CNSC PRESIDENT: Dr. Edwards, can you hear us?

DR. EDWARDS: Hello? Can you hear me?

THE PRESIDENT: Yes, we can.

DR. EDWARDS: Oh, my phone was apparently muted, I didn't realize that.

THE PRESIDENT: And you're talking about the most complicated technology on earth.

DR. EDWARDS: That's right. We need an emergency backup system. *[Laughter]*

THE PRESIDENT: Okay. We have been waiting for you, so welcome and please proceed with your presentation.

DR. EDWARDS: Thank you very much, President Binder, and good wishes on your retirement. I have been actually involved in the nuclear debate for four and a half times as long as you have I think, because it's since 1975 that I've been involved.

We all know that nuclear power plants are potentially dangerous. It is the nature of the beast. Metaphorically speaking, we have a ferocious lion in a strong cage. From the point of view of public safety, it is important to know how ferocious the lion is and how strong the cage is.

Everyone agrees that if the lion gets out there will be hell to pay. So, extreme precautions must be taken and are taken. As Alvin Weinberg, one of the pioneers of nuclear energy in the U.S.A., has expressed it, "The price of nuclear power is eternal vigilance."

So, let's talk a bit about the lion and the cage. We'll start with the lion.

In the case of Pickering, the "lion" is the irradiated nuclear fuel containing hundreds of human made radioactive poisons that were never found in nature before the nuclear age, but are created in the core of the reactor.

Irradiated fuel is so fiercely radioactive that a single fuel bundle freshly discharged from a Pickering reactor would kill any unshielded human being at a distance of one metre in about 20 seconds.

And radioactivity cannot be shut off by any method known to science. In fact, immediately after a nuclear reactor has been completely shut down, the radioactivity of the irradiated fuel continues to generate about seven per cent of full power heat. In the case of a Pickering reactor, that's over 100 megawatts of heat.

That heat, the so-called decay heat cannot be shut off. In the absence of adequate cooling, decay heat is more than enough to melt the core of the reactor at a temperature twice as high as the melting point of steel.

If the gases and vapours and ashes from the radioactive core material are disseminated into the environment, large areas of land may remain uninhabitable for decades or centuries.

Within 30 kilometres of Chernobyl it *[the region]* is expected to be uninhabitable for at least a hundred years – largely due to the deposit of radioactive cesium-137 on soil, trees, buildings and other things. *[Parenthetical comments are not from the transcript.]*

Using existing technology, no one can change the nature of this beast. Our only option is to ensure that the cage is strong enough to contain this beast under any circumstances.

So, what is the cage that keeps the lion imprisoned? It is a combination primarily of two things, plumbing and containment. Without a proper plumbing system you may not be able to keep the fuel cool enough in an emergency to prevent the irradiated fuel from overheating and even melting, thereby liberating large quantities of radioactive gases and vapours, including a lot of cesium-137 from the fuel. Under such dire circumstances, it is necessary to contain the radioactive material, not allowing it to escape into the environment, even in the event of severe core damage.

That's where the CNSC *[Canadian Nuclear Safety Commission]* comes in. The CNSC has stated very firmly that it will never compromise safety, CNSC will always ensure that the cage is totally secure. That means that the plumbing system will be the best that it can be and the containment will be absolutely top notch.

Indeed, Ontario is committed to spending tens of billions of dollars to replace the plumbing in 10 nuclear reactors, eight at Bruce and four at Darlington, most of them older than the Pickering reactors. The expense is justified for safety reasons.

Refurbishing a CANDU reactor means replacing thousands of irradiated pressure tubes and calandria tubes inside the cores of the reactors and replacing them with brand new tubes. It's kind of like a heart transplant.

The effort and expense is justified by the fact that the old tubes have become increasingly brittle over time and more likely to break, especially in case of a thermal shock caused by the injection of cold, emergency cooling water into the super-heated fuel channels.

Refurbishment also means replacing thousands of feeder pipes that are directly attached to both ends of the core, because these pipes have become weak and corroded and are not quite up to snuff. The steel walls of some of these feeder pipes have become much thinner and more fragile over time, in some cases only about 60 percent of the wall thickness of new pipes. So the easiest thing to do for safety sake is to replace them with new pipes.

Refurbishment also involves the replacement of the old boilers, weighing hundreds of tonnes each – sort of like a kidney transplant. That also addresses safety concerns because if several of the narrow tubes inside the boilers were to break under stress during a severe nuclear accident, it would establish a clear pathway for radioactivity to go from the crippled core, through the pipes, and reach all the way to the outside environment, a potentially weak link in the containment system. So it is best not to take any chances. Why not just replace the old boilers, also called steam generators? That's what has been done.

So most Ontario reactors are getting a major makeover being brought up to snuff at great expense with new pressure tubes, new calandria tubes, new feeder pipes, new boilers. In 2012, Quebec decided not to refurbish its only operating nuclear reactor, Gentilly-2, and consequently that reactor has been permanently shut down.

Back to Pickering. OPG decided years ago to save some money and effort by not refurbishing any of the four reactors that go under the Pickering B designation. These four reactors are old. Like the Gentilly-2 reactor in Quebec, they should be shut down permanently. Indeed, when OPG decided not to refurbish them that was the stated intention. But now, here they are, asking to run these four old reactors into the ground without bothering to bring the cage containing the lion up to state-of-the-art conditions.

As for the two operating Pickering A reactors, they are of course the oldest power reactors in the province and they too do not represent state of the art safety – because they have only one fast shutdown system, while all other CANDU reactors are required to have two independent fast shutdown systems. The necessity for two fast shutdown systems is based on the fact that any loss of coolant accident caused, for example, by a pipe break, causes a surge of power to occur in the reactor core. Unless this surge is terminated within two seconds, there could be very severe core damage.

Back in 1952 at Chalk River, the NRX reactor destroyed its core because the one shutdown system it had did not operate properly, so better to have two. In the CANDU literature, severe core damage implies the pressure tubes and calandria tubes fail, ejecting fuel bundles into the calandria. The sudden pressure spike inside the calandria will burst the rupture disks at the top of the calandria, expelling moderator water out of the core and providing a pathway for radioactive gases and vapours, including the cesium-137, to escape into the containment along with a great deal of explosive hydrogen gas.

Now, inside the core of a CANDU reactor – a Pickering reactor – there are at least 50,000 terabecquerels of cesium-137. According to a study published by CNSC, staff expect that the cesium releases into the environment *[in the event of severe core damage]* would only be 100 terabecquerels. That's way, way less – that's about a thousand times less than what is available to be released. So that raises a question: Is the containment actually that good?

Every example of a major nuclear accident that I am aware of has always been accompanied by violent hydrogen gas explosions. Is the containment of the Pickering reactor qualified to withstand such powerful explosions as were witnessed at Chalk River in 1952, at Three Mile Island in 1979, and at Fukushima in 2011? This is an important question because any failure of the containment system will allow radioactive gases and cesium-137 to escape and cause widespread radioactive contamination.

At Chernobyl it is estimated that some 80,000 terabecquerels of cesium-137 escaped. That's 800 times more than the CNSC study has assumed. And as a result, we have a no-man's land around the crippled Chernobyl reactor that extends for a radius of 30 kilometres and will remain uninhabitable for an expected period of 100 years or more.

Within 30 kilometres of Pickering there are about 2.2 million people living. Can anyone imagine such a region remaining uninhabitable for decades or centuries? Well, it all depends on the containment system, if there is a severe core damage accident. It's important that this containment system be able to reduce the amount of cesium inside the reactor from several tens of thousands down to only 100 or less. It is not something that we can take a chance on just because OPG wants to cut corners by not providing a second fast shutdown system for the Pickering A reactors, and not replacing the plumbing in the Pickering B reactors.

By the way, it's important to realize that the distribution of iodine pills, the KI pills to the populations around Chernobyl would have done some good, especially for the children, by preventing thyroid exposures but it would not have prevented the evacuation of the territory and the uninhabitable nature of the region to this very day. That was necessitated by the cesium-137 contamination, not because of the iodine-131 releases. The same thing at Fukushima; the regions closest to the reactor are still uninhabitable seven years later.

Even if the Pickering containment system somehow survives a series of hydrogen gas explosions, does anyone really know how good it is? Has the containment system ever been tested under realistic pressure loadings? In fact, how many times has the containment system at Pickering been actually physically tested? When was the last time it was done, and what was the result?

As a scientist myself who graduated from the University of Toronto in math, physics and chemistry, with a gold medal in mathematics and physics, and one who subsequently obtained a doctorate from Queen's University, I am disappointed in the CNSC senior staff who have chosen to disseminate what I consider to be biased and scientifically questionable information to the public on the potential releases following a severe core damage accident in a CANDU reactor. This is referring once more to the study that picked the number 100 terabecquerels of cesium-137 to be released. In the very report published by the CNSC they make it clear that that is the lowest amount of cesium-137 that could even qualify as a severe core accident situation.

So where is the conservatism? It seems to me that one has to take into account a leaky containment that would allow for much greater releases, orders of magnitude more, and in that case it could seriously affect all of the emergency planning. I mean, we are fooling people into thinking that the emergency planning only has to be distribution of pills and possible temporary evacuation, not dealing with the possibility that it could be far worse than that.

If the CNSC decides to allow this ancient reactor complex to keep operating under such conditions it should stop using the slogan: "We will never compromise safety."

Given the accepted practice for all other CANDU reactors, which is to either refurbish them or retire them, it is clear that allowing the Pickering B reactors to run under these circumstances and also the Pickering A without the prescribed shutdown systems, is in fact compromising safety by reducing the safety margins that would have existed after refurbishment.

So I am asking the Commissioners to show some courage here in saying that, look, we want the very best containment. We want to replace the plumbing system or we want you to shut the reactors down, because otherwise it is setting a bad example and it's a slippery slope. How far is this going to be pushed?

Thank you.

THE PRESIDENT: Thank you. Questions? So Dr. Edwards, I don't know if you had a chance to listen over the last four days for a discussion about the emergency planning by the Office of the Fire Marshal; Health Canada. I guess I want to know how much are you aware of those discussions?

DR. EDWARDS: Well, I have been following the literature. I haven't listened to all of the discussions that have taken place, but it is my understanding that there are no plans in the emergency planning as they had to do in Japan to go from house to house decontaminating the roofs and gardens and even decontaminating forest lands. This is a huge undertaking and it means that it severely interferes with normal life for a very long time to come in the future. *[See www.ccnr.org/MEIA_Winnipeg_2014.pdf]*

I don't know if that's part of the emergency planning, but I don't believe it is.

THE PRESIDENT: Okay, I just wanted to know -- we don't want to repeat the same kind of a discussion. I just wanted to know where you are in this particular thing.

So who wants to ask? Dr. Demeter...?

MEMBER DEMETER: Thank you for the intervention.

I wanted to ask OPG and, I guess CNSC, if need be. Dr. Edwards on page 6, I guess in a presentation to the Toronto health committee, comes up with a scenario of an explosion in a nuclear power plant that creates vaporization of the water in irradiated fuel bays. *[I want to]* get a sense, is this at all realistic?

DR. EDWARDS: No, I think you misread the document. This was a submission to the Toronto Board of Health who was considering the question of the effects of nuclear weapons. So the hearings were specifically about the effects of nuclear weapons.

And I pointed out, just as an example, that if a nuclear weapon were to explode anywhere close to the Pickering plant, it would liberate one to two million terabecquerels of cesium-137 from the spent fuel bays which are not under any strong containment such as the reactor itself is. *[See www.ccnr.org/CCNR_CNSC_Pickering_2018.pdf]*

MEMBER DEMETER: Thanks for that.

DR. EDWARDS: That's what the scenario was. Actually that's not a realistic scenario but it does point out that any kind of accident such as a plane crash, or a terrorist attack for that matter, that could impact the spent fuel bays at Pickering could release an enormous amount of radioactivity, far more than you would find from the fallout of all the nuclear test explosions that have been conducted all over the world up to the present time.

MEMBER DEMETER: I'll withdraw the question. Thank you for the clarification.

THE PRESIDENT: Okay. Mr. Berube...?

MEMBER BERUBE: This is *[a question]* for CNSC. So Dr. Edwards just pointed at the containment systems and saying that he doesn't know that they have been tested or that they have been certified. Could you please elaborate on what your findings are and what you've done?

MR. FRAPPIER: Gerry Frappier, for the record. I'd go to Ottawa and ask Mr. Ken Kirkhope if he could explain a bit on, I guess, the vacuum building in particular that was being discussed?

MR. KIRKHOPE: Yes, hello. This is Ken Kirkhope, Engineering Design Assessment Division.The Pickering containment systems, vacuum building, is subjected to tests every 10 years, according to CSA N287.7 Standard.

DR. EDWARDS: When was the last time?

MR. KIRKHOPE: I would have to ask OPG to perhaps answer that.

THE PRESIDENT: Go ahead please.

MR. GREGORIS: Steve Gregoris, for the record. I'm going to ask Paulina Herrera to expand on my answer. But I'll start by saying that there are a number of different tests we do on containment, some of those tests are on the reactor buildings themselves at low pressure, and also at higher full design pressure.

We also do a test of the pressure relief duct and the vacuum building every 10 years during a station outage, we call that the vacuum building outage. All of those tests are required per our regulations and standards. There are very specific criteria around those tests that need to be met, including leak tightness. All of our tests have been well within those safety requirements in each of the tests that have been done.

I'll ask Paulina to expand on that.

MS HERRERA: Paulina Herrera, for the record. So, as Steve has stated, the containment structures at Pickering site, which include the vacuum building, pressure relief duct, and the reactor buildings, are tested periodically in accordance with CSA N287.7.

This pressure test consists of pressurizing the building to their design pressure. With the vacuum building, the last time it was tested was in 2010. The results of these tests are submitted to the CNSC, and they were well below our safety limits for leakage.

In the case of the reactor buildings themselves, we have been conducting them, they're performed on a six-year frequency, with the most recent ones through the units being conducted from 2016 and mostly recently in 2018.

All of these timelines are clearly stated in our Licence Conditions Handbook and our Periodic Inspection Program. In addition, we do conduct exterior inspections of the reactor buildings themselves on a periodic basis as well to ensure the integrity of the structures, which have been confirmed.

Again, all of this is documented and submitted to the CNSC.

THE PRESIDENT: Thank you.

DR. EDWARDS: Can I ask, what is the design pressure that you test to in the case of the reactor building?

THE PRESIDENT: Go ahead, OPG. Have you got the numbers?

MS HERRERA: Paulina Herrera, for the record. I need to confirm, I think it's 43 kPa *[43 kilopascals = 6.23 pounds per square inch].* I'll need to confirm from our reports

> *[NOTE: Light Water Reactors, like those in the USA, are designed to withstand pressures 9 to 12 times higher, from 412 to 515 kPa. See https://www.sciencedirect.com/science/article/pii/0029549384902620]*

THE PRESIDENT: Okay, thank you.

DR. EDWARDS: Do you know if there have been any tests -- or calculations, even -- of hydrogen gas explosions and what that might do to the pressure boundary, especially of the reactor building itself?

THE PRESIDENT: Go ahead please.

MR. VECCHIARELLI: Jack Vecchiarelli, for the record. Yes, we have assessed this. That's part of the work that we did to address the generic action item 88G02 and is part of our probabilistic safety analysis.

We look at the impact on the containment from a range of potential hydrogen concentrations and the associated burns, and we found that there's lots of margin, containment is very robust and well able to withstand repeated burns as a matter of fact.

So there's no issue with respect to post-accident hydrogen burns in containment.

> *[NOTE: The question was about hydrogen gas explosions, not hydrogen gas "burns" that are less problematic. See NRDC Report R-14-02-B, Preventing Hydrogen Explosions In Severe Nuclear Accidents: Unresolved Safety Issues Involving Hydrogen Generation and Mitigation, from the Executive Summary, "In 1985, the NRC required installation of hydrogen igniters – systems to burn off leaked hydrogen before it accumulates to explosive concentrations."]*

THE PRESIDENT: Thank you. Questions? Go ahead.

MEMBER BERUBE: Another concern that was brought up by Dr. Edwards was the suitability of a moderator drop tank as basically being a viable shutdown system on Pickering A. CNSC Staff, could you speak to that first please? Dr. Edwards, are you still there?

DR. EDWARDS: Yes, I'm here.

MEMBER BERUBE: Okay.

THE PRESIDENT: Go ahead, Staff.

MR. ELDER: Peter Elder, for the record. I'm the Vice-President of Technical Support and the Chief Science Officer.

We did touch on this a little bit earlier in the hearings. So the dump tank as the second system is adequate for slow events. Dr. Edwards is correct, that what was the intent of having two independent shutdown systems was to make sure that you had very high confidence of shutdown for fast events.

In the mid-1990s the AECB *[Atomic Energy Control Board]*, at the time, ordered OPG *[Ontario Hydro at that time]* to make improvements to the fast system at Pickering A. So there's a substantial improvement to the design to make sure that it had the same functionality as the two shutdown systems, as two independent shutdown systems.

Since then, this has been reviewed a number of times through the periodic safety review and also through the PSAs, and we have achieved the same intent; that is we have very high confidence that the reactors will be shutdown on any situation.

THE PRESIDENT: Thank you. Questions?

DR. EDWARDS: I would like to make a comment on that last answer if I could?

THE PRESIDENT: Go ahead please.

DR. EDWARDS: I just think it's, on the face of it, absurd that the one fast shutdown system is equivalent to the two fast shutdowns. Why then are you causing the other reactors to have two fast shutdown systems? Why don't you just get them all to use the one "really good" fast shutdown system that Pickering A has?

There's a very good reason for this, and that is you don't take any chances. Fast shutdown systems do fail or not function perfectly. That can lead to total destruction of the core of a reactor. That's why you have two fast shutdown systems. I think, at the very least, the Commission should not allow those oldest reactors to continue operating.

[Also,] given the reluctance of Ontario Power Generation to do a refurbishment, replacing the plumbing of Pickering B, the Commission should require that and say "Look, if you want to continue operating them, beyond what was reasonable and what you previously pledged to do, then refurbish them."

THE PRESIDENT: Okay. Let me try to explain what I understand from Staff. Pickering A was first built with one shutdown, Pickering B – and the rest – were with two. When the instruction was to improve, they put in an alternative means to a fast shutdown, which is the gadolinium and all that stuff. Is that my understanding?

DR. EDWARDS: No, that's not right.

THE PRESIDENT: The alternative stuff is as good or is as functional as having two shutdowns. Am I understanding correctly?

> *[NOTE: In all operating CANDU reactors other Pickering A, there are two independent fast-acting shut-down systems. Shutdown System 1 (SS1) involves a bank of neutron absorbing solid "shut off rods" that are very rapidly inserted into the core of the reactor from above. Shutdown System 2 (SS2) involves a neutron absorbing liquid called "gadolinium nitrate" that is injected into the core from the sides by means of high-*

> *pressure nozzles. Either system can stop the nuclear chain reaction in less than two seconds by "swallowing" neutrons needed to sustain the reaction. Pickering A is not equipped with a system of gadolinium nitrate injection. It is disquieting to learn that the head of the nuclear regulatory agency was not even aware of this defect in the Pickering A design.]*

MR. FRAPPIER: Gerry Frappier, for the record. Not quite. So Pickering A does not have a gadolinium system. We just went through the periodic safety review where we just went through the analysis. Perhaps I could ask Dr. Al Omar to explain exactly where it's centred around the shutdown system for Pickering A?

DR. OMAR: Al Omar, for the record. Again, Pickering A originally has two systems to assist the shutdown of the reactor. One of them was slow – or judged slow – which is the dump tank.

Currently in the PSR *[Probabilistic Safety Report]*, the current PSR, the current two shutdown systems have been assessed and declared qualified for the events that are analyzed. So we have two shutdown systems now for Pickering A. The only difference is that the extended or enhanced shutdown system, we'll call it shutdown system 2, does not have gadolinium injection, but we added absorber rods, but it satisfied the design function, safety and regulatory requirement as shutdown system 2.

> *[NOTE: CANDU reactors can only sustain a nuclear chain reaction by having a tank of liquid heavy water "moderator" surrounding the fuel channels inside the core of the reactor. At Pickering A the chain reaction can be stopped by draining the moderator into a "dump tank" beneath the core. But it takes six seconds or more to accomplish. This is much too slow to cope with a severe nuclear accident. While the "moderator dump tank" is a shutdown system, it is not a FAST shutdown system. This defect was discovered by the regulator years after the Pickering A reactors were already operating. Originally the regulator demanded that a second independent fast shutdown system be installed at Pickering A but the licensee negotiated a cheaper deal: just adding more shut-off rods. As the man says, "we'll call it Shutdown System 2", but in fact it is NOT a second independent shutdown system – it's only a beefed-up Shutdown System 1.]*

THE PRESIDENT: Okay, thank you. Dr. Edwards, anything else you want to ask?

DR. EDWARDS: Well, it's definitely cutting corners, there's no question about it. I mean, it's an old reactor. You would not require the Bruce reactors, the Darlington reactors, the overseas reactors, you wouldn't require them to have two *[independent]* fast shutdown systems if one was enough.

If you solved the problem for Pickering A so that you have a fast shutdown system based on rods, one that's totally adequate to *[or equivalent to]* the two shutdown systems, then why go to the extra expense of having two shutdown systems in every other CANDU reactor?

I think that we're just bandying words here. We're not really talking about the fact that you are, to some degree, shaving the margin off the safety margin, and that could be a huge difference in the event of a violent emergency.

If you have, for example, an earthquake situation that somehow interferes with the descent of the rods into the core – as happened at NRX in 1952, the rods just didn't descend into the core properly, and that's why the core of the reactor was totally destroyed. So I think we're bandying words here. My point is that if the CNSC is really dedicated to never compromising safety, then they shouldn't compromise safety.

THE PRESIDENT: Okay. OPG, you were going to say something about that?

MR. LOCKWOOD: Randy Lockwood, for the record. I'm going to ask Steve Gregoris to – we spoke about this yesterday – that Pickering A does have two shutdown systems: one, drop rods into the core; and, as well, the second was the dump tank drop [of] the moderator, hence you can't maintain criticality.

Sometime ago it was determined that for some events the dump tank wasn't fast enough. Then there was an extensive enhancement to the system that initiates dropping the rods. I'll let Steve walk through the enhancements. Steve.

MR. GREGORIS: Steve Gregoris, for the record.

So, as Mr. Lockwood said, there are two ways to shutdown the Pickering 1 to 4 reactors. Shutoff rods fall into *[the]* core, or the moderator dumps. The moderator dump is the deepest insertion of reactivity, because you remove the moderator. There is no way that that reactor can go critical. You know, we talked about benefits and maybe some challenges to that system, that system is an effective system. You know, I want to give that appreciation to the Commission.

When this was reviewed in the mid-1990s to early-2000s, when Pickering 1 to 4 was coming towards return to service, there was a lot of discussion, it included the Staff, it included the Commission, Commission presentations.

To improve the shutdown systems on 1 to 4 there was a shutdown system enhancement done. That increased the number of shutoff rods that originally were designed for those reactors. It also included a set of separate parameters to monitor the different parameters that would require a shutdown; those are neutronic parameters and also process parameters.

So effectively, we have, you know, an additional set of parameters monitoring, we have additional shutoff rods, plus the original two systems and the original parameters that are monitored. With all of that, you know, it was proven that that's equivalent to two fast-acting shutdown systems, and it was proven that the ability to shutdown the reactor or [rather] not shut it down was an incredible event.

DR. EDWARDS: Well. "Incredible." That's an interesting word. All the accidents that have ever happened in the nuclear field have been incredible.

The point of the matter is, and I repeat, nobody since the early days – like around the time of the Royal Commission on Electric Power Planning, it was by that time fully acknowledged that the moderator dump while, yes, shutting down the reactor, is way too slow. You have to shutdown the reactor within two seconds.

Because in a CANDU reactor you have a problem similar to the one at Chernobyl, which is when you lose the coolant – if you have a loss of coolant accident – you're going to get a power surge. If you don't terminate that within two seconds, you're going to have a destroyed core. The core of the reactor's going to be totally destroyed. The moderator dump is absolutely incapable of dealing with that.

So these fast shutdown rods are one system, and you can increase the number of them, but that doesn't make it independent. It was decided early on by the Atomic Energy Control Board in order to make sure that we do not compromise safety, in order to ensure that we live up to that high standard and the trust that the Canadian public has put upon us, we will insist that there be two fully independent fast shutdown systems, each one of which could totally shutdown the reactor quickly in less than two seconds.

Because if one of those shutdown systems fails, there's still another one that can do it. You don't have that at Pickering A.

MR. FRAPPIER: That's correct, Dr. Edwards.

THE PRESIDENT: Okay. Staff, last word on that?

MR. FRAPPIER: Gerry Frappier, for the record. I'd ask Mr. Vali Tavasoli to explain the equivalency of the shutdown systems.

DR. EDWARDS: Mr. Frappier – you're with CNSC, right? I'm surprised that CNSC is defending OPG on this instead of letting OPG defend itself.

THE PRESIDENT: Okay. I'd like to hear about the regulatory oversight here and the inspection that goes with it. Who's going to talk to this?

MR. FRAPPIER: Vali Tavasoli is in Ottawa, and should be able to talk to that.

THE PRESIDENT: Okay. Go ahead please,

MR. TAVASOLI: This is Vali Tavasoli, Director of Reactor Physics and Fuel Division at CNSC. There's a couple of things that I'd like to mention. One of them was a statement by our own Staff regarding the enhanced shutdown system being a second shutdown system. This is not true.

One other thing I'd like to add is that, as Dr. Elder said, the moderator dump is effective for more probable slower transients. These transients – because of some of the component failures that Dr. Edwards has brought up himself, like steam generator failure, pressure tube failure, feeder failure – these are slower transients and for these types of transients which are very probable – not very probable, [but] more probable than other faster transients – the moderator dump is fully effective.

> *[NOTE: Mr. Tavasoli is missing the point. If a severe accident damages the core and also breaks tubes in the steam generator, there is then a direct pathway by which radioactive vapours such as iodine-131 and*

> *cesium-137 can escape directly into the environment, bypassing the vacuum building and all filtration systems.]*

With respect to the fact that the moderator dump might not be fully effective for faster transients, there might be a residual risk. This residual risk has been taken into account in the PSA *[Probabilistic Safety Assessment]* studies.

The statement that Mr. Jammal made in the first night about the equivalency of that was based on a risk-informed assessment that the CNSC had done many years ago. That risk-informed result was that, yes, that on a risk-informed basis the two systems could be considered equivalent.

> *[NOTE: The term "risk-informed assessment" is a code for theoretical calculations of probability that are in effect just educated guesses as to how likely a certain event is imagined to be. Fact is, nobody really knows what the real probabilities actually are. Even if the true probabilities were known, they would not dictate individual outcomes at all. Probabilities do not tell us WHETHER something will occur, but only HOW FREQUENTLY it will occur. It is scientifically and mathematically incorrect to say that a low probability makes any particular event "incredible".]*

THE PRESIDENT: Okay. Dr. Edwards, any final thoughts you want to share with us?

DR. EDWARDS: Well, my final thought is that in my 40 years of intervening at CNSC hearings I have found it difficult to understand why the licensee and the CNSC Staff always seem to be saying the same things and supporting each other.

I would expect that in a proper regulatory agency, the Staff of the regulator would be asking tough questions all the time of the licensee, holding the licensee's feet to the fire, and insisting that they get adequate answers in the interest of public safety, rather than simply echoing what the licensee is putting forward.

I do ask the Commissioners to consider the fact that we intervenors do not have the opportunity to engage in cross-examination. I cross-examined nuclear experts for a period of three months during the Royal Commission on Electric Power Planning, and was able to make a lot of headway, and the Commission came out with a report which sided against many of the *[safety]* claims that were being made by the industry.

In these hearings, these regulatory hearings, *[these]* licensing hearings, there's no such opportunity. As a result, you have both the regulator and the licensee coming in with the same story, asking for the same thing of the Commissioners, and the only opposition you really get to hear, or the only tough questions you get, are from intervenors – who are like gadflies, because they only get 10 minutes and then a short period of Q&A.

I believe that there are serious questions here, *[questions]* that the Commissioners should examine their conscience about, and say "Do I really want to give a licence to a plant that is not really up to snuff even by the current practice that is acknowledged for all other CANDU reactors?"

THE PRESIDENT: Okay, thank you. Thank you for your intervention.