by which those additional information requests would be received.

That is separate and distinct from an August 4th letter we submitted to the Commission for unplanned outage approvals. And I think the reason why that's important is in some of the dialogue this morning it's been suggested that Unit 3 is part of the blanket approval, which it isn't. So I thought that clarification was really important.

And I'm happy to answer any of your questions. Thank you, President Velshi.

THE PRESIDENT: Thank you for that, Mr. Scongack.

We will now open the floor for questions from Panel members. And the initial round of questions will focus on the orders issued to Bruce Power and OPG. And once we have completed the questions on the orders, to assist the Commission in its deliberations on whether to confirm, amend, replace, or revoke the orders, we will proceed then with rounds of questions dealing specifically with the requests by Bruce Power and OPG for pre-authorizations to restart units following a planned or forced outage.

EAC members are attending to provide advice or views for the Commission's consideration. And as I stated in my introductory remarks, the licensees will be provided an opportunity to address any views expressed by the EAC should they wish to do so.

So Members, let's start with questions that are specific to the orders issues by the designated officer. Please indicate whether your questions or comments apply to Bruce Power, OPG, or both. And we'll start with Dr. Lacroix, please.

MEMBER LACROIX: Thank you, Madame la Présidente.

Well, this question is directed to staff. From what I understand, the orders were issued and will remain valid or will prevail as long as the assessment criteria are not addressed by the operators. Am I right?

MR. JAMMAL: It's Ramzi Jammal, for the record, in capacity as designated officer.

The clarity I would like to provide with respect to the assessment criteria is very much established. The key point here is the order established conditions with respect to the elevated Heq of 120 ppm. We cannot provide that approval for restart as staff because it's outside the licensing basis. That requires you as a Commission to provide that approval, if you agree and accept staff's assessments based on the conditions, A or B. So staff's assessment is providing the 120 ppm is the licensing basis, which is the takeoff point with respect to the approval by the Commission. And we'll provide you with support of the assessment with respect to the flaws present or not and the elevated Heq.

MEMBER LACROIX: Okay, thank you. You've answered my question. Okay.

Thank you, Madame la Présidente.

THE PRESIDENT: Maybe I can follow up on that, Mr. Jammal.

So the orders would stay in effect until there is a model that staff believe and the Commission accepts better predicts the Heq levels and the licensing basis has been amended?

MR. JAMMAL: Ramzi Jammal, for the record.

The order stays in effect with respect to the licensing basis being determined by the Commission.

So let me break it up into short term and long term, Madam Velshi, or Madam President.

The key point here is the 120 ppm is

currently the licensing basis as it stands today. Let's move forward. If there is enough evidence that the licensing basis and the safety case can be amended for higher than 120 ppm, that will require a licence amendment, even though the order can be valid. But it's much better to go through the licensing process for licence amendment for higher than 120 ppm to prove the fracture toughness.

On the short term, the order has the two conditions, the "and" and the "or," in order to provide you with sufficient information with respect to the safety of the pressure tube. But regardless of -- I shouldn't say "regardless." Our assessment will provide you that information. But the restart approval cannot take place because of the limitation of 120 ppm.

If the demonstration that it's below 120 ppm, just like Units 1 and 4, then the order is moot. So in other words, the licensee is operating within the licensing basis as established by you, the Commission.

THE PRESIDENT: Thank you.

Ms. Maharaj?

MEMBER MAHARAJ: Just a point of some clarification with respect to the order issued regarding Pickering units. Let me just make sure I get this right, because they all have similar numbers.

So staff is recommending that the order

with respect to Pickering Unit 1 and 4 be removed -- be amended to remove the requirement for approval prior to restart based on the information that those particular pressure tubes are young enough to not have accumulated hydrogen concentration.

Does that mean that the balance of the order for the Pickering units would be confirmed? And the question would be for staff, please.

MR. JAMMAL: Ramji Jammal, for the record.

That is correct, Madam Maharaj. The fact that the -- when I issued the order, we included all units. Based on the information that's been submitted, Pickering Unit 1 and 4, after staff's assessment and the conclusion that these two units are operating within the licensing basis, hence I recommend to delist, if I'm using regulatory terms, delist or remove them off the list of the order, and then keep the other units while you confirm the order, as the other units will be listed as they are without Units 1 and 4. So in other words, amend the order to remove 1 and 4 and confirm the balance of the order as is.

MEMBER MAHARAJ: Okay, thank you.

And my follow-up question for that, Mr. Jammal: Is there any new information that you've received through the course of these last most recent submissions that would cause you to change your recommendation with respect to any of the other units that you have in your submission asked the Commission to confirm the orders for, the DO orders for? Is there anything new in these last round of submissions that would change your recommendation?

MR. JAMMAL: It's Ramzi Jammal, for the record.

It's premature for you to give any recommendations based on the latest submission that was given by the licensee. This information is evolving as we speak. So in other words, it is submissions are taking place, and staff review recommendations have been finalized based on the new information.

So I go back to the fact that the confirmation of the order stands -- or sorry, let me repeat. The request for the confirmation of the order stands as it is today with respect to the information that we received in relation to the time the issue -- the order was issued.

So in other words, I will conclude the confirmation for the order remains as requested by me, supported by staff, that the order stands as we speak today 'til we have enough time to evaluate the information submitted by the licensees.

MEMBER MAHARAJ: Okay, thank you.

THE PRESIDENT: Dr. Vecchiarelli, please.

DR. VECCHIARELLI: Thank you, President Velshi.

For the record, Jack Vecchiarelli.

I just wanted to make a comment regarding your previous question, President Velshi. And I respect Mr. Jammal's response.

Just to be clear, in OPG's perspective, the orders as written, we believe and consider that we have addressed them. We did so proactively for both options. We consider that we are within our licensing basis as it relates to hydrogen equivalent concentration measurements and predictions, and we have spoken at length about the very, very limited number of flaws too in Pickering Unit 5 within the region of interest.

So our request is, just to be clear, we believe that we have an abundance of information in evidence put forward currently for the Commission to make a risk-informed decision.

And certainly, we will continue to work with CNSC staff as they have laid out a short-term and longer-term expectations. We are engaged and collaborating with Bruce Power and the rest of the industry. Certainly, we will be doing more work to just enhance our knowledge and improve our understanding. But as it stands today, just to be very clear, we consider that we have met the conditions of both orders.

Thank you.

THE PRESIDENT: And thank you for that, Dr. Vecchiarelli. I think what we've heard from Dr. Jammal, the staff needs more time to review what has been submitted before they can determine and recommend to the Commission whether those conditions are met.

But let me take this opportunity to ask you, and then I'll ask Bruce Power the same question, because you have asked to be heard around these orders.

What OPG's position is, the orders as issued were fine. We've talked about, you know, shouldn't have included -- or staff is recommending Pickering Units 1 and 4, the order should be amended to exclude them.

Your position is the orders were fine. It's just that now you believe you've met the conditions of the order and it can be closed for the OPG units. So there are no issues as far as amending or revoking or replacing the orders from your perspective.

DR. VECCHIARELLI: Jack Vecchiarelli, for the record.

That is correct.

THE PRESIDENT: Thank you.

And maybe I'll ask Bruce Power the same question. From your perspective, as far as the orders that have been issued, any concerns about the orders, the scope, the staff's -- the designated officer's requirements under that for the --

MR. SCONGACK: Madam Velshi, James Scongack, for the record.

So we see these as two distinct items. There's your specific question on the order, and then the request we submitted. We accept the order. We recognize the order. We believe the technical methodology is sound, as noted in our presentation.

And we can address the issue of our two submissions in a later forum as you see fit, later in today's meeting.

THE PRESIDENT: Perfect. Thank you. That'll be the next round.

So Mr. Jammal?

MR. JAMMAL: Thank you, Madam President.

I just want to reiterate the fact that the order is not static. Based on the information that comes to us, the staff, to review and provide you with a recommendation, it's an ongoing process. So as we are before you today, the confirmation of the order is an order, according to our request, if you accept it. And the amendment of the order still stands, based on staff assessment.

As we get -- and for us, we have to be -- for the record, let me state the fact that our staff are working diligently on information that was submitted to us as recent as 48 hours ago, as recent as 24 hours ago.

So like I said before, we are continuing to evaluate the submissions of the licensee against the conditions of the order. Once we have proper, full submissions from the licensee that is adequate to be assessed by staff, we will come back to you with recommendations based on the information that's been provided by the licensee.

THE PRESIDENT: Thank you.

Back to Dr. Lacroix, please.

MEMBER LACROIX: No, I have no further question on this matter. My questions have been answered. Thank you very much.

THE PRESIDENT: Ms. Maharaj, anything on the orders?

MEMBER MAHARAJ: Sorry, I'm just reading. Just I'm checking one quick thing, Madam Velshi, sorry. I just wanted to verify for my --

THE PRESIDENT: Fine, take your time.

MEMBER MAHARAJ: No, I think those are my questions. The operators have both accepted the two conditions that are in the order.

THE PRESIDENT: Perfect.

Well, maybe I'll ask our EAC members, from your perspective, do you believe that the requirements that staff have stipulated in the orders are sufficient?

DR. LUXAT: Good afternoon, President Velshi and members of the Commission. My name, for the record, is John Luxat. I am chair of the External Advisory Committee and a professor at McMaster University, professor of nuclear engineering.

I would like to, if you'll allow me, start off with a little bit of a summary of some of the known and empirically verified facts about pressure tube degradation during in-service operation.

Firstly, we know that there is pickup in both ends of the end-fitting region of the inner side and the outer side. The outer side picks up more because of the increased temperature and the fact that the coolant is flowing through the channel, subject to radiolysis, for example, which releases some deuterium gas. So it's not surprising that there is that imbalance. In the early days, there was no issue.

The other factor which is -- clearly has been demonstrated is that with increase in equivalent full-power hours, the pressure tubes tend to -- or are subjected to diametrical creep. In other words, the diameter of the pressure tube increases. And that occurs -- the largest creep is actually in the skewed -- downstream and closer to the outlet, and that's because of the combination of the flux, the temperature, and the pressure. Those two -- temperature and pressure are two parts of the driving term from creep.

Now, we also know that as a result of the creep, the fuel bundles sit on the bottom of the pressure tube, and the area between the top outer elements of the fuel bundle and the upper region of the pressure tube, that area increases. So you get increase in flow area. And from the thermal hydraulics point of view, you will get a reduction in the temperature pickup by the coolant in that area. So the higher -- you're stealing some of the flow. And more creep you get, the more the area is, the more flow bypasses. And that was actually mentioned, I think, in OPG's submission.

Now, that is a systematic effect. It occurs. It'll occur in every CANDU reactor that's operating. And the magnitude will just depend on the type or the power of the reactor, the pressures. And we know a lot about that, the effects of that on -- from a safety point of view, that the flow bypass tends to reduce the flow going through the bundle. And ultimately it will reduce the margin to dryout on the fuel, which is a safety concern.

So we've done a lot of analysis. We've got the -- measured, I believe, all the tubes that have been inspected have estimates of the creep which can be verified from in-service inspection. And we also have the knowledge from the Stern labs experiments that were mentioned earlier, where they had simulated bundles inside a crept pressure tube. And yes, indeed, there is a reduction. And in fact, what, 20 years or so ago it was -- became a limiting fact in operating power of some of the CANDUs, in particular in Gentilly and Point Lepreau. And that led to a reduction in power.

Now, the effects of that flow bypass is that it gives you cooler coolant at the top, entering the top of the end fitting, and hotter coolant entering at the bottom of the fitting -- of the end fitting or region of the pressure tube. And that leads to a temperature gradient which is hotter at the bottom, lower at the top. So there will be a migration through diffusion of hydrogen from the bottom, where it's entering, to the top.

And the only way you can reduce that concentration building up is by pushing some of it back axially, in the axial direction if you had a high enough temperature gradient. But the temperature gradient of the coolant is actually very small in that region because it's -- over six metres it's picked up somewhere around 40 degrees, so -- on average, due to the pickup of energy from the fuel bundle.

So that leads to a situation where there should be a link between pressure tube creep and hydrogen concentration build-up in the outlet end-fitting region.

Now, I haven't seen any results from either licensee as to what the creep of the pressure tubes, for example, at Bruce Unit 3, Bruce Unit 6 and any of the OPG reactors, so they should have decent estimates of what their measurements, actually, of the creep of the channels are, and it would be, I think, important to be able to establish a correlation between creep and hydrogen content build-up at the 12 o'clock position, which is the coldest region in the infilling rolled joint area.

Now, that would help also if they could establish from inspection of some pressure tube, first of all, are there other channels that haven't been inspected which have the same level of creep, meaning that they have similar temperature, pressure and fluids conditions in operation. And if that were the case, if they could verify that, indeed, there is this link between creep and hydrogen pick-up, that would provide very good confirmatory information which will increase the level of assurance that we understand what's going on.

Right now, they're not linked, and I'll ask one of my colleagues, Dr. Daymond, to comment on that aspect. He's a very well-recognized expertise in zirconium alloys and things such as fitness for service.

And then I'd like my other colleague, Paul -- Dr. Paul Spekkens, to make some of his comments that he -- where he has some concerns regarding the issue of the level of defence in depth.

With that, I'll turn it over to my colleagues and I will keep quiet.

THE PRESIDENT: Thank you for that, Dr. Luxat.

And before Dr. Daymond takes the mic, I want to make sure that the first round of questions is just around the Orders, the three Orders that have been issued and the adequacy of the Orders.

And I think the next one when we get into do we understand why we're getting these high levels and what's the hypothesis, can we save that for the second part of the discussion?

I just want to make sure if the EAC has any thoughts that they would want to share with the Commission as we decide what should happen with the Orders themselves.

DR. LUXAT: Okay. Well, with respect to the Orders, I think we agree with the CNSC Staff regarding Pickering's 1 and 4.

There's -- on, I think, it's Darlington there's one unit where, at the end of life, you -- before refurb, the concentration in the region of interest is 119, is it, as opposed to 120, and there -- that leaves very little room for uncertainty.

So I would -- I think we feel that the other Pickering units are reasonably low because they have much lower fluids, lower temperatures, and Darlington has the assurance of the fuel carrier which will prevent -- mitigate against flaws developing from fretting wear in the crossflow region of the liner tube.

THE PRESIDENT: Thank you for that, Dr. Luxat.

So just to confirm that from the EAC's perspective, you know, you're satisfied with staff's Orders as have been issued before any units that can get restarted.

And then we'll definitely come to Dr. Daymond and Dr. Spekkens later on.

So let me then ask our licensees if they'd like to comment on what the EAC has said.

And I see, Mr. Knutson, you've got your hand up, so we'll start with you and then over to Bruce

Power.

MR. KNUTSON: Just to comment on two items there.

The 120 ppm end of life is the very conservative prediction. Our sample results don't indicate that. We're -- in some cases, we're in the 50s and lower in terms of our actual numbers, but we do do the upper bound prediction as part of our model in that area.

The other is that we do -- we do look at creep in pressure tubes, and that's an add-on that I'm throwing to you, is that the -- we do measure the -- you know, the percentage of creep on average, and that's one of our criteria for the channels we inspect. So just to add that in there.

Thank you.

THE PRESIDENT: Thank you.

Bruce Power, did you want to make any comments to what Dr. Luxat has said?

MR. NEWMAN: Gary Newman, for the record.

I agree with what Dr. Luxat indicated about the diametral creep. We not only measure it, we model it as well for various reasons. And it actually is included as part of the two-dimensional finite element work that I talked about earlier in my presentation.

And the magnitude of the temperature

gradient is directly related to the amount of diametral creep.

THE PRESIDENT: Thank you.

And maybe before we move to the second part, I just want to clarify that there is good understanding on the Conditions A or B, particularly when it comes to the regional area of interest.

Staff's definition of that is a little different than, say, Bruce Power's. You know, it's the full circumference, Bruce Power is the 120 degrees.

And so before we leave the Order, I just want to make sure that the conditions of the Order are well understood and well accepted, so maybe I'll ask Staff to go first, and then Bruce Power, around the clarity around the region of interest, please.

MR. JAMMAL: It's Ramzi Jammal, for the record.

I will call on Dr. Viktorov to provide that precision, but we -- and from our perspective, we did have discussions with the licensees and the clarification with respect to the requirements of the condition of the Order have been discussed with the licensees. And Staff will provide you with more precision on the criteria, Madam Velshi.

THE PRESIDENT: Thank you.

MR. JAMMAL: Alex?

DR. VIKTOROV: Alex Viktorov, for the record.

I believe the clarity is here. We haven't heard disagreements with the definition or, rather, there is disagreements of definition, but it's on the essence of it, not what we requested.

Licensees have proposed a different definition, narrower than ours. We provided, in our approach, a margin accounting for lack of understanding of the mechanism.

I think the understanding is here. There may not be full agreement, and that's where is the industry or our technical specialists may provide additional details.

MR. JAMMAL: I'll ask, Madam President, for Mr. Blair Carroll to speak about the region of interest and the conservative establishing criteria.

Mr. Carroll?

MR. CARROLL: Blair Carroll, for the record.

So as Dr. Viktorov mentioned, the approach that was used by CNSC Staff to make that recommendation was based on incorporating conservatism given that we didn't really know at the time and really, right now, don't have a full understanding of what the cause was that led to the elevated Heq in the pressure tubes.

As you recall, last week at the Commission meeting, Commissioner McKinnon asked some questions on the idea about safety margins that are incorporated into different assessments.

In developing this criteria, CNSC Staff took the same type of an approach. For instance, we -- and when I spoke to Dr. McKinnon, I was talking about in terms of doing fitness-for-service evaluations for flaws in pressure tubes, the fitness-for-service criteria requires that a licensee demonstrate that a pressure tube can withstand three times the normal operating pressure with the flaw in place.

That's not because we expect -- ever expect a pressure tube to see three times the normal operating pressure. It's because there are uncertainties around that assessment that may not be always be able to be accounted for. So that safety margin allows for some of those uncertainties to appear and not immediately put a pressure tube in jeopardy.

So given that we didn't know what the cause was of the elevated Heq and we don't know if it's going to progress with time in other tubes that could be affected by it, we felt it was prudent to put that type of a margin in place so that if it turns out that the region of interest does expand circumferentially, you've accounted for it, or if it does get a little bit longer axially, we've accounted for it and we've put that type of a margin in place.

So that was the basis for CNSC Staff's recommendation.

THE PRESIDENT: Thank you.

Dr. Spekkens.

DR. SPEKKENS: Yeah. For the record, my name is Paul Spekkens.

Let me start with a comment, and then maybe some questions for some of the participants.

Whenever we start out one of these issues where something happens that we're not expecting, there is a tendency for everybody involved to jump really far. And that's okay, but you have to be prepared to walk back when the facts start emerging.

And I think what I'm -- I feel much better about what I heard today than what I heard last week because I heard more and I saw more.

So I think there is -- so to go back to the concern I had last week, which I didn't articulate, had to do with defence in depth.

So we've always said that in our CANDU

reactors, the first layer of defence against a pressure tube failure is the absence of cracking. We don't allow cracks.

The second layer of defence is that we say to ourselves, "Well, what if we're wrong and there is a crack?". And that's how we use the fracture protection assessments and leak before break assessments.

In this event, it looks like our first layer of defence is there are no cracks, and our second layer of defence is there are no cracks. I think we've lost a layer of defence in depth.

Luckily, we have more than two, but I think we have to acknowledge that we have lost something here because there's something that could potentially happen in a region that we don't know a lot about.

Now, having said that, one of the heartening things is that when people who do this for a living start to assess these flaws at very, very high hydrogen levels that, for a lot of flaws, it doesn't matter how high the hydrogen level gets, the flaw is still benign. And I think we have to take that on board.

The view of the CNSC that we can't say anything about flaws that we previously thought were benign because everything has changed, I think that's good as an initial view, but that really has to step back a bit because I don't think that's particularly helpful to coming to a technical resolution.

I must say that when I saw the notion of the region of interest expanding a little bit, meaning it's doubled or a bit more than doubled, I don't understand that. I just don't understand what it helps to expand the region of interest into an area where we know there could be flaws. What's the point?

We've always had to assess the fact that there's flaws there and we have to be able to show that they're easily passable even with conservative rates of hydrogen uptake, conservative levels of hydrogen.

There's an area that we are puzzling about, and I just don't think it makes sense to go from that area to full 360 degree circumference. I don't think it aids anything.

The -- now, I think the licensees have kind of taken the position that in some areas they can say with absolute certainty there are no flaws. Now, zero is a very small number, and again, I don't think it's -- it isn't necessarily zero. What you have to be able to show is that if there is a flaw there, this is the way we would assess it. And if we can show that the flaw -- so let me take -- let me give you a specific example.

So in OPG's assessment document -- don't know the number here. It's the written submission. There's a Section 5.2 where they talk about the fact that the fuel bundles at Darlington hang out over -- hang out past the burnish mark, and so they keep the bearing pads away from the burnish mark because the burnish mark is an area of high stress and you don't want to put a flaw there.

Well, if I recall correctly from way back when, there are times when it doesn't quite go right and there is a burnish mark flaw caused by the inadvertent presence of a bearing pad, and that's because at Darlington they're managing that location of the bearing pad with long and short bundles. And if you don't quite get it right, you can get an interaction between the bundle and the burnish mark.

But that's not what it says in the report. It says that there are no flaws in this area.

So the -- this obsession about zero, I think, is hurting us in trying to come to grips with this thing.

I'm going to stop there and give Mark Daymond a chance to speak or, I guess, the others at the table.

THE PRESIDENT: Thank you very much, Dr. Spekkens.

Well, let's listen to Dr. Daymond and then we'll get the licensees and Staff to respond to what you've said.

Thank you.

Dr. Daymond?

DR. DAYMOND: Thank you.

Mark Daymond, for the record.

With respect to the question about the Orders and with respect to the region of interest, I think from what we've seen so far, I agree. I would tend to more closely follow the thoughts of the licensees with regards a suitable region of interest in terms of focusing on the top of the top sector of the tube where we are seeing these very high hydrogen contents.

I do respect the idea of needing to be conservative in our assumptions, but I think things are moving quickly and we are already seeing a fair amount of evidence that sort of strengthens the idea of where there is an issue and where we really need to focus.

I think Dr. Spekkens covered the other points I was going to make, so I'll stop there.

THE PRESIDENT: Excellent. Thank you.

Let's see if we've got licensees first and then Staff to comment on what we've heard from the EAC members and then, Commission Members, we'll come to you for your thoughts.

Bruce Power.

MR. NEWMAN: Thank you. Thank you, Madam Velshi.

Gary Newman, for the record.

So I don't think I disagree with anything I've heard. I think some of this is timing related as well because, as noted earlier from the CNSC Staff, you know, we've sent them information very recently, and in that information is the basis of our definition for the 120 degrees by 50 millimetres.

And I think some of this is sort of -- you know, when you listen to their logic, is maybe a week ago, you know, because that's when their submission was made and so forth. And they need to be given time to catch up to -- and metabolize the information that we've sent them.

We felt pretty confident with the 120 degrees because we've looked at a lot of information and it also marries very well with the modelling work that we've done, both the CHF work that really drives the temperature gradient. And we've actually generated preliminary -- with the modelling tools that we have, we can actually generate temperature gradients on a tube-by-tube basis now. And that's based on some industry standard tool set modelling thermal hydraulic codes.

And so for example, a preliminary result for one of our leading tubes, Foxtrot 16 in Unit 3, has been estimated. It still needs to be verified, but a temperature gradient of 26 degrees at that last bundled position from bottom to top, so cooler at the top, warmer at the bottom.

So just as implied by many of the members that were just speaking, we're rapidly adding understanding almost on a daily, certainly on a weekly basis, to what we're finding.

I do want to make one comment about the -- that maybe the optics of possibly removing one of the layers of defence in depth. I don't think we're doing that.

What we -- what we're going to do, and I said that in my presentation, and perhaps I wasn't clear, we will still be demonstrating fracture protection even in the region of interest. That is our -- and that will be the risk informed item.

We haven't submitted that yet. That will come on the 17th, as I indicated in the presentation. But that's all part of the argument because in the CSA requirements, 285.8, that is part of the fitness for service that you have to do.

So I -- our full intention on Unit 3 is to meet all those requirements and, furthermore, we're going to meet them following all the deterministic safety factors, so we'll be in complete compliance with the fitness-for-service requirements in the standard.

THE PRESIDENT: Thank you, Mr. Newman.

Dr. Vecchiarelli?

DR. VECCHIARELLI: Thank you, President Velshi.

For the record, Jack Vecchiarelli.

I'd like to make a couple of comments and then invite Mr. Knutson to elaborate and offer his perspective.

The first point regarding the region of interest, I would like to draw to the Commission's attention that in our supplemental submission of September 8th on page 2 of 21 in the enclosure, we have described our perspective on what we think the region of interest should be appropriately considered to be. And I'll just read this out loud here:

"OPG considers that the top of the tube 120 degrees or 10 to 2 o'clock positions and within 75 millimetres of the outlet burnish mark to be the region of interest." (as read)

So that is one comment.

And the other comment relates to the -- as Dr. Spekkens was describing, this notion of no flaws in the region of interest.

As we've heard for Pickering Unit 5 in the region of interest, we have dispositioned those flaws and have taken corrective actions to prevent further recurrence of those types of flaws.

A thought for the Order and the wording, the Option B, it talks about no flaws in the region of interest, and perhaps that is overly restrictive. We consider that with high confidence that we meet the intent of that, but perhaps that could be modified to no -- for something like "no undispositionable flaws" in the region of interest.

It gives a little more flexibility and recognizes what -- as Dr. Spekkens was indicating, sort of common industry practice in accordance with CSA standards as to how we regularly disposition flaws in general.

So with that, I will turn it over to Mark Knutson for some further comments.

MR. KNUTSON: What I would add to Jack's comments and agree with him is the -- like we have done the assessments on a fracture protection and the sensitivity towards high Heq for those analysis and do not see an impact there. So we are still fully within and have not invalidated any of our assessments for safety as a result of this OPEX.

The other is OPG has done sampling around the 360 degree around the pressure tube punch samples and do not see this. So we don't see how we can go look further in this area because we have looked. Thank you.

THE PRESIDENT: Thank you.

Staff, any thoughts from you?

MR. JAMMAL: It's Ramzi Jammal, for the record.

Now I will put my hat on as Chief Regulatory Operations Officer.

Two things I would like to reiterate.

For regulatory decisions we need to be risk-informed, I fully accept it, at the same time taking conservatism. So based on staff evaluation of the information they had and the recommendations with respect to the criteria to the Order, as it was mentioned by, I believe, Bruce Power, we implemented CSA requirements. Even though the condition of the Order says no flaws, the intent was never zero. If you look at the assessment criteria under CSA, we unequivocally stated flaws greater than .15 in dimension. So the criteria is already being shared with the licensee and risk-informed decision-making based on quantified and tested CSA.

Now, based on the information we received with respect to the RI being 120 versus 360, as we stated before, the predictability -- the validated predictability of the model was in question and as more information comes to us for us to assess as we apply performance-based requirements, we will look at that.

The licensee has the responsibility for safety and to demonstrate to us at all times they are within the licensing basis, number one, and number two, the safety case that was approved by the Commission will continue to have to be proven. So the intent of the Order is to put back the bounding element of the licensee to the safety case and the safety analysis report in addition to the licensing basis. So that is our position at this point and the licensee is providing us with the information to demonstrate that they are meeting both the safety case and the conditions of the Order.

But, in closure, the condition of the Order with respect to 120 ppm uptake is not bound to a region of interest. It is not specific at all. Any point at the pressure tube greater than 120 ppm requires Commission approval for restart if there is planned or unplanned outage. So I want to close with that perspective.

So in conclusion, we start from conservatism, but we take risk-informed decision-making based on the information we have at hand and staff will continue to evaluate accordingly. I will --

THE PRESIDENT: Thank you.

MR. JAMMAL: I'm sorry, Madam Velshi. Madam President, I will ask if anyone of my colleagues would like to add from the specialists or Dr. Viktorov.

DR. VIKTOROV: Alex Viktorov, for the record.

As Dr. Spekkens eloquently put it, we jump forward as far as we believe appropriate, but we are willing to walk back if information becomes available to us. Licensees submit us information weekly and we expect more information coming to us next week. Again, as we learn more, we will make appropriate decisions. We don't preclude that the region of interest may be modified as we learn and understand what's happening in the pressure tubes and Heq model. So again, we start conservatively and make risk-informed decisions, as Mr. Jammal just said.

THE PRESIDENT: Thank you, Dr. Viktorov.

And Mr. Knutson...?

MR. KNUTSON: I'm not disagreeing with what Alex or Ramzi said. What I was going to add is that the .15 mm is not the real measure of failure, it is the sharpness of the flaw. I agree that that is adequate for us if in fact the corrective actions listed in clause 2 indicate that we could analyze the flaw and therefore disposition it. So that's the nuance there. I understand the .15 is the CSA definition of a flaw, but having no flaws at .15, if the corrective action is that we can disposition it based on analysis, then we would agree with that.

THE PRESIDENT: Thank you.

So let me just make sure, you know, as the non-expert in this conversation that we understand. Dr. Vecchiarelli suggested that the Order could be amended and instead of no flaws or no undispositionable flaws and, Mr. Knutson, you are saying less than .15 doesn't mean that it's the same as undispositionable, right? So is it less than .15 or is it a flaw if it can get disposition that is acceptable? Staff, maybe just clarify for us, please. What is condition (b)?

MR. CARROLL: Blair Carroll, for the record.

So the original intention of the option and the assessment criteria that go along with it was to limit the flawed depth to .15 mm. That is the minimum depth limit for the CSA standard. It does allow for options to go to deeper flaws if you can disposition them in the standard. However, that requires that you have valid models to do the dispositioning, which we talked about last week with regards to crack initiation and crack growth.

Now, we understand industry's position that they do not expect to see changes in behaviour and crack initiation and crack growth at the elevated Heq concentrations that we may be talking about. However, we have to be careful as staff because there is no data, there is actually no physical data to support that yet. There are theories, but the data just isn't there. So that is why we put that extra restriction on the 0.15 mm.

However, as we clarified in the assessment criteria, we weren't necessarily talking about having zero flaws, we were talking about having flaws that would invalidate the safety case. The safety case, you know, considers the potential for -- in a deterministic safety analysis considers the potential for a pressure tube rupture, so we want to make sure that the population of flaws that did exist there aren't large enough to say we could have multiple simultaneous pressure tube failures.

The probabilistic safety analysis talks about having a limiting -- has an assumption on the limited frequency of flaws or frequency of pressure tube failures that you can see that will not lead to core damage. So we can use those criteria as well to change it from having zero to having something that is reasonable within the bounds of the safety case for the reactor.

So that was sort of the intent and the clarification that was provided with the assessment criteria. However, as Dr. Viktorov and Mr. Jammal have already said, these criteria came in at a point in time when we had very limited information. As we collect new information, and the licensees have provided some, and we get a chance to review it, the intent was always to be able to say -- for us to go back and reevaluate and say, do we need to keep it this stringently or can we make changes based on new information? However, we haven't had time to review the most recent information and make those determinations at this point.

THE PRESIDENT: Okay. Thank you, Mr. Carroll.

Well, let's proceed with questions that are specific to the requests that have been made by Bruce Power and OPG for pre-authorizations to restart units following a planned or forced outage.

Let's start first with questions to Bruce Power on their specific requests, first around Unit 3 and then Units 4, 5, 7 and 8.

Ms. Maharaj, we will start with you this time, please.

MEMBER MAHARAJ: Thank you, Madam Velshi.

Specifically I want to start with Unit 3.

My question with respect to the request on Unit 3 to Bruce Power specifically is how do we get comfortable now with the fact that the modelling didn't forecast these elevated hydrogen levels? If this unit is currently in outage, is there going to be physical inspections to ensure that we get over the threshold necessary to be satisfied that it is safe to restart and that that unit is fit for service? So I am struggling with that dichotomy between the modelling didn't bring us to a point where the result was predictable and now that we know that, how do we become comfortable enough to say that the request is reasonable?

MR. NEWMAN: For the record, Gary Newman.

Great question. Let me begin with the modelling piece. So in actual fact, just to reinforce part of what I had communicated in my slides -- and again, maybe I didn't do that clearly -- in the majority of the pressure tube, like 99.5 percent by volume, the pre-existing, if you like, classic model, one-dimensional model works very well and in fact it is very conservative.

Where we found that it wasn't working was in this region of interest, which Bruce Power has defined as 120 degrees by 50 mm. In that region we went to a two-dimensional finite element model and we got very good agreement. So what we will be able to do now going forward is we will be able to predict what that region will do over time. So I am not concerned about being able to model that.

And then on top of that what we have done is we expanded our inspection. As part of one of my slides, we talked about the initial scope was eight channels' worth of CWEST, and that is sampling for hydrogen isotopes. We then -- as soon as we saw this, we expanded to an additional 26 channels. And then once we had all of those results, we further expanded to another 21 channels. Now, some of these are not completely unique and so the total number that we did was 42 in that additional two campaigns.

We did two things during that campaign. We did extensive scrape sampling so that we knew exactly what the concentration was at various clock positions and various axial positions, and we also did full volumetric inspection in that region as well, using our ANDE inspection tool.

So what that does is it really tells us two things: what can we expect the material properties to behave like, and that's for fracture protection and flaw assessments and so forth; and the other one is do we have any defects in that region. So that was the region that we did that.

So those two items taken in combination

are currently being prepared and will be submitted by next Friday, following our normal fitness for service requirements -- and this is in accordance with CSA N285.8 -- and that will then be the technical basis on which we would make a request to restart the unit. Of course that has to be reviewed and accepted by CNSC staff and ultimately the Commission.

MEMBER MAHARAJ: Thank you very much, Mr. Newman.

Just as a follow-up question, I'm looking at your slide number 13 where you spoke about the pressure tubes and then increasing up to the 42 with the CWEST scrape samples.

MR. NEWMAN: Yes...?

MEMBER MAHARAJ: My understanding is there are 480 tubes in that unit. So this 42 units that have been -- or 42 channels that have been sampled using CWEST technology or technique, or whatever it is, that represents about 10 percent of the channels. So when you do the ANDE inspection to look for the flaws in that area, because we are looking for the high concentration of hydrogen plus the potential flaw as the risk, did you limit the inspection using ANDE to those 42 channels or do you do that examination on all of the channels as part of your maintenance and assessment and analysis prior to making the request to restart?

MR. NEWMAN: What we did there -- for the record, Gary Newman.

There are two parts to the answer there.

So we have been inspecting channels for many years now and all of that information is also part of what we use. These 42 channels were specifically selected because of the various inputs. So for example, you know, Dr. Luxat talked about this temperature gradient in the channel and I have touched on that as well. That is seen in every channel to varying degrees, but there are specific channels that we are interested in and it has to do not only with metallurgy of the channel, it is also ingot chemistry that is associated with that.

So when we picked these 42, they were picked with very specific background information and history that we could use to then zero in on the channels that we thought would be bounding for the subgroup of channels that needed to be looked at. So that is the basis on why we think we are very confident that we have captured that particular feature with just the 42 channels.

MEMBER MAHARAJ: So then would it be a reasonable conclusion to draw that these 42, as you say, are bounding and so the balance, the remaining 89 percent of the tubes would fall within a less bounding condition, so you are less concerned about those as showing -- from a risk-based analysis the risk would be sitting on the 42 that you analyzed. Is that fair?

MR. NEWMAN: That is a correct -- for the record, Gary Newman.

That is correct. We are able to rank all of these channels and we believe that we have looked at the most important ones and that they would be bounding to the balance of the channels that one would look at. Not all 42 of these showed high hydrogen concentrations. Some of them were very good, some of them were very normal, but you have to look at some good ones to be able to compare with ones that have higher values, like control tubes, if that makes sense.

MEMBER MAHARAJ: Was your analysis able to show any correlation between the conditions that you used in order to identify the 42 tubes and those of the 42 channels that showed elevated hydrogen equivalent concentration or not yet?

MR. NEWMAN: We are still finalizing that, but we have gotten a very good correlation with -- for example, we have two types of configurations in Unit 3. We have front end outlets and back end outlets. What that refers to is the front end of the extrusion of the tube versus the back end, you know, in other words, what part of the tube comes out of the extrusion die first and which one comes out last. That has an influence on the microstructure. So that is the microstructural -- we believe that is important.

We also believe that it has to be in a high-power channel, so in the inner zone of the core. And there is some other chemistry elements like iron that appear to be important. All of that gets rolled into a ranking model that we then use to rank all the channels in that subgroup and that is the basis on which we feel confident that we have bounded, you know, this channel group within the core. It's not all the channels, it's just a subset.

MEMBER MAHARAJ: Okay. And then that's the methodology you would use for the remaining units as if they were to go into an unplanned or forced outage, this methodology would be used to help with your analysis of complying with the two conditions that are in the D.O. Order. Is that fair?

MR. NEWMAN: Gary Newman, for the record.

Partially. Some of the work that we did in Unit 3 covers a similar configuration and we had very good performance when we did those measurements and we can use that information to help manage the other units.

MEMBER MAHARAJ: Okay.

MR. NEWMAN: And then when we do go -- pardon me. When we do go into the planned outages for each of those units, we already have predetermined scope and what we will do now is we will take what we have learned from 3, we will roll it into the inspections planned for those other units and we will be able to confirm exactly what the behaviour is in those. We haven't seen any evidence of a problem in the other units, but we are going to go in and look in a similar way to what we have done in Unit 3. And yes, all of the modelling work that we have done in 3 will be very -- will be used to inform the scope that we do in the other units.

MEMBER MAHARAJ: Perfect. Thank you.

Madam Velshi, I will let my colleagues have a turn.

THE PRESIDENT: Okay. Thank you, Ms. Maharaj.

Dr. Lacroix, questions for Bruce Power on their requests, please.

MEMBER LACROIX: Yes, I do have a number of questions for Bruce Power. Well, these are questions and also observations.

I am still baffled by the magnitude of the Heq concentration. It is almost twice the licensing limit, so I still cannot understand why it is so high. And I am still also perplexed by the rate of hydrogen uptake. I am still baffled also by the diffusion of hydrogen within the wall of the pressure tube itself.

Also, I read in your submissions as well as in OPG's submissions, you talked about models for hydrogen uptake. You talk about models for hydrogen diffusion. You talk about models for crack initiation and you also talk about models for fracture toughness. One thing that really surprised me is that it seems that flaw analysis is not impacted by elevated hydrogen concentration but the material properties are, the tensile strength, the ductility is affected. So, you know, I am not comfortable with this language in the sense that it seems that many of the assessments seem to be qualitative. I understand your point of view but, you know, I need more data, I need more reassurance in the way the pressure tubes are operated. So could you comment on this?

MR. NEWMAN: For the record, Gary Newman.

You touched on a lot of points there.

MEMBER LACROIX: I know.

MR. NEWMAN: We do have models for various parts of the fitness for service work that we do, you are absolutely correct, and we validate those models using typically test specimens. In the case of fracture toughness we do burst testing, we do small specimen testing, and all of that gets rolled into the development of those models. They are all predicated on fracture mechanics and they have a mechanistic basis. So they are not just a curve fit, they actually have a fundamental fracture mechanics logic behind them that allows you then to predict laboratory outcomes when you do accelerated aging and the associated tests.

Maybe I will try and answer one of your points related to the issue of additional hydrogen perhaps not having an influence on GHC initiation. I think that was maybe one of the comments.

In the case of delayed hydride crack initiation we have modelling that has been developed referred to as the process own model and what this really looks at is the critical displacement at a notch root beyond which you will actually get crack formation and propagation. Once you have a certain -- there is only so much real estate at that notch tip, right, there is only so much volume, so much area and once you have a certain amount of hydrogen in that region you can't get any more in. You form zirconium hydride and that's it. You just can't add any more to that notch root. So we are not saying that hydrogen concentration is not important, we think it is, but after you get beyond a certain point then it doesn't -- it kind of flattens out, it plateaus, it doesn't have any additional degradation influence on the propensity for crack initiation there.

Now, having said that -- and we have a technical basis for that -- as Mr. Carroll indicated, we're also doing confirmatory tests in order to prove that. We've done some of that, you know, years ago, but we're going to do some more of that testing. That will be occurring over the next few months. And that will be done to substantiate the technical basis that we've created there.

I'm not sure if I answered all your questions there.

MEMBER LACROIX: Well, yeah, well, you gave me -- you make me think.

Are you saying that at the 12:00 position, the top of the pressure tube could be saturated in hydrogen, and this hydrogen could be -- well, the hydrogen hydride could be diluted by the coolant itself, but it could also diffuse back down to the 6:00 position, where it is affected by the friction with the bearing pads and you could provoke or induce a crack and then have a leak over there? Is it possible?

MR. NEWMAN: Gary Newman, for the record.

No, once the hydrogen moves to the top of the tube, it will remain there, largely because the temperature gradient is maintained. And whether there's --

MEMBER LACROIX: When you say the hydrogen will stay over there, you mean within the pressure tube wall? Or at the top of the flow itself?

MR. NEWMAN: Within the pressure tube wall.

MEMBER LACROIX: Okay, okay. And it will not diffuse down?

MR. NEWMAN: No, because it likes to be in the coldest portion of the pressure tube. And at the bottom --

MEMBER LACROIX: Okay, so by temperature gradient.

MR. NEWMAN: Exactly. And --

MEMBER LACROIX: Not by mass diffusion.

MR. NEWMAN: Yeah, and metallurgy and so forth.

But the switch -- because the other comment I would make is we looked at these tubes at the inlets as well, right, so same chemistry -- different temperature, mind you, because it's the inlet. But no preference for hydrogen isotope at the top or bottom; it's all uniform. And why is that? Well, it's that way because there is no temperature gradient because the coolant is coming into the channel. It's completely uniform, no temperature gradient. But by the time it gets to the end of the string, as Dr. Luxat indicated, you have a flow bypass element [indiscernible - multiple speakers] --

MEMBER LACROIX: That's right.

MR. NEWMAN: -- cooler at the top, and that's what drive the diffusion to the top of the channel. Once it gets there, it stays.

MEMBER LACROIX: Okay, okay, okay. Thank you. Thank you very much.

THE PRESIDENT: So maybe I'll ask questions of Bruce Power, then we'll get EAC to comment, and then we'll get to staff and then Bruce Power can comment on the EAC's comments.

So Mr. Newman, what you're saying is -- or confirm for me these additional 42 channels that you have inspected you believe will give you the high confidence that staff has required in meeting the conditions of the order.

What I found difficult to follow in your submissions, and particularly as I was looking at the supplemental CMD, is of these 42 channels, what were the high levels greater than 120 ppm that you measured? There's a Table 1 in there, and it had got numbers of 600 and 452, and I wasn't quite sure whether I was reading the table right or not.

MR. NEWMAN: For the record, Gary Newman.

Yes. And so what you're looking at in the table there is scrape locations that are also in the rolling group region of the rolled joint. And as Dr. Luxat noted, you have higher concentrations out there all the time. That's not a problem because that entire region is in compression. The end fitting itself provides all of the -- takes all of the load.

All that region really does from an importance perspective, it can act as a source of hydrogen isotope, which eventually could diffuse into the fuel channel. We do see small amounts of that occurring. It does contribute to that region of the pressure tube. So it's really inside that burnish mark inboard where it becomes important.

And so the kinds of concentrations that we're seeing in at the burnish mark is really more the area of focus for us.

And then as I mentioned in one of my slides there, when we do postulated flaws for fracture protection, it then becomes important what the hydrogen is at that flaw tip, at that postulated flaw tip. And that's where the 20 millimetres comes in. So we take whatever the measured hydrogen is there, and we actually went in and scraped that location so we have exact numbers. And that's the point where -- that we use for doing our fracture protection analysis.

I don't know if I answered all your questions.

THE PRESIDENT: Yeah, so maybe just a follow-up then.

So for in these areas of interest for these 42 channels, how often did you measure greater than 120 parts per million?

MR. NEWMAN: I think out of all of the channels, I think we had 10 channels in total that would've been above at the burnish mark.

THE PRESIDENT: And what was the highest that you measured?

MR. NEWMAN: I believe it was 295 at the burnish mark.

THE PRESIDENT: And that is in the supplemental CMD that you submitted, is the --

MR. NEWMAN: I believe that information was submitted yesterday.

THE PRESIDENT: Yeah, I think that's the supplemental.

Okay. So my second question for you, then, is the request from Bruce Power. I mean, you yourself have said information has just been sent. There is more information coming, more analysis being done. So a bit premature for the Commission to make a determination on whether we would grant authorization or approval.

But as I look at the kinds of information that you've identified that is coming, the timeline, the addition -- or some that's just come in, the one piece I was not quite sure of -- and this is when we talk about flaws and do they, you know, if you don't have a flaw, you don't have to worry about fractures.

But have we understood at these high levels of almost 300 or sometimes even more than 300 ppm -- how confident are we around how the pressure tube behaves? Because your burst testing has not been done at those levels and has not been planned at those levels. So does one extrapolate? How do we know? How do we have -- how do you have the high confidence around --

MR. NEWMAN: Gary Newman, for the record.

So that's why we do fracture protection assessments. And it kind of touches on some of what Dr. Spekkens talked about where, you know, even if you haven't found any flaws, you have to assume that maybe you've missed one. And so that's why -- that's the sole purpose of doing the fracture protection analysis.

And that's what we're working on now and will be submitted in about a week's time is to be able to demonstrate that. And there's ways to do that. And that work is being done now and will be all packaged up and submitted as part of the request to restart the unit.

Now, of course, then that all has to be reviewed and discussed and agreed to ultimately by the CNSC staff and yourselves.

THE PRESIDENT: Okay, thank you.

And maybe I'll get CNSC staff first before we get to EAC. So CNSC staff, anything you wish to add based on the questions the Commission has asked to the responses we've got from Bruce Power? And are you confident that the information that Bruce Power has submitted, is likely to submit is -- you know, I mean, you don't know how complete it is. But do you think they're looking at all the right areas for staff's assessment and review?

MR. JAMMAL: It's Ramzi Jammal, for the record.

I'll start, Madam Velshi, and I'll pass it off to Dr. Viktorov.

Just would like to reiterate the fact that the information has arrived, and as you mentioned, Madam President, we are looking at the sufficiency of the information being presented.

But I will like to give the comfort to the

Commission. Is the licensee submitting information based on our discussions with them and the criteria? The answer is yes.

Now, is the sufficiency of the information being presented will be adequate for staff to make that determination with a recommendation to you as a Commission for the restart for specific -- for Unit 3? So I cannot predict. I can say to you that discussions are ongoing. I have the capability to say to you, talking to our staff that clarity is provided to the licensee and the package that we are waiting for on September 17 should include the information that we requested from Bruce Power.

And anyone from either Vali or Alex, if you want to add anything from your perspective?

DR. VIKTOROV: Alex Viktorov.

Just to supplement the answer, it's fair to say I believe that the industry is moving in the right direction. We are getting information as we requested. Not all quantitative analysis is performed or submitted to us, but we are getting commitment it will be done shortly.

And again, to summarize again, we're getting assurance that a large scope of the inspection is done or will be done in the next outages, that models have been built to understand better specific behaviour in the region of interest. We also are getting confidence that the safety case has currently accepted these are valid and he's not challenged by these assumptions. So we're getting a better understanding of the reasons, the impacts, and the overall risk implication. That will help us to make risk-informed recommendations once we get submissions that are coming shortly.

Thank you.

THE PRESIDENT: And Dr. Viktorov, can you comment -- and I know this is probably not terribly fair -- but if the submissions come September 17, like how long does it take staff to review and make a recommendation? Is it days? Is it weeks? Is it months?

DR. VIKTOROV: Alex Viktorov.

Our staff is miracle workers, then, it's too much to expect that we have -- but we recognize the importance and the high priority of this activity. There are other important activities, but we dedicate our utmost attention to this. So I believe we count in rather days, a few weeks at most, I believe. But again, it will depend on the completeness, information, whether we'll need to get more.

THE PRESIDENT: Okay. Thanks. Thank you for that.

Let me ask our EAC members. Given what you've heard, what you have seen so far, how -- you know, any advice to the Commission on should Bruce Power be doing more inspections, more analysis, are you concerned with what you have seen for the Bruce units so far? Any flags you want to raise?

DR. DAYMOND: Maybe I can jump in first, if that's -- Mark Daymond, for the record.

So like Dr. Spekkens, I've been very pleased or feel much more comfortable after a lot of the information that's been presented and the submissions that have been coming in over the last couple of days.

I think the evidence so far strongly supports this mechanism of flow bypass-induced temperature gradient causing the hydrogen redistribution. That's what the EAC had hypothesized a week or so ago was likely to be the cause. And I think Mr. Newman mentioned 26 degrees, and we had hypothesized around 20 degrees and come up with very similar temperature -- hydrogen gradients as well, so -- using pencil and paper. So and not nearly as accurate, but at least of the right order of magnitude.

There are two things that stem from that being the mechanism.

The first is that flow bypass only gets worse as the pressure tube gets older. So the amount of hydrogen redistribution will increase. But as Mr. Newman noted, that depends on the manufacturing history as well as flux in temperature. So that does give it a lot of predictability and therefore the opportunity to understand which of the tubes are leading the pack, if you like, which are the ones that are going to be most susceptible. And he also mentioned the back-end and front-end tube effect, which was certainly something that would be of an issue.

It's very promising to hear this additional data that Bruce is going to submit. I am not surprised to hear that it supports continued operation of these -- even in this high hydrogen content. As was noted, while properties degrade in the initial increase of hydrogen, you do reach a sort of steady state. And at that point, properties degrade relatively slowly with further increase. So I'll be very interested to see that.

So I think that's my comments for now. Thanks.

THE PRESIDENT: Thank you very much, Dr. Daymond, for that.

Dr. Spekkens, did you have anything you wanted to add?

DR. SPEKKENS: Yeah, I was just going to -- you asked earlier about the notion of pre-approval. And frankly, I am not a big fan of pre-approval. I would much rather see a regime where there is agreement between the licensee and the regulator about what is going to be done in a forced outage if one was to happen or in a planned outage, and that the ticket out of the outage is just to demonstrate that you've done what you were going to -- that you said you were going to do something and you've done it.

There is always a possibility that further analysis will reveal something that wasn't known at the time that, you know, it was allowed back up. But then you bring the unit back down. And I don't think that's going to happen very often.

If there's good thought given into what is reasonable to do during an outage of the length that a forced outage is and a planned outage, and then it's just doing what you said you were going to do and not seeing anything untoward in a first analysis of the data, that shouldn't take very long.

And I think that's a better regime, because it means both sides need to stay on their toes.

THE PRESIDENT: Right. Thank you. Thank you for that, Dr. Spekkens.

Dr. Luxat?

DR. LUXAT: Yeah, I agree with Dr. Spekkens. The key is actually being able to manage the return to power, so the -- and that's where pressure temperature envelope becomes important. There is a significant hysteresis in the terminal solubility when you are heating it up and dissolving the hydrides as opposed to when you are cooling down and they're precipitating out. And that gives you a kind of a fairly narrow band to work within on the -- how you return a unit to service.

Another thing I would suggest that it should be quite readily available is to add to the data being supplied where we have -- the licensees have collected data from in-service inspection on hydrogen equivalents is to provide also the state of creep of the pressure tube.

Because if the mechanism is -- has flow bypass, it will only increase with time as the diametrical creep increases. So that will give a larger and larger delta T. So it might appear that you actually taking up hydrogen more quickly, whereas actually you may just be redistributing it more rapidly.

Because the concentration of hydrogen -- usually in the diffusion process, the concentration of a particular substance is also an important element. So if you have very high levels, you're more likely to -- if you get into an additional redistribution, such as going from the outlet end-fitting roll-joint region to the -- axially down the tube, that could influence the concentration of -- in that region of concern.

So that's just a suggestion. It could be useful to know that.

THE PRESIDENT: Thank you.

Bruce Power, any comments on what the EAC members have said? Mr. Newman?

MR. NEWMAN: For the record, Gary Newman.

Thank you. There seems to be a time delay when I try and get onto the -- unmuted. Yeah.

Maybe I'll start with the -- I don't think I disagree with anything Dr. Luxat indicated. We, for example, in for Unit 3, the diametrical expansion that would be bounding for that right up to the point at which we get to MCR is about 3.3 per cent. And that is something that's included as part of the modelling work that we do.

It's not really the end objective, obviously. It's the -- it's really the temperature distribution that we're most interested in. But he's correct that that does -- that is one of the inputs to that. Because it does change over time.

And the testing that we've done, we've done right up to over six per cent. So and the modelling tools that are available can supplement the testing that's been done right up to those amounts.

So we don't view that as being a limitation in any way, shape, or form. We simply would follow, you know, that as part of our protocol for doing predictions at the time of the next planned outage, whether that be a normal outage or the MCR, as it would be for Unit 3.

So I'm in agreement with that. No problem there at all.

In terms of getting agreement on the forced outage campaign, I guess part of my concern there would be launching an inspection campaign in a forced outage circumstance, the logistics of doing that would -- could create other risks and hazards as well. So I think it's something that we would need to think about.

Certainly for the planned outages, I would fully endorse that. But for a forced outage, provided that we're able to demonstrate that we haven't had any pressure excursions, we've cooled down and heated up following our protocols and so forth, my advice would be that we simply return the unit to service. And then when we get to the planned outage, we would certainly move to our full inspection scope where it can be planned and thoughtfully carried out.

That's just my perspective.

THE PRESIDENT: Mr. Mudrick, please?

MR. MUDRICK: Yes. Thanks. I just wanted to add to Gary's comment there. I've got two points.

One, appreciate that the information is still coming in and quickly. And our whole purpose here was to make sure that as soon as we get that information that we're turning that over to the CNSC and reviewing it, making sure. So while it seems like, you know, some of this information is fresh, it is because we're trying to purposefully get that information. It's an important issue to us, and it's important that we share that as soon as possible. So it is quickly evolving information as we get it, so I appreciate your patience with that.

Second, you know, as Gary mentioned, I do believe that, you know, we do have planned inspection campaigns in the slides that James showed. Those are coming up shortly. We have Unit 7 coming off in November. We have -- followed by Unit 5. We currently have done a number of inspections on Unit 3. So with our planned campaigns, we will continue to refine the model, continue to do those inspections, continue to categorize.

Taking that time to do that in a forced outage, from an operational perspective, can be completely disruptive and can really, you know, alter, you know, the plans for the currently planned outages. So it's important that we have that certainty only because I think that is the -- will provide the shortest duration that we get to the answers that we're looking for on these longer-term issues.

So just wanted to add that. Thanks.

THE PRESIDENT: Thank you.

And maybe I'll ask -- Mr. Mudrick, if you can just hold on one moment, I just want to get Dr. Spekkens' perspective on this.

Dr. Spekkens, for the unplanned outages -- or is it Dr. Luxat? -- one of you. Who wants to, you know -- on some concerns that Bruce Power has raised, what were your thoughts?

DR. LUXAT: I'll let Dr. Spekkens answer. I just wanted to clarify I was not at all suggesting that you try and do inspections during a forced outage.

THE PRESIDENT: Right, yes. I didn't think you were. Right.

Dr. Spekkens?

DR. SPEKKENS: Well, that's essentially the same as what I was going to say. If you're in a poison outage and you've only got three days, then no, you're not going to do any inspections. But some forced outages last more than three days. So if a forced outage is going to last a month, not doing any inspections at that point I think is -- that's starting to push it a little bit too far.

So again, there has to be agreement ahead of time between the regulator and the licensee on what is reasonable in a very short forced outage or a longer forced outage.

So it's not going to be one recipe for forced outages and a different recipe for planned outages. It all depends on length.

THE PRESIDENT: Thank you. I hear you.

Ms. Maharaj.

MEMBER MAHARAJ: Thank you, Madam Velshi.

Just a couple of comments that Mr. Newman and his colleague had made just made me think with respect to the planned outages piece because we started with Unit 3 but we've sort of moved through now to the unplanned outages.

I'm taking a look at CMD21-H11-2B, the supplementary submission by Bruce Power, and I just would ask Bruce Power if they could clarify the six assumptions that they listed in their supplementary submission which are the assumptions or the key principles that they say are core to the submission. And I presume that submission is with respect to the unplanned outages as well as the request to restart Unit 3.

Particularly when you look at point number 1, it suggests that the hydrogen uptake is not increasing beyond the predicted rate. And my question with respect to that principle is, isn't that why we're here in the first place because the hydrogen uptake increased beyond predicted rates?

So if that's a principle upon which Bruce is relying in order to give the Commission comfort to agree to the request, how do they -- how does Bruce Power bring together those discrepant concepts?

THE PRESIDENT: Thank you, Ms. Maharaj.

Mr. Newman?

MR. NEWMAN: For the record, Gary Newman.

We've tried to stress throughout here -- that's a great question, and it's an opportunity to clarify.

We do not see an incremental change in the rate of deuterium pick-up, and that's reflected in the modelling and bounding nature of the deuterium predictions we're doing in the largest part of the pressure tube.

What we are seeing, though, where that model doesn't work and we've had to go to, now, a new model and a two-dimensional treatment is that we're getting a redistribution of that. But it's not a change in the corrosion rate or the pick-up rate; it's actually just -- it's just a redistribution of the hydrogen that's already there.

Hopefully that clarifies.

MEMBER MAHARAJ: Okay. So if I just simply, it's not as though you're seeing additional hydrogen deposition. You're just seeing it relocated. Is that fair?

MR. NEWMAN: You're absolutely correct.

MEMBER MAHARAJ: Okay. And then with respect to the other key principles, you also mention that your future unit scrape sampling would be repurposed to identify flaws in the region of interest.

Can you just help me understand what you mean by that, that third -- it's number 3 in your list of six principles?

MR. NEWMAN: For the record, Gary Newman.

I don't have that in front of me right now, but I can respond to your query.

We have set -- scope that we set for every planned outage. It's all part of our life cycle management plan for our major components, and the fuel channels are one of those.

So what we meant by that statement was that we're going to refine what we were planning to look. We normally will do full-length volumetric inspections that goes from one end of the channel to the other. What we're going to do now, though, based on what we found in Unit 3, is we're going to refine that and we're going to look in the regions in a very similar way to what we've done in Unit 3.

We may not increase the number of channels that we actually ultimately scrape sample, and we'll have to look at the technical basis for that, but I think what we want to do is take all the learnings from Unit 3 and then redeploy them into the plan campaigns for the upcoming units.

As Mr. Scognack indicated, over the next 18 months we'll be looking at all the other units.

I hope that helps.

MEMBER MAHARAJ: Yes. So then if I can draw a conclusion, what I believe you're saying is that you're going to focus on the area that seems to have created the concurrence between elevated hydrogen and flaws which raises a risk of cracking, which raises a risk of all sorts of other bad things to happen in your inspections of the upcoming units. Is that a fair distillation? Do I understand correctly?

MR. NEWMAN: For the record, Gary Newman.

Yes, you are correct.

So we're going to take all the learnings from Unit 3 and we will roll that understanding in terms of where to scrape in each of these channels into that scope.

MEMBER MAHARAJ: Okay. And then your

final key principle that I wanted to understand better is you indicated that additional operational measures are being put into place to build operational safety margin during heat-up and cooldown in particular, as well as during cold primary heat transport conditions where there is low but finite potential for overpressure conditions to occur.

So is this a change to your existing inspection process or can you help me understand that?

MR. NEWMAN: Yeah. Mr. Mudrick kind of touched on a number of those elements during his presentation last week and in more detail this week, but I'll summarize.

So the way we cool the unit down, we do it in a stepped pressure fashion so that you reduce the load on the fuel channels as the unit cools down. And by doing that, you decrease the -- you know, the load that the fuel channels are carrying as the primary pressure boundary.

What we're doing is just -- we've always done that at all of our Bruce units. All we're doing right now is refining that and making that even more -- even reducing the loads even a little further, and it's sort of a refinement that we're putting place for Unit 3.

As Mr. Mudrick indicated, we will look at the other units to determine whether or not that needs to be done as well, but right now we're focused on doing that for Unit 3 and then we'll decide whether the other units require it or not.

That's the heat-up and cooldown portion of it. Then for the -- when you're in a cooler condition in the primary heat transport system, you can have a loss of pressure control. And that's what you referred to as the cold overpressure transient.

And what we're doing is put a modification in place following our engineering change control that will not allow that to happen, so it won't allow the pressure to go up when you're in a cooler pressure of the -- of that cooldown.

MEMBER MAHARAJ: So does that explanation that you've just given that did make sense to me, thankfully -- does that also apply in the case of a forced outage or is that in the case of a planned outage only?

MR. NEWMAN: Right now, it's just for -- it'll just be for Unit 3 as a first step, and then we'll assess whether or not that needs to be applied for the balance of the units, like Units 4 through 8.

MEMBER MAHARAJ: Okay. But it is a key principle that you're relying upon to submit that the Commission ought to give a blanket authorization to restart the other units after a forced outage, so how do you reconcile those two positions?

MR. NEWMAN: Well, we put measures in place as we cool down and as long as we follow those requirements and we don't have any -- we monitor the pressure and temperature as we cool the unit down, provided that we don't have any excursions in pressure, then -- and that's all -- that's all recorded, then we would say we cooled the unit down fine, there's no reason to do anything further. We can just restart the unit without a concern related to, you know, that loss of pressure control at a lower temperature.

I'm talking about temperatures down in the, you know, 50, 60, 65 degrees Celsius.

MEMBER MAHARAJ: Okay. I think I understand, but I think I've also hit the end of that line of questioning for myself.

Thank you.

THE PRESIDENT: Mr. Scognack?

MR. SCONGACK: James Scognack, for the record.

Ms. Maharaj, just one other point to -- I think to underscore, and perhaps we didn't fully clarify it in our earlier presentation. And it really ties in with principle 6.

In addition to the forward-looking

conversation that Mr. Newman and Mr. Mudrick noted on Units 4, 5, 7 and 8 with planned outage inspections over the next 18 months, it's also really important to note that all of those units have undergone planned inspections, scrape, volumetric inspections over the previous 18 months as well.

So we have been into those units. They're consistent with the periodic inspection program and consistent with all licensing requirements.

THE PRESIDENT: Okay. Commission Members, have we exhausted questions for the Bruce Power request?

I don't see a hand up, so let's now proceed with questions to OPG on their request regarding the Pickering and Darlington units.

And we'll start with Dr. Lacroix first, please.

MEMBER LACROIX: Yes, I do have a technical question for OPG.

In your supplementary submission, on Section 3.3, you talk about the possibility of having damage by the fuel bundle or to the pressure tube when a pressure -- when a fuel bundle rests near the flow holes. And I was wondering, is it -- what is it, exactly -- what do you mean by "flow holes"? Are you in the region of the feeder itself? Is it the fueling machine? I'm not sure.

And there is a picture on page 7, I guess, from your supplementary documentation which is CMD21-H11.1B. On page 7, yeah, there is a picture, but I still don't understand what are these flow holes.

THE PRESIDENT: Mr. Knutson?

MR. KNUTSON: Thank you, President Velshi.

Thank you for the question. Mark Knutson, for the record.

Yeah. The flow holes as described there are essentially -- the pressure tube runs horizontally, and the two feeders, what we call feeders on either end of the pressure tube feed the coolant into the tube itself, so it's an entry point for the flow of heat transport water into the tube and those holes allow for a control and straightening of the flow. But when we push the fuel out through the end of the tube there in refueling, the fuel bundle will go underneath that flow and, therefore, vibrate and potentially cause fret.

But what we've seen through our experiences, that's normal to push through that region and it stays there for 30 seconds or a minute, but if you leave it there for two days or three days, it vibrates enough to potentially cause a fret damage, which are typically, in our inspections, are benign, are flat, no sharp edges. But we did procedural changes in 2015 to say that if you're in this region because maybe the fueling machine has broken, has an issue, and so you're held there in that position, we would shut the unit down and also shut down our main heat transport pumps to stop the flow from causing that vibration.

So in that -- in that change in 2015, in subsequent events similar to this we actually -- we don't -- we go and inspect, but we don't stay there as long as we used to and, therefore, those types of flaws have essentially been eliminated because of that operational procedure.

MEMBER LACROIX: That's clear. Thank you very much.

THE PRESIDENT: Ms. Maharaj.

MEMBER MAHARAJ: Thank you, Madam Velshi.

My question is really around the concept -- and it came up in the context of the Darlington units -- that there's been a large population of inspections that have shown a result that there are no flaws in the region of interest and none would be created because of the fuel carrier system, a unique fuel carrier system.

My first question is whether that fuel carrier, fuel handling system actually does create a zero risk of flaw scenario and, if so, is that fuel carrying system applicable to other units or the Pickering units?

It seems like a good thing if that's the case.

So is it transferrable?

MR. KNUTSON: Mark Knutson, for the record.

What I would say is the -- yeah, the carrier for Darlington is a design obviously next generation compared to the Pickering design. The Pickering design is older. So that would -- that right now is not feasible to retrofit that type of design on the Pickering units.

The good news is for Darlington and for Pickering, we do inspect that area. That's part of our full-length visual inspection and, therefore, that's why we're informed of what flaws are there and what flaws could be created. And we don't see that from normal fueling.

MEMBER MAHARAJ: So if I can just clarify, then, Mr. Knutson, at Darlington this advancement in technology has created a better situation where there are -- there's a lower risk of flaw creation. Is that part correct?

MR. KNUTSON: That is correct.

MEMBER MAHARAJ: Okay. But as I believe it was Dr. -- one of the gentlemen on the EAC, the second one, he said zero is a very small number.

Is it your position that this new fuel

carrier system eliminates the risk of flaws or is there some context you can give us as to how limited the risk is?

MR. KNUTSON: Yes. So we obviously say very low because of the -- our inspections don't show any flaws there over many years of operation, so we have pretty solid evidence that the design for Darlington works very well. It restricts the motion up and down in terms of a vibration and the impingement of the flow, it also controls that when the fuel passes through this area.

And again, similar type actions. If we had a fueling issue where we had to stay in that position for an extended period of time, we would do the similar action in terms of shutting the unit down.

So that's why we -- you know, one is that we have a design that is -- makes it much more obvious to us that we shouldn't have flaws, but the other is we inspect. And that's where the confidence comes from.

Okay. So then with respect to the condition in the Designated Officer Order, the second condition, is this design for Darlington how you would support a position of a high degree of confidence that no flows are present?

MR. KNUTSON: That is correct. And that is our position, that based on the design plus inspection, we already have high confidence that flaws do not exist in that region.

MEMBER MAHARAJ: Okay. And is that the basis for your position with respect to Darlington, at least, that post-forced outage or unplanned outage you ought to have a blanket authorization to restart? Is this the foundation?

MR. KNUTSON: That's part of -- yeah. I mean, the fact that we have no measured Heq high is one clause which we would stand by, and then the second is no flaw in the region of interest. That is correct.

MEMBER MAHARAJ: Okay. Thank you.

THE PRESIDENT: And so maybe with that I will ask Staff a question.

So the OPG position is that they have been operating within the licensing basis, they're high confidence that they don't have high Heq levels. And we just heard no flaws or no undispositionable flaws.

So Staff, is -- and I know you -- you know, data and results are coming in real time. Is the issue from your perspective just that you need more time to review what has already been submitted? Are you expecting more information?

Because one of the issues you had raised, I believe, is that maybe the inspection results for the Pickering and Darlington units may not be sufficient given that they haven't been able to inspect as well in the area of interest, say, as the Bruce 3 Unit or 6 Unit has.

So Staff, your thoughts on OPG's request. Is it a question of timing? Is it really a lot more information that you're still waiting for?

MR. JAMMAL: Ramzi Jammal, for the record.

I'll start now with the discussion on the condition of the Order and the information submitted. I will start at the high level and I'll pass off either to Dr. Viktorov or Mr. Carroll.

I'd like to start with what the initial -- or the intent of the Order has been achieved to start to put the information together in order to make sure that the restart will be in accordance to the licensing basis as established by the Commission.

At the time, the information submitted by the licensee was relied on probably inspections and predictabilities of the model, but according to Staff, nothing was being presented as new information. That was all the assumptions that were given to us all along.

Now, with the new information coming to us, we will be able to assess the technical information submitted for regulatory decision, but the dispute -- not dispute, sorry. The discussion within the CNSC Staff, was the information submitted adequate to present us with a statistically significant assurance based on the inspections done that the predictability of the information submitted to us in support of the restart is adequate.

So either Alex or Blair, over to you.

THE PRESIDENT: And sorry, Mr. Jammal, before Alex or -- Dr. Viktorov or Mr. Carroll answers, the request from OPG is -- it's not just restart, it's actually saying, "Close the Order for us. It doesn't apply to us".

So can you comment on that, Dr. Viktorov and Mr. Carroll?

DR. VIKTOROV: Alex Viktorov again. I will offer my perspective and Mr. Carroll, I'm sure, will be able to enrich the discussion with technical insights.

From our perspective, when we issued the first request under 12(2) and then followed with Orders, we didn't have a full appreciation of similarities of conditions in Bruce reactors versus those of Darlington and Pickering. As more information come in, we start to understand what's similar and what's different. Again, having the more substantive submissions will help us to situate and appreciate the risk and, on this basis, to define the best course forward.

Again, as I mentioned, overall the strategies taken by licensees in Bruce Power and OPG somewhat different, but they seem to be coming from the facts and objective evidence, and that will be also the basis for our recommendations, the objective evidence supported by inspection or test results and validated modelling.

And I'll pass to Mr. Carroll to supplement.

MR. CARROLL: Blair Carroll, for the record.

So yeah, to go back to some of the discussions already been provided, I mean, at the time we had limited information and we don't make assumptions as staff as to what the cause is. We require evidence to support what -- to support those cases.

So at that point in time -- and even at this point in time, we still have some questions about the -- you know, the Heq levels in the Darlington units.

Yes, from what's been measured, it hasn't been seen that these very high levels that have been observed in Bruce Unit 3 and Unit 6 are observed in the tubes that are operating in the Pickering and Darlington units. But because we don't fully understand the cause, it's hard to say at this point in time that it doesn't exist in some fuel channel or pressure tube that has not been inspected yet or will not occur with continued operation.

Because we have to not just look at what's happening now, but when we approve -- or if CNSC staff is recommending a restart, we're looking three years into the future, because that's probably the next time that unit may go down for further inspections. So if there's something related to hydrogen uptake that has increased the uptake level more than expected, we have to be able to think three years into the future to make sure that that's not going to put the pressure tubes into an unsafe state, even if they're in a safe state today.

So as we get more information, and for instance, with the Darlington we now have a better explanation of -- if we take the information with regards to the inspections that have been done plus the physical and mechanistic understanding of flaw formation that's specific to that location in the pressure tube, we can take that information together and look at how we can provide an overall recommendation to the Commission that may be specific to the Darlington units.

But from my perspective at this point in time, and I think this is shared by some of my other colleagues, to make a case solely on hydrogen equivalent concentration at this point, without fully understanding all the parameters that went into the results or the events that occurred at Bruce and OPG -- or sorry, Bruce Power

Unit 3 and Unit 6, it's a bit premature to say we will blanketly accept what's happening is not happening somewhere else.

THE PRESIDENT: Thank you.

Given what OPG has said -- well, you know the information that they have provided you, I don't think you're expecting more information from them, are you? It's just going through what's been submitted? For some immediate recommendation to the Commission, I mean.

MR. CARROLL: Blair Carroll, for the record.

I guess I can take this from a technical perspective.

At this point, we will go through what's been submitted within the past, you know, two to three days and actually within the past week. At a technical staff level, we will look at that. There may be some questions that arise and we may have to go back to OPG for additional clarification.

We're not expecting anything specific from OPG at this point, other than what they've already committed to in their most recent letter. But we may talk about timing of work that they've committed to do, or we may talk about specific details and work that out as part of our review. And we will go through that process before making the recommendation to Dr. Viktorov and his group.

THE PRESIDENT: Thank you very much.

Then let me turn to EAC members, then, for your perspective around the OPG units. And we'll start with Dr. Spekkens, please.

DR. SPEKKENS: Yeah, so I agree with what Blair is saying.

But I think you have to take a step back and look at what the situation is at Darlington. Unit 1 comes down for a refurb in five months. The highest level that's been seen is 75 ppm. It's just incredible to think that you'd go from 75 to over 120 in five months.

So if there was a three-year run ahead of it, then you look more carefully. But when you're counting -- they have about 4,000 hours left, and they're at about 230,000 hours. So it's a minute little bit of operation at the end of life. I think you have to look at that pragmatically.

THE PRESIDENT: Thank you, Dr. Spekkens.

Any other EAC members?

Mr. Jammal -- sorry, just make sure no other EAC members have anything to add. Dr. Daymond? Dr. Luxat? No?

Okay, Mr. Jammal?

MR. JAMMAL: Thank you, Madam Velshi.

Support Dr. Spekkens' comments, and that's part of the evaluation on the time at risk and the assessment for us to look at each unit specific; hence, the request first we need more information for blanket approval and that we'll take each unit according to the request from the licensee.

And what Mr. Blair said, the three-year is the most conservative way. But we're going to take into account the fact that the length of the operation between outages and the risk and time at risk with respect to the analysis that was done based on each unit specifically.

I just want to close that loop, Madam Velshi.

THE PRESIDENT: Thank you very much, Mr. Jammal.

Mr. Knutson, your reaction to the EAC comment?

MR. KNUTSON: Yes, thank you, President Velshi.

Mark Knutson, for the record.

I'd just add to that sort of information. Unit 1 does come off line in February of next year. Unit 4 has a planned outage this fall where we will be doing our normal planned inspection program with some enhancements in terms of going to top dead centre in terms of some of the scrape samples.

So we believe we'll be informed by the planned outages and the inspection campaigns and that forced outage type campaigns for inspections comes with risks in terms of -- right now, typically, it's about an eight-week program to get an outage campaign where we would inspect tubes in a forced outage. And that means tooling, people, dose, and a number of issues there.

So I would say that OPG's position is we'll inform going forward based on our planned outages.

THE PRESIDENT: Okay, thank you.

Maybe I'll ask Dr. Luxat.

DR. LUXAT: Yeah. I just wanted to add one other factor which could be causing a difference between Bruce and Darlington, and that is Darlington was designed to have some boiling -- limited boiling at the exit of the channels. And if that existed in some, you'd get a lot more mixing of the flow, which would tend to reduce the delta T if you just -- through a single phase liquid going there. So that could ...

Just raising that as an issue, which is a design issue. Now, it's up to Darlington to make the assessment whether that's relevant or not.

THE PRESIDENT: Okay. Thanks, Dr. Luxat.

Ms. Maharaj? Dr. Lacroix? Before we

close the hearing, any additional questions you have of licensees, staff, or EAC members? Dr. Lacroix?

MEMBER LACROIX: No, I do not have any question right now.

THE PRESIDENT: Ms. Maharaj?

MEMBER MAHARAJ: No further questions.

THE PRESIDENT: Okay, thank you.

So this concludes the hearing.

I know the CNSC staff will be sending further recommendations to the Commission once they've had a chance to review all the information that has been submitted and more that's coming, so we will be -- we will be waiting for that before we move ahead on some of the matters in front of us.

But this does conclude our hearing. I do want to thank you all for your participation.

And Marc, I'll turn it over to you for any final comments you may have, please.

MR. LEBLANC: Thank you.

To complete or complement what you just mentioned, this does close the public hearing.

With respect to the three orders, the Panel of the Commission will deliberate with respect to the information that it has under consideration and then determine if further information is needed in addition to what has already been discussed or if the Commission is ready to proceed with a decision.

With respect to the requests for restart, the Commission will also consider the submissions that have been made and determine if the Commission requires additional information or if the Commission is ready to proceed with a decision, again with the caveat that some information will be forthcoming in the near future.

We will advise accordingly. Thank you.

THE PRESIDENT: Okay. Thank you, everyone.

--- Whereupon the hearing concluded at 5:57 p.m. /
L'audience s'est terminée à 17 h 57