

**MR. EDWARDS:** Well, thank you very much to the Panel for this opportunity to present. Unfortunately, due to a registration error I wasn't able to request a 30-minute presentation. I'm very glad to receive the 10-minute interval you've given me.

We all know that the proposed DGR currently being discussed was inspired by another project, the possible construction of a DGR for high-level waste. Not unreasonably, the Mayor of Kincardine asked the question, "If a DGR is safe for high-level waste, why not also for low and intermediate-level waste?" And hence, we have this project being presented and discussed.

The elephant in the room in both cases is the question of abandonment.

I noticed that the associations who earlier supported the idea [of the DGR] and testified to OPG's capabilities of constructing and operating this facility, made no mention of abandonment.

The interesting thing is that many of the qualities that OPG has – such as safety culture, oversight, accountability, root cause analysis, learning from the past and so on – make no sense once you abandon the waste.

Because once you abandon the waste there will be nobody there.

That's the whole problem. The whole problem is that we are assuming that geological disposal combined with abandonment is a logical choice. In fact, it's being presented in many cases as if it were the only logical choice.

The fact of the matter is that we have had some embarrassing failures and we should really call into question whether the whole idea of abandonment is in fact scientifically valid or even an ethical choice for society to make.

As the Seaborn Panel said in their Executive Summary: **"The concept in its current form does not have the required level of acceptability to be adopted as Canada's approach for managing nuclear fuel waste."**

I would maintain – my organization would maintain – that the same applies to the storage of nuclear waste that remains dangerous, as these wastes will, for hundreds of thousands, even millions of years.

So [we come to] this question of Rolling Stewardship.

[See <http://tinyurl.com/n75cb9n>]

I would like to clarify a couple of things. It's not intended to be a permanent solution. It's not even intended to be a solution. It's simply an ethical waste management scheme that gives future generations the ability to protect themselves.

The problem with abandonment, if it backfires, is that future generations are saddled with the results of a situation where they do not have the necessary resources and tools, or even the knowledge, to [be able to] protect themselves and to take corrective action.

When I look at the questions that were raised by the Panel I would like to say something about questions number two, number four, number five and number six.

Question number four, I believe, is the one having to do with alternatives.

The only alternatives that are identified in the Panel's questions – two of them are surface storage at the Western Waste Management Facility either in its current status quo condition or in some kind of enhanced condition.

But both of these are right beside Lake Huron, and many people on both sides of the border have expressed great trepidation over the idea of permanent storage of radioactive waste, nuclear waste, right beside Lake Huron – right beside the Great Lakes.

So I'm surprised that the Panel did not ask about the possibility of Rolling Stewardship away from the Great Lakes.

I think that most people would have assumed that when the Bruce facility closes down, as it ultimately will, that these wastes would be moved to [a place] further away from the lake. Much further away. Away from the lake.

The only reason for them being at the lake is because the reactors require a lot of water to cool their cores during operations. There's no other reason to be so close to water.

We have to consider the future very carefully. We have to realize that making irrevocable choices at this point in time is based on the fact that we don't have one single operating safe deep geological repository for nuclear waste operating anywhere in the world.

So it seems to be a bit of a leap to assume that we're going to be the first – and we haven't even broken ground!

With regard to the WIPP experience, I would like to point out that although 22 workers were contaminated with plutonium dust at the WIPP facility as the result of an accident, we had hundreds of workers contaminated with plutonium dust at the Bruce facility – and it wasn't even an accident. It was just during normal operations when they were doing the refurbishment of the Bruce reactors for a period of – I believe it was something like six weeks.

There was plutonium dust in the air and the workers were told by their superiors that they did not have to wear respirators or other protective clothing and as a result, hundreds of workers were contaminated. And this was not an accident. This was just as a result of improper administration.

Yet, I'm really very perplexed to see that as far as I know there were no penalties assigned to this. There was no -- nobody was held accountable for it. There was no responsibility assigned.

And, yet, Dr. Frank Greening who had worked so many years for Ontario Hydro and then Ontario Power Generation, said that it was well documented that the pipes that they were handling had contained plutonium and americium and curium and other alpha-emitting materials.

They [the supervisors] should have known this. It was all documented. And yet, these mistakes were made.

But this is not really the main point.

The main point is that we all know that humans are fallible. We all know that mistakes can be made.

Better to have a situation where we do have people with a good safety culture, people who are well trained, people who do have a conscientious regard for their own safety and the safety of others, to be in charge of this waste and to be able to be on the spot, to be able to monitor it and retrieve it and repackage it or repair it when necessary so as to protect the environment and to ensure that any situation that does develop is very quickly corrected.

Again, it's this abandonment problem which is a fundamental obstacle to a rational approach.

Now, sometime in the future if we do develop a technology which is truly fail-safe and truly proven to be safe in every respect, then we can move to [implement] that. Rolling stewardship is only intended to be looking after the waste until that time comes.

That time, however, may not be in the lifetime of the nuclear power industry. Therefore, careful planning and accommodations have to be made now.

These conditions have to be institutionalized today so that there will be people who will transmit the knowledge, who will transmit the resources to the next generation and they to the next generation, perhaps at 20-year intervals with the "Changing of the Guard" in order to ensure that these wastes are not just packaged in the status quo method but continuous improvement [takes place].

We can improve. Each generation can make an improvement over what the previous generation did until such time as we actually reach a genuinely satisfactory solution that everybody can agree on.

Now, with regard to the long term analysis – this is question number two, the geological verification – there is a problem, and that is that geology is not really a predictive science.

Just as in science generally, we have had major upsets recently in the 20th century. In the early 20th century, the discovery of quantum theory. In the late 20th century, the discovery of dark energy and dark matter. Who would have believed that such things would be possible?

And also, in the late 20th century, we discovered in Mathematics that what we thought were deterministic mathematical models – models that were able to give accurate predictions of the future – [these] are not necessarily so.

When you have non-linear mathematical models, and when they are iterated many, many times, you can get chaotic behavior and you can get total unpredictability occurring.

This was first observed in the 19th century but not understood until late in the 20th century. Henri Poincaré, the great Mathematician and Physicist, wrote in 1914:

"A very small cause which escapes our notice determines a considerable effect that we cannot fail to see and then we say the effect is due to chance.

"If we knew exactly the laws of nature and the situation of the universe at the initial moment we could predict exactly the situation of that same universe at a succeeding moment.

"But even if it were the case that the natural laws had no longer any secret for us, we could still only know the initial situation approximately. However, if that enabled us to predict the succeeding situation with the same degree of approximation that's all we require and we would say the phenomenon has been predicted.

"But we have now discovered it is not always so.

"It may happen that small differences in the initial conditions produce very great differences in the final phenomena. A small error in the former will produce an enormous error in the latter. Prediction becomes impossible –

**THE CHAIRPERSON:** Mr. Edwards, if I could begin? I'm sorry, but we do have -- we are out of time. So if you could sum up quickly, please?

**MR. EDWARDS:** Okay.

What I am claiming – and I say this as a mathematician who has been involved in the study of Mathematical Sciences throughout Canada for the Science Council of Canada, at which time I discovered that the Economic Council of Canada had a [mathematical] model that had predictions that were wildly inaccurate under certain circumstances – I do not believe that we have the capability to predict the future over such enormous lengths of time.

As such, we do not have the scientific legitimacy to abandon these wastes. We must keep an eye on them and see what happens as the future evolves.

**THE CHAIRPERSON:** Thank you very much. Panel Members, did we have some questions? Dr. Muecke...?

**MEMBER MUECKE:** This is to CNSC.

*We just heard from Dr. Edwards about the contamination during the Bruce A refurbishment and workers being exposed to inhalation of plutonium-contaminated dust.*

*Could CNSC confirm this and how was this incident dealt with and how and when was the incident communicated to the workforce?*

**DR. THOMPSON [CNSC]:** Patsy Thompson, for the record.

*There was an alpha contamination event at the Bruce nuclear power plant during some refurbishment activities.*

*The CNSC found out about the event through the reporting system that is in place as part of the licence for unplanned exposures. I will ask my colleagues, Christina Dodkin and Melanie Rickard, to explain the event and essentially the regulatory actions that CNSC took and the communication and the oversight of communication between Bruce Power and the workers.*

**MS RICKARD [CNSC]:** Good afternoon. My name is Melanie Rickard. I'm a dosimetry specialist with the CNSC.

*Yes, the events were reported to the CNSC initially in 2009, and immediately CNSC took action.*

*A request pursuant to section 12(2) of the general regs was issued to Bruce Power and to all the nuclear power facilities to ensure that workers were -- measures were put in place so that workers were immediately protected.*

*Over the course of several years CNSC staff actually presented several CMDs in open Commission hearings on this topic.*

*Essentially, major programmatic changes were recommended to the industry and some of those programmatic changes -- there were actually 17 in total -- include things such as zoning, dosimetry, instrumentation, training, monitoring. There are several others which I can share with you if you would like the entire list of the 17 correction actions.*

*But essentially those corrective actions were put in place to meet two goals. The first is to ensure that workers are protected and the second was to ensure that*

*alpha dosimetry hazards are being assessed appropriately and that the characterization is being done appropriately so that best practices are being followed at all times.*

*Since the closure of the event, a retrospective dosimetry assessment was done and 330 doses to all the workers were ascertained and submitted to our National Dose Registry.*

**THE CHAIRPERSON:** *Dr. Muecke, did you have a follow up?*

**MEMBER MUECKE:** *Yes.*

*How was it possible for this to happen in the first place? What knowledge gap existed that allowed it to happen?*

**MS RICKARD:** *Essentially, the reason why the event happened was when they went into the system and opened it up as part of the refurb activities, they weren't - they had not appropriately characterized the hazard.*

*They had not foreseen that the hazard would be there. They had assumed that other checks and balances were in place that would prevent such an event.*

*And while they were doing the work the air monitors did pick up contamination that was related to alpha contaminations.*

*At that time they realized that they obviously had not expected those types of contaminants to come out of the system.*

*This was when the report was made to the CNSC and the 12(2) was immediately issued to ensure that staff were immediately protected onsite and then a series of corrective actions followed after the investigation was complete.*

*But essentially at a high level, the risk was not appropriately characterized at that time. And since this time the CNSC has taken these lessons learned and shared with the international community.*

*Essentially after this event, after the implementation of the lessons learned, Canada is now leading the way in ensuring that alpha hazards are appropriately characterized at nuclear power plants around the world.*

**THE CHAIRPERSON:** *Thank you very much, Dr. Edwards.*

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**DR. GREENING:** *This is directed at the CNSC.*

*I wrote to the CNSC in January, 2010 and I also wrote to Bruce Power about the alpha contamination incident that occurred in Bruce in Units 1 and 2 in December of 2009 and I was totally ignored by the CNSC. I've never received any correspondence from the CNSC to this day about that incident.*

*But the truth about that incident is that it was definitely due to a degraded safety culture because the rad protection staff knew about the alpha contamination problem and ignored it in the interests of production, because they were under pressure to get the grinding of the feeder pipes finished.*

*So I would ask the CNSC to comment. My question is, would the CNSC confirm that that is, in fact, the true story about what happened.*

*They say that they didn't know, or they say they have a different story. I would like them to confirm my story. I believe that is a question.*

**THE CHAIRPERSON:** *Dr. Thompson...?*

**DR. THOMPSON:** *Patsy Thompson, for the record. I'm going by memory because it's been a while and there's a number of Commission member documents that the CNSC provided to the Commission on these events so, if needed, we can go back tomorrow and bring forward some information.*

*My recollection is that when the events happened there was air sampling going on and the measurements were being compared to a ratio of two radionuclides, and I can't remember the names of those radionuclides, but the ratio of those radionuclides had been developed from historical information and was used as the basis for predicting the presence or absence of some alpha particles.*

*The events at Bruce indicated that ratio was not always appropriate and not always a good indicator of the presence of alpha contamination. On that basis, the CNSC did a fair amount of investigation. We also got information from our international colleagues to develop requirements for alpha monitoring programs.*

*The CNSC also did a research project through our research and support program to better understand the presence of various radionuclides and particles and understand the relationship between those radionuclides so that we could have a better sense of the appropriateness of the ratios ever being done for monitoring purposes and for work control purposes.*

**THE CHAIRPERSON:** *Dr. Thompson, the panel just heard Dr. Greening make a rather worrisome statement in terms of the degraded safety culture. Could you please comment?*

**DR. THOMPSON:** Patsy Thompson, for the record.

*If you would allow me, I can come back during the day tomorrow to address that issue better. I don't have the information now that I could use.*

**THE CHAIRPERSON:** Thank you. Was that all of your questions, Dr. Greening?

**DR. GREENING:** That was hardly an answer. . . .

*[one day later, on September 10]*

**DR. THOMPSON:** Patsy Thompson, for the record.

*Dr. Swanson, we had made a commitment yesterday to bring some information back on the issue of the Bruce Power Plant Safety Culture in relation to the events that were raised by Dr. Greening for the alpha contamination event.*

*And so CNSC has, since the mid-1990s, safety culture assessments being done at Canadian nuclear power plants. The results of these assessments are reviewed by CNSC staff and it is considered. Essentially CNSC has oversight of these activities.*

*As Dr. Harrison mentioned yesterday, there has been safety culture assessments performed at both Darlington and Pickering. And in the Bruce specific case last year, in 2013, Bruce Power conducted a site-wide nuclear safe culture assessment. For this assessment Bruce Power adapted the industry's best practices on safety culture.*

*CNSC staff witnessed the assessment on site and followed up with more detailed review of the final report. The information submitted by Bruce Power regarding their 2013 safety culture self-assessment, the methods, findings and corrective action plans and implementation were considered appropriate by CNSC staff.*

***In relation more specifically to the Bruce Power alpha contamination event, CNSC staff have confidence that Bruce Power has a healthy safety culture for the following reasons:***

- \* this event was unforeseen for reasons that I don't have right now;***
- \* there was no evidence that there was a potential for this event, so it's not something that Bruce Power or employees decided to ignore;***
- \* the event was quickly reported to the CNSC;***
- \* the licensee took adequate corrective actions to mitigate the event and prevent a recurrence; and***
- \* the lessons learned were shared internally and throughout the industry.***

**THE CHAIRPERSON:** Thank you.

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