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Commission Members present

Ms. Rumina Velshi
Dr. Marcel Lacroix
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via videoconference / par vidéoconférence

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mardi 22 février 2022 à 9 h 15

THE PRESIDENT: Good morning and welcome to this hearing of the Canadian Nuclear Safety Commission on the application from Bruce Power for authorization to restart Bruce Unit 3 from future outages and to close a Designated Officer Order issued to Bruce Power on July the 26th, 2021.

I thank you for joining us today to help answer questions that the Commission has as we deliberate on this request.

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 for the land.

--- Pause

THE PRESIDENT: The Panel of the Commission for this hearing is comprised of Dr. Marcel Lacroix, Ms. Indra Maharaj, and me, Rumina Velshi.

Also joining us are Lisa Thiele, Senior

General Counsel to the Commission, Denis Saumure, the Commission Registrar, and members of the External Advisory Committee on Pressure Tubes. Thank you for joining us.

The Commission has reviewed the submissions from Bruce Power, CNSC staff, and the External Advisory Committee. We have some outstanding questions prior to deliberating on Bruce Power's request and this morning we would like to take the opportunity to ask those questions.

Please mute yourselves unless you are speaking and use the "Hand up" function if you want the microphone passed on to you.

Without further ado, I will turn to Ms. Maharaj to start the question period.

Ms. Maharaj, over to you, please.

MEMBER MAHARAJ: Thank you, Madam Velshi.

I would like to ask some questions focused on the region of interest issue.

There seems to be a little bit of lack of alignment between staff and Bruce Power with respect to what the extent of the region of interest should be and I'm hoping that somebody can help me understand that a little bit better.

So from what I have read and understand, the likelihood of elevated hydrogen equivalent

concentration is primarily, and to date has been shown to be, at the top of the pressure tube because that is where it is cooler. However, there is currently a question with respect to why Bruce Power is taking the position that the circumferential region of interest should be less than 360 degrees.

So I'm hoping Bruce Power can clarify that for me and I also just point you to the commentary in the response from the EAC to deal with that as well.

THE PRESIDENT: Mr. Scongack, please.

MR. SCONGACK: Sorry, just coming off my video.

It's a great question. Before I pass it on to our Chief Engineer, Mr. Newman, maybe I could just sort of refresh people with respect to the process and sort of how we got to where we are today, because I think some context is really helpful.

Earlier on in this process, dating back to early August -- obviously, Commissioner Maharaj, that was prior to a lot of additional work that has been done in this space -- CNSC staff provided Bruce Power, and I believe other licensees, their view of the region of interest, and that region of interest was defined, as you noted, at 360 degrees.

CNSC staff at that time also noted that as

additional information became available that they were prepared, based on data and facts and results, to consider revising that region of interest. And so, as you noted, that was 360 degrees.

At the time, based on the knowledge Bruce Power had, and that remains the case today, Bruce Power believes a more appropriate region of interest would be 120 degrees. That is an area that as we continue to work through the process with CNSC staff we will provide the evidence from those various pressure tube inspections and the analysis for CNSC to consider, as they noted in that August letter, revising that region of interest. That is obviously a matter that is still before CNSC and, frankly, CNSC staff is still working through that and our technical teams are engaged.

As it relates, though, to the discussion today, the region of interest, and there is only one region of interest and that's the region of interest that CNSC staff decide and Bruce Power engage with that. As it relates to the region of interest defined by CNSC, that is really the subject of today's Commission Member Document that provides a recommendation to restart Unit 3 from a planned outage and that is with the 360 degrees.

So there has been a bit of an evolution here and that is just really a timing issue.

But with that, I will pass it over to Mr. Newman to provide some further technical and broader context.

MR. NEWMAN: Thank you, James.

Gary Newman, for the record.

James summed it up quite nicely, including the temporal aspect of developing our understanding and so forth, but quite simply put, if we look at all of our surveillance tube results plus all of the scrape sampling information that we have accumulated to date, it all supports the region of interest as defined by Mr. Scongack. So I'm not sure there's much more on the technical front that I can add to that.

THE PRESIDENT: Thank you, Mr. Newman.

I will turn to Dr. Viktorov to get the CNSC staff perspective on this.

Dr. Viktorov.

DR. VIKTOROV: Thank you.

Alex Viktorov, for the record. Good morning, everyone.

I'm not going to contradict in any way what was presented by Bruce Power, but it's CNSC staff's view that we take a conservative position at this time. Until we have evidence that there are no mechanisms that will affect the hydrogen distribution circumferentially, we

prefer to take a conservative stand. It's a more prudent approach until we have experimental results and modelling explanations of the phenomenon that closely matches the available empirical data.

The available results do align with Bruce Power's position, but until the licensee presents a model that explains well the observed phenomenon and rules out future expansion of observed region of interest, we prefer to be conservative in our position.

MEMBER MAHARAJ: Thank you, Dr. Viktorov.

Madam Velshi, if I might just follow up with a quick question.

You started to touch on the wording that was giving me the concern, which is in the response. It says:

> "...there is insufficient evidence to support that the region of elevated Heq concentration will not continue to expand axially and circumferentially with continued operation."

So, Dr. Viktorov, when you speak about being conservative, am I understanding correctly that if you take a snapshot of the pressure tube and the data and the evidence that you have so far, there's no lack of

alignment with Bruce Power's position but that we haven't got a clear line of sight as to whether or not that status might change? Is that what this comment is referring to?

DR. VIKTOROV: Alex Viktorov, for the record.

Correct. Yes, that's what we are trying to convey. Factual data, we have no disagreement with it. We are trying to get a better handle, better assurance that in future the situation will not change significantly.

MEMBER MAHARAJ: And in the response to the EAC comment, there was a comment that said "choosing to eliminate the bottom of the pressure tube because there is not a likelihood of flaw formation because there are no bearing pads there." Do you agree with that statement or is that a different topic?

DR. VIKTOROV: Generally, bearing pad marks are on the bottom of pressure tubes. However, at the outlet region, because of the particular design of the fuel channel, in Bruce reactors there are no bearing pads, again prevented or excluded by design configuration. So in a way, that particular aspect is not of great concern. However, again, we cannot exclude the formation of a defect in this area definitively. It's still a possibility, but in our mind, it's a remote hypothetical possibility that's not really borne out by available evidence.

But here, I am stepping into a specialized area and I would like to request our specialist to maybe offer a more precise view on the issues you are raising.

MR. CARROLL: For the record, Blair Carroll, specialist with Operational Engineering Assessment Division.

So with respect to the questions that were raised by the EAC.

With regards to the region of interest, as Dr. Viktorov had mentioned, there are no bearing pads located circumferentially or axially within that region. So that's the main driver for the formation of deep flaws.

With regards to Unit 3, there have been 111 pressure tubes inspected at this point and there have been no deep flaws detected in any of those pressure tubes in that region.

Overall, if you look at the Bruce Power reactors combined together, there have been almost 500 pressure tubes that have been inspected, and, again, no flaws in that region of interest that are going to initiate cracks.

So while we are looking at it from the perspective of we aren't ready at this point in time to say that the region won't expand, even if the region does expand, there are no flaws that should impact the potential

for crack initiation. So whether it's defined right now as the top of the tube or the full circumference of the tube, it doesn't change the conclusions of CNSC staff that there is a low risk of having cracks in that location.

MEMBER MAHARAJ: Perfect. Thank you very much.

THE PRESIDENT: So maybe I can ask a couple of follow-up questions on that. Maybe I'll start with you, Dr. Viktorov, and then we'll turn to the EAC for their perspective on this.

So, Dr. Viktorov, what I heard from Bruce Power is that they actually have evidence or additional results and maybe some other information that they have submitted to staff and that you are still currently reviewing it. I just wanted to confirm. Do you already have this information under review or are you expecting more before you can revisit what your current definition of the region of interest is?

DR. VIKTOROV: Alex Viktorov, and thank you for the question.

We do get additional information for the results pretty much continuously from Bruce Power as well as other licensees. Information gets accumulated and it's helpful in formulating our position, getting confidence in our recommendations. However, we have not, at least not to

my knowledge, received a model that definitively explains the observed behaviour closely, quantitatively closely to the results that have been obtained through testing or surveillance. Model development is still ongoing and we have not received this revised model yet.

THE PRESIDENT: Thank you.

And maybe I'll turn it over to the EAC because your position in your report is that this better get resolved sooner rather than later. So I wanted to get your thoughts around how critical is it that there is alignment between the CNSC and the licensee and the timing of that alignment.

Dr. Luxat, we'll start with you first.

DR. LUXAT: Okay, and I'll hand it over to Paul Spekkens, who was the originator of that comment.

But I guess where we are coming from, our remittance in terms of the Committee is to provide advice to Committee members and not get involved in specific details either coming from intervenors or from staff. So we will -- we've been basing our comments primarily on the evidence that we are aware of. Now, if there's other evidence, that obviously would make matters different. But I think the issue really comes down to what is inferred from the available evidence from Unit 3 and Unit 6.

Now, I'll hand it over to Paul and he

could perhaps expand a little bit on that comment.

Paul. If you just unmute.

DR. SPEKKENS: Paul Spekkens, for the record.

So the comment was really just a reflection of the fact that when you read two different CMDs about a single topic, it certainly sounds as if the two groups are speaking about different areas and that can be very confusing to the Members of the Commission but also to the public who have an interest in this sort of thing.

So the comment was that while this whole thing is being sorted out, there needs to be clarity on what the one ROI is that all the submissions have to deal with, and that kind of clarity isn't there now.

Dr. Viktorov's comment about waiting for a model indicates that we could be waiting a very long time. This is not -- the model that will describe this behaviour is not something that we would expect to be able to develop quickly and then validate. So it sounds as if there could be a discrepancy for a long time and that's a bad thing.

Letting the inspection data define the region of interest is a pretty valid approach, particularly because there are going to be additional inspections and we will know if this region of interest expands because there will be results showing the hydrogen level creeping up on

the sides of the tube.

The last thing we have to remember is that Bruce 3 doesn't have such a long operating run anymore and it's, in my mind, highly unlikely that there would be a major change in the area of the hydrogen levels in the last year the plant was operating.

So our plea is for consistency between the region of interest as defined by the staff and by the utility and then that consistency has to be sort of reflected in the submissions. And right now, having read both submissions, it sounds as if the two groups are talking about different areas and that's not a good thing.

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

And maybe I'll just ask CNSC staff and Bruce Power if they wish to add anything.

But what we have heard from Bruce Power is the CNSC's definition of the region of interest is -- they accept that. So it's not a question of alignment, it's just that they believe that there is enough evidence to revisit that, it's a question of the timing of when that happens.

So, Dr. Viktorov, anything you wish to add to the EAC comment?

DR. VIKTOROV: Thank you.

Alex Viktorov, for the record.

Two quick points and then I'll ask Luc Sigouin, Director for Bruce Site, for his view.

So my two points.

The CNSC region of interest envelops or bounds the industry or Bruce Power region of interest. So, again, it includes it but also covers more than that.

The second quick point is it's not really material to the conclusion. Even with a large region of interest as we defined, we still come to the conclusion that it's safe to authorize a restart as Bruce Power requested. So there may be some confusion in the definition, but it's not material to the recommendations.

With this, I'll ask Luc Sigouin to offer his interpretation of the matter.

MR. SIGOUIN: Thank you, Dr. Viktorov.

Luc Sigouin, for the record, the Director for the Bruce Regulatory Program.

Just echoing the comments that Dr. Viktorov made, staff's view as documented in our CMD is unequivocal: The region of interest is 360 degrees by 75 millimetres. Notwithstanding the proposal or the technical arguments that Bruce Power may be considering to reduce it, that has neither been fully reviewed yet by staff and certainly not accepted by staff. So the recommendations

that staff have made in the restart CMD are based on the 360 degree by 75 millimetre region of interest that staff has established.

So the information presented by Bruce Power is interesting and it may be considered in the future, but it's not, as Dr. Viktorov has said, material to this decision. And the regulatory controls that are set up in regards to the region of interest are very clearly defined and Bruce Power understands what they are: 360 degrees by 75 millimetres. So it's very well circumscribed and very easy for staff and the Commission to understand that Bruce Power is meeting that requirement.

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

Bruce Power, Mr. Newman.

MR. NEWMAN: Yes. For the record, Gary Newman.

I think I'm in complete agreement with all the comments made and particularly yours, President Velshi. We wish to continue to accurately convey what we're seeing from both our pressure tube surveillance, that's from removed pressure tubes as well as our scrape program. With that concept in mind, that's why we are still conveying the details that we are in our submission.

Having said that and as Mr. Scongack noted

at the beginning, there's only one definition of the region of interest as defined by Dr. Viktorov and Luc Sigouin, and that's the region that we use where relevant in any of our submission assessments and analysis, et cetera, et cetera.

I hope that helps.

THE PRESIDENT: Thank you.

Dr. Luxat?

DR. LUXAT: Yes. If I may, could I ask Mark Daymond to make a brief comment because I saw him unmute and then mute again. But our comments were essentially unanimous amongst the three members.

So I'd like Mark to just make a comment. Thank you.

DR. DAYMOND: I was just actually going to -- Mark Daymond, for the record.

I was just going to actually say I agreed with the previous comments. I didn't have anything to add. I was just preparing in case I was asked to speak. Thanks for drawing attention, though, John.

THE PRESIDENT: Okay, thank you, Dr. Daymond.

Okay, let's move to Dr. Lacroix.

MEMBER LACROIX: To follow up on the region of interest, from what I understand -- and correct me if I'm wrong -- but hydrogen diffuses in metals and

alloys. But when the Heq levels are above the solubility limits, the hydrogen isotopes become bounded chemically with zirconium to form zirconium hydrides. And these hydrides are not free to diffuse. So this is a mechanism or phenomenon that slows down the diffusion of hydrogen inside the pressure tube, and as a result, it reduces the region of interest. Am I right? Did I understand correctly?

THE PRESIDENT: Dr. Lacroix, is that a question to CNSC staff?

MEMBER LACROIX: It's a question to CNSC staff as well as to Bruce Power.

THE PRESIDENT: Okay, let's start with CNSC staff.

DR. VIKTOROV: Then I'll ask our technical specialist to take this on. They will be in a much better position to explain the nuances.

MEMBER LACROIX: Thank you.

MR. CARROLL: Blair Carroll, for the record.

So while there is a solubility limit, and once you go above that level, you will form hydrides that remain permanent, even at operating temperatures if you reach the solubility limit for normal operating temperatures.

But there is still hydrogen that will come into the pressure tube through the end fitting and through the slow corrosion process that happens on the inside of the -- so there will be an increase. And that will redistribute. And during the heat-up and cool-down cycles, there is also a release of and a formation of hydrides. So the process is quite complex.

But it will continue -- the hydrogen level will continue to go up. More hydrogen will be -- will form hydrides and will remain locked in place. But there is additional hydrogen that can be added with time. And also, as you go through the heat-up and cool-down cycles, that hydrogen can also be free to -- some of that, not all of it, some of that hydrogen can be free to move as well.

So it is -- there is the potential, given the thermal cycling, given the addition of new hydrogen, that the area can expand with time. And much of it will be locked in place in terms of -- in the form of solid hydrides. But that region can get bigger where you have my hydrides locked in place.

MEMBER LACROIX: Okay, okay. And do we have an idea of the rate of progression of hydrogen inside the metal in terms of millimetres per year, for instance?

MR. CARROLL: Blair Carroll, for the record.

So there are models that are in place that industry has been using traditionally; however, that's been the problem with the situation is those models have not been able to predict what's happening particularly in this region of interest.

Outside of that, the models seem to be following normal pickup rates, and generally it's on the order of a few PPM per year. It's not significant.

But because this phenomenon in the region of interest has not been observed before and the levels have been higher than anticipated, there's something -- there's a phenomenon here that the current models cannot currently predict, and that's what CNSC staff is waiting for industry to move forward with in developing these models to help better characterize what's happening in this location.

And that goes back to the question of why we haven't recommended a reduction in the region of interest at this time, because we don't -- those models are not yet developed.

And as pointed out, even with the larger region of interest, they can still meet the criteria that was put in place for closure of the order and so that's not the concern. But the concern is we want to be able to -- or want industry to be able to demonstrate that they can

model what's happening in this particular location.

MEMBER LACROIX: Okay, okay.

THE PRESIDENT: Bruce Power, did you wish to add anything? Mr. Newman?

MR. NEWMAN: Thank you. Gary Newman, for the record.

Just wanted to agree with Mr. Carroll's feedback. It was a good answer. The only thing I would add is we have been developing more complex models which -- but I would view them as being preliminary.

And we are planning a workshop with industry and CNSC in the March time frame where we'll be, you know, having conversations about what our capability is, timelines for developing something more permanent, that sort of conversation. So. I mean, that period will be very helpful in that session.

MEMBER LACROIX: Okay, thank you.

THE PRESIDENT: And Dr. Luxat, you've got your hand up. Did you wish to add something? Well, maybe not.

So Mr. Newman, maybe a follow-up to your comment around the workshop and the model and refining or updating or whatever it is. I know the Commission absolutely is very interested in it. I know there are many other members of the public very interested around this new

model and the timeline, because early on we had thought it was going to be spring of this year that industry and staff would be back in front of the Commission with an updated model.

Can you give us a sense of time? I'll ask you, and then I'll ask staff to comment on how is this model development coming along and what is your best estimate right now as to when you may be appearing in front of the Commission on that.

MR. NEWMAN: For the record, Gary Newman.

I think, in terms of a schedule for that, I think we're talking it's going to take longer than just the spring for, you know, finalizing that model. But each day that passes, we're -- that development continues and actually has already done pretty well at making some predictions with the two-dimensional model that has been put in place.

Having said that, it is going to take time -- and I'm thinking more like a year to two years -- for that kind of development process to be complete.

In the interim period, the -- as already noted by Mr. Carroll -- the one-dimensional model in all other portions of the pressure tubes still does a very, very good job of predicting and bounding what we're seeing in those parts of the pressure tubes. So I think there's

some further work to do here.

Obviously, we're going to continue to do scrape-sampling, and as Dr. Spekkens noted, that will be very helpful as well with the modelling aspect of our program.

THE PRESIDENT: Thank you.

CNSC staff?

DR. VIKTOROV: Alex Viktorov, for the record.

Acknowledge all that's said by the industry representatives. Again, we are not surprised by the time taken for developing a model and validating it, as it requires additional results to be generated which are taking time.

Nevertheless, the results are available to us and preliminary insights from a new model are encouraging. It's not to say that we are fully satisfied that we have or the industry has a good handle, but they are encouraging for us. And so I believe we are moving in the right direction.

But yeah, it may take up to two years to have a good, fully acceptable model in place. But as time moves on, we'll see more and more results.

THE PRESIDENT: So Dr. Viktorov, I want to understand what “encouraging” means. From a safety

perspective, are you concerned that maybe the margins are smaller than what we had anticipated? At what point do alarm bells start ringing? Or is it encouraging to say, Well, you know, I think they're getting a better handle on predicting what the levels are? Help me understand from the safety aspects of it.

DR. VIKTOROV: Alex Viktorov, for the record.

Encouraging in the sense -- well, in two senses, perhaps. First, that we seem to be able to rule out abrupt cliff-edge effects0 there. Again, we understand and accept that likely driving mechanisms are due to thermal and stress gradients that exist in these particular regions of the pressure tubes, or at least a fundamental understanding is in place.

Again, and as we also get scrape results from other pressure tubes, they seem to be aligning, not indicating any other unusual behaviour which would be difficult for us to accept and explain.

So in this sense, having observed this elevated concentration, we no longer see any other unexplained behaviours in the region of interest.

And well, I see James Scongack would like to comment on this as well.

THE PRESIDENT: Thank you.

Mr. Scongack?

MR. SCONGACK: Thank you, President Velshi. For the record, James Scongack.

So if I take a step back and I look at this issue, I think that the word "predictability" is what is important here from a modelling perspective. And Mr. Newman and his team will probably be able to add more colour if the Commission is interested.

But if we take a look back at everything we learned in 2021, those learnings were applied to an outage that we just completed on unit 7. That unit 7 included a more extensive scrape campaign than was originally planned. And so if we take a look at the channels that were selected in unit 7's planned outage, which wrapped up at the end of January, on a channel-by-channel basis, and we look at the revised predictions based on what we learned in 2021 versus the actual scrape results, what it's telling us is our prediction model is -- has dramatically improved in terms of the accuracy of those to the point where -- and Mr. Newman can clarify the specifics of the number of channels -- but very conservatively predicted especially in those particular areas.

So I think from a Commission perspective, President Velshi, yes, this will continue to be an ongoing

process. But right now, we are in the unit 5 outage, as an example. So we'll take those results from unit 7; we'll apply them to unit 5, and we're going to have actual results on unit 5 to see what that predictability is.

So don't want to leave the Commission with the impression that, Hey, you're going to get something a year from now in terms of that confidence as what was predicted and what was found. What was predicted, what was found. And we're demonstrating a really good focus on that area. And I think the more and more work we do on this, our knowledge of this will increase.

But it doesn't change the fitness for service and the fracture protection arguments that are before the Commission today.

I'm not sure if Mr. Newman would like to add anything else.

MR. NEWMAN: Thank you. For the record, Gary Newman.

Just to reflect that what Mr. Scongack described is consistent with what we did in unit 7 and similarly in unit 5, which is our lead unit on site. We expanded the scope of our CWEST campaign and ANDE campaigns. That's our scrape-sampling program as well as our full volumetric program to not only do the body of tube work that we would normally do as part of our in-service

inspection program, but also expanded it to do a broader number of rolled joint inspections as well to make sure that we were doing a comprehensive programmatic approach to unit 7 as well as now unit 5. We've just finished the first window, in fact, of a two-window campaign within unit 5 2251 outage. End of comment.

THE PRESIDENT: Thank you, Mr. Newman, and thank you, Mr. Scongack.

Mr. Elder?

MR. ELDER: Thank you.

I wanted to -- just a couple points because they're talking about the time to get the full model validated.

This is not the first situation where we've been in a situation where they need to change models. And there are a couple of variables that we do, and we've seen it even on the current situation when we said 120 was actually a situation where we accepted a model up to a certain point, recognizing that more work was going to be done. So there are mechanisms we can use to get -- to feel that we're confident in the safety of the things while the models are being developed.

The other one I wanted to point out is that the most important point about the predictive model is it's actually telling us the time between inspections.

That's one of the key things that we need to do. And again, in the past, as they were working on models -- I'm not saying that's the situation right now -- but the licensees have had to shorten the time between inspections while they are developing the data to support the models.

So there are some mechanisms that we can use that don't -- to maintain the safety that don't require the full validation of those models.

THE PRESIDENT: Thank you for that.

Ms. Maharaj, back to you.

MEMBER MAHARAJ: I've been just digesting all of this information, and I almost wonder whether I opened a can of worms with my question.

But if I can summarize this issue for myself, then, at this stage, there's no drive by Bruce Power to change the requirements of the region of interest. They accept the region of interest. And so specifically as it pertains to this order and this hearing, this proceeding, I think everybody is in agreement.

My question, just a small question that remains, is with respect to the scrape testing. I thought it was interesting that the shape that was chosen was a shape that mimicked the bearing pads. But in this particular units, or in this unit and these tubes, there are no bearing pads in the area where it could be of

concern. So I was wondering why Bruce chose that particular shape to do their scrape testing. Is it a standard or is it -- is there a reason why that particular shape was chosen?

THE PRESIDENT: Mr. Newman?

MR. NEWMAN: Good morning. Gary Newman, for the record.

Great question. First of all, I should probably just explain the orientation of the scrape, because what we're trying to do is get very high resolution. And our scrape-sampling used to be axial in orientation when we did damp scrape and so forth. We now have CWEST, which is a wet-scraped tool, so we can do it with the channel flooded, and it is in a circumferential direction. What that allows us to do is access all of the axial locations we care to, because the scrape width is less than 10 millimetres in dimension. So that gives us good axial resolution, and that's proven to be very, very helpful here.

It's just by coincidence that it looks similar to a bearing pad. And as I think we noted in some of the documentation, it is an engineered geometry to make it as benign as possible. And this is consistent with the way that the industry normally takes witness samples like this, not only in pressure tubes, but this -- the removal

of what's referred to sometimes the nomenclature is boat sample is also used on things like turbines and so forth to take a non-intrusive sample of the material to check for degradation mechanisms. And that's simply what we did here. End of comment.

MEMBER MAHARAJ: Thank you.

I don't have any further questions, Madam Velshi. I was just curious about that one.

THE PRESIDENT: Thank you.

Dr. Lacroix?

MEMBER LACROIX: Speaking of the scrape sample, is the stress intensity factor dependent on the size of the scrape sample?

MR. NEWMAN: For the record, Gary Newman.

Another good question. It really is more dependent on the geometry. So in some sense of the word, it is. It doesn't really track with the -- with the circumferential dimension. But you know, it's very insensitive to that. But it would be sensitive to depth -- so it's fairly shallow, on the order of about 0.35 millimetres, maybe a little bit deeper -- and then its geometry, so the radius and so forth that's associated with it. But again, it's very gentle and really is more like a contour so that it remains a benign and engineered sort of geometry.

MEMBER LACROIX: Okay, okay. Thank you.

THE PRESIDENT: I have a question for staff. In your CMD in section 3.2, when you talk about these initial crack initiation tests that were done, and this is on unirradiated pressure tube material, at higher Heq levels of 240 parts per million, the threshold for the crack initiation had increased by 20 per cent compared to the lower level, and you didn't think that was significant enough. So what percentage would make it significant? That's the first part.

The second part, probably more for Bruce Power, are similar tests being done with irradiated pressure tube material?

So maybe I'll ask staff first around the higher Heq levels and crack initiation testing.

DR. VIKTOROV: Alex Viktorov, for the record.

I will only start providing the response and ask Blair to elaborate.

Again, this kind of test was exactly the reason why Bruce unit 3 was late in getting our approval for restart. Again, we wanted to get assured that elevated hydrogen concentration will not eat all of the margin. And we see that while there is effect but still there is margin left.

And I'll ask our specialist to provide additional detail on the subject.

MR. CARROLL: Blair Carroll, for the record.

So as you may recall, this issue came up with the crack initiation modelling because Bruce Power has scraped in locations where the hydrogen equivalent concentration is typically higher than what has been used to validate the initial crack initiation model.

So to support their case, Bruce Power provided us with the stress evaluation for the crack -- for the geometry of the scrape samples that are removed and demonstrated that even if they reduced key input parameters in their -- two key input parameters in their crack initiation model by 50 per cent, they would still not have a concern with crack initiation.

So this one test that's been done to this point or this series of tests that have been done to this point are based on a flaw geometry that's much more severe in terms of stress intensity than the scrape samples. And it has shown that there's about a 20 per cent drop for that flaw geometry in terms of the crack initiation behaviour. So there is still margin. We've seen about a 20 per cent drop in that.

Bruce Power's indicated that, you know,

key input parameters could drop by 50 per cent. The 20 and 50 per cent don't link up one to one initially, but there is a sufficient margin left that even if the material does exhibit this drop in crack initiation behaviour, there's still the stress intensity associated with the scrape flaws is not significant enough to initiate cracking.

And Bruce Power's continuing to do work to assess what -- the results of this finding, and we will be reviewing that work as it comes in.

We have also asked the question of them of when they do plan to test the irradiated material in this program, but it was the tests are scheduled to be carried out in late 2023 or 2024. We have asked them if they were looking to accelerate that, and they said they would, but we don't have a date yet. So maybe they can respond to that question.

THE PRESIDENT: Thank you, Mr. Carroll.

And actually, that's a good segue to the question to Bruce Power. Tell me, you know, as you refine the model or get a better handle on the predictability of an updated model, what are the different tests, the different analyses, the different experimentation, sampling that's planned? Give a sense of what's planned and a bit about the timing as well.

MR. NEWMAN: Gary Newman, for the record.

That is a very broad question, now, because we do a very extensive amount of testing, but let me give it a try here.

So we have an ongoing program of burst testing. And I think we've talked about that program in the past and conveyed details of that, so I won't spend a lot of time on that. Just for reference, though, that is done on ex-service pressure tubes which have been doped with hydrogen to whatever the concentration, and that's tested under conditions of temperature and pressure that are relevant to, you know, that part of the experimental envelope that we're trying to define.

Beyond that, we are also doing crack initiation tests. And Mr. Carroll touched on some elements of that. So we do it with geometries that are reflective of in-service flaws. And that was associated with the 20 per cent that he was referring to. We also did it on a predominantly smooth surface, which are more reflective of the scrape sampling which were the subject at that time and why unit 3 was still, you know, left in the order.

That work has been completed on the unirradiated specimens with irradiated testing to follow in our program. And those results ranged for different stress levels, six specimens each, cantilever beams, all yielded no failures in any of that. The way that we normally --

and this experimentation is being done consistent with the way that we approach our program, which is we do unirradiated first to scope out the broader envelope, and then narrow it down and do some more specific tests on irradiated, just to be able to better quantify the irradiation effect.

But that was a very broad stress -- series of stress settings. And so we feel it's fairly robust by itself. But those tests will follow in 2023 on the irradiated portions.

THE PRESIDENT: So you haven't accelerated that, then? It's still 2023 that you're planning on doing that?

MR. NEWMAN: That's correct. Now, that can always change, depending on -- but given the results that we got for the unirradiated specimen, we felt that, you know, early 2023 was a, you know, a responsible time frame.

THE PRESIDENT: Thank you.

Dr. Lacroix?

MEMBER LACROIX: A quick question. What do you call the stress intensity factor? It's equivalent to the fracture toughness, isn't that the right -- am I right?

MR. NEWMAN: Gary Newman, for the record.

Typically, we will have an applied stress intensity, and then a material property on the flip side, which is the material resistance. And that can, on the stress intensity side, it can manifest itself in a few different ways. But effectively, that is the comparable component in both of those spaces.

MEMBER LACROIX: Okay. Thank you.

THE PRESIDENT: Ms. Maharaj, any more questions from you?

Dr. Lacroix? Anything else? No?

MEMBER LACROIX: No more questions.

THE PRESIDENT: Thank you.

Let me ask the EAC members if they wish to add anything else from what you've heard this morning. Dr. Luxat?

DR. LUXAT: No, I would not.

But I do want to point out one thing which I think might be relevant, and it's -- I'm not saying this is the answer, but in the region of interest, that's in essentially a very low flux, neutral flux region. So the irradiation I would expect not to have significant impact. Certainly, it has an impact on creep, but not in the region of interest so much.

THE PRESIDENT: Thank you.

Dr. Spekkens?

DR. SPEKKENS: Paul Spekkens, for the record. And yeah, no further questions from me.

THE PRESIDENT: Thank you.

Dr. Daymond?

DR. DAYMOND: Mark Daymond, for the record.

Maybe just one comment on the question that Dr. Lacroix had asked about whether the transformation of the hydrogen to hydride would affect diffusion. That was one of the earlier questions.

We would not expect it to have a significant effect on the diffusion rate at the sort of volume fractions of hydride that we're talking about. And I think even were it to have an effect, you would expect it to slow it down. So continuing to treat it as not being -- as not having an effect would be a conservative assumption. End of comment.

MEMBER LACROIX: Thank you.

THE PRESIDENT: Thank you very much for that.

Okay. Thank you, everyone, for your participation today and for taking the time to answer our questions. It's greatly appreciated.

And this concludes the question period.

Have a great day, everyone. Stay well.

--- Whereupon the hearing adjourned at 10:04 a.m. /

L'audience est ajournée à 10 h 04