Canadian Nuclear Safety Commission

Commission canadienne de sûreté nucléaire

Public meeting

Réunion publique

March 8th, 2017

Le 8 mars 2017

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

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

Commission Members present

Dr. Michael Binder
Dr. Sandy McEwan

Commissaires présents

M. Michael Binder
Dr Sandy McEwan

Secretary:

Mr. Marc Leblanc

Secrétaire:

M. Marc Leblanc

General Counsel:

Ms Lisa Thiele

Avocate générale :

Me Lisa Thiele

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Ottawa, Ontario / Ottawa (Ontario)

--- Upon commencing on Wednesday, March 8, 2017 at 9:05 a.m. / La réunion débute le mercredi 8 mars 2017 à 9 h 05

Opening Remarks

MR. LEBLANC: Good morning, ladies and gentlemen. Bonjour à tous et à toutes. Welcome to the public meeting of the Canadian Nuclear Safety Commission taking place on this International Women's Day.

My name is Marc Leblanc. Je suis le secrétaire de la Commission et j'aimerais aborder certains aspects touchant le déroulement de la réunion.

We have simultaneous interpretation. Please keep the pace of speech relatively slow so that the interpreters have a chance to keep up.

Des appareils pour l’interprétation sont disponibles à la réception. La version française est au poste 2 and the English version is on channel 1.

We would also ask that you please identify yourself before speaking so that the transcripts are as complete and clear as possible, and we would also ask that you keep the pace of your speech relatively slow so that the interpreters have a chance to keep up.

La transcription sera disponible sur le site Web de la Commission dès la fin de la semaine prochaine.

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 in the room, please silence your cell phones and other electronic devices.

Monsieur Binder, président et premier dirigeant de la CCSN, va présider la réunion publique d'aujourd'hui.

President Binder...?

LE PRÉSIDENT : Merci, Marc.

Good morning and welcome to the meeting of the Canadian Nuclear Safety Commission. Welcome also to those joining us via the webcast or through teleconference.

My name is Michael Binder. I am the President of the Canadian Nuclear Safety Commission.

I would like to start by introducing Dr. Sandy McEwan, the other Member of the Commission that is here with us today.

We also heard from the Commission Secretary Marc Leblanc.

We also have with us Ms Lisa Thiele, Senior General Counsel to the Commission.

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

Please refer to the Agenda published on March 2, 2017 for the complete list of items to be presented today.

CMD 17-M8.A

Adoption of Agenda

THE PRESIDENT: So with this information, I would like to call for the adoption of the Agenda by the Commission Members, as outlined in CMD 17-M8.A.

MEMBER McEWAN: Great.

THE PRESIDENT: I think we have concurrence.

CMD 17-M9

Approval of Minutes of Commission Meeting

held on January 26, 2017

THE PRESIDENT: Next, I would like to call for the approval of the Minutes of the Commission meeting held on January 26, 2017, as outlined in CMD 17-M9.

Any comments, additions, deletions?

MEMBER McEWAN: No. Good.

THE PRESIDENT: Therefore, for the record, the Minutes are adopted, or approved.

CMD 17-M10

Oral presentation by CNSC Staff

THE PRESIDENT: The first item on the agenda for today is the Status Report on Power Reactors, which is described in CMD 17-M10.

I understand that we have people via videoconferencing at Darlington office and at Pickering.

OPG, can you hear us?

MR. KHANSAHEB: Yes, we can hear you. This is Ontario Power Generation.

THE PRESIDENT: Okay. Are you speaking also on behalf of Pickering?

MR. GRANT: Yes, we can hear you.

THE PRESIDENT: And I have just been told that NB Power is also online.

NB Power...?

MS PRIME: That's correct.

THE PRESIDENT: Okay.

Dr. Nijhawan, are you with us?

--- Pause

THE PRESIDENT: Okay. We will see if we can connect or you will phone in. He has to phone in, okay. Thank you.

So let's hear from CNSC. Mr. Frappier, do you have any opening remarks?

MR. FRAPPIER: Yes, I do, thank you.

Good morning, Mr. President and Members of the Commission. I am here to present Commission Member Document 17-M10, the power reactor status update.

For the record, my name is Gerry Frappier and I am the Director General of the Directorate of Power Reactor Regulation. With me today are the Power Reactor Regulatory Program Division Directors plus technical support staff who are available to respond to questions on the status report.

Also with us are licensees' representatives, as you have just mentioned, should there be any questions.

As you will note, this CMD was finalized on March 3rd so it could be sent to yourselves. I would like to present some short updates to the report that took place since then.

First, Darlington Unit 1 fuelling resumed on March 6th after a brief shutdown due to inability to fuel during the installation of the Unit 2 bulkhead.

At Pickering, Unit 7 is currently running at 10 percent of full power following an unplanned outage on March the 4th, 2017. In that case, the high boiler pressure on Unit 7 caused the large steam release valve to open, ultimately leading to an unplanned outage. Later that evening the turbine was tripped on condenser vacuum low sensor reading. A vacuum control module had failed and has been removed and replaced and Unit 7 is expected to return to full power on March 10th, 2017.

To be clear, the steam release valve that we are talking about is on the non-nuclear side, so it's not a case of any radioactive elements being released into the environment. There is no safety concern and nothing has been released to the environment, other than the water that is contained in the steam.

With that, I will conclude my remarks on the Status Report on Power Reactors, and staff and licensees are available for any questions.

THE PRESIDENT: Thank you.

Dr. McEwan...?

MEMBER McEWAN: Thank you, Mr. President.

My first question is the February 26th forced outage in Unit 2 at Bruce -- I guess there are two questions -- what caused the forced outage? And it seems to me that fretting is likely to have been going on for a long time, so why wasn't that degree of potential damage picked up in routine inspections earlier than that?

MR. FRAPPIER: I believe Frank Saunders is with us from Bruce Power and could respond to that.

MR. SAUNDERS: Yes. Frank Saunders for the record.

Yes, in Unit 2 of course these pipes are insulated. This is on the conventional side of the plant, so it's feedwater to the turbine, so it is not obviously apparent that the fretting has occurred. There was a mod that has been completed on the other units, Unit 2 hasn't been done yet, and this was low pressure piping. So it was detected on rounds, people took the right action obviously.

And there was no pipe thinning here, this was a fret. Fret really occurred because of a construction aid. There are a couple of bolts that were there to hold this pipe in place during construction and those bolts were actually interacting with the hanger and causing some stress and hence why it was changed in the past, but this unit hadn't been done yet. So it came offline and did the repair and did the mod as well so it won't reoccur in the future.

THE PRESIDENT: Forgive my ignorance, what is fretting?

MR. SAUNDERS: Fretting is just when two pieces of metal rub together essentially, right, and create a small cut into the pipe or a hole. So it's a combination of the materials rubbing together and the stress that's caused by the hanger that causes a leak through the pipe.

THE PRESIDENT: Thank you.

MEMBER McEWAN: So I guess two follow-on questions. Thank you for the answer.

If there had been a full break, what would the safety risk have been and have all the other units now been modified or is this still a work in progress?

MR. SAUNDERS: No. This is the -- this unit is modified, they are all done. There was no pipe thinning, so a fret like this wouldn't cause a full break, right. And we have an inspection program that looks obviously for pipe thinning and the like, so we would detect it for that reason.

It is -- it's low pressure but it is hot water, so it would flash the steam likely, but it's in an area -- so if you're -- I mean any kind of a pressurized pipe, if you're standing next to it when it fails and the water is hot, then obviously there's risk, not a huge risk to the plant but obviously a personnel risk if you were in that location when it occurred.

THE PRESIDENT: Still on Bruce, the event of February 23rd, the emergency coolant injection failed a safety test. You know, what does it mean? What was wrong? How serious was it?

MR. SAUNDERS: Yes. Well, there is continuing testing of safety systems, as you know, and the ECI system is one of the primary ones. In this particular case the system actually failed safe. It was a valve that failed in the open direction after the test. However, it means that we couldn't test in the future. So, you know, when the valve is stuck open, you have to have a way of maintaining the circuit while you are doing the test. So with the valve stuck open, we couldn't do the test, so we were on a clock at that point to repair it so that we meet -- the requirements are that it has to be tested every so often. So at that point we needed to repair it before it came time to do the next test. But it was actually failed in the safe direction, so the system would have operated if required. It just interfered with our ability to test the operation.

THE PRESIDENT: So it's not that the emergency cooling injection failed, it's the test. I'm just trying to make sure I understand. Every time you say "failed safety system," I'm worried about that.

MR. SAUNDERS: Yes, we should be a little clearer. Usually, almost always, I mean our requirements are such that if those systems don't work, you can't operate. So when we say an SST failed we are normally saying the component failed, but in our system these components are duplicated and sometimes triplicated to allow us to test them essentially. So you can take one out to test it while the other one is in operation. So when we say an SST failed, we are usually saying a component failed. If the case was that the ECI system wasn't available, we would have had a shutdown immediately to repair that. So it would have been a different reaction if the system itself wasn't available.

THE PRESIDENT: Thank you.

Dr. McEwan...?

MR. FRAPPIER: Gerry Frappier for the record. Maybe just to make sure that that's clear for the record.

So the emergency coolant injection system was always there, it was always available, would have worked if there had been an accident, would have worked as designed. What we are talking about is a valve that's off of the main line of that emergency core, emergency cooling injection system, which is a required place for us to be able to -- for the licensee to be able to do testing. So they could not do testing on the ECI, but the ECI itself was always available.

THE PRESIDENT: Thank you.

Dr. McEwan...?

MEMBER McEWAN: Again, a plea for a diagram. That would have been actually helpful in understanding that, I think.

So Pickering February the 24th. The report is not very helpful in terms of understanding where the leak came from, what caused the leak, what was leaked, and apart from resealing the construction joints, is there anything else that needs to be done to prevent a leak accumulating?

MR. GRANT: Yes. For the record, this is Fraser Grant, Director of Operations and Maintenance at Pickering Nuclear.

So, Commissioner McEwan, in terms of extent of conditions, so we are in the moderator room today, we are cleaning some areas. We expect to remove the sealant from the construction joints. We do have an engineering team on standby to analyze what has failed, so we are moving through this with a sense of urgency and significance, but we are on --

THE PRESIDENT: Can you come closer to the microphone, please?

MR. GRANT: Yes, sorry. So again, for the record, Fraser Grant, Director of Operations and Maintenance at Pickering Nuclear.

So, Commissioner McEwan, in terms of the actual cause in terms of what we believe to be a degradation in the construction joints, so we are in there today, we expect in the next few days to start pulling some of the construction joint material out. At that point we do have engineering on standby to do an analysis and testing to understand what failed and then we do have materials to repair. Once we have more understanding around the exact cause of the failure, then we will develop a path forward in terms of any extent of condition.

MEMBER McEWAN: So the water that leaked is just water, there's no contaminants or anything else in it?

MR. GRANT: For the record, Fraser Grant, Pickering Nuclear.

No, the water is contaminated water. We have done analysis on the water, it does contain some tritium. We do believe at this time that the leakage through the construction joint is fully contained within the foundation drain system and the fuel handling tunnel.

MEMBER McEWAN: So presumably as you develop an understanding of what happened we will be getting ongoing reports and ongoing follow-up? Do you need to do any additional work to sort of trace the possible outflow of the leak?

MR. GRANT: For the record, Fraser Grant at Pickering Nuclear.

So we are continuing to be open and transparent. We do have a meeting scheduled with the site reps tomorrow, we have a full presentation in terms of the analysis that we have done to date, and we will keep them updated as we move on.

MR. FRAPPIER: Gerry Frappier for the

record.

So it probably would have been good to have the extra line in there that says we are expecting a full report from them, and I'm not sure exactly when that is going to come though but we will be getting more information on this incident.

THE PRESIDENT: And you will give us an update on this unplanned Unit 7, the root cause?

MR. GRANT: Fraser Grant for the record, Pickering Nuclear.

So I can give you a brief right now. So Unit 7 that did come offline on this weekend. We have traced the fault, it's to do with our turbine control system. It did force us offline. The unit did respond as expected and we placed the unit in a safe state. We have since corrected the fault. Repairs were completed, the unit was returned to service. It was synchronized at 0630 this morning. We have removed the part that failed and that's with our Maintenance and Engineering Department to do a full examination to come up with a root cause of what caused the failure.

THE PRESIDENT: Thank you.

My turn, I guess.

On Darlington, there's a note here on

March 3rd. There is: "Following a brief Unit 1 shutdown" during the installation, right. I'm trying to understand the relationship between Unit 1 and Unit 2 under refurbishment. I didn't see the connection here. Why is one affecting the other? You are doing the refurbishment, why is it affecting Unit 1?

MR. FRAPPIER: Gerry Frappier for the record, and then perhaps somebody from Darlington will add to it.

So Unit 2 is going through refurbishment, as you have noticed. For some operations, and in particular putting the bulkhead in, there is staff that would be in a location where it would not be allowed to bring the fuelling machine through Unit 2 on its way to Unit 1 and therefore Unit 1 becomes a bit isolated from the fuelling machine and so they end up running into issues about being able to refuel. So perhaps with that as a bit of a segue into our friends from Darlington...?

MR. KHANSAHEB: Yes. This is Zar Khansaheb. I am the Director of Operations and Maintenance, for the record, at Darlington.

So, President Binder, that's correct.

And in terms of where we are, what occurred was reactor power was being reduced to 59 percent full power as a result of our Reactivity Management Plan. Following that power reduction, it was unsustainable from a reactivity perspective and that's what initiated the reactor shutdown on March 3rd. So at that point we completed the poison outage and then restarted the unit back to 30 percent full power.

THE PRESIDENT: I'm just struck -- so during the refurbishment of Unit 2, you're going to have an impact on Unit 1. Are there any impact -- is that going to be like that throughout the whole refurbishment of all the unit? There going to be some impact between the refurbishment work and the actual operation?

MR. KHANSAHEB: President Binder, this is Zar Khansaheb again, for the record.

At this point right now, as people are in the duct, finalizing the installation of the bulkhead, that is when the impacts will be felt. We expect all of that maintenance to be completed this month, and once that separation takes place from our fueling machine duct into the Unit 2 vault. That is when that relationship will essentially end.

We'll be separated, and the tie between station operation and refurbishment will cease.

THE PRESIDENT: Thank you.

I have -- for Point Lepreau on January the 27, just can you give us a bit more information about why was the unit was de-rated for governor valve 6 testing? What does it mean?

Do you have to do this in order to be able to test? Is that what this is about?

MR. POULET: Ben Poulet, for the record, Director of Gentilly-2/Point Lepreau Regulatory Program Division.

The -- there are four governor valves that operate in parallel, and in this instance, one of the valves was not operating exactly as it was supposed to, so in order to do calibration you have to close the flow path of steam, so that leaves only three flow paths to the turbine from the -- from the boilers.

And so in order to ensure that the operation remains stable, they lower reactor power to reduce the flow-through to three instead of four. So that allows for maintenance on the one governor valve that wasn't quite functioning. That is the answer.

THE PRESIDENT: Anything you want to add?

MR. THOMPSON: For the record, Paul Thompson from NB Power.

No, that's a very accurate response.

Thank you, Mr. Poulet.

It's to make sure that the steam -- steam lines maintain within our normal operational limit, and that's why we reduce reactor power.

THE PRESIDENT: Thank you.

Anything else?

So I just have a general question to Bruce, in fact. I read in the press that people talking about life extension. When -- even though -- when we can expect an application? Are we going to get an application for licence application?

It's a bit putting premature announcement of life extension when -- without application to us to -- a licence application; right?

MR. SAUNDERS: Yeah. Frank Saunders, for the record.

Yeah. In fact, we've already notified you of that, and the application will be coming your way in June.

There are many aspects to life extension, of course, and our asset management work on the conventional side of the plant has actually been under way for a couple years now, maybe even longer. So when we talk life extension, we're talking a very broad scope of work.

So the work in the reactor systems and the major component repair, of course, is what will come to you this June for an application to do that work, which won't actually commence until 2020. So that work is still in the future, so we're looking forward to your agreement with our scope of work and a positive sign to go ahead.

THE PRESIDENT: I'm glad you're going to stick to our agreement. That's not the way the press reads it, though. That is like that application -- it's not like the application or their approval has already been given. That's what -- my concern on this.

Okay. Thank you.

Anybody else? Anything else?

Thank you. Thank you very much.

The next item is Event Initial Report regarding the Darlington Nuclear Generating Station on contaminated motors shipped to an unlicensed vendor. This is outlined in CMD 17-M11.

And I understand OPG is still available to answer questions via videoconference, and I understand Mr. Santini will make some comments on this event.

CMD 17-M11

Oral presentation by CNSC staff

MR. SANTINI: Good morning. Miguel Santini, for the record, Director of the Darlington Regulatory Program Division.

As stated in the CMD, this event's still under investigation by OPG. They are conducting a full cost assessment on the event.

CNSC staff has been following up on this event very closely, and there have been multiple meetings with the licensee management and senior management and staff itself, and we have been digging information very deeply on this.

We will also be following up on the resulting corrective action plan and the -- and the corrective measures put in place by OPG, and we will be coming back to the Commission when we -- when this is finalized to give the update.

Finally, our staff also contacted Ainsworth -- this company is an unlicensed company -- to ensure that the workers who are non-nuclear workers are satisfied by the information provided by OPG on this event and the risks -- potential risks they could have been subjected to.

We have CNSC staff available to answer questions. Specialist Suzanne Karkour is our senior inspector at site to answer questions on this event as required by the Commission Member.

Thank you.

THE PRESIDENT: Thank you.

Does OPG want to make a comment on this?

MR. KHANSAHEB: It's Zar Khansaheb, for the record, OPG at Darlington.

So Mr. Santini was correct in terms of the description. This is clearly an event that we're not satisfied to have occurred, and we are working very diligently in terms of doing a root cause analysis to understand the implications and understand why this has happened so this will never happen again.

So the details are as presented.

THE PRESIDENT: Thank you.

Dr. McEwan?

MEMBER McEWAN: Thank you, Mr. President.

I guess the first question as I read this that comes to mind is, was it foreseeable?

You know, you open one, it's dry. You open another one, it has water in it.

Would you expect there to be water in each of these units, or is this something that you would not normally find?

MR. KHANSAHEB: So this is Zar Khansaheb again, for the record, Director of Ops and Maintenance at Darlington.

These are sealed motors from our vapour recovery systems. There is no expectation to ever find water inside a motor, and so this was -- this was not foreseeable at this point. And again, we're going to be continuing to do our root cause investigation to understand how this could -- this could occur.

MEMBER McEWAN: So the water will be internal to the unit. Is there any monitoring that would detect contaminated water inside a unit like this, or are you actually blind when you do the survey?

MR. KHANSAHEB: It's Zar Khansaheb again, for the record.

When we do surveys -- and I have my radiation protection manager with me. When we do the surveys, we will do external contamination surveys using masslin kind of cloth and then do indirect surveying with a pancake meter.

We will also take a Scintrex device which looks for tritium contamination and go in around the motor or its survey point.

So those are the survey methods used. Again, that's part of our investigation to understand is that the correct methodology for these kinds of motors.

THE PRESIDENT: So let me ask you, so once you found the water, did you look at why that particular unit passed the test?

I'm interested to know whether your test should have detected the water or not.

MR. KHANSAHEB: It's Zar Khansaheb again for Darlington, for the record.

Part of this motor -- this motor sits inside a vapour recovery system dryer unit. It is inside a tritiated environment, a tritiated vapour environment. And again, it's not expected to find tritiated water inside the motor inside a sealed unit.

So clearly, that motor would have been subjected to different conditions than we would have normally expected.

In terms of discussing this with Ainsworth, who does motor rewinds for us and has done that for many years, this was a very surprising event to themselves as well, and so, you know, from our perspective, we have to understand what this motor was subjected to, and the only way it would have been is if it was submerged in some way or a continuous stream of water was flowing on it.

So again, that's part of our detailed investigation.

THE PRESIDENT: But that's not my question. My question is, once you decided to ship it out, you did a survey and make it fit to be sent out.

What I'm interested in the report is why did -- whatever surveys you did didn't detect the contamination in this particular unit.

MR. SANTINI: If I may answer this. Miguel Santini, for the record.

So OPG has a very strict procedure in order to release the components from the plant that may have been exposed that could be contaminated. So I'm going back to Dr. McEwan's question.

It was not foreseeable for them to have water inside because this was a sealed motor, so they didn't expect to have water. So the testing procedure for release of the motors off site did not anticipate that from happening.

Now, the root cause assessment will have to come with conclusion whether the procedure to release certain components of the plant will have to be beefed up because they haven't anticipated these kind of things that were not foreseen when developing the release procedure.

THE PRESIDENT: I'm looking forward to the report. But, just so you understand, you do the test exactly to test whether there's unforeseen stuff. That's my understanding of a test, otherwise, if you don't foresee it and you have run the wrong test, you shouldn't send them.

So, either the tests are not sensitive enough to detect this or somebody didn't do the correct testing. That's the only outcome I can see here.

MR. SANTINI: Miguel Santini again, for the record.

And that will be -- all the investigation will find the root causes, whether the procedures were followed properly or whether the procedures need to be beefed up for other conditions that were not foreseen in the past.

MEMBER McEWAN: So, would I be correct in thinking that if the contamination was only in the water and the water was only inside the sealed motor, that the shielding of the motor itself would probably make the pancake metre ineffective?

MR. KHANSAHEB: This is Zar Khansaheb, for the record, Darlington.

That is correct. The two instruments that are used; one is a pancake device, the shielding would not detect internal contamination. Tritium also is a beta emitter and cannot be detected by the pancake device.

MR. MANLEY: Dr. McEwan -- it's Robin Manley from OPG, for the record.

Perhaps I could just add one additional clarifying point. Over the years Ontario Power Generation has evolved its mechanisms and its procedures for surveying equipment that are going to be shipped off-site. So, long ago it was a much simpler process, but not as robust.

Over the years the process has evolved so that where an object is known to have internal openings in it, for example, something as simple as a computer that has a fan that allows air to be exchanged into the internals of the compartment, you know, long ago we wouldn't have known to be checking in there, but we evolved our procedures through learning and operating experience to do internal contamination checks on components or materials where there's known openings and those surveys would, therefore, be chosen so as to be able to detect contamination that would otherwise be shielded by the metal of the object.

However, where an item is believed to be completely sealed and, thus, to not have any mechanism for internal contamination to occur, we would not have foreseen to have done that sort of survey.

So, I think what the other speakers were relating to is that through the investigation that's being done here we're going to be looking for, is there something that we should have known about sealed motors or other kind of objects where we believed that we had adequate processes in place? And if that root cause identifies that we need to make improvements to our program, as we've done in the past, then we'll do so again.

MEMBER McEWAN: Okay. Thank you.

So, if I look at the way it was handled at Ainsworth, it seems to me they were exemplary in, once this had happened and how they handled it and what they did.

Do they have any surveying capabilities on-site or do they have to bring somebody in to do surveys?

MR. SANTINI: Miguel Santini, for the record.

Perhaps OPG could add on details, but basically this is a company that is not the licensee, so they are not supposed to receive contaminated material, and so they don't have their own capabilities for that.

And, in this particular case, it was the presence of OPG staff who did all of the preventative measures.

MR. KHANSAHEB: And it's Zar Khansaheb, for the record.

Thank you, Mr. Santini, that's exactly correct. Our response brought on those -- on-site those metering capabilities to measure the contamination and also all of the clean-up items that we needed for clean-up.

THE PRESIDENT: Thank you. And, by the way, thank you for the photos, very helpful just to picture what's going on.

Thank you. I'd like now to move to the next item on the agenda. But first, do we want -- I'd like to verify, Dr. Nijhawan is with us. No?

Okay. The next item on the agenda is information item on CNSC staff assessment of the industry's disposition of issues raised during the Bruce and Darlington licensing hearing of 2015 as outlined in CMD 17-M.14 and 17-M.14.A.

Marc, over to you.

MR. LEBLANC: Yes. So, I will start with a few contextual remarks.

We have been trying to reach Dr. Nijhawan by phone and by e-mail this morning and he had mentioned he would join us, so we're still going to work on trying to reach him since those issues have been raised by him.

So, as the President just alluded to, this presentation is a follow-up on discussions that took place during the April, 2015 Bruce and November, 2015 Darlington Commission hearings.

In the context of the Bruce hearing, the NPP industry and Dr. Nijhawan had agreed to meet to address the numerous technical questions and issues Dr. Nijhawan was raising on his interventions. The same questions were also raised in the context of the Darlington hearing.

And the Commission, in both of these licensing decisions, asked staff to update it on the progress of those discussions and on the work of the CANDU Owners Group respecting these issues.

So, what we are dealing with today is the assessment by the CNSC staff of the report of the CANDU Owners Group that we refer to as the COG Report regarding Dr. Nijhawan's 34 questions.

Separately to the COG/Dr. Nijhawan interactions, CNSC staff retained the services of third party consultants to assist with the review of the COG Report. The two consultants are Dr. Luxat from McMaster

University and Leeds, that are represented by Marc Satorius and Eric Leeds, that are U.S. specialists.

These reviews were to provide an external review of whether the CNSC staff exercised due diligence concerning the topics raised by Dr. Nijhawan and how these topics were addressed by industry and the CNSC.

Their presentations will be incorporated as part of the CNSC staff's live presentations.

Following the CNSC staff presentation, there will be presentations by the CANDU Owners Group and then by industry, followed by presentation by Dr. Nijhawan.

More importantly -- and that's why we were asked for the presentation to be concise -- there will then be a question period where no time limit has been ascribed to discuss these matters.

Mr. President...?

THE PRESIDENT: Thank you, Marc.

So, I'm hoping, at least for us, given all the expertise in front of us, to get to some consensus whether there is remaining lingering safety issues that require some further attention or not.

So, some of those issues have been around for a while, so we're looking forward to maybe come to some sort of consensus about the way ahead.

So, Dr. Nijhawan, I'm still hoping that you are with us.

MR. LEBLANC: Not yet.

THE PRESIDENT: Okay. So, we will start with CNSC staff with their presentation, and I understand that Mr. Frappier will make the presentation.

Please proceed.

CMD 17-M.14/17-M.14.A

Oral presentation by CNSC staff

MR. FRAPPIER: Thank you, Mr. President and good morning, again, to yourself and the Members of the Commission.

My name is Gerry Frappier, for the record. I'm the Director General of the Directorate of Power Reactor Regulations here at the CNSC.

Before you today is CMD 17-M.14 which is the CNSC staff update to the Commission on the action placed on staff to report on progress towards the resolution of issues raised by the intervenor, Dr. Sunil Nijhawan, during the Bruce Power re-licensing hearings held in April, 2015.

With me today is Dr. David Newland,

Director General of the Directorate of Assessment and Analysis, Dr. Hatem Khouaja, lead technical advisor in the Directorate of Power Reactor Regulations, along with CNSC's directors and specialists, third party reviewers contracted by the CNSC and licensee’s staff.

CNSC staff have, as was mentioned, have contracted external experts to conduct third party reviews of the technical aspects of the CNSC assessment, as well as the regulatory approach taken by the CNSC, and they will present a little bit later.

The CNSC third party experts are here and will speak to their findings as part of the staff presentation.

The presentation outline follows the CMD structure that was submitted to the Commission. We will start with a brief background and provide you with context. We will look at the actions taken by the licensees under the CANDU Owners Group, or COG for short, to disposition the intervenor's comments, and then we will go over the CNSC staff assessment of Dr. Nijhawan's questions and the dispositions provided by COG.

The CNSC staff assessment will include presentations by the external parties, Dr. John Luxat and Mr. Eric Leeds.

I will conclude the staff presentation with overall conclusions, CNSC staff recommendations and the steps moving forward.

And with that, I'd like to now turn the presentation over to Dr. Khouaja.

MR. KHOUAJA: Thank you, Mr. Frappier. Good morning, Mr. President and Members of the Commission.

For the record, my name is Hatem Khouaja. I'm speaking to you today as the project lead for this CMD 17-M.14.

So, during the re-licensing hearing for Bruce Power held April 14th to the 16th in 2015, Dr. Sunil Nijhawan presented 34 technical questions that were raised previously in his interventions under CMD 15-H2.145A and B.

At that same meeting, Bruce Power senior management committed to meet and discuss the issues raised by the intervenor, and to agree on a path to disposition all of his questions.

Bruce Power staff met with Dr. Nijhawan on April 30, 2015 to review the 34 questions and develop a path towards resolution. CNSC staff did not participate in this meeting.

Given the generic nature of the questions raised for CANDUs, Bruce Power requested the CANDU Owners

Group (COG) to examine and disposition the technical questions raised by Dr. Nijhawan.

In response, COG initiated a joint industry project, and met with the intervenor.

COG then carried out the review of all questions raised, and produced a final report on their disposition of all 34 questions.

Dr. Nijhawan is the primary recipient of the COG deliverables, and he received the COG final report for his review and comment.

He agreed to provide written responses confirming disposition, or else provide a technical explanation.

Copies of the COG reports were also provided to the CNSC for information.

CNSC staff were not part of the discussion between Dr. Nijhawan and COG, nor did they take part in the COG dispositioning process.

CNSC staff did conduct an independent assessment of the COG final report. The review is documented as a CNSC staff internal report.

In addition, CNSC staff retained external experts to review the issues and CNSC staff actions. These third-party reviewers will present to you the results of their assessments, shortly.

When COG met with Dr. Nijhawan both parties agreed that eight of the questions in four key areas were of concern to him. They agreed to a process with two phases. The first Phase 1 will address the four key areas of Dr. Nijhawan's questions. In the second phase the remaining questions would be addressed.

COG completed the Phase 1 report on the eight questions in four key areas in November 1st, 2015. The second phase addressing the remaining questions was completed on October 2016.

The COG final report included disposition of all issues raised by the intervenor, including the eight questions in four key areas and the remaining 26 questions. COG sent copies of both the Phase 1 report and the final report to the CNSC staff for their information.

CNSC staff completed a detailed assessment of the eight main technical questions, grouped into the four key areas you see here. So area number one is the bleed condenser relief valve (BCRV); two is the hydrogen/deuterium production and passive autocatalytic recombiners, or PARs, for short --

THE PRESIDENT: Sorry to interrupt. I am told that Dr. Nijhawan is now connected.

Dr. Nijhawan, can you hear us?

DR. NIJHAWAN: I can, sir.

THE PRESIDENT: Welcome. Thank you.

DR. NIJHAWAN: Thank you, sir.

THE PRESIDENT: Please proceed.

MR. KHOUAJA: So I continue with area number three is the Modular Accident Analysis Program modelling for CANDU, or MAAP-CANDU, for short; and the fourth area is In-vessel retention (IVR).

CNSC staff also completed a review of the 26 remaining questions to evaluate the safety significance. Copies of the CNSC final assessment of the disposition, along with a copy of the CMD 17-M14, were provided to both COG and Dr. Nijhawan on January 22, 2017.

So if we start with the four key topics:

Key topic number one which is the bleed condenser relief valves, Dr. Nijhawan's questions related to bleed condenser relief valves, were first raised in 2001, and repeatedly for the past 15 years. These have been investigated by CNSC staff and the industry.

The bleed condenser relief valves provide pressure relief for the primary heat transport system. Dr. Nijhawan questions the capacity of these valves, and claims they provide inadequate relief for long-term loss of heat sink accidents, such as an extended loss of all electrical power. He also questions if the requirements of the ASME Boiler and Pressure Vessel Code were met in the valve testing.

In 2014, CNSC retained the services of third-party subject matter experts to evaluate the intervenor's submission on ASME code requirements. This independent evaluation was posted on the CNSC website, and was made available to Dr. Nijhawan.

CNSC disposition of all relief valve-related questions was also made available in a technical paper posted on the CNSC website in 2015. A link to the technical paper abstract is provided in this slide.

Dr. Nijhawan's comments, and the resulting COG dispositions, do not provide any new information to affect the CNSC staff position, as discussed in this technical paper.

CNSC staff remain satisfied that the relief capacity is adequate, for all design-basis accidents, and the safety case of operating CANDU plants, is robust.

On the second key topic area which is the hydrogen/deuterium production and passive autocatalytic recombiners, or PARs effectiveness, PARs are designed to keep deuterium and hydrogen concentration low enough, to prevent destructive burns or combustion, in containment, during a severe accident. They passively recombine deuterium and hydrogen with oxygen, in the containment.

All licensees of Canadian nuclear power plants have installed PARs (either before or after Fukushima). Several levels of redundancy were designed into these PARs, to account for any uncertainties.

Most testing of PARs is performed without deuterium. It is done using recombination of hydrogen with oxygen. Research shows a very small influence in the differences between hydrogen or deuterium, on PARs effectiveness. Further, follow-up full-scale experimental work is being carried out at Canadian Nuclear Laboratories, or CNL, for short.

Dr. Nijhawan questions the performance of the PARs because testing is performed without deuterium. He claims that the difference in physical properties from hydrogen leads to a much lower recombination rate. This claim is not supported, based on all the best evidence available.

Dr. Nijhawan also questions the lack of specific models for steel oxidation in severe accident analysis, because during severe accidents, deuterium and hydrogen can be produced from oxidation of hot steel components.

The dominant source of hydrogen/deuterium during a severe accident will be within the reactor core where the hottest components are.

The components that Dr. Nijhawan refers to are outside the reactor core, and are relatively small contributors to hydrogen production.

For the third key topic area regarding Modular Accident Analysis Program, (MAAP) -- CANDU modelling, MAAP-CANDU is the computer code used to model severe accident progression for CANDU reactors.

Uncertainties in the MAAP-CANDU modelling is compensated for with conservatism in the design; strengthening in the defence-in-depth, such as the installation of the emergency mitigating equipment; and the implementation of Severe Accident Management Guidelines, or SAMG.

Dr. Nijhawan questions the capabilities of this code and the physical models incorporated into it.

CNSC staff find, however, that the COG responses to the MAAP-CANDU modelling topics reflect the current best practices with respect to severe accident modelling, and MAAP modelling code is fit for purpose which means, the level of detail of the models used by the code is consistent with the level of accuracy needed for the results.

Now for key topic number four which is in-vessel retention, in-vessel retention refers to the ability to retain molten core debris inside the calandria vessel, after core collapse.

In-vessel retention is only important in the events which progress to core melting. In other words, only if all safety systems fail to stop accident progression, including failure of the emergency mitigating equipment that was installed in response to the Fukushima accident.

Dr. Nijhawan questions the robustness of the calandria vessel during a severe accident.

The structural integrity of the calandria vessel was addressed, as part of lessons learned from the Fukushima nuclear accident.

Licensees of Canadian nuclear power plants identified practical and concrete plant modifications, such as:

- Additional capability for overpressure relief by modifying the design of the Shield Tank Overpressure Protection;

- Installation of the calandria vault or the shield tank coolant make-up systems for in-vessel retention;

- And installation of emergency mitigating equipment to prevent progression to severe accident.

Industry is also carrying out experimental work under COG and CNL, to measure the critical heat flux on the external surface of the calandria vessel.

In addition to an assessment of the eight major questions in four key areas, CNSC staff completed a review of the remaining 26 questions to ensure no issues of safety significance were overlooked.

There are two questions that the CNSC staff requested updates on, both of which relate to previous actions under the CNSC action plan, and were investigated by the industry.

These updates relate to source term of combustible gasses and containment during severe accident, and instrumentation survivability for monitoring capability in post-accident conditions. Both of these update requests are of low safety significance. In the CNSC Staff review of the 26 remaining questions none were found to be of safety significance requiring regulatory action and no issues of safety significance were overlooked.

A summary of the CNSC staff assessment of the COG's disposition of Dr. Nijhawan's full list of 34 questions and the CNSC Staff position on the safety significance of the issues raised is presented in Appendix C of CMD 17-M14.

Now, to recap the CNSC Staff safety assessment, CNSC Staff agree with the COG's disposition of the topics raised by Dr. Nijhawan. The request made by CNSC Staff in their assessment of COG's disposition are related to either ongoing confirmatory research carried out by the industry or the need for some documentation to fully support the basis for industry disposition of the issues raised.

All of these are considered of low safety significance and will form part of the regulatory oversight through either of the safety control areas on safety analysis or follow-up on station-specific Fukushima action items.

As Mr. Frappier and Mr. Leblanc mentioned in their opening remarks, CNSC engaged two third-party experts to review the CNSC Staff technical assessment as well as review the regulatory process used to disposition the intervenor's questions.

Dr. John Luxat is a Professor of the Department of Engineering and Physics at McMaster University and senior Industrial Research Chair in Nuclear

Safety Analysis with world-recognized expertise in CANDU design and safety analysis. Dr. Luxat performed an assessment of the technical merit of Dr. Nijhawan's interventions and the responses of COG and CNSC Staff reviews. Dr. Luxat will present his major findings and recommendations.

CNSC Staff also obtained the services of Mr. Eric Leeds and Mr. Mark Satorius to perform an assessment of CNSC's regulatory processes and actions in connection with the interventions of Dr. Nijhawan. Mr. Leeds is a former Director of Nuclear Reactor Regulations and Mr. Satorius is a former Executive Director for Operations. Both at the U.S. Nuclear Regulatory Commission or U.S. NRC.

Both Mr. Leeds and Mr. Satorius have the necessary background and extensive experience to assess and compare CNSC regulatory practices against those of the U.S. NRC and internationally. Mr. Eric Leeds will present their major findings and recommendations.

I will now turn the presentation over to Dr. Luxat and then to Mr. Leeds.

DR. LUXAT: Thank you. Good morning, Mr. President, Members of the Commission. For the record, my name is John Luxat, and my credentials have been mentioned by the previous speaker for the CNSC.

What I'd like to do in this presentation is briefly summarize the results of my independent review of the intervenor issues and, as you'll see on our next slide the objectives of the review were to determine if the CNSC Staff has exercised due diligence concerning the issues raised by the intervenor and the disposition of these issues by Canadian nuclear power plant licensees.

Then to determine for each of the questions and some issues raised by the intervenor, whether the issue is clearly stated by the intervenor, whether the issue is adequately addressed by the licensees and by COG, and is the CNSC response appropriate.

Finally, document the results of the review, including an overall conclusion on the due diligence exercised by CNSC staff.

For the scope of the review I reviewed written communications between the intervenor and the CNSC over a period from 2001 to 2015, a fairly large volume of communications I might add. In addition, there was the draft COG joint project report, Phase 1 report, on CANDU post-Fukushima questions and the follow-up CNSC screening review of draft joint project report.

Now, my focus was on eight of the 34

issues, which had been agreed to between COG and the intervenor as being primarily technical in nature and covering four topics, which have already been mentioned: the bleed condenser relief valves; hydrogen/deuterium production and passive autocatalytic recombiner effectiveness; MAAP-CANDU modelling; and in-vessel retention.

Just to give you some idea of what I decide to establish in order to inform my review, was what is a technical basis available in the literature today, currently, up to 2016, and going back actually to 1940. So it covered a large period of time. There is a significant amount of information in engineering literature relating to these four topics.

I addressed eight textbooks, which I referenced in my report. Most of these are second edition and fifth edition textbooks very recently published up-to-date information covering topics such as thermodynamics of materials, high-temperature oxidation of metals, metallurgical thermochemistry, nuclear severe accident phenomena, and combustion, since these are the topics that are of major, in my view, safety concerns. In particular, the issues around hydrogen production and recombination.

One can argue about bleed condenser relief valves, and I believe that issue has been pretty much resolved. But the one topic which really had significant potential impact was the hydrogen, so I focused quite significantly on that. In addition, I went to the Technical Journal Literature covering the major journals in both nuclear materials, nuclear engineering and design, oxidation of metals, Metallurgical and Materials Transactions and Progress in Nuclear Energy.

These are where current papers can be found on these subjects. So I wanted to make sure it was not just my opinion that I was expressing, but it was based upon available scientific engineering technical information.

So given that basis, I will now summarize very quickly my conclusions.

The first conclusion was actually the last one in my instruction or charter, and that was it. Based upon the material I reviewed, the extensive amount of material reviewed, it was clear that the CNSC had exercised appropriate due diligence in addressing the issues raised by the intervenor and the disposition of these issues by the Canadian nuclear industry. Everything was addressed and it was transparent.

For each of the issues raised by the intervenor there has been, in my view, a lack of supportable technical statements of these concerns. By that, I mean there have been a lot of assertions, but very little back-up information, analysis, assumptions, models, that’s not at all apparent, it's just an erroneous statement and that's meant to be fact. So the issue was, how factual were these assertions?

The other thing that struck me was there seems to have been an apparent lack of awareness of the state of technical knowledge on his part. Now, I'll get to that shortly.

The assertions made by the intervenor regarding bleed condenser relief valve capacity certification requirements displays an incorrect interpretation of both the certification process and code requirements. This was addressed very clearly by the independent consultant hired by the CNSC, a company called ANRIC, who are very clearly knowledgeable in this area, and they went to the ASME committee and got opinions as well. So there was a lot of basis supporting the disposition of this issue.

The other thing that struck me was this had occurred over many years in fact and there had been --

the intervenor had failed to respond to the information and continued to restate these assertions. Now that is, in my view, an unacceptable way to resolve the issue; you can't just keep repeating what you said and ignoring what other expertise have said. There has to be some resolution, but there doesn't seem to be any desire to do so.

The next set of conclusions -- and this really is focused primarily on the hydrogen issues -- there is a very large scientific and engineering literature basis in conjunction with the governing behaviour during the postulated accident, and this does not support steam oxidation of carbon steel feeder pipes being a significant source of hydrogen/deuterium.

As mentioned, the dominant source of a relatively short period of time will be from steam oxidation within the fuel channels due to steam zirconium oxidation, which is much more exothermic than iron oxidation, which in turn when you look at the hydrogen, the gas that the carbon steel feeders are being exposed to is a mixture of unoxidized -- unreacted steam, what remains, and hydrogen. The impact of the hydrogen is important for deuterium, same as hydrogen effectively, is that it lowers the oxygen potential for the oxidation reaction. The oxidation potential comes from dissociation of the steam.

Lower oxidation potential means less oxidation capability. So it is not likely that you are going to get an extreme, rapid, highly exothermic oxidation of feeders. Steel is not as exothermic an oxidation as zircaloy.

So the next issue, the potential combustion of deuterium or oxygen and steam gas, which is a mixture that would be subject to the PARs in containment, will exhibit very similar behaviour to hydrogen/oxygen/steam mixtures and this is based upon the fact that thermodynamically the difference between deuterium and hydrogen in terms of the thermodynamics, chemical thermodynamics, are very, very similar. In fact in terms of being exothermic at lower temperatures the deuterium may be 3 percent more exothermic, at higher temperatures about 1 percent more exothermic. This is basically a large body of thermodynamic data that has been collected since 1940 and essentially has not changed.

So the other issue relating to the rate is the so-called diffusion factor of 2, but the factor of 2 comes from comparing the molecular mass of hydrogen and deuterium: one, deuterium, is twice as much. But in order to react you have to have molecules of oxygen, and oxygen has a molecular mass of 32, so oxygen is the heaviest reactant in the mix and that will be the one which will --

if there is a diffusion impact, would be the one that dominates. But the diffusion is not a significant issue other than at the boundary layer between the catalyst and the gas. There is turbulent mixing or turbulent diffusion, which is mixing and transport of the gases to the catalyst, which would be more dominant.

So finally, a third conclusion which I should -- I struggled whether I should make this conclusion but I decided in the end I would make it, and that the fact it occurred so frequently in what I reviewed was really very surprising in a technical setting. The intervenor has at times resorted to what I call, kindly, intemperate unprofessional language aimed at the regulator and industry. The reason for this is not apparent, but it certainly does not advance the credibility of technical arguments, nor does it facilitate the discussion of the issues, and both the CNSC and industry have displayed restraint in not responding to such language. As I say, it's not a technical issue per se but it does relate to the technical discussions around the issues.

Finally, the last conclusion is that the CNSC staff have exhibited commendable patience in responding to the intervenor, as might be expected from what I consider to be a professional regulatory organization. Where uncertainty does exist, they have appropriately referred the issue to the licensees to address.

And my closing observation, concluding observation is that we should always keep in mind that when you get to severe accident there will always be issues of uncertainty as to how the accident might progress, what phenomena, behaviour might occur, but these issues, in my view, are not resolved by building bigger and better codes based upon information where there is uncertainty, the uncertainty is inherent in the complexity of the processes. Where from a safety perspective -- and this is where you rely on defence in depth -- is what do you have for contingency to respond to these accidents and mitigate the progression of the accident. That's where the implementation of emergency mitigating equipment has been, in my view, a very major increase in safety and defence in depth, safety because it provides a means independent of other engineered systems to mitigate the progression.

With that, I thank you for your attention.

CMD M14-C

Oral presentation by E. Leeds and M. Satorius

MR. LEEDS: Okay. Thank you, John.

Good morning, Mr. President, good morning, Commission. My name is -- for the record, my name is Eric Leeds and I will present the work that I did with Mark Satorius, who is seated here to my left, in performing an independent review of the CNSC regulatory disposition of the issues being discussed this morning.

Next slide, please. Thank you.

The objective of our review was to determine if CNSC staff exercised appropriate due diligence concerning the topics raised and their disposition by the Canadian Nuclear Power Plant licensees. We compared the areas of concern and CNSC response with applicable international practices.

Our focus for this review were the regulatory requirements in place for a beyond-design-basis accident; regulatory openness and transparency; rigour of the technical review of the potential safety issues; and finally, an appreciation and respect for differing professional opinions.

Our scope of review were the four major

technical topics addressed in the CANDU Owners Group Phase I Report which have been discussed during this meeting.

Next slide, please.

Our findings and conclusions.

First, we found there was limited safety significance with regard to the issues raised. The majority of issues involved disagreements in the application of engineering practices and levels of precision that were not warranted for the applications involved. Many of the assertions, as you heard from Dr. Luxat, are not technically supported and were impossible to verify. We found that the most salient assertions have been made since the accident at the Fukushima Daiichi nuclear power plant in Japan involving the generation of explosive gases during a beyond-design-basis accident. However, it should be noted that the CNSC already had activities underway to verify their conservative assumptions for the generation and mitigation of explosive gases as part of its lessons learned from the Fukushima accident.

We found that the CNSC has a robust regulatory process that emphasizes openness and transparency with the public. Based on our international experience, CNSC's work to broadly disseminate and make available relevant information to the public is exemplary. CNSC goes beyond international standards for openness in that it actively seeks and encourages community engagement through its Participant Funding Program.

With regard to allegations and assertions from the public, we found that the CNSC provides multiple paths for individuals to raise issues and concerns to the CNSC, including through normal correspondence as well as directly to you, the Commission. A positive practice we found here at the CNSC is that they use the same procedure for conducting a technical assessment whether the concern is raised by a member of the public or by the CNSC staff itself.

We found that the CNSC reviews reflected international standards, including International Atomic Energy Agency fundamental safety principles and IAEA safety standards. CNSC actions reflected international practices to address beyond-design-basis accidents through the use of IAEA design extension conditions. The CNSC actions in response to the Fukushima Daiichi accident are in accordance with its obligations to the *Convention on Nuclear Safety* and are consistent with actions taken by other international regulators as described by the Nuclear Energy Agency. The Nuclear Energy Agency has reviewed the actions taken by its member countries in response to the Fukushima accident and published its findings in a report last year entitled "Five Years After the Fukushima Daiichi Accident."

We found that although the majority of issues have been reviewed and no further activity is warranted, for those issues remaining, the CNSC has action plans in place for their closure. The action plans include industry clarification of select issues for completeness of the record as well as large-scale testing with regard to explosive gas generation to verify already conservative assumptions. The CNSC has plans in place to track these actions to completion, which reflect the seriousness in which they have reviewed and addressed the concerns raised.

We concluded that the CNSC staff exercised due diligence in the review, assessment and disposition of the issues raised. CNSC engagement with the Canadian nuclear industry to address these issues was appropriate and consistent with international regulatory practices.

The strength of an organization -- and I want to pause here -- and this was very important to us to express to the Commission. The strength of an organization often lies in its underlying values and its dedication to its mission. As retired regulators we would be remiss if we did not address our personal observations of the CNSC staff in the conduct of this review. The rigour with which your staff has addressed the technical issues raised now and previously and the professionalism we experienced in our discussions of these issues with your staff have been admirable and they reflect the CNSC values and expected behaviours. The importance for the regulator to live the CNSC value should be emphasized and may in some ways be stronger than laws and regulations to instil a safety culture throughout the nuclear industry.

Next slide, please.

We will go to our recommendations.

Our first recommendation is that the CNSC staff should consider establishing a process to engage senior management or, if necessary, the Commission when dealing with an individual or organization that continues to raise the same issues repetitively without providing new or substantiating information. The CNSC, like all organizations, does not have unlimited resources and the diversion of staff to respond to issues that have been addressed and resolved previously when the submitter has provided no new or substantiating information detracts from its mission to protect public health, safety, security and the environment. Now, we caution implementation of any process that could result in a loss of openness, transparency and responsiveness that we observed from the CNSC staff. Therefore, we suggest that a decision to stop responding to an individual needs to be made at the appropriate management level and is done openly, with respect and professionalism.

Our second recommendation is that the CNSC staff could benefit from a more robust system of controls and oversight for responding to issues raised by the public. A system that allows for easy identification of issues could reduce resource expenditures and provide a stronger mechanism to track and trend responsiveness to issues raised by interested members of the public. A more robust system can allow for the establishment of metrics and goals for responding to public inquiries and also provide a database for knowledge transfer for the CNSC staff. We suggest that CNSC should consider benchmarking. Certainly there are other foreign countries that use these systems. We suggested using the U.S. Nuclear Regulatory Commission's procedures or benchmarking them for responding to allegations made by members of the public which contain many of the attributes that are described in this recommendation. In our role as public servants, any system chosen should always default to being as open and responsive as possible to public inquiries.

That concludes my presentation. Thank you, and I will pass it back to Mr. Frappier.

MR. FRAPPIER: Thank you, Mr. Leeds.

So just to summarize, Bruce Power and later all Canadian power reactor licensees engaged with Dr. Nijhawan to fully understand his concerns and established the CANDU Owners Group Joint Project to prepare a report documenting their disposition of these concerns. The final report was issued in October 2016, titled "Final Report on CANDU Post-Fukushima Questions." The CNSC staff reviewed the COG final report and also contracted external third-party reviewers to perform due diligence both from the technical perspective and the regulatory assessment perspective of the CNSC staff actions.

CNSC staff agree with the COG responses to the topics raised by Dr. Nijhawan and find that the actions completed by COG at the request of the industry is complete and all issues identified by the intervenors have been dispositioned appropriately. This conclusion is shared by the external expert reviewers and, as you heard today, based on the results of third-party reviews, CNSC staff exercised due diligence in assessing concerns raised by the intervenors from technical and regulatory aspects.

CNSC staff confirm that issues raised are of low safety significance given the enhancements in defence in depth implemented post-Fukushima to arrest progression of a severe accident and there is adequate conservatism in design that take into account uncertainties in knowledge of plant behaviour under severe accident conditions.

Any future follow-up action to provide additional information, analysis and confirmatory research will be tracked as per the established CNSC regulatory oversight program. CNSC staff will provide updates of any new information on any significant findings to the Commission through its annual regulatory oversight report for the Canadian nuclear power plants.

CNSC staff recommend to the Commission that the issues raised by Dr. Nijhawan and presented in CMD 17-M14 be closed. By accepting closure of these issues, CNSC staff request the Commission accept the fact that staff will not perform any further detailed reviews on these repetitive issues until such time new risk-significant issues have been brought forward based on well-supported information.

Finally, CNSC staff recommend that the Commission accept the conclusions and recommendations brought forward by the third-party experts, and to be specific, the recommendations brought forward by Mr. Leeds and Mr. Satorius for the development of a process to engage senior CNSC management and, if necessary, the Commission when faced with repetitive interventions or allegations; also, the consideration of benchmarking against the U.S. NRC's procedures for responding to allegations made by members of the public.

Thank you. That concludes the staff's presentation. We are available to answer any questions.

THE PRESIDENT: Thank you.

I will now turn the floor to the CANDU Owners Group for their presentation, as outlined in CMD 17-M14.1 and M-14.1A.

I understand that Dr. Henry is joining us via teleconference.

Dr. Henry, you are not online? Not yet. Okay, I understand.

So in the meantime, Mr. Dermarkar will make the presentation. Over to you.

CMD 17-M14.1/17-M14.1A

Oral presentation by CANDU Owners Group

MR. DERMARKAR: Thank you very much, Dr. Binder.

For the record, my name is Fred Dermarkar. I am the President and CEO of the CANDU Owners Group.

Thank you for this opportunity to make a presentation on the process that COG followed in producing the report that has been referenced so far.

In this presentation I am going to provide you with a very brief overview of the CANDU Owners Group. I will not be going into the background, as suggested on the slide, because that has been very well covered by Mr. Frappier, Dr. Khouaja and others. Rather, I will focus more on the project itself, its objectives, the approach we use, the process and the opportunities that we provided for inputs, and then I will finish off with a summary.

The CANDU Owners Group was formed in 1984 and it came into existence with Ontario Hydro, New Brunswick Power, Hydro-Québec and AECL coming together to form a group that would share information, that would engage in research and development, that would engage in joint projects, all committed towards the excellence of

CANDU technology, CANDU operation through collaboration. Today, the CANDU Owners Group has the operators of all 47 CANDU or pressurized heavy water reactors worldwide in seven countries as its members. In addition, we have Canadian nuclear labs as one of our members, almost 20 supplier participants that support the CANDU industry, and we also have established formal agreements or memberships with other major international organizations, including the Electric Power Research Institute, WANO, the International Atomic Energy Agency, and here in Canada, AECL and the Canadian Standards Association.

We are a not-for-profit organization, we are entirely funded by our members, but we are very much a technical organization. We do not engage in advocacy or in policy-setting, but we do engage in research and development and joint projects that enhance the safety, reliability, environmental performance and cost of operation of CANDU reactors worldwide. Altogether in the area of research, development and projects, over the last number of years, we have consistently spent approximately $65 million a year annually. COG doesn't do the work, but what we do is manage the work and have it executed by reputable organizations such as Canadian Nuclear Labs, amongst others.

Over the last few years I want to highlight some of the work that we have done in the R&D program that is relevant to the items under discussion today.

We have done work in the development and refinement of computer codes such as GOTHIC and MAAP-CANDU. We have done work in the behaviour of passive autocatalytic recombiners in waterborne fish and product behaviour. We have done assessment through investigation, both experimental and through simulation, of the in-vessel retention assumptions related to the calandria vessel structure and we have done very recently some large-scale testing of the effect of hydrogen versus deuterium on passive autocatalytic recombiner performance in CNL's Combustion Test Facility. I mention these because they are central and germane to the issues that are being discussed and have been raised by the intervenor to reinforce the fact that as an industry we actively do research in these areas to continue to advance our knowledge.

As I mentioned, I am going to skip the background because it has been adequately covered.

When we kicked off the joint project, the objective was, as shown on this slide, first, for each of the 34 issues that were raised, we would carefully examine the issue; we would compare the issue and comments pertaining to that issue to what the industry had already done post-Fukushima; we would determine whether any additional actions were required; and we would provide a justification for the disposition in each and every case.

We divided the project into two parts. Phase 1 was intended to cover four main areas covering eight of the 34 concerns. We divided it into these two phases for a specific reason. Phase 1 addressed the hard-core safety analysis issues that were raised and we judged these to be the most significant. The other -- what we wanted to do was obtain input from the intervenor regarding how we had dispositioned his comments and then we would -- having taken his input into consideration, we would disposition his response to us in a Phase 2 report and at that moment we would also address the remaining 26 concerns. That's what we had discussed with the intervenor back in July and we had, in our view, an agreement on that path forward. That was the basis for the two-phase approach.

So when we started off the project for Phase 1, we needed to form an expert team. This team was made up of severe accident analysis experts from each and every one of the Canadian utility licensees. We also got an expert from SNC-Candu Energy, who is the OEM for CANDU Technology, and we got an expert from Canadian Nuclear Labs, and CNL had done the majority of the analytical work, the experimental work underlying our understanding of accident analysis. So we felt we had a very solid team from both an operational perspective as well as an analytical perspective and an experimental perspective.

Each of the team members followed their own respective organization's QA processes for assuring the accuracy of technical information. We did not produce any new analysis in this report. Rather, what we did was we compiled what we already had. If we identified there was a gap and we needed to do new work, then we would have identified that in the disposition. But in the report itself it was a compendium of work that had already been done and then this report was reviewed by all the members of the expert team so it had a very detailed review.

Finally, we exposed the Phase 1 report to an independent -- to review by an independent international expert and we went to Dr. Robert Henry for several reasons. First of all, we viewed him as being truly independent because he is outside the Canadian industry. Dr. Henry is based in the United States and although he has done some work in his prolific career relating to CANDU and has some understanding of CANDU, he is not a key member of the CANDU industry, so he is truly independent. We also selected him on the basis of his credentials. He is a co-founder of Fauske & Associates, which is recognized worldwide for phenomenological modelling of nuclear accidents. He personally contributed significantly to the development of the MAAP code which is central to a lot of the discussions that we are having here today and he is considered a world expert on two-phase flow and blowdown behaviours. Now, these phenomena, two-phase flow and blowdown are central to the entire discussion around relief valves and their adequacy under the severe accident conditions that are postulated. So we felt that he was eminently qualified to pass judgment on all of these technical issues.

We asked him in the review to do three things, to answer three questions.

Question number one was: Does the report adequately disposition the technical issues that have been raised by the intervenor? And to that he answered affirmatively.

Question number two was: Do the statements made in the report make sense from an engineering perspective? And to that he also answered affirmatively.

And the third question that we asked him to answer was: Are there any specific points in the report that in his opinion need to be further clarified or better supported? And to that he provided some suggestions and guidance regarding how we could better support some of the arguments in the report, but none of these suggestions invalidated the conclusions of the report.

Now, as part of the process, a central focus was to give the intervenor an opportunity to provide detailed comments on our dispositions, detailed comments in writing. So at the outset we invited him in July of 2015 -- just one month after we started the project, we invited him to a meeting at COG where he could present his views. We were not there to debate his views. Rather, the expert team was there to listen to him firsthand, make sure they understood his concerns and then ask him questions of clarification. We wanted to make sure we answered the right questions. Then in late November-early December, we forwarded the draft Phase 1 report to him and asked him for his comments in writing. He got back to us in February to advise us that he would not be providing comments until he saw the final report which addressed all 34 of his comments. Now, that was a bit disappointing to us because we had established this two-phase process to give us an opportunity to get his comments and disposition them for the final report. We proceeded to do the Phase 2 report and we finished that Phase 2 report and transmitted it to him in October. In January of this year he provided us comments on the entire report. His comments were largely providing more details regarding the initial comments that he raised. We reviewed them to see if there was any need for additional disposition and we concluded that the report as it stood was adequate in addressing the additional details that he provided us. He did provide some additional comments beyond the scope of the 34 concerns that he had additionally raised and the licensees dispositioned those individually and they would be prepared to respond to those themselves, but they were not part of the COG report process because they were not part of the original scope.

Similarly, whenever we transmitted a document to Dr. Nijhawan, we also transmitted it to the CNSC so they were kept apprised of the work that we had done. In May of 2016 we did receive comments from the CNSC on the Draft Phase 1 report and we reviewed and dispositioned these comments and reflected the dispositions in the Phase 2 report. We also transmitted the final Phase 1-Phase 2 report in October and we received comments from the CNSC in January. You have heard the summary of the CNSC's comments. There are some low-significance items that we are continuing to follow up that industry is continuing to follow up and discuss with the CNSC.

So, in conclusion, COG is very much a technical organization. I am not here to advocate, but rather to inform you of the technical process that we followed. The process included a review -- it included input by a group of experts from the utilities, SNC, the OEM and CNL, a broad spectrum of views from the Canadian industry and an independent review from the international community. The process provided multiple opportunities for the intervenor to provide input, as well as the CNSC, and any written comments that we did receive we reviewed carefully. The ones from the intervenor did not introduce any new information that would change the conclusions of the COG report and the COG project team is continuing to follow up with the CNSC on the remaining comments that they had, which, as the CNSC has characterized, are of low significance.

Thank you very much for this opportunity. That's the end of my presentation.

THE PRESIDENT: Thank you.

MR. DERMARKAR: Oh, and if I may add.

With respect to Dr. Henry's availability, he is travelling today and he has told us that he will be available at 11:30. He might be available sooner, but he will certainly be available at 11:30 and we have made arrangements for him to call in should you want to question him directly. Thank you very much.

THE PRESIDENT: Thank you.

CMD 17-M14.2

Oral presentation by

Ontario Power Generation, Énergie NB Power,

and Bruce Power

THE PRESIDENT: I would like to turn the floor to the representatives from the industry for their presentation, as outlined in CMD 17-M14.2. The industry is represented by OPG, Bruce Power, NB Power.

Before beginning the presentation, I understand that we also have a representative for Point Lepreau available by teleconference.

Point Lepreau, can you hear us?

MS PRIME: Yes, we can.

THE PRESIDENT: Okay. Thank you.

I understand that Mr. Saunders will make the presentation. The floor is yours.

MR. SAUNDERS: Good morning. Frank Saunders for the record.

So the purpose of this presentation is really just to show the systematic approach. We have talked about a lot of components, a lot of bits and pieces in this discussion. However, all these pieces go together as an integrated whole within the system and the purpose of this presentation is really just to give you a view of that.

I'm not going to go through each slide here, I'm only going to touch on three or four of them, but of course we are open to questions should you wish to have them later.

So I think the first bit just to have a look at here is how the reactor is designed, what the requirements are. The safety requirements on the reactor are set out in the Siting Guide and it is basically based on the impact on the public. So the reactors are designed to -- I'm on Slide 4, sorry, if you are having trouble following me -- designed to go through a dual accident. So that's a serious process failure which could damage fuel and a special safety system failure that could impact the public beyond certain limits. And that's the basis of design.

The design itself is controlled -- and I'm on Slide 5 -- that design is approved in the licensing process. It is controlled. Any changes to that design that would impact the safety case or the safety basis requires CNSC concurrence, and in fact if we made a change that was going to change the design basis in a negative direction, it would in fact require Commission concurrence because it would be a change in the licensing basis of a plant.

So I'm going to flip down now to the heat transport system. It will take me a second to get there.

So this is a schematic. Hopefully you can see it half decent. It's not too bad. My cursor will show up, will it? There we go.

So I just want to do this as sort of a spatial thing to start with. A heat transfer is a large system. It's an open system. The piping design of the heat transport system is open. There are no valves or no components in the system that could potentially fail and block flow. That's an intentional design of the system.

Again, on slide 15 you can see here -- I keep losing the cursor -- these are the steam generators. Over here are the primary pumps. Top of containment you can -- I'm having a little trouble seeing the drawing itself. The headers are just -- the heat transfer headers are just underneath here, the reactor component itself of course and -- okay. This vessel right here in this area, these three vessels are inventory control and pressure control on the heat transport system, and one of the questions raised by the intervenors was the location of this system relative to the top of the steam generators and we will talk more about that. This is the pressurizer here. A pressurizer is a big kettle. Essentially it has heaters in the bottom. Fine pressure control is created by the pressurizer. Normal pressure control is through the feed and bleed system which sits just beside it. So that's pumps and valves that can maintain the inventory, maintain the pressure. The pressurizer itself heats up water, creates a steam space above it, and that steam space is fine pressure control.

The design of this system is such that a failure of a pressure tube is considered an anticipated operating occurrence and what that means to the design is that normal process systems have to be able to handle a pressure tube failure without requiring special safety system interaction. So the makeup system to the heat transport system provides enough water that even in a pressure tube failure the emergency core injection system will not need to work. And we have had a few examples where that has actually been true and it does work. It's an important concept.

This next slide on 16 just provides you a depiction of this without the spatial layout. You see essentially on this system, these are the four heat transport pumps on the corners here, top and bottom. You have two inlet headers, one outlet header. The two inlet headers actually provide equalization between the inner core channels and the outer core channels. That's why they are there. You see again the pressurizer on the bottom. That pressurizer feeds directly into one of those inlet headers and maintains that pressure control. The total volume of the heat transport system, as I mentioned, is 300 megagrams, or 300 cubic metres. The total volume of the pressurizer is less than 30 or less than 10 percent. It is usually about half full of water and the other half is steam, sometimes it's more water. So about 5 percent of that steam inventory in there is one of the discussions around what happens if that should collapse when you have no makeup capability. And that has been tested many times and it still prevents -- still provides for fuel cooling. I'm sure we will have more discussion on it, but I just wanted to show you how it sits in the system.

The steam generators of course are shown down here. Steam generators are the heat sinks. The reactor produces the heat. Water flows through the steam generators through a vertical U tube. That's where the water gets cooled down and then it flows back through the reactor again. So the heat sink, the reactor -- or, sorry, the heat source is the reactor, the heat sink is the steam generators. That's in normal operation and in shutdown mode. The steam generators with no pumps running will thermal siphon and keep the fuel cool. One of the safety cases provides that even under a loss of power, as long as you keep the steam generators full, they will continue to cool the reactor and keep the -- protect the fuel. And even with the collapse of the steam space, that continues to be true.

So a little bit on the ECI system. This is the emergency core injection system. We talked about this a little bit on that valve failure that we talked about earlier this morning. The emergency core injection system provides water makeup to the reactor in the case if all else fails. If there is no inventory control and so forth, then the ECI will inject. The ECI has a fast response. You will see here initially these four tanks are full of water and these tanks up here are nitrogen tanks. So nitrogen pressure, that's maintained all the time, it doesn't require a pump to start. These tanks will flow into the system as soon as the pressure drops to a certain point. Each one of these tanks contains several times the shrinkage in the heat transport system from hot to cold. So in a system like heat transport, the water is of course less dense when it's hot. When it cools you have to provide makeup because the water shrinks. If there was no way of doing that through the normal process systems, these tanks have more than enough water in to do it. So they have several times the volume necessary to do that. They are intended of course to flow through the reactor.

That was kind of the main point I wanted to make with the ECI system. Of course pumps will kick in later, and a recirculation system for long-term cooling also exists.

So the question then is the one other thing I wanted to touch on, is what did we change after Fukushima?

Slipping down to Slide 21, this is a discussion of the things that we undertook as a result of the Fukushima accident in our review. It's important to note a couple of things. Many of these things are actually done and operational now. So we added a whole new layer of water from emergency mitigating equipment, so portable equipment that can be brought in should the plant be completely inoperable, as was the case in Fukushima.

We began with the ability to add water to the pool and to the steam generators. The steam generators, as I mentioned earlier, or heat sink, so keeping them full of water provides a heat sink for the reactor, keeps the fuel cool even if there is no power, it doesn't matter. So that system is in place. We have added quick connect so you can do this very quickly. Those mods have all been made. We also created severe accident management kits so that we can add makeup to the heat transport system via this method, to the moderator system via this method and to the shield tank via this method. We are currently installing quick connects to this as well. So Unit 5 outage is on right now as establishing quick connects to the heat transport, moderator and shield tank for additional makeup capability from the EME. We can do it now with a kit. It takes a little bit longer to do it with a kit so that we will now have quick connects there that can actually make a very fast hookup. The other work that is underway at the moment is extra relief capacity on the shield tank to make sure that the shield tank stays intact even in a severe accident, so that the calandria and shield tank are together. Those installations will be completed during subsequent outages and that will actually complete all of the Fukushima mods as we move through the next couple of years.

And I think that's pretty much it. The conclusion is I think -- you know, we are certainly open to questions on any of those slides, but the conclusion is that as a result of Fukushima, we basically added a whole new layer of protection in terms of our ability to maintain heat transport system inventory to cool the fuel and even in the case of the heat transport system being damaged because of hot fuel, we have the capability now to continue to add water to the moderator and to the shield tank, which will continue to cool the fuel. So the Fukushima results have added a very significant piece of capability to our reactors. I will conclude with that.

THE PRESIDENT: Thank you.

I would like to ask Dr. Nijhawan. Would you like to make your presentation now or after a 10-minute break?

DR. NIJHAWAN: Whatever is convenient to you. Perhaps people would like a 10-minute break and be more receptive to my ideas at that time. So why don't you break.

THE PRESIDENT: Okay. Sounds good. Thank you. So we will reconvene in about 10 minutes. Thank you.

--- Upon recessing at 10:56 a.m. /
Suspension à 10 h 56

--- Upon resuming at 11:10 a.m. /
Reprise à 11 h 10

THE PRESIDENT: We're back, and we'd now like to turn the floor to Dr. Nijhawan for his presentation as outlined in CMD 17-M14.3.

And Dr. Nijhawan, I must tell you that your 34 questions caused a lot of attention in many, many places, so we are looking forward to your intervention. Please proceed.

CMD 17-M14.3

Oral presentation by Sunil Nijhawan

DR. NIJHAWAN: I am thankful, Dr. Binder, for the time you have afforded me, and I'm happy to be talking to you today on the very important subject of severe accident mitigation.

This is a very special day as we celebrate International Women's Day, and I'd be remiss if I didn't salute all the women present and women who have made such important contributions to the industry and having recognized for the service in all positions, all the way from chief engineer of AECL to a number of VP positions as engineers, researchers, scientists.

And as the father of multiple daughters, I'm very cognizant of the contribution of women and my duty to their future and the future and safety of my grandchildren.

As an engineer, I'm bound by the oath I took to safeguard public safety foremost of all. It is in this spirit, and this spirit alone, that I broke rank from my peers and used my 30 years of experience as a person specializing in CANDU severe accidents to point out the opportunity that we have in the planned refurbishment of CANDU reactors to rejuvenate this 40-50 year old design and reduce the risks to public.

A lot of money's at stake. The refurbishment will cost more than the GDP of each of the lowest 75 countries of the world or the combined GDP of the lowest 23 countries or so. A lot of private interests are involved, as are the interests of the companies and regulators who have known nothing else but the technology they have been making a living on, and swear by it.

I made a number of suggestions for improving the risk profiles for operating reactors against severe accidents, and with five reactor years lost in 15,000 reactor years of operation, this is not a hypothetical accident any more.

I must also tell you that I've no continued interest in arguments with CNSC, COG, or the Canadian nuclear industry, and I know that it's not in mine, but it's in your interest that you pay attention to what I have to say.

It's really easy for you to poop on what I have to say, but in my belief, after what I've seen happening in Ukraine and Japan, Canada's surviving will depend on your ignoring or accepting or seriously considering what I have to say and what I've said in the submissions to you.

I understood for many years that none of the operating Canadian power reactors, not one of them, designed 40-50 years ago, could be built in any jurisdiction today because most regulatory bodies all over the world, including ours, are responsive, accountable, law-abiding, rule-based, and they use relatively robust regulatory processes. And they actually see from the experience of companies and locations where decisions are made otherwise. Then it costs us hundreds of billions of dollars indirectly in costs and the loss of hundreds of square kilometres of land.

We in Canada, in spite of what flag we wave in the spirit of technology, cannot afford to ameliorate an appetite for the Fukushima-like accident near Highway 1, 21, or 41.

I worked in Darlington since 1984, and I'll take that as an example in my discussions today. I know Darlington did not consider severe accidents in the design process, so when I look at Darlington, I know it's unreasonable for me to expect (indiscernible) accident mitigation.

I see -- and I'm going to talk about 15, 16 different things here, then I'm going to talk about what do I see if a station blackout occurred, and then we're going to talk about the 34 issues I've raised.

I say that, in Darlington, a number of critical equipments like boilers, pumps, (indiscernible) outside the containment. The (indiscernible) protection in all relevant reactor systems are inadequate. But even the baseline load (indiscernible) the heat transfer system, the

Calandria, the shield tank and the low lying pressurizer in case of a station blackout scenario and in case of (indiscernible) all the water from above the headers from actually -- from inside the boiler tubes and (indiscernible) ineffective after that.

The design process (indiscernible) of reactor pressure boundary (indiscernible). There are no provisions for direct manual depressurization of the heat transfer (indiscernible) station blackout (indiscernible). There is no high pressure makeup or intervention. There is no high pressure emergency water injection into the boilers. The moderate expulsion upon boiling and rupture (indiscernible) accelerate the core damage by 30 to 60 minutes just because (indiscernible) did not put adequate relief valve for (indiscernible).

The Darlington containment is one of the weakest in the world for pressurization at about .5 to .9 atmospheric pressure, and severe accident will cause pressurization.

So this particular containment, it's (indiscernible) because it will receive all the activity and combustible gases directly right after they are created because there is no (indiscernible) reactors.

There are very high sources of hydrogen or what we call hydrogen -- deuterium -- from very large (indiscernible) carbon steel (indiscernible). The currently planned parts are inadequate. They have been designed only for design basis accident. Even then, for design basis accident, they've been watered down, and they're potentially dangerous. The reactivity device (indiscernible) containment bypass.

There is a huge potential for Calandria vessel failure because it's only 19-20 mm thick and it has two annular plates welded at right angles to the main tanks. It is -- really, it's an analysis we had commissioned at a very large cost and an analysis done within -- within CANDU energy which -- as mentioned by Dr. (indiscernible) at one of the meetings at CNSC that I attended, they cannot take the (indiscernible).

The current shield tank cannot contain pressure upon boiling and can fail, and the restoration of cooling in the shield tank currently is problematic because the flow outlet is in the top of the vessel, so if the water depletes a little bit, they cannot restore cooling.

There's not sufficient instrumentation and control for severe accident management. There is relatively poor survivability of equipment in the containment because the containment receives all the energy created inside the heat transport system.

The reactor building is relatively small, and will trap hydrogen or deuterium. There are very few simulated accidents. The methods that they use at Darlington reactors for severe accident simulation is outdated, crude and inadequate. And some things have been done.

They've brought in some very shiny pumper truck and put in containment venting, and they're talking about a shield tank pressure relief system (indiscernible). There are a lot of paper trails, but nothing meaningful has been done.

The very first point that I raised in my report related to the emergency (indiscernible). Emergency (indiscernible) are the ones whose loss will lead to a station blackout. And when (indiscernible) building closest to the lake at Darlington, it's housed in the building between the steel buildings unable to survive earthquake or flooding.

So if I were to look at this reactor and based on the computer codes that I use now and the computer codes I created in the past and (indiscernible) industry uses, I see this. In a station blackout scenario, the boilers are guaranteed heat shield for no more than about one hour. Not five hours; one hour. Not really a lot of time.

(indiscernible) in the future (indiscernible) about two hours and (indiscernible) replenished the water, the pressurizer will swallow a lot of heat (indiscernible) water and not (indiscernible). The heat transport system periodically pressurized (indiscernible) and no water (indiscernible) boilers will work. And as the fuel leaks out, the fission product release rate is very high.

The release rate of fission product -- and we all talk about Cesium-137 as the gold standard -- it's about one percent per minute at 15°C, so in three or four or five hours, a large amount of fission products from any channel which has overheated -- and they don't all overheat at the same time -- will be out in the containment. And (indiscernible).

And you might (indiscernible) one unit. We're looking at contamination of all units. And look at the containment.

Containment has a design pressure less than one atmosphere. It is designed leakage rate, not under severe accident loads. It's designed leakage rate at 48 percent mass per day, which is 480 times more than that for a PWR containment or any modern containment, perhaps 1,000 times more, so (indiscernible) will be very high.

The deuterium production from 12 kilometres of feeders made from carbon steel is a very low chromium content which, for Bruce and Darlington, on the order of 0.08 percent. The deuterium production from these feeders will match or exceed, depending upon the accident, from that from (indiscernible) within two channels (indiscernible) will be trapped inside the reactor walls or the reactor building. And the number of (indiscernible) which you have put in there will cause explosions, if nothing else.

We designed them for 65 kilograms of hydrogen, not for 3,000 kilograms of deuterium that we expect after severe core damage. The accident management is difficult.

The tabletop SAMG exercises are a joke, in my opinion -- I'm sorry. I promised myself I would not use words like that.

There are -- the codes that are used to develop the basis for the SAMG are obsolete, and the ruling assumptions, for example, are the ones about five hours available for the boilers, are meaningless.

So I see that, in this reactor, there will be significant off-site consequences. There will be early fatalities there will be (indiscernible) evacuations. Millions will be affected, billions in damage. And the best part is a large number of these things can be fixed. We can fix them if there's a will to fix them.

If we go out and say, well, nobody told me to do anything, then you can live with what you've got and walk away from it. But I'm telling you we have a reactor which is one of the weakest in mitigation capabilities for severe accidents.

Oh, I must say, before I go into my conclusions and talk about (indiscernible) when I --

THE PRESIDENT: Dr. Nijhawan, you're breaking up on us. I don't know if you're using hands-free, but if you can -- see if you can get closer to the speaker because you're breaking --

DR. NIJHAWAN: I am -- I am using -- my daughter's a lawyer. She gave me her headphones that she uses for teleconference. That's what I'm using.

Are you able to hear me now? Are you able to hear me now?

THE PRESIDENT: It's still kind of breaking up here.

DR. NIJHAWAN: I'm sorry. It's not good.

You should have told me before. I don't know what to do now.

THE PRESIDENT: Okay. Now is good.

DR. NIJHAWAN: Okay. Well, I brought my phone close to my mouth.

THE PRESIDENT: Okay. Go ahead.

DR. NIJHAWAN: So let's try that.

THE PRESIDENT: Okay.

DR. NIJHAWAN: But before I go any further, I'd like to tell you that I'm very thankful to Dr. Luxat for his kind words about my technical competence and for Mr. Leeds for his welcome relevancy of my repeated interventions. And I'm (indiscernible) expertise in helping avoiding serious accidents in any -- severe accidents in US-designed reactors. It's all well known, as is Mr. Luxat for his independence of views and humble disposition, and the depth of his knowledge in all things nuclear.

I specialize only in one field, and that is severe accidents. I have designed (indiscernible) matters not only for the CANDU reactors in Canada, but also for other (indiscernible) pre-exists for (indiscernible) machines, for (indiscernible) research reactors.

Based on what I know, my conclusion is

that Darlington reactors pose more risk than we thought earlier. Refurbishment was a good time to put in design enhancement and suggested that we should look at all the accident hazards and design enhancement individually.

Don't talk about this cockamamie combined -- what was it called -- COG used a very interesting word. It'll come to me in a minute.

I say that we look at the accident hazards and design enhancements individually, and so I proposed the 34 things.

The very first one -- and you can look at the list as I talk about them because your translation of some of my 34 points as being non-technical is totally wrong. They're all technical.

And your choice of four points out of the 34 is good, but it isn't exactly the top 10. They don't really make the top 8 list.

The first one was to move the -- reduce the probability of a station blackout, move the emergency diesels and backup diesels into a seismically more secure building at a higher ground as you did for your new EPS.

The current structures are weak. They're built in only to the national building standards, the national building code, and the location is inappropriate.

They're right -- the first building (indiscernible) because of the flooding potential. Then the buildings, which are industrial buildings, cannot survive in an earthquake. First point.

Second, put in steam turbine driven auxiliary feed water pumps so that you don't need to depressurize the boilers and jeopardize the heat transport system integrity. The shock of depressurization can cause boiler tube failures and containment bypass.   Not only that, you lose 40 percent of your water that you're trying to replenish when you depressurize.

So my first and second point was, put in a steam turbine driven auxiliary feed water pump. Point Lepreau has already done that. Many (indiscernible).

Third was to put in means to inject water into the boilers from the dearator at high pressures from your other locations like in Bruce and Darlington for emergency boiler water systems and also at low pressure like you're going to do with your pumper truck, and examine carefully with analysis the impediments that are -- that could be there for using low pressure water in addition to these options for boilers.

Remember the Fukushima errors in emergency water injection. They put the water in the wrong place.

Fourth was to -- in Darlington, where the volume of the pressurizer is 65 cubic metres, same as the volume of water in the boiler tube above -- above the plate, move the pressurizer to a higher location or power the pressurizer in a way you can close the system after a station blackout scenario (indiscernible) to expel the water back in the pressurizer using alternate means not related to normal power systems that may have failed.

Number 5, replace the inappropriately-sized BCRVs to remove the (indiscernible) and steam. It is understood that (indiscernible) years and I have so many papers in front of me that tell me that you have not done a good job. And people who have been asked to review it today in 2017 were the same people who reviewed it inappropriately in 2001.

The testing which was done, and I'm reading from -- and I'll come back to the reading of this document -- has been inappropriate and the extrapolation of data has been absolutely inappropriate.

So number 5 was to replace the BCRVs so that you never pressurize to fail.

One of the positions the industry is now (indiscernible) a pressure tube. A pressure tube failure is a billion-dollar accident. We don't want that to happen. But somebody has dug in their heels in order to do it.

Number 5(sic), do not crash cool the boilers to add water to them (indiscernible) SAMG, but prefer to use high pressure water pumps in the current emergency boiler water storage system.

Forget pumper trucks as the first EME, and don't use them as a first EME because, otherwise, you lose 40 percent of your water.

Number 7, improve on your containment. Improve on (indiscernible) containment which is ridiculously leaky, ridiculously low pressure retentive --

THE PRESIDENT: Excuse me, Dr. Nijhawan.

DR. NIJHAWAN: Yes.

THE PRESIDENT: You're not going through the 34 issue one by one?

DR. NIJHAWAN: I am. Only the headings. Five more minutes.

THE PRESIDENT: Look, we've gone through this. The whole idea here, we're trying to follow here so we get some question period.

We are fully aware of the question you posed, and what we want to do now --

DR. NIJHAWAN: No. I tell you, sir, is that you're not fully aware of the questions posed because the translation of the questions has been poor. I have had no contacts --

THE PRESIDENT: Why didn't you reply to the COG report and the CNSC report and give us --

DR. NIJHAWAN: Let's do that. We could do that.

We could do that, but I think it would serve the common good, so if I was able to quickly just describe what the 34 were, not how they were interpreted --

THE PRESIDENT: Look, we want to have a conversation, not a one-way conversation. We want to have a dialogue amongst all the parties, so I'm not suggesting that you go through all 34.

If you want to summarize the highlights of what you want to tell us, please proceed to do that.

DR. NIJHAWAN: I will be happy to do that, sir. Thank you.

THE PRESIDENT: Okay.

DR. NIJHAWAN: I also -- I understand you, sir. That's fine. That's fine.

Let's look at the four issues that we were talking about.

The very first issue was the BCRVs. I'll read you a -- read you -- I'll give you two pieces of information.

The one is, BCRVs, for example, at Pickering are designed to give 40 grams of steam relief. They have been tested to relieve 40 grams of steam.

In order to justify 10,000 grams of steam relief through these valves, or more, what some analysts did was to take an area of relief which is significantly higher than physically possible, built to a cross-sectional area of the pipe rather than the opening area of the -- of (indiscernible) valve.

This is documented in the report which is in front of me, which is -- for Pickering is MK30DRT3330-00017.

I also would suggest to you that nobody, not the company that CNSC hired or anybody else, has talked about the numerical value of the release from these valves which testing was done in contravention of the CNSC -- I'm sorry, in contravention of the ASME requirements, and I read from MK30DRT33323-005 page, which says:

> "ASME Section III requires that relief valves be capacity tested at national Board authorized lab." (As read)

Since no national Board authorized test facility was available to test these valves, the CNSC agreed it was acceptable to do two sets of capacity tests at two independent non-authorized labs. The manufacturer, (indiscernible), performed one test, and the other test lab was Wylie.

The manufacturer does not have any facilities to test the valve under actual hot plant conditions, so there is nothing coming from the manufacturer on this.

The manufacturer warned us that the data on opening they have provided us, which is (indiscernible) release valve is based on air testing that was not applicable to skin tests.

The people who did the calculation not only used the wrong area here, they also used the wrong opening when they did use an opening, and the openings are for steam.

THE PRESIDENT: Okay.

DR. NIJHAWAN: The point here is that by using wrong numbers, by extrapolating 40 grams to 10,000 grams, something was removed. And if you did use a model, it should be able to reproduce your 40 grams at the other end. It never happened. So BCRV is an issue.

You are very welcome to close, and you are welcome to close all 34 issues. I will walk away from it.

The country will lose out, the industry will lose out, the company will lose out, as TEPCO did, as Japan did, as Ukraine did.

This is the -- the response to this is highly irresponsible and it's based either on people not knowing what they're talking about or using data which is totally wrong and not following the recommendation of ASME, not following the recommendations of --

THE PRESIDENT: Listen, okay. Thank you for that --

DR. NIJHAWAN: (indiscernible) steam. I don't know how much to do. But I do know that from Wylie, left in steam was one, left in air was three, left in water was five. So don't use five. But they did. And, therefore, the numbers can be as rosy as you want.

THE PRESIDENT: Okay. Can you -- can you -- excuse me.

DR. NIJHAWAN: Therefore, the industry (indiscernible) it's been totally mishandled by some very, very misinformed people.

THE PRESIDENT: Okay, listen. Excuse me. Excuse me, can you allow us --

DR. NIJHAWAN: This is no different from hydrogen/deuterium nonsense.

THE PRESIDENT: Excuse me.

DR. NIJHAWAN: Absolute nonsense in terms of dynamically they are very different from each other --

THE PRESIDENT: Are you going to let us --

DR. NIJHAWAN: -- in capacity they are different because they are different types of conductivities and they recombine differently. There are at least 39 papers in my office right now which show that the processes which follow which allow -- combinations are different for these two.

THE PRESIDENT: Dr. Nijhawan...?

DR. NIJHAWAN: It's a question between atoms of hydrogen and deuterium. On copper surfaces it's five times different at the temperature you're talking about.

THE PRESIDENT: Dr. Nijhawan...?

DR. NIJHAWAN: It's a basic fusion equation. The expectation of deuterium in combination will be at least 40 percent less.

THE PRESIDENT: Dr. Nijhawan...?

DR. NIJHAWAN: The number of recombiners is --

THE PRESIDENT: Dr. Nijhawan...?

DR. NIJHAWAN: -- the number of recombiners that been assigned inside our containments for deuterium or actually --

THE PRESIDENT: Dr. Nijhawan, are you going to allow for a discussion to occur or are you going to talk to yourself?

DR. NIJHAWAN: Yes.

THE PRESIDENT: Okay. This is not going to work --

DR. NIJHAWAN: The combiners creates explosions at high hydrogen concentrations --

THE PRESIDENT: Can you let me --

DR. NIJHAWAN: -- if you have enough of them --

THE PRESIDENT: -- hello?

DR. NIJHAWAN: -- become high. If not positioned properly, hydrogen will cause ingestion to become high. Actually, in our reactors the hydrogen concentration of reactor walls such as in Darlington will be high (indiscernible) started creating their hydrogen and everything out.

So these recombiners will create explosions. Have zero Lithium recombiners. It will be better than the recombiners you have in four units at Pickering. The number of recombiners is wrong. The type of recombiners is wrong. There are new recombiners in Germany now which limits the temperature in the recombiners so you have an inadequate number that have been put in with -- as the temperatures are not such that there is an explosion.

THE PRESIDENT: Dr. Nijhawan...?

DR. NIJHAWAN: The recombiners even -- even in Chalk River --

THE PRESIDENT: Dr. Nijhawan...?

DR. NIJHAWAN: **--** and in Japan and other places. And I would be very happy to talk about these with you.

THE PRESIDENT: Dr. Nijhawan...? Dr. Nijhawan...?

DR. NIJHAWAN: And these are the two main issues which there has been --

THE PRESIDENT: Dr. Nijhawan...? Dr. Nijhawan...?

DR. NIJHAWAN: **--** the third discussion is about the computer code. Of course you've got --

MR. LEBLANC: Let's put him on mute.

THE PRESIDENT: Dr. Nijhawan...? Dr.

Nijhawan...?

DR. NIJHAWAN: -- codes that we worked on -- yes, sir.

THE PRESIDENT: This is unacceptable behaviour on your part. You are talking and you do not allow a reaction here, and you totally ignore me for -- now for 10 minutes.

DR. NIJHAWAN: I'm sorry. I didn't ignore you. I'm sorry. There is a problem in your communication because I took off my headset.

THE PRESIDENT: Okay, so listen --

DR. NIJHAWAN: I'm sorry. This is not my intention.

THE PRESIDENT: -- this --

DR. NIJHAWAN: No, no, no.

THE PRESIDENT: Okay. Can we --

DR. NIJHAWAN: No, no. This is a --

THE PRESIDENT: Can we have a conversation?

DR. NIJHAWAN: I can hear you now, yeah.

THE PRESIDENT: Okay. Can we have a conversation now?

DR. NIJHAWAN: Yeah, I didn't -- I didn't hear you. I thought the second part -- I took off my headset so I can read from these papers over here.

Go ahead, sir.

THE PRESIDENT: Okay. You have raised many of those. You just went through a rant about those four issues that were discussed.

DR. NIJHAWAN: Only about two, only about two.

THE PRESIDENT: Okay. Let's deal with those two. The first one you dealt with was the BCRV --

DR. NIJHAWAN: Yes, sir.

THE PRESIDENT: -- that you didn't like the assessment by CNSC. I would like -- this has been done -- as far as I was concerned this file was closed. I will give the industry and staff one more kick at this can before we decide what we are going to do with this.

DR. NIJHAWAN: Sure, sir.

THE PRESIDENT: Who wants to go first? CNSC..?

MR. FRAPPIER: Gerry Frappier, for the record.

Yes, as you mentioned this has gone through this many times. Dr. Nijhawan believes that the ASME code was not put in place or was not followed appropriately. You may recall a couple of years ago we went to the -- as we mentioned in our report here, we went to the ASME standard committee which is responsible for that standard and they provided their learned interpretation that matches our interpretation. We do believe the valves have been adequately sized for the purpose.

But I would open it to friends from COG or perhaps a person that you have not heard from in the past which is Dr. Henry who is absolutely a world expert on this sort of thing.

THE PRESIDENT: Industry, you want to add?

MR. DERMARKAR: I believe Dr. Henry -- it's Fred Dermarkar, for the record -- I believe Dr. Henry is online. Can we get a confirmation of that?

THE PRESIDENT: Dr. Henry, can you...?

DR. HENRY: I am online. Can you hear me?

THE PRESIDENT: Yes, please. Can you comment about this particular issue?

DR. HENRY: I'll give a very short one on the developments on many things all related to phased compressible flow.

Their staff certainly knows what they are doing. They know how to run experiments. We have looked at the experiments that they have run. I wasn't personally involved in the CANDU experiments, but I have seen the data and I did my own sidebar calculations and I get basically what you would expect to get by -- as a CNSC person said, using the correct interpretation of the ASME code and also the way all organizations throughout the world that I know of have used the compressible flow behaviour.

So I certainly don't agree with Dr. Nijhawan and --

DR. NIJHAWAN: I don't (indiscernible)

THE PRESIDENT: The second issue that --

DR. HENRY: -- comments very short.

THE PRESIDENT: Sorry, I missed that last comment.

DR. HENRY: Just that I would keep my comments very short. That's it.

THE PRESIDENT: Okay. The second issue that Dr. Nijhawan just raised was the hydrogen/deuterium. Can somebody tackle that particular issue?

MR. FRAPPIER: Gerry Frappier for the record. I'll start off and I'm sure other people might have comments.

But again, this is not a new concern that's been expressed by Dr. Nijhawan. We have done both experimental and analytical work. I think that as you see in the presentations earlier and in the analysis that has been done, while there certainly is -- we understand that there is atomic differences between deuterium and hydrogen, they are -- the effect of them with respect to the problem that we're looking at are overwhelmed by things like thermal hydraulic considerations as opposed to diffusion.

And I'm not going to pretend to be an expert in that but I have read a lot about what the experts have done on this.

And perhaps I'll turn it over -- I'm not sure -- to Dr. Luxat or Carlos -- either OPG or Dr. Luxat.

MR. LORENCEZ: Carlos Lorencez for the record, Ontario Power Generation.

We have conducted as part of our R&D with COG lots of experiments regarding the behaviour of hydrogen and deuterium with PARs. We have a lot -- we have conducted a smaller scale -- large-scale test in Canadian nuclear lab and we haven't found any significant difference in performance for PARs whether you used deuterium or hydrogen. So for us the issue is non-existent and closed.

DR. NIJHAWAN: Lovely.

THE PRESIDENT: Okay. Dr. Luxat?

DR. LUXAT: Dr. Luxat, for the record.

I just want to reinforce the fact that

having gone through many, many different technical sources, general papers, textbooks and facts, there has been essentially no change in the thermal chemical dynamics or parameters relating to deuterium and hydrogen. This is very important because the -- in terms of production, as I said earlier, the oxygen potential is the governing factor and that is much lower in the feeders than it is in the channel and therefore will be less likely -- much less exothermic reaction, much lower kinetics.

With respect to the PARs issue, again the whole issue there is that the recombination in the catalytic reaction occurs as a surface reaction. There is no diffusion of molecules into the metal. The surface reaction is a control thing. It is a chemical reaction.

DR. NIJHAWAN: (Laughs)

DR. LUXAT: It's a chemical reaction which is controlled by the electrons and not the atomic mass. And that is consistent also with available information that was obtained from experiments going back to the 1940s at Oakridge.

And so again, there is nothing in the literature that would support Dr. Nijhawan's contentions or assertions.

THE PRESIDENT: Okay. Thank you.

I would like to move now to the two other issues. They are uncertainty in the MAAP and the vessel -- the in-vessel retention.

Dr. Nijhawan, a quick --

DR. NIJHAWAN: Sure.

THE PRESIDENT: -- a quick description of those issues.

DR. NIJHAWAN: Yes, sir.

The MAAP code was developed between 1987 and 1994 at Ontario Hydro who are the main developer of that code, irrespective of what Dr. Luxat put in his -- in his diatribe of a recommendation. He essentially wrote that my contribution was botched up. I wrote up in line with that code that every part of that code is related to CANDU, in particular a large part of the MAAP code itself which later on became MAAP-4.

I, since that time, pointed out and was engaged in 2005 to 2008 to write an input file, to correct the input file for that code. So I'm quite familiar with where that code stands today. And I know that there have been practically no improvements except keeping the code alive and sold to very eager people over here.

That computer code runs today. That with a certain number of complications and a certain number of things runs today on my computer in six minutes. It does a 24-hour simulation.

While the computer codes here developed and used now, where we have looked at other phenomena which have been missed inside of that CANDU, the new model that the Koreans use, the Chinese have used, the other countries have used and I use takes me 60 hours to run because I get significantly more detail in its analysis.

It's not that this is a bigger code. It is just a better way that we should all develop to do an analysis. And I suggested that you should do a more detailed modelling of reactor codes with different shading between bundles and different shading between channels; better modelling perhaps which is better.

That would be the first one, where 18 channels were modeled and as a result the codes had or a large number of them became hot very quickly and then as a result very severely affecting our SAMGs that we started believing that the code -- the whole code will collapse and cool down for eight hours and nothing new will happen. No new fission products will come up.

THE PRESIDENT: Okay, I'd like to --

DR. NIJHAWAN: But that's the first part.

Secondly, we said, the modelling of these two properties they use H_2O. There is no difference: modelling of D_2 production, D_2 removal, not hydrogen removal; oxidation of everything, oxidation of feeders. There are people who make knee-jerk responses.

Like Mr. Frappier said last time, the feeders will get warm. The feeder gets very hot. If it's only by doing detailed analysis you find out that low-power channels that's 50 percent of what a reactor really is, they don't really fare very easily. They stay hot for a long period of time and in those low-power channels after your fuel has oxidized the potential -- oxygen potential that Dr. Luxat so loves, is increased in feeders. And we know this creates a lot of hydrogen. We should consider better representation of efficient products -- we should do.

We should look at conquering fires. I've never seen an accident which -- that is a flood or an earthquake where there is no fire. We should look at straight action fires then.

We should look at the consequences of calandria vessels failure in wells instead of saying that calandria vessels will never fail. Calandria vessels will fail because it's a very thin vessel, only 50 percent thicker than the pot I use on my stove which is 12 metres -- 12 mm in thickness. This is 19 mm thickness thick vessel at some indications.

And look at the failure in calandria vessel penetration inside your codes. Look at the explosive interaction of water within calandria vessels. Look at deuterium and on.

Now, there are a large number of other points that I raised that the code was not something you depend upon as a singular source of inspiration but improve it --

THE PRESIDENT: Okay

DR. NIJHAWAN: -- that people have done.

THE PRESIDENT: Okay.

DR. NIJHAWAN: That was my thing about the code.

THE PRESIDENT: Okay. Let me -- let's hear some --

DR. NIJHAWAN: Of course, people who sell you that code will say it is the best in the world.

THE PRESIDENT: Can you let us hear somebody else's opinion about that?

Okay. CNSC...?

MR. FRAPPIER: Gerry Frappier, for the record.

Again, maybe I will start and somebody might want to put some additional detail.

There is always other codes. There is always mechanisms to make codes more complicated, more detailed. I think the important part here is that the MAAP-CANDU code as it's used today has evolved from when it was first started but it is fit for purpose as we've mentioned that -- and we've looked at again as we reviewed in preparation of this report.

And perhaps COG or somebody from industry would like to add too. I think there has been looked at -- different software, but MAAP-CANDU is the one that has been used for licensing purposes.

THE PRESIDENT: I was told also that Dr. Henry is an expert on this.

DR. HENRY: This is Bob Henry again. I'll keep my comments very short because codes always continue to develop. If they stop developing then they die. So we have adjustment issues as people can find issues and bring those important experiments to bear.

But one of the key experiments in my line is always there as well as the behaviour in Three Mile Island in terms of oxidation. And I see things a lot differently than Dr. Nijhawan here because the core -- the materials directly above the core -- the core support plate that's about six inches above the core didn't even completely melt. So he's saying something -- he has translated that into what's the behaviour in computer terms.

I agree totally with what John Luxat said and, from my perspective, all of this large-scale data, just like what happened on Three Mile Island, is supportive of that. We must always continue to compare to both experiments and experience and that's what help MAAP develop over the years and it continues to develop.

That's the end of my comments.

MR. DERMARKAR: Thank you, Dr. Binder. For the record, Fred Dermarkar.

I would just also like to add that all of these comments that have been made so far are all addressed in the COG report. Opportunity was provided to Dr. Nijhawan to give us comments so that we could disposition them. And what we're doing is answering questions that are already well documented.

I just wanted to make sure that you were well aware of that, that we are going through what's already written down.

THE PRESIDENT: So, Dr. Nijhawan, why didn't you -- why didn't you reply to all their conclusion of the COG report?

DR. NIJHAWAN: I expected this question. Let me tell you why. Let me tell you why.

The tone of the report was dismissive from the beginning to the end. So I took upon myself to answer one of those questions. One statement made in the COG report was that they know of no difference between hydrogen and deuterium. So I sent them 12 graphs (indiscernible) 12 graphs of differences between hydrogen and deuterium, of data that we have collected from experiments and to our correlations for -- and it's actually quite widely available.

I sent it to them. They put it in a drawer and the final report still says "we believe there is no difference between hydrogen and deuterium in its use."

There is no difference in its combustion, a small difference in its combustion; large difference in its transport properties and therefore the effect on the behaviour to the rest of the system. It'll pick up more heat. I'll pick up less heat and flow slower and flow faster. Various things that can't be excused in a dynamics test, really. So they ignored that. They actually ignored that and said, no, we know no difference.

And then I gave them information on PARs. I said PARs is being developed. What you have is for 65 kg of hydrogen in Darlington, which is a joke, I said (indiscernible) and it's dangerous. They said, no, we don't care. It will help.

No, no, no. Wait a minute. That won't help. That will hurt you because a PARs becomes a source of explosions. They said, "We don't care. We have this holistic approach."

Oh, that's the word I couldn't find in the beginning; holistic approach whereby we will not care about failing the reactor from beginning to the end, various places that could be put into intervention of high-pressure injection of mitigation but we will put in the principal containment vessel. We will put in pumper trucks and filter containment, nothing else in between.

So when I gave them the responses, they were ignored. So there is no real -- I mean I can sit and actually write you reports but you have people from the U.S. write you a 15-page report at $97,000 and people who are paid to write these reports.

I have done this for the last 10 years for free for you. And I have produced computer codes that give weight to your conferences -- your place that told you, you guys are not doing it right. Here is additional information.

So I gave it to them but they said no. I did not listen. I didn't -- so what's the -- what am I going to do? Sit down and write you answers to 34? Look at their answer. Look at my very first one I showed you. The points I raised --

THE PRESIDENT: M'hmm.

DR. NIJHAWAN: -- was not in their answers. They're telling you the answer that is not there. You get an answer about things, emergency diesel in the different locations. It isn't there.

THE PRESIDENT: Dr. Nijhawan --

DR. NIJHAWAN: The actual -- yes, sir.

THE PRESIDENT: Dr. Nijhawan, the arrangement was post-Bruce Power hearing and Darling hearing that you and COG will sit together and try to deal with all those issues one by one.

DR. NIJHAWAN: Yes, sir. I went there. They refused to talk to me. I went there and they said we'll listen to you but not talk to you.

THE PRESIDENT: Well --

DR. NIJHAWAN: I tried talking to CNSC staff and the CNSC staff told me, "Do not send me any emails" and they verbally told me that now we are not supposed to talk to you until the present CNSC commission is still there.

I was told -- your people are telling me, "Don't talk to me by email. Don't talk to me otherwise." They don't want to talk to me. They want to make their own decisions. So please go ahead. You can disposition these comments. All I say is that you're taking -- making a big mistake.

THE PRESIDENT: Okay. So --

DR. NIJHAWAN: They have -- appear weak in a large number of areas and they should be fixed.

THE PRESIDENT: Okay. We --

DR. NIJHAWAN: But they won't fix it. A lot of money at stake.

THE PRESIDENT: Okay. We heard you. We are hearing you. What are -- to be practical, you know, in the time allotted for this, what I would like to do is you take the COG report. And they bunched it into -- I'm looking at the COG report, page 16. There is a grouping of issues and responses. I think we've dealt with item number 9, the safety analysis, maybe with the exception of in-vessel retention.

But I propose to go through all those

things and I want to know if there is outstanding issues in here that still require either a further kind of an analysis or there is -- as far as staff and industry and Dr. Nijhawan agree that they are kind of -- will either agree to disagree or there is a consensus on those issues.

DR. NIJHAWAN: But Dr. -- I hear you, sir. Your intentions are very good. All I'm telling you -- and I am very happy to hear what you just said.

All I can tell you, sir, is that only about five of the 34 issues have been addressed starting with the Fukushima action items. Nothing new has been addressed because there's no will to do that.

And the people that they have assembled to give (indiscernible) they won't get back -- are not the right people. There are people in this world who are straight action and the experts. Bring them over. Let's form an independent commission and then we can sit around and analyze this.

COG is not independent. COG is not independent and the people they brought in are not experts. The people they brought from the U.S. have no idea what CANDU reactors are. They are talking about that your procedures are good. People they brought in from ASME can tell you the BCRVs are good and did not comment on the number and documents (indiscernible) in the American. They have said that Mr. Nijhawan's language was loose and that -- I pointed that to you in the previous meeting -- and that the numerical value was logic-less and I'm talking about the numerical value of BCRV.

How can something which is tested for -- by sleight of hand, 40 grams a second, by sleight of hand becomes 10,000 grams a second? It cannot. It was tested, and the law required it be tested at a specific kind of lab, which you didn't use.

And when the manufacturer told you, don't use the bigger area, you still went ahead and did it, then you went ahead and used the wrong area.

So, some junior person made a mistake and it's been carried on for 15 years. Nobody at CNSC did any -- sit down with me and look at the numbers, not one bit, they all refused to. And it's your loss, it's not mine. I walked away, and so far away that none of these reactors can affect my family anymore.

But I'm telling you that you have a big issue and the industry is not interested in doing anything and the industry hired their friends to tell you how good they are. It's up to you. I don't care.

THE PRESIDENT: Okay. Well, since it's up to us --

DR. NIJHAWAN: But I do want to go on the record to show that the issue is still open, the very first one. You haven't moved the diesel, you have not.

THE PRESIDENT: Okay. Okay, look, I --

DR. NIJHAWAN: The first one, even better off with the (indiscernible), they are not, but the (indiscernible) is open. You can go in and close it, I could care less.

THE PRESIDENT: Dr. Nijhawan --

DR. NIJHAWAN: Please note that I speak for public safety alone.

THE PRESIDENT: Dr. Nijhawan?

DR. NIJHAWAN: Yes, sir.

THE PRESIDENT: Breathe. Breathe. Let somebody else intervene here.

What we need to do here is, we are an independent Commission, we need to listen to all points of view and we'll accept that in some of those areas there may be disagreements and we'll have to decide what we're going to do about those.

What I would like --

DR. NIJHAWAN: I --

THE PRESIDENT: I would like to start going systematically through these particular issues. I want to hear on issue number 1, emergency mitigation, EME, covering nine issues. Is there anything that requires further work to be done in this particular area?

Staff, do you want to start with this? Or maybe COG, since this is your area of -- that you aggregated them.

MR. DERMARKAR: Let me just see if one of the utilities would prefer to respond to this.

Our intent was not --

THE PRESIDENT: This is page 16 of your report.

MR. DERMARKAR: We have -- it's a long report and I'm not sure exactly what the approach is because we've dispositioned every one of the items in the report.

THE PRESIDENT: I got that. I want to know -- and some of them said you still are in the process of implementing all -- some further confirmatory research needs to be done.

MR. DERMARKAR: Okay. So, in terms of the status of what the state of implementation is of the utilities, the utilities I think are best positioned to speak to that.

MR. SAUNDERS: So, Frank Saunders, for the record.

In essence, most all of the actions from Fukushima are complete. The emergency mitigating equipment is in place, has been tested and demonstrate it can be used. Make-up to the steam generators is available, ability to relieve the steam generators, even in a loss of power is available.

We have completed the Severe Accident Management Guide. So, we've completed the severe accident kits are all in place for severe accidents. We've begun drilling these things, as you've seen from our exercises.

The remaining modifications that are currently being installed are really four modifications and that will complete the Fukushima action items.

These are make-up to the heat transport system from the direct connect to the fire trucks without any kit necessary, so it's a fast connect is what it is essentially.

Heat transport system moderator and shield tank make-up. And, as I say, we're starting to install those now, they'll be done in successive outages as we go forward.

And the one other one that remains is the relief to -- additional release capacity on the shield tank, which is also -- you know, we have that design, we're working on Unit 5 right at the moment and expects to work through it.

So, we'll know after the Unit 5 outage whether we have difficulty with any of those designs, but our expectation is that they should all go forward in successive outages at this point.

THE PRESIDENT: But I'm still surprised that some of them are still not in place because I have been -- my comfort level on the safety, no matter what happened in the plant, you now have enough make-up water to shut down the plant; maybe not save it, but shut it down.

MR. SAUNDERS: Yeah, that's already in place, right.

So, design changes when you get into certain systems take a little bit of time because, as I mentioned, there's a fair amount of control on design changes to systems. Everything you do to improve a system has the possibility of actually doing the opposite, so it takes some time.

So, the first changes we made were the high priority ones, which was to get the cooling water in the steam generators. Already done, was done two years ago now. Get the EME in place so that it can be deployed and operate, have all the infrastructure to do that, test all the communications and all the pieces. So, your accident management kit which includes all the tools you might need in a severe accident to do things. That stuff is all done already, it was a first priority.

The second priority is now make-up to the heat transport system -- well, Phase 2 of the Fukushima project. All the designs are done, the implementation, the materials acquired and we're starting to put it into place. That Phase 2 took a little longer, but it's also the place where we got the most redundancy in the plant. So, you should never actually have to get there to use that stuff, you're already in a severe accident.

The first priority was the stuff that would prevent you from getting to a severe accident; the second part is to add more mitigating equipment for the severe accident.

There was actually a rather large amount of work here accomplished in a very short period of time. This was a significant undertaking in design change in a nuclear plant and I think we set records for the speed at which we are doing it. Typically we would not get design changes done anything like this kind of timeline.

THE PRESIDENT: Okay. I'm going down this list. Maybe somebody, if you would, find a way of going through it faster, feel free.

Number 2, containment integrity.

MR. FRAPPIER: Gerry Frappier, for the record.

So, I think for all of these I'd be asking Chris Harwood, who is the lead technical evaluator from the CNSC.

It is a bit of a different grouping you've put us on, that's why we're sort of walking around a little bit, but just with respect to the questions posed by Dr. Nijhawan associated with EME, there was no further action CNSC's looking at.

We are -- as Mr. Frank Saunders mentioned, part of the Fukushima action items has some things left to be looked at. They've all been completed, but industry is now upgrading those ones and we're watching that fully.

With respect to containment, I would ask Chris Harwood, please?

MR. HARWOOD: For the record, Chris Harwood.

For the containment integrity, I believe we have no outstanding issues.

I'm afraid our report grouped things slightly differently, so I'm having difficulty finding how these correspond. The issues have been grouped in various ways by various people and --

THE PRESIDENT: Well, since the Bruce and Darlington decision was for the industry to get together with Dr. Nijhawan and COG, we thought we were going to go through the COG Report, but if you have a different way of dealing with those issues, feel free.

MR. HARWOOD: THE CNSC's Assessment Report went through them by --

THE PRESIDENT: One by one.

MR. HARWOOD: -- 1 to 34.

THE PRESIDENT: Right. I was trying to save you --

MR. HARWOOD: -- areas, but that's --

MR. PRESIDENT: Okay. Let's associate --

MR. HARWOOD: On the containment integrity, I believe we have no issues outstanding.

THE PRESIDENT: Number 3, design modification for ISE?

MR. HARWOOD: Chris Harwood, for the record.

For that we have one small outstanding

issue. The Fukushima action item related to instrumentation and control asked the industry to do survivability assessments for their instrumentation for the severe accident management period. They've done that and we've closed that Fukushima action item.

We do have a slight residual concern which is for the limited amount of instrumentation that will still be needed beyond the accident management phase into the long-term recovery phase which will be months after the accident.

So, there we're asking industry to provide us with some information related to what instrumentation they will need and what concerns they will be looking at, like corrosion and how their instruments are expected to perform or whether they could be replaced.

That's new, it's outside the scope of the Fukushima action item, but it's something we will be progressing.

THE PRESIDENT: Actually, go through it quickly and if anybody has any other comment, please raise your hand.

Number 4?

MR. HARWOOD: Chris Harwood, for the record.

For pressure relief, we have no outstanding issues. We think this has been fully addressed.

DR. NIJHAWAN: Not yet, not good enough.

MR. HARWOOD: Number 5, radiation detection. We have no outstanding concerns there.

DR. NIJHAWAN: Oh, beautiful, let the public suffer.

THE PRESIDENT: I'll give you the floor, Dr. Nijhawan, when we finish this.

DR. NIJHAWAN: Fine, sir.

THE PRESIDENT: Number 6?

MR. HARWOOD: Severe Accident Management Guidelines. We have no outstanding issues at this time. We are still performing our reviews of Severe Accident Management Guidelines, so there may be issues raised. They will just be covered under our normal regulatory oversight program.

THE PRESIDENT: Number 7?

MR. HARWOOD: Number 7, reliability. We have no concerns. Security, no concerns. Safety analysis, I'm not sure.

THE PRESIDENT: Those are the four principal issues.

MR. HARWOOD: That would cover MAAP-CANDU. We've asked industry to provide us with a prioritized list of the future enhancements for MAAP-CANDU.

It says it's been mentioned before. These codes are undergoing continuous improvement. It's just a normal business in nuclear, everyone is striving for continuous improvement. So, there will be future upgrades to the code. We just want to know what the priority ranking that the industry is proposing.

THE PRESIDENT: So if I understand this correctly, as a result of Dr. Nijhawan's intervention, you did find some areas that you want to do some further confirmatory research, analysis, more information, is that correct?

MR. HARWOOD: Yes, this is true. We are looking for a bit more information on some areas as experimental work that's ongoing. We mentioned specifically the large-scale testing of PARs that's ongoing.

THE PRESIDENT: So, Dr. Nijhawan, my understanding is that Staff was not ignoring you, neither is COG, they found out some areas that further work needs to be done. It may not be the same areas that you think are high priorities, but those areas in which you raise some concerns, there'll be some further work done.

So any comments that you want to make now on that?

DR. NIJHAWAN: Yes. I'm happy that they've finally understood, sir, that hydrogen is not deuterium, and they're doing some work on that. Although, I just heard the OPG representative saying that they've already come to the conclusion that there's no difference between that, and that he likes to come to conclusions based on knee-jerk reactions rather than concerns (indiscernible) come out of it. But there are 25 other issues that absolutely no attention has been paid and nothing has been done, and this will lead to a greater chance of a loss of power (indiscernible) of the thousand instigators turning into a severe accident.

What are we trying to do was to try to arrest the accident early, (indiscernible) holistic approach that Bruce Power suddenly came up in saying, well, we'll put in water through the pumpers or we will have a (indiscernible) containment venting. Like, you're just preparing for the funeral and nothing else.

I want to talk about why don't I put in steam-driven turbines so that I don't depend on anybody, any instrumentation that's totally passive. Why don't I depend upon putting in a better valve in a calandria vessel so that it doesn't throw out its water, so an additional hour to put in water in the heat transfer system? Why you're not putting in water into the heat transfer system at high pressures instead of waiting to depressurize inside the boilers in the primary -- subsequent depressurization?

There's so many things which have merit, and they have said no. There the issue was very simple, like DCRVs, a high school student will understand easily. People have dug in their heels and said, no. So they have said that I screwed up in the beginning, I'm going to keep my position.

I must tell you, sir, that the new design of ACR fixed that problem. I must tell you, sir, that these valves are properly designed in the initial design of the reactors. They were only wrongly put in in 1997 when there was a problem with Pickering. It is that decision in 1996 or 1997 to put in wrong valves that I'm talking about.

Original designers, (indiscernible), and people of that decade did not make that mistake. The new designers like Mr. (indiscernible) who was the guy who designed the system for (indiscernible), they did not make that mistake. The new world and the new reactors are proper. Americans have valves which are 100 times more able to remove steam. We don't. There's no reason for us to have valves... There are people who come to you and say, well, I can use the wrong area, I can use the wrong equation, and still live with it. This is wrong.

Somebody screwed up, so why don't you get an independent person to sit with, and I will -- and send it to me over here in Halifax and I'll sit with them and explain to them very calmly why those positions are contrary to public interest. Why a very simple accident of loss of power, this has already happened; loss of (indiscernible) power at Darlington 1993 when there was a fire at the transformer. These things have already happened. I've already seen (indiscernible) pressurizing (indiscernible) water, I saw that in that accident from the data which is published by NRC.

So those things are available, these people refuse to do it. I couldn't care less if I don't ever see you or talk to any of these people again for the rest of my life, I'm going to retire. All I'm saying is that you are losing a very good opportunity before you're putting $10-25 billion dollars in Darlington of not creating a safer reactor for Toronto and for Ontario.

That's all.

THE PRESIDENT: Okay. Let's let industry react to this. Do you have a final word on this?

MR. DERMARKAR: It's Fred Dermarkar, for the record.

I would just like to provide some additional context regarding what work is going on. Since the Fukushima accident in March 2011 the CANDU owners group have spent around $13 million on R&D and projects just focused on severe accidents. This was driven by benchmarking that we did, learning from the Fukushima event, Fukushima action items from the CNSC, that drove us to initiate a fair bit of work. Some of that work is continuing to go on today. Some of it converges with some of the issues that Dr. Nijhawan has raised.

I also want to emphasize that we have ongoing processes that keep things alive and moving. So Dr. Henry already alluded to MAAP. Just earlier this year, we issued the MAAP Version 5 CANDU, this is the latest evolution of MAAP and it's a major release, and that was just earlier this year. That work had been going on already prior to all the issues that Dr. Nijhawan was raising, but it's represented a significant evolution in development of MAAP.

We are doing large-scale or just finish large-scale testing for hydrogen versus deuterium, but before that we had small-scale testing that we had done through the COG program.

With respect to behaviour of passive autocatalytic recombiners, we have an ongoing program to test PARs as they age, and that's already part of the COG program.

So at COG the industry invests, as I mentioned earlier, a total of about $65 million a year. We prioritize that based on those things that are most significant, most significant from a nuclear safety perspective, from an environment perspective, from a reliability perspective, and from a cost perspective. We take all those considerations into account and we prioritize the list and make sure that we're working on the most important things.

We can't work on everything all at once, so there may be some issues that are important to Dr. Nijhawan that we would have assessed and prioritized low, that's the natural part of our process.

Mostly what I wanted to do was just reinforce that there is work going on in the area of severe accidents and it is substantive work and important work, and we will be in further discussions with the CNSC to discuss some of the lower significant items that they've identified, and we'll decide whether or not we should be pulling those into the program or reach agreement that the are of sufficiently low significance that they should not disclose a higher significance item.

Thank you.

THE PRESIDENT: Dr. McEwan, do you want to ask anything?

MEMBER McEWAN: So I think I have a question for Dr. Nijhawan.

DR. NIJHAWAN: Yes, sir.

MEMBER McEWAN: I think all of us in this room have over the course of our careers relied heavily and extensively on consultant advice. When you listen to that consultant advice you tend to balance it against the expertise, the background, the data that are presented, the way in which those data are presented, and the conclusions that arise.

What I've heard you say, and certainly what I've heard you write, you are effectively saying I have seen the advice you, the Commission, have gotten from all of these consultants, and it's not helpful.

So I'd like you to help me to understand why my perception of the quality of the advice we have had is wrong. Because when I look at CVs, when I look background, when I look at expertise, when I look at publication records it seems to me that we have a balance of advice that is measured that appears to address the questions that you have asked, that appears to address the questions that the President has stated are important.

So my sense of listening to this, reading all of the documentation, listening to the conversations in the past is that we have been given good consistent reliable advice supported by data and supported by evidence.

You're saying that evidence is not valuable. Can you please help me understand why I should move in the direction of an outlier rather than follow the guidance that we've had from the expertise that we've asked to guide us?

DR. NIJHAWAN: An outlier -- as an expert, I have spent three years working with --

MEMBER McEWAN: Let me reframe that. That may be a little unkind. An outlier --

DR. NIJHAWAN: No, no, go ahead --

MEMBER McEWAN: -- an outlier in the context --

DR. NIJHAWAN: -- no, no, I don't care.

DR. McEWAN: -- of the advice that we currently have.

DR. NIJHAWAN: I would not comment on the irrelevance of the résumés of some of the people that were hired, I would not do that, I would not go into personal evaluation of other people's work. All I say is that if people had worked on CANDU severe accidents, like I have, they would listen to me, they would understand me. In private, a large number of CNSC Staff who talk to me, they say I agree with you. But there are other forces, there are other reasons.

It's up to you to take my advice. I'm here to give you my advice. You don't want to do that, I walk away. I will find other ways of making my views known. I don't intend to walk away from my concerns, I intend to walk away from this forum. It's up to you. It's up to you, whatever you want to do.

But I'm telling you that very simple information that I give you a high school student would understand. Here is a valve which is tested for 40 grams/second of steam. It is designed for 40 grams/second of steam by some very competent people. It's claimed now to one -- sorry, 10,000 grams of steam, it's just impossible.

When I tell you that PARs will work to create explosions, it is based on an equation and experimental data which are presented. The answer to that from your experts and from COG is it would never help. We are happy with doing 7 PARs into each reactor, not the 75 that you say. We are happy, because it will help. We don't want to do severe accidents (indiscernible) like containment for the venting system. We are happy to do that in a very -- you know, for...

We are happy to not put in radiation detection equipment outside --

MEMBER McEWAN: Okay, Dr. Nijhawan, can I just interrupt you?

DR. NIJHAWAN: -- happy to do that.

MEMBER McEWAN: Because again, you need to help me understand. You've raised, in the case of the valve and the PARs systems two very specific questions, the --

DR. NIJHAWAN: I will give you 24 more.

MEMBER McEWAN: No, no, hang on, hang on. I asked you to help me understand, and I can use these two as a nucleus around which I can build that understanding.

So if I take the very specific, I think you said 40 grams and 10,000 grams, through a valve. So perhaps I could ask one of our experts or COG, or Staff, to explain that numerical difference and why the safety case is maintained. That, to me, is what will help me balance the conversations I've heard.

DR. NIJHAWAN: Wonderful. Let's do that.

MR. DERMARKAR: It's Fred Dermarkar, for the record.

Since we have Dr. Henry on the line, I'd like to invite him to provide a response. I know he's done a very detailed review of this relief valve issue.

DR. HENRY: Again, I went through the table that shows the areas for the various valves of the various plants. Whether they are single valves or paired valves, et cetera, compared it to the data that's been reported in the literature, independent of Wylie, I did my own calculations with it, whether you want to do it with the Henry-Fauske model or the homogeneous equilibrium model, what you would get for the flow rates through the valves.

I get these flow rates that are in the order of magnitude of 10,000 grams/second, like 21 kilograms/second as an example, which is what is being used, as I understand it, in the safety evaluations. That's also, unless Wylie was totally off base in whatever the areas were, the opened valve, that's what kind of flow rates they were measuring.

DR. NIJHAWAN: I totally agree, sir. This is not the area which is the right area then, isn't it? You were just given the areas, you were not give the tests reports, sir. The test reports are (indiscernible). The areas are wrong, I've been saying that for a long time, the areas are wrong. They are derived by (indiscernible) in one of the reports.

DR. HENRY: You'd have to have a very tiny valve for 40 grams/second.

DR. NIJHAWAN: There is a report, NK30-DIP-33323-0005, it tells me it's 40 grams. I've got 10 of these reports that OPG people send to me. There are people within OPG who are up in arms saying nobody wants to do anything about safety issues. They're telling me that in this report, this is what it says --

MEMBER McEWAN: Dr. Nijhawan, let me again -- I'm trying to understand. But you've now just thrown out --

DR. NIJHAWAN: I --

MEMBER McEWAN: -- you've just now thrown out a statement that is perhaps intemperate and certainly unhelpful in the context of this discussion.

So, again, you are asking me now to not follow the guidance we're getting from our consultants, not follow what seems to me to be modestly robust or fairly robust experimental data to support the safety of the valves on the basis of what I think is an opinion.

So I think this has been very helpful to me in understanding the flow of this conversation. I think I probably have no more questions.

THE PRESIDENT: Okay. I think we need to bring this to --

DR. NIJHAWAN: May I just give -- you do not have any experimental data, sir. The experimental data is the 40 grams. Ten thousand grams is based on the areas just provided to Dr. Henry. The area is wrong. Dr. Henry's right, he's just been given the wrong area. It is not experimental area. It is an area derived by one of your engineers using the wrong cross-section, that's all.

THE PRESIDENT: Okay. Before we conclude, I need to address one more question. We have our friends from the U.S. NRC that proposed some measures, some recommendations, about how to deal with -- two recommendations. I'd like some Staff to comment on them.

MR. FRAPPIER: Gerry Frappier, for the record.

So just to conclude that last interaction that was going. So we have been talking about valves for several years here at the Commission. I personally have been involved in having I think I can think of about five or six different independent consultants who are not associated with the CNSC review the same information that Dr. Nijhawan has reviewed, but come to a different conclusion.

So in many many many of these areas, virtually all of these areas, we have an expert, I'll give Dr. Nijhawan credit for that, and we have many other experts who do not agree with his position.

So from that perspective, we have to make decisions, and we have designers of valves that have been involved, we have engineering test facilities that have been involved, we have a whole bunch of independent consulting engineers that have been involved, we have the American Mechanical Engineering Society that's been involved. At a certain point you have to come to the conclusion that we are not going to agree with Dr. Nijhawan on this.

That brings us to the recommendation that we're talking about, because Dr. Nijhawan is very passionate about his view, and I commend him for that, he obviously believes what he's saying, but we have to make decisions based on much a broader viewpoint than one individual who has comments.

But the recommendation and the amount of effort that we're spending on this, there has to be a certain how do we manage that? The U.S. NRC has the same problem on many occasions, they have a much bigger program than we have and they have lots of intervenors that want to provide constructive technical information, but sometimes people are overly passionate and are not going to change their mind.

They do have a process by which the Commission manages that and we do not, so I think the recommendation that they're putting forward is that we should maybe consider how we would do that. We have not gone forward to sort of plan this out or even have benchmarked this against the U.S. NRC's process. But I think the recommendation is that that's something we should look at doing, and I would agree with that.

THE PRESIDENT: Could you share with us, from the U.S. experience, how many times do you actually deploy that mechanism?

MR. SATORIUS: Mark Satorius, for the record.

Several. I can't tell you a number, it's not 100, it's probably closer to 10 -- 10 times in our collective experience. So it's a very very rare occurrence that takes place. It's something that even though a decision is made to move forward based on all good reasons, it has to be done transparently so that your stakeholders, whether they be members of the public or licensees or allegers or intervenors, understand that this is a process to move forward.

If there is information that has been thoroughly sifted through, as Gerry has said, all the experts within your organization as well as others have come up with a path forward, a decision has to be made that unless we see information awry that doesn't bring new facts to the table, we will not be responding.

THE PRESIDENT: Has it normally been your experience that it's been accepted, the decision by those particular intervenors?

MR. SATORIUS: Well, as it has been stated earlier, you know, a lot of these people are very passionate about some of their thoughts. So I wouldn't say that it is a wholly accepted with open arms, but I think it's, for the most part, reasonable people can be reasonable. I think that there comes a point where the best thing to do is to move forward and get past it.

THE PRESIDENT: Thank you.

Dr. McEwan?

DR. McEWAN: Thank you.

THE PRESIDENT: So let me conclude by thanking everybody for this. For us, it's been very interesting to go through some of those technical issues, and thank you for all the hard work.

Dr. Nijhawan, you have the final final say in this.

DR. NIJHAWAN: Thank you, Dr. Binder, for giving me this opportunity. I am, needless to say, disappointed in the process which was undertaken, and the choice of so-called experts in looking at some very technical issues which affect the safety for my people in Canada.

I will strongly recommend that CNSC fund, organize a separate group of people who are real experts who talk about numerical issues rather than policy issues, and look into the points I've raised. It doesn't affect me, but one day you will have regrets that we did not use this opportunity to address the technology in this country.

I am very disappointed in the audacity of our American colleagues to come into our forum here and tell us to shut people like me out. I am very disappointed in the CNSC even turning this into an issue, that you shut people out at a certain time and turn that into a policy. It is something that we will definitely challenge. I hope that cooler heads can prevail and that CNSC will look into these issues from a matter of national security, from national pride, that we should make our reactors better, our public a little more safer.

The technical issues that I raised will stand, and we only have added to them since that time. There are people who know that reactors have to be improved and they're improved in other countries, we're just being left behind by this very (indiscernible) behaviour by the industry of not wanting to do anything.

So in conclusion, I recommend, I request that let us please set up a meeting, just me and you, Dr. Binder, with Dr. McEwan, with other people, sit and calmly explain to you in technical terms, because some of you do have some technical background. You, Dr. Binder, having a background in physics, you would know the difference between deuterium and hydrogen; the surface reaction requires (indiscernible).

So anyway, I request that we look at it in an independent forum, not the forum which has been set up by other people who have done nothing substantial on these issues for the last 30 years that we've been working on severe accidents.

I thank you for the opportunity, sir, and

I wish you all good luck and good time. Bye, bye.

THE PRESIDENT: Thank you. Hopefully, you're going to join us for the afternoon for another session on some other topics.

We will reconvene at 1:45. Thank you.

DR. NIJHAWAN: Thank you, sir. Thank you.

--- Upon recessing at 12:38 p.m. /
Suspension à 12 h 38

--- Upon resuming at 1:50 p.m.
Reprise à 13 h 50

CMD 17-M12/17-M12.A
Continuation of Commission
Meeting Item (August 17, 2016):
Risk-informed Assessment of CANDU Safety Issues

THE PRESIDENT: Okay. We are back with the last item on the Agenda, which is a continuation of a discussion from the August 2016 Commission Meeting on the Risk-informed Assessment of CANDU Safety Issues. This is outlined in CMD 17-M12 and M12.A.

We also have joining us here Mr. Tolgyesi and Ms Velshi as they were also present at the August meeting and they are joining us here to pursue this discussion.

Marc...?

MR. LEBLANC: Yes. I have a few contextual comments or remarks.

So, as the President indicated, this is the continuation of a Commission Meeting Item first presented in August 2016. The Commission determined that this item should be continued so that CNSC staff could present a table dealing with all 74 CANDU safety issues and that a more fulsome discussion could take place at a later date -- that is today -- to address matters raised by the three intervenors who also participated in August.

In this regard, the Commission Members will refer to documents filed both for the August 2016 and the March 2017 proceedings. The objective of this item is not to close CSIs as these will always remain in one of the three categories. It is more an assessment of progress being made on the consideration of these issues, including the recategorization of CSIs towards other or lesser categories, that is, either Category 1 where it is no longer an issue because it has been satisfactorily addressed or Category 2 where appropriate controls are in place to maintain safety margins, and this as a result of developments in the research and understanding of these issues.

A question period, for which no time limit has been ascribed, will follow the presentations, first by CNSC staff, followed by Dr. Greening, then Dr. Nijhawan and the consideration of Dr. Duguay's submission, who will not be joining us today.

A notice was issued to invite the three intervenors who participated in the August meeting. Dr. Greening and Dr. Nijhawan, as I indicated earlier, will present verbally, and Dr. Duguay filed his written submission. And all of these will be considered in a single question period that will follow all presentations.

Mr. President...?

LE PRÉSIDENT: Merci, Marc.

First, let me check to see if Dr. Nijhawan, are you online? Can you hear us?

DR. NIJHAWAN: Welcome, sir. Welcome back, sir. Yes, I am here, sir.

THE PRESIDENT: Thank you.

So I will turn now to CNSC staff for their presentation.

Mr. Frappier, the floor is yours.

MR. FRAPPIER: Thank you very much.

Good afternoon, Mr. President and Members of the Commission. For the record, my name is Gerry Frappier and I am the Director General of the Directorate of Power Reactor Regulations. Staff are here to present further information on the Risk-informed Assessment of CANDU Safety Issues to the Commission.

With me today are Dr. David Newland, Director General of the Directorate of Assessment and Analysis, and Dr. Doug Miller, Lead Technical Advisor for the Directorate of Major Project Management and Regulatory Improvements, as well as technical staff that will be available for questions.

In the August 2016 public meeting of the Canadian Nuclear Safety Commission, CNSC staff presented a technical briefing, Commission Member Document 16-M34 entitled Risk-informed Assessment of CANDU Safety Issues. CMD 16-M34 described the approach taken to assess the current status of design and analysis of safety improvement initiatives and research for Canadian CANDU reactors and to develop a path forward for their timely implementation.

After deliberations, the Commission decided to continue the discussion on the status of CANDU safety issues that was started in the August 2016 Commission Meeting as there was limited time to disposition intervenors' comments on the CANDU safety issues.

CMD 17-M12, which is before you today, Continuation of Commission Meeting Item: Risk-Informed Assessment of CANDU Safety Issues, was published in December 2016 and it provides dispositioning of intervenors' comments and information on the recategorization of CANDU safety issues.

I would like to give a little bit of background, but first, to be clear, nuclear reactors operating in Canada meet regulatory requirements and licensees are qualified and are making adequate provisions to operate the reactors. Safety cases for currently operating reactors fully apply the defence-in-depth framework and have appropriately conservative safety margins, but a healthy safety culture of a nuclear regulator includes having a questioning attitude, looking for opportunities to continuously improve safety and increase regulatory knowledge. Ongoing regulatory research and taking operating experience into account are key aspects of continuous safety improvement and increasing our regulatory knowledge. The risk-informed assessment of CANDU safety issues focuses on the activities undertaken to confirm the adequacy of safety margins, increase regulatory knowledge and enhance the safety of CANDU reactors.

In 2007 CNSC staff were the main contributors in the development of an IAEA Technical Document on Generic Safety Issues for Nuclear Power Plants with Pressurized Heavy Water Reactors. An initial list of technical issues was developed using the IAEA Technical Document. We have consolidated the safety issues in the technical document with the CNSC's previous generic action items, which include findings from ongoing nuclear safety research and experience feedback from regulatory oversights of currently operating reactors in Canada and worldwide. Collectively, these technical issues are referred to as CANDU safety issues.

As discussed, ongoing regulatory research and taking operating experience into account are key aspects of continuous safety improvement and increasing regulatory knowledge. While the CNSC staff have reported on these initiatives in regulatory oversight reports over the years and during licence renewals, CMD 16-M34 and today's 17-M12 consolidate the CNSC staff reviews. This presentation describes the current status of these CANDU safety issues and addresses feedback from intervenors.

As a reminder, the initial list of CANDU safety issues were assessed as follows:

CNSC experts first considered whether the item was addressed in the design of Canadian CANDU reactors, whether licensees have matured safety and control measures in place and whether licensees have made design upgrades. If one or more of these criteria was met, the item was determined not to be an issue in Canada. These items are referred to as Category 1 CANDU safety issues.

Next, we considered whether existing measures need additional confirmation or if improved knowledge or understanding was needed to confirm the adequacy of safety margins. If the answer was no, it was determined that the licensees have appropriate control measures in place to address the issue and to maintain safety margins. These are referred to as Category 2 safety issues.

An issue was categorized as a Category 3 CANDU safety issue if further experiments and/or analysis are required to improve knowledge and understanding of the issue or to confirm the adequacy of safety margins. In this case, the CNSC's risk-informed decision-making process was applied to develop the path forward, i.e. the risk control measures for issue resolution. The CNSC will reconfirm the adequacy of safety margins and monitor licensees' management of the issues to ensure its timely and effective resolution.

So, to summarize, Category 1 issues are not an issue in Canada. A CANDU safety issue is determined to be a Category 1 issue if the issue was addressed in the design of CANDU reactors; licensees have matured safety and control measures in place; or licensees have made design upgrades. Category 1 items are subject to ongoing regulatory oversight. If information should come to light regarding a Category 1 CSI, the CSI will be revisited and CNSC staff will determine if regulatory actions are needed.

Category 2 items, the issue is a potential concern in Canada. However, the licensees have appropriate control measures in place to address the issue and to maintain safety margins. Category 2 safety issues are subject to ongoing inspection and desktop reviews. In addition, confirmatory research and development and analysis may be needed for some Category 2 CANDU safety issues. The CNSC monitors licensees' management of and progress towards resolution of these issues.

Category 3 items, the issue is a concern in Canada. However, the licensees have control measures in place to maintain safety margins, but further experiments and/or analysis are required to improve knowledge and understanding of the issue and to confirm the adequacy of safety margins. The CNSC will reconfirm the adequacy of the safety margins and continue to monitor licensees' management of the issues to ensure its timely and effective resolution.

Category 3 items require more focused regulatory oversight.

So for Category 1 and Category 2 issues, the uncertainties in the safety case are well understood and covered by an appropriate level of conservatism imposed by the CNSC. However, industry may still be doing further research on some Category 2 issues to be able to reduce regulatory conservatism in the safety case, or for operational reasons.

So what is the status of CANDU safety issues today?

In 2007 when this work started, there were 24 Category 1 issues, 29 Category 2, and 21 Category 3 issues. Overall, through industry's efforts in addressing the Category 3 CANDU safety issues and the CNSC's effort in assessing submissions, there are now 25 Category 1 issues, 45 Category 2 issues, and only 4 Category 3 issues. Note that one Category 1 CANDU safety issue on fuel cladding corrosion was moved to Category 2 and we will discuss this shortly.

The recategorization process includes the following steps: a licensee will provide their submissions stating the request for recategorization and including supporting documentation; the CNSC staff then review the submission and evaluate the recategorization request in view of the measures to be taken for that CANDU safety issue; after it has been verified that the risk control measures have been implemented, the Category 3 CANDU safety issue is recategorized to 1 or 2. The definitions provided on the previous slide are used to determine if the CANDU safety issue should be moved to Category 1 or 2. It is also possible that if a new information arises, as was mentioned, then it may be recategorized upwards. So that's also a possibility and has occurred.

During the Fifth Review Meeting for the Convention on Nuclear Safety in 2011, there was a peer review of the application of the CNSC's risk-informed decision-making process to develop the path forward for resolution of the most significant CANDU safety issues. The process and its applications were accepted and as such the peer review under the *Nuclear Safety Convention* endorsed the CNSC's risk-informed categorization of CANDU safety issues. The process and its applications were accepted by the international community.

Coming now to the feedback on CMD 16-M34, there were three interventions on CMD 16-M34. Overall, the intervenors questioned the basis for the initial categorization and recategorization of the CANDU safety issue. Detailed comments were provided regarding total loss of alternating current power, fire protection, fuel channels, hydrogen control, primary heat transport system relief capability, emergency core cooling strainers, and others. These comments will be discussed later in this presentation.

CMC staff emphasize that rigorous processes for the initial categorization and subsequent recategorizations were followed at all times. The basis for the initial categorization was documented in the CNSC report "Development of Regulatory Positions on CANDU Safety Issues: Categorizations of Safety Issues", which was published in 2007. The process followed for recategorization is as we have described earlier.

CNSC staff applied their in-depth science and engineering expertise in the assessment of licensees' submissions. Independent technical panels in key areas were also established to support assessment of the licensees' submissions.

In addition to addressing technical points raised by the intervenors and providing the basis for recategorization of Category 3 CSIs, this presentation will provide information on the current status of the Category 1, 2 and 3 CANDU safety issues.

I will now turn the presentation over to Dr. Miller.

DR. MILLER: Doug Miller for the record.

Good afternoon, Mr. President and Members of the Commission. I am Doug Miller, Lead Technical Advisor for the Directorate of Major Project Management and Regulatory Improvement.

We will now discuss the basis for recategorization of the Category 3 CANDU safety issues.

The following information was provided for each CANDU safety issue: a brief description of the issue; the measures developed to address the safety issue and the basis for recategorization, including a summary of information submitted by licensees to support the request for recategorization; a summary of the staff assessment of the licensee's submission, including the decision on whether the Category 3 CANDU safety issue is recategorized to Category 1 or Category 2; and the ongoing work for Category 3 CANDU safety issues recategorized to Category 2.

As part of this work we note that the CANDU safety issues were recategorized based on one of or a combination of design, changes, analysis, research and development, or improvements in programs, processes and procedures. The basis for recategorization of these CANDU safety issues was provided in Appendix A of CMD 17-M12 and contain the information that I have just described.

I would like to point out that molten fuel moderator interaction, CANDU safety issue PF 15, and emergency core cooling sump screen adequacy, SS 1, have been recategorized from Category 3 to Category 1. The remainder of the CANDU safety issues listed on this and the next slide have been recategorized from Category 3 to Category 2. As mentioned, these items were recategorized based on a combination of design work, analysis, research and development, and improvements in programs, processes and procedures. The letters beside each of them indicate the type of information supporting the recategorization. We would like to note that none of the CANDU safety issues were solely recategorized based on analysis, it is always a combination of tools that is used to provide the information to address the concern.

We would like to take this opportunity to point out that with regards to CANDU safety issue PF 18, fuel bundle/element behaviour under post-dryout conditions, CMD 17-M12 states that the independent technical panel proposed a derived acceptance criteria of 600 degrees Celsius. To be clear, this did not portray the acceptance criteria accurately. A set of criteria addressing possible damage mechanisms to the fuel and fuel channel have been established through the industry work and licensees must indicate what criteria they will use in their safety case. They do have flexibility in the criteria they propose and it is up to them to make their case that it is suitable for their facility.

There is also another item that we would like to note with regard to the documentation for CANDU safety issue AA 3. So this is found in Appendix A of CMD 17-M12. The CNSC assessment that is referenced was based on discussions held with industry up to 2012 and the industry's submissions are in accordance with these discussions.

We will now discuss the status of Category 1, 2 and 3 CANDU safety issues.

CNSC staff reviewed the basis for the recategorization of Category 1 CANDU safety issues. The status was documented in Appendix D of CMD 16-M34, Risk-informed Assessment of CANDU Safety Issues. There are currently 25 Category 1 CANDU safety issues. As part of the meeting process, no comments were received on 18 of the

Category 1 CANDU safety issues. The names of these items are listed in the appendices to this presentation. Comments were received from intervenors on seven Category 1 CANDU safety issues and they are listed on this slide. Further detailed information on these issues is provided in the appendices to this presentation.

Based on the CNSC review and consideration of feedback from intervenors, no new issues have been identified regarding the Category 1 CANDU safety issues. CNSC staff conclude that Category 1 CANDU safety issues are categorized appropriately. It is important to note that if new information comes to light regarding a Category 1 CSI, the CSI will be revisited and CNSC staff will determine if regulatory actions are needed, and we do have the example that we will get to.

We will now turn our attention to the current status of the Category 2 safety issues.

CNSC staff have reviewed the basis for recategorization of -- the categorization of Category 2 issues. The status was documented in Appendix E of CMD 16-M34. There are currently 45 Category 2 issues. Through the process, no comments were received on 30 of the Category 2 issues. These are listed in the appendices to this presentation. Comments were received on 15 of the

Category 2 issues. These are listed on this slide and the next. Further detailed information on these issues is provided in the appendices to this presentation.

Please note that RC 2 on fuel cladding corrosion and fretting has been moved from Category 1 to Category 2. This was due to operating experience in the past few years related to an increase in deposits on fuel bundles in one reactor and excessive fuel bundle vibration being identified at another reactor. This is a case where an issue has been recategorized to a higher category based on new information.

So Slide 24 just presents the remainder of the 15 items.

Based on the CNSC review, no new issues have been identified regarding the Category 2 CANDU safety issues. CNSC staff conclude that these Category 2 issues are categorized appropriately.

And as for Category 1 items, it is important to note that if new information comes to light regarding a Category 2 CANDU safety issue, it will be revisited and CNSC staff will determine what regulatory actions are needed.

Turning our attention to the Category 3 CANDU safety issues, first, we would note that the industry has made significant progress in implementing the risk control measures for the CANDU safety issues, thereby enhancing the safety of the reactors. The remaining four Category 3 CANDU safety issues are related to IH 6, the need for systematic assessment of high-energy line break effects; AA 9, analysis for void reactivity coefficient; PF 9, fuel behaviour in high temperature transients; and PF 10, fuel behaviour in power pulse transients. The latter three are addressed as part of the consideration of large LOCA safety margins. The regulatory positions and path forward for addressing these Category 3 issues are well established. Further experimental work and analysis are required to confirm the acceptance criteria and analysis methodologies proposed for use in licensing applications.

Through the process, in addition to the comments on specific CANDU safety issues, intervenors provided questions of a more generic nature. Items included progress in addressing CANDU safety issues; the basis for the initial categorization and recategorization of CANDU safety issues; details on the risk-informed decision-making process; containment testing; and safety report updates. Further detailed information on these items is provided in the appendices to this presentation.

I will now turn the presentation over to

Mr. Frappier.

MR. FRAPPIER: Thank you.

In conclusion, safety analysis and design have always been conservative and all reactor types have ongoing research activities. Periodically it is useful to review the information from research and operating experience. We have consolidated the safety issues in the IAEA TECDOC on Generic Safety Issues for Nuclear Power Plants with Pressurized Heavy Water Reactors with the CNSC's generic action items that include findings from ongoing nuclear safety research and experience feedback from the regulatory oversight of currently operating reactors in Canada and worldwide.

Licensees must undertake focused actions on issues where further experiments and/or analyses are required to improve knowledge and understanding of the issue and to reconfirm the adequacy of safety margins. To be clear, the safety case for facilities remains valid and adequate provisions for safety are in place at Canadian nuclear power plants.

There were three interventions on this CMD. Overall, the intervenors questioned the basis for the initial categorization and recategorization of some of the CANDU safety issues. The CNSC staff emphasize that rigorous processes for the initial categorization and subsequent recategorizations were followed at all times and were used for the initial categorization of the CANDU safety issues and for any follow-on recategorization. The basis for the initial categorization was documented in the CNSC report, "Development of Regulatory Position on CANDU Safety Issues: Categorization of Safety Issues", which was published in 2007 and confirmed in CMD 16-M34 and 17-M12.

The CNSC staff applied their in-depth science and engineering expertise in the assessment of licensees' submissions. Independent technical panels in key areas were also established to support assessment.

CMD 17-M12 demonstrates that recategorization was done in a systematic way based on technical reviews. In no case was recategorization done only as "a paper exercise". There was always either an improvement to licensees' programs, an improvement to physical design or increased knowledge for research to support the recategorization.

It is important to note that following this assessment and consideration of intervenors' comments, there were no new issues or items that required immediate attention by the licensees. Our conclusion is that the basis of recategorization for the CSIs remains valid.

Ensuring safety and looking for safety improvement opportunities is a never-ending task and requires ongoing research and attention to operating experience. Going forward we will continue to identify and establish the path forward for any safety concerns through the periodic safety review process carried out in accordance with CNSC's REGDOC-2.3.3 Periodic Safety Reviews and of course our ongoing compliance program which occurs every day in the plant throughout the country. All safety issues, including CSIs, are tracked under the CNSC's regulatory information bank. Any research subject that is related to a safety issue or has any safety significance concerns are also tracked and reported on through the Regulatory Oversight Reports. Staff updates the Commission on an annual basis on these matters through our NPP Regulatory Oversight Report.

So now comes the interesting part. CNSC staff is ready to go through the details of the appendices if that is the Commission's desire, and/or answer any other questions. Thank you.

CMD 17-M12.1/17-M12.1A

Oral presentation by Frank Greening

THE PRESIDENT: Thank you.

Before we get into the question session, we would like to hear from Dr. Greening, as outlined in CMD 17-M12.1 and 12.1A.

Dr. Greening, the floor is yours.

DR. GREENING: Thank you, President Binder, and to the Commissioners I would like to extend my thanks for allowing me to come here and address you all today.

What I would like to talk about is -- I have given it the loose title, "Defence in Depth?" And just to get started, this strange-looking device is called a Beetle and it's the limit of the defence-in-depth for this leak-before-break, a methodology which I would now like to address. So let's talk about leak-before-break.

CANDU reactors are claimed to have layers of safety in place that provide a defence-in-depth against catastrophic accidents from component failures. Indeed, the safety of a reactor depends on the integrity of its pressure boundaries such as feeder pipes, pressure tubes and other heat transport system components. It is therefore crucial to be able to determine the strength of these boundary materials and how a reactor will behave in the event of a boundary failure. And for the very important pressure tubes, a key element of its defence-in-depth is its predicted so-called leak-before-break behaviour in the event of a through-wall crack.

The failures of a pressure tube can range from a small leak of around 1 kg of heavy water per hour or less to a catastrophic rupture involving the discharge of more than 100 kg of heavy water per second. The former type of leak occurs when a small slowly growing crack penetrates the 4 mm wall thickness of the tube. The latter type of leak is the one we have to worry about. It's a fast, uncontrolled fracture that occurs once the so-called critical crack length -- CCL is the abbreviation I will be using -- is reached.

Now, in the event of one of these leaks, the way CANDUs deal with this is that the outside of every pressure tube in a CANDU reactor is surrounded by a carbon dioxide filled annulus gas system (AGS) that is used for the detection of pressure tube leaks through continuous dew point measurements of the circulating carbon dioxide.

The leak-before-break methodology is based on the assumption that the time for a leak to grow to its critical crack length is always greater than the time required to detect the leak.

So let's look at this annulus gas system in a little more detail. This is a cross-section of a CANDU reactor. I'm sure we have all seen this diagram many times before, but just one more time. You can see -- this isn't working. Sorry. Anyway, you can see the horizontal pressure tubes. Then the part labelled 2 is the endshield cooling which is needed to keep the calandria from overheating. And then these little aerials you can see are called the bellows and that's where the annulus gas is fed into and out of a channel.

Just to emphasize what we are talking about here, this is the face of a Darlington reactor with 480 pressure tubes and if one of them leaks, the problem is to figure out which one of these 480, because if you don't know which one is leaking, you don't know how to fix it.

Now, here is a side view of the same thing which shows the fuel channel coming out the reactor face and this really doesn't tell us much about the annulus gas system, so I included this little diagram which shows the pressure tube in the black at the top right-hand side and inside that is the heat transport water and the fuel. I don't show the fuel. And the annulus gas system is the yellow strip. And what is important to recognize here -- and there is a nice mockup of this, by the way, down in the lobby where you can go and actually look at how narrow this gap is. You have these bearings which support the fuel channel. There are two. There is the inboard and the outboard. This gas has to work its way through that very convoluted path. Then it comes into this region on the left-hand side where we see bellows, and this little pipe that comes down is dubbed a pigtail because it often curls around and kind of looks like a pig tail.

So what we are dealing with in the event of a leak or a crack is shown in this schematic where we have this little hole in the wall of the pressure tube and the heat transport water comes through that hole, flashes to steam and is carried away by the annulus gas. And we will get to where it goes in a minute but just to give you some numbers, the annulus gas bases its measurements on dew point. You have dew point metres in the external circuit and here are some numbers for what the dew point would be in the event of a .1 kg, 1 kg and 10 kg. The dew point gets very high very quickly.

And now here we have the path of the annulus gas. They don't really hook up 480 separate inlets and outlets. What they do is they connect them in what are called strings, which is the row. If you go back -- sorry, wrong way -- these are the rows, the vertical assemblies of fuel channels. So the annulus gas goes -- actually skips over one because that is the way it's configured. So the most extreme -- I'm going the wrong way again -- the most extreme case is 12 fuel channels in one string. So you can see the annulus gas comes in at one end of a fuel channel, goes down to the other end, comes out at the pig tail, goes down then into the next one, and so on and so forth. It has to follow this very circuitous path to make its way through the reactor core.

And here is the schematic showing the whole annulus gas setup. This one is for Bruce, where you have 48 individual strings. They come out and they are recombined and then they have two paths they can follow. One is to go through the dew point metres -- and here there is a second one shown but that's just a backup -- down to the compressors and back in, and that is the basic route that the annulus gas has to follow.

But there is one other thing to note here. You will see at the outlets of the annulus gas system, off to the left here, we have the beetle. And the beetle is just a moisture detector. It's like a glorified spark plug and it sits down in the sump in the reactor building and the idea is that if enough water leaks out of the heat transport system, it will eventually make its way down to the beetle, the beetle will fill up and make a connection and it will send an alarm to the control room.

So that's enough on the annulus gas system. Let's go back to leak-before-break.

As I mentioned earlier, the important quantity here is the time that it takes for the crack to grow to this critical crack length, and it is represented by a very simple equation. The theory is that the crack will grow to a point where it penetrates the wall, and that is given the symbol L_p, that's the crack length penetration. The crack can then grow to the critical crack length, at which point catastrophic rupture occurs.

The other term in this equation is V_0, that's the crack velocity, that's how fast the crack grows, measured in units like millimetres per hour, and the factor of 2 is because a crack can grow in two directions, whereas the velocity just goes in one direction.

So let's look at some numbers for these variables. Back in the 1980s, Brian Cheadle at Chalk River estimated critical crack lengths in the range of 40 to 90 mm and crack velocities .36 to 2.16 mm/h. The more recent values, these are from a paper by Doug Rodgers at Chalk River, critical crack lengths 41 to greater than 80, basically the same as in 1989. Crack velocity is slightly different, a little bit lower, but what this slide shows is that the old data stands, that the values they were talking about in the '80s are still the values they talk about today.

But just to show you what some real data looks like, these are critical crack lengths from removed pressure tubes. There's Pickering Unit 4, Unit 3, Point Lepreau, Bruce 1 and 2 and Darlington, and you see the tremendous scatter. This is plotted against the neutron fluence, which is the amount of neutrons these pressure tubes have seen. And I should just point out that the 10 here in terms of years would correspond to about 20 years and what you do see is a trend downwards towards this value of 40. And bear in mind that today you can double the width of this plot we are working out here. We are working at 20 -- sorry, 30, 35, 40 years.

The other parameter we need to look at is the L_p, which is the crack length penetration. In the early days they assumed a value of four times the wall thickness. I'm not exactly sure where they came up with that, but that works out to be about 16 mm. But work by Gerry Moan in 1988 showed that the crack can actually tunnel through the wall and then break through and they realized that this L_p could be a lot more than four times the wall thickness and they settled on a value of 27 mm, which is seven times approximately the wall thickness.

Now, this is a very interesting slide because it shows you the science behind this. These are all good, serious engineers giving their best estimates on what this time should be. Ed Price in 1988 said it was 100 hours, it would take 100 hours for the crack to grow, the critical crack length, whereas Shalaby in the same year, also works at AECL, he said it was 10 hours, and I think that's why in 1990 Ed Price revised his number to 18 hours.

After that we have not much work being done in Canada, it seems to have all shifted to Korea. And the Koreans, maybe because they have no vested interest in selling CANDUs, their numbers are a lot less, 11.7 hours, 15.4 hours, 2.7 hours in 1999, 8.6 hours in 2004 and a remarkable 1.7 hours in 2005. And I should also point out one other number, this is by John Jin, who may be in this room, he presented this to the U.S. NRC and he said it was 18 hours, but he used the wall thickness of 4W, which nobody uses anymore. But this is the number he said. This is what he told the U.S. NRC, 18 hours, back to that number.

But what this slide really shows is that if I was asked how much time do you have for the operator to detect a leak, the answer is somewhere between 100 hours or less than two hours, you choose.

The other important ingredient of this leak-before-break analysis is you need to work out what the leak rate would actually be, how many kilograms per second, minute or hour are you likely to see for a given crack length, and here we have some more interesting history.

In 1990 AECL used a linear function, they just said the leak rate should be proportional to the crack length and so Q equals .5L and there is a constant which is to do with the penetration issue.

The Bruce Design Manual -- and I work with the people who wrote this -- they came up with another linear function, Q equals 0.61L.

And again the Koreans, they also like a linear function.

So the main point here is in the early days everyone assumed that the relationship between the leak rate and the crack length is a linear function.

However, the CSA have a lot to say about this and this is in their Standard N285.8 and if you read this and they say: The leak rate data from the Chalk River Active Crack Leakage Experiment, known as CRACLE -- we will get to that in a minute -- should be used -- or they used, rather, to get the relationship between the crack length and the leak rate and they came up with a cubic equation. It's proportional to the crack length cubed.

So I decided I would take a closer look at this. Here is the actual data.

I have noticed Gerry Frappier and Dr. Miller using terms like "in-depth science" and "science-based." Well, this is not science-based, because as you can see, this curve extends into a region where there is no data. The data stops at 30 mm but they are using this curve out of 50 mm and they claim that it's a cubic function. Well, I checked that out. Here's the cubic fit and you will notice the R-squared is only .75, which is not a very good fit. I was able to try other functions and I found that a power log is a much better fit. The R-squared is now .87. And I'm just toggling back and forth here. It's the same data, different fit.

Why the CSA insisted on using a cubic function is beyond me, but anyway you certainly get a better fit with a power log, which means that it depends not on the crack length as a linear function but as a function where it's L to the power of 1.6.

So what does all this mean?

Well, if we now -- just going back, the

left-hand scale is log, but the lower scale, the length is linear, so let's go log-log. We get a nice linear relationship and now we get to where the problems begin because dew point metres only work down at the bottom of this plot where -- and this has been worked out by thermal hydraulic analysis -- at 26 grams per hour, the dew point meters fail because you get condensation and the annulus gas system starts to fill up with water.

And that's where the defence in depth comes in, I guess, because the beetles take over, but they only take over, as I'll show in a minute, when you've got substantial leaks like more than one kilogram per hour, maybe 10 kilograms per hour. Kilograms.

The dew point meters go blind at 26 grams per hour. And the region of interest is up here on the right-hand side of this plot, not down here.

This is down in the weeds. This is the day-to-day variation.

If you've got a real leak with a real crack, you're interested in the right-hand side of this plot. So let's look at how well the beetles perform in this situation.

Well, the blue line at the bottom is what the beetles will -- how they'll react to such a leak. The problem with the beetles is that they only get to see about 10 percent of the water that's going into the annulus gas system because it's like a big tank slowly filling up with water, and it takes quite a while for it to trickle down to where the beetles are.

I mark on this plot that it's after about five hours is the best you could do, but that's really being very optimistic.

Let's see what Bruce Power has to say about this.

This is from the Bruce B annulus gas design manual, and what it shows is the time it will take before you get a beetle alarm. And of course, it depends on where in that string the leak occurs.

If it occurs at the start of the string as in position 1, then the water has to work its way through all of these other channels before it will get to the beetle. That takes 26 hours.

The best you can hope for is if it's Channel 12, and even that takes about five hours.

So let's just quickly go over what I see as the main problems with the leak detection as it's practised these days.

If you read CSA N285.8, you will discover that it fails to address leak detection performance, calibration, calibration checks and/or maintenance. It just says the leak will be detected, and it doesn't say how or when or why. It just says, oh, we'll detect the leak. We've got lots of time. No problem.

But here's the problem. The two methods to detect the leak are the dew point meters and the beetles.

The dew point meters have a very narrow dynamic range. It's only about 1,000 when you need about a million. They go blind very quickly.

The other thing, when they're tested, they usually are way off because I don't know what the frequency of recalibrations are, but they're obviously not often enough. And you also find these detectors, they drift. They poison out. They just don't work very well.

And the biggest flaw of all is they do not give you a location for the leak. You've got one dew point meter for 480 fuel channels, and it's going to tell you where that leak is? I don't think so.

And the final point with the dew point meters is they are very slow in recovering. Once they get wet, you have to vacuum dry them. And that takes maybe a day or two.

Now, let's look at the beetles. This is the defence in depth, supposedly.

Well, they have lousy sensitivity. They need kilogram quantities before they register. And of course, they're not quantitative. They're just like an on/off switch. There's either a leak or there isn't a leak.

They have, as I've just shown, a delayed response. Can be up to 28 hours before they wake up and say, "Hey, there's water coming into the system".

And they, just like the dew point meters, cannot tell you where the leak is. They can just tell you there's a leak. And if they fail, they have no back-up.

So am I the only person that sees this?

Well, if we look at the IAEA, in 1993 -- I won't read this, but I hope people will take the time to read it. But they basically question whether -- I'll read the first -- the second sentence:

> "The possibility exists that large cracks may initially produce only low leak rates." (As read)

So they are not really enamoured with this annulus gas leak detection capability. Neither are the U.S. NRC.

And I find it very ironic that you hire Americans to criticize Sunil Nijhawan when the Americans will not license CANDU reactors because they don't accept this leak before break methodology.

Why? Because they don't like zirconium pressure tubes with rolled joints. This is a material that's subject to creep, it's subject to brittle fracture, and for those reasons, and those reasons alone, the U.S. will not license CANDU reactors.

And when ACL tried to promote the CANDU reactor in 2004 down in the States, the -- and again, to save time, I won't read this, but the U.S. NRC basically said, "We don't think much of your annulus gas system, especially if it's not fully function, and we don't see a monitoring -- you monitoring the flows", another reason not to license the CANDU reactor in the U.S.

And finally, the ACB, I believe, was the forerunner of the CNSC. And if you go to what they had to say about all of this in 1989, they were very concerned that the leak before break methodology would be robust over a long period of time because of the way that curve was dropping.

So there's many other people besides myself have questioned this whole leak before break methodology.

So just to conclude, a pressure tube through wall crack is expected to start when it's about 27 millimetres long, and it will grow at a rate around 1.44 millimetres per hour. This means that for a critical crack length of 40 millimetres, a catastrophic fast rupture of a leaking pressure tube is likely to occur after only four and a half hours.

Even for small leaks of 100 grams per hour, dew point meters will cease to function within one hour due to condensation of D_2O in the AGS.

And an AGS can retain up to 12 kilograms of D_2O before sufficient liquid reaches a beetle detector and triggers an alarm.

So even for a fairly substantial pressure tube leak of one kilogram per hour, it may take up to 12 hours. That's actually the graph I showed you, which is from the Bruce annulus gas design manual, says 26 to 28 hours before a leak can be detected.

So in conclusion, the leak before break acceptance criteria set out by CSA in its Standard N285.8 are not satisfied by currently operating CANDU reactors.

Thank you.

THE PRESIDENT: Thank you.

I'd like now to move to the next presentation, which is from Dr. Nijhawan as outlined in CMD 17-M12.3.

Dr. Nijhawan, the floor is yours.

CMD 17-M12.3

Oral presentation by Sunil Nijhawan

DR. NIJHAWAN: Dr. Binder, thank you. Can you hear me properly?

THE PRESIDENT: Yes, we can. Go ahead.

DR. NIJHAWAN: Good.

I don't have that much to say today, but I could speak for two hours. I'm happy we have no time.

My main concern in this risk informed decision-making paper was that there was no risk informed decision-making. To suggest a paper exercise enclosing a large number of safety issues to seem to be doing something. Well, we're doing something. We've put it from one category to the other.

Nobody else is doing it that way, and nowhere else, in my opinion, the regulators are taking that leadership in declaring the reactors to be so safe that we shouldn't worry about it.

So what I've seen is that the closure and downgrading of a number of issues are based solely on opening a file on the topic. At least we've started to do something.

And in parallel to that, a large number of other things have quietly been done. We were downgrading a lot of the requirements in our documents (indiscernible) document (indiscernible) containment testing intervals or removing some very important (indiscernible) design basis accidents from the area of design basis into nothing. For example, removing (indiscernible).

And this rationale was very murky, but there were, you know, we can't have (indiscernible) because we have this leak detection system (indiscernible) --

THE PRESIDENT: Dr. Nijhawan, you're fading on us. It's back and forth, back and forth. I don't --

DR. NIJHAWAN: I don't know what to do. I could go out and stand in the open. You know --

THE PRESIDENT: No, I think if you get close to the mic, I think may --

DR. NIJHAWAN: Okay. Let me try again.

My apologies, sir, and also --

THE PRESIDENT: That's good.

DR. NIJHAWAN: -- my apologies for fading out this morning, but that's -- I wish really now, in retrospect, that I would have come there and talked to people directly. And I hope we will continue at least on this topic more.

What has happened is that you've taken 140 issues and broken them into zero, almost. And the amount of information provided even today to downgrade a topic is only based on the promise -- for example -- and you'll get many of them, but for example, it says that deterioration (indiscernible) this item was recategorized to -- as an outcome of written assessment carried out through 2009 as documented in this report. It doesn't tell me anything.

For example, aging of equipment and structures, the staff concluded that the adequate provisions for aging management have been implemented. That's it.

They didn't tell me what the issues are. They didn't tell me what are the critical experiments being done, analysis being done, data being collected, inspections being done. None of that is there.

And look at more. Need for -- for example, high temperature bundle experiments. No experiments have been done since 1981. And there were bundles actually collapsed into each other.

Those issues are all the issues related to these -- these very important topics based on some sort of submission by the industry. That's just, in my opinion, sir, not enough.

For example, in need for systematic assessment of (indiscernible), they found -- the staff found assessment to be acceptable and recategorized to number 2 for Bruce Power and OPG, and Bruce Power expected to carry out further analysis to confirm their initial assessments.

No. Let them carry out the assessments, look at more (indiscernible). Oh, my God. This is a very important one.

All they have said is -- and nobody in the world will believe you that you can (indiscernible) rupture of a channel at a pressure greater than 3.5 MPa and there'd be a modest pressure rise in the Calandria tube alone and nothing else. That is not acceptable.

This kind of attitude and claim, I'm going to move the stuff to (indiscernible) has been done is not acceptable.

For example, for PARs, they said that they had promised to do some work on PARs, therefore, well, show us the documents. Just didn't make any sense.

What I would like you to do, sir, if possible -- and I will give the benefit of doubt to the staff. And some of your staff are very good. Some of the staff I look up to.

And some of your management, I could not understand why they're still there doing this kind of work saying, for example, sir, that in high dosage controlled measures, licensees have committed to conduct an engineering assessment to determine whether additional PARs units are required for mitigating hydrogen potential -- potential hydrogen production.

That's all. And they (indiscernible) moved it from category 3 to category 2.

What I would please request you, sir, is to have them create 140 Chapter 2 reports, 140-odd issues that began -- that we started with and say this is the issue and these are the technical bases for not working it any more.

In this very -- in my opinion, sir, alliance (indiscernible) and the loss of safety culture. From the time when I started working with AECB back in 1982, '81, there was a questioning attitude. Now, a time when they're completing each other's sentences, practically, as we saw this morning, (indiscernible) let us ask them to very simply create 140 documents putting -- stating the problem, stating the solution and giving all the information that they have in that document instead of saying refer to the list of documents because I pulled out some of those documents. They're just letters. They don't give you any technical information.

I suggest, sir, that we do not have, right now, information necessary to even have reached this low number of 17 category 3 in April this year. We probably have a larger number of issues which have not been closed. And perhaps one of the reason not enough fundamental research is not being done in Canada, why we are not able to (indiscernible) is that we are closing all the issues.

I would request that at least the correspondence that you have that you referred to people can file so we can at least look at it. And please create a document which fully reflects the severity of these issues instead of saying these people have agreed to do something, therefore, we close the issues.

I thank you for your time. Thank you.

THE PRESIDENT: Okay. Thank you.

What I will propose to do now is to go systematically through the various CSI.

I just want to acknowledge that there is a written intervention from Dr. Duguay, CMD 17-H12.2. And that's part of these documents under consideration now.

So what I would like to do, I would like to use the appendices of CNSC staff as the guide to go through all 74 issues, particularly those we got some comments on. But before we do that, I would like to ask the Commissioners whether you have a general comment. Maybe you'll do one or two question, and then dive into the actual list of the categories.

So Ms Velshi.

MEMBER VELSHI: Thank you, Mr. President.

And I'd like to start off by thanking the staff and the intervenors. We left the August meeting -- I know from the Commissioners' perspective, it wasn't -- I don't think it was as a result of lack of time that we didn't address those issues. The information just hadn't been presented to us where we could get comfort that the issues had been handled appropriate with appropriate due diligence.

So again, thank you to staff for going through this so thoroughly and showing us how you have addressed the concerns as well as the categorization and recategorization.

And I'd like to thank the intervenors for remaining engaged, and their commitment.

And Dr. Greening, I'd very much liked your presentation as you walked us through the annulus gas system. The leak before break was very clear --

DR. GREENING: Thank you.

MEMBER VELSHI: -- and helpful.

So I do have some general questions, and some that got raised at the August meeting. And I don't know if they have necessarily been answered.

So the 72 or so issues that we talk about all came from the IAEA report, is that correct, from 2007?

And I know, staff, in your presentation you've said, well, we do look at operating experience and any other emerging issues. But these CSIs that we're looking at, was the genesis of those the IAEA report?

MR. FRAPPIER: Yes. That was one of the geneses. And also, we had what we called at the time generic action items that were also combined.

MEMBER VELSHI: So it has not -- I mean, we had agreed that this would be a dynamic list and that you would consolidate as new issues came up. And so when we say CANDU specific issues or CANDU safety issues, it seems to imply that this is the full bucket of CANDU safety issues, but there may be some more, that you were going to augment that, but I just wanted that clarification.

The other --

THE PRESIDENT: Sorry, but I think this deserves an answer.

So what happened since that time? Because we only hear about the 74 issues, so what happened to any new issue? Where does it find it parking spot?

MR. FRAPPIER: As I mentioned in the presentation, so issues in general are tracked as part of our regulatory data bank. We have actions that are tracked as part of site specific action items that have to be done.

We have actions that are tracked through the research program. So not all action items -- in fact, most action items are not through the CANDU safety issues.

So this is not the list of everything that comes up.

So for instance, you'll be very familiar with the Fukushima action items. So the Fukushima action items, they've all been tracked, continue to be tracked, ensure that that turns into results, and they were -- they're not on this list, for instance.

THE PRESIDENT: But isn't it strange that we will keep carrying those 74 issues forever? They're going to be 1, 2 or 3, and all other issues are somewhere else.

I mean, does it make sense? Something doesn't computer in my mind here. Do we need a list of all issues, whether they're old, new, et cetera?

I just want to understand your view on this.

MR. FRAPPIER: I think issues come up for different reasons at different times, and mechanisms are put in place to ensure that they're taken care of.

These ones were done as noted in a very international way through the IAEA, and so that gives them a special sort of status, if you like, but not necessarily in, from my perspective, the best to keep them on as a separate group forever and forever. We would like to sort of integrate them more into a list, if you like.

But at this point in time, it is a legacy tracking issue, if you like, as to how we -- it's very clear for a lot of people, both in industry and for ourselves, what these issues are and how we are managing them.

MEMBER VELSHI: Well, maybe something for you to consider is those other issues, if they're equivalent to category 3, I think it would be helpful for the Commission to see all of them put together and brought forward.

The concern I have as I went through all of this is, is this optimal use of resources when they may not be highly safety critical issues but require a lot of time and a lot of staff effort and maybe if the focus was on category 3 issues, for instance, or equivalent to category 3, then maybe that would be -- would be better.

Again, something for you to think about.

And before I turn the mic over to my colleagues, is this the first time that these CANDU safety issues in this form have been presented at a Commission meeting where the public have had a chance to intervene? And the reason why I ask is, are -- these concerns that the three intervenors have raised, have they been raised before?

MR. FRAPPIER: Gerry Frappier, for the record.

Just to be clear, we don't put the same amount of effort on all these -- on all these CSIs. So as you're suggesting is exactly why the categorization is important from our perspective. We put the emphasis on the category 3 CSI issues, not so much on the others.

Every once in a while, in particular in

this case, we're bringing them all together for visibility at the request of the Commission.

However, they're reported on all the time. So, annually for many, many years now that we bring them up to the Commission as part of our annual report, the status of them. And, in fact, this set of discussions that we're having now came out of one of those meetings where I think the President was asking us to, what exactly is the timeframe for these to be closed out and was pretty pointed with respect to, he'd like to have a meeting to concentrate on these as to what the status of them are, which is why we've now pulled them together, both last August and now.

So, they are being reported on. So, I'm saying again, anything in the sense of a category 3 that's not on this list, for instance, the Fukushima action items, they're all brought before the Commission on a regular basis as part of our annual report.

MEMBER VELSHI: But these ones, would the public have had an opportunity to review and express their comments and concerns on them before?

And the ones that we've heard from these three intervenors, have those issues been raised before?

DR. MILLER: Doug Miller, for the record.

The reports from 2007 and 2009 were made available to the public at the time they were produced and, through various hearings and meetings, there has been comments on select items.

So, it's not the first time. It's also been discussed in the Nuclear Safety Convention, that's more of a peer review, but it has been out in the public domain. Mr. Rzentkowski committed to that in 2009 when we first did this.

THE PRESIDENT: Just to be clear, also, many times I've heard that there was no risk informed methodology to categorize those, yet I have in front of me a brick of a document dated August, 2009. Was that document available to everybody? It's labelled "CNSC Risk Informed Decision-Making Process to Category 3, CANDU Safety Issues".

DR. MILLER: Doug Miller, for the record.

Yes, that indeed is the document that was made available to the public writ large. If you're good with Google, you can find it pretty easily. It's out there in the public domain.

And that illustrates the application of the CNSC's Risk Informed Decision-Making which actually does take into account probabilistic safety assessments.

THE PRESIDENT: So, did you get any public comments on it?

DR. MILLER: The comments came in somewhat sporadically through the -- on individual topics over the years in the regulatory oversight reports.

The main focus was on the void reactivity coefficient in the 2010-2011 timeframe.

THE PRESIDENT: Thank you.

Dr. McEwan...?

MEMBER McEWAN: Thank you, Mr. President.

If I may, I'm going to straddle the general and the specific dose screening again.

Thank you very much for your talk. It was really helpful, not only as a specific, but in sort of understanding the broad categorization that we're discussing.

So, if I can very broadly simplify your presentation, it is that the leak-before-break is a critical component of the way in which we have a safety component to the way we assess.

DR. GREENING: Absolutely.

MEMBER McEWAN: So, let me follow this through and just make sure, because I think this is an important -- certainly for me, I found this I think the most difficult series of files that I've looked at in my three and a half years on the Commission and I found it really hard to understand the sequential steps.

So, as you went through you defined a series of arguments that said, this is the system, this is the way the system works, these are what appear to be some of the limitations of the system, these appear to be some of the criteria by which the system could not be responsive enough to identify the question, is there a leak, within the timeframe that is required and, therefore, there may be systematic flaws which impair the safety characterization that comes out of this particular safety system.

Would that be a very fair huge simplification?

DR. GREENING: Well, it'd be fair. It's a very complex --

MEMBER McEWAN: Sure. I mean, I'd love to have a full-out conversation, but...

So...

DR. GREENING: I think --

MEMBER McEWAN: Sorry. If you are then identifying a potential significant systemic flaw in the way in which this particular safety system works -- so, I guess my question to staff and to the operators is, how do you take a presentation like this, which is nicely stepped out, to me it appears logical in the way in which the arguments are built, and how do you then respond to each of those different components and build a case that those flaws may, in fact, not be the systemic flaws that they appear to be and that they don't impair our ability to monitor safety?

Because I think the answer to this question helps me understand many of the other elements that come into the 74 and the other questions that we also addressed.

MR. FRAPPIER: Gerry Frappier, for the record.

So, the area of leak-before-break is a complicated pressure boundary area and I'm going to ask one of our specialists to give you a bit of a rounded view as how we do it.

One of the problems in what you're just discussing is, in fact, the narrative is a little bit wrong.

So, to be clear, the Annulus Gas System is not a safety system, so it's a monitoring system and it's used in different things. The analysis -- the steps that are gone through, while very logical, is not how we analyze leak-before-break. So, that becomes part of our problem right there, if you like.

We could easily have a four-hour conversation on how we actually do that, but what I'd ask is for Glen McDougall to give you a very short little snapshot on some of that.

MR. McDOUGALL: Glen McDougall, for the record.

Yes, as Gerry Frappier says, we could go into quite an involved discussion of how the Annulus Gas System performs and I think it would be more important, in that case, to focus on what is actually expected of the Annulus Gas System, but perhaps we can -- I'll try and stick to some general observations that Commissioner McEwan requested.

The other point is that Dr. Greening has raised some very interesting issues and questions, but I think the key issue that CNSC staff would raise with his presentation is that he isn't giving any credit for the sophistication of modern LBB assessments.

There are a number of arguments and equations, for example, in his presentation that are at a conceptual level but, in fact, the current leak-before-break assessments that are done by our licensees are far more complex than that.

For example, one of the points that he puts quite a bit of emphasis on is the notion of Critical Crack Length; and that is, if you like, the target that you try and determine whether a cracked pressure tube will reach that target or not.

If the operators identify a leak and respond appropriately and they can shut down the reactor and cool the heat transport system before that threshold is reached, we call that leak-before-break.

If, on the other hand, the crack in the pressure tube keeps growing and, despite operators' best efforts, you reach the critical Crack Length, then we refer to that as break-before-leak.

The current thing I'd like to leave you with is that all licensees in Canada have a regulator accepted leak-before-break case; there are no break-before-leak cases in Canada right now.

The last time that we had a break-before-leak incident was in 1986 and industry has made substantial improvements: the design, the operation, the training of operators, a number of different areas since that time. So, that is literally the last time that the regulator had any concern about industry's ability to avoid break-before-leak.

In keeping with the general theme of my comments, I guess the other thing I'd like to leave the Commission with is the fact that leak-before-break is not the only tool that CNSC staff uses to ensure that licensees are operating their reactors safely.

I could give you many examples, but I'll give you two key ones right now. The first is that a leak-before-break assessment assumes that a crack already exists in a pressure tube. That's done for analytical purposes, it's not because it's actually a representation of what's going on in a CANDU.

The reason I say that is because one of the things that we put most of our effort on as staff in my area is the periodic inspection of fuel channels. And Canada operates with a fitness-for-service regime for its fuel channels, which means we have a zero tolerance rule on cracks. There's no such thing as inspecting a pressure tube, finding a crack and then making some argument to the regulator that you can just keep on going. The current CSA Standards say that if you find a crack or even anything crack-like in a pressure tube, that's the end for that pressure tube.

All other flaws in the pressure tube, regardless of their source, before the licensee can resume operating that unit, they have to satisfy people like me through a hard engineering assessment that that flaw will not, in fact, become a crack.

So, the line in the sand, if you like, for safe operation of CANDUs is not leak-before-break, the line in the sand is, if you have any flaws in a pressure tube that could become a crack, and that's quite apart from whether that crack might, in fact, ultimately lead to a pressure tube rupture.

So, we only use LBB assessments to cover the possibility of undetected cracks in pressure tubes that haven't been inspected yet.

Perhaps I've -- have I addressed your concern?

MR. FRAPPIER: Gerry Frappier, for the record.

I was just going to add before it goes over there that -- and then, coming back to the risk informed decision-making, if you like, and the importance of the risk, we have to also remember that should there be a break in a pressure tube that is a design-based accident that the CANDU reactor is designed for. There are safety systems that would take that into consideration: would shut down the reactor, would ensure that it is under control, would make sure that it's cooled. There would be no release of radioactivity to the environment. There would be no threat to staff and there are systems that are designed exactly for that event.

So we have to make sure that -- and then that's why I think sometimes we have a bit of a difficulty with some people who focus in on just one system and talk about it, whereas our risk-informed decision making forces us to step back a little bit and see what is the actual risk involved in the situation.

MEMBER McEWAN: So, yeah.

DR. GREENING: A couple of points. I'd like to ask staff in the case of PT G16, which was the break before leak, was that flaw detected before it happened?

THE PRESIDENT: That's an industry question. When did that happen?

DR. GREENING: August 1983.

THE PRESIDENT: Eighty-three ('83), before my time. Anybody here...?

MR. FRAPPIER: I would ask Glen McDougall to start and then industry may want to add

THE PRESIDENT: Okay. Go ahead.

MR. McDOUGALL: Glen McDougall for the

record.

Yes, PT 616 is a well-known event. It's well known for a number of reasons. The main one is because it prompted CANDU industry to remove all the pressure tubes of that particular type from service in Canada.

That was an old type of zirconium alloy that is not used in any CANDU in Canada. It had a number of problems. Some of them were design related. Some of them were operation related but, to its credit, industry spent a substantial amount of time and money understanding what happened in that event and making substantial changes to both the design and operation of CANDU reactors. So there has not been another event of that kind since then.

DR. GREENING: I believe I'm correct in saying that the flaw that caused that rupture was not detected before it happened.

And on the same topic, of the 480 pressure tubes in Darlington how many flaws are there and how -- have you inspected all 480 pressure tubes?

THE PRESIDENT: Industry one. But on this particular event that you talk about, did the machines shut down?

DR. GREENING: It ruptured like --

THE PRESIDENT: I understand --

DR. GREENING: -- a banana and it was they were pumping heat transport water from the floor from the sump back into the reactor. They had to scramble to save that reactor because it was completely unanticipated.

And I know they're claiming that's Zircloy-2 too and now they've got Zirc Niobium but they said to the IAEA back then that Zircloy-2 was the best alloy in the universe and it should last the full length of the life expectancy of the reactor, and that didn't happen.

They made a prediction that was false, and I'm saying: How do they know Zirc Niobium couldn't do something similar? And how many pressure tubes have they inspected in Darlington to find these flaws that they are so worried about.

THE PRESIDENT: Industry?

MR. SAUNDERS: Yeah, Frank Saunders for the record. Just a few points, I guess. I'm maybe the only guy in the room old enough to remember the Pickering event.

But, yeah, we in fact in those days we didn't have an inspection program for pressure tubes to speak of. That program was created after that event, in response to it.

We also didn't inspect the spacer springs that kept that pressure tube from contacting the calandria tube which was in fact one of the bigger issues here, was that. And the metal itself was susceptible to that kind of cracking.

So industry learned a lot. A lot of an -- excuse me -- an awful lot of analysis was done. But even more so, the inspection programs have been beefed up in a very significant way from it.

So nowadays every outage we're in there with tools looking for cracks, looking for spacer locations and other things so that we have a very large pool of data that tells us where the pressure tubes were at. Did we inspect every single pressure tube all the time? No. And you don't do that in any other piping either, so it would be unreasonable to think that you would do it here.

We do inspect the tubes before they go in and we inspect them before they go on service. We make sure there is no flaws to start with and then we continue to inspect them to make sure they are not growing.

The defence-in-depth here really works in two or three different ways. I think you have got to look at it first off, the design of the reactor is -- and I need to correct Mr. Frappier a little bit. The design of the reactor actually is to handle a fill pressure tube with no initiation of safety systems.

So the process systems in the plant should deal with the pressure tube failure without requiring any safety system activation. And, in fact, the one advantage that Pickering showed that that was actually true. The design works, not that you ever want to have that event.

The defence-in-depth is you don't want to have a pressure tube failure. You don't want to have cracks. A leak-before-break is one of those defence mechanisms.

Inspection is another defence mechanism. We do the in-core inspections but we also periodically take pressure tubes out of the reactor for the sole purpose of sending them to Chalk River and inspecting them to see that the condition is as we said.

We have a very large R&D program that continues to test the robustness of the tubes which is directly related to the crack propagation issue and confirm that the robustness of the tubes continues to meet the design criteria that's specified.

So the defence-in-depth is a whole series of work and experiments that are done. There's pages and pages of data and analysis on this to show how the cracks will propagate, when they'll start, what affect hydrogen and neutrons have on those tubes in terms of brittleness and toughness.

So that's all the defence-in-depth. But if that fails and a tube fails, the reactor is designed to survive that event. No safety systems, no release to the public and, you know, of course considerable financial impact to the operator because we'd have to shut down and take it.

As far as the leak-before-break, there is a number of things I think we should point out in that discussion of the Annulus Gas System. I mean first off the picture of the beetle is interesting in the sump but that's not actually how it looks in the Annulus Gas System. It's not actually how it works. It is indeed more -- as Dr. Greening said, it's a spark plug. It's not sitting in a sump, though. It's screwed into the bottom of the piping on the Annulus Gas System which allows it to detect a very small amount of water.

But the primary defence is actually the rate-of-rise of dew point. The Annulus has been done on that. Our operating limits and conditions were pretty significant.

So for example, we do actually monitor the flow on all the Annulus gas strings. This is done by the operators and we're not allowed to operate if all the strings don't have an Annulus gas flow. The reason they're in series is actually so that we don't have any blockage. So if there is a blockage in any channel it interrupts the flow and, therefore, you know you've got a problem. The dew pointers for sure would saturate if they had seen a high dew point but we're not allowed to get there anyway.

Any significant rate-of-rise is actually monitored in the control room and alarms in the control room. We are required to start a manual shutdown within an hour of a rate-of-rise detection on the beetles and yet -- or sorry, not on the beetles, on the dew point monitors.

And there's various other controls that are part of our OP&P limits and part of our -- you know, based on the analysis we have done, the analysis has all been submitted to CNSC. We continue to look at that.

Indeed, they had many problems with the Annulus Gas System over the years, you know, sort of from the mid-eighties to the late-nineties as we really learned how to use it and make it operate functionally and very -- you know, systematically operate the way it should. But it does operate today pretty much error-free.

Annulus, you know, sets other limits, like dew point must be below -5 degrees. That's to prevent the saturation that you talk about so that the rate-of-rise indication will in fact work and we will see it if there is a leak.

And so I think, you know, it's a big system. It's a complicated system but those operating limits and conditions are well established. They are established based on analysis. They are part of our licence conditions. We can't ignore them. We are required to take action.

Beetle alarm; rapid rise in the rate alarm require us, like I say, to shut units down very quickly. We do it manually rather than trip because you don't want to create a stress environment there. You shut down manually, reduce your pressure.

We can't actually find the leak by a variety of methods. You can't find it from the dew point themselves. You can't find it by isolating the strings but we have to do that as we take the reactors off, offline, so you can find which string has the issue and then we can move forward and detect the leak.

THE PRESIDENT: So, look, something doesn't compute. Dr. Greening was -- at one time one of you, I think, chief scientist. I don't know if you actually identified this particular issue at the time.

What he claimed is that you're monitoring the dew point monitor and the beetle detectors don't work. So you either don't -- you either don't -- you either agree with an analysis or you don't agree with an analysis. So is it working or is it not working, because if it's not working, you know, why do you have those systems?

And he also suggested in his presentation there is other things that can measure it better. So I want to hear -- I don't know if Dr. Greening, would he have raised this issue before, and I want to know what Bruce's view was if they were raised before.

DR. GREENING: Well, I spent 10 years working on Annulus Gas Systems and I know that the engineers at OPG who are working on it would confide in me that it’s a nightmare, that it's a complete mess. I've seen those flow rotameters; 48 little ball bearings rising and falling in flow rotameters. They would stick. You tap them and they move. That was due to the formation of this yellow goop which they now plainly fixed up by adding oxygen which, by the way, was my suggestion. Sometimes the oxygen addition system is down and every time air gets in which happens quite frequently, it makes nitric acid and it chews up the dew point metres and they just cease to function. The compressors fail. There is a whole list of problems all the time.

The Annulus Gas System is a nightmare and it was an add-on. It was not really part of the original design and a nuclear power demonstrator didn't have one. It had an open Annulus and they thought they could rely on the rate-of-rise of the dew point in containment. And then they realized, oh, that might take 40 hours, so they decided to put the bellows on.

And I would like to question this notion that, oh, we can detect leaks from the rate-of-rise but once you -- once the dew point meters go blind then you literally have to sit there twiddling your thumbs waiting for a beetle alarm.

And I would ask Frank Saunders, does he agree with this plot or not. This plot, which is from the Bruce B design manual shows 28 hours as a worst case for a beetle alarm.

THE PRESIDENT: Okay. That's a quick yes/no answer. Go ahead.

MR. LORENCEZ: Carlos Lorencez, the public relations for the record.

Whether the system is a nightmare or not is a personal opinion. It's a system. Therefore defence-in-depth, right, it has the dew point; it has the beetles, it has a level indicator and it works fine. It has a reliability of 10^{-3}. So we cannot be operating a reactor -- we cannot pressurize a reactor without Annulus Gas System in service because it would be an OP&P violation.

So the system works. We do not wait for the beetles to alarm. The rate-of-rise is our indicator, right. The dew point oscillates between -30 and -5 and when it goes too fast, the rise is too fast, then we react to it. It works. It works in any of our units.

The latest demonstration of that it worked was in summer of 2013 when we were returning Unit 1 to power in which as soon as we pressurized and started warm-up all the indications came on. And it happened that we had done some work and we concluded it about 22 millimetres, two spoonsful of water have entered the system and caused all the alarms. Of course, we have all our approved procedures to immediately shut down within an hour, shut down the pressure, cool down to ensure that the crack doesn't propagate.

Whether it is a nightmare is another point of view; right?

THE PRESIDENT: Is there experience in the last -- I don't know. How many times did we actually experience, the industry experience leak-before-break? How much data do you have that there was a leak and then you discovered a break, actually documented evidence? Are there lots of cases?

MR. McDOUGALL: Glen McDougal, for the record.

Yes, there are many cases, Mr. President. The majority of the cases happened in the late 1970s and early 1980s.

They were the result of an early design in the method of forming what are called roll joints as the connection between the pressure tube and the large stainless steel end-fitting. The designs were of an early type and so they ran into an unexpected cracking near the roll joints of these pressure tubes. So what you had was a reasonable number of pressure tubes with tiny hairline cracks that were feeding moisture into the Annulus Gas System.

In every one of those cases the tubes demonstrated leak-before-break. Now, industry didn't just sit there and wait for this problem to continue, hoping that their Annulus Gas System would always save them. In fact, what they did is two things. They changed the way that the roll joints were designed and they changed the way that they were installed.

Since then they have made substantial improvements in the way that Annulus Gas Systems are monitored.

THE PRESIDENT: So there are no more recent? I'm talking about the last 10 years. There are no example of leak-before-break?

MR. McDOUGALL: Not in the last 10 years, sir. No, 1986 was the last example.

THE PRESIDENT: Okay. We're still in -- I'd like to jump into some of the specifics but, Mr. Tolgyesi, do you have a general observation/comment?

MEMBER TOLGYESI: Yes, I have two, really.

One is in the last meeting on August 17 and 18, what we said -- the Commission suggested that the flow charts should be modified to indicate dynamic bidirectional nature of CSA organizations.

Now, when you are looking at this chart, I don't see that really there. And I don't see -- you were saying that there is one CSA which was re-categorized from Category 1 to Category 2. How do you do that? Because when you look at that here it doesn't fit somewhere. I mean it's no regulation which is saying how you should proceed.

MR. FRAPPIER: Gerry Frappier for the record.

Yes, I remember that discussion. The categorization of safety issue flow diagram that we have and that we have used again is the one that we had used as part of the categorization. So it is what was used at the time and why we left it.

That's why I wanted to mention specifically that in fact you can -- as new info -- if any new information comes in or if there's -- well, if there is any information comes in where it comes from. Then there is the potential to re-categorize back upwards should the data suggest that that's what you should do.

We had looked at putting it on the drawing but we frankly felt it just added a complexity that the chart was already complex enough. So we thought that we'd handle it with the speaker notes.

MEMBER TOLGYESI: Okay. My second-last, in general, you know when you're looking at this basis for re-categorization of Category 3 CANDU safety issues, you have there -- in each one you have a table which is a kind of table of staff assessment, what's the process. And you have licensee's request for re-categorization. You have specialist's internal memo or email and CNSC re-categorization letter to licensee.

Now, usually is this follow up; first is the licensee's request after the specialist's internal memo and after is acceptance and re-categorization letter; except for two things. One was a computer code and the plant model validation and the other is the SS1, just sump adequacy.

Where it was not in this sequence? It is for some reason or it just happened like this?

When you're looking it's page 13 on your CMD 17-M12.

MR. FRAPPIER: So Gerry Frappier for the record. I'll get Doug Miller to give some details.

But just to be clear, the process you're describing there is the sort of formal documented process as we go through. There is, of course, a lot of back and forth work that is being done before the industry has turned around to submit a -- it doesn't come like just suddenly one day.

So there is a lot of back and forth discussions, review of research, participation in different analytical discussions that would happen before the licensee would have formally submitted a request for re-categorization. Having done that formal request and, as you pointed out, the process requires us to formally capture our viewpoint in a document, the actual technical assessment

But for these particular ones, Dr. Miller, can you add to that, please?

DR. MILLER: I would say that you've described the situation well, is that there's ongoing discussion and the CNSC staff assessment summarize the state of the documentation with licensees and then licensees would reflect that in their submission after.

As we went along we improved on the process. So what you're seeing there is some early items. It's a bit of an artefact, yes, but it does -- there was a process where the CNSC view was stated. Industry came along after with their documentation.

THE PRESIDENT: On page 13 there's a little table. I just want to make sure that the dates you're depicting there are correct. It says licensee. Let's say pick up AA3 BP. November 27, 2004 the request came in -- 2014; then the specialist internal memo is 2012.

MR. FRAPPIER: So, as I was saying, so that -- I know when you look at the --

THE PRESIDENT: It doesn't sound right.

MR. FRAPPIER: Yeah, when you look at the very simple linear progress of the process it doesn't sound right. However, again, these items are being discussed before. There is material that's being produced. In this particular case the specialist had some views -- I'm not sure -- and somebody might be able to help on that date.

I don't know who was -- but oftentimes the specialist input and that would have a request for the licensee to do something. Some kind of criteria are set that might take a little bit of time to do.

But having done that and having met the criteria, they submit the request for re-categorization and if nothing other than that has changed, there's no need for us to reassess it.

We said here's the problem. Fix this and then you'll be able to be re-categorized. They come in and say they've fixed it and that's what it would be.

So it's along those lines.

THE PRESIDENT: I would strongly recommend you check your dates here. None of the other tables has this peculiarity, so I would lay odds that something is wrong with the dates here. I could stand corrected but it's bizarre that all those three items, the only place in the tables where it's -- the sequence looks to be out of step.

MR. ELDER: Just to add -- Peter Elder for the record.

So one of the things I did was do the quality assurance on this one. So we checked those dates three times and we checked the situation that, yes, they are the right dates where it was research-related. We had the results of the research but the licensees had to come back and actually formally give it to us and ask for closure.

THE PRESIDENT: Well, in that case you should put a footnote explaining this.

MR. ELDER: Yeah.

THE PRESIDENT: It doesn't sound right.

MR. ELDER: Because it was looking -- and we did notice it, we went into it to make sure there was a concrete story. In hindsight, yes, we should put in the footnote.

THE PRESIDENT: Okay. Thank you.

What I would like to do now is I would like to go to the staff slide, starting with Slide 37 because that will take us through all 74 issues, okay. And we will take as long as we need to to deal with them.

So we're dealing with Category 1 and slide

38 and 39, those are CANDU issues where no comments were received. So I'd like to ask my colleagues here. Is there anybody that has an issue about them or do we accept them as in the right category?

Okay, silence is golden. I assume this is approval.

So then let's look at slide 40, which are seven issues for which we received comments on Category 1 issues.

Okay. So on these seven issues we did receive comments and some of the Staff comments on those comments are shown in the following slide. So the first one is AA2, the adequacy of plant data used in accident analysis.

So here, Dr. Nijhawan, you had a comment? I don't know if you want to add anything to Staff comments? I assume you've got a copy of this slide deck?

DR. NIJHAWAN: I am sorry, I am not in tune with you on the exact page.

THE PRESIDENT: This is --

DR. NIJHAWAN: I was actually looking at the report, not at the presentation.

THE PRESIDENT: The Staff presentation, I'm using it as a template to follow through all the 74 issues. These are Category 1 issues which you commented on, and that is AA2, adequacy of plant data used in accident analysis.

DR. NIJHAWAN: I'm sorry, I'm not in tune. It will take me two more minutes, sir. I was only looking at the report and not at the presentation, because the presentation was not used so far.

THE PRESIDENT: This is in your report. Which report are you looking at? Are you looking at CMD 17-M12?

DR. NIJHAWAN: Yes, sir.

THE PRESIDENT: So I think it was on Appendix -- page 50.

DR. NIJHAWAN: Right.

THE PRESIDENT: So you have comments on AA2, AA4, and AA6?

DR. NIJHAWAN: Right. I'm looking at number 23.

THE PRESIDENT: So any additional comments you want to make at this stage?

DR. NIJHAWAN: No, I don't.

THE PRESIDENT: Okay. So I'm now on slide -- members, anybody, you have questions? You'll jump in when you have questions?

I'm on slide 47 on SS1, emergency core cooling, sump screen adequacy.

Again, Dr. Nijhawan, you spoke about that in page 52, 53 and page 47. So these are still Category 1.

DR. NIJHAWAN: Well, actually, I raised a number of questions in all these places. For example, on this page we were talking about external conditions, which are not covered under number 35. Where the external conditions which can be common mode. This really is not covered under this answer.

Also on page 50 there was the question of how many SCRs were raised in this area of quality assurances and analysis. That has not been addressed at all in the answer.

But ultimately, my questions were all -- were qualitative, because I have found that (indiscernible) like the behaviour of bundles, behaviour of the feeders in -- under the (indiscernible) accidents to produce hydrogen, and (indiscernible). What I was looking for was a more complete answer to the problem and more -- better statement of problems, that's what was (indiscernible). That's why the questions are very simple. What about giving a complete answer to the -- complete statement of the problems, all the answers that have been generated.

THE PRESIDENT: Staff, anybody, picked up...? Dr. Nijhawan, we're still having a lot of difficulties in the transmission. But, Staff, anybody wants to reply to this?

MR. FRAPPIER: I think that -- and sorry, the connection's a little bit rough, but if I understand Dr. Nijhawan's comment is that he's not necessarily against the conclusion we've come to here. He would have liked to have seen more information available to him as a technical person to collaborate -- corroborate with the conclusion we have.

So that's not something that we can package into necessarily a chart like this in the CMD.

THE PRESIDENT: Okay. I think we would like to take a break for about 15 minutes, which will get us back to 3:55.

Okay, 15-minute break. Thank you.

--- Upon recessing at 3:43 p.m. /
Suspension à 15 h 43

--- Upon resuming at 4:03 p.m. /
Reprise à 16 h 03

THE PRESIDENT: If everybody is ready, we would like to proceed.

Sorry, let's start again. On Category 2, CSI, and slide 51, and slide 52, and slide 53 are those issues that we received no comments on.

Anybody, Commissioners, any issues you want to raise on this one?

MEMBER VELSHI: It's more a general question for Staff.

Is it okay or is it acceptable from a regulator's perspective for an issue to remain Category 2 in perpetuity, because there are adequate controls in place and the licensees are managing the issue well?

MR. FRAPPIER: Gerry Frappier, for the record.

I guess the answer is yes. As you can see, there's some that have been for quite some time. If the situation is well-controlled, is part of their normal practice. For instance, they've changed perhaps an inspection practice or something, then that would be acceptable.

What makes it still Category 2 is that we'll be monitoring it as well.

THE PRESIDENT: So we are on slide 54 and 55, where we received comments on Category 2. I'll open the floor to intervenors, whether you want to speak to any of those comments.

Dr. Greening?

DR. GREENING: No, we (off microphone)

THE PRESIDENT: Okay. Dr. Nijhawan?

DR. NIJHAWAN: Well, sir, between the categorization on the slides and categorization in the Staff report, and between the original Staff, there is a lot of confusion. But I would like to just point out that without doing any new experiments or developing new computer codes, you cannot move things like issues related to void activity to a different category. You cannot start creating closure of or changing things like (indiscernible) into a nonissue or creating new rules when looking at (indiscernible) or, for example, looking at (indiscernible) which, for example, on page 46, a very very important issue which we have raised for so long (indiscernible) of these reactors. It's nothing even really, as you look more you find out the experiments which were done either (indiscernible) or rather they were done in the plant (indiscernible) working, and (indiscernible) under those conditions is quite different.

Like I pointed out this morning, the loss of thermosiphoning at Darlington will cause significantly severe consequences because the operator has no idea (indiscernible).

So closing the (indiscernible) issue, closing the hydrogen issue, closing the thermosiphoning issue, or all -- recategorizing them into latent issues, I think is wrong. I think that's the way we should look at, whether it's (indiscernible).

I agree with the -- the Commissioners raised the same confusion as I did. Why don't we have one list? Why don't we talk about the Fukushima action items in the same list as these items? Why don't we talk about some of the other newly-raised issues and why there have been no new (indiscernible) all these years? In one place, and then we categorize them. For somebody to say (indiscernible), it's very difficult to do that. Let's do them per subject basis.

But my main complaint, sir, is about the three main things. That we have -- and one other thing, for example, we don't really look at containment testing the same way as we used to and our study suggests. But I'm told, and I'm never inside the plant, that between Bruce, Darlington and Pickering, the pressure testing of containment and vacuum building every six years has not been done. Not been done? Why are we not looking, sir?

If we had everything in one place.

For example, a two-million-litre leakage of irradiated water -- or not irradiated, activated water from the shield tank at Point Lepreau for the last 32 years. What are they doing with that water? Is it not a safety issue? Today, after all these years, that system has not changed. We continue to lose 8 kilograms an hour of water. Within -- I have some pictures of that and, quite simply, you look at them and they're flooding. You could tie on tubing and plastic buckets to collect the irradiated water. I have no idea in any of these reports what happens to that water.

But setting that aside, the (indiscernible) issue, the hydrogen issue, and the containment issue. These are, in my mind, the three issues, in addition to multiple other issues which have been closed, downgraded, or turned into acceptance just because some work has been done (indiscernible), some work has been done at some (indiscernible) labs. Are those issues closed because there are doing some experiments in Point Lepreau -- I'm sorry, in Chalk River? They're not, you know.

Then suddenly they start saying the deuterium/hydrogen issue has been -- differences have been studied for years. The word deuterium didn't come into the vocabulary until about two years ago, until they started raising hell about it, (indiscernible) started raising issues about it.

So, please, all I request is -- a lot of this stuff -- a lot of good work has been done, but for the last 20 years or so no experiments have been done, no computer codes have been developed, science has not been progressed the same way the other people are doing.

When I go and see people in China and Korea doing fundamental experiments and they're not doing this because it's only decided (indiscernible) experiment released in 1980, and (indiscernible) hired me in 2006 to comment on that, and I did. Those experiments are nice, but they were done with electrically-heated bundles which cannot be translated into behaviour of regular (indiscernible) experiment.

So when (indiscernible) bothers me. What we should do is listen to our Commissioners who said let's put them all in one place, and take my position and let's write a summary of each one of them and say, how are they (indiscernible) I, personally, see no reason to foreclose on the hydrogen issue. We are far away from closing it, we are very dangerously stepping in a location that hydrogen will be produced and no system to take care of it.

THE PRESIDENT: So let me --

DR. NIJHAWAN: Yes, sir.

THE PRESIDENT: -- so let me understand. My understanding is that nothing is closed here, but Staff and industry, do you want to elaborate?

MR. FRAPPIER: Gerry Frappier, for the record.

So just a couple of things, first of all, and that's why it's important to make sure we have facts that are correct. So containment testing is occurring, so --

DR. NIJHAWAN: Every six years at every plant?

MR. FRAPPIER: He's throwing those things out.

DR. NIJHAWAN: (indiscernible)

MR. FRAPPIER: They're not part of the discussion today.

THE PRESIDENT: Excuse me. One person at a time.

MR. FRAPPIER: So the hydrogen management, as you say, is still here on our list. However, it's not true to say nothing's happened. All the plants have been upgraded with PARs now for hydrogen management. It's a very very -- he will argue whether it's effective enough, but nobody can say that nothing has occurred. That's a very major design change to increase the safety and the management of hydrogen. In our opinion, it's sufficient. In his opinion, it’s not. But it's not that nothing's happening.

As you were just mentioning, the reason we're putting all these in front of us again is because they haven't gone away. We are monitoring them. But it is important to know which ones need focused regulatory attention and those are the Category 3 items, not the 2s and the 1s.

MR. SAUNDERS: Yes, Frank Saunders for the record. I think it's important to stress a few points here.

Dr. Nijhawan makes a lot of very bold statements, most of which are simply not correct, right. Testing has not stopped. In fact, testing has increased over the years. Certainly, if there is no fundamental research going on, I'm paying somebody an awful lot of money to do something. I'm not sure where that money is going, but as far as I can tell it's going into fundamental research. And the codes and standards have been advancing continuously. We work on new codes, new standards.

Large-break LOCA is a good example where we have spent 10 years developing new codes to allow us to make better predictions about pipe break, opening size and time, and so forth, and we are at the point now where we are turning those things into actual safety cases for the plants. It will take another couple of years to finish that.

But there is just huge amounts of work going on. I would say there is more work going on than there ever has been in the industry and so I take great exception to some of those comments. And I have listened to him for several days now and it has kind of gotten to a point where I think we just need to say that a lot of those facts are simply not facts, it's not correct and --

DR. NIJHAWAN: Well, can you say --

MR. SAUNDERS: I respect your opinion, Dr. Nijhawan, but it is your opinion and you are not looking at the current facts.

DR. NIJHAWAN: It's not an opinion, sir. It's not my -- it's a simple question: Has every containment in these three multiunit plants been tested for pressure, both in the vacuum building and in the reactor building every six years as required by (indiscernible);

yes or no?

MR. SAUNDERS: The vacuum building doesn't require a test every six years, it's every 12 years. We follow the CSA Standard which requires us to test both containment and the vacuum building on a set frequency. We have just done them at Bruce over the last few years and we still have to do the vacuum building at Bruce A I think in the next four or five, I can't remember the exact timing. So the tests go, the CSA Standard is there, it's an approved standard, it's the approved way to do it and we follow it.

DR. NIJHAWAN: (Off microphone).

THE PRESIDENT: Okay.

Commissioners, question on this Category 2 feedback that we received?

Dr. McEwan...?

MEMBER McEWAN: I have a question on MA 13, which is on slide 55 of the staff deck, and it's Dr. Greening's question from 16-M34:

"Availability of R&D, technical and analysis capabilities for each NPP".

So I think there are sort of three things that come up to me out of this. As I read Dr. Greening's original intervention, there was sort of -- if I again can paraphrase what you have written, there were three questions. The first is the R&D capability, the second is knowledge translation, and then the third is ongoing review. So if I understand it, the way the R&D piece works, there is an element in each NPP, there is some done by CNSC and there is some done by the Operators Group, the CANDU Operators Group.

So if I take those three very simplified -- I hope you will accept those -- ways of looking at this intervention, are those issues that are likely to be affected by for example budget cycles or do you have a committed component of budget that is put into R&D activities and that is put into knowledge translation capabilities, and do we check it?

MR. SAUNDERS: I mean, I think the general question is, yes, I mean we do commit a lot of money to R&D and to training and knowledge bases. It does fluctuate with the need. So we have specific commitments with CNSC and others that we must fulfil of course. We have other commitments which we want to fulfil because it affects our knowledge of the reactor and our ability to predict the maintenance or other activities we will need going forward.

So the answer is: Is there a considerable budget allocated for those things? Yes. Is that an actual fixed amount? Not really. I would say it has a tendency to be an ever-increasing amount, from my experience, quite frankly. It hasn't really gone the other direction anytime in my history.

So yes, I think the training of people in that is probably the one that requires a lot of attention and our training programs today -- you know, I came into the industry 35 years ago and I will tell you that the training programs today, especially the technical programs, are leagues ahead of where they were when I entered the industry in terms of your ability to really know and understand the specific technical details that apply. We got a lot of operations and system knowledge when I came in, but you got much less of the specific technical metallurgy and those things, which today we are very good at training people on or making sure that we pick people with the right knowledge in those areas. And certainly with the aging workforce that we are all subject to in Canada, we have for the last 10 years been focusing on those young people and those people coming in that can do it.

We also are very conscious about the consultants and specialists that we use, so we are very conscious about maintaining a pool of those people that are capable and trained and so we think in our contracting strategies and other things about how to make sure that there are solid groups there that survive and have the technical capabilities. As far as this goes, of course we need it in the long term. Otherwise, we would all of us have to staff up to do those things and it's more advantage. So we do think about it, we are very -- we are in a technical business, so we know that knowledge is important, we are very aware that that needs to be maintained and we spend a lot of effort making sure it gets maintained.

MR. MANLEY: If I could add -- Robin Manley for the record -- just on that last point that Frank was just speaking to. For a number of years CANDU Owners Group on behalf of the licensees is also reporting to CNSC staff through a COG R&D maintenance capability report where we sort of status the ongoing capability in the broader technical nuclear industry, in the R&D programs.

MR. FRAPPIER: Gerry Frappier for the record. If I could add from staff's perspective.

So as was just mentioned, we have at least once a year a review of the industry's research program that Mr. Dermarkar talked about this morning. We also work with AECL. We are on the Board of the Steering Committee for the federal government funding that goes to CNL and what it's going to be used for. So we are considered a prime stakeholder in the government-financed research that goes on at CNL and we have ability to influence it.

I think the second part of the concern here was with respect to personnel. So we do have a REGDOC-2.2.2 that has requirements with respect to personnel training and identified positions, which is part of the licensing requirement that we have talked about often on relicensing, as to how that's done and it has some strict requirements that industry must meet.

MEMBER McEWAN: Dr. Greening, can I just ask one question? Why is this a 2 and not a 1 then if everything is going as well as you tell us?

DR. MILLER: As we have worked through this -- it's Doug Miller for the record.

As we have worked through the review of the CANDU safety issues we have identified that there may be some Category 2s that are candidates for Category 1. It doesn't mean we would never look at them, it's that they might be suitable given that they could meet the criteria. We are still having those discussions.

MR. FRAPPIER: Gerry Frappier for the record. If I could add to that.

So last time we went through these things there was a lot of discussion about what was going to happen to Chalk River. There was quite a bit of concern within ourselves -- within the regulator with respect to the capability, not so much the personnel training that is going on at the licensees, but the infrastructure, the science infrastructure that was needed. The Government of Canada was changing to a GOCO, government owned/contractor operated process at AECL. It was not clear there was going to be -- what kind of funding that was going to be associated with the government research in nuclear safety and that. So we had -- we wanted to keep it a little bit more active as far as our looking over that. As Dr. Miller said, that's now starting to settle down. We seem to have a better idea how that is going to work and we will probably review this.

MEMBER McEWAN: Dr. Greening, does that give you a sense that there is actually forward movement and that some of your concerns are less important as we move forward than they might have been looking back?

DR. GREENING: Well, a couple of comments. Frank Greening for the record.

I worked at Bruce Power just recently for three years and I found it very disturbing that the -- for example, the guy who was managing Bruce B Chem Lab was an electrical engineer and I couldn't have a conversation with him because he's an electrical engineer. And the person in charge of environmental emissions has a degree in Crop Science. So these people are qualified but with the wrong subject matter material. This is very common at Bruce because there is a lot of nepotism at Bruce. Family members, you can find names and you can trace them, that the father, the son, the daughter are all working at Bruce. It's a great employee agency. So I question this thing about, oh, our training is just perfect. I have come across this as well at Darlington and at Pickering, chemical engineers running mechanical engineering, and so on and so on. So it's not just the training, it's who is being trained.

And on the topic of research, when I was in Working Party 35 back in the 1980s, we were spending $10 million a year to research pressure tubes. Working Party 35 was corrosion and hydrogen ingress. In the 10 years I was in that group we spent $100 million and the progress was zero. And they are telling, oh, they are still at it. Forty-five years of running CANDUs and all I hear is, oh, we are on it, we are doing lots of research. They are dismantling these reactors at Darlington and these guys are still doing research. So that's my comment.

THE PRESIDENT: Does anybody want to react to that? I particularly want to know about whether staff, do you ever look at the kind of research that comes and the quality of research that is being produced?

MR. FRAPPIER: Gerry Frappier for the record.

As mentioned, we take a look both at the plan of the research, but any of the research that we consider is important from a safety perspective we would have designated specialists that would be following the research. In some cases we will actually be looking at some of the objectives of the research to make sure we are comfortable that that is going to provide information we want.

And I would like to -- so we are happy that there is high-quality research going on and that we are familiar with it and we know what the results are.

I disagree with the last comment as to why we are doing research. We are always going to be doing research and, as a matter of fact, that's one of the things we are requiring them to do, both because there are aging mechanisms at work, there is research that's a good training ground to produce people who have the technical skills that are needed, and also because there are improvements that can be made, improvements that can be made in analyticals, improvements that can be made in understanding of fundamental material properties, or whatever the case might be, that may end up being very useful for us in a circumstance that we don't know about that's coming around the corner.

So I would never want to discourage research. I would want to be encouraging it.

THE PRESIDENT: Industry, you may want to answer also, but I'm curious to know, do you have a policy of conflict of interest, internal conflict of interest, family issues, things of that nature?

MR. SAUNDERS: Yes, absolutely, I think everybody does. Of course Bruce being in a rural area, in a local area, yes, you will see members of the same family working there, but that happens. There are various rules around it. You can't have your family working for you for example, people have to be separated and not in those things. You do have to be qualified for the job you do. Some supervisor jobs don't require you to be an expert in the field. The technicians are experts and we have what we call a functional area manager who needs to be an expert in the field and they oversee both Bruce A and Bruce B operations.

So, yes, that happens and it would be near impossible to operate a large organization and have everybody be a technical expert in a field. You just -- it's very hard to manage staff in that way but you do need to make sure that the expertise is in fact there, and we do that. You know, it's obviously in our interest to do that. So, yes, you will see that there are family members at the Bruce. You won't see them being supervised by family members though, that is not allowed. And their interviews are not conducted by family members, so you can't -- you know, I couldn't interview my son for example for a job, somebody else has to do that. I have to declare a conflict so that people know and so forth, so that people are being hired on their merits, not on the fact that they have a family relationship.

So especially in the professional positions it's much more -- much more individualized in how you hire people. And there are minimum hiring criteria, so you need to have certain things before you can even get the interview, let alone get the job. So if you don't have those things, you wouldn't even get an interview, let alone get hired. It is not that easy to get into those roles. So, you know, I think it is just an unfair comment, quite frankly, to make.

And yes, we will always be doing R&D and we will always be doing more in R&D. There has been a lot of results and a lot of changes because of R&D. We talked about some of them earlier. You know, the annulus gas system that we talked about is one that's benefited from that R&D and from all the analysis that has been done over the years. Indeed, the system when we first started using it in the early '90s had a lot of problems, but it actually works quite smoothly now and various issues that were there have been cleaned up and that's because we did the work to make it so.

THE PRESIDENT: Commissioners...?

Mr. Tolgyesi...?

MEMBRE TOLGYESI : Merci.

I will turn this question a little bit towards CNSC staff. So could you give us a short résumé on the hiring requirements and the training procedures and programs at CNSC when you hire somebody who becomes an inspector or how it goes with promotions?

MR. FRAPPIER: Thank you for the question. So that one is related to the CNSC staff and we have not talked about that, so thank you for that.

Yes, we have a hiring criteria obviously and requirements with respect to both technical competencies and ability with respect to behavioural competencies. Depending on the position you are going into, there is very specific training. So for instance if you are going to be an inspector, we have an inspector training program that one has to go through and have on-the-job -- a certain amount of on-the-job experience before they will be issued an inspector card. If you are a specialist, then you are expected to be hired because of your technical background and your knowledge. That will be supplemented with courses either here in Canada or typically elsewhere that will bring you more up to speed on whatever the latest methodologies are and then you will also be expected to be keeping your professional status up by participating in workshops or international things.

So from that perspective, we have, both on the human resource side, job descriptions that have sets of requirements that can include obviously education and that, but also experiences, and a progressive step promotion, if you like, based on experience and abilities.

MEMBER TOLGYESI: So when somebody becomes an inspector, he should have a kind of technical background and some knowledge, because you know when you hire say a young graduate and he is coming to the industry as an inspector, I suppose from industry, from the employee's side there is a kind of perception that who is this young man. In French you call that blanc-bec, how much he knows, you know, he will not show me how he wants to inspect me.

MR. FRAPPIER: Gerry Frappier for the record.

Yes, you're right. And especially we have just gone through quite a program over the past two years to be staffing with new graduates, both male and female I would suggest, so it's not just he, it could be her, and they come in with a certain amount of technical background, typically engineering or some kind of science. As I mentioned, we have an on-the-job training program that they will have to be going through. They will have to then -- sorry, some training programs, coursework and that that they have to do. Then they have some on-the-job training, that they must, you know, have participated in a certain number of inspections and whatnot, to the point where they get the -- have the requirements to get an inspection card. But even once they have the inspection card, as I mentioned, there are junior inspectors and there are senior inspectors and people in between. So there is -- the site supervisor has a responsibility to make sure that the person is getting the experiences needed before they can progress to the next level.

There is also designated officer status for some employees, not so much the inspectors, and again that is training that is done within the CNSC, both through coursework and through structured interactions with legal personnel to ensure that people understand the various legal requirements as a regulator and our powers and authorities to do things. So there is quite a bit of encadrement, if you like, as far as the new employees.

MEMBER TOLGYESI: My last question is industry. Do you think or do you feel that there is -- there are fields where staff expertise may be improved or should be improved?

MR. MANLEY: Robin Manley for the record. Could I just ask you to clarify? Are you referring to CNSC staff or licensee staff?

MEMBER TOLGYESI: I'm talking about CNSC staff now.

MR. MANLEY: Ah, okay. Robin Manley for the record.

So as in any area there is always an opportunity for improvement. We recognize that in, you know, training of our own staff and notwithstanding, you know, anything that anyone such as Frank has already said about our own training and development program, where, you know, nonetheless we are always seeking to improve that.

And we recognize that there are, you know, new junior CNSC inspectors who are at our sites and, like any new person on the job, they have an opportunity to learn and grow, and sometimes that means that we spend a significant amount of face time with them answering their questions. I think it would be fair to say that we have observed lots of questions arising from relatively new staff and that's okay, that enables us to answer their questions. And, you know, they probe, they have a questioning attitude and they learn from the experience.

We have also observed some of the site CNSC inspectors participating in our very in-depth training programs. We have a five-month advanced operations overview for managers course that we put on. It's not as in-depth as our control room shift manager course obviously, but it covers many of the same topics. And some of the CNSC staff have participated in that as a learning experience and we welcome their participation and, you know, they bring a fresh perspective to those courses as well, so our own people learn from that as well.

THE PRESIDENT: On that particular item, do you find it difficult to find expertise that you need in the recruitment from university? Do they produce enough -- the kind of expertise you actually need moving forward?

MR. LORENCEZ: Carlos Lorencez for the record.

We go to universities and we select the crop of the crop as well, right. So we want to ensure that the new grads that come to the company are exactly coming to the areas that we need them. So we look for new grads from U of T with nuclear engineering backgrounds, we look especially for chemical engineers, mechanical engineers, civil engineers for our organization. Once they arrive, we subject them to what we call core training. It's a two-year program in which they need to take a number of courses to become fully qualified to become an engineer in our company. So once we receive them, we give them additional training for years and after that period we give them some extended core training for specific positions in the company as well. So we have no problem finding the proper new grad that wants to come and explore certain areas of the company.

Also, what we do is what we call knowledge transfer. We associate one of these new grads with a person who is close to retirement, so it is a mentor-mentee relationship in which we absorb the experience from those people who are about to retire and we pour it into all the new grads just to ensure that we -- we call it this knowledge retention and knowledge transfer for the good of the company.

THE PRESIDENT: Thank you.

Dr. Greening...?

DR. GREENING: Thank you.

Based on what we just heard, I would like to ask CNSC staff to comment on this, that CNSC inspectors have had to complain to the union, their union, and have received counselling over their treatment in nuclear plants because they complain that the station staff question their credentials, don't take them seriously, insult them, et cetera, et cetera. That doesn't seem to be consistent with what I have just heard from everyone. That's my question.

MR. FRAPPIER: Gerry Frappier for the record.

So first, to be clear, all the CNSC inspectors at nuclear power plants work in my group, so I'm very familiar with them. I'm not exactly sure where he's getting the quotes he is getting from, but I would point out that it was something that the Auditor General recently came in and looked at how we do inspections at nuclear power plants, very detailed, and although they had some things they wanted us to improve, the one thing that they mentioned that was rock solid was that in everything that they looked at, 100 percent of the time when an inspector wanted something done, the licensees did it. So I don't think there is any evidence that the licensees are taking inspectors -- CNSC inspectors lightly. The results of our inspections are always dealt with promptly, as expected. So I'm not sure where he is getting his quote from.

DR. GREENING: This was on the -- I have forgotten the name of the union that the CNSC inspectors belong to but there was an article about this and I find that very disturbing. And I also worked at Bruce Power for three years and I can tell you there are plenty of people who have nothing but contempt for the CNSC. They would joke about, "Oh, we are dealing with the CNSC, no problem." I sat in on meetings where Bruce Power staff were telling CNSC staff what they would do and what they wouldn't do and the CNSC staff were very compliant.

MR. FRAPPIER: I think Mr. Jammal would like to add to this.

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

I'm not sure what the discussion between the staff to the union. We are a scientific organization with respect to debate with licensees or internal debate. One thing I would like to clarify to everybody, and the public, that it is embedded in law that the cooperation with the inspector is in our Act and any failure to do so is very severe consequences by the licensee. So the hearsay is hearsay. If the evidence ever comes before me or before the Commission, action will be taken. It is in our law that cooperation by the licensee is a must. We have applied our regulatory oversight accordingly and we will continue to do so. So if Dr. Greening has any evidence, I would like to look at it.

DR. GREENING: Well, I can name the head of Rad Protection, Maureen McQueen, was in on a meeting discussing the alpha event and she was running the show. She was telling the CNSC -- the CNSC wanted to know about Iron-55. Maureen McQueen said, "It's not important, we are not going to talk about Iron-55." And the CNSC staff said, "Okay, Maureen, that's fine."

MR. FRAPPIER: Gerry Frappier for the record.

So I mean there is a normal banter that would be going back and forth. Inspectors are perhaps not the expert on that particular system. We certainly do not want to be suggesting that the licensee would do something and they would blindly do it without having any view as to the consequences. So there is certainly an ability for licensees and an expectation for licensees to be letting us know what is within the realm of possibility or what is not or what is more difficult. The inspectors know that they have, as Mr. Jammal has said, the full force of the law behind them if they want to force something. They also have a supervisor and perhaps if it's a junior inspector, to go to a more senior inspector as far as how to deal with things. Our site supervisors have complete open door with respect to getting to the senior management of Bruce or OPG or New Brunswick Power, so if there was any real concern about how an action was going to be done by the licensees, then there are certainly methods of making sure that that is raised to the appropriate level. So I can only assume that when the information that you are talking about, if that is true, made sense to the inspector once they had heard the rationale around something.

MR. SAUNDERS: Frank Saunders for the record.

You know, since Bruce has been mentioned a few times here, I felt like I ought to say something. I mean of course we have some interesting discussion with CNSC inspectors or staff who are down on the back and forth, but at the end of the day if the inspector wants something, the inspector will get it, right. I do the internal inspections for Bruce Power in many things and I can tell you sometimes they don't like me very much either. So what, quite frankly. You know, they tell me what they think and I tell them what they are going to do and we go forward from there, right. And it's the same with CNSC inspectors. If they don't get what they want, they can escalate to their supervisors, escalate to me. At the end of the day, CNSC has the right to request anything of us and if they request it, we provide it. The fact that an individual staff member might think they don't need it, well, that's interesting, but it's really neither here nor there, at the end of the day it's not the rule. As Mr. Jammal has said, legally we are required to provide it, we can say we don't think you need that, but in the end of the day if they feel they need it, they will get it.

THE PRESIDENT: Ms Velshi...?

MEMBER VELSHI: Given the seriousness of the concern that Dr. Greening has raised, particularly about inspectors feeling that they are getting dismissed or ridiculed or not being heard by licensees, I think it would behoove Mr. Frappier and Mr. Jammal to just confirm with the unions that that concern indeed has not been raised.

MR. FRAPPIER: Gerry Frappier for the record.

So certainly anytime we have information, we are going to, you know, look and see what we have to do about it. We do have very regular meetings with staff. There's lots of opportunities for them to raise concerns and I can certainly -- or I will be looking into this one a bit more carefully, a bit more specifically.

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

To add to Mr. Frappier, I personally videoconference with site staff on a monthly basis at minimum, without any supervisors present, just myself and the staff. One of the questions that will be always talked about, what do they have to say, and when staff approach me about actions against licensees, we -- full power was given for our staff when issues are raised. It has been documented as severe as staff were ready to issue orders and they have the full -- full capacity in order to make their own decision. And one thing that has been demonstrated by the OAG audit, that 100 percent of the action notices or notifications or compliance activities were closed to our satisfaction. There was not one item that was not closed properly. So that demonstrates the power of the inspector. I will take into account the fact that we have frequent discussions with the union, it's called a Labour Management Committee, where issues are raised by the union, let it be safety culture, issues pertaining to staff within the union, and we have that discussion. So there is always ongoing discussion and, to be honest with you, that is the first time I'm hearing an allegation made that staff were muzzled by a licensee.

MEMBER VELSHI: But you are going to follow up with the union and just make sure that there isn't any substance to it?

MR. JAMMAL: We have a Labour Management Committee meeting coming up shortly and that will be one of the things we will be adding to the agenda items.

MEMBER VELSHI: Thank you.

THE PRESIDENT: Okay. Any other issue on the Category 2 items that we have comments on?

So what I would like to do now is move on to Slide -- let me find my way here. I'm looking now at Category 3 CSI and we got comments on those four items and they are -- now it's Slide 86 and I think we got comments on these. So any of the intervenors? Dr. Greening...?

DR. GREENING: Well, I'm assuming we are going through these number by number and I don't see where we have addressed Slides 63, 64 or where we have even addressed Slides 56, 57, 58, 59.

THE PRESIDENT: Well, those are the slides that I asked for comments because they were Category 2 issues that received comments. So if you want to make any comments on those slides, now is the time.

DR. GREENING: All right. Yes.

I'm talking about Slide 65, about the annulus gas reliability, whether CNSC claims that it has made improvements to the annulus gas operating mode and to the leak detection capability. I fail to -- I am at a loss to know what those improvements are. Could someone please explain what improvements have been made?

THE PRESIDENT: Okay. I thought we started to discuss this in a previous discussion. So any additional comments staff can make care here?

MR. FRAPPIER: I would ask Glen McDougall to add to that, please.

MR. McDOUGALL: Glen McDougall for the record.

I guess I will go through the bullets in order.

In terms of the annulus gas system operating mode and the annulus gas system composition, there has been a clear evolution in the last 30 years in the way that the annulus gas system is operated. For example, in terms of the gas that has been used, as Dr. Greening pointed out earlier this afternoon, if you go back to the 1960s with the nuclear power demonstration reactor, there was no recirculation or added gas for that matter. The annulus gas system was basically open to the air in the reactor vault and there were a number of problems with that, the biggest of which was severe corrosion of most of the components inside the vault from production of nitric acid.

When the first power reactors were built, there was a decision to switch over to recirculating gas mode because that would give you superior leak detection capability, and the earliest reactors in fact used nitrogen as a gas. But industry learned from that experience there were two different problems with using nitrogen. The first was that it created a radioactive specie of carbon which generated emission problems that the plant had to deal with. And there was also the discovery through R&D that the pressure tubes were no longer being protected on their outside surface. The nitrogen was simply not oxidizing, so there was a window on the outside surface of the pressure tubes for hydrogen to find its way in.

Industry benefited from that experience and made the decision to switch from nitrogen gas to carbon dioxide gas, but, as Dr. Greening pointed out, in the late 1980s and early 1990s they found that under the right circumstances that carbon dioxide could be converted in the reactor into waxy deposits that could cause flow restrictions in the annulus gas system, and that is of course a problem if you are trying to use the annulus gas system to look for leaks. So an improvement was made at that point. Dr. Greening was the originator of that suggestion, that oxygen be deliberately added to the carbon dioxide gas so then the oxygen would act to basically eat up these waxy deposits and also maintain the oxide on the outside of the pressure tubes to protect them from picking up hydrogen.

That recirculating gas mixture of CO2 and oxygen is in fact where we are right now with the CANDU stations. And since the addition of oxygen, we have no further reports of deposit build-ups in annulus gas systems and the pressure tubes that have been removed from reactors, the R&D that we have looked at shows that they are in fact protected on their outside surface because the oxygen is oxidizing them. So this is an example of the kind of evolution that has gone on in annulus gas system design and operation.

On the second bullet, the leak detection capability, the earliest leak detection systems were basically beetle alarms and, as Dr. Greening pointed out, they are only really effective for measuring moisture that's actually developed in the annulus gas system. By the time you get to having moisture collecting in the beetle, you actually have either a number of leaking fuel channels or a fairly substantial crack in one of the fuel channels. So industry realized in the 1970s-1980s that you could do much better than having beetle alarms. They moved to what are called dew point monitors, which actually give you a very accurate measure of how much moisture is in the system. It doesn't have to be liquid water, it can simply be a small amount of steam that exists in the annulus gas system when a coolant leaks through a crack in the pressure tube.

But in fact, it turns out that you can go one better than that and all of the new CANDUs and in fact some of the earlier CANDUs have now been refitted so that there is now a rate of rise alarm on dew point monitors. So rather than an operator having to sit in the control room and watch to see whether a dew point measurement is changing every few minutes or changing maybe every few hours, what they really concentrate on is an alarm that goes off when there is a rate of change of that dew point. As Mr. Saunders pointed out earlier, at Bruce for example, when you have a rate of rise of four degrees C in dew point in an hour, that triggers immediate action by operators. So again, this is an example where the technology has evolved in the last 35 years so that we are now at the point where licensees have deliberately set up their annulus gas systems to be able to quickly respond to leaks of any kind into the annulus gas system.

And the last point that I would like to make, I guess I have already touched on it already, is operational provisions to support fuel channel condition. What we mean by "operational provisions" are things like annulus gas system availability criteria. These exist in the operating policies and procedures for licensees. What they do is they are basically a set of rules that the operators have to follow. If any of the criteria cannot be met, then the system is considered impaired and there are time limits and prescribed actions in the policies and procedures. So it's not left to an operator's discretion what has to happen, it is right there in writing in front of them and they follow it. They also have action limits for things like dew point rate of rise and there are fixed criteria in the operating policies and procedures. We have had lengthy discussions with licensees to make sure that these criteria are being followed and the licensees take the criteria very seriously.

THE PRESIDENT: Thank you.

DR. GREENING: Can I ask if the purge frequency, which in some cases gets down to like every 12 hours they have to purge because water is coming in so fast, they are almost in what's known as continuous purge mode, is that a criterion that must be followed and is there a limit on purge frequency?

MR. McDOUGALL: Glen McDougall for the record.

The last instance where I am aware of that a licensee had to go with a continuous purging of their annulus gas system, when they were planning this, they met with CNSC staff and went through a significant amount of analysis that they had done to demonstrate that they still had leak protection -- or, pardon me, leak detection capability for their pressure tubes and they did institute a number of specific actions that would be in place for operators in the control room to take account of the fact that that's a unique situation, it's not a common situation. And we were quite satisfied by the analysis that was presented to us.

DR. GREENING: Is that -- as a supplemental then, continuous purge, is that considered to be an impaired condition and, if it is, how long can they go? How long are they allowed to operate under continuous purge?

MR. McDOUGALL: Glen McDougall for the record.

There is no unique answer to that question. CNSC staff's responsibility is to look at the case-by-case analysis that is presented by engineers from the station who are familiar with the annulus gas system and its limitations, but bearing in mind that the guiding principle is that leak detection must be available at all times. One case that I am aware of, the recent one that I spoke of a few minutes ago, the time limit was 72 hours.

DR. GREENING: Well, I believe Bruce B in 2008, on one of their units, was allowed to go for months with close to continuous purge. Is that considered acceptable?

MR. SAUNDERS: The only thing I was going to add -- Frank Saunders for the record -- was that, yes, the continuous purge mode has been analyzed and shown to be effective as long as you are below -5 degrees C. You only use that really when there is some tort of in-leakage into the annulus gas system. You don't use that to allow you to operate with a leaky pressure tube. So I wanted to make sure that people understood that, right. So if you have an in-leakage into the system, you want to run for a short period of time to figure out where the leakage is. In fact, you can tell that it's in-leakage by looking at the isotope by the water. So we have a cold finger at a sample point where you can take the water off. We look at how the water is made up, whether it's H_2O or D_2O. We can tell whether the water is coming from inside the reactor or elsewhere. So the continuous purge is not the normal mode of operation but can, based on the data you are given, you know, be used for a short period of time. And as Mr. McDougall has said, it's sort of case-specific based on what the circumstances of the analysis is at the time, but it can't be done without analysis.

THE PRESIDENT: Okay. Look, I want a bottom line to all of this. So I don't know who is right, who is wrong, how severe this is. What happens if everything fails with the annulus here? Give me the doomsday scenario that a leak will not be -- you know me, I always asked the same question, what will happen to the station?

MR. SAUNDERS: Frank Saunders for the record.

First off, if the annulus gas system stops operating, then we shut the reactor down. So that's the first step in the process. If it's not working and a leak develops, which is a pretty unlikely thing in itself, and a crack develops and the crack expands and eventually leaks to a point where the pressure tube ruptures, then the emergency makeup in the heat transport system, not the emergency coolant injection but the emergency makeup will kick in and will supply additional water to the heat transport system to make up for the leak and they will recirculate the water from the sump if they need to. You will of course -- if the reactor doesn't trip just based on the disturbance, you will, of course, shut it down.

You will -- you know a controlled shutdown is preferred and you shut the reactor down. You continue to recirculate the cold water, the water from the sump back through the -- back through the reactor to keep the fuel cool and then you eventually move into repair mode to go and fix the fuel or, sorry, go and fix the fuel channel; so defuel it, take the fuel channel out; put a new one in.

So these scenarios do not result in a release to the public and, I guess Pickering is, you know -- like I say, is an unwilling -- is an unwelcome example but it's an example of how that system worked and, in fact, that that tube split quite a long way. It was a pretty severe crack as cracks go and, yet, the system behaved quite normally and successfully shutdown. There was no release to the public. There was no damage to the reactor beyond the tube.

THE PRESIDENT: Okay. We need to move to other issues.

MR. FRAPPIER: Just to make sure everybody is clear, though. Gerry Frappier for the record.

So Frank has introduced an accident scenario now, right. The pressure tube has failed and he's gone through that if that was the doomsday question.

But the doomsday scenario question you were asking, I think, was whether if the Annulus Gas System is not working. Nothing happens. They will be required to shut down the unit and they won't go back up until they have it fixed. But there's no safety consequence to an Annulus Gas System having a problem. It's going to be detected. They are going to have to shut down the reactor and they will have to fix it before they can come back up and operate.

THE PRESIDENT: Okay. I think we need to move on to other issues in this category. And again, I'd like to hear, commissionaires, any issues? I'm still -- Dr. Greening, if you have another issue in this category this is -- this is the "2s" that we received comments on. Otherwise, I'd like to move to Category 3.

DR. NIJHAWAN: Dr. Binder, may I please go back to some of the issues in Category 2? It's Sunil Nijhawan.

THE PRESIDENT: Which issue you want to deal with?

DR. NIJHAWAN: There are four really important issues --

THE PRESIDENT: Okay. By now -- excuse me, by now I would really like you to identify the issue you are trying to talk to.

DR. NIJHAWAN: Hydrogen control issues.

THE PRESIDENT: Okay.

DR. NIJHAWAN: The thermosiphoning issue; the LOCA LOECC issue are three of the issues which -- and the (indiscernible) issues. These are the issues for which I have provided additional information and we have sort of glossed them over.

We do not have a credible hydrogen mitigation system even for design basis accidents because we have reclassified the LOCA LOECC for Darlington into a very benign accident instead of calculating the steam flow which is consistent with the mode of water available inside the heat transport system after the accident, we have (indiscernible) and as a result the hydrogen mitigation system at Darlington, for example, is qualified only for 65 kilograms of hydrogen while in the design basis accidents of LOCA LOECC the amount of hydrogen can be considerably higher once we do a more a complete and a longer analysis.

That is point number one that they let go.

And point number two, whether the heat transport system (indiscernible) issue -- I give you a very simple point.

At Bruce -- I'm sorry. At Darlington -- at Pickering I have come across reports which say the design value is 40 grams a second, protected value is 40 grams a second; for any loss of heatsink scenario, we need 40,000 grams a second. And the only way we can reach that is by using a wrong area. And that's what they did. The valves there are not sufficient.

And I should really go back to an alternative issue is that they demonstrably solve and not just pick up an area out of thin air and say, well, based on that we model -- this has to be very high. I think that's the wrong thing.

The third thing was about the PHT, water being sucked up by the pressurizer inside -- in Darlington and in Bruce and not letting thermosiphoning work.

These are the issues which remain and become -- the three issues and they should be actually fixed up. They are not. They are just being ignored. And I think that is -- that is absolutely -- these are important issues. And I have not understood why LOCA LOECC has been turned into a beyond design basis accident. CANDU owners in India and China and Korea have viewed it -- they look at that as a design basis accident and try to design their systems consistent with that.

I'm having some issues with that and if the staff could tell me why 65 kilograms of hydrogen is all they are going to mitigate inside a reactor that big, then how come seven PARs, which in my opinion would be flamethrowers because they would reach temperatures which are beyond the capability of the containment to withstand the -- once there is an explosion resulting from that. Why they would even be put in there? There should be 75 of them, not seven of them.

THE PRESIDENT: Okay.

DR. NIJHAWAN: So this is -- yes, sir.

THE PRESIDENT: Can you let somebody answer some of your questions, please? I'd like to go in a systematic way one by one, not with a bunch of them. So --

DR. NIJHAWAN: Okay --

THE PRESIDENT: No, let me start. No, let me start now with you raised the issue of hydrogen control. Anybody wants to talk to that?

MR. FRAPPIER: Gerry Frappier for the record.

So he has mentioned a couple things, but with respect to hydrogen, yeah, I think he's in error with respect to saying that it's not the large LOCA with failure. That is the prime generator of or the worst-case scenario for hydrogen generation. That is what we use.

We've talked about it before but perhaps Norredine Mesmous could add a little bit more to this.

MR. MESMOUS: Norredine Mesmous for the record. I am Director of Reactor Behaviour Division and I have with me our experts from hydrogen.

So the large loss of coolant accidents plus the loss of emergency core cooling system is the scenario used for the hydrogen protection and actually this is a design basis accident for the determination of the number of PARs for hydrogen. Actually, there are three scenarios. As presented in Slide 83, you have no flow, trace flow and partial flow.

When the flow is small there is not sufficient hydrogen protection -- production. When the flow is high it becomes a coolant so the event -- there is not high temperatures to the production of hydrogen. And the trace flow is the optimal flow to produce the maximum hydrogen, and that's why it has been chosen for hydrogen production to determine the number of PARs.

And I will pass the question to my colleague to talk about the details on the numbers of PARs for this design basis accident and how many PARs should be installed and actually how many are installed now.

MR. GYEPI-GARBRAH: Samuel Gyepi-Garbrah for the record.

For example, in the Point Lepreau containment, analysis shows that you need only PAR but for defence-in-depth two but, based on the geometry, 19 PARs were installed in the Point Lepreau containment for the design basis accident. So even if the accident progresses to beyond design basis there is that capacity of PARs to handle the amount of hydrogen that will be produced.

THE PRESIDENT: Okay. Industry want to add anything to that?

MR. LOR0ENCEZ: Yeah, the topics mentioned -- Carlos Lorencez for the record -- the topics mentioned are the same ones we discussed in the morning.

Yes, hydrogen as has been explained, we know all about it for the design basis accident and beyond design basis accident. For Pickering; for example, our units in the Pickering, 5 to 8, each of them has 30 units, three PAR units because it depends on the geometry and all that.

For Darlington, for example, it's 3-4 for the whole station because the geometry of the containment and confinement are slightly different.

So we have looked into all these issues, the LOCA, loss of ECI, and we are following the REGDOC 2.4.1 and in that is described the frequency of 10^{-5} as the division between design basis and beyond design basis.

We are not -- we are talking and discussing and working on with the CNSC staff about those numbers. We are implementing the REGDOC in our licences and it doesn't mean that the LOCA plus loss of ECI is going to disappear. No, we used it for the same purposes at the stations. We are not going to change the design now. So the concern about LOCA plus loss of ECI disappearing is unnecessary.

DR. NIJHAWAN: Excuse me, at this point -- I apologize. This particular statement came from your document which said that LOCA plus loss of ECI is a beyond design basis accident now.

And secondly, there's no way you can tell me that Point Lepreau requires one PAR for a design basis accident. Where you would place that one PAR? There are 56 different rooms within the hydrogen can go and definitely the number of PARs for a design basis accident required is very small. But to say that this is sufficient for a beyond design basis accident is totally irresponsible?

THE PRESIDENT: Why are we talking about -- why are we talking about one when there are nine in there --

DR. NIJHAWAN: There's 19, sir.

THE PRESIDENT: -- 19.

DR. NIJHAWAN: Yeah, but you -- in Point Lepreau they need 75 for a beyond design basis accident --

THE PRESIDENT: Okay.

DR. NIJHAWAN: -- beyond design basis accident we're fine, sir. But beyond design basis accident we're not. But they made the statement that for beyond design basis accident these PARs are sufficient. That's what they said. And as far as flow is concerned, something has been changed.

We were doing hydrogen -- I'm sorry -- LOCA LOECC analysis with 10 to 15 grams of steam for (indiscernible). For Darlington it has been done with 0.1 grams of steam which gives them total a hydrogen of 65 kilograms for 500 channels. That is a bad engineered conclusion if you do a complete analysis and you also look at hydrogen for feeders. Your total amount of hydrogen for a design basis accident would be at least five times higher than 65 kilograms that you have here. So you're not looking at the (indiscernible) properly and they are putting hydrogen recombiners which when exposed to high concentration will create explosions. This issue is not closed and this is totally --

THE PRESIDENT: Okay. Look, we discussed this in the morning and we discussed it here now. I think it's time for us to -- this issue is not closed. And, you know, you're welcome to --

DR. NIJHAWAN: That's what I want. That's all I wanted. Don't close the issue.

THE PRESIDENT: Okay. So can --

DR. NIJHAWAN: Don't tell me that the number of PARs is sufficient.

THE PRESIDENT: Can I move on to any other issues in Category 2 that has not been discussed?

DR. NIJHAWAN: Yeah, thermosiphoning. How will Darlington reactor and Bruce reactor assure thermosiphoning in case of a loss of power when we do need thermosiphoning, loss of --

THE PRESIDENT: So --

DR. NIJHAWAN: -- when the water from the heat transport system will be sucked into the pressurizer? How will they ever make sure of that and why is that not an issue number one?

THE PRESIDENT: Let's hear from industry.

Industry...?

MR. PURDY: Peter Purdy for the record from Bruce Power.

Dr. Nijhawan identified that we would lose thermosiphoning after a period of time in a complete blackout event. We don't dispute that. It's the following conclusion that there is no heat transfer available after that that is in error.

So I'll start with the operator's action, first of all, is to -- I can wait for you to get to the slide, if you like?

The operator action is to isolate the

pressurizer immediately upon events where there may be a reduction of inventory such as the loss of Class 4 power. That gets the pressurizer out of the equation and allows thermosiphoning to continue. Nevertheless, we have been analyzing this scenario for many, many years and it has been long recognized that the core on entering the pressurizer and cooling down and depressurizing will in fact interrupt thermosiphoning.

That's not the end of the story, however. When thermosiphoning ends there is another heat sink mechanism that takes place that has been demonstrated experimentally, analytically and with the tools that have been validated for that. That one is called intermittent buoyancy induced flow.

And so when the thermosiphoning ends there is still sufficient water even though it's gone into the pressurizer to keep the heat transport system full up into the boilers, not necessarily all the way to the top but into the boilers.

This new mechanism -- essentially the coolant in the fuel channels does vaporize and a vapour bubble forms in the channel. And when it gets large enough because of the difference in buoyancy between the liquid and the vapour, it becomes unstable and goes up the feeders and transfers that heat into the boilers. When that happens the coolant floods back into the channels, re-cools the fuel and that cycle continues over and over again.

The temperature of the fuel remains very close to, near to the saturation temperature of the fuel channel or of the water which is on the order of 100 or less than 300 degrees which is well below temperatures that would fill the fuel or melting any of the fuel.

Thank you.

MR. SAUNDERS: I should just add there that we have tested this experimentally, right, so we know this works. It's not just a paper exercise. This was done actually in the eighties and nineties in response to CNSC requests to demonstrate the ongoing heat sink and loss of power. So this is an old story that's been solved a long time ago.

THE PRESIDENT: Okay. I think it's time to move to Category 3. I would like to hear any comments, any intervention on Category 3. There are four issues in there, listed in Slide 86: systematic assessment of high energy line break effects; analysis for void reactivity co-coefficient; fuel behaviour in high temperature transient and fuel behaviour in power pulse transient.

Anybody wants to make any comments? If

not we can move onto some other general issues here.

Dr. McEwan...?

MEMBER McEWAN: I have a question. Since Slide 86, the staff comment at the bottom, "The regulatory position and path forward for addressing these issues are well established" what is it? Just can you give me a Coles notes' version of what that position is for specifically Category 3 issues?

MR. FRAPPIER: So Gerry Frappier for the record and I'll ask Dr. Miller to give you details. But what it means is that for each one of these four things we have an agreed-upon path forward that is going to result in actions that we hope will get us to the point where we'll be able to re-categorize them to a Category 2.

And Doug, maybe you can go through each one for --

MEMBER McEWAN: Just agreed with whom?

MR. FRAPPIER: Pardon me?

MEMBER McEWAN: Agreed with whom?

MR. FRAPPIER: With licensees.

DR. NIJHAWAN: Of course.

DR. MILLER: Doug Miller, for the record.

Regarding systematic assessment of high energy line break the licensees have followed a methodology accepted by the CNSC and right now for Bruce and Darlington the item is Category 2 because they have completed their assessment and have some confirmatory work to do. For OPG Pickering and Point Lepreau submissions have been received and CNSC is currently reviewing them. So that's a work in progress. Re-categorization would be done if the analysis was appropriate, not just because a submission was made. So the CNSC will do its due diligence in assessing those.

Regarding large LOCA, we had discussed this in the summer but it's a long time since. There was originally five items related to large break LOCA; three remain which is AA9, uncertainties associated with void reactivity coefficient; fuel behaviour in PF10 under high -- and fuel behaviour.

This has been addressed by industry in what's referred to as a Composite Analytical Approach and that the results to date have shown that the Composite Analytical Approach is a viable approach. Industry may want to add to this and now there is an agreement on the path forward for the methodology for doing the analysis for licensing purposes. A pilot was done.

So there is clarity on what work is to be done. Now, it is just a matter of time to do the analysis to demonstrate there is adequate safety margins for large

LOCA.

MEMBER McEWAN: If I understand correctly, and this is a good slide to understand, so the process that you will follow to define this path forward is identify the issues, review ways in which those issues can be analyzed, understood, addressed and acted on.

That would then come back to you for agreement that that process is appropriate and there would then be an implementation process that the operators would implement and follow. You would order it.

Are there timeframes associated with that? Are there deliverables associated with that or is it within a broad strategic objective?

MR. FRAPPIER: Gerry Frappier for the record.

So there would be timeframes that are put to that. The one piece that I would add to your process description there is -- and there has to be demonstrations, no safety issue today; right, so that a lot of these are to improve the analytical approach or demonstrate that what they have said is in fact going to occur.

But, yes, they do come with a project plan, if you like, that has milestones and deliverable dates.

MEMBER McEWAN: So if there was an issue that was not in the 74 but was identified that could pose either an opportunity for improvement or perhaps a safety issue, you'd use broadly the same process in addressing that issue as well? Are you getting away from this idea of there is this list and this list and this list?

The process for a path forward would have many commonalities between lists or issues?

DR. MILLER: Over the last couple of years -- oh, I think it's in the last year -- there was -- we've referred to it today as the generic action items. There is a revised updated process where if there is a generic issue that comes that affects all plants then it would be -- we would call it something like a generic action item. The issue would be described, maybe even like we did in the 2009 report in its detail. Then there would be a discussion about what the appropriate measures were to address the issue. They would commit to a schedule and we would track.

Of course you can only go as fast as you can do the work. You don't put an artificial deadline on it.

THE PRESIDENT: Well, maybe this is a good time to ask. So what's in your view, would be an efficient way to keep us up to date as to what's going on? I don't want to go through another session like this every month to find out the progress you made. What would make sense?

I'm still not convinced that having those 74 generic or 74 issues forever because they were identified by the IAEA some years ago is the way for us to keep a list of all the outstanding issues. I'm not using the right language here. You'll have to help me. I don't know outstanding issues but issues that you are actively monitoring, and maybe we should have another list and you add new ones, if new ones appear.

What's the process to keep us all informed about what's going on and progress made? You may not have to answer it now, you may want to take it and think about that.

MR. FRAPPIER: Gerry Frappier, for the record.

I think most pieces I can answer now and some we'll probably come back.

First of all, if any of the research leads to a discovery item that is of safety significance today, now, we would be bringing it forward to you as we do every month with our NPP monthly report or, in fact, even quicker if it was more significant through an EIR. So, that's one way.

Secondly is, as we mentioned, on an annual basis we're before the Commission and that's available to all the public and the report is available for public comment, in our annual regulatory oversight report.

And in there we -- and I think we have to maybe make it a little bit more clear where these pieces are, and that will be coming to you on an annual basis with updates and as necessary.

I think that as far as the management of all the lists and that, it's one of the reasons we're going towards periodic safety reviews so that, then, each facility will have a detailed safety review that's done on a certain period and within there we will capturing both all of the safety concerns that there might be or safety requests and, then, that can be tracked through their implementation plan of the results of the periodic safety review.

I do agree with you that it's a bit confusing right now with a few of these lists, so it would be better to come back, pull them all together somehow.

THE PRESIDENT: In the same vein, is there an incentive for industry to get all those issues go from Category 3 into one?

MR. SAUNDERS: Frank Saunders, for the record.

In our view, some of the issues in Category 2 and all the issues in Category 1 you shouldn't be tracking at all at this point in time, they're part of our design basis, they're tracked by our normal processes. They're really no different than other issues that we have, they -- just because they came from an EIR report, in our view, doesn't make them special, right.

Some of the issues, you know, Mr. Frappier talked about the process. So, the large-break LOCA issue, for example, that's effective to reactors was, in fact, identified by the industry in the mid-90s when they realized that an assumption in a safety report wasn't entirely true. So, we had notified that and that started that discussion, didn't come from the IAEA.

And the reaction to that was pretty prompt. I think we reduced most reactor power to 60 per cent until we could do enough analysis to put the safety case back on its feet. And, indeed, the Bruce Power reactors are still limited to 93 per cent because of this issue, right.

We have changed the way we fuel, we fuel different directions now than we used to to take out the power pulse. We've done years of work on the analytical approach, the deterministic approach to large-break LOCAs to assume a complete guillotine failure of the largest pipe in the heat transport system.

Nobody else actually does that, the CANDU is the only one that considers that a credible scenario.

The question was, if it's not a credible scenario, what is the credible scenario? And that's what the analytical work is about, is to say this is a credible scenario that we should be designing to and that changes the whole complexity of this.

So, a lot of work has been done on this. So, is it an issue that should stay forefront? Yeah. Is there a motivation for us to close this out? You bet. We're still operating at 93 per cent. So, would we like to close this? Yes, we would.

As we said, we've done the basic model here and now what we're actually doing with that model is putting the Bruce Power detailed data in that model, doing all the Q/A and the verifications that are required to make a proper safety case.

And when that's done -- that will take about two years' worth of work, and when that's done we will present it to CNSC as the safety case and that will be the first attempt to remove these large-break LOCA issues entirely from the record.

THE PRESIDENT: Thank you. I think this is probably a good time to bring in the written intervention from M. Duguay, Professor Duguay.

CMD 17-M12.2

Written Submission from Michel Duguay

THE PRESIDENT: You have a question?

MEMBER TOLGYESI: Yes.

THE PRESIDENT: Okay. M Tolgyesi, go ahead, please.

MEMBER TOLGYESI: My question is, there are two independent reactor shut-down systems. In the case of an accident, to what extent does size or intensity of LOCA may impair the efficiency of these two safety systems?

MR. FRAPPIER: Gerry Frappier, for the record.

I think my short answer would be it does not. Both shut-down systems are designed to operate automatically. The shut-down system one with the rods, they're going to fall, they're going to enter and that will take away the reactivity. Shut-down system two with the gadolinium is going to inject and, again, that will -- in both cases, they'll be effective at shutting down the reactor.

I don't know if anybody else wants to add to that.

MR. SAUNDERS: Yeah, I think -- Frank Saunders, for the record -- it's actually a good point to -- good thing to point out. The CANDU is the only reactor in the world that actually has two completely independent, fast-acting, diverse shut-down systems, right.

And the reason for that, quite frankly, is the void coefficient, right, that's why it's there and so, the design already accounted for that. In fact, in the design basis model it won't affect either shut-down system; in a beyond design basis accident where there is disruption of the calandria vessel itself, it would affect shut-down system two but, of course, you know, it will also remove the water or change the water in the calandria so it won't matter at that point, but, in the initial injection it won't make any difference at all to that.

THE PRESIDENT: Okay. Ms Velshi, please.

MEMBER VELSHI: On Mr. Duguay's -- so his -- the CMD 17-M12.2, staff help me understand, how is this submission related to the CSIs and which particular ones are they related to?

It all had to do with a July, 2012 letter or article and I guess Dr. Binder got that reviewed -- got his submission reviewed by a third party and he's got concerns on the reviewer's comments and disposition of his concerns.

But how is that related to CSIs and which particular one has he expressed concern on? I couldn't find the trail.

DR. MILLER: Doug Miller, for the record.

On the basis of Mr. Duguay's submission, he is making reference to a difference of opinion with John Froats regarding the safety margin for large-break loss-of-coolant accidents.

That is actually related to the five -- the three remaining Category 3 large LOCA items. So, there's a little bit of an intersect there.

The intervention is more about a disagreement between technical experts. So, there's that.

I could quote that the CNSC has quoted that:

> "The CNSC has taken seriously the large-break LOCA safety margin issue." (As read)

And, as Mr. Saunders indicated, there's been a wealth of -- an awful lot of research done regarding, addressing, demonstrating that there's sufficient safety margin.

Aging of equipment and structures is also mentioned and that's one of the safety issues, GL 3 aging.

The dangerous build-up of oxide -- build-up of uranium oxide fuel damage is related, again, to fuel behaviour under high temperature conditions.

And then, on page 4 of his intervention he is actually quoting from the 2009 CNSC Report, the RIDM Report regarding issue PF 18 which is fuel behaviour under post-dryout conditions. And there has, again, been significant research done in that area and that's related to the dryout acceptance criteria for safe operation under such transience. And I've looked at the existing R&D database and fuel behaviour and determined that the fuel is fairly robust up to high temperatures.

So, in fact, he has tied his submission to the CANDU safety issues in various ways.

MEMBER VELSHI: Fair enough, he's tied them, but has he raised any concerns with the path forward that staff have identified?

DR. MILLER: For the record, Doug Miller.

No, and in fact, he's indicating continue doing what you're doing. The CNSC has identified the correct issues and keep working on them.

Thank you.

THE PRESIDENT: You passed over the software issues. Was there anything in there that is new? This is still on his page 4, the last...

MR. NEWLAND: Dave Newland, for the record.

So, I think in regard to the item on software issues, it's actually in relation to the fact that we have REG DOC 3.1.1 which requires licensees to update their safety analysis report every five years.

I believe in the particular case of G2 because they were about to go into a refurbishment, we allowed a delay to that safety report update, but then, consequently, they shut down, so there was no need for the safety report update.

THE PRESIDENT: Thank you. Any other on M. Duguay? No?

Okay. Any other issue that we want to raise on everything that we've just heard today? Any other issues?

Dr. Greening...?

DR. GREENING: Yes. Back tracking a little bit. Basically slide 60, I would just like to ask about something.

CNSC staff keep insisting that they're really into science, research is really, really important. And I consider myself a researcher and I know if I'm looking at a problem I look to the source of the problem.

But, according to the CNSC, what do they say on that slide, they say our focus is on the accurate measurement of hydrogen, not on the sources of hydrogen.

Now, the accurate measurement of hydrogen, as an analytical chemist, that's taken care of, that was taken care of 30 years ago. To say that they're not interested in the source of hydrogen is absurd because that's the root of the problem.

The classic example of that is P3 L9 which was -- that's Pickering Unit 3, tube L9, which had the highest deuterium pick-up of any zirconium niobium pressure tube ever. It was 120 ppm and no one could explain it, but the people I work with eventually came out with this so-called analyst gas hypothesis, which was that the hydrogen was coming in from the outside of the pressure tube because it was reducing -- it was dry and reducing. I studied that pressure tube and what did I find? It was wet and oxidizing.

So they got the right answer for the wrong reason. I believe that that hydrogen is going in by a very strange route that involves nitrogen. I say this because the oxidation of zirconium by pure oxygen is slower than by air. The presence of nitrogen seems to do something. I would say it's too bad that the CNSC are not interested in the sources of hydrogen, and I'd like to ask them why?

FRAPPIER: Gerry Frappier, for the record.

Perhaps the wording is a little bit -- could have been done a little bit more. I think the key focus here was on the research being done on fitness for service for fuel channel integrity. In particular, there has been a lot of discussion around how we determine fitness for service, full power effective hours and hot hours, and we had a whole bunch of those discussions. We're trying to emphasize here that the key parameter here is the hydrogen concentration.

But perhaps I could ask Glen McDougall to give us a little bit more information around the fuel channel research program and that?

MR. McDOUGALL: Glen McDougall, for the record.

Yes, I'll first talk about the hydrogen

issue specifically, and then I can talk about -- maybe take this opportunity to address a little bit about Dr. Greening's comment about fuel channel R&D and what Staff thinks about the status of industry's work.

When we made the comment that CNSC Staff is not focused on the source of the hydrogen, it says, Mr. Frappier said, "Our primary goal is not to delve into the middle of licensee R&D." For the record, I'd like to state that licensees have ongoing R&D programs looking into the source of hydrogen in pressure tubes.

But from our point of view, when we look at the structural integrity of pressure tubes, what we're interested in is to what extent can hydrogen affect the ability of the tube to resist cracking or indeed the formation of cracks in the first place.

When it comes to those issues, it doesn't really matter where the hydrogen comes from. By that, I mean does it matter whether the hydrogen comes from the outside of the pressure tube or from the inside of tube? All that matters is that the hydrogen is present within the tube at a sufficient concentration that you can actually develop a crack.

Our assessments are based on the actual amount of hydrogen that licensees measure in their pressure tubes. We insist that they use bounding values from those measured hydrogen levels for their fitness for service assessments. So, for example, if they find a flaw in a tube, we will insist that they use an analysis method that takes into account measured hydrogen levels to assess whether that flaw in the tube can actually become a crack at some point.

On the second point in terms of Dr. Greening's claims about the level of fuel channel R&D that's going on right now, staff in my division have spent the last six years carefully reviewing a very large industry program on fuel channel R&D which is intended to address very specific issues that could occur in units like OPG and Bruce Power units that are being operated beyond their nominal design life.

This is a huge program and I'd like to point out that this program is in parallel with two other programs that are also going on within industry. The Canadian National -- or the Chalk River Nuclear Labs has a reasonable sized R&D program looking at specific issues. As well, there is the COG fuel channel R&D program which is funded by all the licensees and it looks into still another group of fuel channel issues.

So to say that the industry has somehow

downsized its R&D effort on fuel channels is a misconception.

THE PRESIDENT: Dr. Greening?

DR. GREENING: I never said that it's downsized its research program. In fact, it's probably upsized it. I mean $100 million already spent, you'd think they would have figured two parameters. One is some kind of limit on the uptake, and yet that's not determined, and a limit on the fracture toughness, that's not determined.

It's written into the licences of Darlington and Pickering that we're working on that. I can't believe that, that after all these years, millions of dollars, they can't come up with a number, a lower limit for the fracture toughness and an upper limit for the deuterium uptake. How much research do they need?

THE PRESIDENT: Research is forever, I hear all the time. Maybe you'll get an answer though on that.

But I want to differentiate between from a regulatory -- if I understood what you were saying, from a regulatory perspective, yes, it would be nice to know the source. But the safety issue here is the actual level of concentration.

So did I get this right? You differentiate between, it would be really nice for the industry to find out what the source is, but for the regulator you are focusing on the actual concentration in order to shut them down, if need be?

MR. McDOUGALL: It's Glen McDougall, for the record.

That's correct, Dr. Binder.

THE PRESIDENT: Mr. Manley.

MR. MANLEY: Robin Manley, for the record.

Dr. Greening, as a researcher has, you know, a lot of experience in doing fundamental research. So, frankly, I find it a little bit puzzling that it seems to be a negative thing to be doing research and development. In fact, I've heard the Commission many times recognize the value of research and development and the desire to have papers published.

As an operator of nuclear power plants, our fundamental requirement is the safety of the plant. While we might, as individuals, like research and development, we aren't doing R&D for the pure reason of doing R&D. We're doing it to prove the plants are safe, safe and fit to operate, and so it takes what it takes.

If that means that we have to continue doing research and development through the entire operating life of the plant, that's what we'll do. We have to do that to satisfy ourselves as professional engineers or scientists, managers and directors and vice-presidents of engineering programs. We have to do that to satisfy the requirements of the people who live around our plants. We have to be able to show it when we show up at a licence hearing that we have done the necessary research and development.

We have to do it to satisfy the CNSC technical specialists who, I will tell you in this particular area, are extremely demanding. I'm not saying that as a criticism, I'm saying that as a fact. That they are very demanding that we are continually answering questions, doing inspections, driving us to do more R&D and show the head lights that we can see into the future are far enough into the future, so that we can always demonstrate fitness for service through the operating period that we're going to.

So the fact that we continue to answer these questions as we run these plants is a good thing, not a bad thing.

DR. GREENING: I am the last person to say you shouldn't be doing research. But what I'm saying is this particular problem of hydrogen pick-up seems to be an intractable problem. You still can't tell me where it's coming from, how it's getting there. There's all kinds of theories.

But the key finding of the research is variability. You pull out one pressure tube and you find 50 ppm. You pull out the pressure tube right next to it, and you find 80 ppm. You pull out the third one and you find 30 ppm. So what does that mean? It means these numbers are all over the map. There's huge variability.

If you're trying to do an extrapolation with scattered points and there's uncertainty now, the more you extrapolate the more uncertainty you introduce. You get to a point where all -- they have a thing called the design equation, which they pumped way back in the 1980s to predict the amount of deuterium in a pressure tube in 10 years, 20 years, 30 years. Every time they reached one of those milestones they found that the design equation wasn't working, and then so they'd revise it.

They have all kinds of theories that it's chlorine, residual chlorine in the pressure tube or maybe it's phosphorous, or maybe it's a combination of iron and phosphorous, and who knows what?

I've been involved in this for 20 years, I see no progress because I believe it's an intractable problem, the variability's so great, and unless they pull out every pressure tube and measure all of these impurities -- and even when they've tried to do that, and they still can't figure it out. That's not --

THE PRESIDENT: Are they not going to do it during refurbishment? I thought they'll take, you know, Unit 2, for example. Would they not be able to get some data on that?

DR. GREENING: I'm sure they'll analyze it to death, but I mean --

THE PRESIDENT: Did you suggest a method of attack, maybe a solution to...? You know, maybe it's a good example in another area that we always welcome -- I think Staff welcome suggestions for looking at the problem from a different side, different methodology. We have never -- I never got an answer yet.

You have a lot of problems with CSA Standard N285.8. I don't know, what is the solution? Are you suggesting that that standard has to be rewritten or more research needs to be done on that? Have you suggested that formally to the CSA to actually take a --

DR. GREENING: Sorry. I wrote to the CSA about this about two years ago, I never got a reply, they just ignored me.

THE PRESIDENT: So, Staff, industry, anybody wants to comment on that? Do we believe that the CSA needs to review that particular standard?

MR. FRAPPIER: Gerry Frappier, for the record.

I want to put a couple things in perspective. So, as Dr. Greening was saying, maybe they should have a better understanding where the hydrogen comes from, and that might give them some operational options as far as what they want to do and all this stuff.

But coming back, just to be clear, from our perspective it's not a whole bunch of mystery. We're looking for hydrogen in the pressure tubes to demonstrate that fitness for service is met. That is the criteria that we're going to hold to and, if it's not met then, as you suggested, the reactors will have to be shutdown.

Mr. Manley made reference to the headlights, and I think that's a good analogy. What we're requiring them to do is to be able to make sure that through the licensing period that they are licensed to operate, we have a good visibility of the fitness for service of those pressure tubes. The industry is certainly continuing to do research, because they want to push that fitness for service further, and great if they can demonstrate the safety. But if they can't, then they won't be allowed to do that.

With respect to the CSA Standard, I'll ask Dr. John Jin to provide detailed comments. But, in general, the standards -- and, again, with all this research that's been ongoing, there are perhaps improvements, and those will eventually work their way into various standards. So there could be improvements needed on the standards. But perhaps John Jin would like to add to that.

DR. JIN: John Jin, for the record.

I would like to pass it to Glen McDougall who is the technical committee member of the CSA N285.8

MR. McDOUGALL: Glen McDougall, for the record.

Two points I can make on the CSA committees. First of all, the CSA committees welcome members of the public, especially former CANDU industry representatives who wish to sit as private members on the committee and lend their expertise.

Currently, we have two public individuals on the committee that I sit on, but two seats have recently been freed up, so I'd be happy to share the name of the Chair of that committee with Dr. Greening if he'd like to contact him personally. We're always looking for more expertise on the committee.

The second point is that at any given time we have a number of different activities going on on the technical committee looking at hydrogen. When I said that CNSC was not interested on the source of the hydrogen, I can't speak for the CSA committee or for industry.

What I can tell you is that on the CSA committee there are a number of activities going on right now, looking at hydrogen and looking at improvements in the way that it can be modelled and the way that the hydrogen can be analyzed and the results applied to fitness for service situations.

So I think we need to be clear about what exactly CSA is doing to try and improve its standards.

THE PRESIDENT: Dr. McEwan?

MEMBER McEWAN: Forgive me, sort of trying to shift fields. But as I've listened to this conversation, it's become clear to me that we've been using the word "research" in different ways. If I look at my own field, if you'll forgive me just a small trip into the byways, we actually use three terms to describe the research that we do: one is discovery research; one is translational research; and, one is clinical research. As I've listened to this conversation today, it's very clear to me that that sequence really applies to what we're discussing today.

I think that some of the issues that Dr. Greening is raising are what I would put into the discovery research domain. But we're trying to understand the fundamental question of why there is hydrogen concentration variability, why it happens.

The translational analogy, if I can use that, is well we understand that that's happening whilst we're discovering, identifying the root cause, how does that impact what we do on a daily basis? How do we translate that into learnings for the power plants, learnings for the regulator, learnings for the operators?

Then the clinical research is actually what we're talking about with the outcomes that the Commission is looking at, which is is the hydrogen concentration safe, is it creating a risk that we cannot call safe?

So if I could maybe suggest that trying to be very careful in how we use language, such as research, to define very specific questions may actually get away from some of the overlap that I've detected today in interpretation. And, yes, Dr. Greening is right, you've been working at this for 20 years, you haven't solved it. But through that work you've identified a number of issues that impact day-to-date operations, they impact the way the Commission regulates.

So, again, just a plea for some clarity in how we use English I think might help the conversation, particularly around some of these issues moving forward.

THE PRESIDENT: I like the medical analogy because you guys can figure out where does cancer come from, but you deal with symptoms, right? It didn't prevent us from doing treatment. So here you've got -- you don't know the source, you know the symptoms, and you now apply the best knowledge we can to the symptoms, right? So there may be something behind that. I don't know if we need to be careful when we talk about particular research, whether it's discovery research or is... So I like this analogy here.

Anybody want to react to that?

MR. SAUNDERS: Frank Saunders, for the record.

I think it's important that we clarify some things. The predictability on hydrogen in pressure tubes is now actually pretty good. We can not only predict what the tube will be, we can tell you where in the tube it'll be highest and what it'll look like. We can tell you what batch the tube came from. We can tell you where on the reactor it was. We know the different manufacturing techniques and how they affect the hydrogen uptake in the tubes.

So when you look at the refurbishments that are going underway, we are using a particular manufacturer of tubes because we've trialed them in Unit 8 in at Darlington and other places, and their uptake of hydrogen is much less.

We know this partially based on our prediction capability theory, but mostly based on many many many samples we've taken from the operating reactors over the years that tell us -- and we take it along the whole length of the tube, so they tell us really what the hydrogen content in the tube is, you know, and we know that. We have models that predict for us and we go sample again and we test to see if we're in the right area, and our predictions are actually now very accurate. The newer tubes that we'll be using in the refurbished reactors are less uptake again of hydrogen than the old ones.

So do we understand all of the mechanisms for hydrogen uptake? Probably not. We certainly understand some of them. We understand temperature, we understand stress, we understand various things about the hydrogen and where an uptake will be more and where it will be less.

There are probably still some mechanisms we don't understand, we'll continue to do the R&D.

But in the end of the day, you need to be able to predict the amount of hydrogen in the tubes so you know whether that tube continues to be safe to operate. There is actually a lower round curve on fracture toughness that exists in the CSA standard.

All these R&D work that we're doing up at Chalk River is actually experimental data to make sure that that curve that we've predicted is actually behaving as you would expect in the experimental data. So you're putting experimental data on the line that says, yes, this is my curve, and here's experimental data and, yes, it lines up with the curve as you'd expect it to.

We will probably, for another three or four years, continue to do that until we have enough data on that curve that we're fully satisfied that the curve is as accurate as we can make it. That's a traditional approach.

THE PRESIDENT: Do you share the internal research that you do widely so people can keep up with the knowledge on a particular issue?

MR. SAUNDERS: Some we do and some we don't, because some can be proprietary. It's a lot of money to do this research and in some cases we want to get some return for it. But, generally speaking, we share it, we certainly share it with CNSC, and most of what's shared with CNSC is public information anyway. We do share it with some other manufacturers.

Do we publish it in an open journal? Generally not. I guess it's something we could take under advisement to consider, right? But it is --

THE PRESIDENT: You can make money knowing what the source of --

MR. SAUNDERS: Yes.

THE PRESIDENT: -- hydrogen comes into your tube? I wonder.

MR. SAUNDERS: Well, there are other people that build CANDU reactors. We're not the only people with zircaloy in a reactor, so...

THE PRESIDENT: Okay. Dr. Greening?

DR. GREENING: Yes. I disagree with Frank Saunder's statement that they seem to have it all under wraps.

Because right here on slide 61 we have a statement, "When a removed pressure tube exhibits an unexpected material property." That keeps on happening. It happened in -- I don't know about Bruce, but Darlington, they -- OPG will use the word "unexpected." What do they do? They revise the theory.

I find this paragraph rather ironic, because they refer to an unexpected property, and then they say we'd better check to see if it's statistically different. Well, to me, if it's unexpected, it's statistically different. So this keeps on happening.

It's the rogue tube. It's that one tube that comes along out of nowhere, suddenly it's got three times more deuterium than your theory predicts. So what do you do? You revise the theory. Because once the tube's in the reactor, it's in there. You can't tweak the amount of chlorine in that tube, the best you can do is pull the tube out, put another one in, because you blend chlorine. Well, what about phosphorous? What about iron? What about nickel?

When they try and write programs to fit all this... I'd love to see this research. Too bad it's proprietary. But I don't buy this, that we've got everything well sorted out now after all these years.

THE PRESIDENT: I think I heard that they said they are not all completely known about the theory. I think they are dealing with some of the outcomes that they observed. That's what I got out of this. And the research is still going on.

I still believe that this area of research, it can be probably more public oriented, I would argue. But I think CNSC sees the material and you can probably assess how far they've gone or how close to understanding they are.

MR. FRAPPIER: So Gerry Frappier, for the record.

And maybe I'll ask Glen McDougall in a second to talk about Section 8 that was referenced here of the standard.

But again, remember what we're doing here. There's certainly research going on, so if there's research going on, people are looking for more information.

We do have models that we believe are acceptable for today so that we understand and are confident that the pressure tubes are fit for service, but industry wants to go beyond today. They want to go far into the future and for them to be able to convince us and themselves, first of all, then more research is being done.

But perhaps, Glen, you could -- Dr. Greening brought attention to Section 8 and the role it plays, and perhaps you could tell us a bit about that.

MR. McDOUGALL: Glen McDougall, for the

record.

Yes. Until about a decade ago, when industry found new property measurements for a pressure tube that they removed from the reactor, the practice was simply to plot it on a graph with all of the other data that other licensees might have collected and they would draw an upper bound to all of the data points and say, well, that's the limit of our understanding. That's the -- those are the kind of numbers that we'll use in fitness for service assessments.

But after a while, it was realized that that approach was not very rigorous. For one thing, it wouldn't identify those pressure tubes where maybe industry, through their R&D program, would take a much more careful look to see if what they were looking at was actually a rogue tube, as Dr. Greening described, or is, in fact, the beginning of an upward trend in pressure tube behaviour and, somehow, they have just discovered the tip of the iceberg.

So through the CSA committees, a much more rigorous method was developed for looking at any new pressure tube data that a licensee sees when they remove pressure tubes. They take quite a significant number of measurements each time a single pressure tube is removed from a reactor, and what they came up with was a statistical method of looking at new results and saying is this result basically part of the same population of data that other licensees have been seeing. And if it is, that would -- that would mean that the model licensees were using for that particular material property would still be valid for doing fitness for service assessments in pressure tubes because that is -- at the base of it, that is how fitness for service assessments are done.

They are done using input data that actually comes from removed pressure tubes. They're not done using R&D data or engineering judgment. They're based on hard data.

On the other hand, if the statistical test shows that as a result is outside the bounds of the model, you're doing two things. You're basically red circling a data point and saying this is an area where industry probably needs to spend some more attention doing R&D. Maybe they can find something positive from that tube. Maybe they can identify that there's a reason why that tube is behaving differently.

But they won't be penalizing the entire industry by taking one high data point and insisting that everyone in the country will now treat their reactor as though it's behaving the way that that one result is telling you.

So when the statistical model was developed, it was debated within the CSA committees and it became part of the N285.8 standard. And that's where it is right now.

And staff participated in the development of that Section 8, and we stick by it.

THE PRESIDENT: Okay. I think -- unless somebody has another thing, we want to move to other issues.

Yeah, please. Other issues.

Ms Velshi.

MEMBER VELSHI: Question to staff. Have you considered or likely to consider just as initially how you got a peer review of your planned risk informed process done that at some point you actually get a third party to look at your recategorization and say, well, did you really implement what you were doing to do? Do you see any value in that?

MR. FRAPPIER: Gerry Frappier, for the record.

So as mentioned a few years ago, we did, in fact, do that with the international community with respect to the process that we're following and the way we are doing it.

We have and continue to, on occasion, have third parties come in to help us with a particular safety case, so certainly pressure tubes and fuel criterias, we've had lots of independent technical personnel to support us.

As far as the overall process goes, I think we're, as we've talked a couple of times about, we're taking a look at how that's going to evolve.

I wouldn't expect that we would use a third party for the overall process right now.

MEMBER VELSHI: Right. And that's what I was getting at, not technical experts to help you review submissions, for instance, it really is, did we do the recategorization appropriately and do you take, you know, a sample and just make sure that your process was actually followed robustly.

MR. FRAPPIER: So Gerry Frappier, for the record.

So of course, this whole process we've been going through with the Commission along that line, we've opened it up to the public. We've had some people with some definite expertise challenge us a bit on it.

We have brought in outside experts to take a look at some of the specific areas and how they were reclassified, so we're pretty confident that we've got the categorization right.

THE PRESIDENT: Okay. Dr. McEwan?

MEMBER McEWAN: So slide 99, I just want to be clear that I did understand correctly that OPG and Bruce Power have pressure tested containment in decades? I think that's what you said earlier.

MR. SAUNDERS: Yes. For containments over six years, for vacuum buildings every 12 years, there is a provision after you've done enough vacuum building tests to not do the positive pressure test on vacuum buildings because it's seen as doing more harm than good in the end of the day.

So yes, we continue to follow that CSA standard today. We've done them.

In fact, two years ago, we did -- two years ago, we did Bruce B and just last year we did Bruce A. Right? Yes.

So yeah, we continue do to those according to the standard and according to the regulatory requirements.

MR. MANLEY: Robin Manley, for the record.

Yes, we did the Darlington vacuum building in 2015 and Pickering vacuum building in 2010. And I should also add that in major unit outages, we also test the containment structure as well for those individual units.

MEMBER McEWAN: Okay.

THE PRESIDENT: Mr. Tolgyesi?

MEMBER TOLGYESI: I'm just short on -- could you explain the difference between risk based and risk informed decision?

MR. FRAPPIER: Gerry Frappier, for the record.

So we're usually very careful to say we use risk informed, so the risk information will be used as part of the decision-making, but often there, for instance, could be legal reasons why something is not -- a decision would have to go one way or the other or potentially there's deterministic safety requirements that we do not want to budge on.

So for risk informed, we take that information as part of the decision-making.

Risk based is usually when you have a formula type arrangement where, as soon as the risk is -- whenever it has to be, that then you must do this or you must not do that, whatever the case is.

So there's not -- there's not an ability to then bring other judgments to bear on it. It's strictly risk based, so we do not use that approach.

THE PRESIDENT: Any other questions?

So I would like to give the intervenors the last word.

Dr. Greening.

DR. GREENING: Thank you, Dr. Binder.

And I have to say I'm very thankful for being given this opportunity to come here today and to address the Commissioners.

And I'd like to maybe leave you with one point, among the other points that hasn't been brought up so far. And that relates to comments made this morning by Professor Luxat, by Mr. Leeds and by Mr. Satorius with regard to what they called intemperate language. And in particular, I think they were directing that to Sunil Nijhawan.

But I'd just like to point out one thing here, that I worked for OPG for 23 years and I worked for Bruce Power for three years. My work was always valued, praised. In fact, they won the technical excellence award at Hydro Research in 1998 voted by 200 PhDs in relation to my work on carbon-13 dating of oxytes.

And then a strange thing happened. Once I left the nuclear industry and started intervening, as I have done at Pickering, Bruce, Darlington -- I've intervened about DRLs. I've intervened about the Radicon report. I've interviewed about the Bruce alpha event and the DGR inventory question.

And I met, I'm sorry to say, with hostility. So much so that CNSC saw fit to put a critique of one of my letters on the internet, leave it up there for two years.

And this response to my efforts included such allegations that I'm disingenuous, that I act with questionable intent, that I jump on typographical errors, that I make wrong assumptions and false statements, I show lack of perspective, I fail to understand data, I fail to understand dosimetry, I don't understand scientific evidence, I'm negligent and make irrelevant arguments, I misuse data, I make computational errors and I make illogical and irrational assumptions.

Well, I think this morning, the shoe was on the other foot, and I -- but I do believe we have a case of the pot calling the kettle black.

Thank you.

THE PRESIDENT: Thank you.

Dr. Nijhawan, any final comment?

DR. NIJHAWAN: Dr. Binder, I thank you for the opportunity to appear with you -- appear in front of all of you.

I am very thankful -- I'm very happy to hear about some of the progress which has been made and some of the clarifications which were provided.

I'm very disappointed in some of the evangelical language used to say everything is beautiful at these reactors and getting everything right and we have all the expertise when we know they're using huge number of outside people just to get the work done.

I'm very disappointed in certain answers. For example, when I showed them that, at Darlington and at Bruce, a simple loss of power would result in a bad accident, they're saying, "Well, you know, IFIS will take care of that".

I took part in IFIS in 1982-83, for God's sake. I know what that is. All we're looking at is industry coming back and giving answers to not make technical sense and your staff accepting it. I refuse to accept some of the answers, and you should follow them up.

All I'm saying is that our reactors are old, our reactors are obsolete. Our reactors are run by companies which do not have all the technical expertise that they should have.

Our staff is very compliant to the demands of these companies. The CNSC staff is relatively compliant compared to other jurisdictions that I've seen. The opportunity for improving these reactors has been lost.

And at Darlington, for example, a simple loss of power is turned into a huge accident and there's nothing anybody can do about it unless we sit down and put our heads to it.

Our hydrogen issues are very large. We are not solving them. Our local energy issues are very large. We're not solving them.

So all I say is I'm glad we had some dialogue going, but people are getting marginalized and are being told that this is an old issue, that IBIS will take care of that. That kind of response is an insult to the intelligence and we say, okay, be that way.

And it's a shame that the freedom to speak the people of my age and racial status at this time are able to do have been totally disregarded in this manner.

And Frank was right. Frank Greening was right that to be ridiculed is not very -- and it was done by your consultant brought in from the U.S. to tell you that you should stop people like me from talking to you about technical issues. The fact that he had the audacity to do that was because you encouraged him to do that.

I'm sorry that things are going this way. I'm very interested and continue to be interested in the safety of our reactors, and I will continue to work on that.

I continue to work on new computer code, new analysis. And my findings are much in conflict with some of the findings that you have.

I've offered to come to CNSC to you to present it to the staff on an informal basis. We can sit down and talk. And I've been told no, not until this president is gone; we will not -- I don't know whether they used the name, but they said not until this one's gone because they can't. They're not interested in talking to me any more.

But to you, sir, personally, I've been thankful for this opportunity and the kind way in which you have treated me today. I thank you, sir.

THE PRESIDENT: Thank you very much.

This concludes this hearing. I thank you all for your input.

Anything else I have to say here?

MR. LEBLANC: No. Just safe travels, and if you borrowed any interpretation devices, please make sure you return them so you can get back your ID cards.

Thank you. Good night.

THE PRESIDENT: Good night.

--- Whereupon the meeting concluded at 6:17 p.m. / La réunion s'est terminée à 18 h 17