Canadian Nuclear Safety Commission	**Commission canadienne de sûreté nucléaire**
Public meeting	**Réunion publique**
January 21st, 2021	**Le 21 janvier 2021**
Public Hearing Room 14th floor 280 Slater Street Ottawa, Ontario	Salle des audiences publiques 14e étage 280, rue Slater Ottawa (Ontario)
via videoconference	*par vidéoconférence*
Commission Members present	**Commissaires présents**
Ms. Rumina Velshi Dr. Sandor Demeter Dr. Timothy Berube Dr. Marcel Lacroix Dr. Stephen McKinnon	Mme Rumina Velshi Dr Sandor Demeter M. Timothy Berube M. Marcel Lacroix M. Stephen McKinnon
Secretary:	**Secrétaire:**
Mr. Marc Leblanc	Me Marc Leblanc
Senior Counsel:	**Avocat-principal :**
Mr. Denis Saumure	Me Denis Saumure

TABLE OF CONTENTS

Ottawa, Ontario / Ottawa (Ontario)

--- Upon commencing on Thursday, January 21, 2021 at 9:00 a.m. / La réunion débute le jeudi 21 janvier 2021 à 9 h 00

Opening Remarks

THE PRESIDENT: Good morning and welcome to the meeting 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 acknowledgement 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: Dr. Sandor Demeter, Dr. Stephen McKinnon, Dr. Marcel Lacroix, and Dr. Timothy Berube.

I also have the pleasure to announce that Ms. Indra Maharaj was appointed by the Governor-in-Council on December 11 as a Commission Member for a term of five years.

Congratulations and welcome to the commission. Ms. Maharaj is joining us today is an observer.

Mr. Denis Saumure, senior counsel to the Commission, and Mr. Marc Leblanc, Commission Secretary, are also joining us remotely.

As always, I would like to begin today's commission meeting with a safety moment, to talk about the recently announced COVID-19-related restrictions across Canada.

In response to a doubling in COVID cases over the past three weeks, the real and looming threat of the collapse of the provincial hospital systems and alarming risks posed to long-term care homes as a result of high COVID-19 transmission rates, federal and provincial governments have increased restrictions across the country.

We each need to do our bit if we are to save lives and resume normal activities in the not-so-far-distant future. This means following to a T the directions of our provincial governments and the advice of our respective health authorities. How? By working from home if we can, not leaving home unless it is essential to do so, limiting gatherings and travel, wearing masks, washing our hands frequently, getting vaccinated when we can, just to name a few ones.

I know that you all know this, but we have to remind ourselves each day that this is good, for our families, our co-workers, our communities, and for our own good. There is light at the end of the tunnel, but still a fairly long way to go and this is the time to raise our game even more. Let's continue to do our part. Thank you.

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

Marc?

MR. LEBLANC: Merci, Madame la Présidente.

For this Commission meeting, we have simultaneous interpretation. Please keep the pace of your speech relatively slow so that the interpreters are able to keep up.

To make the transcripts as complete and clear as possible, please identify yourself each time before you speak.

The transcripts should be available on

the CNSC website within one to two weeks.

I would also like to note that this proceeding is being video webcast live and that archives of these proceedings will be available on our website for a three-month period after the closure of the proceedings.

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. During the question period, if you wish to provide an answer or add a comment, please use the Raise Hand function.

The *Nuclear Safety and Control Act* authorizes the Commission to hold meetings for the conduct of its business.

Nous vous invitons à référer à l'ordre du jour qui était publié le 12 janvier 2021 pour la liste complète des items à présenter aujourd'hui.

I also wish to note that all the Commission Member Documents, or CMDs, listed on the agenda are available on the CNSC website.

In addition to the written documents reviewed by the Commission for this meeting, CNSC staff and other registered participants will have an opportunity to make verbal comments and Commission Members will have an opportunity to ask a question on each of the items before us today.

Madame Velshi, présidente et première dirigeante de la CCSN, va présider la réunion publique d'aujourd'hui.

President Velshi.

THE PRESIDENT: Thank you, Marc.

CMD 21-M2

Adoption of Agenda

THE PRESIDENT: With this information, I would now like to call for the adoption of the agenda by the Commission Members as outlined in CMD 21-M3. Do we have concurrence?

For the record, the agenda is adopted.

CMD 21-M3

Approval of the Minutes of Commission Meeting held on November 5, 2020

THE PRESIDENT: I will now call for the approval of the minutes of the Commission meeting held on November 5, 2020, as outlined in CMD 21-M3.

Are there any comments, additions, or

deletions that the Commission Members wish to make to the draft minutes?

I note that there are no changes. Therefore, I would ask the Commission Members to approve the minutes.

Do we have concurrence? Thank you.

For the record, the Minutes of the November 5, 2020 Commission meeting are approved. These minutes include the decision of the Commission approving version 3 of REGDOC-2.2.4, Fitness for Duty, Volume 2: Managing Alcohol and Drug Use.

The minutes are available upon request to the Secretariat and will be available on the CNSC website in both official languages at a later date.

The minutes of the December Commission meeting will be presented for approval at a later date.

The next item on the agenda is the status report on power reactors, as outlined in CMD 21-M7. I note that we have representatives from the nuclear power industry and CNSC staff joining us for this item. They can identify themselves later, before speaking.

Dr. Viktorov, the floor is yours.

CMD 21-M7

Oral presentation by CNSC staff

MR. VIKTOROV: Thank you. Good morning, Madam President and Members of the Commission. For the record, my name is Alexandre Viktorov. I am the Director General of the Directorate of Power Reactor Regulations. With me today are other regulatory and technical managers and specialists available to respond to your questions.

The status report on power reactors, CMD 21-M7, was finalized on January 7. The following are updates reflecting changes since that date.

For Bruce, Unit 1 was shut down for a planned maintenance outage.

For Darlington, Unit 2 is now at 80% full power and is returning to full power following the outage to remove a fuelling machine stuck on channel.

For Pickering, Units 1 and 6 have returned to full power. And Unit 8 was shut down for a planned maintenance outage.

One COVID-19 case was reported under REGDOC-3.1.1, reporting criteria.

For Point Lepreau, on Saturday, January 16th, the plant was taken offline. A steam rupture disk on the secondary side failed which led to steam venting through the rupture disk to the atmosphere and a loud noise. The plant responded to the transient as designed and there were no injuries nor radioactive releases to the environment. Investigations and repairs by New Brunswick Power are currently in progress.

CNSC staff completed inspections and verified that Point Lepreau staff have established a rod-based guaranteed shutdown state and are maintaining the availability of heat sinks as per procedures. CNSC staff also confirmed that the work areas for possible repairs are being prepared in accordance with the requirements.

CNSC staff will continue to monitor the situation.

This concludes the Status Report update on Power Reactors. CNSC staff are available to answer any questions that the Commission may have. Thank you.

THE PRESIDENT: Thank you, Dr. Viktorov.

I'll now open the floor for questions from the Commission Members to staff and licensees.

We'll start with Dr. Demeter.

MEMBER DEMETER: Thank you very much.

I did have a question on the Darlington part of the report. I'll just read the sentence here and ask the question. This is in regards to the isolation of the fuel channels.

> "The variation in the strategy was the use of one ice plug rather than two, due to the configuration of how the fuelling machine was connected to the channel."

Then it goes on to say that that was reviewed and felt to be okay.

I want to know, is this a one-off discretionary okay? Does this set a precedent? Is this variation going to become part of a new way of managing these issues? Can I get a sense of if this sets a precedent.

MR. VIKTOROV: We have a specialist online who is available to provide details of this approval and we have also licensee who can elaborate on the specifics of repairs conducted.

We can start with the representative from DPRR. John Burta will start while the specialist gets online.

MR. BURTA: I am the Regulatory Program Director for the Darlington Regulatory Program Division. So to answer your question, the concurrence that was granted to OPG Darlington for this use of one ice plug as opposed to two was for this one instance. It was not an ongoing approval and it does not set precedent for future decisions. Each decision would be reviewed against the current unit configuration and available information to make a future decision.

THE PRESIDENT: Thanks for that, Mr. Burta.

Do we need a specialist to complement that response? Are you okay with that, Dr. Demeter?

MEMBER DEMETER: I'm okay. Thank you.

THE PRESIDENT: Dr. McKinnon.

MEMBER McKINNON: Yes, thank you. I also have a question for OPG in connection with Darlington Unit 2.

In connection with the fuelling machine becoming stuck, is there any chance that there could have been any damage to the pressure tube?

MR. VIKTOROV: The reactor cannot be restarted unless we have assurance that the facility is safe to restart. So necessary inspections have been conducted to confirm that the facility is safe and there is no damage to any equipment that is important for safety. That relates both to the reactor and the fuelling machine itself.

MEMBER McKINNON: Okay. Thank you very much.

THE PRESIDENT: Dr. Lacroix.

MEMBER LACROIX: Still on this event at Darlington, I've got a schematic of the CANDU fuel channel in front of me. And I'm trying to understand, the ice plug, is it formed inside the feeder pipe or at the end fitting?

MR. VIKTOROV: The ice plug is formed on the feeder pipe, not inside the end fitting.

MEMBER LACROIX: Okay. And I still don't understand why one ice plug -- there are two ends to the fuel channel and I'm trying to understand how can you cut off the water flow from the feeder pipe if you have only one ice plug? There's something missing here.

MR. VIKTOROV: I think the licensee would be best positioned to take on this question and provide the clarification you're seeking.

MEMBER LACROIX: Okay. Thank you.

MR. GRACE: Good morning. Allan Grace for the licensee. I'm the Director of Operations and Maintenance here at Darlington.

The isolation is formed with a combination of ice plugs and channel isolation plugs. These are special plugs that are designed to isolate flow to the channel. Because of the unique configuration of the fuelling machine on one end, that necessitated the difference in the strategy in this case.

MEMBER LACROIX: And all this work is done remotely, I presume?

MR. GRACE: Remotely in the sense that we do have people in the reactor vault working on the ice plug and the fuel machine is controlled remotely on the other side. So I would say it's a combination of remote operations and in-presence operations by the operations team.

MEMBER LACROIX: And the fact that the fuelling machine got stuck with the fuel channel, is it an unusual event or is it something that you regularly experience?

MR. GRACE: What I'll say is, going back to one of the earlier questions about the approvals for this configuration, this is not something that we experience very frequently at all.

MEMBER LACROIX: Okay. How frequent?

MR. GRACE: I'll say this particular configuration is a first of its kind for Darlington.

MEMBER LACROIX: Okay. Thank you.

THE PRESIDENT: Thank you.

Dr. Berube.

MEMBER BERUBE: I have a question pertaining to Point Lepreau in this ruptured disk issue.

Just a couple of questions for the operator. First of all, what is the location of the ruptured disk and is it on the secondary turbine circuit? Obviously not on the primary, I think, if that's correct. And could you discuss the reasons for the transient? Where are you in your investigation at this point?

MR. REICKER: Good morning. Nick Reicker, NP Power Regulatory Affairs Manager for the record.

So to the first question, it is on our secondary side of the system that is located off our high-pressure turbine, so not on primary.

As far as where we're at with assessment, we are currently looking at the full assessment of the equipment and finalizing the extent of condition for the additional ruptured disk. As we progress that, we'll indicate our additional repairs that need to be made on the system following that timeline and we'll support our run up of the station.

MEMBER BERUBE: Do you have any initial thoughts as to why you had a high-pressure transient or you just don't want to speculate at this point?

MR. REICKER: At current, we're still doing the assessment and don't want to speculate as to what was the cause of the transient. That transient review is currently still ongoing and is part of our condition assessment.

MEMBER BERUBE: CNSC, could you talk about the compliance issues with this kind of an event and how you follow up on that.

MR. VIKTOROV: I'll start and then I'll ask our staff at Point Lepreau site to complement again.

That's a transient that led to a power reactor shut down. CNSC staff respond to such events with inspection and verifications as may be dictated by the case. In case when guaranteed shutdown status is established, there is additional attention being paid to this. We will be also looking at whether the repairs conducted in the station will be safe to a return to power.

And with this, I'll ask Heather Davis to supplement the response.

MS. DAVIS: Good morning, President Velshi, Members of the Commission. For the record, my name is Heather Davis and I am the Power Reactor Site Office Supervisor for Point Lepreau.

In terms of monitoring, CNSC staff continue to monitor the situation through attendance of decision-making meetings and discussions with the licensee. Fuel verifications have been done by CNSC site staff, including confirmation of heat sinks, that they are available, that GSS is established, and that the required disk maintenance is proceeding according to requirements. Thank you.

THE PRESIDENT: Any further questions, Dr. Berube? No, you're good. Okay. Thank you.

I have a question for you, Dr. Viktorov. In the report you talk about international collaboration and around sharing experiences around regulators. Under whose auspices was this conference held and is there a report expected from that?

MR. VIKTOROV: Discussions are ongoing in various fora and agreements. Particular items that were referred to in the report is a meeting under the auspices of Working Group on Inspection Practices, which is a group -- a working group under NEA, Committee on Nuclear Regulatory Activities. It has not happened yet. It will take place in February, and the report will follow later.

THE PRESIDENT: Right. Sorry. Yes. Thank you.

I also wanted to commend you for the COVID-19 report. Great detail and explanation. Again, good work by the licensees in how they're managing the pandemic.

Commission Members, any further questions or can we move to the next agenda item?

Okay. Not seeing any hands up, then let's move to our next item, which is the update on CNSC's readiness for the regulation of small modular reactors, SMRs, and advanced reactor projects as outlined in CMD 21-M5.

I note that representatives from the industry, Natural Resources Canada, the Nuclear Waste Management Organization, and Atomic Energy of Canada Limited are joining us and will be available for questions after CNSC staff's presentation.

I'll turn the floor over to Mr. Robertson.

CMD 21-M5

Oral presentation by CNSC staff

MR. ROBERTSON: Good morning, Madam President, Members of the Commission. My name is Hugh Robertson. I'm the Director General of the Directorate of Regulatory Improvement and Major Projects Management.

The purpose of this presentation is to provide an update to the Commission on the CNSC's regulatory readiness for small modular reactor projects.

This presentation is for information only and is not accompanied by a written CMD.

While CNSC staff are not seeking any regulatory decisions, we welcome any feedback the Commission Members may have.

I am joined by experts from across the CNSC who will be speaking to specific aspects of these projects, namely, Mr. Christian Carrier, Director of the New Major Facilities Licensing Division; Ms. Lynn Forrest, Director, Regulatory Framework Division; Ms. Melanie Rickard, Director Assessment and Integration Division; Ms. Mok Cher Fong, Senior International Relations Officer, and Mr. Adam Levine, Team Leader, Indigenous Relations and Participant Funding.

We also have many other CNSC experts who are available to answer questions.

Today's presentation builds on information provided in three previous presentations, including information about what SMRs are, the types of regulatory questions they introduce, and what work CNSC staff have done to establish ongoing readiness as stakeholder interest in these technologies gradually increased.

Can we move to slide 2, please. Thank you.

In 2014, CMD 14-M8, The Evolution of Nuclear Reactor Technologies, introduced the Commission to the concept of an SMR. CNSC staff sought to understand how the Canadian regulatory framework might be able to address such technologies if introduced in Canada.

In 2016, CNSC staff presented CMD 16-M71, Development, Deployment and Regulation, which briefed the Commission on recently initiated Vendor Design Reviews for SMR technologies, early SMR activities occurring in Canada, and key consultation results from SMR discussion paper 16-04 which covered CNSC staff's position on a number of regulatory areas pertinent to SMR facilities. In addition, formal international collaboration by CNSC kicked off in the IAEA SMR Regulators' Forum. All the work done to date by CNSC staff was being fed into early regulatory readiness activities, such as regulatory framework updates.

And finally, in 2018, as stakeholder interest continued to grow and the number of Vendor Design Reviews grew, CNSC presented CMD 18-M31, Small Modular Reactor Update - Development, Deployment and Regulation, to update the Commission on our readiness strategy, which included increasing cooperation with other like-minded regulators.

Building on this past work, and our

commitment to keep the Commission informed of SMR developments and progress, the purpose of today's information presentation is to show how CNSC staff are ready to regulate small modular reactor projects effectively and efficiently using our robust management system, regulatory framework, open and transparent stakeholder engagement, and international cooperation activities.

Can we go to slide 3, please.

We will be focusing on our readiness activities to conduct regulation of near term first-of-a-kind reactor facility projects in Canada.

However, in addition, we will also discuss work we are doing with a longer view in mind, recognizing that proponents of new reactor technologies are looking beyond first-of-a-kind projects to fleet-based projects.

After some brief contextual information, this presentation will cover the six subjects noted on the slide.

Next slide, please.

I would now like to briefly explain what SMRs represent from a regulatory perspective and why having a readiness strategy is important.

CNSC staff have noted that SMRs have

similarities with many of the smaller reactors that were built in the past, while recognizing the modern advancements that are being proposed. For example, the first reactor facilities were small, in the order of 100 to 300 MWe in output per unit. These facilities were built on green-field sites with very little infrastructure on them. Everything except the concrete was manufactured offsite and delivered by truck or barge to the location for assembly.

In the photo on the left, we see the installation of the calandria reactor assembly at the Douglas Point Generating Station in 1966. This first-of-a-kind 220 MWe facility operated from 1967 until 1984 and demonstrated commercial grid scale power generation.

In the photo on the right, the Beznau power plant in Switzerland started operation in 1969 and is still generating 300 MWe per unit. In fact, the waste heat from this facility supplies district heating to nearby local communities.

Next slide, please.

It is important to recognize that the first SMR projects can still be complex projects because of their first-of-a-kind characteristics.

The photo shown here is a good example of a grid scale SMR currently being commissioned in China.

Generally, grid scale SMRs remain in the range of 100 to 300 MWe to address smaller capacity grids. This is a full-scale commercial high temperature pebble bed reactor facility that will use the heat from two separate helium-cooled reactors connected to a single turbine to produce both electricity and process steam for industrial use. It has a rated output of 211 MWe. The facility is of similar size to the former Douglas Point Nuclear Generating Station.

Site preparation and early construction for this project started in 2012 and the reactor vessels were installed in 2016. In 2020, nearly eight years after the project began, cold commissioning is underway. This first-of-a-kind demonstration facility will gather experience to inform optimization of the design for the next plants to be deployed, which may include up to six reactors connected to a single large turbine.

Next slide, please.

Just like any other nuclear power plant, SMRs are subject to the Class I Nuclear Facilities Regulations and licensing decisions will be made by the Commission.

Any licence applications will need to address all of the 14 Safety and Control Areas stipulated in the licensing process, commensurate with a graded approach.

CNSC staff are governed by the CNSC's management system Policy on the Use of a Risk-Informed Approach for Regulatory Oversight of Nuclear Activities and Facilities. CNSC staff follow this policy when required to make risk-informed decisions or recommendations pertaining to licensing, certification, compliance and the development of regulatory requirements and guidance.

If you would like more information about the graded approach, we have included a link to our public web page on this subject.

Next slide, please.

CNSC staff have been paying close attention to new build projects around the world. Currently, there are only a few SMR projects underway, but lessons learned are starting to emerge from these ongoing projects. Additionally, there are many large nuclear power projects underway worldwide and the lessons learned are generally applicable to SMR projects of any size.

Some of the top lessons regulators are noting time and again which have major impacts on project timelines include incomplete licence applications that introduce delays and uncertainties into the assessment and decision-making process. In some instances, experience shows that proponents may not fully understand how to apply the regulatory framework.

There are instances around the world where there is insufficient design information provided to support the safety case. In some cases, design activities are still being conducted while the facility is being built.

Timely research and development outputs are needed to support novel features in a design so that areas where uncertainties remain are addressed through appropriate safety and control measures.

There continues to be quality issues in the conduct of construction and commissioning activities with the potential for safety implications. This is often traced back to organizational performance deficiencies.

The need for early and continuous engagement by the applicant as well as decision-makers is necessary to allow opportunities for participation by all stakeholders.

Next slide, please.

As new technologies evolve and are considered by potential applicants for projects, we are cognizant of the need to maintain efficient and effective oversight in light of these quickly and continuously changing parameters.

In December 2019, the CNSC published its Strategy for Readiness to Regulate Advanced Reactor Technologies. We are executing this strategy, aware that projects can emerge at any time and may include new technologies and approaches to consider.

In that light, what exactly does readiness to regulate look like? All of the eight areas shown in this slide work together to maintain a state of readiness to regulate and are necessary for the CNSC to execute its mandate effectively and efficiently.

Over the last decade, we have done extensive work in support of each of these areas.

Of utmost importance is that readiness also includes a strong underpinning program of work to continually build trust with Indigenous groups and the public through meaningful ongoing dialogue and engagement activities.

With regards to international collaboration, these activities are accelerating and we are seeing that the lessons learned from our technology review projects are stimulating a learning culture being fostered in Canada and internationally alike.

For the remainder of this presentation, my colleagues will describe in more detail the progress we have made in our readiness efforts to regulate SMR projects.

I will now turn the presentation over to Mr. Christian Carrier, who will present an overview of current activities in Canada.

Mr. Carrier.

MR. CARRIER: Could I have the next slide, please?

Good morning, Madam President and Members of the Commission. For the record, my name is Christian Carrier and I am the Director of the New Major Facilities Licensing Division.

In this section, I will provide you with an overview of the current SMR landscape in Canada, including what is happening both at the industry and governmental levels.

This landscape has been evolving quickly, and one objective of this presentation is to illustrate how the CNSC is responding to these changes.

Next slide, please. Thank you.

Firstly, let's start at the industry level.

In 2018, following the recommendations from a parliamentary committee, the Natural Resources Canada coordinated a pan-Canadian consultation on the benefits of the deployment of SMRs in Canada. This initiative called the Pan-Canadian SMR Roadmap involved many stakeholders including the industry, the public and Indigenous communities, reactor vendors, and the provinces.

The report identified key areas to guide SMR development and deployment in Canada.

On December 18, 2020, the SMR Roadmap Action Plan was issued by the federal Minister of Natural Resources Canada.

In this release, NRCan presented SMRs as a promising new technology that has the potential to provide zero-carbon emission, affordable and reliable electricity supply supporting Canada's transition to net-zero emissions by 2050.

The Canadian Nuclear Laboratories continue to provide technical support to the government and the industry on SMR technology topics, both on the deployment side and regulatory support.

CNL is also continuing to invite proposals for SMR demonstration projects on one of their sites, with an objective of first operation by 2026.

Finally, there are various industry SMR fora that have been formed. This includes the CSA, the CANDU Owners Group, and the Canadian Nuclear Association.

Task forces have been established to address SMR areas of interest including the standardization, harmonization, and various deployment-related topics. Note that we have invited and today people are -- members of these groups are online today should there be any questions on this matter.

At the provincial level, energy ministers from Ontario, Saskatchewan, and New Brunswick have signed a Memorandum of Understanding committing to work together on the deployment and development of SMRs. Alberta recently also expressed interest in joining.

The provinces are collaboratively developing options to address three potential applications for SMRs, namely: Grid size SMRs suitable for potential replacement of fossil fuel plants, with power ranging from 100 to 300 MWe, with the possibility of adding multiple units on a given site; remote mining operation with energy needs ranging from 25 to 100 MWe per site is another option or another venue; and finally, remote communities with power demands ranging from 1 to 5 MWe.

The existing nuclear utilities in Ontario have announced a number of initiatives in support of SMR deployment.

Firstly, at the Darlington New Nuclear Power Site just east of the existing Darlington Nuclear

Generating Station, Ontario Power Generation holds a licence to prepare site and is seeking to renew this licence at a hearing in June 2021.

OPG announced last October that it is in the process of selecting potential grid-sized SMR technologies for that site. It has down-selected three specific technologies, while still not closing the door to potential others.

On December 2, OPG informed the CNSC of its intent to submit an application for licence to construct by March 31, 2022, noting that this is still the subject of approval by the Province of Ontario.

Representatives from OPG, again, are online to answer any questions on this matter.

Also in Ontario, Global First Power submitted a licence application in March 2019 for a licence to prepare site for a 15 thermal MW reactor facility to be deployed on the land at the Chalk River Laboratories.

According to GFP, the facility will provide either high-quality heat or up to 5MWe power to the site.

Global First Power is co-owned by OPG and the designer of the reactor technology, namely, the UltraSafe Nuclear Corporation, or USNC. Note that the

CNSC has completed a Phase 1 Vendor Design Review for this design and the USNC has applied for a Phase 2 Review which should be commencing in the near future.

That project will be a full-scale commercial demonstration facility. GFP has indicated that it will be used to demonstrate the reactor concept, including commercial viability; integrated facility technical performance; the conduct of licensing, operations, and maintenance; gathering technical experience; security and safeguards by design; and, finally, support staff training and certification.

The diagram in this slide shows a conceptual cutaway of the reactor building only. It does not include all portions of the facility, like the secondary-side.

The intent of the final commercial design will be to provide continuous supply of energy to the site for 20 years. The environmental assessment for this project is currently underway.

This is an example of a potential design that could be used for either mining or large communities and/or northern communities.

Representatives from Global First Power are online to answer any questions.

In New Brunswick, the provincial

government is investing in an SMR Nuclear Energy Cluster.

Two SMR vendors, namely ARC Nuclear Canada and Moltex Energy, have established their offices and are working with New Brunswick Power to develop their technologies for use in the province and beyond.

The ARC Nuclear Canada design is a 100 MWe liquid sodium cooled reactor. The Moltex Energy design is a 300 MWe Molten Salt Reactor.

New Brunswick is also in the early stages of investigating the potential use of processed CANDU fuel in those technologies.

Representatives from New Brunswick Power are online to answer any questions.

The Canadian Nuclear Laboratories, academic institutions, and private industry are establishing programs of work to provide expertise in research and development for the deployment of SMRs in Canada. In some cases, research activities are emphasizing support for industry as part of their technology readiness.

The Canadian Nuclear Safety Commission is involved in independent regulatory research which can be used to support our regulatory framework and assessment activities.

The Canadian Nuclear Laboratories is

providing services to the government and to the industry in support of SMR development activities. CNL receives federal science and technology funding and is expanding cooperation on SMR research, both nationally and internationally, with like-minded laboratories.

Overall, all of these efforts will ultimately contribute to support SMR deployment in support of regulatory decision making.

In my previous slides, I focused on SMR interest in Canada and how stakeholders are preparing for their potential deployment.

On this slide, I will focus on the high-level CNSC staff observations gathered through pre-licensing engagement with both vendors and potential licence applicants.

Firstly, we note in our pre-licensing engagement that, in some cases, we are dealing with SMR vendors that are new to the Canadian regulatory environment and to Canada's commercial nuclear energy sector.

In addition, potential applicants are introducing new organizational models in their deployment strategies and are increasingly relying on service providers and contractors to perform core functions, such as design and safety analysis.

Irrespective of the approaches taken, the licensee will always remain responsible and accountable for safety.

In this context, the effective management of subcontractors could very well become the focus of regulatory scrutiny to confirm that effective measures are in place to ensure the safety and security of the operation of the proposed facilities.

We note that a benefit of early pre-licensing engagement activities is to ensure clarity of regulatory requirements to newcomers in the country and to clarify expectations on novel approaches to operation.

I will now pass the presentation to Ms. Lynn Forrest, who will discuss the readiness of CNSC's Regulatory Framework for SMR projects.

MS. FORREST: Thank you, Christian.

For the record, my name is Lynn Forrest and I represent the Regulatory Policy Directorate. One of our roles is to develop and maintain the CNSC's Regulatory Framework.

I am going to present a short overview of the CNSC's Regulatory Framework as it pertains to the CNSC's state of readiness to regulate projects for the new SMR or advanced reactor technologies.

A country's regulatory framework is the

foundation on which its licensing and compliance regime is built. The CNSC's framework is science-based. It's comprehensive, structured, and robust. It sets out requirements and guidance to ensure that any nuclear activities in Canada do not present unreasonable risk to health, safety, and security of persons or the environment. The framework has been comprehensively reviewed over the past several years and is both modern and fit for application to SMR and advanced reactor new build projects.

The regulatory framework is aligned with IAEA safety fundamentals, the licensee has the primary responsibility for safety.

The framework lays out fundamental safety requirements in a non-prescriptive manner such that applicants may propose how they will meet the CNSC's nuclear safety objectives while, one, being innovative; and, two, considering a graded approach to safety and control provisions.

In August of 2018, the CNSC published REGDOC-3.5.3, *Regulatory Fundamentals*, as a capstone information document to replace previous policy documents. This document is a starting point to develop an understanding of how the CNSC regulates.

Reviewing regulatory documents such as

this one, in addition to undertaking pre-licensing engagement processes, can help a stakeholder to develop a working understanding of the regulatory environment in advance of triggering any decision-making process.

To promote an understanding of the CNSC's Regulatory Framework for reactor facilities, CNSC staff has engaged in many outreach activities for many years, in light of increasing interest in SMRs. This slide provides information about the level and type of outreach that has been undertaken in the past two years.

Outreach continues and is always adjusted to meet the needs of the specific audience.

We are committed to ongoing outreach to build understanding and trust in Canada's nuclear regulatory system.

So the CNSC has a suite of Licence Application Guides, affectionately known as LAGs, that provide guidance to proponents on what makes up a complete application.

A complete application contains the pertinent information needed to conduct assessment activities for all of the Safety and Control Areas, demonstrate the regulations have been met, and enable CNSC staff to make licence recommendations to the Commission.

LAGs have been established for the

licence to prepare site, licence to construct, licence to operate, or combinations of these licences, if an applicant is appropriately prepared and chooses to do so.

CNSC staff have specifically designed the LAGs, such that they can appropriately be applied to any new-build project regardless of the size and complexity and of course commensurate with a graded approach.

In order to further reinforce this fact, in 2019, the CNSC published REGDOC-1.1.5, *Supplemental Information for Small Modular Reactor Proponents*, to support the LAGs. This document contains additional guidance on specific considerations for establishing safety and control measures for SMRs. The document also describes pre-licensing engagement tools that can be used to improve a working understanding of Canadian requirements.

Although designed for applicants, just as importantly of course, LAGs allow other stakeholders wishing to participate in regulatory processes to understand the scope, depth, and nature of information that is needed to support an application, therefore improving their ability to participate in the process.

The CNSC's Safety and Control Areas are technical topics used to assess, review, verify and report on regulatory requirements and performance across all regulated facilities and activities. All Safety and Control Areas apply to SMR projects.

The CNSC's Regulatory Framework has Regulatory Documents for all of the Safety and Control Areas. They contain detail on safety principles, objectives, and requirements in each area. Guidance in REGDOCs elaborates on how requirements may be met. These documents are expected to be used in conjunction with LAGs to develop the application.

The way requirements and guidance are articulated in REGDOCs enables innovative proposals, while ensuring underpinning safety objectives will be met.

The CNSC has a rolling five-year Regulatory Framework Plan. REGDOCs are regularly reviewed. A decision to revise requirements and guidance is always based on objective technical evidence accumulated by actual experience, considering potential impacts on licensees.

So every SMR project proposal will be subjected to a robust, science-based environmental review.

Each review will consider the scale and complexity of the environmental risks associated with the proposed nuclear facility or activity.

Early in the project proposal process, CNSC staff determine the type of environmental review that applies by reviewing the information in the licence application and the supporting documentation.

Future SMR project proposals may be subject to an impact assessment under the *Impact Assessment Act* as determined by the project thresholds in the physical activities regulations. This process is undertaken jointly about the CNSC and the Impact Assessment Agency of Canada, formerly the Canadian Environmental Assessment Agency.

If the project does not trigger an impact assessment under the IAA, it will be reviewed as part of the CNSC's licensing assessment under the *Nuclear Safety and Control Act*. This assessment includes a thorough environmental protection review.

In addition, any project may be subject to a provincial, territorial, or land claim environmental assessment which may be undertaken sequentially or in parallel with the CNSC's process or with the impact assessment process.

Note that under the IAA, any project, nuclear or otherwise, that is proposed to be built on federally owned lands will also be subject to a federal lands review under the IAA.

In all cases, the CNSC ensures that the appropriate technical expertise is engaged to assess whether the applicant or licensee will, in carrying out a licensed activity, make adequate provisions to protect the environment and health and safety of people.

The Nuclear Security Regulations are currently relatively prescriptive, setting requirements to protect currently licensed nuclear facilities. Extensive early consultation with stakeholders was undertaken several years ago, where the CNSC sought to obtain a deeper understanding of new, modern security approaches and provisions that might be introduced in nuclear facility proposals.

For example, SMR designers are proposing increased use of engineered security-by-design provisions.

So CNSC is proposing amendments to the Nuclear Security Regulations. These will take an objective or performance-based approach like that of other regulations under the *Nuclear Safety and Control Act*. This would provide flexibility to meet security requirements with innovative proposals that consider a graded approach.

As with other Safety and Control Areas in the CNSC's Regulatory Framework, amendments to regulatory documents will be proposed to clarify the requirements in the regulations and provide guidance in support.

Amended proposals for the regulations and the supporting REGDOCs have been developed. Further consultation will take place in 2021 to allow stakeholders to comment and to obtain information about the proposed requirements and their potential implications for facilities.

The CNSC anticipates proposed amendments will be pre-published in *Canada Gazette* in early 2022 and finalized in 2023.

To ensure the regulatory framework incorporates the most recent experience, the CNSC is amending five REGDOCs which are particularly pertinent to new reactors. These revisions are not expected to impact current Vendor Design Reviews or licensing processes and will be rolled out via an implementation plan.

REGDOC-1.1.2, the LAG for *Licence to Construct a Nuclear Power Plant*, has just completed public consultation. A general revision has been made to better align with the safety and control framework.

REGDOC-2.4.1 is in early analysis to develop a second version. Staff are considering the impact of data collected related to previous implementation challenges, new reactor technologies, and new international guidelines.

REGDOC-2.4.2, version 2, on Probabilistic Safety Assessment, will be out for public consultation shortly. It will be retitled "Probabilistic Safety Assessment for Reactor Facilities."

REGDOC-2.5.2, about Design of Reactor Facilities, is being updated to consolidate requirements contained in older document RD-367, Design for Small Reactor Facilities. This new version 2 will further support a technology neutral approach.

And finally, information about CNSC's Risk-Informed Regulatory Approach, or graded approach, is being added to REGDOC-3.5.3, Regulatory Fundamentals.

So this concludes the regulatory framework section of the presentation.

I will now turn it over to Melanie Rickard, who will speak to the readiness for technical assessments of SMR projects.

MS. RICKARD: Thank you very much.

My name is Melanie Rickard and I am the Director of the Assessment Integration Division in the Directorate of Assessment and Analysis. One of our roles is to conduct technical integration for the Vendor Design Review Projects. Being an integration division means we work closely and co-operatively with various subject matter expert and licensing groups.

Now that you have been provided with an update on what's happening in the regulatory framework, I will now speak to how our readiness activities over the past years have set the stage for efficient and effective conduct of regulatory activities.

Taken together, these aspects support applicants and licensees in developing comprehensive, high-quality submissions.

In this section, we will discuss two types of pre-licensing activities with a special focus on Vendor Design Reviews. I will also discuss some lessons learned and provide an example of a technical issue and how we face such issues.

The CNSC has two pre-licensing processes to support early engagement with potential applicants and vendors. They are both described on our website as well as in Regulatory Document 1.1.5, called Supplemental Information for Small Modular Reactor Proponents.

The two distinct processes recognize that future applicants have different needs from a reactor vendor when they engage with CNSC staff. However, in both cases, pre-licensing engagement serves to aid in an understanding of regulatory requirements, improve understanding of how to use the framework, and to obtain clarity when looking to try innovative ways of conducting regulatory activities.

The process on the left hand of this

slide is the Vendor Design Review. An example of a vendor is the developer of a new SMR technology who, as a result, may eventually be supplying services and products to licensees. A vendor must understand Canadian requirements and be prepared to explain to an applicant how they have addressed those requirements. I will speak a bit more later on about the VDR process.

On the right-hand side of this slide is a process that permits a controlled engagement by a potential applicant with CNSC staff to obtain clarity on what information to submit and support on a licence application. This process is executed by a licensing division such as the New Major Facilities Licensing Division, but may include the need for specialized technical expertise.

Because the applicant, as a future potential licensee, will be responsible for safety, they are expected to oversee the establishment of the safety case for their specific project. This means they need to both ensure their own user requirements are met by the vendor and ensure that their own proposed activities will meet regulatory requirements.

Through these activities, efficiencies in future licensing processes can be realized.

While pre-licensing engagement does offer benefits, it is separate from the licensing process and does not influence decisions made by the Commission.

I will now speak to the Vendor Design Review process in the next several slides.

As mentioned, CNSC staff have presented to the Commission on the matter of SMRs in the past, most recently in 2018. As such, this slide is just a brief reminder of what a VDR is.

It is an optional, pre-licensing process where vendors or designers engage with the CNSC under a signed service agreement. The review is an opportunity for both the CNSC and the vendor where the CNSC provides feedback on the vendors' efforts to address the Canadian regulatory requirements and identifies fundamental barriers to licensing, if any, early in the process.

And it is also an opportunity for CNSC staff to develop an understanding of the vendor and its design and identify any regulatory issues along with resolutions. An example of such an issue will be presented shortly.

This process is governed by Regulatory Document 3.5.4, shown on this slide, which addresses the objectives and scope of a VDR and its 19 focus areas.

Focus areas cover topics with potential long lead implications in a design. In other words, if problems are noted early in these areas, there is time for the vendor to resolve them before these issues become problems during a licensing process for a new facility.

These focus areas range from highly technical areas such as core and fuel design to more cross-cutting programmatic areas such as research and development and management systems.

VDRs are carried out in up to three phases, with each phase representing an increasing level of detail. To enter into a review, the vendor has, at a minimum, to have made reasonable progress in the basic engineering phase. This means that the basic design has been laid out following the Vendor's Reactor Design guides and design requirements.

The CNSC has been reviewing new reactor designs for well over a decade. Most recently, this process has been used to complete four Phase 1 reviews for SMRs, as indicated on this slide.

As you can see, all of these designs are quite different from each other and vary in power output from 5 MWe to 200 MWe.

In each case, a Phase 1 review examined how a vendor was demonstrating intent to meet Canadian requirements throughout their design and safety analysis activities, using examples from the vendor's conceptual design.

Executive summaries from these projects are posted on our website. And I'd also like to point out that all of these vendors have applied for service agreements to proceed with a Phase 2 review.

This slide represents the five vendor design reviews with assessments in progress by CNSC staff. One of which is a Phase 1, one of which is a Phase 2, and three are combined Phase 1 and 2 reviews.

There are also several other vendors that are communicating with the CNSC and are at various levels of engagement. However, the timing for all of these projects remains under discussion. For example, as Christian mentioned earlier, UltraSafe Nuclear has applied for a Phase 2 review which is likely to commence in the near future.

A Phase 2 Vendor Design Review carries on the work of a Phase 1 but looks at the more detailed design information and results of the safety analysis to understand how the vendor's design is meeting regulatory requirements. At the end of a Phase 2, CNSC staff will identify any issues that may pose a fundamental barrier to licensing, if not addressed prior to the submission of an application for a licence to construct.

A combined Phase 1 and 2 review combines the objectives of both the Phase 1 and 2 VDR and results in a single integrated report to the vendor at the end of the project.

It should be noted that NuScale, GE and X-energy, noted on this slide, are involved and associated with formal co-operative activities with the U.S. NRC under the Memorandum of Cooperation which will be discussed later in this presentation.

From this work, as well as other SMR readiness activities, CNSC staff have drawn some lessons learned. I will now take the opportunity to discuss them in the next few slides.

Over the years, we have noted several aspects that make the VDR more meaningful and efficient.

For example, it is critical that the vendor, over the course of the VDR, does not simply state awareness of Canadian requirements, but explains how their approach intends to meet or already meets the requirements.

Additionally, the vendor must choose and justify the use of codes and standards or methods that they will follow. In the absence of codes and standards, they will be expected to describe the types of information and activities that will be used to substantiate safety claims with a sufficient degree of confidence.

The vendor also needs to identify what research and development is required.

Further, the CNSC expects the vendor to have processes in place to identify and address gaps and that they have effective governance in place, including arrangements between the vendor and any service providers or contractor.

The CNSC also expects, and vendors understand, that a well-established management system is very important early in the design process for many reasons. It underpins and supports all design and safety analysis work, it ensures there is verification and oversight of these activities, and ensures traceability associated with these activities and outcomes, all of which give confidence in the design.

Of particular note is that CNSC staff review the management system focus area early in the review process and also, as part of the Phase 2 review, CNSC staff conducts an on-site evaluation of the vendor's management system which is concerned with design, safety analysis, and research and development. This process includes interviews of vendor staff and requests specific examples of process outputs.

The Vendor Design Review process work that we have done for the past several years has helped us gauge our state of readiness for upcoming projects.

In general, CNSC's staff have a very strong set of skills that are built upon a foundation of people that have the education and experience in the necessary science and engineering disciplines, most of which can be applied to any technology. Maintaining these core skills requires consideration of continual improvement and succession planning.

With that said, VDRs expose staff to cutting-edge technology issues and enable us to exercise our regulatory requirements and guidance in new circumstances.

Certainly, there may be areas where we need to develop further or perhaps where interim specialty assistance may be warranted.

For example, as part of reviewing reactor technologies using graphite-based moderation, the CNSC has sought out expertise from laboratories in the U.K. who have experience from their own fleet of gas-cooled reactors.

Because the Vendor Design Review is a standardized process, it can be used as a tool to engage early with other regulators who are also looking at the same design.

Now, after having discussed the VDR

process and some learnings, I will walk you through an example of a novel approach that has been proposed and how we are dealing with it. This case is predicated on using new types of fuel design to support a robust approach to confinement of radionuclides and containment of releases under normal operating and accident conditions.

Designing means of containment and confinement is an excellent example of innovative practices under development by some vendors. Before I go on, though, please note that the expectations associated with containment that are shown on this slide are simply examples and are not meant to be complete or exhaustive.

Means of containment have traditionally been met by specific structures that served an important and diverse role in the prevention of accidents that could lead to unplanned releases of radioactive material into the environment. For example, all Class I power reactors in Canada have robust containment buildings made of reinforced concrete.

REGDOC-2.5.2 requires nuclear power plants to install a containment structure that is designed to be leak tight. This means that leak rates must be designed to be as low as practically attainable and consistent with state-of-the-art design practices.

It must also be designed to be a safety

system, which is one that is designed to ensure the safe shutdown of the reactor or remove residual heat from the core or to limit the consequences of anticipated operational occurrences and design basis accidents.

It must also protect against external hazards such as high winds, earthquakes, and aircraft impacts.

And it must provide radiation shielding from the radioactive source term.

Several new designs are proposing alternative ways to implement containment structures as defined in REGDOC-2.5.2.

For example, rather than a traditional concrete containment building, they propose to rely on combinations of structures, systems, and components, also known as SSCs, working together. This does not mean that there will not be a building at all or a containment building at all, but rather that certain civil structures would be suitable -- perhaps suitable to contribute to the safety function of containment.

Vendors are proposing the use of fuels that are claimed to have superior failure tolerance under accident conditions and, in particular, superior retention of fission products. These designers also claim that these characteristics support a claim that any large release from the facility due to an accident may be practically eliminated.

Some of the expectations shown on the left-hand side of this slide may be achieved by the fuel or other SSCs that make up the plant design rather than a dedicated traditional containment structure. Civil structures will still be necessary to demonstrate robustness to impacts from outside the plant such as aircraft crash or severe weather events.

Two examples of fuel technologies associated with claims of superior performance are shown on this slide. On the left is an image of a TRISO fuel particle. TRISO stands for tri-structural isotropic, which means that there are three different materials used as barriers to surround the fuel kernel shown at the centre of this image. This would include graphite layers, an inner pyrolytic carbon layer, silicon carbide and an outer pyrolytic carbon layer. Each layer plays a different role from, for example, preventing other layers from cracking to retaining gaseous fission products and slowing the migration of metallic fission products.

A typical core will contain millions of these TRISO particles. Designers claim that the release of fission products from TRISO fuel particles is negligible and has formed the basis for a departure from traditional containment structures.

CNSC staff are assessing these claims as part of the Phase 2 Vendor Design Review. Any new fuel, however, will need to be demonstrated to be sufficiently qualified for use in a reactor facility.

TRISO fuel technology does have decades of experimental pedigree and has been used in some first and second generation reactors. Many labs in the U.S. and other countries have continued to develop the evidence needed to support fuel qualification. This fuel type has been chosen for use in a number of high temperature reactor designs including high temperature gas-cooled concepts such as those produced by X-energy and UltraSafe Nuclear but also some molten salt concepts such as Kairos Power in the United States.

Similar in concept but different in application is the image on the right. This is an example of a fuel salt used for some Molten Salt Reactor concepts. In an operating reactor, the fuel is in liquid form, as shown on the right of this image. Under different conditions, such as ambient temperature, the salt solidifies as shown on the left.

Where TRISO fuel uses mechanical means to make the fuel more robust and retain radionuclides, molten salt tries to do the same by using inherent chemistry characteristics to perform the same fission product retention and uses a liquid with a very high boiling temperature, which means the coolant will remain liquid and potentially keep the reactor cool even at very high temperatures.

Again, CNSC staff are assessing these claims as part of the Phase 2 Vendor Design Review for specific Molten Salt Reactor concepts.

We may see combinations of fuels, pressure vessels and civil structures combined into integrated approaches to achieve containment functions.

However, in order for the vendor or applicant to support their safety case, several key considerations must be addressed, such as:

All levels of defence in depth must be addressed, recognizing that more emphasis is being placed on prevention and interception and the use of inherent features to minimize consequences.

Evidence of the claimed retention of fission products within the fuel must be demonstrated through the fuel qualification program.

And the impacts of the releases of radionuclides from the fuel must be analyzed through its safety analysis.

CNSC staff are currently using a

well-established internal management system process in order to address this issue and set parameters for interpreting requirements and guidance.

Existing requirements are being systematically evaluated by a cross-functional team of experts to clearly document the underlying intent and safety objectives.

Because this is an issue of interest with other regulators, CNSC staff are reaching out to them as practicable to share information and insights. For example, CNSC staff have had discussions with the U.K. Office of Nuclear Regulation to leverage technical experience and expertise on this matter.

This process can be applied to reviews of other designs and specific topics and may result in recommendations for enhancements to existing requirements and guidance in our regulatory framework.

It should be noted, however, that designs regarding changes to Regulatory Documents will, of course, follow the transparent CNSC Regulatory Document process and that ultimate acceptance of any revised REGDOCs is carried out by the Commission.

No matter the novelty of the SMR design or approach, CNSC staff rely on a set of key principles to conduct our assessments. I will describe these now.

Alternative and novel approaches can present challenges, but also result in opportunities for improvements in safety and security performance if implemented in a systematic way. This is a critical mindset that any regulator must have in order to prevent becoming a barrier to innovation and change.

The use of the graded approach by the CNSC, applicants and licensees is central to our regulatory approach. It is important to note that the use of the graded approach is not a relaxation of requirements. Requirements can be applied in proportion with the risk associated with the proposed activity.

Regardless of the design, there is the common thread that the features and approaches must be proven.

Additionally, regulators must make conclusions regarding the extent and quality of experimental data and computational results and other research and operational data required in order to reach sound and robust decisions relating to the safety case.

This is especially important in first-of-a-kind facilities.

For a first-of-a-kind facility which may not have high degree of operating experience or there are uncertainties in knowledge or reactor behaviour, the CNSC staff expect the proponent to compensate for uncertainties in their safety and control provisions.

For example, they may need to be more conservative in design decision making and setting operational limits, or have additional commissioning tests or in-service inspections.

In all cases, the fundamental safety objectives must be met. These include the safety objectives and concepts provided in REGDOC-2.5.2 such as the radiation, technical and environmental objectives as well as defence in depth operational limits and conditions and the interface of safety with security and safeguards. These are key requirements associated with little flexibility.

Further, safety margins must be identified and maintained.

Experience has shown, as previously mentioned, that other regulators may have encountered similar issues and have additional insights to offer. Therefore, CNSC staff will leverage credible scientific information to the extent practicable.

Now I will pass the presentation over to Ms. Mok Cher Fong who will further discuss more on how we are leveraging experience and expertise from other regulatory bodies.

MR. LEBLANC: Excuse me, you are muted and your camera is not open. So if Mok cannot join us, can somebody take over?

MR. DE VOS: I'm just trying to figure out how to start my camera.

For the record, this is Marcel de Vos. I'm a Senior Project Officer with the New Major Facilities Licensing Division at the CNSC.

In this section, I will walk you through some of the many international cooperation activities the CNSC is participating in and show you how they are supporting our ongoing readiness to conduct efficient and effective regulatory activities.

As recommended in the SMR Roadmap, the CNSC is continuing to collaborate internationally to support the development of enabling frameworks for the global deployment of SMRs.

For Canadian new build projects, international cooperation can be used to enhance efficiency and effectiveness of technical assessments. This is done by exchanging lessons learned and leveraging scientific information of technical assessments which include research and development data.

Scientific information can be used by multiple regulatory bodies of different countries as long as the information is of sufficient quality for use in decision making.

Another major benefit of international cooperation is that regulators can establish conditions for increased mutual recognition of regulators' assessment activities and the ability to conduct joint assessments. Ultimately, this supports convergence and promotes harmonization of regulatory practices while continuing to respect regulatory sovereignty.

CNSC is active in various international fora and actively influencing the dialogue on the readiness for the regulation of new build projects worldwide.

We work closely with the International Atomic Energy Agency and the Nuclear Energy Agency to share good practices and lessons learned.

CNSC staff participate in IAEA regional workshops and meetings which include leading the development of an IAEA document for the application of the graded approach.

At the NEA, CNSC staff is chairing a number of committees and working groups, such as the Working Group on the Regulation of New Reactors and the Working Group for Safety of Advanced Reactors.

CNSC also leads and participates in

international peer reviews such as Integrated Regulatory Review Service, or IRRS, missions.

At the IAEA, CNSC is the chair of the Commission on Safety Standards that provides strategic advice on the overall IAEA's safety standards programs and worldwide application of standards.

Since 2015, the SMR Regulators' Forum has been understanding and documenting regulatory implications being presented by design and deployment of SMR technologies.

Its goal is to better understand the impacts of novelties on existing frameworks and to develop common positions in order to make recommendations to the IAEA on areas of improvement to the safety framework.

Starting in January 2021, in other words this month, the SMR Regulators' Forum will be developing guidance on establishing processes for increased mutual recognition and use of regulatory information. The intent is to make recommendations to the IAEA to use the results of this work to produce a publication on the subject.

Not only have the CNSC been actively applying lessons learned from the forum in its day-to-day work, but also in bilateral discussions with member countries.

One of the objectives of bilateral

engagements is the exchange of regulatory insights from technical reviews on design topics to enable efficient and effective regulatory reviews in both countries.

In 2019, CNSC and the U.S. Nuclear Regulatory Commission signed a Memorandum of Cooperation to guide and further expand cooperation on SMR and advanced reactor technologies.

We have made good progress in cooperation efforts under this arrangement, including the establishment of an Advanced Reactors and Small Modular Reactors Subcommittee. Under this arrangement, we have defined a terms of reference providing a commonly understood structure to effectively manage activities enabled through this cooperation.

The Memorandum of Cooperation signed by Canada and the U.S. enables staff in both organizations to leverage scientific data and review results from one another. The governing framework provides clear parameters for the sharing of information, including requirements on its use and protection. It also establishes clear communications between organizations.

To facilitate cooperation, there needs to be a good understanding of specific technical and legal terminologies in each country. This supports effective leveraging of information from regulatory reviews carried out by each country.

In 2020, the CNSC signed a Memorandum of Cooperation with the United Kingdom, or U.K., Office of Nuclear Regulation, or ONR. This arrangement aims to build on the existing relationship and cooperation of technical exchanges, as well, sharing of technical programs and development activities between both countries.

The CNSC, U.S. Nuclear Regulatory Commission, and U.K. Office of Nuclear Regulation are all mature regulatory bodies that jointly recognize that participation in international fora provide information that the regulators can use to achieve efficient and effective regulatory reviews.

CNSC is supporting increased international harmonization of safety requirements through bilateral and multilateral cooperation and through the proven IAEA safety framework. As the chair of the IAEA's Commission on Safety Standards, the CNSC will be working with members to prioritize safety standards. In the long term, this can contribute towards increased regulatory certainty.

The first step of harmonization is documenting commonalities between regulators while understanding the differences.

We are doing this in co-operative arrangements with other regulators and forums. We also recently participated in a meeting that the Nuclear Energy Agency convened with the CNSC, the U.S. Nuclear Regulatory Commission, the U.K. Office for Nuclear Regulation, and their respective government representatives and policymakers to further discuss an approach that facilitates the regulatory review of SMRs between the three countries. Doing this will identify opportunities for convergence and how we can accept the results of other regulators' work for use in our regulatory decision making. Although our focus will remain on information that we can gain from bilateral exchanges, this initiative will support our ongoing harmonization efforts.

In addition to the SMR regulators' forum initiatives, CNSC staff is working on a process and rules for leveraging information from regulatory cooperation. This is intended to address considerations to support mutual recognition and use of other national regulators' information. In other words, a consent strategy.

All of these activities will be used to further refine IAEA safety standards and guides and to export know how to other countries.

This concludes the international cooperation section of this presentation. And I will turn the presentation over to Mr. Adam Levine to discuss effective engagement with the public and Indigenous groups. Thank you.

MR. LEVINE: Thank you very much. Good morning. My name is Adam Levine and I am the Team Lead for Indigenous Relations and Participant Funding for the CNSC.

Today I will be speaking about the CNSC's approach to effective early and ongoing engagement with the public and Indigenous groups with regards to SMRs and emerging nuclear technologies.

The CNSC is a transparent and collaborative regulator that is committed to building trust with the public and Indigenous communities with interest in nuclear projects and activities in Canada, including SMRs and emerging technologies.

The CNSC understands that trust in the regulator and the regulatory process are key to the acceptance of decision making and the development of new technologies. This is why the CNSC is putting significant effort to ensure that both us as the lifecycle regulator and industry build collaborative long-term relationships with Indigenous groups and the public.

The CNSC sets the standards for the nuclear industry with regards to both safety and public and Indigenous engagement. The CNSC expects that industry puts in as much effort in their safety case for their project as they do in their engagement and relationship building with the public and Indigenous communities.

Early and ongoing engagement is key to building trust and partnerships.

With regards to new emerging nuclear technologies like SMRs, it is vitally important for the CNSC to have a strategic approach to outreach and engagement.

Historically, the vast majority of existing nuclear facilities and activities regulated by the CNSC are concentrated in a few specific regions of the country, and despite a broad and diverse engagement and communications program that spans the country, there are still many regions and communities in Canada that may not be aware of who the CNSC is and what we do.

As different regions across the country explore the possibility of SMRs, it is vitally important for the CNSC to begin engaging early on with local communities and organizations in these regions.

Early and ongoing engagement, even before a project is proposed, is a best practice and will help to ensure that local communities can learn about the CNSC's role as Canada's nuclear regulator and our thorough and transparent regulatory review process for proposed nuclear projects.

The CNSC has a thorough and transparent regulatory process and encourages all interested communities, organizations and individuals who have interests or concerns about specific nuclear projects or activities to get involved and participate in the CNSC's processes, including license application reviews and Commission hearings.

The CNSC provides multiple opportunities for the public and Indigenous groups and interested parties to review and comment on Regulatory Documents, Commission Member Documents, licence applications and supporting documentation through an interventions process.

In addition, through its Participant Funding Program, the CNSC offers funding to eligible recipients to support their participation in the regulatory review process, including Commission hearings.

In advance of all Commission hearings, the CNSC conducts a number of outreach, engagement and consultation processes with the public and Indigenous communities to ensure that all interested parties are provided with information regarding the proposed project and regulatory review process early on and have their questions answered by the CNSC's experts.

The CNSC also has a number of tools and approaches to engage and communicate with the public, Indigenous groups and industry including workshops and conferences, webinars and video conferences, fact sheets and infographics, an interactive website, educational videos and reports, meetings with the leadership of Indigenous communities, municipalities and the public as well.

Engagement and ongoing dialogue with all interested parties is a priority for the CNSC with regards to nuclear projects and facilities, including SMRs, and are committed to continually enhancing and adapting the way we do this important work to ensure it meets the needs of key audiences across the country.

To complement the CNSC's public, industry, and Indigenous engagement on SMRs, our Strategic Communications Directorate uses a suite of modern tools, guided by an overarching strategy.

Over the past two years, this had included the creation of original web content, the launch of one information video for social media, and an increased social media presence on all of CNSC's platforms that aims at effective disseminating scientific and objective information on SMR technologies. Content also encourages participation in all of CNSC's public webinars and workshops, highlights CNSC's international collaborative efforts on harmonization and has started to tell the story of how SMRs will be regulated in Canada.

In addition, it is important to note that the CNSC is committed to answering questions that come in to our info and media relations lines in a timely and informed manner.

Engagement and ongoing dialogue with all interested parties is a priority for the CNSC no matter the facility or type of project, and we will continually work to enhance and adapt the way we do this important work in order to ensure it meets the needs of key audiences across the country.

I will now pass the presentation back to Hugh Robertson. Thank you.

MR. ROBERTSON: Thank you, Mr. Levine. Hugh Robertson for the record.

In summary, CNSC staff are ready to regulate small modular reactor projects and are leveraging our robust management system and regulatory framework to do so effectively and efficiently.

The CNSC's regulatory framework is ready for use in new-build projects and has processes in place to incorporate lessons learned as experience is gained.

In 2019, CNSC completed an IAEA IRRS

service mission. One of the key conclusions was that the CNSC management system is well established, documented, and implemented based on a process approach which integrates all functions and activities.

Additionally, our pre-licensing activities were highlighted as a good practice by the IRRS mission. These processes enable both CNSC and proponents to independently ready their workforce and understand, plan, and resolve potential regulatory challenges early. We are able to conduct these activities while retaining a high degree of regulatory independence from the industry we regulate.

The CNSC is implementing international cooperation activities to support our assessment work through the sharing and leveraging of information, while making further progress to converge safety principles and approaches between regulators.

This is a path to harmonization of safety requirements.

At the same time, we will continue early and ongoing engagement with stakeholders, both public and Indigenous groups as well as industry, in order to build and maintain trust in the regulator.

Thank you, and this concludes our presentation. CNSC staff are available to answer any questions the Commission may have.

THE PRESIDENT: Thank you very much for the presentation, a very comprehensive, complete presentation.

We'll take a 15-minute break and come back and move to the round of questions from Commission Members. So we'll get back at 10:50 a.m. We'll see you then. Thank you.

--- Upon recessing at 10:35 a.m. /
Suspension à 10 h 35

--- Upon resuming at 10:51 a.m. /
Reprise à 10 h 51

THE PRESIDENT: We will now resume with the agenda item on Readiness for Small Modular Reactor Regulation. We will start with questions from Commission Members to staff as well as to external participants who have very kindly joined us today.

We'll start with Dr. McKinnon.

MEMBER McKINNON: Thank you for a very comprehensive presentation on an interesting topic. My first question is in connection with CNSC workforce readiness. And I guess the real challenge in any engineering design project is -- for new and complex systems is always anticipating what the potential modes of behaviour are, potential modes of failure, and therefore the risks.

How does CNSC determine that all the potential failure modes and risks have been identified and accounted for in terms of the safety assessments?

MR. ROBERTSON: That is why the VDR process is so invaluable to us. It gives us that early look at what is being proposed. But I'll pass it over to Ms. Melanie Rickard to respond in more detail.

MS. RICKARD: Good morning. Melanie Rickard for the record. Thank you for the question.

Absolutely, yes. So as Mr. Robertson mentioned, the VDR process does allow us to start to explore this in quite some level of detail, especially for the Phase 2 reviews. So as part of that, we start to investigate the applicant safety analysis which covers the identification of hazards, the probabilistic safety assessment, and also the deterministic safety assessment. All three of those components that are provided to us by the vendor look into normal operation and accidents conditions -- accident conditions, pardon me, to understand how the reactor is going to behave in all those different conditions. Also, they have to demonstrate the uncertainties and how they're going to deal with the uncertainties through, for example, research and support or experimental evidence, computational evidence, for example.

So this is absolutely something that we look at and, of course, will continue to be looked at if the project moves into licensing.

In terms of the capability and capacity of staff, as was mentioned in my presentation, our engineers are well qualified to perform these assessments, and certainly in areas where there are, let's call them unknowns, we do have opportunities to reach out to external expertise. Certainly we have partnerships within the Government of Canada that are also supporting our licensing projects, when and if they do come to be. And, finally, as was mentioned, we have lots of expertise and contacts throughout different countries such as the U.S. and the U.K. so that, let's just say, none of these decisions are ever made by one expert. We don't have single fail situations happening where one expert is making a decision like this. This is something that's looked at holistically by the CNSC staff and we have many processes in place to ensure that is done.

MEMBER McKINNON: Thank you. Yes. I was very interested to hear about the Vendor Design Reviews, and especially to hear about the Phase 1 and Phase 2 because design obviously is obviously embedded and connected very strongly with safety, so you need that long-time interaction to really make sure that connection is there strongly.

So over what period of time typically do the Phase 1 and Phase 2 reviews take place in order to provide that depth of knowledge for CNSC staff to really get an assessment of what could go wrong and, therefore, to participate in possibly effective design decisions to make sure that the design is as safe as possible?

MR. ROBERTSON: Phase 1 usually takes about 18 months. Phase 2 is probably around two years. But I can pass it on to Mr. Marcel De Vos to speak to that in more detail.

MR. DE VOS: That is correct. Phase 1 is much more process focused. It takes about 18 months to do. We focused on how the designer is implementing the requirements that we have in our regulatory framework within their design decision-making processes. So at that point we are looking for iterative design decision making.

Phase 2 typically takes approximately two years because we're getting into much deeper level of design. This is at what we would call a system level of design completion, long before any procurement activities would begin, and that would take approximately two years to complete.

MEMBER McKINNON: Thank you.

THE PRESIDENT: Thank you.

Dr. Lacroix.

MEMBER LACROIX: Thank you very much for this comprehensive presentation. Inasmuch as I'm enthused by the technology of SMRs, I do have a number of concerns. Among all my concerns are specifically the licensing process itself. I do have many questions concerning the risk, the time, and the cost of the licensing process, the in factory certification, the liability of technology vendor and supplier, the emergency planning zone for SMRs versus large reactors. The decommissioning, the reuse, the replacement, and the recycling of some of the components or some of the modular parts of the SMRs, and also concern about the legal and regulatory framework.

So instead of delving into each of these categories and take up all the time devoted to the question period, let me encapsulate my thought in one single impertinent question to staff. This question is the following: Does the CNSC have the legal authority, the resources, whether human, financial or legal resources, and the capacity to licence next-generation designs?

MR. ROBERTSON: Yes, and that is a big part of what our readiness strategy has all been about, the VDR process, is to ensure we have that capacity on all those fronts to move forward as well as our international collaboration to leverage information for -- to be more efficient and effective.

But I'll pass it over to Mr. Christian Carrier to speak in a little bit more detail.

MR. CARRIER: So we have published in 2016 a discussion paper for -- a discussion with the industry and stakeholders in Canada on the challenges that we as a regulator perceived existed on the potential deployment of SMR. So that was subject to extensive public and industry consultation. We received a number of comments from the public expressing those concerns. We received feedback. We had a workshop with the industry players in this area.

We had an action plan on what we heard reported, we identifying areas of challenges or potential challenges. One of them is the security regulations that basically were identified as being very prescriptive and being demanding for those -- and may not be totally adequate or, if you wish, not totally oriented. There were some prescription that could not usable, maybe, for some of those smaller facilities.

So we've been engaging. This readiness started almost 10 years ago. So we have been engaging with the different parties as these projects started evolving. So we've been consulting with the industry, we've been consulting with communities and the provinces. So we have a good picture of where the challenges are.

What we hear from people and as alluded and as a result of that discussion paper, there is a need for the further discussions on the application of the graded approach. And that is a challenge. It looks like a panacea to resolving every problem and in a sense maybe it is. But it doesn't mean necessarily that it's going to be easy.

The first-of-a-kind reactors will be a test case on the application of the graded approach and we will be testing it. And it touches on design and safety analysis and that is a lot of work we are carrying out in the Vendor Design Reviews, but it has to translate into operations. So people are approaching us, well, what is the minimum staffing? Can you operate those units remotely? There is all sorts of questions about transportation of those reactors. The first units will be test cases for demonstrating. It is easy to make claims that, oh, I don't need any operator in that facility, but you need those arguments and you need to prove it.

So, again, the graded approach is promising. It allows us to apply our regulatory framework in an intelligent and sound fashion. The application of it will be difficult. The reality is that it will involve a lot of discussions with the applicants and the industry players and demonstration in first units.

I hope I answered your question. I am available --

MEMBER LACROIX: Yes, well, let me pursue my question in a sense with an example. For instance, they are -- there is a technology which is called an integral design, which is a design that is assembled and sealed in a factory. What if this factory is located outside of Canada, will CNSC be allowed to conduct an inspection in a factory outside of Canada? Once the certification has been released in this factory, is it still valid after transportation and installation on site? So these are the kinds of questions that I'm -- when I say that I'm concerned about the legal framework, to what extent can you pursue this?

MR. ROBERTSON: Yes, and early on we realized that as part of the supply chain we would have to go much further back in the supply chain than before. But I'll again pass this to Mr. Carrier to respond in more detail.

MR. CARRIER: So we have experience in this area already with the Darlington New Nuclear Project. So we recognized early on through the licensing process that there is a need for carrying out compliance activities, both at the licensees, both looking at the oversight of licensees over procurement activities, and also getting involved directly and conducting inspections at the factory setting. There is provisions to -- in the licence that basically the licensee will facilitate by requirement of the licence condition the carrying out of those compliance activities, including internationally. We have not tested it yet, to be quite frank.

That being said, we are currently involved in different activities in international fora. I will note, for instance, the Vendor Inspection and Cooperation Working Group under the NEA -- under the multiple design evaluation project that is coordinated by the NEA, where inspectors from Canada and different countries are carrying out inspections at the factory. And it is not about comparing practices. It is about doing inspections together. So it's been done in Canada, it's been done in the U.S., it's been in Europe.

So we would like to pursue this activity for SMRs and we have been engaging with different fora to -- especially NEA to continue on those activities. So again, it's on the table.

MEMBER LACROIX: Okay. Thank you very much. Thank you for your answer.

THE PRESIDENT: Thank you.

Dr. Berube.

MEMBER BERUBE: I just want to follow up a bit on this because I have a manufacturing background and I know how difficult that is in a multi-national environment to maintain standards and quality control right down to managing labour issues. But let me ask you this question, CNSC, you know, how are you going to manage this? I mean, this is a manufactured product. Basically it gets stuck in a crate, transferred internationally. Are you going to licence a particular design or are you going to licence the final installation or are you going to licence the transportation and handling? How are you going to control that entire process? Because a lot of things can go wrong, right from the sourcing of materials right to final welds, pressure verifications, all kinds of things. Because this is not just a one-off product in Canada, it's potentially an international-based product which coming from all over the place, how do you certify a product that's fit for use?

MR. ROBERTSON: Internationally we've been seized with these new requirements or what we see coming down the pipe. But again, I'll ask Mr. Carrier to speak to this in more detail. And following that, I'll also pass it to Mr. Ramzi Jammal, our Executive Vice-President and Chief Regulatory Operations Officer.

MR. CARRIER: Okay. So I've just been requested to increase my volume. Could you confirm you hear me better? Okay, thank you. It's been a hiccup with my computer.

We've been under a discussion on the notion of certification of reactors for more than a decade now. Canada has an experience in precedence setting. We have been licensing reactors and I will say that no two reactors -- we have been improving the design, starting from the Douglas Point and NPD, and moving about the Pickering and Bruce and Bruce and Pickering -- and then ultimately the CANDU six reactors.

Precedent setting has been good. There has been an evolution. I will say that it took a long time before the design would stabilize. We understand that some countries are proceeding with design certification. Again, design certification is a big word. There is elements of the design that are certified, not all of them. There will be dependencies on where you put your reactor.

So design certification is usually

limited. We have been engaging with the U.S. to understand the practice. We're not totally closed to the idea, but if I were to make a comparison with the aeronautics industry, nobody would dream of having a paper airplane and just putting it on the ground and then put passengers and then it flying in the air. It takes a lot of energy to design and prototype the plane. Before any passenger goes into that plane, it has flown around the earth several times.

What we view in Canada, the current trend is that we're not against certification, but we would like demos especially on those novel and innovative technologies to be demonstrated by practice on acquisition of operational experience and maintenance experience, identified by vulnerabilities and better designed before we go into a fleet approach.

So again, this is maybe a medium- to long-term, if you wish, aspirational goal. But for the time being, we are focusing on first-of-a-kind and acquisition and demonstration of those novel technologies.

THE PRESIDENT: Dr. Demeter.

MEMBER DEMETER: Thank you very much.

I'll start with just an observation because it would be too long a discussion, but it may invite a further discussion or presentation. When I read slide 24 and I looked it as a member of the public, and I read the first bullet, it said:

> "Amendments proposed to establish high-level principles similar to other regulations and remove prescriptive requirements."

My concern is that this discussion about prescriptive performance base, and to me performance base just means pulling the prescriptive elements up to policies versus down to procedures, might not be comprehensible to the general public. When they see "remove prescriptive requirements," there may be a sense that we're reducing the safety threshold. And I think it would be really good to have -- not at this time because it would take too long, but to have a discussion about prescriptive versus performance-based policy and how safety is maintained and how you find that sweet spot so that the public understands when we say we're removing prescriptive requirements, we're not watering down the safety case.

I just put that as an observation, when I saw that it kind of rubbed me the wrong way the way it was worded because it's a complicated discussion that requires some context. This venue and this presentation won't allow the time for that, but I think it's important as an observation in possibly a future discussion or presentation.

My specific question is my understanding is that some of these models will use some degree of enriched uranium, and what factors have we taken into consideration, since none of our CANDU fleet -- they all run on natural uranium. We've sort of taken all of our enriched stuff and repatriated back to the U.S. How are we going to manage getting back into the scenario where we might actually have enriched uranium in power plants on Canadian soil? How is that going to affect our safety approach?

MR. ROBERTSON: I'll pass this to Mr. Carrier to respond.

MR. CARRIER: Nuclear power plants in Canada have been operating for the last several decades using natural uranium. That being said, Canada has experienced in operating reactors using either highly enriched uranium or low-enriched uranium. So there is been an experience with the NRU reactor, for instance, and the NRX for more than 50 years operating with those -- with those reactors.

So a reactor is a reactor. That is uses natural uranium or highly enriched uranium or low-enriched uranium, whether that be below 5% or below 20%, we have experience doing it in Canada. That being said, acquiring that material may be challenging. So again, there's been discussion within the industry in getting that type of material. It's not as available as people may think. Again, that's an industry problem.

Finding uranium of less than 5% enrichment is relatively easily. Below 20% or 5% and 20 -- but there is a significant discussion at the policy level and industry level to acquire that material. I would not see this as necessarily a safety concern. There has been practice. People have been doing it and we have had experience doing it.

Maybe Dr. Doug Miller could be complementing my response on this one.

MR. MILLER: Doug Miller for the record.

In this case, in view of any fuel that's proposed, we would do a comprehensive review of the application to verify that all regulatory requirements and elements in our regulatory documents would be addressed. So in a way all applicable laws, regulations, and criteria will have to be met.

THE PRESIDENT: Thank you.

Dr. Demeter, I'm sure the Secretariat has made note of your recommendation around perhaps topic in the future on prescriptive requirements versus performance-based requirements.

Maybe what I'll do is I'll ask our external participants and we'll go around the room to them and get their perspective on how [indiscernible] they believe the CNSC is for regulating SMRs and if they have any other suggestions or insights that they would like to share with the Commission on that.

I'll start with Bruce Power, please.

MS. KLEB: Good morning. My name is Heather Kleb for the record, and I am the Director of Next Generation Nuclear Power at Bruce Power.

Generally speaking, the answer to your question, the short answer is yes. We do believe the CNSC has the flexibility to licence SMRs currently. That said, the discussion around a graded approach and an appropriately scaled approach is critical, but there is an understanding of that within the CNSC.

In addition, we would reinforce that there needs to be a risk-informed approach, but we see good progress in both of these areas and are supportive of the work that's been done to date.

THE PRESIDENT: Thank you for that.

Maybe I could ask OPG if they share that or if they have any other insights they would like to share.

MR. MANLEY: Robin Manley here for the record, if you can hear me.

THE PRESIDENT: Yes, we can.

MR. MANLEY: Thank you.

I am the Vice-President of New Nuclear Development at Ontario Power Generation and responsible for our Darlington New Nuclear Project. I'll say a couple of remarks and then Jack Vecchiarelli will add a few other points.

First off, to the CNSC staff, thank you for, as noted, a very extensive presentation today, and thank you to the Commission for the opportunity for licensee representatives and utility representatives to comment.

OPG as a whole is confident that in Canada we have the right regulatory framework, capable operators, strong supply chain and overall the capability to go ahead and safely and effectively deploy new nuclear technology, small modular reactors to assist, for example, in fighting climate change. And we look forward to the opportunity to do that.

Obviously, there are always things that can be improved. I read with interest the CNSC's responses in the SMR Action Plan recently published, where the CNSC identified several areas they were actively working on and those were spoken to today. And I encourage CNSC to continue to work in those areas because I think they are high-priority items and appreciate you doing so.

Jack.

MR. VECCHIARELLI: Thank you, Robin. This is Jack Vecchiarelli for the record. I am the Vice-President of Nuclear Regulatory Affairs and Stakeholder Relations at OPG. I would just like to add briefly to what Mr. Manley said.

With respect to the readiness of the regulatory framework as presented by CNSC staff here today, overall I would agree that it's robust and does offer flexibility for SMR licensing. There are some areas where, as already noted, there needs to be further discussion and engagement with the CNSC staff. We have provided our comments on the draft revision of REGDOC-1.1.2 on the guide for licence to construct application, and there definitely are areas where we would like to have further discussion in the context of a risk-informed graded approach, level of detail, timing of certain information for different phases of the licensing process. But we're confident that those discussions will be constructive. And, overall, we see that there is enough regulatory flexibility to accommodate SMR licensing. Thank you.

THE PRESIDENT: Thank you.

Turning over to New Brunswick Power then, please. Mr. Thompson.

MR. THOMPSON: Good morning. For the record, my name is Paul Thompson. I'm the Senior Strategic Advisor at NB Power working on the advanced small modular reactor team.

I absolutely concur with the comments from my colleagues, and also want to thank the CNSC Commission for holding a meeting such as this to get an update on the state of readiness and of the regulatory aspects of regulating small modular reactors. Such a comprehensive presentation by staff and excellent work on the SMR Action Plan.

We have excellent regulatory framework as identified as well by my colleagues, a number of areas where we have identified that some further evolution and fine-tuning needs to be done. The CNSC staff clearly have the processes and are following them. So the industry is engaging, as is the general public, with the commenting on these types of documents and getting involved in that process. So we're very encouraged. As well as the work on international collaboration, and we're very pleased with that. We are confident that this will continue to evolve in a very positive way. Thank you very much.

THE PRESIDENT: Thank you.

From the utilities, let's move to CNL. Can we get your perspective, please.

MR. GRIFFIN: Good morning. For the record, I'm Jeff Griffin, Vice-President of Science and Technology for Canadian Nuclear Laboratories.

As far as the answer to the question, I think I want to concur with the other remarks we just heard. I will say that our experience has been -- our position on this is that we believe that the graded approach that's been discussed this morning of the regulatory process that includes requirements and timelines that are scaled appropriately is the right way to go. We believe that the CNSC strategies for readiness to regulate, as we saw discussed this morning, will deliver the desired results. We also agree with the CNSC that a demonstration could be key to proving the technology. Thank you.

THE PRESIDENT: Thanks very much.

Let's now hear from a proponent, Global First Power.

MR. TRAIN: Good morning. It's David Train, Licensing Director for Global First Power. Thank you for the opportunity to come to the Commission today and provide our perspective.

I would say from Global First Power's perspective, we would concur with the previous comments that have been echoed by other members of industry. As an author or one of the authors of the SMR Roadmap in 2018, we concluded at that time that the existing Canadian regulatory framework was suitable for licensing an SMR. As a proponent in the process right now, we would continue to agree with that assessment. Our challenge at the moment is working that process for, say, a reactor of the size that we have seen discussed today. But to date we've had a lot of good engagement with the CNSC staff, very appreciative of their feedback. And we continue to work through the process.

THE PRESIDENT: Thank you. And maybe I can ask for your perspective on the VDR process and how valuable or not you found it or are finding it.

MR. TRAIN: Global First Power is a licence applicant for a site preparation licence at Chalk River. As such, we are somewhat removed from the Vendor Design Review process. That is a process between the technology developer and the CNSC. So while we are aware that that is progressing, we are not an active participant in that for obvious reasons.

THE PRESIDENT: Okay. Thank you.

Maybe we can hear from NRCan, not so much as the action plan and the CNSC's contribution or expectations around that, but maybe more generally. What are your thoughts around the CNSC's readiness?

MS. CAMERON: Good morning, everyone. We also concur that a lot of analysis -- oh, I'm sorry. Diane Cameron, director of the Nuclear Energy Division for Natural Resources Canada for the record.

Through various analyses and initiatives including the SMR Roadmap analysis in 2018, extensive stakeholder engagement, outreach to Canadians and Indigenous peoples, followed by the Action Plan, the SMR Action Plan in 2020, we have a very high degree of confidence in Canada's overall readiness from the perspective of legislation, policy frameworks, and regulatory readiness with the CNSC. So we're very confident that Canada is ready to oversee these technologies. The CNSC playing its role as the independent regulator, the government playing its role with respect to legislation, with respect to international commitments and so on.

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

Maybe then turn to AECL. Anything you want to add?

MS. QUINN: Yes, thank you. For the record, my name is Shannon Quinn. I'm the Vice-President of Science, Technology and Commercial Oversight for AECL.

AECL also agrees with all of the comments and agrees that the CNSC is ready in respect of regulating SMRs. One of the things I might point out as being particularly relevant to this is that sort of over the course of my engagement with the CNSC on this topic that extends back almost a decade, I can validate that the CNSC has been working on this over that entire time and, indeed, they were proactively looking at many of these things long before this became a topic of national conversation. So that ability of the staff to look forward in time, identify trends, and get an early start here has been tremendously valuable to Canada moving forward effectively on SMRs.

One of the things, though, I would just point out perhaps is that key to all of this is, of course, the resources, as has already been pointed out, including human resources. One of the challenges for the CNSC, but also for AECL, and I would venture for all of the organizations participating here, will be acquiring the additional human resources, the additional capacity that's going to be needed in order to move forward on this, which is not to say that there's any question about the capability, the competency, and indeed the expertise of the existing staff, but just to say that there will be a requirement for more.

Also, I would say that in order to be able to move ahead in this graded approach, taking an innovative look, part of what's needed there is a variety of perspectives. So at AECL, we try to make sure that we have a diversity of experience at all levels of our organization to make sure that we can continue to challenge ourselves to make sure that we don't get sort of a traditional view that prevails. So we are going to continue to look for additional talent at all levels, as I suspect will you. So we'll all be in a position of trying to acquire talent from a very limited talent pool.

THE PRESIDENT: Okay. Thank you very much for sharing that, Dr. Quinn.

I believe we've got someone from SaskPower with us as well, and I know the CNSC is kind of new to you, but anything you would like to share? And maybe your perspective on what -- anything more the CNSC should be doing to introduce the regulator -- I mean, we're known in Saskatchewan, but on the power side and reaching out to the communities there.

If we could get your perspective, please.

MR. HARRY: Sure, happy to do that. For the record, my name is Iain Harry. I am a Senior Business Advisor with SaskPower and have lead responsibility for the evaluation and development of nuclear power within our company.

I would concur with the comments of our colleagues. We at SaskPower have had a very productive engagement with the CNSC going all the way back to 2012, 2013, and we continue to engage with the CNSC staff as we advance a recommendation to our board in a couple of months to proceed with site selection and the initiation of a site licence application with the CNSC.

So the -- you asked about the role of the CNSC in engaging folks in Saskatchewan with regard to the potential for nuclear power generation. We certainly have identified the CNSC as a very important voice as we work to build confidence and support for nuclear deployment in Saskatchewan. We would also see that kind of a relationship with the NWMO, and we have already started to engage along with our colleagues in the other nuclear utilities in Canada as well as NRCan and the Canadian Nuclear Labs and other organizations in Canada, including the Canadian Nuclear Association.

So we have appreciated the productive relationship that we've been able to establish with the CNSC and will continue to work with the CNSC staff to prepare to initiate a licensing process.

THE PRESIDENT: Okay. Thank you.

Lastly, let's turn to the NWMO.

MR. WILSON: Thank you. Derek Wilson, for the record, chief engineer and vice-president of contract management at the NWMO.

While the NWMO is not a formal requirement in the process of the CNSC, obviously we are integrated with the overall fuel cycle of SMRs and the *Nuclear Fuel Waste Act* contemplated new market entrants as an inevitable cycle within the potential fuel inventory going forward for Canada. So once these SMRs become reality, we would see ourselves as having to mandate the long-term management of the used fuel.

We have very much been following the industry progress with respect to SMRs. We have engaged with many of the vendors and proponents as it relates to fuel. As for the CNSC staff and for the presentation, it's early days and there's a lot of different technologies that are out there. As more information becomes available, obviously we would be able to better assess the potential impacts as it would have related to our long-term management of used fuel. As you can imagine, 99.9% of our fuel is CANDU fuel.

And so we are watching and available to

work with the industry as required. Again, we're not a formal requirement in the process, but are integrated into that as much as we can through our member organizations. As many of the potential proponents have indicated, we are engaging with them. I think from the CNSC perspective, it is well positioned to be in a regulatory position for the SMRs.

And I would mention that from the Vendor Design Review, we have actually utilized that ourselves in our design and found that was a very robust process. While it's not related to the SMRs, it had been a productive process for us going through a Phase 1 review and we look forward to our Phase 2.

THE PRESIDENT: All right. Thank you very much for that.

So thank you all for sharing that. It certainly gives us at the Commission a lot of comfort to know that staff is doing the right things and is getting to where it needs to in a very collegial way with all the other different stakeholders.

Let me see if Commission Members have other questions. We'll start with you, Dr. McKinnon.

MEMBER McKINNON: Yes, thank you.

I would like to ask a non-technical question this time and return to a point that was brought up by Dr. Quinn of AECL and it's in connection with personnel and talent availability.

I could imagine if an SMR is used at a remote mine site, for example, it could be a period of 10 to 20 years, it would be a complete life cycle of the nuclear facility compressed into that time period that would involve licensing decisions, ongoing safety monitoring, reporting and so on. If there are numerous SMRs deployed throughout Canada, my question to CNSC is: What would the potential impact be on the personnel capacity and site staffing requirements to manage this workload?

MR. ROBERTSON: Certainly that's one of the questions, not only our internal capacity, but supporting these broader deployments.

But I would pass it over to Mr. Christian Carrier to respond in more detail.

MR. CARRIER: I suggest that there is two parts to this question. There's the staff capability at the CNSC level and there's the staff capability at the industry level. The CNSC has internal initiatives dealing with capability for nuclear safety and management of knowledge, so knowledge management within the organization. So we are tracing, we are evaluating capacity at the CNSC level for continuing purpose and continuing needs.

Regarding the industry, your question gets a bit more complicated. We're dealing here with a concept of the fleet approach. Are we going to deal with separate operators in that fleet or are we going to deal with a single operator in that fleet that would be operating several units? The current tendency in what we hear from the industry is the tendency of having a single operator that would be operating multiple units. Probably in this case, I would allude that continuity of knowledge and continuity of staffing would probably be more sound.

I would redirect questions on the capability for nuclear safety to Ms. Melanie Rickard, and the question about industry capability and continuing capability to the industry. So I would start with Ms. Melanie Rickard.

MS. RICKARD: Thank you, Christian.

Actually not a whole lot to add to that, although obviously available to answer any more specific questions. But just to complement what Mr. Christian Carrier mentioned is that this is really part of our day-to-day activity at the CNSC. We're constantly evaluating whether or not we have the right balance of capacity and capability. So despite the fact that it is part of our day-to-day, we have as an organization done some more comprehensive exercises to clearly document the capability that we have and identify any areas that may need improvement or growth. That exercise was actually carried out a couple of years ago.

Now that we're looking at future deployment of SMRs, there is an exercise ongoing to identify, again as Mr. Christian Carrier said, that we do have the capacity and the capability to take on the new work that is likely to come.

But in terms of your question, you're quite right. We really don't know right now where this is going to go, we don't know how many new applicants we're going to have and exactly the time frame that they're going to come. So I would simply conclude by saying that this is something that we have to monitor on a regular basis and we're very cognizant of the issue.

THE PRESIDENT: Before we open it to industry for their perspective, maybe I can ask Ms. Cameron from NRCan, from a policy perspective, is there a likelihood of narrowing down the number of different types of technologies that get deployed in Canada?

MS. CAMERON: Hello. Diane Cameron, Director of Nuclear Energy Division, Natural Resources Canada, for the record.

It's not so much a question of policy. There are a variety of competitive processes that are underway in parallel that collectively are narrowing down the list of technologies and bringing some front-running technologies to the forefront. So I would say that some of the conditions for success, so successful technologies that are vying for space in this market, they must meet with the approval and standards of the CNSC. That is the first hurdle that they must pass. And they begin to demonstrate their credibility in this space through the VDR processes and ultimately through with the licensing processes. So that is a necessary condition for success, but it's not sufficient. It's necessary but not sufficient.

They also need to convince operators. We have three expert and experienced and reputable nuclear operators in Canada who are also, through their own processes, evaluating these different technologies to determine which ones they would be prepared and comfortable operating, which ones they feel that they could do both safely, securely, and economically for the benefit of their stakeholders and to help them achieve their mandates in providing affordable, reliable electricity and energy to their constituents. So that is another necessary condition, but also not sufficient.

There is also the question of site owners. And sometimes those site owners are the utilities themselves. In other case, the site owners are the federal government through Atomic Energy of Canada at Chalk River. So there are processes where site owners are evaluating whether they wish to allocate their strategic asset, which is their land, to a technology. And so, for example, Canadian Nuclear Laboratories is also evaluating technologies to determine which are the most appropriate, which are the most feasible, all from a technology feasibility but also safety, security and overall viability.

Now, in addition to that, there are the financiers. Here we're looking at a combination of private finance and government financing. So there is yet another layer of scrutiny that is being applied. Certainly from the perspective of the federal government of Canada, any federal government funding that is allocated to a technology will be based in large part of a very critical evaluation of that technology and its potential benefits to Canada and to Canadians.

When we look at applications for funding to the federal government from SMR technology developers, we evaluate it from the perspective of technical feasibility, of innovation, of safety, security, et cetera, but we also look at it from the perspective of public acceptance and from the perspective of jobs and value and supply chain in Canada.

So you can see that collectively there are a variety of processes being undertaken to evaluate and review technologies from different lenses. So it is this sort of -- it's the confluence of these different evaluations that is going to determine who the winners are in Canada.

What I can report is that, at this juncture, there are some technologies that are coming to the top of the pile, if you wish, or coming to the front of the race.

In the on-grid space for near-term deployment, OPG and SaskPower have identified the front three technologies. They are Terrestrial Energy, GE Hitachi, and X-energy.

In the Generation IV space, New Brunswick has identified two technologies, Moltex and ARC Energy.

And in the microreactor space for potential application off-grid mining and community applications, there are two front-runners presently. One of them is Global First Power working with OPG and the first to apply for a licence to prepare site. And the other is eVinci working with Bruce Power.

So now we're starting to see from where we were a few years ago where there were 150 designs that were under review, we're starting to see which ones are real, which ones are viable, which ones are safe, secure, and will provide benefits to Canada and Canadians.

THE PRESIDENT: Excellent. Thanks so much for that, Ms. Cameron.

The CNSC, as we have seen with this Vendor Design Review process, have got a number of applicants. What I had also heard was that some of these proponents, even though they may think that there is a low likelihood of their design getting deployed in Canada, would like to get the CNSC's kind of the stamp of chair, which would make their design perhaps more marketable globally.

Again, this would be a challenge for the CNSC, where do we prioritize our efforts? Just because someone is willing to pay our costs, you know, this is a limited resource that one has. So very much appreciate you walking us through the different considerations in who would be coming to the front of the line, and, again, for the CNSC then to decide what does that mean from a prioritization perspective.

Let me open it up to industry to see if any of them have anything they would like to add to what's already been said by staff and NRCan. Anyone?

Mr. Manley.

MR. MANLEY: President Velshi, it's Robin Manley here, for the record. I will give some thoughts on behalf of some joint industry working groups. So this is going to be a bit high level, but maybe will help add to the conversation.

So the industry recognizes that there are new technologies and new things to learn, and we want also in some ways to do new nuclear a little bit differently. So it's not just same old, same old. With new technologies, we recognize there are new opportunities, both in safety, in efficiency, in construction techniques, in operating models, and in engineering.

So while we have -- in order to support our existing nuclear facilities, we have, you know, well-developed programs for knowledge management, for bringing in the highly capable staff and developing them, training them, mentoring them to safely operate and maintain our stations and manage them. You know, we also recognize that there are things to learn. So we have, as the CNSC staff's presentation mentioned, put together a variety of industry working groups. I'll just mention a couple of them.

We have been working with the CANDU

Owners' Group, COG, which is broad-minded enough to recognize that there are other opportunities for nuclear power plants in Canada and has established a COG SMR Technology Forum, which I have the honour to chair. We work collaboratively amongst the utilities and CNL, but we also bring in experts from across the broader industry, including the university network. So the University Network of Excellence in Nuclear Engineering. We have representatives from the Canadian Nuclear Society. We have representatives from the Canadian Standards Association. And we bring to this forum all sorts of questions, including this kind of thing: What do we need to do to be ready? And that can include bringing in and developing the next generation of nuclear power plants, engineers, operators, support staff, and what have you.

So our Canadian SMR action plan recognizes that there have been -- there had been recommendations made around diversity, for example, and bringing in new populations of staff. So those kind of recommendations have turned into commitments by various organizations who have responded in the action plan.

So I mentioned the SMR Technology Forum. We also -- and you mentioned the question around working together -- well, potential pan-Canadian fleet. Well, we have what is called the CEO SMR Forum and the CEO SMR

Working Group, where executives of OPG, Bruce Power, CNL, NB Power, SaskPower, and the Canadian Nuclear Association and COG, we get together on a regular basis to discuss challenges, opportunities of mutual interest, and things we can work on collectively so that those issues, including knowledge management, retention of staff, bringing in new people, whatever it may be, so that we are laying the framework to solve those things before they become a challenge.

So that all goes part and parcel to my earlier statement where I said we believe we can accomplish this safely and effectively and that includes personnel. Thank you.

THE PRESIDENT: Okay. Thank you very much for that.

Maybe in the interest of time that we can get back on to the agenda, but maybe I'll turn to Mr. Jammal to see if he wants to conclude the staff presentation on this item.

MR. JAMMAL: Thank you, President Velshi, Members of the Commission.

You've heard a lot about the SMR. I would like to focus on the CNSC itself with respect to our challenges. I do not want to let the fact go that we do not know what the challenges are. We are facing challenges. We recognize what they are. Within the CNSC itself, we have multiple defence in depth from structure perspective. We are organized internally with respect to our Regulatory Affairs branch, with respect to strategic pressures we're facing. We've got several committees that do exist in place, let it be from innovation as the first of the kind coming to us or innovation we're going to implement with respect to our regulatory oversight.

So, Dr. Lacroix, you asked a question, do we have a legal mandate. Yes, we do. It's -- the Parliament has mandated the Commission and for us staff to provide you with the recommendations solely based on acceptable risk and safety. So that framework does exist and that final decision lies with you as Commission Members.

With respect to the future, we will take the challenges as an opportunity rather than an impediment. We are working at all levels, international harmonization. So in other words, the technical information you -- the Commission Members touched a little bit about certification. The outcome is not the issue. It's on what foundation the outcome of the licensing process or the approval process is based on, will be based on fundamental science and proven science so that safety is not compromised, regardless of what it is, let it be contaminant, let it be emergency primary zone, off-site impact, on-site impact, or the operations.

I want to give confidence to the Commission that we are working internationally and we are collaborating from staff exchanges to knowledge management and to move towards the future so that we will build our capability.

From financial perspective, we work closely with our colleague Ms. Cameron and NRCan in general. As a matter of fact, the CNSC has requested extra funding from the Government of Canada and we are awaiting that decision.

As we move towards the future, we've taken a lot of operation experience. My colleagues mentioned the Darlington new build process a few years back and we will continue look at -- adapt where we need to adapt.

And to clarify the fact that we do not remove prescription, we implement the fact that performance objectives will meet our requirements, but it's up to the applicant or to the operator to demonstrate that they are meeting our safety requirements based on performance rather than us trying to dictate what we think is adequate.

So all I can say is we will continue

facing the challenges. We know what they are. We are working at all levels, national and international, in order to maintain that there will be no compromise to safety. We're learning from the existing vaccine capability of lessons learned, how can we adopt -- Canada did adopt information from other regulatory bodies around the world, again without compromising the safety of Canadians. Same thing in the airline industry. So we will be providing you with updates on the progress towards the SMR.

In my opinion, as chief regulatory operations officer, we are ready, we are moving in the right direction, and the end point will be no rubber stamping and no compromise to safety.

Thank you, Madam Velshi.

THE PRESIDENT: Thank you, Mr. Jammal, for that. Thank you, staff and our external participants, for a very informative session. We look forward to getting updates in the future as this very important file progresses. Again, thank you.

CMD 21-M8

Written submission from CNSC staff

THE PRESIDENT: So let's move to our next agenda item. These are updates from previous Commission meetings. The next submission is an update from CNSC staff on an overexposure to a member of the public at CancerCare Manitoba as outlined in CMD 21-M8. This was this was an action item from the September 16, 2020, Commission meeting.

The Commission confirms receipt of the new information filed by the CNSC staff.

The Commission is satisfied with the information provided as it pertains to this event and has no further questions. The action item is therefore closed. However, the Commission requests that staff make a technical presentation at a future public Commission meeting on the matter of dosimetry and dose calculations.

CMD 21-M9

Written submission from CNSC staff

THE PRESIDENT: The next submission filed by CNSC staff is an update pertaining to Suncor Energy Inc. as outlined in CMD 21-M9.

Again, the Commission is satisfied with the information provided and has no further questions. So this action item is also closed.

CMD 21-M11

Written submission from CNSC staff

THE PRESIDENT: The next item is the event initial report regarding an elevated hydrogen level in a leach tank at Orano Canada's McClean Lake operation as outlined in CMD 21-M11.

I note that representatives from Orano as well as a representative from the Saskatchewan Ministry of Labour Relations and Workplace Safety are joining us remotely and are available for questions.

Before opening the floor for questions, I will turn it to CNSC staff.

Ms. Murthy, would you have anything else you would like to add to this?

MS. MURTHY: Good morning, Madam Velshi, and Members of the Commission. My name is Kavita Murthy, and I am the Director General of the Directorate of Nuclear Cycle and Facilities Regulation.

With me today are Mr. Peter Fundarek, Director of the Uranium Mines and Mills Division, and Mr. Salman Akhter, Senior Project Officer responsible for the McClean Lake file at the CNSC.

The event report outlined in the -- Event Initial Report, CMD, is self-explanatory. There is information related to an event that happened at the site. CNSC staff have reviewed the actions taken and planned by the licensee in response to the event and are satisfied at this point with the proposed actions that are outlined by the licensee.

In addition, CNSC staff also wish to note that there is an inspection planned of the human performance management program at that site and that inspection is a virtual inspection that is going to take place in the next week. CNSC staff are focusing on training in that inspection and we will be checking to see the changes and improvements that have been proposed by the licensee are included in that inspection.

CNSC staff are available to answer any questions that you may have. Thank you.

THE PRESIDENT: Thank you, Ms. Murthy.

I will turn the floor to Orano. Mr. Laniece, do you wish to make any remarks before we open the floor to questions from Commission Members?

MR. LANIECE: Good morning, Madam Chair. Vincent Laniece for the record. I'm with Tina Searcy who is with me, the manager with --

MR. LEBLANC: Mr. Laniece, we cannot hear you. So can you increase your volume, please.

MR. LANIECE: Is that better?

MR. LEBLANC: This is fabulous.

MR. LANIECE: Sorry. I'm not very used to using Zoom. Sorry for that.

Good morning, Madam Chair. Good morning, Members of the Commission. I am Vincent Laniece for the record. I am the Vice-President of Safety, Environment and Engineering for Orano. I've got with me attending today, Ms. Tina Searcy, who is the Manager of Regulatory Relations, and Mr. Dale Huffman, who is the Vice-President of Operations at site.

THE PRESIDENT: Let's open it up for questions, starting with Dr. Lacroix.

MEMBER LACROIX: Thank you. Well, I do have two snap questions. The first one is concerning the hydrogen accumulated in the ore. I understand the process of radiation hydrolysis of groundwater. What I don't understand is the timing. Is the accumulation of hydrogen increased? Does it increase with time or is it a constant?

MR. LANIECE: Dr. Lacroix, that's a very good question. I'm not fully sure of the response by itself. It seems that the hydrogen that is captured is mostly captured in the clay that surrounds the ore and because it's captured by the clay at some point in time, we are getting to some kind of saturation effect so the concentration doesn't increase anymore. A number of Ph.D. studies have been done on that topic. It's not fully clear if we've got some kind of saturation effect on that. So I'm offering the best that I would know as of today.

MEMBER LACROIX: Okay, thank you. That's good. And my second question, snap question also, you mentioned in the EIR that you are working on an additional barrier to the digital control system. So is the work done?

MR. LANIECE: The work is done. The additional barrier was to place a lock that is controlled by the general supervisor, the operations general supervisor on the valves themselves so there is no chance that operators or maintenance employees can shut off the sweep air on their own. They have got to ask for permission first to the general supervisor. The [indiscernible] that we still have in progress, but we are striving in achieving that as quickly as we can, is the full training of our operators on the importance of not shutting down the valves for the sweep air or drain the tank, and this is in progress, as we speak. We are unfortunately in a [indiscernible] mode right now due to some COVID precautions that we're taking and we're using that time to train our employees as quickly as we can.

MEMBER LACROIX: Oh, that's great.

MR. LANIECE: It will be in place before we restart.

MEMBER LACROIX: Thank you very much. Thank you.

THE PRESIDENT: Dr. Berube.

MEMBER BERUBE: Yes, my question has to do with actual testing of the slurry itself. I believe the issue here was the ore slurry composition had changed actually and it was sort of a surprise, hadn't seen this before. I'm curious, are you actually putting in testing procedures now as the slurry comes in as part of this or are you going to use process to actually deal with it?

MR. LANIECE: As of right now, the ore slurry is evolving on a regular basis and we've got the process that is fully designed in order to deal with the hydrogen as it comes. We know that it comes and we know that any time that it's being placed into acidic conditions, that's where the hydrogen starts being released. So there was no change compared to previous with what we had been experiencing.

The one change we had been doing is on the leaching system itself. We have got seven tanks in the leach [indiscernible] that we're using and they're all equipped with hydrogen analyzers. At the same time, this summer we made a change to the configuration of the seven tanks. Prior to the change, we were able to use them or to operate them in theory. So that would be from one tank to the next. Each and every time that we needed to do any maintenance on one tank specifically, then we would need to shut down the entire circuit. So we put in place a way to bypass one tank at a time this summer after a number of engineering studies and making sure that everything was okay. And that's a new feature that we've been using since September when we restarted the production for 2020. We need right now effectively to better train, we had started training of the employees with this change, but obviously the training that we've been doing is not sufficient. So that's what we're currently doing right now.

THE PRESIDENT: Thank you.

Dr. Demeter.

MEMBER DEMETER: My question was answered. Thank you.

THE PRESIDENT: Dr. McKinnon.

MEMBER McKINNON: Yes, thank you. I have a question for Orano. Just to clarify, my question may have been partially answered already, but I understand that the hydrogen is in the clay, in the encapsulating clay, and I just want to clarify, is it only released by the acid leaching process or is it something that could occur elsewhere in the ore handling system, including maybe in the Cigar Lake mine? And has that been investigated?

MR. LANIECE: Yes, Dr. McKinnon, that is a very good question too. Yes, we've been investigating that. We've been doing some measures of the hydrogen that is at Cigar Lake. And during the entire process of our logistics of transportation and the hydrogen starts to be released when the pH goes lower than 5, so when it is being effectively under the acidic leaching process that we have at McClean Lake.

MEMBER McKINNON: That is below a level that the acidity of natural groundwater would not be below that, so it would not be of concern in situ anywhere?

MR. LANIECE: Yes, you're correct.

MEMBER McKINNON: Thank you very much.

THE PRESIDENT: Thank you.

I have a question for the Saskatchewan Ministry of Labour Relations and Workplace Safety Rep who is here with us today. Can you comment based on your investigation on the adequacy of corrective measures that Orano has taken or is planning on taking to address this risk?

MR. KASKIW: Len Kaskiw, for the record, Chief Mines Inspector for the Province of Saskatchewan.

We completed our investigation and issued our report to Orano and they have taken the appropriate actions. So that's all I really want to comment on pertaining to this incident.

THE PRESIDENT: Okay. Thank you. Maybe if you can't, maybe you can ask Orano. How bad could this have really got? [Indiscernible] it is a serious incident, like, are we talking about major explosions? What was the worst-case scenario here?

MR. KASKIW: I think Orano should comment on that.

THE PRESIDENT: Maybe I can ask Mr. Laniece to comment on that, please.

MR. LANIECE: Thank you, Madam Chair.

Yes, if the explosion would have happened inside the tank, we've got some barriers in place. The tanks are placed into a leaching vault which is surrounded by very thick concrete walls. The concrete walls initially were there for radiation protection purpose, not for hydrogen explosion, but right now they are very handy in kind of isolating the zone from any hydrogen explosion. And of course, we're not wishing that we would get any hydrogen explosion. The vault itself has limited access and permitted access by the operations only. So you are not supposed to be in the vault at any time unless you've been agreed by operations to get inside. And that's the worst that could happen.

An explosion with hydrogen is very intense, has got a significant amount of energy. So if ever we would incur that, we would have lots of assets damage, that's a given. And depending on if we've got anybody around the asset at the time of the explosion, we could get some fairly severe injuries.

THE PRESIDENT: Thank you.

Commission Members, anyone else with additional questions? Okay. I don't see any hands up.

Again, thank you for coming and giving us an update on this.

CMD 21-M10

Written submission from CNSC staff

THE PRESIDENT: So we'll move to the next event initial report that we have received and this one is regarding an exposure above regulatory limit of a non-nuclear energy worker at the University of British Columbia as outlined in CMD 21-M10.

I believe we have a representative from the university who is joining us remotely and is available for questions. I'll turn it to the CNSC staff first before we open it up for questions.

Mr. Faille, if you would wish to add anything.

MR. FAILLE: Good morning, Madam President and Members of the Commission. My name is Sylvain Faille, and I am the Director of the Nuclear Substances and Radiation Devices Licensing Division. And with me today are Mr. Luc Jobin, Inspector from the Operation Inspection Division; Ms. Caroline Purvis, Director of the Radiation Protection Division; and as well as Mr. Diego Estan, Radiation Protection Officer within the same division.

We are here today to report on an exposure to a worker not designated as a nuclear energy worker that is above the annual limit for members of the public.

On November 9, 2020, the Radiation Safety Officer from the University of British Columbia notified the CNSC that an action level was exceeded. One of their laboratory workers who was not a nuclear energy worker received a dose of 0.93 mSv for the first quarter of 2020.

The licensee initiated an investigation to establish the cause for reaching the action level and submitted a report to the CNSC on November 30, 2020.

The report noted that due to the pandemic situation, there was a delay in the submission of the dosimeters to the licensed dosimetry service provider, which caused the delay to the licensees becoming aware of the action level exceedance, which in turn resulted in the non-nuclear energy worker exceeding the limit with a dose of 1.3 mSv. The delay in the licensees becoming aware of the action level exceedance prevented the licensee from implementing corrective actions to mitigate further exposure. This contributed to the continued poor worker practices in the third quarter that ultimately led to a cumulative exposure in excess of the limit for non-nuclear energy workers.

The investigation revealed that the laboratory worker did not follow the established safe work practices and determined that this led to a higher than normal personal dose to the worker. It is worth nothing that at this level of exposure, there is no risk of a radiation-related effects.

The licensee investigation identified improvements for the supervision of workers through periodic verification of worker adherence to establish safe work practices. Further, as a result of this event, the worker was reminded of the importance of following all steps in the safe work practices.

The CNSC staff reviewed the report,

including the calculations used in the licensees dose reconstructions, and confirmed that the calculations provided were accurate.

This concludes my presentation, and CNSC staff are available for questions.

THE PRESIDENT: Thank you, Mr. Faille.

I'll turn the floor to Ms. Hankins from UBC, if you wish to make a statement or add anything before we open it up for questions.

MS. HANKINS: Janet Hankins for UBC. No statement at this time.

THE PRESIDENT: Thank you. Well, let's start with questions with Dr. Berube.

MEMBER BERUBE: That's an interesting incident, but can you tell me, was this person -- maybe with CNSC, I'll start with them. Were they actually trained to actually do this type of work and they just forgot or they just thought that the rules didn't apply to them? What does the initial investigation look like?

MR. FAILLE: According to the report from the licensee, the worker was trained initially when they started working in the laboratory. They're not -- it seemed like the person kind of didn't follow the work practices that were in place.

Perhaps Ms. Hankins can provide more

information on what they discovered as their discussions with the worker themselves.

MS. HANKINS: It's definitely an interesting question. The worker, when they arrived at the laboratory to -- this is a post-doctoral fellow, when they arrived to do a post-doctoral fellowship had experience working with radiation and was trained in the techniques used in that lab and monitored initially to ensure that she had a complete understanding of the techniques. It was very surprising, both to the laboratory supervisor and to the overall laboratory head, that this change which was failure to use shielding for a particular pH step in a labelling reaction was not followed.

This is far from usual in the laboratory. This was a very unusual incident and has definitely caused a -- prompted a revision of their training methods and supervisory methods.

The worker did not provide any substantive reason for the deviation from using shielding for that step.

MEMBER BERUBE: Does this person still have lab privileges or have they been revoked?

MS. HANKINS: The person is no longer with the university. This was at the end of their post-doctoral fellowship. I could speculate all kinds of reasons why they might have been shortcutting, but it would be pure speculation. They have since moved on to a different affiliated organization where they have been declared a nuclear energy worker.

THE PRESIDENT: Dr. Hankins, before we leave the question of workers following the approved practices, the other part about the dosimeter being left on the lab coat, I think we had previous incidents at UBC of worker practices, you know, not again being in compliance with requirements. Can you comment on that part as well and what are you doing about that?

MS. HANKINS: So one thing I will state categorically is that is a practice that it's now very clear to both the head of the lab and the lab supervisor that that will not continue, as it was their dosimeters that were most affected by the other person's lab coat. In one sense, it was very useful because when the head of the laboratory's dosimeter came back with a reading, it was extremely surprising because he was not in the country during that dosimetry period. Definitely that aided in our investigation in the sense that it led us know that something had gone very awry with the readings.

THE PRESIDENT: Thank you.

Dr. Demeter.

MEMBER DEMETER: Some of my specific questions have been answered, but I do have a broader question for CNSC. As the pandemic hit us largely in March at the end of the first quarter, I would have assumed that from a radiation safety point of view there would have been contingency put in place to ensure that dosimetry services were maintained despite the pandemic. And are we having this issue that this first quarter dosimetry result really didn't get notified until late in the third quarter, notified to CNSC until November, which is really late. Is this a broader issue with licensees not submitting their first quarter dosimeters for this year? And should they have submitted it, should they have had a contingency, or should there be an expectation that despite the pandemic the first quarter dosimetries be submitted?

MR. FAILLE: I'll just give a quick highlight and then I'll pass it on to Ms. Purvis, but also probably Ms. Hankins might want to comment on that aspect.

But first of all, I think in this case it's a component of two items. There's one where the licensee didn't submit their dosimetry report until July in this case because the labs were closed because of the pandemic before the end of the first quarter. Then the second one is for the licensee dosimetry service having some backlog or some issues with some of the workers because of the pandemic conditions, had a longer turnaround time in reading the dosimeter and then returning the data to the licensee.

Perhaps Madam Purvis can provide further information on this from CNSC's perspective.

MS. PURVIS: Sure. Good afternoon. It's Caroline Purvis for the record. I'm the director of the Radiation Protection Division. We're also the division in the directorate that licenses dosimetry services. So it's a good question. And what I'll start by saying is that the CNSC engaged with the licensed dosimetry services early on, first communication in -- just after the pandemic was declared in mid-March.

We asked at that time for a status update from each of the commercial dosimetry services, including the one that was involved in this particular case, as to the -- their capacity to continue to offer services. Because they were declared an essential service, they had maintained a minimum complement of staff. They were meeting their requirements as per their licence. And they noted that in order to maintain capacity of dosimeters in circulation to serve their clients, there would be some modifications to the wear periods for low-risk types of licensees such as this one in an academic or institution.

So in essence what that means is instead of wearing the dosimeter for a three-month period, the dosimeter wear period was extended to approximately six months.

It's my understanding that as a consequence of the pandemic, UBC's research labs also were -- ceased operations and perhaps Ms. Hankins can offer more in that regard.

But I will just provide a little bit of clarification. We did check with our commercial services again in July, in the July time frame, and there were no reports of delays in their capacity to meet their licence condition of reporting the doses to the National Dose Registry within 45 days. However, they did report that a number of clients expressed concerns with shipping delays through the mail service. So that again could have contributed to some of the longer timelines.

THE PRESIDENT: Thank you, Ms. Purvis.

Dr. Hankins, do you wish to add something?

MS. HANKINS: So I will say that as of March 16, all operations at UBC were curtailed to essential services, which primarily meant that all laboratories, unless ongoing in vivo experiments would result in a large loss of research information, were shut down and they were shut down quite suddenly, as we were dependant on the province of British Columbia providing an okay for us to shut down. And it did, unfortunately, result in some things going uncompleted, such as returning of dosimetry. But the researchers actually had no option to go into the building as the building was firmly shut down and all access cut off.

THE PRESIDENT: Thank you.

Dr. Demeter.

MEMBER DEMETER: Just for UBC a few short questions. So on what date were you aware that their first dosimetry results were 0.93 mS?

MS. HANKINS: November 9.

MEMBER DEMETER: And what is your institution's action level for a quarterly dosimetry reading to take -- to take note a threshold action level?

MS. HANKINS: We take action at 0.75.

MEMBER DEMETER: Okay. Thank you very much.

THE PRESIDENT: Dr. McKinnon.

MEMBER McKINNON: No questions. All my questions have been answered. Thank you.

THE PRESIDENT: Thank you.

Dr. Lacroix.

MEMBER LACROIX: My questions have been answered. Thank you.

THE PRESIDENT: Okay. Thank you very much. Thank you for coming in and briefing us on this.

We will now take a break for lunch and we will reconvene at 1:15 p.m. So we shall see you then. Thank you, everyone.

--- Upon recessing at 12:20 p.m. /
Suspension à 12 h 20.

--- Upon resuming at 1:15 p.m. /
Reprise à 13 h 15

THE PRESIDENT: Good afternoon, everyone, and welcome back. We're ready to move to our next item on the agenda which is a status update on the condition of pressure tubes in operating CANDU reactors in Canada, as outlined in CMD 21-M4. I note that representatives from the industry are joining us and will be available for questions.

I will turn the mic to CNSC staff for their presentation.

Mr. Tavasoli, over to you.

CMD 21-M4

Oral presentation by CNSC staff

MR. TAVASOLI: Thank you, President Velshi.

President Velshi and Members of the Commission, my name is Vali Tavasoli and I am the Director of the Operational Engineering Assessment Division. Today, we will be providing an update on pressure tube fitness for service for the Canadian nuclear power plants, with a focus on the regulatory requirements and regulatory oversight.

In addition to staff from the Operational Engineering Assessment, we are also accompanied by staff from the Directorate of Power Reactor Regulation.

Following the presentation, we will be available to answer any questions you may have.

Pressure tube fitness for service has received significant attention from Commission Members and intervenors with the planned extension of the operating lives of several Canadian reactors.

The purpose of this presentation is to update the Commission on several issues that have been discussed during licence renewals and annual reports on nuclear power generating stations, with a focus on pressure tube fitness for service in the context of reactor safety, the regulatory oversight process, and updates on specific topics of interest identified by Commission Members.

This CMD is provided for the information of Commission Members and no actions are requested.

The presentation will focus on four main subject areas: Overview of pressure tube fitness-for-service requirements and regulatory oversight, status of pressure tube fitness for service in operating reactors, closure of Commission Action 20052, and the status of fracture toughness model following industry burst test BT-29.

Commission action 20052 was assigned following the November 2019 presentation of the Regulatory Oversight Report for Nuclear Power Generating Stations when Commission Members requested that staff provide a briefing note on the mathematical models and semi-empirical models used to make predictions for fracture toughness and the hydrogen equivalent concentration for pressure tubes. The briefing note was provided in December 2019.

Additional regulatory oversight was required for the development and validation of the pressure tube fracture toughness model following a 2017 laboratory burst test result for specimen BT-29 which was not bounded by the current fracture toughness model.

Information related to both of these subjects will be discussed later in this presentation.

At this time, I would like to turn the presentation over to Mr. Blair Carroll, Technical Specialist with the Operational Engineering Assessment Division.

MR. CARROLL: Thank you, Mr. Tavasoli.

Good afternoon, President Velshi and Members of the Commission. My name is Blair Carroll.

I will cover the following topics: An overview of the configuration of CANDU fuel channels with a primary focus on the pressure tubes; the main degradation mechanisms of concern for pressure tubes; important concepts for the evaluation of pressure tube fitness for service, especially for extended operation; regulatory oversight activities used to assess licensee compliance with pressure tube fitness-for-service compliance verification criteria; a brief summary of the status of fitness-for-service evaluations for operating pressure tubes; a summary of CNSC staff's response to Commission Action 20052; and CNSC staff's observations regarding the impact of the BT-29 pressure tube test result on the current pressure tube fracture toughness model.

I will begin with a review of the CANDU fuel channel configuration.

The main components of a CANDU fuel channel are the pressure tube which houses the fuel bundles and through which the primary heat transport system coolant passes. The pressure tube is made of a zirconium - 2.5% niobium alloy.

The calandria tube which houses the pressure tube. The calandria tube separates the hot pressure tube from the cooler moderator. The calandria tube is made of a Zircaloy-2 alloy.

End fittings which attach the pressure tube to the feeder piping. The end fittings are made of a stainless steel alloy.

The annulus spacer between the calandria tube and the pressure tube. This annulus space is filled with carbon dioxide gas, which serves to insulate the hot pressure tube from the cooler calandria tube. The annulus space also serves as a means of detecting possible leakage from a pressure tube by monitoring the moisture content in the annulus gas.

And finally, the annulus spacers, which are wire coils used to prevent the pressure tubes from contacting the calandria tube. Typically there are four annulus spacers. New fuel channel configurations use tight-fitting annulus spacers, which are snug to the pressure tube, while older configurations used loose-fitting spacers. Annulus spacers are sometimes called garter springs.

Canadian reactors contain between 380 and 480 fuel channels depending upon the specific plant design. Taken together, all the fuel channels in the reactor are often referred to as the core.

The fuel channels are oriented horizontally within the calandria vessel.

Pressure tubes are approximately 6.3 metres in total length, 100 millimetres in diameter and have a 4.2 millimetre wall thickness when installed in a reactor.

During normal operation, the temperature of a pressure tube ranges from approximately 250 degrees Celsius at the inlet end, where the coolant enters the tube, to about 310 degrees Celsius at the outlet end, where the coolant exits the tube.

Operating pressures range from about 11 megapascals at the inlet to 10 megapascals at the outlet.

I will now briefly discuss the primary

mechanisms that contribute to aging-related degradation of pressure tubes.

Degradation of pressure tubes arises from exposure to high temperatures, high pressure, and intense radiation fields. This results in dimensional changes to the pressure tubes, corrosion of pressure tubes and end fittings, changes in material properties, and degradation of annulus spacers.

In addition, flaws can be introduced to the inner surface of the pressure tubes due to fuel loading and interactions with the fuel bundles during operation.

Pressure tube dimensional changes arise from a mechanism known as irradiation induced creep. The length and diameter of pressure tubes will increase and the wall thickness will decrease. The original pressure tube design specifications were primarily focused on these dimensional parameters.

The dimensional changes of the pressure tubes also leads to the tube sagging between the annulus spacers, reducing the gap between the pressure tube and calandria tube. The calandria tubes also experience irradiation-induced creep, but to a lesser extent than the pressure tubes. A gap must be maintained between pressure tubes and the calandria tubes to prevent contact between the two tubes. If a hot pressure tube contacts a cooler calandria tube, hydrogen in the pressure tube will migrate towards the contact point. When the hydrogen level is high enough, a hydride blister can form, which could ultimately crack and cause a pressure tube to fail.

This slide illustrates the scenario of pressure tube to calandria tube contact which can occur as a result of pressure tube elongation. The effect can also be enhanced by the movement of annulus spacers, which is a potential issue in reactors with loose-fitting spacer designs. A hydride blister may form at the contact point of contact between the pressure tube and calandria tube, which could ultimately lead to the formation of a crack and rupture of the pressure tube, if the hydrogen equivalent concentration is high enough.

Pressure tubes and end fittings corrode when exposed to the coolant. The amount of wall loss due to corrosion during the operating life of a reactor is typically not significant on its own, but must be considered in conjunction with the wall thickness reduction due to irradiation-induced creep when assessing the fitness for service of tubes.

The more significant impact of the corrosion process is the generation of deuterium which contributes to an increase in the hydrogen equivalent concentration. This will increase the potential for crack initiation and decrease the pressure tube fracture toughness.

Flaws may be introduced on the inside surface of pressure tubes.

Flaws can form as a result of mechanical wear when fuel bundle bearing pads vibrate against the pressure tubes. These flaws are known as fuel bundle bearing pad frets.

Sometimes small debris particles can become trapped between the fuel bundles and the pressure tube and vibration can cause mechanical wear. These flaws are call debris frets.

Under the right conditions, localized corrosion can occur in the small crevice between the fuel bundle bearing pads and the pressure tube wall. The resulting flaws are called crevice corrosion flaws.

The tube wall may also be scraped by fuel bundles during fueling operations.

These flaws result in localized stress concentrations which will attract hydrogen and lead to zirconium hydride formation. Under the right combination of stress and hydride concentration, it is possible for cracking to initiate as a result of a mechanism known as delayed hydride cracking.

It is also possible for cracks to initiate due to fatigue.

These crack initiation mechanisms have been observed in laboratory tests and are a focus of pressure tube fitness-for-service evaluations, but it should be noted that crack initiation has not been observed from service-induced flaws for the current Zr-2.5%Nb tubes in Canadian CANDU reactors.

Irradiation leads to an increase in the strength of the pressure tubes but a decrease in ductility.

Irradiation and increasing hydrogen equivalent concentration also reduce material fracture toughness and increases the potential for crack initiation and increases crack growth rates.

Possible degradation of annulus spacers is an important consideration for pressure tube fitness for service since the annulus spacers prevent contact between the pressure tubes and calandria tube.

An understanding of the impacts of hydrogen absorption by pressure tubes is key for pressure tube fitness-for-service evaluations.

Pressure tubes contain a small amount of hydrogen from the manufacturing process. Additional hydrogen, in the form of the deuterium isotope, is acquired during operation through corrosion.

When exposed to the coolant, the pressure tube material will corrode to form a zirconium oxide surface layer. In addition, corrosion occurs at the end fitting connection to the pressure tub. Both of these corrosion mechanisms release deuterium and a fraction of that deuterium is absorbed by the pressure tube.

The amount of hydrogen absorbed in a pressure tube is usually quantified as the hydrogen equivalent concentration often shortened to Heq.

The neutron flux and the coolant temperature impact corrosion rates along the tube which impacts the amount of deuterium available for absorption along the length of the tube.

The red line in this picture shows how Heq typically varies along the length of the tube. The very high concentrations at the ends of the tube are not a concern for fitness-for-service evaluations. Each end of the pressure tube is mechanically rolled into the end fittings. The regions with very high hydrogen are within the end fitting and the resulting pressure tube hoop stress is compressive. For fitness for service, the primary concern is the length of the tubes between the rolled joints.

The dashed ellipses illustrate the

roll-joint regions. The Heq levels are elevated in these regions because of their proximity to the end fittings so there is more deuterium produced. It should also be noted that Heq values are generally higher near the outlet end fitting where the corrosion rates would be relatively higher due to the higher coolant temperature.

Hydrogen and deuterium concentrations are reported as milligrams per kilogram of pressure tube material or parts per million.

The concentrations are combined to establish the hydrogen equivalent concentration in a pressure tube.

The hydrogen equivalent concentration increases with operating time due to the absorption of deuterium.

Licensees measure deuterium concentration in a sample of pressure tubes periodically to assess the hydrogen equivalent concentration and develop models to predict the future concentration for fitness-for-service evaluations based upon the deuterium uptake rates. There are separate models for the body of tube and the rolled-joint regions.

Heq is an important parameter for evaluating fitness for service because absorbed hydrogen can react with the zirconium to form zirconium hydrides.

The amount of zirconium hydride present in a pressure tube at any time will depend on the Heq concentration and the temperature of the tube.

Increasing the Heq increases the potential for hydride formation, which can increase the potential for crack initiation due to delayed hydride cracking. This cracking mechanism involves a repeated process of forming hydrides at the tip of a flaw, followed by cracking of the hydrides.

The presence of zirconium hydrides can also decrease the fracture toughness of the material. The effect on fracture toughness depends on the hydrogen equivalent concentration and the size, orientation, and number of hydrides present.

Also, if the pressure tube were to come into contact with the calandria tube at locations where the Heq is sufficiently high, a hydride blister could form in the pressure tube.

There have been several examples of leaks and tube ruptures of Canadian pressure tubes.

In 1973 and 1974, several leaks were observed in the rolled joint region of several Pickering A pressure tubes. These pressure tubes were the first fabricated using the Zr-2.5%Nb material and during installation, high stresses were imparted in the rolled joints used to attach the pressure tubes to the end fittings. This led to delayed hydride cracking.

A similar occurrence occur in 1982 at Bruce A.

The process used to make the rolled joints has since been modified to reduce the stress levels and the potentially affected tubes have been replaced. This is no longer an issue for the current in-service population of pressure tubes.

The first pressure tubes were manufactured from Zircaloy-2 material instead of Zr-2.5%Nb.

Deuterium uptake rate in Zircaloy-2 was higher than in Zr-2.5%Nb. In 1983, one of the original Pickering pressure tubes with a high hydrogen concentration ruptured after it contacted the calandria tube and a hydride blister formed. There are no Zircaloy-2 tubes in current operating reactors.

In 1986, a pressure tube ruptured at Bruce A due to a manufacturing flaw. The leak was detected by the station leak detection system, but during operations to locate the leaking pressure tube during the station shutdown, the tube was over-pressurized and ruptured.

Inspection programs have been updated to address manufacturing flaws and procedures have since been changed to prevent over-pressurization during leak searches
should tube leaks be detected in the future.

The issues that caused past in-service failures in CANDU pressure tubes have been addressed and no in-service leaks or cracking have been detected since 1986.

In all of these cases, the plant safety systems responded as designed to the pressure tube failures to prevent impacts on the safety of people and the environment.

In 2015, a pressure tube leak was detected at the Kakrapar Unit 2 in India. The next year a pressure tube ruptured in service at Unit 1 at the same station. In both cases, safety systems performed as designed to prevented an impact on safety.

The cause of the tube failures was attributed to contaminants in the annulus gas that was used at the units, which led to external corrosion of the pressure tubes and delayed hydride cracking.

CNSC staff reviewed the Indian experience to determine if Canadian reactors could be impacted by the identified degradation mechanism. It was concluded that the Indian experience was not an issue for Canadian reactors.

In the next section of the presentation, I will discuss how the concept of defence in depth is applied to develop a safety case for pressure tube operation.

There are five levels of defence in depth described in CNSC REGDOC-2.5.2, *Design of Reactor Facilities: Nuclear Power Plants*. Three of the levels are particularly significant for pressure tube fitness for service.

The objective of Level 1 focuses on activities intended to prevent deviations from normal operation, and particularly important for pressure tube fitness for service, prevention of failures of components.

Level 3 defence in depth strategies focus on minimizing the consequences of accidents and prevention of damage to the reactor core. In this context, the rupture of a single pressure tube in a reactor core is classified as a design-basis accident in nuclear power plant safety analysis.

Level 4 defence in depth strategies focus on ensuring that radioactive releases caused by severe accidents are low so that health and safety of people and the environment are not impacted.

The pressure tubes form a key part of the Primary Heat Transport System which cools the fuel during normal operation.

Pressure tubes are designed in accordance with the requirements of CSA Standard N285.0, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, and are designed for a low likelihood of failure throughout the operational life of the reactor due to dimensional changes and operating loads.

In order to confirm a low likelihood of failure is maintained, licensees must also establish programs to inspect and assess the condition of pressure tubes that are most likely to be affected by aging-related degradation. Many of these degradation mechanisms were not considered in the original design specifications, so additional fitness-for-service evaluation methods were developed by the industry.

Inspected pressure tubes must be evaluated to confirm the safety margins inherent in the original design specification are retained throughout their operational life. If this cannot be demonstrated, then corrective actions are required. Corrective actions will depend upon the nature of the degradation mechanism impacting the pressure tube and can include: Shortening operation intervals between outages to permit more frequent fitness-for-service evaluations, defueling pressure tubes, replacing specific pressure tubes, and in scenarios where too many pressure tubes are affected to make it economical to implement tube-specific actions, shutting down the reactor.

A pressure tube rupture is considered a design-basis accident. In the event that unforeseen circumstances result in actions to address Level 1 defence in depth being ineffective, CANDU plants have safety systems to mitigate the consequences of a pressure tube rupture.

As part of Level 3 assessments, deterministic analysis is done to demonstrate effectiveness of the special safety systems in mitigating consequences of simultaneous and instantaneous rupture of pressure tubes and its corresponding calandria tube. Probabilistic assessment is also carried out to determine the contribution of fuel channel failure to the overall core damage frequency.

Under Level 4 defence in depth, a licensee must demonstrate that a rupture of a pressure tube will not lead to unacceptable releases of radioactivity should the event progress to a level of a severe accident. This is accomplished through the development of Severe Accident management Guidelines and Probabilistic Safety Assessments to estimate the frequency of large releases.

Level 4 defence in depth requirements are not directly considered in pressure tube fitness-for-service evaluations, but provide an extra level of defence in the event that an issue were to arise that was not foreseen in a Level 3 evaluation.

In addition, post-Fukushima, further enhancements were made to Canadian plants to maintain control, cool and contain functions in case a design-basis accident, such as a pressure tube failure, were to progress to a severe accident.

The case for safe operation of pressure tubes aligns with the defence in depth levels. A licensee is required to implement programs to confirm the condition of pressure tubes and prevent pressure tube failures.

Even though these programs exist, the CANDU reactor incorporates safety systems that are designed to respond to a pressure tube failure to keep the fuel cooled and prevent damage to the reactor core.

Finally, the CANDU reactor is designed with barriers to prevent the release of radioactivity.

Extended operation of pressure tubes

refers to operation beyond 210,000 equivalent full power hours, or EFPH, which is sometimes referred to as the original design life of pressure tubes. The use of the term "design life" in this context may lead to the misconception that extended operation is a compromise to safety. CNSC staff would like to clarify that safe operation is not limited to 210,000 equivalent full power hours.

In order for a CANDU reactor to be economically viable, it was determined that they should operate for at least 30 years. It was also assumed the reactors would be operated for 80% of the time on average. The other 20% of the time is allocated for maintenance or other outage activities. So in one calendar year on average, a reactor would operate for about 7,000 equivalent full power hours. Multiplying 7,000 equivalent full power hours by 30 calendar years equates to 210,000 equivalent full power hours.

To achieve this operating objective, pressure tube designers conservatively estimated the rates at which the tube dimensions would change due to irradiation and corrosion to ensure that the dimensions would not exceed allowable limits prior to reaching 210,000 equivalent full power hours.

As the Canadian reactors began

approaching the operational target, licensees realized the pressure tubes were not approaching the dimensional design limits because of the conservatism in the original design assumptions and concluded that additional operating margins were available. This was the basis for extending the operating lives of the Canadian reactors beyond 210,000 equivalent full power hours.

Pressure tubes can be operated safely as long as the dimensions of the tubes and the material properties do not exceed the limits that ensure the tubes can support design loads. Extending the operation of pressure tubes does not compromise safety as long as these limits are not exceeded.

Operational targets expressed in equivalent full power hours are generally used for planning purposes. If assumptions related to the rate of change of dimensions and material properties are conservative compared to the actual operating experience, the margins established for safe operation are not consumed as quickly as expected and it is safe to continue operating the tubes beyond the operating target.

Conversely, if the actual rate of change of dimensions and material properties is higher than expected, the margins established for safe operation will be consumed faster than expected and it may not be possible to achieve the operating targets.

The equivalent full power hour operating targets for extended operation of pressure tubes in the existing licences are based on the current knowledge concerning the rates of change of dimensions and material properties. Licensees are required to monitor the rates of change to confirm that they can safely meet those targets. Licensees are not permitted to operate pressure tubes that do not satisfy safety margins regardless of the operating target specified in a licence.

I will now pass the presentation to Mr. Scott Langille to discuss regulatory oversight for pressure tube fitness for service and the status of current pressure tubes.

MR. LANGILLE: President Velshi and Members of the Commission, my name is Scott Langille. I am a Specialist with the Operational Engineering Assessment Division.

In this section of the presentation, I will present the regulatory oversight strategies for licensee programs established for pressure tube fitness-for-service. CNSC Staff would like to point out that there has been no impact on regulatory oversight activities for pressure tubes due to the COVID-19 pandemic.

The operating licence and licence conditions handbook for each station establishes regulatory requirements for the implementation of aging management and periodic inspection programs to verify the fitness-for-service of pressure tubes.

Fitness-for-service programs are comprised of four key elements: A licensee must demonstrate an understanding of the degradation mechanisms that will potentially impact pressure tubes, sources of information include research activities, and operating experience. Plans must be developed to adequately manage potential degradation mechanisms. Plans for research, inspection, and examination of pressure tubes are required. The plans must be implemented, which includes conducting inspections throughout the operating life of the reactor and periodically removing pressure tubes from service for destructive examination. The results of the monitoring activities must be evaluated to confirm that required design and fitness-for-service safety margins are maintained. The results of these evaluations are also used to verify the current understanding of the degradation mechanisms is correct.

These elements form a continuous feedback loop throughout the operating life of the pressure tubes.

The overall program is evaluated and

accepted by CNSC staff. CNSC staff actively monitor licensee activities to ensure compliance verification criteria are met.

This table identifies the regulatory requirements which establish the compliance verification criteria used by CNSC staff to evaluate the licensees fitness-for-service strategy for pressure tubes. A combination of CNSC Regulatory Documents and Canadian Standards Association standards are used.

CNSC REGDOC-2.6.3, *Aging Management*, establishes the requirements and expectations for life-cycle management plans. The plans identify the potential forms of aging-related degradation and provide an overall strategy to verify the condition of pressure tubes and manage aging to the end of operational life.

CSA Standard N285.4, *Periodic inspection of CANDU nuclear power plant components*, establishes the minimum requirements for inspection programs to provide assurance that the likelihood of pressure tube failure has not increased significantly since the plant was put into service. The minimum requirements are based on the assumption that significant service-induced degradation is not occurring. If that is not the case, then inspection programs are expanded and the expanded programs are generally governed under the life-cycle management plan.

Activities carried out under the expanded programs use the same inspection and evaluation procedures as the periodic inspection program, but the number of inspections and inspection frequencies are increased.

CSA N285.4 also provides the acceptance standards used to evaluate inspection findings. The acceptance standards are conservative and pressure tubes meeting those standards do not require detailed evaluation.

Inspection results that do not meet the acceptance standards must be dispositioned to support continued operation. Dispositions must be completed and submitted to CNSC staff for acceptance prior to returning a reactor to service from an inspection outage. CNSC staff acceptance of a disposition is an indication that CNSC staff have confirmed that the inspection results were evaluated in accordance with established practices and appropriate corrective actions have been implemented, when required.

CSA Standard N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*, contains the evaluation requirements and acceptance criteria used to disposition inspection findings that do not meet the CSA N285.4 acceptance standards.

More detailed evaluation methods and degradation models are used to assess inspection findings to determine the acceptable operating period for pressure tubes. If pressure tubes cannot be dispositioned to the expected end of life of the reactor, then corrective actions are required. This could involve, for example, more frequent and focused inspections to closely monitor the condition of a pressure tube and refine evaluation assumptions or scheduled replacement of pressure tubes that cannot satisfy acceptance criteria to the planned end of life.

The evaluation process will be discussed in more detail in subsequent slides.

Recognizing that the CSA standards represent consensus standards, if CNSC staff determine that inspection or evaluation requirements established by the standards are not adequate to meet regulatory expectations or do not provide sufficient clarity, CNSC staff can recommend enhancing regulatory requirements with the adoption of additional compliance verification criteria in the licence conditions handbook.

CNSC staff dedicate significant personnel hours to regulatory oversight of pressure tube fitness-for-service activities.

Licensees are required to submit

life-cycle management plans and periodic inspection plans, and CNSC staff review these programs to verify compliance with regulatory requirements. CNSC staff have also carried out compliance monitoring inspections of program activities.

Following each pressure tube inspection outage, licensees are required to submit dispositions of inspection findings for CNSC staff acceptance prior to returning the reactor to service. Following an outage, licensees are required to submit a report summarizing all inspections completed during the outage for CNSC staff review.

Licensees are required to submit the core assessments for fracture protection, the core assessments for flaws, leak before break, and pressure tube to calandria tube contact for CNSC staff review.

CNSC staff also review control room procedures and protocols established to respond to pressure tube failure events to confirm that they align with assumptions used in evaluations.

There are several notable challenges facing licensees who extend the operation of pressure tubes beyond the originally assumed 210,000 equivalent full power hour operating life.

There is a reliance on research and

material surveillance testing of removed pressure tubes to enhance predictions of future pressure tube performance.

Increased elongation of the pressure tubes due to irradiation-induced creep increases the potential for pressure tube to calandria tube contact. To address this concern, licensees may need to increase inspections to measure the annulus gap or carry out additional maintenance activities to ensure annulus spacers are in optimal locations.

To predict the behaviour of pressure tubes farther into the future, industry has shifted from bounding deterministic core assessments to probabilistic core assessments, which has required the development of novel evaluation approaches.

CNSC staff are actively involved in regulatory oversight activities to assess licensees' responses to the challenges to verify that design and fitness-for-service margins are maintained during extended operation. Compliance verification criteria has been enhanced when required.

For example, the Bruce Power and Pickering operating licences contain specific compliance verification criteria regarding extending the validation of the pressure tube fracture toughness model for hydrogen equivalent concentrations exceeding 120 ppm.

Regardless of the length of the licence period for a given station, operation of pressure tubes that do not meet safety margins established in the compliance verification criteria is not permitted. In the event that corrective actions to resolve issues will not be effective or are impossible to implement, a reactor would have to be shutdown prior to the maximum operating limit specified in the licence.

In this section, I will provide a more detailed discussion of the pressure tube evaluation process used to demonstrate fitness for service.

Pressure tube evaluations are generally divided into two categories: Evaluations for inspected pressure tubes and risk assessments used to extrapolate the findings from inspected pressure tubes to make judgments about the condition of the entire population of tubes in a reactor core.

Generally speaking, about 30% of the pressure tubes in the reactor core will undergo inspection during the lifetime of a reactor to assess the condition of the tubes.

Please note that this does not mean that 30% of the tubes will be inspected for every possible degradation mechanism.

Inspection activities for specific tubes

are usually targeted based upon the most likely degradation mechanism affecting specific tubes. The inspection scope for all reactor units currently exceeds the minimum periodic inspection program requirements established in CSA
Standard N285.4.

70% of the tubes in a reactor core may never be inspected. Inspection programs attempt to identify the tubes that are mostly likely to be susceptible to various forms of degradation. The evaluation of the inspection results for those tubes are considered to be representative for the uninspected population of tubes, and evaluations are carried out to assess the likelihood of failure in the uninspected population by extrapolation of the findings from the inspected tubes to the entire population.

After every inspection campaign, inspected pressure tubes must be evaluated against compliance verification criteria to demonstrate that the tube will meet the established safety margins to at least the next planned inspection or, in some cases, to the expected end of life.

For extended operation, licensees often state a maximum period of time expressed in equivalent full power hours for pressure tube operation. For example, Darlington units are licensed to 295,000[*sic*][1] equivalent full power hours and Bruce Power units are licensed to 300,000 equivalent full power hours. These limits only apply for pressure tubes that satisfy all fitness-for-service compliance verification criteria up to those limits.

Through the execution of the fitness-for-service strategy, if it is determined that tubes will not maintain the required safety margins up to the licensing limit, corrective actions will be required. As previously mentioned, this could include: Enhancing inspection activities to obtain data to improve evaluations, repositioning annulus spacers, defueling channels to reduce degradation rates, and replacing pressure tubes that cannot meet the required safety margins.

The following evaluations are required for inspected pressure tubes.

For detected flaws, it must be demonstrated that there will be no crack initiation prior to the next planned inspection. Pressure tube to calandria tube contact cannot occur in pressure tubes where the hydrogen equivalent concentration is high enough to initiate a blister prior to the next planned

[1] 235,000

inspection.

The rate of hydrogen uptake must be evaluated. For tubes extracted for material surveillance, material properties in the expected growth rate of delayed hydride cracking must be measured.

In addition to the evaluations for inspected tubes, licensees must maintain valid core assessments. Core assessments may need to be updated based upon new inspection findings.

Fracture protection assessments are required to demonstrate that tubes retain sufficient fracture toughness. These assessments are also used to establish the pressure and temperature operating limits during heat up and cool down to ensure that the tubes will not be exposed to conditions that would reduce the fracture toughness below acceptable levels.

Core assessments for flaws are carried out to extrapolate findings from inspected tubes to the population of uninspected tubes to demonstrate that there is a low likelihood of failure.

Leak-before-break evaluations are required to demonstrate that a reactor can be safely shut down without rupturing a tube, if a new leaking flaw was detected during normal operation.

Pressure tube to calandria tube contact

evaluations are required to demonstrate that the uninspected population of pressure tubes with hydrogen equivalent concentrations sufficient to form blisters will not come into contact with the calandria tube.

There is a multi-tiered evaluation approach for pressure tube fitness for service.

Pressure tubes are designed to meet specified safety margins and the initial condition of tubes is established.

A sample of pressure tubes are inspected periodically throughout the life of the reactor and evaluated to demonstrate that safety margins are maintained.

Results from research, inspected pressure tubes and tubes removed for material surveillance are used to assess the risk of failure in the population of tubes that are not inspected.

The overall objective is to provide assurance that safety margins are retained.

In this section, I will provide an overview of the current status of Canadian pressure tubes.

The information on slides -- the information on the following slides illustrates the current status of the pressure tubes fitness-for-service evaluations. Licensees develop strategies to evaluate the fitness for service of pressure tubes to the end of the desired of the operational life, but they do not claim that all pressure tubes are fit for service for the entire operational life. Instead, evaluations are completed for intervals of typically two to three years depending on outage schedules for the reactors. As a minimum, the evaluations are updated following each outage and more frequently if new information is obtained from research activities or operational experience that would impact the conclusions of an existing evaluation.

The "Fitness for Service Evaluated to" dates are based on the most limiting assessments for flaw dispositions, pressure tube to calandria tube contact, fracture protection, core assessments for flaws or leak-before-break evaluations. In most cases, flaw dispositions or contact assessments are the limiting assessments.

This slide summarizes the current status of completed fitness-for-service evaluations for the Pickering units.

OPG is currently preparing an updated pressure tube to calandria tube contact evaluation for Unit 5 to support operation to the next scheduled outage. This will be reviewed by CNSC staff to confirm compliance verification criteria are met.

Unit 6 was in an outage when this presentation was prepared and CNSC staff had not completed a review of the updated fitness-for-service evaluation.

This slide summarizes the current status of the completed fitness-for-service evaluations for the Darlington units.

Fitness for service of the Darlington pressure tubes is evaluated until at least the next scheduled outages.

This slide summarizes the current status of completed fitness-for-service evaluations for the Bruce Power units.

At the time this presentation was prepared, fitness for service of the Bruce Power pressure tubes was evaluated to at least the next scheduled outage for all units, except Unit 8. A scheduled outage for Unit 8 was underway.

This slide summarizes the current status of completed fitness-for-service evaluations for Point Lepreau.

Fitness for service for the Point Lepreau pressure tubes is evaluated beyond the scheduled 2024 outage.

I will now pass the presentation back to Mr. Carroll.

MR. CARROLL: I will now provide an overview of the information provided in the December 2019 briefing note prepared by CNSC staff related to Commission Action 20052.

Commission Action 20052 was established to obtain additional information on the industry models used to predict pressure tube fracture toughness and hydrogen equivalent concentration, including a discussion of model uncertainties.

The two models are used to predict pressure tube material behaviour to assess safety margins for pressure tube operation in the future.

Modelling of these parameters can be used to directly compare estimates to compliance verification criteria. For example, there are specific acceptance standards for deuterium uptake rates in CSA standard N285.4.

The model results are also used indirectly in pressure tube evaluations. For example, predicted hydrogen equivalent concentrations are an input to the fracture toughness model.

These two parameters are linked since fracture toughness is generally dependant on the hydrogen equivalent concentration when tubes are exposed to temperatures below normal operating temperatures, for example, during heat-up and cool-down conditions.

The measurements used to develop the hydrogen equivalent concentration models are mostly obtained from samples scraped from the inner surface of operating pressure tubes.

The samples are analyzed using a mass spectrometer and the measurement accuracy for the equipment is about 1 ppm. It is possible to repeat scrape samples from the same axial location to monitor the rate of change with time, but for practical reasons it is only possible to repeat scrapes once from the same axial location.

To augment and verify the scrape sample measurements, full thickness samples are obtained from pressure tubes removed for material surveillance.

Operational parameters affect the corrosion rates, so tube-to-tube variability is observed in the Heq measurements and this variability must be addressed by the model.

There are separate models for the rolled joint regions at the ends of tubes and the body of the pressure tube. Uptake rates are different at these locations because of the effects of the end fittings.

These models are updated or recalibrated periodically to bound the most recent data available concerning deuterium uptake rates.

Deterministic and probabilistic Heq models are developed. The deterministic models represent a 95% upper bound fit to the measurement data. These models are used to evaluate the condition of inspected pressure tubes and used to generate the predictions for licensing limits.

The probabilistic models are used for the probabilistic core assessments to assess the likelihood of failures in the uninspected population of pressure tubes.

Industry has established a testing program for pressure tube fracture toughness. The pressure tube fracture toughness model is generated from results of tests of segments of pressure tube material conducted in a laboratory. A through-wall crack is introduced into the tube sections and the internal pressure is increased until the tube section bursts.

It is only possible to carry out a limited number of pipe section bursts tests, so the results of

these tests are supplemented by small-scale tests to verify trends in expected fracture behavior.

Pressure tube fracture behavior depends on the hydrogen equivalent concentration and material temperature. The change in behavior due to temperature can be divided into three regimes as discussed on the next slide.

For a given hydrogen equivalent concentration, the pressure tube fracture toughness will be lowest at low temperatures.

In the lower-shelf regime, the lowest possible fracture toughness is experienced and in this regime there is no change with temperature.

Similarly, there is no change in fracture toughness with temperature in the upper-shelf regime, but the fracture toughness for the pressure tube will be at its highest. The upper-shelf regime typically commences at temperatures around the minimum full power operating temperature of 250 degrees Celsius.

In the transition-temperature regime, the fracture toughness increases with increasing temperature or, conversely, decreases with decreasing temperature. Modelling of the behavior in this regime is important because pressure tube temperatures will be in the transition-temperature regime during heat-up and cool-down.

In the illustration on this slide, the red line indicates the expected change in fracture toughness for pressure tube material with a specified hydrogen equivalent concentration as the material temperature changes.

There are two fracture toughness models for pressure tubes.

The upper bound model is used for the upper-shelf regime. The model is essentially a lower bound fit to multiple variable regression of fracture toughness tests conducted for temperatures above 250 degrees Celsius.

The lower-shelf and transition region model is often called the cohesive zone model in literature. This model is used to predict fracture toughness for the lower-shelf and transition temperature regimes.

Revision 1 of the cohesive zone model is currently being used and is only valid for hydrogen equivalent concentrations below 120 ppm because of the limitations of the dataset available at the time it was developed.

As will be discussed in later slides, there is an additional limitation that was imposed on this model for the front end of pressure tubes based upon a fracture toughness test result obtained in 2017.

Current fitness-for-service evaluations for future performance of pressure tubes are only valid as long as the Heq limits for the model are not violated.

To address uncertainties in the fracture toughness measurements, Revision 1 of the cohesive zone model is used to predict the 2.5th lower percentile of the test data used to create the model.

To date, there has only been one test result that was observed to fall below this percentile bound. As mentioned, this led to an additional restriction placed on the use of the model following the test.

Industry plans to issue Revision 2 of the cohesive zone model in 2021, which will be subject to a detailed review by CNSC staff. Revision 2 is expected to expand the use of the model for hydrogen equivalent concentrations up to 160 ppm and address the so-called "front-end effect."

I will now address the issues from and response to the BT-29 fracture toughness test.

A 2017 fracture toughness test conducted by the Canadian licensees, referred to as the BT-29 test, challenged the conservatism of the fracture toughness model in CSA standard N285.8, which was referred to as Revision 1 of the cohesive zone model previously in this presentation.

This section of the presentation will provide an overview of the information that was previously provided to Commission Members during the Pickering licence renewal in 2018 and a December 2019 briefing note, regarding the CNSC staff and industry actions following that test.

The test specimen was fabricated from a tube that was removed from a Canadian reactor and artificially hydrided in a laboratory to increase the hydrogen equivalent concentration to 103 ppm.

The test specimen was tested at 225 degrees Celsius and taken from the front end of the pressure tube. The test generated a fracture toughness value below the lower bound prediction of Revision 1 of the cohesive zone model.

Pressure tubes are mechanically extruded from ingots of Zr-2.5%Nb.

The front end of a tube is the end where the extrusion process starts.

Differential cooling along the length of the tube during the extrusion process modifies the microstructure along the length of the tube.

The BT-29 test result represented a potential concern for safe operation because the front end region of the pressure tubes could have a lower fracture toughness than that predicted by Revision 1 of the cohesive zone model. So fitness-for-service evaluations using the model could be non-conservative.

This could be of particular concern for reactors where the front end of the tube was installed at the outlet end of the fuel channel where the hydrogen equivalent concentrations are highest.

To assess the potential impact of the finding on pressure tube fitness-for-service evaluation, CNSC staff required that all licensees provide information regarding the front end orientations of the pressure tubes in the reactors and estimated the front end hydrogen equivalent concentrations, and licensees demonstrate that the front end effect for the fracture toughness model did not impact safety margins for operating pressure tubes.

Licensees were also required to evaluate the impact of the findings on existing pressure tube evaluations and report any evaluations that incorporated any Heq prediction above 80 ppm in the front end of a pressure tube.

Finally, CNSC staff required that industry establish a validity limit for the application of the current fracture toughness model to the front end of pressure tubes.

Industry undertook a focused R&D program to test more front end specimens to better understand the phenomenon.

The BT-29 test result was attributed to the zirconium hydride orientation distribution due to the microstructure at the front end of the pressure tube. Nine more burst tests have been completed and none of them exhibited the same low fracture toughness as the BT-29 test.

Industry plans to accommodate the BT-29 test result in Revision 2 of the cohesive zone model.

In the meantime, an additional restriction was placed on the use of the cohesive zone model in CSA Standard N285.8 to limit its application to hydrogen equivalent concentrations of less than 80 ppm within 1.5 metres from the front end of a pressure tube.

The table summarizes the information regarding the front end orientations for pressure tubes currently in operation.

No pressure tubes oriented with the front end of the tubes at the inlet of the fuel channel are expected to exceed 80 ppm hydrogen equivalent concentration before Revision 2 of the cohesive zone model is issued. This includes Darlington Units 1 and 4, Pickering Units 4 to 8, and Bruce Units 4 to 8. There is no impact on pressure tube evaluations, and Revision 1 of the fracture toughness model remains valid for these units.

Pickering Unit 1 tubes which are in the front end outlet orientation are not expected to exceed 80 ppm prior to the end of operation of that unit, so there is no impact on pressure tube evaluations and Revision 1 of the fracture toughness model remains valid for that unit.

Darlington Unit 2, Bruce Units 1 and 2, and Point Lepreau were all recently re-tubed, so none of these tubes are expected to exceed 80 ppm for quite some time. There is no impact on the current pressure tube evaluations for those units, and Revision 1 of the fracture toughness model remains valid.

A number of front end outlet oriented tubes in Bruce Unit 3 may have exceeded 80 ppm based on deterministic Heq concentration modelling predictions prior to the end of 2020, but the likelihood of the fracture toughness of these tubes being below the lower bound of the Revision 1 model is considered low. A Unit 3 tube was artificially hydrided to 115 ppm and tested under the same conditions as the BT-29 test and produced a fracture toughness result that was significantly higher.

The difference in the test results has been attributed to a higher fluence, or radiation dose, that the BT-29 material was exposed to during operation leading to the lower than expected fracture toughness test result. The Bruce Unit 3 tubes have all experienced notably lower fluence than the BT-29 test at the locations where the Heq could have exceeded 80 ppm prior to the end of 2020.

The population of higher fluence tubes that the BT-29 test specimen was obtained from are no longer in operation so there is no immediate safety impact.

Investigations are underway to further characterize this fluence effect.

Please note that there was an error in the 2019 briefing note prepared for the Commission Members. It indicated that Bruce Unit 3 was estimated to have 58 tubes that could have exceeded 80 ppm in the front end by the end of 2020. In fact, that should have been 130 pressure tubes.

These predictions are based on deterministic models which uses upper bound estimates of deuterium uptake rate. Using best estimate predictions, only one tube was actually predicted to exceed 80 ppm by the end of 2020.

There was no impact on the risk evaluation that was completed for Bruce Unit 3.

At this point, I would like to pass the presentation back to Mr. Tavasoli to provide an overall summary of the information that was provided today.

MR. TAVASOLI: Thank you, Mr. Carroll, Mr. Langille.

CNSC staff would like to leave you with the following conclusions. There are extensive compliance verification criteria in place to establish safe operating margins for pressure tubes. CNSC staff are engaged in providing extensive regulatory oversight for licensees pressure tube fitness-for-service strategies. Industry is committed to activities required to understand pressure tube aging mechanisms. There is a multi-tiered evaluation approach for pressure tube fitness for service that aligns with the defence in depth concept. There is a significant regulatory focus on high priority tube issues for extended operation, including modelling of hydrogen equivalent concentration, fracture toughness, and pressure tube to calandria tube contact. CNSC staff concluded that industry's response to the BT-29 fracture toughness test results was adequate to address potential safety concerns and the finding does not currently impact conclusions regarding the safe operation of pressure tubes.

As mentioned at the beginning of this presentation, this CMD was provided for information only and there are no actions requested of the Commission.

This concludes the staff presentation.

We are ready to answer your questions. Thank you for your attention.

THE PRESIDENT: Thank you very much for the presentation. So let's get into the questions. We'll start with Dr. Berube.

MEMBER BERUBE: Thank you for that presentation. It was in my opinion excellent, giving us a very good summary of what the issues are on the inside of the reactors.

The question I have has got to do with the development of the CZM REV-2 development model. Could you bring us up to speed on where you are with that? How close are you getting to the limits that you specified? I think it was 160 ppm if that's correct.

MR. CARROLL: So I will give an overview from the CNSC staff perspective, and then if industry would like to -- anyone from industry would like to comment later after my response, then they're certainly welcome to.

At this point, none of the tubes have approached or are approaching the 120 ppm limit of the current model in near the future. The Revision 2 of the model is scheduled to be issued for CNSC staff review by March of this year. At that point, CNSC staff will undertake a complete review of the model, and industry then plans to adopt it and revise any current evaluations using the new model to extend the evaluations to beyond 120 ppm.

The only current reactor that is potentially affected by the existing model would be the Bruce Unit 3, and it's not because of the 120 ppm, it's because of the 80 ppm front end limit. That unit is going into a shutdown in the spring. Up until that point, it's not considered to be a safety concern. To restart operation after that Unit 3 outage, they will have to demonstrate that using the new model that they can demonstrate safe operation beyond that point.

THE PRESIDENT: Thank you. So before we ask industry if they have anything to add, how long do you expect staff would take to review the model once you receive it?

MR. CARROLL: We've already begun reviewing some of the preliminary basis documentation. We're targeting having the model reviewed in three to four months after we've received the documentation.

THE PRESIDENT: Thank you.

Anyone from industry have anything to add? I'm sorry, I don't see any hands up. Let me go through the list then.

Anyone from Bruce Power?

MR. NEWMAN: Thank you, President Velshi. It's Gary Newman. No, I have no additional comments. Mr. Carroll covered off the response quite well.

THE PRESIDENT: Okay, thank you.

OPG? Just checking.

MR. FABIAN: It's Paul Fabian here, Manager of Major Components Engineering at OPG, for the record. No additional comments to what Mr. Carroll has provided.

THE PRESIDENT: Thank you.

And I suspect not an issue for New Brunswick Power.

Dr. Demeter then.

MEMBER DEMETER: Thank you very much for that very comprehensive review. It's a topic that garners a lot of discussion at hearings, that's for sure, so it's good to have the background.

I wanted to get a sense, without, obviously, prejudice to what recommendations you may or may not make to us in the future for consideration, the sequencing of events. So you're going through this evaluation and you're looking at the 80 at the front and the 120 throughout and you have a current CSA standard. Will the sequence be to try to validate new information to inform a new CSA standard to inform recommendations or will the recommendations come before the CSA standard may change? So what's the sequence of that policy recommendation changes -- potential changes? And I think CNSC might be the best for ...

MR. CARROLL: So the process that will be used in this case is we will review the fracture toughness model and at that point if we consider it acceptable, it will be -- we will adopt it for licensing applications and then the CSA standard updates will come after that. So we will have it in place before the standard gets changed, and industry will begin to re-evaluate their current fitness-for-service evaluations at that point.

MEMBER DEMETER: Just so I understand that correctly, before it's implemented as a change in licensing, it will have to come before the Commission for approval?

MR. CARROLL: Generally that's not the situation. I will ask Dr. Viktorov to determine -- to respond to that, if he would, please.

MR. VIKTOROV: Thank you for the question. Alex Viktorov for the record. Can you hear me?

THE PRESIDENT: Yes, we can.

MR. VIKTOROV: We'll have to determine what impact a change in the methodology has on the licensing basis of each facility. And if the current model accepted by CNSC and approved by the Commission through issuing the licence envelops the new methodology, then there would be no need to come before the Commission. However, if the new model steps outside the box set by the current licensing basis, then it is a matter that likely will come to the Commission, depending on the impact on safety case.

MEMBER DEMETER: Okay. I think I understand. Our current licence is somewhat based on CSA standards, which it sounds like it will be changed after -- anyway, I understand. It would have to be considered.

MR. VIKTOROV: The determining factor, if I may elaborate a little bit, is the impact on safety, which direction it goes. If margin is reduced, then it's considered to be a matter for the Commission to give an approval to.

THE PRESIDENT: Okay. So I think also what we're hearing, Dr. Viktorov, is the Commission wants to know how staff's review of the revised model goes, please. So maybe you can take that as an action, whether we need to approve any changes in the licensing basis or not.

MR. VIKTOROV: We'll make sure to bring this to your attention through the status update reports.

THE PRESIDENT: Excellent. Thank you.

Dr. McKinnon.

MEMBER McKINNON: Yes, thank you for the presentation. It really shows -- it's another very good example of the depth of science that underpins one of the safety inspections.

I'm very interested in this practice of inspected versus uninspected evaluations done one the pressure tubes. And it was mentioned in the presentation that about 30% of the pressure tubes are assessed directly with periodic inspections and the remaining 70% are assessed based on the models. So I was wondering, what is the basis for that split? And is it related to variations that you have in the results from the actual physical measurements and some probabilistic evaluation of what the impact of that could be? Could you explain the basis for this testing decision.

MR. CARROLL: I can give the perspective from the CNSC staff. So the CSA N285.4 standard sets minimum inspection requirements for pressure tube evaluations. And those minimum requirements are established for monitoring purposes. Based on the findings from those, the inspection programs could be expanded.

So the numbers that were provided in the presentation of 30% of the population's inspected and 70% may never be, that's -- they are nominal values. They are not necessarily the same for every unit. It will really depend on the operational findings for that unit.

For some situations, for instance, if a unit has loose-fitting annulus spacers and there is a higher potential for contact, then maybe much more than 30% of those tubes will be either inspected or maintenance performed on them. In some cases, most of the tubes have been addressed for that specific mechanism. Whereas for another mechanism, for example, pressure tube flaws may not be a significant concern for the same reactor, so they would probably be inspected closer to the minimum requirements that are established in the CSA standard.

So those numbers are really based on what's found in the reactor core and what the risk of degradation is for that particular reactor unit.

Once the information from the inspected population is used, then the core assessments are performed and those core assessments we discussed look at the remaining population that hasn't been inspected and what is the risk of failure based on what we've learned from -- what's been learned from the inspected tubes. And then based on those evaluations, it may be determined that the risks are too high and that would trigger industry to do additional inspections to increase the overall inspection scope to bring that risk down to more reasonable levels.

MEMBER McKINNON: Okay. Thank you. I noted on one of the slides there was mention that the percentages of the inspections would vary by station and it was noted and the expected degradation mechanisms. So the focus of this talk is obviously on the pressure tubes and the hydrogen equivalent concentration. But what are some of these other mechanisms and are they as significant as the hydrogen equivalent concentration effect on fracture toughness in terms of the proportion of failures they could lead to? Could you give a perspective on that.

MR. CARROLL: So the hydrogen equivalent concentration actually plays into a lot of the -- is a key element of a lot of these evaluations. As we discussed, there are different types of flaws that are possible to occur in the pressure tubes. For instance, they could be from debris being trapped between the fuel bundles and the pressure tube. There could be fretting between the fuel bundles and the pressure tube, et cetera. So those types of flaws, they form small -- or those types of degradation mechanisms form small flaws on the inside surface of the tubes. Then these types of flaws must be evaluated to determine whether or not they could potentially initiate cracks. And the hydrogen equivalent concentration is a factor in determining whether or not these flaws could initiate cracks. So it's interrelated.

So in some -- most pressure -- sorry, most reactors would have some pressure tubes that are affected by these flaws and inspection programs would be targeted based on the number of flaws, the types of flaws, and the hydrogen equivalent concentration which would increase the risk of cracking initiating in those tubes.

Beyond that, there's -- then we have the pressure tube to calandria tube contact issue which was also mentioned. And in that case, again, hydrogen equivalent concentration comes into play because a pressure tube and a calandria tube could come into contact, but if the hydrogen equivalent concentration is not high, you would never form a blister, so there would never be a risk of failure.

So it's all interrelated. But essentially you would look at the degradation mechanisms that could affect the population of tubes and then target the inspection program to address those different mechanisms. Then you use the core risk assessments for the uninspected population to determine whether industry has done enough work to sort of provide an overall bound to the safety case.

MEMBER McKINNON: Okay. That is very clear. Thank you very much.

THE PRESIDENT: Thank you.

Dr. Lacroix.

MEMBER LACROIX: Well, thank you very much for this enlightening presentation. I really appreciate it. I want to make sure that I understand correctly. Ultimately the lower-shelf improved model will supersede the upper-shelf model in the licensing process. Isn't that right?

MR. CARROLL: That's not quite correct. The upper-shelf model will always exist. The reason -- the upper-shelf model governs the fracture toughness behaviour at normal operating temperatures above 250 degrees Celsius. The lower-shelf model is used to cover the change in behaviour that occurs when you reduce the temperatures.

So right now we have a Revision 1 of the cohesive zone model which covers the lower shelf and the transition temperature and we have the upper-shelf model. The new revision that comes in will replace the current lower-shelf and transition temperature model, but we will still keep the upper-shelf model.

MEMBER LACROIX: Okay, so both models will be used for the licensing process.

MR. CARROLL: That's correct.

MEMBER LACROIX: They're complementary.

MR. CARROLL: That's correct.

MEMBER LACROIX: Okay. I get it. Okay.

Now I have a technical question then, and I'm still baffled by it. From what I understand, as the hydrogen equivalent increases, the fracture toughness decreases. And if I look at slide 54, I observe that the fracture toughness increases with temperature for a constant hydrogen equivalent. But if I look at slide 16, I see that the deuterium concentration inside the coolant increases as it flows along the pressure tube, that is, as a function of temperature.

So I'm a bit baffled in the sense that is it due to the fact that the deuterium uptake by the back end of the fuel channel is less, that is, decreases with temperature? You understand my reasoning? It seems that there is a contradiction over here.

MR. CARROLL: I'll try to help. So first looking at it, I think we need to look at the two slides individually.

MEMBER LACROIX: That's right.

MR. CARROLL: And I'll try to explain each one individually.

So on slide 16 what we were attempting to demonstrate was how the hydrogen equivalent concentration would change along the length of the tube.

MEMBER LACROIX: Exactly.

MR. CARROLL: And that is primarily due to the change in corrosion rate that would be experienced due to the change in temperature. So as temperature increases, you would expect a slightly higher corrosion rate, and that would mean that at the outlet end of the tube, because the temperature are higher, you would see more corrosion. So there would be more deuterium emitted from the corrosion mechanism to allow the tube to absorb that deuterium.

MEMBER LACROIX: Okay.

MR. CARROLL: So what that would indicate is that the fracture toughness could change along the length of the tube because it could change with the hydrogen equivalent concentration.

So that would suggest, based on that, that we would see a higher fracture toughness effect -- sorry, a higher fracture toughness could be possible at the inlet, not because of temperature, but because of lower hydrogen equivalent concentrations.

MEMBER LACROIX: Exactly, yeah.

MR. CARROLL: Right? At the outlet the temperature is higher, but the hydrogen equivalent concentration is also higher. There is a synergistic effect between -- you have to take both into account. You can't just say because the Heq is higher at one end than the other, it will have this effect. You have to look at the Heq and the temperature effects together. And the models compensate for that.

MEMBER LACROIX: Okay. I get it. I get it. And is there a correlation between the fracture toughness and the modulus elasticity? Because the modulus of elasticity decreases with temperature and it might help with the fracture toughness. Is it correlated? I'm just curious.

MR. CARROLL: Potentially, yes, there are correlations between the strength and the fracture toughness. It has to do with temperature -- there's a temperature effect, for sure. There are also irradiation effects that have to be taken into account when you're talking about the strength. Because as the tube irradiation increases, the strength will increase, but the fracture toughness will decrease because of the increase -- or the increased irradiation. So it's a synergistic effect, but usually it's opposite.

MEMBER LACROIX: Okay. Thank you for the explanation. Thank you.

THE PRESIDENT: Question, perhaps for industry. This revision to the fracture toughness model, is that based solely on Canadian pressure tubes and our experience with that or is it the broader population of other CANDU reactors?

MR. FABIAN: Our models that we've developed in the burst tests that we've done through the JPs has been primarily done through Canadian industry. We've basically used ex-service pressure tube material from Bruce Power and OPG. We have one foreign tube that we have tested in the past, but the primary sample set is from Canadian pressure tubes.

THE PRESIDENT: Thank you. And then if this new model is accepted by the Canadian regulator, what are the implications for other regulators, or are there any?

CNSC?

MR. CARROLL: After we go through and do the review for regulatory use in Canada, it would also be reviewed within the CSA Standards Committee. At that point, if it's accepted for general terms, it would be adopted into the standard. Then any regulatory regime that would be using the CSA standard would be able to adopt it as well.

THE PRESIDENT: Okay. That's the mechanism. Thank you.

Members, anyone with any additional questions? I don't see any hands up. Thank you very much for that -- oh, sorry.

MR. LEBLANC: I think Dr. Lacroix may have another question.

THE PRESIDENT: Go ahead, Dr. Lacroix.

MEMBER LACROIX: Thank you. I do have an additional question. It concerns the annulus spacers between the calandria tube and the pressure tube. What are these spacers made of?

MR. CARROLL: There are two different materials used. Typically the loose-fitting spacers that we referred are made up of a zirconium alloy. And the tight-fitting spacers are generally made of an X750 alloy, which is a nickel-based alloy.

MEMBER LACROIX: So both of these alloys are pretty good conductors, heat conductors, I presume, aren't they?

MR. CARROLL: Potentially, yes, I would assume. But the volume -- the spacer material is a coil, so the volume in contact with the tubes is not significant in terms of causing localized cooling spots, if that's what you're referring to.

MEMBER LACROIX: Well, not so much as could it provoke or could it induce a blister on the pressure tube or on the calandria tube itself?

MR. CARROLL: We've not seen evidence of that. I would probably pass that to industry. Maybe they could comment on that a bit further. But as indicated, I don't think the cooling effect of the small contact area with the coil is significant.

MEMBER LACROIX: Okay.

MR. CARROLL: But maybe if someone from industry would like to comment further.

MR. FABIAN: Mr. Carroll is right, there is no localized cooling effect with the spacers. We have done extensive volumetric scans, plus for all of the pressure tubes that we've removed that are ex-service, we have done testing of them and there is no evidence that any blisters or any localized cooling effect from spacers is there. There is no concern from a fitness-for-service perspective with the spacers.

MEMBER LACROIX: Okay. That's great. Thank you.

THE PRESIDENT: Thank you very much for the presentation and for the update.

We'll take a break and we will resume at 3:00. Thank you.

--- Upon recessing at 2:40 p.m. /
Suspension à 14 h 40.

--- Upon resuming at 3:00 p.m. /
Reprise à 15 h 00

THE PRESIDENT: Hello, again. We're ready to move to the next item on our agenda, which is a presentation from CNSC staff on the Non-proliferation and Import/Export Controls Program as outlined in CMD 21-M6. We have Ms. Heppell-Masys with us for that.

So over to you, Kathleen.

CMD 21-M6

Oral presentation by CNSC staff

MS. HEPPELL-MASYS: Good afternoon, President Velshi and Members of the Commission. My name is Kathleen Heppell-Masys, and I am the Director General of the Directorate of Security and Safeguards.

I welcome this opportunity to provide you and members of the public an overview of the Canadian Nuclear Safety Commission's Import and Export Controls Program.

With me I have Pascale Bourassa, the Director of the Non-Proliferation and Export Control

Division and who manages the program; Nadia Petseva and David Reinholz, senior advisors; Brent Ferguson, licensing officer in the division; and also we have other CNSC staff.

We are here today to show how the CNSC controls the import and export of nuclear substances, equipment, and information for the purposes of preventing illicit transfers to a nuclear weapons program while facilitating legitimate commerce.

The CNSC's Import and Export Controls Program has three main objectives: Limiting the risk to the public, environment, national and global security; implementing international measures to which Canada has agreed; and implementing and supporting the key aspects of Canada's nuclear non-proliferation policy.

I will establish what is meant by non-proliferation.

The term "nuclear non-proliferation" is used globally to refer to efforts that prevent the spread of nuclear weapons and other nuclear explosive devices.

In this context, there are two types of proliferation:

Horizontal proliferation which refers to procurement efforts that could allow a state without nuclear weapons to develop a nuclear weapons program.

Vertical proliferation, on the other hand, refers to efforts to increase stockpiles of nuclear weapons or improve the capabilities of existing nuclear weapons.

Since September 11, 2001, there has been an increased focus on radiological dispersal devices. The focus has been on non-state actors who can acquire any radiological substance and use explosives to disperse the radiological substance to a vast population.

Through the implementation of this program, the CNSC helps ensure that imports and exports are for peaceful uses.

Today we will provide you with a brief background on nuclear non-proliferation and lay out the objectives of the CNSC Import and Export Controls Program and the team behind it.

By the nature of the work, the program is bound by both international and domestic frameworks. As these frameworks provide the foundation for the Import/Export program, we will provide you with a brief summary.

We will then provide an overview of the licensing and compliance activities of the program and share some of the impacts the COVID-19 pandemic has had on our work and complete the presentation with our upcoming activities.

The *Nuclear Safety and Control Act* paragraph 3(b) requires the CNSC to implement measures which respect Canada's international commitments on the non-proliferation of nuclear weapons and nuclear explosive devices and therefore provides the authority for the Import and Export Controls Program.

To support nuclear non-proliferation, the CNSC's role is to establish and maintain a robust and responsive regulatory framework, provide credible assurances that material in Canada remains in peaceful use which is reached with having safeguards in place, and provide credible assurances that imports and exports are solely for peaceful purposes. The technical briefing will focus on the import and export program.

CNSC staff within the directorate of security & safeguards play an active role in implementing this program. The dedicated team is composed of 12 individuals with varied backgrounds in engineering, science, and political science who conduct both licensing and compliance activities while implementing bilateral Nuclear Cooperation Agreements.

The CNSC controls the import and export of nuclear items, these are items especially designed or prepared for nuclear use. The CNSC also controls the export of nuclear-related dual-use items. These items are used in many legitimate industries across the globe, but can also be used for nuclear-related applications. We will provide some examples of these items later in the presentation.

In addition to the first two points, the CNSC also controls the export of risk-significant radioactive sealed sources which are used in industrial and medical applications, but could also able used in radiological dispersal devices.

Now I will pass the presentation on to Ms. Bourassa, who will take you through the international and domestic framework.

MS. BOURASSA: Thank you, Ms. Heppell-Masys. President Velshi and Members of the Commission, I am Pascale Bourassa, Director of the Non-Proliferation and Export Controls Division.

We will go through the details of how staff implements the CNSC's Import/Export Controls program, but first I will take you through the key elements of the international framework which provides the foundation for our domestic program.

These include the Treaty on the Non-Proliferation of Nuclear Weapons, the Zangger Committee, the Nuclear Suppliers Group, and the

International Atomic Energy Agency, IAEA, *Code of Conduct on Safety and Security of Radioactive Sources*.

The Treaty on the Non-Proliferation of Nuclear Weapons, also known as the Non-Proliferation Treaty or NPT, is the cornerstone of the non-proliferation regime. It is a legally binding treaty which came into force in 1970. A total of 191 states have joined the treaty, making it the most universally adopted treaty in existence, a testament to its significance.

The NPT established two categories of states. The first is the nuclear weapons states, those which tested nuclear weapons prior to January 1, 1967. There are five: China, France, Russia, United Kingdom, and the United States. The second category is the non-nuclear weapon states, those that did not test a nuclear weapon prior to January 1, 1967. India, Pakistan, Israel, and South Sudan are the only states that have not signed the NPT, while North Korea withdrew from the NPT in 2003.

The NPT is based on three pillars to help reach its objectives which are: To promote cooperation in the peaceful uses of nuclear energy, to further the goal of achieving nuclear disarmament, and to prevent the spread of nuclear weapons and weapons technology.

Peaceful use of nuclear energy recognizes the right of all parties to pursue nuclear energy for peaceful purposes. This makes it an obligation for states to share nuclear technology and material to support civilian nuclear efforts in any state that is in conformance with its non-proliferation obligations.

Disarmament requires that the five nuclear weapon states must pursue good-faith efforts to disarm their nuclear arsenals.

And, finally, under non-proliferation, nuclear weapons states commit to not transfer nuclear weapons to non-nuclear weapons states or to assist them in acquiring nuclear weapons. Conversely, non-nuclear weapons states commit to not acquire and also -- to not acquire nuclear weapons and also accept safeguards to verify that their nuclear programs are strictly for peaceful purposes.

The next key element of the international framework is the Zangger Committee.

Article III.2 of the NPT requires that parties to the NPT ensure that source and special fissionable material and specially designed equipment are only exported to non-nuclear weapon states, subject to safeguards. However, Article III.2 does not identify what these items are.

In comes the Zangger Committee. It was

formed in 1971 to help reach a common understanding of what material and equipment was captured by Article III.2. It aims to serve as a faithful interpreter of this NPT article.

The Zangger Committee created and still maintains what is commonly referred to the "Trigger List," since the export of these items triggers IAEA safeguards in the receiving country. The 39 members, including Canada, have made political commitments to implement these common understandings. The list of members can be found in the annex at the end of this presentation.

I note that the Zangger Committee meets annually to discuss any proposed updates to the trigger list and the CNSC leads the Canadian delegation at this meeting.

The third key element of the international framework is the Nuclear Suppliers Group. While the Zangger Committee provided guidance for when IAEA safeguards should be applied to exports, it did not provide guidance on how states should control these exports. The Nuclear Suppliers Group, or NSG, filled that gap.

The NSG was founded after the Indian nuclear test in 1974, which I'll talk about a bit more later. The NSG guidelines were published in 1978 and applied to nuclear transfers for peaceful purposes to help ensure that exports were not diverted to unsafeguarded facilities or nuclear weapons programs. The guidelines also contain an annex that list all substances, equipment, as well as information which should be controlled for export.

In 1992, the NSG guidelines for transfers of nuclear related dual-use materials, equipment, and information were published after the discovery of the Iraqi nuclear weapons program. The intention of the dual-use guidelines is to prevent industrial equipment from being diverted for use in a nuclear weapons program.

The NSG is a consensus-based group that consists of 48 member countries, including Canada. All 48 members have made political commitments to implement the established guidelines. The list of members can also be found in the annex at the end of this presentation.

The NSG meets about three times a year to work on updating both the nuclear and dual-use guidelines to address both changes in current technology as well as new, emerging technologies. The CNSC provides technical advice to the Canadian delegation, which is led by Global Affairs Canada.

The IAEA Code of Conduct is the fourth key element of the international framework. It's important to note that the NSG covers items that could allow states to develop nuclear weapons. It does not cover the radioactive substances that could cause harm to persons or to the environment as a result of accidental exposure or potentially used in malicious acts such as the construct of radiological dispersal devices. These substances do not contribute to the proliferation of nuclear weapons, but do need to be controlled to ensure that only authorized persons can receive and possess them to achieve a high level of safety and security.

These nuclear substances are identified in the *IAEA Code of Conduct on Safety and Security of Radioactive Sources* and the supplementary *Guidance on the Import and Export of Radioactive Sources*, also known as the Code and Guidance. The Code is a non-binding instrument that contains voluntary provisions to be implemented by subscribing states. It was approved by the IAEA in 2003.

The Government of Canada made a political commitment to implement the provisions of the Code and Guidance which includes import and export controls for risk-significant radioactive sealed sources, or what we can refer to as category 1 and 2 sources.

I note that the Code covers cobalt-60 and cesium-137 sealed sources which have numerous industrial and medical applications. Canada is a big supplier of these sealed sources and the CNSC's controls ensure their safe and secure export.

In April 2007, the CNSC implemented the provisions of the Code into its Import and Export Controls Program.

The CNSC leads the Canadian delegation to IAEA meetings of experts to share information on states' implementation of the Code and its supplementary guidance.

All these four pieces of international framework that I have just presented have helped shape Canada's domestic framework, and this includes Canada's nuclear non-proliferation policy, nuclear cooperation agreements and administrative arrangements, as well as the CNSC Regulatory Framework.

I will describe the first two key elements of our national framework before passing on the presentation on to Ms. Petseva, who will cover the regulatory framework.

Canada's nuclear non-proliferation policy is rooted in commitments under the NPT with the current policy established in 1974 and 1976.

The trigger for the development of the current policy was India's nuclear test in 1974, which India labelled as a peaceful nuclear explosion. The test used plutonium extracted from a research reactor that Canada supplied for peaceful research and development purposes.

The test demonstrated how nuclear equipment and information exported for peaceful purposes could be misused and resulted in Canada suspending nuclear trade with India.

The main objectives of the policy are to assure Canadians and the international community that Canada's nuclear exports are solely for peaceful, non-explosive purposes and do not contribute to the development of nuclear explosive devices, and to promote a more effective and comprehensive international nuclear non-proliferation regime.

The policy also stipulates that Canada can only engage in significant nuclear trade when they are subject to a IAEA safeguards agreement and must be pursuant to a nuclear cooperation agreement which I will explain in the next slide. I note that nuclear cooperation agreements are not required for the export of non-trigger list items and those radioactive sources identified in the Code and Guidance.

A nuclear cooperation agreement, or NCA, is a treaty-level, legally binding bilateral agreement that places certain commitments on the parties on items that are exported subject to the terms and conditions of the NCA. These include:

Assurances that items exported subject to an NCA will exclusively be used for peaceful purposes; control over retransfers of Canadian items; and control over high enrichment of uranium, which is enrichment of greater than 20%; fallback safeguards in the event the IAEA is not able to inspect; adequate physical security; and control over reprocessing of spent fuel.

And, finally, through the exchange of annual inventory reports, we can track the inventories of Canadian items in our NCA partner countries.

NCAs are negotiated with Global Affairs Canada with the support from the CNSC. In addition, the CNSC is identified in the NCAs as the appropriate government authority responsible for their implementation. These agreements are publicly available and can be found on the Government of Canada treaty website. Canada currently has in place 31 NCAs including the Canada-U.K. NCA which just came into force on December 31, 2020. These are identified in the annex to this presentation.

In order to implement NCAs, the CNSC negotiates what is often referred to as administrative arrangements with its foreign counterpart agencies. Typically, an AA is negotiated in conjunction with the related NCA. This is the most effective and productive way, since all the expertise is available in one place.

The AAs are not legally binding. They establish working-level procedures and understandings for NCA implementation and this covers the exchange of information, tracking of items, and annual reports.

The AAs are a responsive tool. It can be modified by the parties through consultation, to address issues that may arise or changes to the current context. The AA essentially makes our work of implementing the related agreement easier and ensures both parties have a mutual understanding of this agreement.

CNSC staff currently administers 26 bilateral AAs pursuant to the NCAs which are also listed in the annex to this presentation.

The CNSC also established bilateral administrative arrangements with several of our regulatory counterparts to ensure that imports and exports of radioactive sealed sources between our nations are conducted in a manner consistent with the IAEA code and respective laws and regulations.

These arrangements are not required for the export of these sources, but are negotiated when the CNSC and foreign regulators agree to establish these procedures to facilitate exchanges and ensure they are conducted in a safe and secure manner. They help harmonizing procedures and communication channels for the efficient implementation of export and import controls. Essentially, they support the implementation of the IAEA Code of Conduct.

The CNSC currently has 12 AAs related to risk-significant radioactive sealed sources with the countries found in the annex to this presentation.

Now that we've gone through the key elements of the international and domestic framework, including the two legally binding pieces, which are the Non-Proliferation Treaty and the nuclear cooperation agreements, I will give the floor to Ms. Petseva who will cover the CNSC Regulatory Framework and our domestic import/export controls program.

MS. PETSEVA: Thank you, Ms. Bourassa. Good afternoon, President Velshi and Members of the Commission. My name is Nadia Petseva, and I'm a Senior Advisor in the Non-Proliferation and Export Controls Division.

The regulatory framework related to the CNSC Import and Export Controls Program consists of the *Nuclear Safety and Control Act*, the Nuclear Non-Proliferation Import and Export Control Regulations, import and export licences, and Regulatory Document

2.13.2. I will talk about these further in the next part of the presentation.

In addition to paragraph 3(b) of the Act that provides for Canada's international commitments on the non-proliferation of nuclear weapons, paragraph 26(a) of the Act requires that imports and exports of nuclear substances, prescribed equipment and prescribed information, shall be conducted in accordance with a licence.

In order to implement some of these international measures, the Commission established the Nuclear Non-Proliferation Import and Export Control Regulations, from here on referred to as "the regulations." They establish application requirements, exemptions to the regulations, and two schedules, part A and part B, which identify the controlled items.

Part A covers nuclear substances, equipment, parts and information, which have been especially designed or prepared for nuclear use. Most of these items require import and export licensing.

Part B covers nuclear-related dual-use substances, equipment and information, which are used in other industries, such as automotive manufacturing and oil well logging, but also have nuclear applications. The items in the regulations are based on the Zangger

Committee and the Nuclear Suppliers Group list which are aligned with international expert guidance.

I will highlight this a little further in the following slides.

Part A.1 covers controlled nuclear substances such as plutonium, uranium, and heavy water. These substances require both import and export licensing. All of these substances are in some way related to the operation of a nuclear reactor.

Part B.1 covers controlled nuclear-related dual-use substances such as aluminum alloys, nickel powder, and zirconium. Most of part B.1 substances require only export licensing. These substances have many uses throughout different industries, but can also be used for nuclear applications.

Canadian industries export a range of controlled nuclear substances such as uranium, heavy water, tritium and nickel powder.

Next, I'll cover controlled equipment.

Part A.2 covers significant nuclear equipment. This includes equipment such as reactors, but also neutron detectors used in nuclear reactors or rotor tubes used in uranium enrichment facilities. Part A.2 equipment requires both import and export licences.

Part A.3 covers parts for controlled

equipment such as pump impellers designed for the primary heat transport pumps. Parts for nuclear equipment only require export licences.

Part B.2 covers nuclear-related dual-use equipment such as CNC machine tools, mass spectrometers, pulse generators and other industrial equipment. Part B.2 equipment only requires export licences.

Canadian industries export a range of nuclear and dual-use equipment such as reactor parts, CNC machine tools and pulse generators.

Next I'll cover controlled information.

Part A.4 covers controlled nuclear information such as designs for any items listed in part A of the regulations, while part B.3 covers controlled dual-use information such as technology for the design of any items listed in part B of the regulations.

Part A.4 information may require both import and export licensing, while part B.3 information only requires export licensing.

While Canadian industry exports a range of technical information, the majority of controlled information exports is in regards to nuclear technology. This includes, more recently, exports and imports of small modular reactor conceptual designs. Controlled information can be imported and exported through tangible and intangible means, such as paper documents or e-mails.

So while the regulations explicitly identify and control the most proliferation-significant items, how would we control the export of an item that was not listed but potentially destined for a nuclear weapons program?

The answer is in B.1.1.20 and B.2.7.6 of the regulations. These two entries provide the CNSC with the means to control unlisted items when there are reasonable grounds to suspect they may be used in connection with a nuclear weapons program. This type of control is based on what the item will be used for or where it is being exported to, as opposed to the other controls which are based on technical specifications of the item. These may include exports to facilities with known ties to nuclear weapons programs.

An example of an item which have been captured under end-use controls include radiation detection equipment exported to nuclear facilities in non-NPT states.

What is important to retain is that end-use controls provide flexibility and readiness to ensure that Canadian exports do not contribute to a nuclear weapons program.

In addition to the regulations, the CNSC published REGDOC-2.13.2 to provide guidance to current and prospective licensees on how to apply for an import or an export licence, how to report non-compliances, or how to spot suspicious inquiries.

The latest version of the regulatory document was published in 2018 and covers both controlled items listed under the regulations as well as risk-significant radioactive sealed sources which I'll talk about further on the next slide.

In addition to the controlled substances identified earlier, staff in the Non-Proliferation and Export Controls Division also licence the export of category 1 and 2 risk-significant sealed sources.

These sources have many medical and industrial applications such as food irradiation and cancer treatments. The sources listed on this slide do not identify all the risk-significant sealed sources, however, these are the ones most likely to be exported from Canada.

Canada is currently the largest exporter of cobalt-60 globally, which is used in both industrial and medical applications.

In order to implement our international commitments and national policy, the CNSC has established a robust import and export controls program. This program includes import and export licensing as well as compliance and enforcement activities.

Furthermore, as part of the program, CNSC staff collaborate and provide support to Global Affairs Canada and other government departments on international initiatives related to nuclear non-proliferation, export controls, and disarmament efforts along with helping with the formulation of national positions.

I will end with a case study regarding a decision to refuse an export licence.

The Commission has delegated the import and export licensing decisions to designated officers. About 1,000 import and export licences are issued each year to approximately 160 different applicants. This high volume of licences is due to the fact that import and export licences are used on a transactional basis with a limited quantity of items to be exported to a particular country. Still, each application is assessed on a case-by-case basis.

Since the Act has come into force, designated officers refused 18 export licence applications and each refusal was reported to the Commission. Not all assessments that result in a recommendation to refuse a licence are ultimately refused. In some of these cases, applicants withdraw their applications, others provided additional information or revised their applications, which may result in the licence being issued.

In the case of a refusal by the designated officer, the applicant may choose to appeal the decision to the Commission. As of yet, there have been no cases of appeal.

We have gone over what items require licences and who issues them, but we have yet to talk about how staff assess the applications and provide recommendations to the designated officers.

Here are the main considerations that staff take into account when reviewing an import or export licence application.

Staff consider the non-proliferation credentials for the receiving country. Are they a party to the NPT? Are they a member of the NSG? Do they possess nuclear weapons? Staff consider whether or not an NCA is required or if there are any other policy implications. In addition, staff look at the proliferation risk posed by the item, the legitimacy of the end use or end user, any concerns about diversion with a particular country or end user.

All of these considerations feed into an assessment conducted by CNSC staff. The assessment forms the basis of a recommendation to the designated officer which allow them to make a decision to issue or refuse the licence.

The CNSC regulates the possession and use of risk-significant radioactive sealed sources through facility licences. These facilities also require a separate export licence to ship substances outside of Canada. Staff assess the export licence applications and provide recommendations to the designated officers by considering information such as:

The risk associated with the end user and consignees involved in the transfer to provide assurances that the sources will not be diverted for malicious purposes; regulatory capability of the importing state to provide assurances that the sources will be managed safely and securely; import consent from the importing state authority for all applications to export category 1 radioactive sources from Canada to further verify the end user's authority to receive and possess the sources.

All of these considerations fit into an assessment conducted by CNSC staff. The assessment forms the basis of a recommendation to the designated officer which allows them to make a decision to issue or refuse the export licence.

The CNSC typically does not issue specific licences for the import of risk-significant radioactive sealed sources. CNSC licensees that are authorized to possess these sources may import them through their facility licences.

Like any other CNSC licence, the import and export licences also include licence conditions. These conditions stipulate the licensee submit a report with details of the activities conducted under the licence. These include prior and post-shipment notifications, annual reports or reports due when the licence expires. Staff conduct over 1,000 desktop reviews per year of these reports to verify compliance with the licence.

Staff also conduct on-site and now remote inspections to verify compliance with export and import records that are kept by the licensees. In case of a non-compliance, staff could use different CNSC enforcement tools such as non-compliance letters or administrative monetary penalties to bring licensees into compliance.

In addition, CNSC staff conduct outreach activities to promote compliance and to provide awareness to potential exporters about certain procurement indicators or red flags to help identify suspicious inquiries, purchase orders that might generate end user concerns, or the need for increased scrutiny.

Section 18 of the General Nuclear Safety and Control Regulations requires importers and exporters of CNSC regulated items to present a CNSC licence to a customs officer at the border.

The Canada Border Services Agency, CBSA, assist the CNSC with verifying compliance with section 18 of the General Regulations.

In certain cases, if a CNSC licence is not presented, CBSA detains items at the border and requests an assessment from CNSC staff to determine the control status of these items. Staff work closely with CBSA to provide critical advice needed for the border officers to determine whether an item requires a CNSC licence. If a CNSC licence is required, the exporter must obtain the licence prior to the goods being released at the border. CNSC and CBSA staff work closely to determine compliance and apply enforcement measures as required. CNSC and CBSA are proactively seeking to conduct joint outreach to improve regulatory compliance among exporters of licensable goods.

Import and export of nuclear and dual-use items is not done in a vacuum. CNSC staff consult and collaborate with different government departments and foreign counterparts. CNSC staff consult with Global Affairs Canada on the application of Canada's nuclear non-proliferation policy. These consultations are often triggered by a specific issue, such as exports to non-NPT states. Furthermore, staff provide technical advice to Global Affairs Canada when establishing nuclear cooperation agreements and during international meetings, such as the Nuclear Non-Proliferation Treaty Review Conference.

As previously mentioned, CNSC staff work closely with CBSA to determine the control status of items detained at the border. We receive requests to assess detained items on almost a weekly basis.

CNSC staff work with other government departments like Public Safety, the Department of National Defence, the Royal Canadian Mounted Police, the Communications Security Establishment and so on, regarding different import and export control issues.

Lastly, CNSC staff work closely with foreign counterparts regarding the implementation of NCAs and AAs.

All of these relationships and sharing of information help ensure we have a strong and robust program.

The next few slides provide a high-level summary of a case where the designated officer decided to refuse the issuance of a licence. The designated officer has provided a more detailed report to the Commission on this refusal, as per paragraph 37(5)(a) of the Act.

The proposed export was for technology related to parts for nuclear equipment. The export was destined to a country that is not a party to the NPT.

CNSC staff completed the assessment of the application and determined that there is a risk of diversion related to this export. Subsequently, staff recommended to the designated officer to refuse the issuance of the licence. As per paragraph 39(1)(a) of the Act, the designated officer provided the applicant with the opportunity to be heard, giving them the opportunity to submit any additional information to support their application.

After a thorough review of the submissions related to the proposed export, including the additional information provided from the opportunity to be heard, considering staff's recommendations and consulting with Global Affairs Canada, the designated officer decided to refuse the issuance of the licence based on the fact that the export would have been inconsistent with Canada's nuclear non-proliferation policy and the measures which Canada has adopted with respect to the implementation of Canada's international obligations on the non-proliferation of nuclear weapons.

The applicant was informed of the

decision and also advised that they can appeal the decision as per paragraph 43(1)(a) of the Act.

As noted on the previous slide, the designated officer provided a report to the Commission on this refusal.

The applicant did not appeal this decision.

Decisions to refuse licences are not taken lightly. They follow a rigorous and transparent process. Decisions are shared with the nuclear non-proliferation officers and other designated officers in the division for knowledge transfer and sharing any lessons learned.

I will now hand over the presentation to Ms. Heppell-Masys for concluding remarks.

MS. HEPPELL-MASYS: Thank you, Ms. Petseva.

The import and export program was not immune to the effects caused by the COVID-19 pandemic, but staff did not miss a beat. Within days of the closure of the offices, staff effectively set up their home offices to continue their work using the existing, well-documented procedures and capability to process applications and issue electronic versions of licences. The number of applications assessed for import and export licences has not been impacted by the pandemic. In fact, in 2020, more licences were issued than in 2019. By mid-year, staff had worked with licensees to start conducting remote inspections.

CNSC has been able to respond to the demand for cobalt-60 without any impediment through its licensing process that ensure controls are in place for the safe and secure export of these sources. Cobalt-60 is used for the sterilization of medical supplies, including personal protective equipment and test swabs used in the fight against COVID-19.

On the international front, certain activities had to be postponed, including bilateral meetings with foreign counterparts, although we started to engage with them in late fall using video conferencing, and also meetings of the Nuclear Supplier Groups, Zangger Committee meetings, and the Non-Proliferation Treaty Review Conference which is held every five years and had been scheduled initially for May 2020.

In addition to ongoing licence and compliance activities, a few notable upcoming activities include the amendments to the regulations and an update to REGDOC-2.13.2 to keep it up-to-date with the regulations.

CNSC staff will be participating in an Non-Proliferation Treaty Review Conference which is now tentatively scheduled to be held no later than August 31 of this year. Staff is also part of the program committee preparing for the 2022 International Conference on the Safety and Security of Radioactive Sources.

In conclusion, I would like to make these final points. The CNSC has a robust and responsive licensing and compliance program for import and export of nuclear items, nuclear-related dual-use items and risk-significant radioactive sealed sources. We also have in-house expertise complemented with domestic and international partners, and a well-established regulatory framework anchored in domestic and international frameworks. These help ensure that Canada's international obligations are respected and Canadians are safe. The CNSC Import/Export Controls Program continues to be effective and efficient in meeting its objectives.

CNSC staff are now available to answer any questions the Commission may have on this technical briefing.

THE PRESIDENT: Thank you very much for that very informative presentation.

Let's start with Dr. Demeter.

MEMBER DEMETER: Thank you. That was very informative. I wanted to get a sense of once a product has been exported, are there passive/active audit-type mechanisms that you can use to track and verify appropriate use of that item in different countries? Do you rely on third parties? How do you verify once you've approved the export, other than finding out by an incident, by reacting to it? Proactively, how do you monitor this?

MS. HEPPELL-MASYS: So at a high level -- and I'll pass on to my colleagues to provide a little bit more details. But the first part, as you heard in the presentation, is the annual inventory reconciliation reciprocal, and so there is an opportunity to look into the material that has been exported and vice versa from the other country.

We also have our ability -- we also have the requirement for safeguards facilities, so the IAEA does conduct those activities from the safeguards perspective. As well as we -- in some NCAs, we have the ability to have verifications, and we have used this last year in December -- two years ago in December 2019, when we actually had an inspection conducted. We also have a network of domestic partners, as well as a network of international partners, essentially.

MEMBER DEMETER: That's good. That answers my question. Thank you.

THE PRESIDENT: Dr. McKinnon.

MEMBER McKINNON: Yes, thank you for the presentation. Everything seemed very clear, but there was one potential grey area I would like to ask about and that's in connection with dual-use substances equipment, information, and the end-use controls of that.

Some of the examples that were mentioned in the presentation included CNC machine tools, aluminum alloys, and other information that could be used in the nuclear field. So this is where the grey area is. And I would like to -- if you could discuss how the determination is made whether something is dual use, and how a manufacturer might be informed that their products could be classified as dual use, and how CNSC is updated by other government agencies or international partners on such items.

MS. HEPPELL-MASYS: Yes, thank you for the question. I think the best expert to speak on this would be actually Mr. David Reinholz.

MR. REINHOLZ: As being a member of the Nuclear Suppliers Group, we're also included in the membership as all of the nuclear weapons states. So when it comes to dual-use equipment, we do rely heavily on the weapon states to provide advice to the non-weapon states about what industrial items can be used for the weapons program as well as what specifications, as you noted machine tools. There are lots of machine tools out there, but the controls are fairly specific.

With respect to outreach or educating industry, we do proactively try to reach out to those industries for which we can see exports being conducted. Machine tools are one example. We've reached out to multiple machine tool resellers in Canada, and as well we discussed our outreach that we're looking to do with Canada Border Services Agency. They have a wider viewpoint of who's exporting what, so utilizing them with our knowledge, we're able to reach out to the industry.

MEMBER McKINNON: Thank you very much.

THE PRESIDENT: Dr. Lacroix.

MEMBER LACROIX: You rely on the weapon states to provide you with sensitive information. Do you mean that you can trust countries like Russia and China?

MR. REINHOLZ: I should clarify that. When I say we're relying on -- it's not sensitive information. We're very careful about what information can be exchanged between the partners. So it's not just China and Russia. There is also the United States, the United Kingdom, and France.

So the way the Nuclear Suppliers Group works is any country can make a proposal to add an item to the list and then all the member countries discuss those proposals, there are back-and-forths between them to tweak the technical specifications of that control. Once all the countries are in agreement, that gets published on to the Nuclear Suppliers Group list and in turn we bring that into the our regulations.

So it is a coordinated approach between the Nuclear Supplier Group members to ensure that the global controls on those sensitive items are in place and that the countries that produce them implement those controls at the same time.

MEMBER LACROIX: And what about -- speaking of the grey area of Dr. McKinnon, what about, for instance, electronics or software? This is far more difficult to determine if it's used for malevolent use.

MR. REINHOLZ: Correct. So there are controls depending on what item you look at. So CNC machine tools, for examples, they use CNC control software. So there are entries in the list that talk about what specific software is controlled, what specifications it needs to meet. And even domestically, we have talked with some of the producers domestically about their control software.

MEMBER LACROIX: Okay, okay. And I've noticed in -- from slide 40 to 43 that 26 countries have a certain arrangement with CNSC pursuant to nuclear cooperation agreements, but only 12 countries have an administrative arrangement with CNSC pursuant to the IAEA Code of Conduct. I was wondering what does it mean and does it make your work more complicated?

MS. HEPPELL-MASYS: What I'll do is I'll pass on that question to Ms. Petseva.

MS. PETSEVA: Thank you, Kathleen. So definitely the number of the AAs that we have for the nuclear items is different than the number for the sealed sources. Now, the AAs, or the nuclear items, are needed so that we can implement the nuclear cooperation agreements. However, the AAs for the sources are basically just a guidance. So this is why the number is not the same.

MEMBER LACROIX: Okay, I see. I understand.

On slide 14 -- that's my last question. On slide 14, it is mentioned that you overlook at the control of reprocessing of any Canadian-spent fuel. So you mean the reprocessing outside of Canada? There's no reprocessing in Canada. Am I right?

MS. HEPPELL-MASYS: That is correct.

MEMBER LACROIX: Thank you.

THE PRESIDENT: Thank you.

Dr. Berube.

MEMBER BERUBE: Well, just because we're such a large exporter of cobalt-60 in particular, can you give an example of where does CNSC take control of that particular substance and where does it relinquish control to a foreign national agency? And what does the tracking look like on all that? Obviously, you want to manage this cradle to grave. So if you could just run me through that procedure.

MS. HEPPELL-MASYS: I'll pass this question on to Mr. Brent Ferguson.

MR. FERGUSON: Good afternoon, Brent Ferguson for the record, Licensing Officer for the Non-Proliferation Division.

Basically, control would shift to the foreign regulator when it's imported into their country. So up until then we would track the shipments, and it's really the exporter who is responsible for the safe transport and delivery to the end-user site. So basically once it is into the foreign recipient country. Thank you.

THE PRESIDENT: Commission Members, anyone with any more questions? Okay. I don't see any hands up.

Again, staff, thank you very much for a really good, thorough presentation.

This concludes the public meeting of the

Commission. The Commission will move in closed session for a presentation pertaining to a regulatory project to amend the General Nuclear Safety and Control Regulations and the Nuclear Non-Proliferation Import and Export Control Regulations.

Thank you all for your participation. Stay safe, stay well. You all deserve a medal for perfect timing today.

Bonne fin de journée. Au revoir.

--- Whereupon the hearing concluded at 3:58 p.m. /
L'audience s'est terminée à 15 h 58