Deep Geologic Repository Project

Projet de stockage dans des couches géologiques profondes

Joint Review Panel
Public Hearing

Commission d'examen conjoint
Audience publique

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Le 10 septembre 2014

Royal Canadian Legion
219 Lambton Street
Kincardine, Ontario

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Joint Review Panel

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Kincardine, Ontario / Kincardine (Ontario)

--- Upon commencing on Wednesday, September 10, 2014 at 9:00 a.m. / L'audience débute le mercredi 10 septembre 2014 à 9 h 00

OPENING REMARKS

MS MYLES: Good morning everyone and welcome to the second day of the additional hearing days of the Deep Geological Repository Joint Review Panel. My name is Deborah Myles and I am the Panel Co-Manager.

Just a few logistics before we get started today.

We have simultaneous translation. The English is on Channel 1 and French is on Channel 2. Please keep the pace of your speech relatively slow for the translators.

A written transcript is being created for these proceedings and will reflect the official language used by each speaker. Transcripts will be posted on the Canadian Environmental Assessment Registry page for the project as soon as they are available. I note that yesterday's transcripts are not posted yet,

but will be this morning.

To make the transcripts as meaningful as possible, please identify yourself before speaking and, as a courtesy to others in the room, please silence your cell phones and other electronic devices.

The hearing is being webcast live and the webcast can be accessed through the home page of the Canadian Nuclear Safety Commission at www.nuclearsafety.gc.ca.

A schedule for the additional hearing days was posted on the public registry on August 26th and daily agendas are being created and are posted mid or late afternoon each day to reflect updates in the schedule.

The hearing will begin each day at 9 o'clock and end at approximately 5:00 p.m.

Emergency exits are located at the back of the room, to my left behind the screen and curtain, and trash and recycle bins are located at the exit. Please drain your beverage containers and use the trash bins out of respect for the Royal Canadian Legion who are our gracious hosts for these two weeks.

Washrooms are located in the

lobby, the main entrance, and the wheelchair access and ramp is located in the back parking lot, where there is a bell.

In the event of fire or a fire alarm, you are asked to leave the building immediately.

If you are scheduled to make a presentation today, please check in with a member of the Secretariat. Each member of the Secretariat has a name tag, except for, I'm sorry, I forgot mine today.

--- Laughter

MS MYLES: No, I just forgot it this morning. So we are easy to identify if you don't know us already.

If you are a registered participant and want to seek leave of the Chair to ask a question for a presenter, you are asked to speak with a member of the Secretariat.

As was done yesterday, questions from hearing participants will be considered after all of today's presentations are done.

If you are not scheduled to make a presentation during the hearings but would like to seek leave of the Chair to make a brief oral

statement, please speak with a member of the Secretariat and complete a request form that is available on the back table.

An opportunity to make a brief oral statement is subject to the availability of time each day and must be for the purpose of addressing one or more of the six subjects that are the focus of the hearings.

Opportunities for either a proposed question for a presenter or a brief oral statement at the end of today's session may be provided, time permitting, on a first-come first-served basis.

In accordance with the Panel's hearing procedures, the resumption of this public hearing is solely for the purpose of addressing the six subjects of the Information Requests issued by the Panel since November 2013. Neither presentations nor questions will be permitted if they do not follow the hearing procedures.

Anyone who wishes to take photos or videos, please see the Panel's Communication Advisor, Lucille Jamault. Any of the Secretariat Members can identify Lucille for you.

Thank you very much.

Dr. Swanson...?

THE CHAIRPERSON: Good morning. On behalf of the Joint Review Panel welcome everyone here in person or joining us through the webcast.

My name is Stella Swanson, I am the Chair of the Joint Review Panel for the Deep Geologic Repository for low and intermediate level radioactive waste project.

I'm going to introduce the other members of the Joint Review Panel. On my right is Dr. Gunter Muecke and on my left is Dr. Jamie Archibald.

We have already heard from Ms Debra Myles, the Co-Manager of the Joint Review Panel, and we also have Mr. Pierre Daniel Bourgeau, counsel to the Panel, with us on the podium today.

As noted in the published agenda, the subject for today's session will be the Reference waste Inventory.

Before we begin I would like to explain the procedure for questions from participants for presenters.

The Panel will ask its questions

after each presenter unless otherwise stated, such as may be the case for government and OPG presentations.

As we did yesterday, the Panel will consider, time permitting, questions submitted by registered participants at the end of the day once the Panel has heard from all presenters. Participants are reminded that questions must relate to today's presentations.

We will now proceed with presentations by Ontario Power Generation and the Canadian Nuclear Safety Commission pertaining to the subject of the Reference Waste Inventory.

The Panel will hear both presentations before proceeding with its questions.

I would like to call on Ontario Power Generation to begin their presentation, which is PMD 14-P1.1B.

Ms Swami, the floor is yours.

PRESENTATION BY / PRÉSENTATION PAR:
ONTARIO POWER GENERATION

MS SWAMI: Good morning,

Dr. Swanson and Members of the Panel.

This morning I would like to take a moment to introduce our presenters. Although some of them have been in front of the Panel before, we have also augmented our team for the presentation this morning.

Dr. Paul Gierszewski, who will lead our presentation, is a Doctor of Science in Nuclear Engineering from MIT in Boston. He has been working on safety assessment of geologic repositories for the past 15 years. Presently he is the Director of Safety and Licensing at the Nuclear Waste Management Organization. His group provides technical support to the OPG DGR project with respect to operations and long-term safety assessment.

Mr. Glenn Round is a professional engineer and OPG's Director of Engineering with our Nuclear Waste Management Division. He is the engineering authority for nuclear waste management as delegated by our Chief Nuclear Engineer in OPG. He is a fully qualified design authority and the program owner of the waste characterization for OPG. He has 25 years of experience in the nuclear industry.

Dr. Michael Brett has joined us. He has a Ph.D. in Chemistry from the University of Birmingham, U.K. He is a member of the Chemical Institute of Canada, the Royal Society for Chemistry and a Chartered Chemist. He has served as a Research Associate in the Metallic Oxidization And Corrosion Section of the National Research Council of Canada and the Canada Centre for Minerals and Energy Technology prior to joining Ontario Hydro. He has a 25 year career in the chemistry field with Ontario Hydro and OPG and is currently the Manager of our Department of Chemistry, Metallurgy and Welding.

Dr. Dave Evans is a scientist with OPG's Corporate Chemistry Group. He has a Ph.D. from McMaster University and is a Chartered Chemist. He has worked in the CANDU chemistry for more than 31 years, including 15 years in research. His areas of expertise include process chemistry, water treatment, ion exchange and waste management.

Mr. Richard Little is Operations Director at Quintessa in the U.K. He has a B.Sc. in Geology and Geography from the University of St. Andrews and an M.Sc. in Engineering Hydrology

from the University of Newcastle Upon Tyne. He has over 25 years consultancy experience in radioactive waste disposal, focused on the management of technical and technical contribution to safety assessment projects in numerous countries. He has also worked as an expert consultant for the International Atomic Energy Agency and the Nuclear Energy Agency. He has been the lead for work for OPG for the post-closures safety assessment of low and intermediate level waste at the Bruce nuclear site since 2002.

Dr. Gierszewski...?

DR. GIERSZEWSKI: Good morning. For the record, my name is Paul Gierszewski, I am the Director of Safety and Licensing for the Nuclear Waste Management Organization.

Today I will give a summary presentation on OPG's response to EIS-13-514 on waste inventory.

I will also comment on some other claims that have been made recently with respect to the DGR Safety Assessment.

In this presentation I will cover the following topics:

the Information Request;

the basis for the Reference Inventory, including the important radionuclides;

OPG's Waste Inventory Verification Plan;

the safety implications of recent changes to the inventory and the safety implications of pressure tube waste and ion exchange resins; and

response to recent public comments.

A key point we will make is that the 2010 DGR Reference Inventory provided a comprehensive preliminary estimate of all radionuclides of potential importance, while emphasizing the most important radionuclides. It recognized that there were uncertainties. These were accounted for in part through sensitivity cases presented in the preliminary safety report.

Furthermore, while the amount of some radionuclides in some waste streams were underestimated compared with current estimates, these are less important radionuclides in terms of potential impact. There was no change in the overall safety case.

Earlier this year, Dr. Greening identified several potential issues with respect to the radionuclide inventories used in the 2010 DGR Reference Inventory Report. These were with respect to pressure tubes and garter springs.

OPG considered these comments seriously and provided a detailed response. In this response we indicated that the inventory values questioned were estimates and were being addressed as part of OPG's ongoing Waste Characterization Program. We also noted that these particular inventory changes were not significant to the safety case.

Subsequently, in the Information Request, the Panel asked OPG to repeat the relevant safety analyses using the revised inventories in order to quantify the effects on the safety case.

The Panel also asked OPG to provide more details on its Waste Characterization Program in general and on how resins would be measured in particular. This is provided in a Waste Inventory Verification Plan. A response to the Information Request addressed these topics.

This summer, Dr. Greening has made further claims to the Panel with respect to the ignition of pressure tube wastes and the behaviour of ion exchange resins. We will also address these claims in this presentation.

The DGR Reference Inventory documents the total projected inventory within the DGR. About half of the total wastes are already in storage at the Western Waste Management Facility. As the rest of the waste does not yet exist, it's inventory cannot be directly measured, it must be estimated using OPG's system plans, calculations and other information.

The first version of the Reference Inventory was released in 2008. The subsequent 2010 version of this report was used as the basis for the current site preparation and construction license application.

As new data becomes available, we assess the significance. If not significant, we accumulate it for future revisions of the Inventory Report.

The Reference Inventory will be updated to support the first operating license

application. This would be required before any waste could be placed in the DGR. The Reference Inventory would be further updated in support of the renewal of the operating license.

The Reference Inventory builds on the results of OPG's Waste Characterization Program.

OPG's fleet of CANDU reactors generates a number of distinct but relatively well defined waste types. We presently consider over 25 different main waste types from incinerator ash to steam generators. The characterization of these waste types considers the data needed for station operation, handling and storage at the Western Waste Management Facility, and placement in the DGR and long-term safety in the DGR.

A key factor in these different data needs is the timeframe. For example, station operation interests include short-lived radionuclides, but these are not important to the DGR since they would already have decayed.

We have identified about 50 radionuclides of potential interest to the DGR, considering both operations and long-term

safety. The Reference Inventory is based on measurements or estimates for all these radionuclides.

For the DGR Reference Inventory we recognized that there were uncertainties. These were to be addressed through the ongoing OPG Waste Characterization Program. For the 2010 inventory report, we particularly focused our attention on those radionuclides with the greatest potential impact on DGR safety.

Slide 6 shows the future waste volume projections from the 2010 DGR Reference Inventory Report. These figures show the projected volumes for low-level waste and for intermediate level waste on the left and right respectively.

The figures cover the period from 2009 to 2054 when the current fleet of reactors is projected to shut down. The different colours represent different types of waste.

In the left figure, looking forward over the next 40 years the low-level waste is expected to steadily increase with time while the nuclear stations continue to operate. About half of the projected total low-level waste

is currently in storage.

The blue area in that figure corresponds to non-processable low-level waste.

The right figure shows that some intermediate level waste is generated at a steady rate as the reactors operate, while some is largely produced over the next decade. That is the grey area in this figure and it refers to retube wastes. Most reactor retubing will be completed over the next decade.

Overall these figures show that there is a reasonable basis now to project future total waste inventories and at the time of an application for a DGR operating license in several years a significant amount of refurbishment waste will also be available to support an enhanced estimate of the radionuclide inventory and retube wastes.

As noted before, OPG has an ongoing multiyear Waste Characterization Program to improve the basis for our waste inventory projections. The program addresses all potentially relevant radionuclides and waste types. It includes characterization of physical content, notably metals and organics, which is

relevant to gas generation.

OPG has provided to the Joint Review Panel a Waste Inventory Verification Plan. This describes the graded approach used with respect to the amount of data needed which depends on the importance of the radionuclide and the waste type.

Verification of the information is provided in part through use of accredited laboratories. These laboratories routinely calibrate their instruments against standards. The results are also verified through comparison with other published data, interlaboratory comparisons and a planned third-party review. This information will be available in time to prepare an updated Reference Inventory.

This, together with any other relevant information, would be used to update the safety analysis for an operating license application several years from now.

This figure illustrates the main elements of the Waste Inventory Verification Plan. As shown at the top of the figure, the core of the program is the ongoing sampling and measurement of wastes.

Current 2014 work, for example, includes analysis of various low-level waste bins and of pressure tube samples and an interlaboratory comparison.

The next several years will include continued work on both low and intermediate level waste with priorities guided by the Waste Inventory Verification Plan.

And interlaboratory comparison will be carried out every few years. During this period, there will also be a third-party review of the Waste Characterization Program and its results.

Around 2021, the data would be used to prepare an updated Reference Inventory to support an application for an operating license.

As noted in previous slides, OPG's Waste Characterization Program's objective is to have data on all potentially relevant radionuclides. However, it is useful to understand which data is most important.

Slide 9 illustrates which radionuclides are key to long-term safety. This figure shows the maximum calculated dose under several normal and disruptive scenarios. Note

that the scale is logarithmic. Each horizontal division represents a factor of 1000 in dose.

The results include all waste streams and all relevant radionuclides. The figure is labelled to show the contribution of the two radionuclides contributing the most to the maximum dose. Other radionuclides contribute smaller amounts and are not labelled.

The figure shows that there are only a small number of radionuclides that are very important to dose impact. Under normal evolution scenarios Iodine-129 is important, the higher dose scenarios are dominated by Carbon-14, Niobium-94 and Zirconium-93. These are important in part because of the amount that are present in the wastes and also because of the relatively long half-lives.

The figure also shows the large uncertainties in the inventory of many other radionuclides would have no material impact on the long-term safety case. This applies to Tritium, for example, which does not appear as an important contributor to maximum dose in any of the long-term scenarios.

Of course, we want to have a good

inventory for all radionuclides, but understanding the potential contribution of each radionuclide helps set priorities.

Slide 10 describes the basis for the inventories of the key radionuclides for long-term safety.

Carbon-14 is primarily produced by neutron interaction with moderator heavy water. The corresponding waste streams in the DGR will be the moderator resins. We project the total amount of Carbon-14 in the DGR based on measurements of Carbon-14 in resins.

Niobium-94 is primarily produced by neutron activation of pressure tubes. For the DGR, the inventory is based on activation calculations to the projected end-of-life exposure of the pressure tubes. The calculations have been validated against measurements of Niobium-94 in pressure tubes.

Early this year, Dr. Greening challenged the projected DGR inventory of Niobium-94 in pressure tubes, however the basis for his concern was not correct. Our values are in fact consistent with the data that he was using.

Zirconium-93 is another key radionuclides that, like Niobium-94, is primarily produced by neutron activation of pressure tubes. It is a harder radionuclide to measure, in part because of its long half-life and, accordingly, we used indirect measurements to validate our calculations, but we are confident of the calculations and we currently have worked under way to provide direct validation.

In this slide 11 we focus on pressure tubes. This is the waste form that was questioned by Dr. Greening in letters to the Panel.

This is a waste that is produced during the midlife retubing of CANDU reactors and also during decommissioning. The pressure tubes are the main source of the key radionuclides Zirconium-93 and Niobium-94. It is also an important source of other radionuclides, including Carbon-14, Chlorine-36 and Curium-244.

The 2010 Reference Inventory assumed retube waste from 16 reactors. This will largely occur over the next 10 years.

Most of these reactors have not yet been retubed so the bulk of this waste had

yet to be produced and an estimate was needed for the DGR.

The projected DGR inventory for pressure tubes was based on calculations for bulk activation radionuclides and an estimate for surface-based radionuclides.

The bulk activation radionuclides were considered to be the most important in terms of potential dose impact and also to be appropriately calculated, as noted in the previous slide.

The surface-based radionuclides were considered less important and were estimated at that time. As noted by Dr. Greening, the amounts of Tritium, Cesium-137 and Curium-234 were significantly underestimated. However, as explained in slide 9, these are not important contributors to post-closure dose.

In 2010 OPG had already identified the pressure tube inventory as an area for improvement. We have collected data from prior measurements and we have specifically acquired additional samples which are currently under study.

Another topic that was addressed

in this information request was the treatment of the spacers placed between the pressure tube and calandria tubes, also referred to as garter springs. Spacers were made from Zirconium alloy for the first 15 reactors and subsequently from an Inconel alloy. The radioactivity of spacers was not included in the 2010 reference inventory.

In terms of the total amount of Zirconium in the reference inventory these are small items, about 50 grams per each 61,000 gram pressure tube. The radioactivity in the Zirconium alloy spacers is small compared to that in the pressure tubes. However, the radioactivity in Inconel spacers is high due to its nickel content and it's important to the total DGR radioactivity for some nickel radioisotopes.

For this information request the safety analysis conservatively assumed Inconel spacers were used in all reactors. The results show that the addition of this radioactivity does not affect the conclusions of the safety case. Nonetheless, spacer radioactivity will be included in subsequent versions of the reference inventory.

Slide 13 summarizes the relevance of the revised pressure tube inventories on operational safety for the DGR.

First, there was no change to the normal emissions from the DGR as the retube waste containers holding the pressure tubes are sealed before arrival at the DGR.

Second, while there are higher inventories of some gamma emitters in the waste, all waste packages must meet OPG acceptance criteria and OPG will operate so as to keep worker exposure below its dose targets.

Finally, with respect to accidents it is first noted that breach of the retube containers is a very unlikely accident due to the container robustness. However, in the event of a breach there would be higher dose consequences but they would remain well below public dose criteria.

In response to this information request, all post-closure assessment level cases were recalculated to check the effect of the changes to the radionuclide inventory in pressure tubes. The results are shown here with the revised results in the white bars. The revised

inventory has very little effect on calculating maximum dose rates. This is because, first, the inventory of only four radionuclides are increased by more than 10 percent and, second, none of these radionuclides or their progeny are important contributors to dose in the DGR. The post-closure impacts remain well below criteria.

Dr. Greening has claimed that the ignition of Zirconium is an important factor to consider in pressure tube waste safety under accident or malevolent conditions. It is correct that Zirconium can spontaneously ignite under certain conditions. Notably, if it is in powder form. This is a recognized hazard and safely managed where it occurs within OPG. However, the OPG Zirconium retube wastes are in coupons similar to those shown in the top right photo. These are too large for spontaneous ignition.

The same report that was used to claim combustibility in fact provides information that indicates these OPG pieces would not spontaneously ignite. And the very small amount of cuttings generated during cutting the retube waste into coupons would be well dispersed within these larger pieces. This is also consistent

with decades of Canadian experience of working with pressure tubes.

I would like to run a short video in which a pressure tube coupon was heated to 1,100 degrees C and did not burn.

--- Video presentation / Présentation video

DR. GIERSZEWSKI: This demonstrates that these wastes, consistent with the literature, do not spontaneously ignite at room temperature.

Furthermore, in the DGR this material is also in sealed containers where there is limited oxygen and the containers themselves are robust steel and concrete containers weighing over 26 tonnes. These containers provide a very high level of safety.

Some of the claims are with respect to risk under malevolent accidents. These claims are not correct because they essentially ignore the presence of the 26-tonne container. For security reasons, I cannot discuss malevolent acts in any detail. Furthermore, emplacing these wastes within a closed repository provides safe and secure protection from accidents and malevolent acts.

Dr. Greening has also recently commented on the safety of ion exchange resins. He first commented on smoke from resin fires. He specifically commented on some technical aspects of an interim 2009 safety analysis. However, the claim misstates our analysis and conclusions.

In our analysis the impacts of conventional hazardous species in smoke were considered. Carbon monoxide and benzene were selected for this analysis while explicitly recognizing that smoke contains many other species. The analysis results confirm the expected conclusion that smoke itself is hazardous. For the final safety report, therefore, we did not see a need to conduct a more accurate analysis of the smoke chemical content. We concentrated on whether the radioactivity that could be in resin smoke was itself significant or not. From a design perspective, our response has always been to work to prevent and mitigate fires.

Dr. Greening has also claimed that the DGR safety assessment does not consider the flammable gasses that could be produced from resin waste degradation. This is not correct.

The possible presence of flammable gasses is recognized in our underground design. This is a key reason for our continued ventilation of the underground emplacement rooms for the monitoring of underground air for flammable gasses until the eventual installation of closure walls on panels.

In summary, the DGR reference inventory was a best estimate as of 2010. It was a preliminary estimate recognizing that we were seeking a site preparation and construction licence. The 2010 reference inventory appropriately estimated the key radionuclides. The other radionuclides uncertainties have little or no impact on the safety case as was shown the information request response.

However, OPG recognizes that it is important to get all the inventories as accurate as possible. OPG has a waste characterization program that is improving the database. Updated inventories would be used for a future operating licence application before any wastes could be emplaced.

OPG stands by its safety assessment. The pressure tube waste in their packages are not spontaneously combustible. The

wastes are safe to handle and store. Placing the waste packages within the DGR will improve the long term safety.

This concludes our presentation. We would be pleased to answer any questions you may have.

THE CHAIRPERSON: Thank you very much.

We'll now proceed directly to the presentation by the Canadian Nuclear Safety Commission which is based on PMD 14-P1.2B.

Dr. Thompson, please proceed.

PRESENTATION BY / PRESENTATION PAR:
CANADIAN NUCLEAR SAFETY COMMISSION

DR. THOMPSON: Merci, Madame la Présidente. Bonjour et bonjour aux commissaires. Mon nom est Patsy Thompson.

I'm the Director General of the Directorate of Environmental and Radiation Protection and Assessment with the Canadian Nuclear Safety Commission.

With me today are Dr. Richard Goulet, a bio-geochemist with the CNSC who led

the CNSC staff's review of OPG's Radioactive Waste Inventory; Dr. Son Nguyen, who reviewed the Post-Closure Safety Assessment; Mr. Mike Jones, a chemical engineer working in the Environmental Compliance and Laboratory Services division; Mr. Ram Kameswaran, a technical specialist working in the Systems Engineering division of the CNSC. Mr. Kameswaran is a chartered chemist with over 30 years of experience in the nuclear industry.

In addition to other members of the CNSC staff's technical review team we have the support of two explosive experts to respond to questions from the panel in this topic area; Mr. Richard Bowes, the head of the Explosives Certification and Hazards Analysis at Natural Resources Canada, and Mr. Patrick Brousseau, the head of the Munitions Energetics and the Weapon Systems section of the Defence Research and Development Canada.

CNSC staff provided a review of the impact of OPG's updated radioactive waste inventory on both the pre and post-closure safety assessments, both sufficiency reviews for the information requests as well as in PMD 14-P1.2.

Today's presentation summarizes

CNSC staff's review as presented in that PMD and provides some further information in response to submissions from intervenors.

I will now pass the presentation to Dr. Goulet.

DR. GOULET: Thank you, Dr. Thompson.

Good morning, Madam Chair, Members of the Joint Panel Review Panel. My name is Dr. Richard Goulet and, as Dr. Thompson noted, I'm a bio-geochemist with the CNSC in the Environmental Risk Assessment Division.

I led the CNSC staff review of OPG's radioactive waste inventory submissions.

For the benefit of the audience today, CNSC staff will first provide background as to why the radioactive waste inventory is the subject of discussions today. Then, CNSC staff will address information requests EIS-514 by first discussing the impact of including radionuclide activity from pressure tubes and garter springs on the results of the post-closure safety assessment.

The presentation will include a discussion on how radionuclide activities from

pressure tubes and garter springs affect the radiological safety of members of the public and nuclear energy workers during normal operation of the proposed DGR.

CNSC staff will also discuss how updates to the radioactive waste inventory affected the assessment of consequences of potential accidents, malfunctions, malevolent acts.

Finally, CNSC staff will discuss OPG's proposed inventory verification plan and whether the proposed plan meets international standards on waste characterization, is likely to reduce uncertainties in the activities of radionuclide in different waste streams and, thirdly, ultimately reduce the uncertainty in the pre-closure and post-closure safety assessment.

The radioactive waste inventory and its importance to the pre and post-closure safety assessment was discussed during the hearings last fall.

CNSC expected reasonable knowledge of the variability in the radionuclide activity in different waste streams from different nuclear generation station over time.

Good quality data provide a reasonable confidence in the radionuclide transport model and, ultimately, the predicted dose to members of the public, workers and the environment.

In early 2014, Dr. Greening wrote to the Panel noting that the radioactive waste inventory did not include radionuclide measurements made on pressure tubes and garter springs.

The GRP requested OPG through information request EIS-13.514 to indicate how the pressure -- how the pre and post-closure safety assessment could be affected by the new data that was provided by Dr. Greening.

CNSC staff reviewed the responses provided by OPG for EIS-13.514. In our sufficiency reviews, CNSC staff provided the following.

First, the basis of the review. Second, the criteria used to review the information request. Third, the original assessment of the pre and post-closure safety assessment. Fourth, how the updated radioactive waste inventory modified CNSC staff conclusions. And finally, whether or not the updated

radioactive waste inventory affects previous recommendations on the environmental assessment and licence application.

To begin, I will first address the implication of the changes in the radioactive waste inventory on the post-closure safety assessment.

CNSC staff reviewed the calculated doses from the normal evolution and disruptive scenarios based on CNSC Regulatory Document G320, IAEA, or International Atomic Energy Agency's, specific requirements SSR5, International Commission on Radiological Protection, or ICRP's, recommendations in publication 122 entitled "Radiological Protection and Geological Disposal of Long-Lived Solid Radioactive Waste" and the EIS guidelines to determine if the calculated doses resulted in an acceptable risk and met the dose limit of one millisievert per year as well as the requirement to keep doses as low as reasonably achievable.

To determine if the DGR project would not impact the health and safety of workers, public and the environment, CNSC staff accepted OPG's proposed criteria for public

radiological exposure at the design stage.

For the normal evolution of the DGR system, the criteria for public radiological exposure is .3 millsievert per year to the most exposed individuals, so it's one-third of the public dose limit of one millisievert.

For disruptive scenarios, calculated impacts are judged against a dose criterion of one millisievert per year. The probability of a disruptive scenario is considered by adopting a human health risk criterion of one in 100,000 years.

These criteria are more stringent than the recommendation of the RCRP Publication 122.

In the original assessment, all maximum calculated doses for the normal evolution scenario and its many variant conservative scenarios were at least 100,000 times less than .3 millisievert per year. CNSC staff concluded that the four disruptive scenarios proposed by OPG were sufficient to assess the risk and were considered bounding worst-case scenarios.

The calculated dose -- the calculated dose from these scenarios were around

the public dose limit of one millisievert per year. The consequences of the updated radioactive waste inventory on the safety care are, therefore, minor.

Please note that there was an error on page 44 of PMD 14-P1.2. The doses predicted in the disruptive scenarios are not 100,000 times below the public dose limit of one millisievert but, rather, around this dose limit.

The difference between the maximum calculated doses in the 2011 post-closure safety assessment and the updated calculation for a normal evolution scenario and variant conservative cases as well as for the disruptive scenarios range from a decrease in the effective dose of .6 percent to an increase of about 7.5 percent.

The consequences of the updated radioactive waste inventory on the safety case are, therefore, minor.

These differences are considered small because the total DGR inventory only increased by 10 percent for four radionuclides in comparison to the 2011 post-closure safety assessment.

Four of these radionuclides, which are nickel-50 -- nickel-59, has a half-life of 76,000 years. Nickel-63 has a half-life of 18 years, Cesium-137, a half-life of 30 years, and Curium-224, a half-life of 18 years.

These half-lives are shorter than the time period when the maximum effective dose is predicted to occur, which is more than a million years. As a result, other radionuclides like Iodine-129 often are the contaminant of interest.

Iodine-129 is a contaminant of interest in other safety cases around the world.

The updated calculation of maximum predicted doses based on the revision to the radionuclide inventory in pressure tubes and garter springs does not change CNSC staff's conclusion regarding the long-term safety of the DGR project.

CNSC staff continue to conclude that the assessment of the long-term safety of the DGR is sufficiently conservative to support, one, an environmental assessment decision and, second, to authorize a site preparation and construction licence.

I will now address the implication of the changes in the radioactive waste inventory to radiological safety to workers during normal operation or, in other words, during pre-closure operations of the proposed DGR.

CNSC staff based their review on the additional information provided by OPG in response to EIS-13.514, and we based on our assessment based on Section 5 of the Class I Nuclear Facility Regulations as well as other provisions from the Radiation Protection Regulations.

CNSC staff confirmed the radiological dose assessment methodology and calculations using MicroShield Version 8.02. MicroShield is a comprehensive photon shielding and dose assessment program that is widely used for designing shields, estimating source strength from radiation measurements, minimizing exposure to people and teaching shielding principles.

CNSC dose limit for nuclear energy workers is 50 mSv per year and 100 mSv over five years.

The criterion used to determine

the safety of workers during normal operations is OPG's occupational dose target of 10 mSv per year for workers, however, licensees are expected to keep doses as low as reasonably achievable and, consequently, if the project goes ahead, OPG would be required to implement an ALARA program as part of their radiation protection program.

CNSC Staff had previously reviewed the input parameters for the radiological dose assessment for all scenarios used by OPG to assess doses to workers, including Scenario 2, which involved the handling of retube waste packages.

CNSC Staff had concluded that the results and methods used by OPG were acceptable.

OPG had adequately assessed the potential radiation exposure scenarios and anticipated radiation doses associated with the proposed DGR project. Radiation exposure and radiation doses to workers were predicted to be less than CNSC regulatory dose limits.

Further, implementation of physical design and administrative controls as required by an operating licence, if the DGR is approved, will ensure that radiation exposures

and radiation doses are kept ALARA or, in other words, as low as reasonably achievable.

Finally, all waste packages must meet the acceptance criteria before being placed in a DGR.

Upon examining OPG's revised dose assessment for the retube waste package scenario, CNSC Staff calculated similar results as OPG for the updated radioactive waste inventory.

It is recognized that there is a four-fold increase in external dose rates to DGR workers associated with the revised pressure tubes inventories, however, the retube waste packages must meet the DGR acceptance criteria before the workers would handle the waste at the DGR facility.

For instance, OPG would need additional shielding or decay time so that all packages meet the waste acceptance criteria. Consequently, no scenarios would, in practice, lead to doses above the 10 mSv per year criterion.

Other ALARA measures will be incorporated to further reduce worker doses prior to placement of waste into the DGR. For

instance, dose rates would be further reduced by shielded forklifts and the use of overpacks.

OPG has committed to address these ALARA measures in the final ALARA assessment for the DGR that would be required for an operating licence application to operate the DGR.

The additional information provided by OPG in response to EIS-13-514 does not change CNSC Staff conclusion in PMD 13-P1.3 that radiation and radioactivity resulting from the DGR project are unlikely to have significant adverse effects on the health of humans, including workers, taking into account the implementation of mitigation measures.

It is important to note that a waste package would not be allowed into the DGR if it does not meet waste acceptance criteria. This will be ensured by actual measurements in the field by OPG employees and these measurements will be confirmed during CNSC Staff inspections.

The updated assessment, including mitigation measures such as waste acceptance criteria and ALARA requirements, provides evidence of the safety of the DGR during

operations and to support both an environmental assessment decision and to authorize a site preparation and construction licence.

This concludes the first part of the presentation. I will now pass the presentation over to Mr. Mike Jones to continue with the assessment of the updated radioactive waste inventory in relation to accidents, malfunctions and malevolent acts.

MR. JONES: Thank you, Dr. Goulet. For the record, my name is Mike Jones. I'm an Environmental Program Officer in the Environmental Compliance Laboratory Services Division. I am the lead in the review of accidents, malfunctions and malevolent acts for many environmental assessments at the CNSC, including for this project.

The objective of the CNSC Staff's review of OPG's EIS with respect to accidents, malfunctions and malevolent acts was to identify and describe possible accidents or malfunctions associated with the proposed DGR project and the potential adverse environmental effects of these events.

Sufficient quantitative

information needed to be provided on all radioactive and hazardous substances that could be released to the environment in significant quantities. The review also needed to address potential environmental effects that could result from intentional malevolent acts.

CNSC Staff's review include the validation of OPG's assessment methodology and calculations.

OPG chose to apply the limits from the Radiation Protection Regulations in their assessment, an annual dose limit of 1 mSv for members of the public and an annual dose limit of 50 mSv for workers.

CNSC Staff also considered these limits in our assessment, however, it should be noted that these dose limits are for normal operating conditions and would not apply in accident scenarios. During an accident, the occupational dose limits may be exceeded as per section 15 of the Radiation Protection Regulations during the control of an emergency and the consequent immediate and urgent remedial work.

The radiological accidents and

malfunctions assessment submitted in the EIS was conducted on credible scenarios during the site preparation, construction, operations and decommissioning phases of the proposed DGR project. It adequately demonstrated that acceptable dose criteria for workers, members of the public and non-human biota will not be exceeded.

All credible accident scenarios were well below the annual dose limit to the public of 1 mSv per year. Although the effects were generally small, OPG proposed mitigating measures and contingency plans. CNSC Staff concluded that OPG's assessment was adequate.

The assessment conducted on potential malevolent acts of sabotage and attack during the site preparation, construction, operations and decommissioning phases of the proposed DGR project determined that, in general, radiological and non-radiological consequences of credible malevolent acts are expected to be similar to those of the malfunctions and accidents considered in the assessment.

OPG concluded that impacted non-human biota would be limited to the vicinity of

the DGR project and there would be minimal impact to members of the public. However, extreme malevolent acts, such as the use of explosives, can cause worker fatalities in the vicinity of the incident.

OPG concluded that malevolent acts are bounded by the malfunctions and accidents resulting in relatively low radiological consequences to workers. CNSC concur with OPG's assessment.

OPG reassessed the original accidents, malfunctions and malevolent acts scenarios using the revised radiological waste inventory. CNSC Staff reviewed the reassessment and concluded that the revised accidents and malfunctions scenarios would not have significant radiological consequences on members of the public and workers.

For all revised accidents and malfunctions scenarios and most malevolent acts scenarios, the dose consequences to workers and the public were well below the regulatory limits.

The one exception was malevolent act Scenario D, involving a person using an explosive or incendiary device affecting waste on

the surface awaiting transfer to the DGR. This scenario was reassessed to focus on retube waste package.

In this scenario, the assessment using the original retube waste inventory resulted in a dose to the public of 2 mSv. The revised inventory for retube waste was also reassessed and resulted in a dose to the public of 3 mSv. This would exceed the annual dose limit to the public of 1 mSv, but would not result in measurable health effects.

The scenario is very unlikely due to the difficulty in targeting a specific package, the robustness of containers, the quantity of explosives necessary and the tight security in place at the Bruce Power site.

I will now pass the presentation over to Mr. Ram Kameswaran to further discuss.

MR. KAMESWARAN: Thank you, Mr. Jones. For the record, my name is Ram Kameswaran. I am a technical specialist with the Systems Engineering Division at the CNSC.

When PMD 14-P1.10 was received from Dr. Greening, the DGR assessment team at the CNSC requested my review of concerns regarding

the malevolent act scenario of a person using an explosive or incendiary device affecting wastes on the surface awaiting transfer into the DGR.

The main comment from Dr. Greening was that the OPG had not estimated the source term correctly based on the pyrophoric property of zirconium metal in the pressure tubes.

Dr. Greening also stated that the OPG has treated the detonation of zirconium as an inert metal and not as a reactive metal and the assumptions and values used by OPG to calculate the source term is incorrect and the resulting dose to the public should be significantly higher.

Before I continue, I would like to provide some definitions and characteristic of zirconium metal. Pyrophoricity refers to a property of spontaneously heating and igniting in air below 55°C. Pyrophoric behaviour is common in many metals under specific conditions. Zirconium metal is pyrophoric only when it is in the form of very small particles, less than 54 microns in diameter. OPG pressure tube wastes are larger pieces with little powders

(inaudible). The material of this size is not really ignitable. This was also shown by OPG in their video that shows zirconium pressure tube waste pieces are not readily ignitable even under extreme temperatures.

Dr. Greening also questioned OPG's source term methodology as it related to the assigned airborne release fractions, ARF, and the respirable fraction, the RF. The main comment was that OPG had not estimated the source term correctly based upon the pyrophoric property of zirconium metal in the pressure tubes.

OPG used a five-factor formula from the United States Department of Energy Handbook 3010, which provides the airborne release fractions and respirable fractions for non-nuclear facilities. This was developed for the source term calculation. OPG obtained ARF and RF values from the published U.S. Nuclear Regulatory Commission Handbook NUREG/CR-6410, which is the handbook for a nuclear fuel cycle facility accident analysis.

CNSC staff find the use of the DOE Handbook 3010 and the U.S. NRC Handbook 6410 to be an acceptable source of information. CNSC

staff concluded that the selected ARF and RF values were appropriate for the stress material combination for the scenario.

Based on the malevolent acts scenario d, the explosive force from detonation was identified as an explosion. This is different from what Dr. Greening has claimed as an implosion. The appropriate airborne release fraction and the respirable fraction values were selected following the standard methodology used by the U.S. NRC. The suggestion by Dr. Greening that ARF and RF values should both be one and the resulting dose to the public much higher does not align with the scenario, the stress and material combination in line with the methodology, that is suggested by the U.S. NRC document.

Therefore, CNSC staff conclude that OPG has appropriately and conservatively assessed the source term and the resulting public dose for a malevolent act.

To conclude this section on accidents, malfunctions and malevolent acts, CNSC staff conclude that applying the revised inventory to accident scenarios would not have significant radiological consequences on the

members of the public or workers. The pre-closure safety assessment is sufficiently conservative to support the environmental assessment decision and authorize a site preparation and construction licence.

I will now pass the presentation back to Dr. Goulet to present the CNSC staff assessment on the inventory verification plan.

Thank you.

DR. GOULET: Thank you, Mr. Kameswaran.

For the record, as I noted earlier, my name is Dr. Richard Goulet.

I will now present the final section of the presentation, an overview of CNSC staff's assessment of OPG's commitment for an inventory verification plan or, as I will call it, the IVP.

CNSC staff previously concluded that the level of conservatism in the contaminant transport model and depth of the proposed DGR project was sufficient to support the post-closure safety assessment of the DGR project. More specifically, conservatism in the contaminant transport model led to doses 100,000

times less than the 0.3 millisieverts per year dose criterion and disruptive scenarios led to doses around a millisievert per year.

Despite the large safety margins in the assessment, CNSC staff still expected OPG to reduce the uncertainty in their radioactive waste inventory during the construction phase and demonstrate that the maximum predicted doses in the pre- and post-closure assessments remained essentially unchanged. These expectations were described in Recommendation No. 2 in PMD 13-P1.3, and discussed during the hearings in the fall of 2013.

CNSC staff expect the radioactive waste characterization program to comply with international standards and guidance. These guidance are the 2009 International Atomic Energy Agency document entitled “Determination and Use of Scaling Factors for Waste Characterization in Nuclear Power Plants”, as well as the 2007 ISO 21238 Standard entitled “Scaling factor method to determine the radioactivity of low- and intermediate-level radioactive waste packages generated at nuclear power plants”.

CNSC staff also contracted an

independent third party to review the original radioactive waste inventory. The contractor, DW James Consulting, has over 30 years of experience in characterizing nuclear waste and actually participated in writing the *ISO 21238 Standard*. This independent expert review was used by CNSC staff to formulate Recommendation No. 2, presented in PMD 13-P1.3.

Recommendation No. 2 of PMD 13-P1.3 was used to review the IVP submitted in response to information request EIS-13-514. In particular, the IVP should account for the variability in the packages and assure representativeness, including providing particular details on sample coverage and frequency. The IVP should also implement inter-laboratory verification of radionuclide measurements. The IVP should also use alternative analysis methods to update better detection limits on certain radionuclides, for instance, Iodine-129. It should also commit to a schedule for implementation. Finally, the IVP should help to demonstrate, as a requirement for the operating licence, that the post-closure safety predictions remain essentially unchanged.

OPG provided the following information in response to information request EIS-13-514. Overall, OPG committed to collect at least three samples per waste type for all waste types to screen levels of radionuclides, hazardous substances like metals, and organic material important in gas-generation predictions.

Then, for important waste types and key radionuclides, a minimum of 10 data per nuclide per waste type will be sampled to quantify the 95 percent upper confidence value, which is the activity value that is above 95 percent of measured activities in the sample collected. These data points will also include at least two from each nuclear generating station where appropriate and cover an extended timeframe in order to provide basic information on variability between stations and over time.

Hence, the IVP now proposed by OPG accounts for the variability and the packages will assure adequate representativeness. It also provides particular details on sample coverage and frequency. Finally, it will improve detection capability to quantify key radionuclides that are difficult to measure, such

as Iodine-129.

If the project proceeds, CNSC staff would verify implementation of the IVP and confirm its effectiveness.

OPG's IVP also meets other aspects of Recommendation No. 2 of PMD 13-P1.3 as follows:

First, accredited laboratories will measure radionuclide activities and inter-laboratory comparisons will be done approximately every three years. This meets the expectation that OPG implement inter-laboratory verification of radionuclide measurements.

Second, an independent third party will review the waste characterization program. This is also a CNSC expectation.

Finally, verification activities are planned up to the 2021, leading to a licence to operate, which meets the expectation that OPG commits to a schedule for implementation.

I will now discuss how uncertainties would be handled.

International guidance in IAEA SSG-22(3) recommends to identify uncertainties in the safety case and to confirm that these

uncertainties do not influence safety. The main objective of Recommendation No. 2 was for OPG to obtain more measurements on the activity of radionuclides in the radioactive wastes that are important to the safety case. More direct measurements of difficult to measure radionuclides will lead to more accurate date on the radioactivity in the waste and less uncertainty about the source term used in the safety assessment.

As more information on the radioactivity of difficult to measure nuclides becomes available the safety case will be updated accordingly.

OPG provided information on uncertainty in the waste inventory characterization in the EIS and provided further information in response to information request EIS-01-06 and EIS-01-20, which were proposed by CNSC staff.

After reviewing all of the information, CNSC staff concluded that OPG had adequately identified the uncertainties. Then, OPG needed to convince CNSC staff that this uncertainty would not affect the safety case.

OPG's approach to deal with this uncertainty was to properly bound the pre-closure and post-closure safety assessment. OPG bounded their assessment by overestimating the radionuclide activity, assuming radionuclides are more soluble than they are in reality, and by assuming that they will not bind to the rock matrix along their diffusion pathway.

Considering that even with these conservative assumptions, most doses were 100 times lower than the 0.3 millisieverts per annum threshold and considering all the other conservative assumptions used in the contaminant transport model CNSC staff concluded that the assessment was properly bounded and that the uncertainties with the radioactive inventory did not impact the long-term safety case.

Despite the assessment being properly bounded, CNSC staff expect OPG to follow best international practices on radioactive waste characterization and proceed with further characterization during construction. This approach is similar to the operation permit for the repository of radioactive operational waste in Sweden which requires a waste activity

description to be approved by the regulator before emplacement in the repository.

To conclude the section on the IVP, OPG's proposed IVP meets the commitment to reduce the uncertainty in the waste inventory by committing to deriving the 95 percent upper confidence interval value for key radionuclides in waste important to the safety case and characterizing hazardous substances, metal and carbon availability in wastes which are important in predicting gas pressure inside a DGR in the long term.

OPG provided a schedule for implementation of the IVP and committed to completing it in time for the application for a licence to operate if the DGR project proceeds.

CNSC staff concludes that the proposed IVP addresses all but one expectation of Recommendation No. 2 of PMD 13-P1.3. The last expectation of Recommendation No. 2 is to demonstrate, as a requirement for the operating licence, that the predicted doses in the post-closure safety assessment remain essentially unchanged. CNSC staff would verify this last expectation by confirming the implementation of

the IVP when reviewing annual updates of the radioactive waste inventory. Should OPG seek an operating licence, CNSC staff would thoroughly review the updated pre- and post-closure safety assessments.

This ends the CNSC staff assessment of the impact of the updated inventory on the pre- and post-closure safety assessment.

I will now pass the presentation back to Dr. Thompson to present CNSC staff's overall conclusions.

DR. THOMPSON: Thank you. I will now present staff's overall conclusions.

In light of our review, CNSC staff concludes that the proposed radioactive waste inventory verification plan addresses all but one expectation that CNSC staff laid out in Recommendation No. 2 of PMD 13-P1.3 regarding uncertainty in the original radioactive waste inventory. The updated radioactive waste inventory that includes measurements of activity in pressure tubes and garter springs does not significantly change: one, the assessment of long-term doses to people and biota; secondly, the dose predictions to workers as long as

mitigation measures are in place; and, finally, those predictions to workers in the event of an accident.

OPG's proposed radioactive waste inventory verification plan is acceptable to CNSC staff as it meets regulatory requirements.

In addition, the pre- and post-closure safety assessments are sufficiently conservative to support an environmental assessment decision and to authorize a site preparation and construction licence.

I will conclude this presentation by reiterating that no package would be allowed into the DGR without external dose measurements and adequate characterization of radioactive waste inventory to confirm compliance with OPG's waste acceptance criteria.

This ends the staff's presentation and we're available to answer questions.

THE CHAIRPERSON: Thank you, Dr. Thompson and your colleagues.

We will now take a break. We will reconvene at about 10:35 a.m.

--- Upon recessing at 10:18 a.m. /
Suspension à 10 h 18
--- Upon resuming at 10:36 a.m. /
Reprise à 10 h 36

THE CHAIRPERSON: Hello. If everyone could take your seats please, and we will resume the hearing.

The Panel will now begin with our questioning for both OPG and CNSC on the presentations they gave just prior to coffee break.

I would like to begin with Dr. Muecke.

MEMBER MUECKE: Thank you.

This is to OPG. The Waste Inventory Verification Plan is a work in progress and is to be reviewed by a third party, expert party.

Can you provide the rationale why only one such review is planned?

MR. ROUND: Glenn Round, for the record.

Currently we have actually one plan for the year 2017, but we also have many

reviews, ongoing reviews from personnel like the CNSC. So although we are only having one current plan for 2017, and that is an independent external review, we have ongoing reviews with the CNSC.

MEMBER MUECKE: But no further plans for third party?

MR. ROUND: Not at this point in time. Unless Dr. Gierszewski would like to add something?

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

So the plan identifies a very specific review in the middle of the next few years based on taking all the information we have accumulated and putting together into a large reference inventory report and reassessment.

So I think that there is a major review plan and that is what has been indicated there.

Along the way the general intent is as we are accumulating more information there probably will be a number papers and publications that will also come out, as we have done in the past, where we describe some of the experimental

results or the results.

So there is certainly opportunity for those to be presented and available in conferences and peer review forums of that nature.

MEMBER MUECKE: Along the same sort of lines, could you explain the rationale for delaying the update of the reference inventory until the application for the first operating licence?

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

So again, the requirement as a minimum has to be done for the operating licence application. As we go through the process we will be looking at the new data and testing it, whether it is significant or not. So there will be some degree of internal updates to the reference inventory.

And whether they seem to be of enough change or not to make it worth issuing a new version or not, I think that is a decision we would make along the way.

Perhaps Mr. Round might want to just speak about the release around the time of

the inventory -- of the review.

MR. ROUND: Glenn Round, for the record.

Yes, along the same lines of Dr. Gierszewski, that is roughly the timeline that we would be looking at. Improving the database is an ongoing process as you described, and we would be looking for a release somewhere around that same timeline. There would be stage releases; 2017 perhaps, and moving forward.

So it is not just putting stuff to the side and waiting as we get updated information we will definitely be updating and releasing the Waste Inventory Plan.

MEMBER MUECKE: Will there be any sort of trigger points that would -- that is to say changes, degree of change that would initiate an update and its publication?

MR. ROUND: Glenn Round, for the record.

We would be looking for key changes, significant changes to the waste inventory. Things like material changes, something that may come up. We would analyze right away and look at that.

If there was any significant change, then the analysis would be rerun immediately. Otherwise, it would be put off to the side and incorporated in the next upcoming revision to the database.

MEMBER MUECKE: This involves presentation of CNSC this morning. I am trying to understand here slide 36. It says, "CNSC staff will verify that the pre and post-closure predictions remain unchanged by reviewing annual updates of the RWI."

How does that fit?

DR. THOMPSON: Can I say something --

MEMBER MUECKE: I guess I am looking for answers from both sides.

DR. THOMPSON: Dr. Muecke, would you like us to start or would you like...?

MEMBER MUECKE: Yes, please.

DR. THOMPSON: Patsy Thompson, for the record.

Essentially, the updated verification plan that OPG submitted meets the elements of the Recommendation 2 in terms of aligning with international standards and best

practices.

The CNSC will be doing annual reviews of annual updates provided by the OPG on the information. We will also, through inspections, review the results of OPG's, for example, their laboratory inter-comparison results and the work that will be associated with the verifications that are being done.

What we will be looking at in terms of whether there could be an impact on the pre and post-closure safety assessment before there is a formal submission with a licence application to operate, for example, would be whether or not the new information has an impact on the 95th percentile values that are used in the safety assessment.

So we can do that assessment without a full new pre-closure and post-closure safety assessment.

MS SWAMI: Laurie Swami, for the record.

In keeping with Dr. Thompson's comments, we would be keeping the CNSC informed of changes. Any of the information that we gathered, we would be providing that to the CNSC

so they could complete their review on a regular basis.

They don't just wait until the final application. It is our practice to keep them informed. Particularly, if there was a significant change we would absolutely keep them informed.

So it is more of a reflection of an ongoing dialogue with the regulator to ensure that the information is meeting their needs and that we are providing the information they need in anticipation of an operating licence down the road.

MEMBER MUECKE: So if we understand this correctly, it is not just a periodic publication of the new data, it is a fluid and continuous process?

MS SWAMI: Laurie Swami, for the record.

That is the normal process with the CNSC, we keep them informed on all of our operations on a regular basis, either through formal correspondence or through dialogue and meetings to ensure that they are aware of our operations. And any concerns they may have they

can express to us, so that we can address those as well.

MEMBER MUECKE: On a different line, decommissioning of waste will add a new waste stream to OPG's waste operations.

We heard yesterday that the long period of experience with the current waste stream provides assurance about the stability of waste mixes.

How does OPG assure that decommissioning waste mixes will remain stable for long periods of time, having not had that experience of handling it before?

MS SWAMI: Laurie Swami, for the record.

While the waste arising from decommissioning is -- we have talked about it in a different context, it is certainly very similar to the waste that we have already generated through our programs.

Dr. Gierszewski can provide more details on this. But essentially, the components that we would be decommissioning, they are components in our plants today.

And I will let Dr. Gierszewski

talk to more specifics on that.

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

So as Ms Swami was saying, there are differences in the radionuclide content and in the amounts of the waste from decommissioning, but they are still basically the materials that the plants are made of; steel, concrete, low-level waste is the kind of materials that are being generated now.

So those would be the same general types of waste as we are currently generating. So we are not seeing, at this point, a substantially different waste stream. Of course, as we get into decommissioning, which is still 30 years off, we would be reviewing that. But right now most of the decommissioning is pretty standard materials.

THE CHAIRPERSON: Dr. Archibald.

MEMBER ARCHIBALD: I believe many of my questions have been asked by Dr. Muecke, but I do have a question for CNSC.

On slide 16 you had mentioned that actual measurements and characterization of the refurbishment waste packages is to be

confirmed in the field by OPG and CNSC staff during inspections.

How often will check inspections be made by CNSC on site or will there be a minimum frequency of occurrence of check evaluations of any OPG measurements?

DR. THOMPSON: Patsy Thompson, for the record. I will start responding and then I will ask Kay Klassen to speak to the inspection programs and how it is suggested through activities that are being undertaken by the licensee.

Essentially, in terms of the work that CNSC staff will be undertaking, there is a combination of document reviews and on-site inspections.

The expectation is that when, if the project is approved and goes ahead, there would be initial work done with the inspectors in Ms Klassen's division. And some of the specialists to review on site the actual work being conducted by OPG and also the results of the inter-comparisons, for example.

In terms of the routine inspections, I will ask Ms Klassen to provide

some data.

MS KLASSEN: Kay Klassen, for the record.

Currently at the Western Waste Management Facility CNSC staff conducts inspections on, as a minimum, three times a year. This includes examining containers that may be in the low-level storage buildings, certainly witnessing waste being lowered into IC-18s.

We also review information with respect to the records on the packages that can be put in -- that are in the Western Waste Management System, and examine other activities that OPG periodically engages with in relation to the -- there was the movement of waste out of the seven low-level storage buildings while they were making changes for the fire detection system.

We certainly, during that period, were on site, observed some of the other packages in other locations. So we maintain an understanding and certainly verifying the compliance with current practices of what takes place with respect to those packages.

This does include our ability to review the waste acceptance criteria, examine

when changes are made, if some new stream or some adjustment to some particular waste was made, we do conduct checks periodically on those adjustments.

Moving forward to the DGR that is obviously sometime in the future, our expectation is, at this time, that these kinds of checks and balances would increase in relation to the planned activities that would occur at Western as they were moving towards achieving an operating licence for the DGR.

CNSC staff and the Wastes and Decommissioning Division would be examining with Patsy's Thompson's division the results of the IVP plan.

Whether this is indicating changes or not to the kinds of materials expected to be going in there, that would be providing an assertion of some of what is existing at Western, and enables us also to plan in relation to staff at the nuclear generating stations; whether we need to request those staff to do some other verification within the plants themselves.

So I can't speak to everything. Obviously something would have to be developed

and planned based on what we are identifying in the inventory. If there are changes from what we understood there to be in current storage, I certainly am not projecting that, but then it would develop in light of what is taking place as we move into a possible future operation of a DGR.

MEMBER ARCHIBALD: For the current process, are there any third-party verifications also done?

MS KLASSEN: Kay Klassen, for the record.

Not at this time, not that I am aware of.

MEMBER ARCHIBALD: If I could move on now to the topic of zirconium, please. From slide 15 the zirconium powder ignition is a recognized hazard by OPG.

Would you have any concept or idea of how much material is currently stored at the Western Waste Management Facility and in what form?

DR. THOMPSON: Dr. Archibald, that is OPG's slide 15?

MEMBER ARCHIBALD: I was going to

be asking both groups. OPG first then.

DR. THOMPSON: But is it OPG's slide 15?

MEMBER ARCHIBALD: OPG slide 15, yes. Does CNSC and OPG have any idea of how much material is currently stored? Because they do co-checks on all of the materials. And in what form would the zirconium be?

Let me make one addition. And in what form, meaning we know that there are coupons of this material, but there are also dust created in the process of making the coupons; either they are sawn or stamped into the coupon form.

So would you have any idea of what percentages would be available as dust or other smaller aggregates than the coupons that you have shown in your slides?

MS SWAMI: Laurie Swami, for the record.

I am going to ask Lise Morton to provide perhaps more detail, although it is a very small percentage, tiny may be a better word to describe that, that it would not be a source of ignition for the storage of this material.

And, as described in the

presentation, we have ways of managing that, should it be required.

But I will ask Ms Morton to provide more detail.

MS MORTON: Lise Morton, for the record. There have been a lot of questions, I hope I address everything correctly.

Yes, the zirconium we would have in storage would be obviously the pressure tubes that we took from Bruce Units 1 and 2. They are located in a specially built retube, what we call a retube waste component building.

With respect to powder, I will give an answer, and I believe Jerry Keto has come to the microphone?

Okay. So my understanding is it is estimated at about .01 to .1 per cent by weight of the pressure tube mass, but we can confirm that value.

MEMBER ARCHIBALD: And what would be the total quantity in storage at the Western Waste Management Facility to set this in scale perception?

MS SWAMI: Laurie Swami, for the record.

Just so that we provide you the right information, was that the total zirconium or was that the total powder, pressure tubes...? What was the total you were looking for?

MEMBER ARCHIBALD: We now know that there is a percentage of .01 to .1 per cent. What would be the total weight stored? And in combination, do they get stored together or is the powder stored separately?

MS SWAMI: Laurie Swami, for the record.

We don't separate the materials. However, we will take an undertaking to confirm the number or we could come back after the break.

MEMBER ARCHIBALD: An estimate would be fine, thank you very much.

MS SWAMI: So after the break or would you like it as an undertaking?

THE CHAIRPERSON: We would prefer just getting back to us after the break please.

MS SWAMI: Thank you.

MEMBER ARCHIBALD: I would now address a question to the CNSC then.

Would you know what factors are necessary to induce the spontaneous heating

ignition and would they conceivably, knowing the quantities possibly, existing within a repository environment to have any capability of inducing pyrophoric behaviour in the stored materials?

DR. THOMPSON: Dr. Archibald, Mr. Ram Kameswaran will respond to the question.

MR. KAMESWARAN: This is Ram Kameswaran, for the record.

For the zirconium powder to ignite we need source of the fine particles, which are less than 50 microns in size, and also come into contact with oxygen, and that should be a movement for that to happen.

And the way it is stored right now, along with the chunks, it would have probably fallen to the bottom of these boxes and probably that is not much exposure to oxygen. And so in my opinion it is not a credible scenario.

MEMBER ARCHIBALD: And so my next following question. Would pyrophoric activation of the dust be expected to initiate? And what you are saying, just to clarify, is that the dust stored in these containers, of whatever magnitude and I suspect that it is several thousand

kilograms, would settle to the bottom, densify and have very low aerial exposure then?

MR. KAMESWARAN: Ram Kameswaran. Yes, that is correct.

THE CHAIRPERSON: Thank you, Dr. Archibald.

I will continue with some -- unless OPG had some further comment?

MS SWAMI: Laurie Swami, for the record.

I am wondering if we could ask Dr. Gierszewski to comment on that as well?

THE CHAIRPERSON: Thank you.

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

So the cutting dust, a very small fraction of the weight that is generated, would be mixed with the retube coupons. And I think what is crucial for these ignitions to occur is there has to be a way for it to get hot. You have to have some way for it to get hot and not have the heat be disbursed.

And that is why the size effect matters. If it is in a large coupon the surface effect gets dissipated over the large volume. So

I think -- I mean, the powder is just being generated as they are cutting, so it is going to be disbursed, it will be on the surface of the coupons.

And firstly, I just think that it will be well -- that they can't ignite because it will be -- I want to say cool, but that is not the right word, but the heat would be dissipated by all the large metal coupons around it.

And then secondly, even if that were to happen, as already shown by the videos and other things, that there is just not enough mass in that to ignite the larger mass of material.

MEMBER ARCHIBALD: Would there be sufficient heat generated? We do not know the actual temperature, the burning temperature of the zirconium. We do know that in your illustration you are demonstrating a propane temperature of 1100 degrees Celsius, would you know the temperature of activation of the zirconium dust should it combust and would that be sufficient to set off any coupons?

MR. GIERSZEWSKI: Paul Gierszewski, for the record.

Again I think there is a thermal calculation here. If you only have a small amount of material burning it can't heat the surrounding material up to the -- maintain it at a temperature at which it could burn.

I think in these particular cases the video that we showed went up to 1100 C, we actually tried taking it up to around 1500 or hotter in temperatures and even at 1500 it wasn't igniting, but at that point the brick that they were running on, actually the brick was melting so we weren't actually able to get the clarity on the ignition temperature of the pressure tube coupons.

THE CHAIRPERSON: I'm going to start my questioning with OPG.

So my first question is, given the results of the analysis of consequences of one of the malevolent acts, i.e. the explosion, and given that the pressure tube container concentrations exceed the waste acceptance criteria, is OPG actually now considering a change in container design in addition to a wall around the waste package receiving building staging area and consideration of increased

storage time for decay as per ALARA principles and as per your commitment?

--- Pause

MS SWAMI: Laurie Swami, for the record.

I seem to be struggling with questions, but I'm wondering if you could help me by maybe rephrasing the question?

THE CHAIRPERSON: I will rephrase it.

The central focus of my question is that CNSC had stated to us, and you have committed to following ALARA principles with respect to meeting the waste acceptance criteria specifically for the pressure tube containers. Given what we now know, especially regarding the albeit little likelihood, but high consequence malevolent act of the explosion, and given that actually we already know the external field for workers from waste container, pressure tube container is going to need to be managed, has this changed OPG's position in any way on the design of those pressure tube containers?

So over and above walls and allowing more decay, are you revisiting the ALARA

principle with respect to your pressure tube container design?

Is that clear?

MS SWAMI: Yes, thank you. I will consult with some of my team members.

--- Pause

MS SWAMI: Laurie Swami, for the record.

So if I have your question wrong, please let me know.

So from the analysis of a malevolent act we are not proposing to change the design of the container, we have other mitigation strategies which we discussed with you in an in camera session on how we deal with those types of low-level events, but in this particular case we are not planning to make a change to the design of the pressure tube containers.

THE CHAIRPERSON: So that was Part A of my question and Part B was the ALARA principle for protection of your workers.

MS SWAMI: So for that perspective I will ask Mr. Round to provide us information on that.

MR. ROUND: Glenn Round, for the

record.

With regards to ALARA, as Laurie Swami mentioned, we are not changing any of the retube waste container design. ALARA, we will come up with our dose assessments and we will follow our RP procedures based on dose assessments for time, distance and shielding requirements, but it's not part of a retube waste container design.

THE CHAIRPERSON: So just to make sure the Panel is completely clear on this, you will rely upon other measures to maintain the acceptable dose limit for your workers, such as shielding or increased time for decay; am I correct?

MR. ROUND: Glenn Round, for the record.

That is correct.

THE CHAIRPERSON: Thank you.

I am now going to direct the same question to CNSC. Have you, as the regulator, considered any requirement for changing the design of the pressure tube containers given the results of (a) the malevolent act analysis and (b) meeting the waste acceptance criteria,

particularly with respect to protection of workers?

--- Pause

DR. THOMPSON: Dr. Swanson, if you could give me a couple of minutes I will come back to you.

--- Pause

DR. THOMPSON: Patsy Thompson, for the record.

The assessment conducted by CNSC staff for the malevolent acts considered both the package design and the other measures of defence against the likelihood of the type of malevolent act that was described by OPG in their safety assessment.

In terms of the elements that we took into consideration, they are the nature of the waste in the packages, the robustness of the packages, the difficulty essentially among the several packages of waste that will be on-site, the difficulty in targeting a specific waste package by someone coming in with a significant amount of explosives and the difficulty in breaching the security on the Bruce site.

So all of that is elements and

all of those elements of defence in depth were taken together to suggest that in our view although the impact on human life of a potential accident of that nature would not be radiological, it would be essentially an impact from the explosion, are so low in likelihood that they would not require a change in the package design.

The impact of of a malevolent act are essentially not of radiological consequences, we found that the radiological consequences were bounded by the accident and malfunction scenarios.

In terms of the package and the type of waste for the operational phase in terms of the protection of workers and the CNSC requirements, I will ask Ms Christina Dodkin to speak to the assessment that was conducted by CNSC staff and our requirements.

MS DODKIN: Christina Dodkin, for the record. I'm a Radiation Protection Specialist.

With regards to the control of worker doses, first of all, the retube waste package will have to meet the DGR waste

acceptance criteria and once it is accepted to the DGR the Radiation Protection Program that is required by regulation must ensure that doses to workers are kept below regulatory limits and as low as reasonably achievable. The expectation is that this would be done through the management of worker doses through work planning and work execution in addition to engineered controls and administrative controls as required.

In addition, OPG did provide a preliminary ALARA assessment which identified a number of areas where efforts may be taken to ensure that worker doses are kept ALARA and that included the identification of a shielding wall in the waste package receipt building in addition to the use of shielded fork trucks for instance.

They have also committed to submit a final ALARA assessment with the operating license application if that is forthcoming.

THE CHAIRPERSON: Thank you.

I am now going to return to OPG and this is now with respect to the Waste Inventory Verification Plan. The details of my questions arise not from your slides but from

your written submission.

So I noted the number of samples that you were planning to take and that you were going to be sampling each waste type at the stations.

My question is, do you intend to conduct random sampling of each waste type?

MS SWAMI: Laurie Swami, for the record.

Mr. Round will provide an explanation of that. Thank you.

MR. ROUND: Glenn Round, for the record.

Dr. Swanson, when you say "random" I'm going to assume you mean that historical and new samples would be taken from packages that are historical and new.

Is that what you mean when you say "random"? I just want to clarify.

THE CHAIRPERSON: Yes. Obviously you could stratify "random" according to many categories, but my main concern is adherence was sampling such that you can in fact reliably calculate statistics.

MR. ROUND: Yes. Glenn Round,

for the record.

So yes, the sampling as part of our waste characterization plan moving forward, and our schedule, the sampling will be random and it's specified right in our governance that it will be. So following our procedures it will be random sampling; correct.

THE CHAIRPERSON: Thank you.

So long this statistical line -- and bear with me because this starts getting a little convoluted -- what is OPG's upper tolerance limits for the 95th percentile? In other words, what is the required confidence that you must have that you have actually captured the 95th percentile accurately enough for the key radionuclides? In other words, will the upper tolerance limit be influenced by the sensitivity analysis -- or will influence the sensitivity analysis for the post closure assessment model?

There is a lot of iteration going back and forth I'm assuming between the new data that are coming in for your 95th percentile for your key radionuclides, you would be feeding that back into your assessment every so often, I am assuming, hoping that is driven by your

sensitivity analysis and that in turn determines your upper tolerance level. So I just want to have a feel for how sure you need to be about your 95th percentile estimate.

MR. ROUND: Glenn Round, for the record.

I'm going to ask Paul Gierszewski to reply to this one, please.

MR. GIERSZEWSKI: Paul Gierszewski, for the record.

In the assessments that were provided as part of the preliminary safety report, we did do sensitivity cases with up to a 10 increase in all of the radionuclides and looked at the consequences of that. My expectation is that our 95th percentile for key radionuclides would have to be no more than a factor of 10 and I actually think we can actually do better than that.

THE CHAIRPERSON: So in other words, plus or minus 10 percent of variation around your 95th percentile?

MR. GIERSZEWSKI: I'm sorry, Paul Gierszewski, for the record.

Maybe we are talking a different

definition of the statistical tolerance here.

THE CHAIRPERSON: I think so.

MR. GIERSZEWSKI: So maybe just be precise.

THE CHAIRPERSON: I'm talking about how sure you are about that upper -- about the 95th percentile, because depending on your sampling design if you take more samples you get a more accurate -- the more samples you take, the more accurate you can be, but of course there's a trade-off between how many more samples you get and the diminishing returns. So normally when you design your sampling you strike a balance between your effort and how sure you need to be about that upper -- about the confidence limit. And how sure you need to be about the confidence limit of course is driven by your model; right?

So I'm assuming that your team has been comparing notes about how much sampling will be giving you the required certainty about that 95th percentile.

MR. GIERSZEWSKI: Paul Gierszewski, for the record.

I would phrase that we want to be confident in the inventory of the key

radionuclides within a factor of 10 or better and precisely how that translates into numerical definition of confidence in the 95th percentile I can't answer right now, but that would be the guideline that we would use to do that.

THE CHAIRPERSON: All right. I'm over to CNSC with the same question.

As the regulator, first of all, are you satisfied that the 95th percentile is adequate, and is this in accordance with the usual international practice?

Second, what would be, as the regulator, your tolerance limit for the uncertainty around the 95th percentile and is there international guidance for that?

DR. THOMPSON: Patsy Thompson, for the record.

The approach that the CNSC identified in our recommendation No. 2 and which we have spoken about today is the expectation that OPG's program will align with the ISO standard 21-238 for characterizing radioactive waste inventory. The expectation of the 95th percentile comes from that standard and as well as the IEA standard on the same topic. The

expectation is that the level of sampling will be sufficient to have a stable value.

You just mentioned, the more sampling we do at some point you will get, you know, less variability in the values. So the expectation is that there is sufficient sampling done of the key radio nucleotides that we can have them the confidence that the safety case would reflect the radioactive waste inventory, but we would rely on those two international standards.

THE CHAIRPERSON: Thank you.

May I have the CNSC slide 32, please. At least it was in my package, it may be slightly different now. It's the one where the sample sizes for the verification plan appear.

--- Pause

THE CHAIRPERSON: The title is "CNSC Staff Assessment of the Inventory Verification Plan."

Okay. So there we have, Dr. Thompson, the OPG commitment to the sample sizes and, as we have just discussed, what we are looking for is settling around a stable estimate of the 95th percentile.

In the CNSC review, are you satisfied that this commitment is adequate?

DR. THOMPSON: Patsy Thompson, for the record.

We are satisfied that the planned response aligns with the ISO standard. The ISO standard and the IEA documents have been developed for a variety of waste practices and in many countries the sources of waste are from very different types of operations.

In the case of OPG, all of the waste to be placed in the DGR is from the operation of CANDU nuclear power plants and so the types of waste streams and the types of operations are fairly stable and so our assessment is with the plan proposed by OPG is acceptable at this time, but what we also mentioned is that we will be doing reviews of the annual updates that OPG would be submitting as well as doing some of the other verifications. So through that work if the level of accuracy in the radioactive waste inventory is not appropriate, then we would expect that more sampling be done.

So what we are looking for is

enough samples to give us, you know, a high level of confidence in the source term for the post-closures safety assessment.

But we are satisfied that for the time being the plan aligns with international best practices.

THE CHAIRPERSON: Thank you.

If I now could have the OPG slide No. 6?

This illustrates the projected waste volume with time and this relates back to what the Panel had heard a little bit about yesterday which is your waste reduction programs.

So does OPG expect that the amount of low-level waste in particular will actually decrease with time so that there will actually be less than shown on slide 6 on the left-hand side there and, if so, what is your target for reducing that slope of that line?

MS MORTON: Lise Morton, for the record.

So as I indicated yesterday, yes, we have begun this pilot to look at especially non-processable wastes which, as Dr. Gierszewski pointed out in the presentation is the biggest

volume here, the blue section on the slide. We have begun that.

I want to be cautious giving numbers, but the very first indications we got were that we could potentially achieve a volume reduction of about 5:1 on that waste stream, but again, that was a very limited sample size and this pilot that we are conducting is intended to validate that information.

Sorry, I haven't done the calculation with respect to how much that might attribute to a long-term volume reduction, but we will have better information on that as we go through this pilot. That's the kind of number we are aiming for right now.

THE CHAIRPERSON: Now may I have OPG slide 14, please?

In this slide the Panel notes that the descriptive scenarios, human intrusion and severe shaft failure, although they seem to end at the 1 mSv per year dose limit, and I understand why you can't show that it actually slightly exceeds that, but I think in terms of transparency can OPG, for the Panel's benefit, please confirm that the risk associated with

these two scenarios remains acceptable, because the likelihood of these two scenarios is actually relatively small, thus rendering the risk within the limit of 10 to the minus 5.

MR. GIERSZEWSKI: Paul Gierszewski, for the record.

I confirm that. That's correct.

THE CHAIRPERSON: Thank you.

My next question, skipping around in topics here a bit, to OPG. Would there be a possibility that flammable gases would build up after the closure walls are in place?

MR. GIERSZEWSKI: Paul Gierszewski, for the record. While the facility is ventilated, it's an oxygenated atmosphere and generally you would expect CO2 or whatever, but we do allow for the possibility that within containers in a more anaerobic environment you would have some hydrogen or methane generated by degradation processes and that's why the facility is ventilated.

After you close the facility, the oxygen would be consumed by various processes, so at that point, subsequently you'd expect the gases to be formed could well include hydrogen

and methane and flammable gases of that nature. That would be appropriate in an anaerobic environment.

THE CHAIRPERSON: And could you please remind the Panel whether your post-closure assessment took into account the presence of flammable gases upon closure, and would your conservative model assume certain scenarios that would cover that eventuality?

MR. GIERSZEWSKI: Paul Gierszewski, for the record. So the key point is, we put the closure walls on and those closure walls are capable of withstanding any detonation that would occur in those rooms.

In the long-term post-closure, again, it doesn't matter because if you put the shaft seals on and it's further enclosed by the 700 metres of seals, so there's no opportunity for oxygen to mix at the 700 metres depth, so that's why it's not important.

THE CHAIRPERSON: And, again, the Panel apologizes if we have forgotten what you told us earlier, but just to confirm, in the pre-closure with respect to worker safety in particular, what did the analysis show?

MR. WILSON: Derek Wilson, for the record. You are correct that in the pre-closure assessment in looking at the closure walls as we go through and make a series of panel closures, we did assess the potential for flammable gas buildup in behind those closure walls and assessed what the closure wall monolith, if you want to call it, would have to be to withstand the blast pressures that would be behind those walls as a basis of closing it off.

And if you look at panel 1 being the largest panel of placed waste and consisting of a lot of the low-level waste bins, that was kind of our bounding scenario, we looked at that and the closure walls, we've done the analysis that they would withstand the blast pressure very similar to that that you see in the coal mining industry around blast walls.

THE CHAIRPERSON: Thank you. Question again for OPG. Does OPG plan to update the waste verification plan after the Phase 2 WIPP report is released?

MS SWAMI: Laurie Swami, for the record. I think we need to see the outcome of that before I could assess whether we would

update it or not. I think that we have an understanding of what our waste is and we believe that it's different than the material that caused the event at WIPP, but we need to assess that and, as part of our process, we would look at what things we may need to change and that could include the waste inventory plan, or it could include other things.

So we just need to see that before we could definitively say one way or the other.

THE CHAIRPERSON: Thank you. And the same question to CNSC. What is your intention with respect to their making use of the results of the Phase 2 WIPP report?

DR. THOMPSON: Patsy Thompson, for the record. There's two elements to the response.

The first is that the expectation from the CNSC is that OPG has in place an OpX program, which they do, and that the OpX program be used to review the final report from the WIPP.

We would also review the same report in terms of whether our regulatory requirements need to be adjusted for,

essentially, two things. As Ms Klassen just reminded me, some of the issues that appear to have caused the radiological release is a chemical reaction, and so the current operations at the Western Waste Management facility and waste generation may have to be reviewed as well as any significance of those events for anything that would happen in the future DGR.

But certainly the expectation is that the OpX program would do a full review of the incident.

THE CHAIRPERSON: Thank you. This question is also to CNSC. As part of the verification plan, OPG has committed to an intra-laboratory comparison "every few years", and on their chart in their slide they really only showed one -- I guess it was every few years.

In CNSC's experience and opinion as the regulator, is "every few years" sufficient for intra-laboratory comparisons, particularly for some of these radionuclides that are apparently very difficult to characterize and measure?

DR. THOMPSON: Patsy Thompson, for the record. The expectation is that the

laboratory methodology that is being used by, or that would be used by OPG be developed and validated for the radionuclides that need to be assessed and we would expect OPG to use methods that have been validated internationally.

There's a lot of work being done by various groups, including under the IEA, to develop methodology for measuring radionuclides.

The intra-laboratory verification is a second element and we would expect that the intra-laboratory verification be done more thoroughly and probably earlier on for some of the difficult to measure radionuclides and, once we have a good sense, you know, that the methods used by OPG have been validated, then certainly those verifications can be done at longer intervals.

But the expectation is that there's enough work done early on to have confidence in the methodology.

THE CHAIRPERSON: Thank you. Again to CNSC. What lessons have been learned internationally, for example, at Forsmark in Sweden, in CNSC's experience and with respect to your, for example, tours or interactions with

your international peers with respect to waste verification?

DR. THOMPSON: Dr. Swanson, could we come back perhaps after lunch with a more complete answer?

THE CHAIRPERSON: Certainly.

DR. THOMPSON: Thank you.

THE CHAIRPERSON: I apologize. This is now to CNSC and it's back to the zirconium issue. Earlier a response from CNSC stated that there was -- the zirconium dust probably would not ignite. What is the basis for this assertion? Is there a way to get the zirconium dust hot enough? Have you looked at all possible credible scenarios, including igniting gases in the container?

I guess the basis for the Panel's question is, this is a severe enough potential disruptive scenario or malfunction or accident.

The Panel requires some assurance that some very open-ended thinking has gone into making sure we have this absolutely taken care of as an issue and that the physics and chemistry, that I'm certainly not in expert in, but has been thoroughly examined with respect to the amounts

required, the physical and chemical conditions required within these containers that would or would not cause ignition.

--- Pause

DR. THOMPSON: Patsy Thompson, for the record. I will ask Mr. Richard Bowes from Natural Resource Canada to respond to your question.

MR. BOWES: For the record, I'm Richard Bowes. So I understand we're looking at a scenario where the coupons are stored in a container and in the container there are also filings or small size zirconium.

We have the reference written by Thurman Cooper and in that reference Sony gives ignition temperatures for zirconium powders and they are -- well, the ignition temperature depends on the surface area to mass of zirconium powder and for fine powders they certainly go right down to ampasuric. So if the powders are in the micron size, they can ignite at room temperature.

But there's also a mass effect. So for ignition to occur in a zirconium powder you need a critical mass and the document gives a

graph that shows, for example, for a 10-micron sized powder you would need about a kilogram for it to ignite at round about 60 degrees.

The same reference shows that massive amounts of zirconium do not burn. So they've done experiments where they've subjected zirconium plates and zirconium rods to ignition from zirconium sponge and zirconium powders and the plates and rods have not ignited and have not sustained burn.

THE CHAIRPERSON: Could we have a bit more information, Mr. Bowes, as to the reference you're referring to?

MR. BOWES: Richard Bowes, for the record. The reference is titled, "Review of Zirconium-Zircaloy Pyroporocity" and it was published in November, 1984 and it's written by Dr. -- Thurman D. Cooper and it's a Rockwell International publication and I understand it was done -- the work was presented on behalf of the United States Government.

So I believe they were paid for it.

THE CHAIRPERSON: Dr. Muecke...?

MEMBER MUECKE: Yeah, along the

same sort of line of questions, and this one is to OPG.

One of the components necessary for the ignition of zirconium is oxygen and you have stressed that.

The Panel's question is, are the containers that contain the zirconium coupons, are they evacuated or is another gas other than oxygen introduced into them to prevent any sort of interaction with the dust?

MR. GIERSZEWSKI: Paul Gierszewski, for the record. I believe the current retube containers are sealed, but it's just an air atmosphere.

MEMBER MUECKE: So, would you have any idea of how much oxygen or what volume of air that is in one of these containers and whether that would be sufficient for ignition to be successful?

MR. GIERSZEWSKI: Paul Gierszewski, for the record. So certainly the volume of them is known, the amount of oxygen could be calculated. I haven't done the particular calculation, but we have -- these containers have about 2,000 kg of zirconium in

them and there's probably a cubic metre of oxygen.

So it would seem unlikely that there was enough oxygen there to sustain anything more than just some surface reaction or some small oxidation of the materials, but I haven't done the numbers.

MEMBER MUECKE: So, you're talking here likelihoods. In your view, would that require some more rigorous examination?

MR. GIERSZEWSKI: Paul Gierszewski, for the record. I mean, it's a simple calculation. We could certainly put the numbers to it, but in my view, it would be unlikely, but the numbers would tell.

THE CHAIRPERSON: Dr. Gierszewski, I think if it's possible, if you could quickly run some numbers for us and have that available to us by the end of the day that would very much help.

And, CNSC, if your experts, Mr. Bowes and Mr. Brazeau, can please have a look as well and get back to us.

As you can tell from the Panel's line of questioning, the Panel simply wants the

additional assurance that the physical and chemical character of the conditions within the containers are insufficient, within reasonable likelihood, to support ignition.

DR. THOMPSON: Patsy Thompson, for the record. Dr. Swanson, could I just confirm that what you would expect us to review is that type of mechanism in malevolent type of scenario where someone actually, or just spontaneous?

THE CHAIRPERSON: No, just spontaneous, please.

DR. THOMPSON: Okay, thank you.

MS SWAMI: Laurie Swami, for the record. If I could just add that the containers themselves, we do safety analysis around them so that they contain the appropriate material.

This is not a new field of study for us, so we have the safety analysis. We'll review that over the lunch break and make sure that we provide you the information that you're looking for.

But, in essence, we've already gone through that analysis and demonstrated to ourselves that these are safe containers for the

pressure tube materials as stored today.

THE CHAIRPERSON: Thank you, Ms Swami. Obviously the Panel will look forward to some details this afternoon.

MEMBER MUECKE: Switching topics. And I'd like to address that to CNSC.

Dr. Greening has pointed out deficiencies in the reference inventory, 2010 reference inventory presented by OPG, particularly with respect to the pressure tubes and garter springs.

Could CNSC explain to the Panel why these deficiencies were not detected and what measures has CNSC taken to avoid a similar occurrence in the future?

--- Pause

DR. THOMPSON: Patsy Thompson, for the record. The assessment conducted by Staff is a phased review. For the purposes of the environmental assessment we focused on the overall long-term safety case for all phases of the project. So we focused on the information necessary for the pre-closure assessment and then for the post-closure assessment.

For the post-closure assessment,

as Dr. Goulet explained in our presentation, there were enough margins of safety added to the information available in the waste inventory. When we looked at the consequences of the long-term safety closure, the post-closure assessment in terms of the consequences -- of those consequences to members of the public, the fact that they were hundreds of thousands factor, you know, less than the public dose limit, the Staff was satisfied that for this stage the information was sufficient.

The expectation in the staged licensing phase is that, especially for disposal of hoists, is that the information becomes more and more detailed and more rigorous as the project moves forward.

And so, the expectation that was clarified in the information submitted to the Panel for the licensing phases last year and the licensing approach is that since, for the site preparation construction licence, there is no radioactive material being handled the information was sufficient for the EA and to have a sense of the long-term safety of the project.

The requirements for an updated

radioactive waste inventory, a more rigorous inventory verification plan was CNSC Staff's way of requiring more detailed information so that we would have a rigorous safety assessment with the licence application.

MEMBER MUECKE: Now, if I could just pursue this a little bit more here. You say that you decided that the margins of safety were large enough and conservative enough at that stage, but the new information coming in, the addition of the activity of the pressure tubes and so on, how did you know that the margin is big enough to encompass any changes or any additions which were missed?

I mean, looking backwards now, it is fairly obvious that the deficiencies didn't affect the safety case, but looking forward, how can you tell that your margins of safety that you have chosen are actually broad enough, okay, to encompass any of the possible changes?

I hope I make myself clear.

THE CHAIRPERSON: And Dr. Muecke, if you might permit me to paraphrase because I had a very similar question to CNSC as the regulator.

You used in one of your slides the phrase or I think in the oral presentation accompanying the slides a phrase called "reasonable confidence" in terms of your role as the regulator.

For example, on your slide 9, the change between 0.6 to 7.5 percent in the effective dose for the normal evolution and disruptive scenarios appears to represent what you would, as a regulator, interpret as reasonable confidence.

So to paraphrase Dr. Muecke, how much would have -- would it have to change to be unreasonable?

And this is speaking to, as a regulator, with your responsibilities for protection of the public and the environment. How sure do you need to be?

And if I could be of any further assistance in helping you answer this, please refer also to international practice and guidance with respect to this.

--- Pause

DR. THOMPSON: Patsy Thompson, for the record.

On the slide 9 that you mentioned, we do talk about the -- which radionuclides are important for safety based on international experience. And the assessment that was conducted for OPG's proposed DGR aligns with the findings from other assessments done in other places where radioactive iodine, I-129, is the -- usually the radionuclide important to safety.

And so in terms of the bonding assessments that CNSC expected to do, we used the CNSC regulatory documents as well as some of the IAEA and NEA safety guides and guidance for post-closure safety assessments.

The work conducted by OPG for the stage of licensing and for the EA was to use the inventory they had and multiply it by a factor of 10 and still, with that increase by a factor of 10, were about 100,000 -- factor of 100,000 below the public dose limit. And the disruptive scenarios were still within the range of acceptable doses for those types of scenarios.

So on that basis, we were satisfied that if the project were to be approved at this stage, we had confidence that it could be

done safely with the recognition that, based on international practice, the uncertainties in the long-term safety case get addressed through the geoscientific verification plan, the information that will be updated with the waste inventory. And the post-closure safety assessment is redone to address any findings from that additional work.

That's the CNSC approach, and it aligns with approaches from other regulatory agencies internationally.

THE CHAIRPERSON: If I could bring CNSC slide number 29 onto the screen, please.

Again, I hope this is the right number. It's the one which shows the doses -- estimated doses, I believe.

Yes, that's the correct one.

So your second bullet on this slide points out that the disruptive scenarios yielded doses at one millisievert or less. The Panel notes that the actual predicted doses were, in fact, slightly greater than one millisievert, for example, in the range of seven to 13.

While the Panel acknowledges that

these estimated doses are, indeed, around one millisievert per year, they are not less than one millisievert per year and, therefore, we ask CNSC to explain how it deals with conservative estimates that just slightly above -- that produce slightly above the dose limit and the explicit reasons why CNSC views the results such as these as reasonable.

DR. THOMPSON: Patsy Thompson, for the record.

We did note the -- an error in our slide. We tried to address it in our speaker notes but, as you saw this morning, we were scrambling for speaker notes that the wrong version got printed.

In terms of the recognition of the disruptive scenarios, a range of disruptive scenarios yielded doses that were above, and some considerably above, one millisievert per year.

What we did in those cases is use the approach recommended by the International Commission on Radiation Protection, the Document 122 that is reference in our presentation, where it's a combination of the probability of occurrence of the disruptive scenario and the

dose criterion or health risk.

And so the CNSC, what we did was to look at the dose from the disruptive scenario -- I'll give an example -- 80 millisievert, for example.

We have a cancer risk associated with that dose, and then we multiply the cancer risk with that dose with the probability of occurrence of that scenario. And if that combination was less than one times 10^{-5}, so one in 100,000, so then it met the safety requirements of a low probability of a health impact from the disruptive scenario.

This was better explained last year in our presentation.

THE CHAIRPERSON: Thank you.

I have a final question for OPG, and it's back to the verification plan.

And this one is, is OPG also planning to design the verification plan to capture the 95^{th} percentile for the non-radionuclide constituents and organics?

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

Yes, it would do that.

THE CHAIRPERSON: Thank you.

Dr. Muecke, Dr. Archibald, did you have any further questions?

MEMBER MUECKE: Dr. Thompson, a little while ago, you discussed the unlikelihood of malevolent acts directed at retube containers, and you attributed a low likelihood or low probability to this ever happening and -- since there would be difficulties identifying the relevant containers and having to get through security systems.

In the news, there are -- recent news, there are numerous incidents now of corporate computer systems being hacked. How easy would it be for somebody to hack either the OPG or CNSC system and get this information almost instantaneously?

DR. THOMPSON: Patsy Thompson, for the record.

There's some security information, obviously, that we can't discuss in this forum, but essentially, the assessment conducted by staff isn't in terms of being able to locate through some computer system or database the location of the -- of the package.

The assessment we did was more in terms of someone being able to breach security having enough explosives on their person, moving forward in terms of the -- through the site to the waste facility, going where the packages are located and having sufficient time and resources to be able to put the explosives in the right place given the inventory of the different type of waste packages.

It's more that type of assessment that we did.

In terms of the issues with security of computer systems, without going into the details, the CNSC has a cyber-security program that -- and those expectations, requirements are for licensees to have in place cyber security programs, which they do.

THE CHAIRPERSON: Thank you, Dr. Thompson.

And the Panel certainly is aware of the fact that no details, of course, would be discussed here.

The Panel would like now to proceed with Dr. Greening's presentation before lunch, and then we'll resume with questions after

lunch based on Dr. Greening's presentation.

Dr. Greening, you have 30 minutes. The lights in front of you will glow green as long as you're still within your limit. It'll start -- it'll turn yellow at five minutes and then red at the end.

Please proceed.

PRESENTATION BY / PRÉSENTATION PAR:
FRANK GREENING

DR. GREENING: Thank you.

I'll be -- I have one little thing I'd like to say based on some questions I was listening.

I'm very surprised that in a room full of PhD chemists and so-called experts that OPG does not know how much zirconium it has in storage because it's a very simple calculation.

One pressure tube weighs 62 kilograms. There are 480 pressure tubes in a reactor. Two reactors were refurbished. So with my trusty calculator, I arrived at 59.5 tonnes in storage.

And if we go with a .1 weight

percent of dust, that's 59.5 kilograms of dust.

I hope that helps.

So I will now proceed with my presentation.

We are here today in Kincardine to consider OPG's plan to deal with its problem child, radioactive waste. This problem child was born more than 30 years ago and is becoming more troublesome every day as vast quantities of radioactive waste continue to pile up at OPG's so-called interim storage facility, originally known as the Radioactive Waste Operation Site No. 1, or RWOS 1.

What a lot of people don't know is, by the year 2000, RWOS 1 was releasing radioactivity into the underlying aquifer and the site was abandoned. Eventually, the leaking waste was repackaged and moved to an adjacent site, now known as the Western Waste Management Facility, or WWMF.

Now, after 30 plus years of prevarication and mostly, I would claim, for economic reasons, OPG has finally decided what it wants to do with this mountain of accumulated radioactive waste, and that is to bury it and

plenty more that is yet to come in a deep hole in the ground euphemistically referred to as a DGR that is to be excavated adjacent to the present RWOS WWMF location.

But OPG is not telling us the real reason for choosing this site, and that is to save the billions of dollars that would have to be spent in moving this pile of radioactive waste en masse to where it really belongs, and that is in a more remote and safer location.

But to further save money, OPG has chosen to skimp on the costs of properly characterizing these piles of radioactive waste, perhaps because the analysis of just one sample costs over $1,000.

So in order to minimize these costs, radionuclide inventories of hundreds of tonnes of waste are being estimated solely on the basis of the analysis of a handful of samples that involve very small quantities of waste and, thus, can hardly be called analyses that are representative of the inventory.

OPG tries to justify not directly analyzing long-lived radio isotopes such as carbon-14 and chlorine-36 in individual waste

containers by offering instead a scaling factor approach that uses calculated estimates of radio isotope concentrations as surrogates to real data.

In addition, these surrogate data sets are calibrated based on measurements of only one radionuclide, typically the neutron-activated corrosion product cobalt-60.

However, and this is very important, there is no theoretical justification for any correlation between carbon-14, chlorine-36, iodine-129, et cetera and the cobalt-60 content of a DGR waste container.

Indeed, a check of radionuclide inventories reported by OPG shows many other highly questionable scaling factor pairs such as tritium and cobalt-60.

But as reported by AECL, real ion exchange resin samples collected from various storage containers at the WWMF exhibit tritium to cobalt-60 ratios that vary from a low of 0.00017 to a higher of 135, which is a factor of almost a million. I would therefore ask OPG a simple question: What scaling factor did it use for tritium in ion exchange resins, and how was that

scaling factor determined?

Now, for refurbishment waste, OPG relies on a different methodology for inventory estimation, namely, neutron activation calculations. However, after I challenged some of the calculated values, OPG acknowledged in a letter dated February the 20th, 2014 that it had, indeed, miscalculated a number of radionuclide inventories such as those for tritium, cobalt-60, fission products and trans-uranics and pressure tube wastes.

In addition, OPG admitted that it had forgotten, yes, forgotten, to consider the neutron activation of garter springs in its calculation of these wastes.

In view of these errors in the inventory report, I wrote to CEAA and the CNSC to point out that OPG's environmental impact statement with regards to the proposed DGR is now in non-compliance with the requirements of CNSC's Regulatory Guide G320 because this standard stipulates that:

> "Measured values of radionuclide inventories should be used, whenever

> possible, in safety assessments."

But OPG's 2010 inventory report is also non-compliant with regard to CEAA's guidelines for an EIS.

CEAA requires that the environment impact of a project should be considered as described in a report entitled "A Framework for the Application of Precaution in Science-Based Decision Making About Risk".

One of the guiding principles of this framework report is that:

> "Available scientific information must be evaluated with emphasis on securing high quality scientific evidence."

Clearly, when it comes to OPG's EIS, far from evaluating available scientific information or summarizing the existing state of knowledge, OPG simply ignores the considerable amount of directly-measured data available for radionuclides in refurbishment wastes and then, to make matters worse, it makes major errors in calculating these inventories.

But now I see that OPG has recently attempted to rewrite the history of this issue.

On May the 5th of this year, OPG issued what is referred to as a frequently asked question, or FAQ, sheet on its DGR which includes the following question and answer pair:

> "Question: How does OPG account for the discrepancy between Dr. Greening statements and OPG's submitted inventory report to the Joint Review Panel?
> Answer: The estimates used in the pressure tube waste inventory for the 2010 inventory report were based on available information at that time."

Now, this is simply not true. OPG did not use available data, but used fabricated data instead. Worst yet, the discrepancies in question are not due to unavailable data, but are due to mistakes in OPG's calculations.

So OPG needs to explain why it ignored real data available from no less than seven studies carried out between 1990 and 2006, studies that provide a plethora of measured values of radionuclide activities in pressure tubes. And OPG also needs to explain its computational errors.

I would now like to consider two radionuclides in particular, chlorine-36 and iodine-129, and I would -- I want to consider these in some detail because OPG's response package number 13 submitted to CEAA in May of this year claims that its safety case remains unaffected by my critique of the DGR inventory because I did not specifically mention problems with chrlorine-36 and iodine-129.

However, this assertion is simply not true because there are major problems with OPG's chlorine-36 and iodine-129 inventories, as I will now explain.

OPG is clearly unaware of a study I completed for the CANDU Owners' Group, and it's been issued as an OPG report -- I have it right here -- that shows that chlorine-36 is leached from pressure tube oxides during reactor

operation.

Furthermore, the released chlorine-36 accumulates in primary heat transport system ion exchange resin, a process which makes the inventory of chlorine-36 in this waste stream at least 1,000 times higher than OPG's estimate.

And research carried out by AECL at the White Shell laboratories also shows that spent anion exchange resin under normal waste storage conditions undergoes radiolithic and thermal degradation of the quaternary ammonium functional group, leading to gradual loss of radio chlorine and radioiodine.

This degradation has a very significant impact on the DGR safety case because OPG erroneously claims that chlorine-36 is first released from a DGR by corrosion of pressure tubes, and this release only becomes significant after about 100,000 years of storage.

In addition, OPG asserts that the DGR chlorine-36 release rate never exceeds 50 Becquerels per year. Unfortunately, the reality is that more than 1,000 Becquerels per year of chlorine-36 will be released from ion exchange resins well before 1,000 years of storage.

And in support of this assertion, OPG should consider the fact that the Western Waste Management Facility already exhibits radioiodine emissions of about 10^5 Becquerels per year, and sometimes that have been as high as 10^7 Becquerels per year.

This is Iodine-131 being released from the Western Waste Management Facility every year. What does this show? This shows the spent iodine exchange resin is unable to retain its complemental radioiodine even for short-term storage let alone for 1,000 years.

OPG's current radioiodine emissions indicate that they are at least 10^{12} becquerels of Iodine-131 at the Western Waste Management Facility yet this radioiodine inventory remains unreported by OPG. OPG needs to revise its safety case calculations, especially those involving radiohalogen releases from its DGR. To do this properly, OPG needs to factor in the early contribution to Chlorine-36 and Iodine-129 emissions from ion exchange resin degradation.

Let me emphasize that these are just a few of the questions that could be asked

about the proposed DGR inventory.

Another issue that certainly deserves mention is found in section 1.3 of the 2010 inventory report where OPG acknowledges that decommissioning wastes are not included in its inventory estimates. This admission by OPG poses a major problem because decommissioning waste inventories are many times higher than operational and refurbishment waste inventories yet the latter wastes are the only wastes considered by OPG. Thus, by ignoring decommissioning wastes, all of OPG's predicted radionuclide emission rates and radiation doses from its DGR are significantly underestimated.

Nevertheless, in spite of these problems I believe OPG's greatest submission in its attempt to characterize DGR wastes is its failure to consider the chemical properties of many wastes, especially in the event of accidents or acts of sabotage.

It should be noted that OPG itself considers incidents such as an underground fire or an explosion to be credible events. However, OPG's analysis of such events makes two unfounded and dangerously misleading assumptions

about the properties of the materials whose safety is being evaluated. These unfounded assumptions are: one, that zirconium alloy wastes are incombustible and essentially inert; and, two, that spent ion exchange resin wastes are chemically equivalent to municipal waste, such as household garbage.

The fact is both of these assumptions are totally false. Zirconium scrap can indeed burn under certain conditions, which I will get to, and ion exchange resin waste is really nothing like municipal waste.

Municipal waste releases mainly carbon dioxide water vapour on combustion with small amounts of carbon monoxide, volatile organics such as benzene, and only traces of sulphur or nitrogen compounds. By comparison, ion exchange resins release all of those plus significant amounts of toxic gases, such as ammonia, NO2, trimethylamine, hydrogen sulphide or SO2 depending on the oxygen supply to the burning resin.

What OPG fails to recognize is that these wastes should in fact be classified as hazardous wastes, especially in the event of a

fire or explosion at the proposed DGR. This is not simply because of the radioactivity in these wastes but because of their ignitability, reactivity and toxicity. More specifically, the pyrophoricity of the zirconium waste needs to be considered and the thermal and radiolytic degradation of ion exchange resins needs to be evaluated.

OPG and the CNSC today have suggested that zirconium scrap is not pyrophoric, so please allow me to explain why this is simply not true.

Thus, consider the hypothetical malevolent act described as scenario d, which is in section 4.3 of OPG's response to EIS-13-514, in which a TNT equivalent of 160 kilograms of an explosive is detonated in close proximity to a pressure tube waste container in a DGR. To analyze the consequences of such an event, OPG uses the following approach:

> "The consequence of an explosion may be estimated based on experimental data, on the fragmentation of metal from a pressure impulse

directed inward through the material." (As read)

OPG then uses the experimental data taken from the U.S. NRC publication "Nuclear Fuel Cycle Facility Accident Analysis Handbook". Unfortunately, OPG fails to recognize that this handbook considers two types of explosive detonation, those involving reactive metals and those involving inert metals.

As described by the U.S. Department of Energy Handbook, another handbook actually, metals such as magnesium, titanium, zirconium and uranium are considered to be pyrophoric or spontaneously combustible because of the ease of ignition, and this is important, when they reach a high specific area ratio, which means thin sections or fine particles.

Thus, in the context of explosive fragmentation, which is scenario d, it's fragmentation we're talking about here, and that little movie of them blasting a piece of zirconium with a blowtorch is just silly. I don't talk about that. We're talking about zirconium being exploded and fragmenting. That's scenario d. Under those circumstances, zirconium

is definitely to be classified as a reactive metal and a pyrophoric metal.

That zirconium can show this behaviour and I don't know why the CNSC haven't discovered these reports. They're called spent fuel sabotage tests and they were carried out at Sandia National Laboratories in the U.S. These tests were designed to quantify and characterize aerosol particles produced in incredible sabotage events involving nuclear waste storage containers. In the particular tests -- I have copies here if people are interested -- zircaloy-clad fuel was used and the debris produced by the detonation of a high explosive device placed in contact with a waste container was collected and the zirconium respirable fraction was measured. High-speed video photography was performed during some of these tests and what did it show? It showed rapid oxidation, i.e. burning of the zirconium metal. In addition, zirconium oxidation was indicated by the appreciable amounts of zirconium oxide that was found in the respirable particles that were collected.

OPG's pressure calandria tube waste package -- and by the way that's also

important. Everyone is forgetting it's not just pressure tubes in those containers, it's calandria tubes, and calandria tubes are a much thinner zircaloy. I would like OPG to repeat that test with a piece of calandria tubing. That would be closer to reality. OPG's pressure tube waste packages do not contain zircaloy fuel cladding but something quite similar, namely zirconium, 2.5 percent niobium and zircoloy-2 scrap in the form of small coupons and cutting debris derived from the refurbishment volume reduction system.

Unfortunately, the analysis of malevolent acts described in OPG's response to EIS-13-514 ignores the fact that under the conditions described in scenario d, zirconium will catch fire and the resulting combustion will impart more than double the energy to the postulated explosion than the energy supplied by the TNT itself.

OPG also appears to be unaware that the deadly combination of zirconium and TNT has been used for many years in high-tech weaponry such as incendiary bombs. Consider, for example, the explosive device described in U.S.

Patent No. 3959041, which was issued in May 1976. I have a copy of it here if people are interested. It describes its incendiary device as follows:

> "The present invention provides incendiary... capabilities to a munition by virtue of the incorporation of a relatively small [amount] of pyrophoric material in the explosive composition of the munition....The term pyrophoric, as used in the present invention, refers to those materials...which ignite spontaneously in air when...disintegrated to fine...particles by... [detonation] of the high explosive....
>
> "The preferred pyrophoric material employed in the present invention is zirconium metal....Also, the

> particle size of the zirconium can be varied widely depending on the effects desired....Thus, granules and chunks of zirconium up to 1/2 inch thick, strips or sheets about 2 or more inches long...can be employed.
>
> “Upon detonation of the explosive containing the pyrophoric material...there is produced a bright flash which illuminates the surrounding terrain. The burning zirconium is spread over [an] area [up to] 1 ,000 feet in radius)....”

In light of this information, it appears that OPG and the CNSC are blissfully ignorant of the fact that its supposedly innocuous scenario d actually describes a very deadly radioactive incendiary bomb. There can be little doubt that the airborne release and respirable fractions associated with the

detonation described in OPG's scenario d would be closer to unity than the values derived from the dispersion of an inert material. It follows that the public dose, due to the breaching of a pressure calandria tube waste container by detonation of explosives, would be closer to 340 millisieverts rather than the 3 millisieverts predicted by OPG.

In conclusion, it is abundantly clear that OPG has not made an acceptable safety case for its proposed DGR but, on the contrary, has understated the chemical and radiochemical hazards associated with a significant portion of its waste. Overall, OPG has not provided a detailed accounting of the chemical and radiochemical characteristics of the waste it plans to bury in the proposed DGR, nor, according to its own pronouncements, does OPG intend to precondition or stabilize any of its intermediate level wastes as is practised in most countries worldwide that are dealing with similar nuclear wastes.

Indeed, this disregard for the safe storage of iron exchange resin waste at OPG's DGR was questioned by France and China

during the 2009 round of submissions to the Joint Convention on the Safety of Radioactive Waste Management. Nevertheless, in response to these concerns OPG simply reiterated its position that:

> "The waste acceptance criteria for the DGR do not require a systematic conditioning of the waste." (As read)

I would say this position illustrates OPG's cavalier attitude to the potential hazards of its nuclear wastes.

Speaking of other countries, I would like to briefly consider the U.S. waste disposal site known as the WIPP facility in Carlsbad, New Mexico, which began operating in 1999. On February the 14th of this year one of the drums stored in Room 7 of this facility spontaneously ignited and ruptured, sending clouds of radioactive material to the surface and exposing 22 workers to radiation. The cause of this accident is still under investigation, but the U.S. Department of Energy has announced that the WIPP facility may not be open for up to three years.

The lessons to be learned from this WIPP event should loom large for OPG and its proposed DGR, but the history of WIPP shows that has always been an accident waiting to happen. Indeed, the Department of Energy's unusual occurrence reporting system indicates that events, such as the discharge of static electricity, spontaneous ignition of pyrophoric materials such as zirconium scrap, reactions involving nitrate-rich materials -- by the way, OPG has gadolinium nitrate absorbed on resins, a whole bunch of gadolinium nitrate absorbed on resins, but that's an aside -- these reactions involving nitrate-rich materials have generated a number of fires, explosions and incidents of drum over pressurization in the Department of Energy's stored radioactive wastes.

Ironically, an evaluation of the chemical specifications for waste to be emplaced in the WIPP facility was carried out in 2002 and the potential for volatile organic compounds to accumulate in the headspace of the waste container was evaluated as part of an accident scenario involving the spontaneous ignition of a drum containing organic waste emplaced in Room 7

of the WIPP.

The resulting official report concluded:

> “The probability of sustained combustion in a partially-filled waste room at the WIPP is estimated to be 5.3 x 10^{-6} per year”. (As read)

That would be an underground fire once every 188,679 years. However, as we know, the actual probability of such an incident occurring at the WIPP facility has turned out to be 12,580 times higher than this official prediction or an underground fire after only 15 years.

I would argue that OPG is playing the same kind of guessing game with its so-called predictions of the safety of its proposed underground repository. As so often is the case, the risks involved in an activity are not recognized before an accident occurs. Only after the fact do to hidden dangers that have always been present become evident.

Nuclear waste is dangerous enough. Attempting to permanently store it deep

underground only makes it more dangerous. Therefore, I am asking the DGR review panel to simply say to OPG: request denied. Perhaps, if they need to give a reason for the decision, may I suggest this: OPG, the owner and operator of the proposed facility, has failed to properly characterize the waste slated for storage in the facility and has failed to recognize the chemical hazards that exist in many of the waste packages; therefore, it has not shown sufficient concern or duty of care with regard to the safety of the proposed facility; for this reason, OPG cannot be entrusted with the stewardship of such a facility.

Thank you.

THE CHAIRPERSON: We will now adjourn for lunch. We'll reconvene at 2:00 p.m., where we will begin the questions for Dr. Greening.

--- Upon recessing at 12:29 p.m. /
Suspension à 12 h 29
--- Upon resuming at 1:59 p.m. /
Reprise à 13 h 59

THE CHAIRPERSON: Good afternoon everyone. Welcome back for the afternoon session.

Before we proceed with questions from the Panel I have a question and a statement to make.

Dr. Greening, you presented a significant amount of new information this morning that was not included in your previous submissions to the Panel. Can you explain why this information was not submitted by the deadline set out in our amended hearing procedures?

DR. GREENING: Frank Greening, for the record.

Mainly because there was so much to consider and I have been working on this non-stop everyday for the last two months. And I apologize if that is a problem, but that is my answer. Thank you.

THE CHAIRPERSON: Thank you for your response, Dr. Greening.

In light of your response and your acknowledgement that there is new information, as you are aware, in the interest of

a fair and efficient public hearing presentations are not for the introduction of new information. The Panel will make a determination whether or not to accept the new information that you presented today.

If the Panel chooses to accept some or all of this new information, we will advise the public accordingly and provide sufficient opportunity for the proponent and CNSC to prepare for questions from the Panel.

The Panel's questions for today will be based on your previously submitted information.

I would like to begin with questions from Dr. Archibald please.

MEMBER ARCHIBALD: Thank you.

Dr. Greening, the energy reactivity of zirconium as we have heard this morning is related to the ignition source, the form of the metal, and the total accumulated mass of the metal.

Do you think that in light of the information provided by OPG this morning that ignition of zirconium in waste containers is possible for the normal safety case scenario?

DR. GREENING: Frank Greening, for the record.

There are examples of spontaneous ignition of stored waste zirconium, so I do believe that it is possible.

And I do know that in the U.S. there are recommendations for storing that kind of waste. And I would presume that the CNSC and OPG would be familiar with what those are. But I can say what they are.

And that is you would normally fill one of those containers only half full with zirconium and then you would top it up with water. And it is very important not to have a trace of water, and the way to get around that is to fill it with water. And that is a practice that has been used in the U.S. I believe.

MEMBER ARCHIBALD: Would you know if such storage also has separation of the dust or aerosol portions versus coupon-size portions, or are they non-segregated?

DR. GREENING: Frank Greening, for the record.

I believe they are non-segregated. I think it would be a lot of work to

start that. And I think we would always have some finds in that kind of waste.

Thank you.

MEMBER ARCHIBALD: On page 2 of your written submission, you had mentioned that there was a fraction of the available zirconium in the spent fuel sabotage test that was oxidized.

Would you know what total fraction was oxidized and what the remainder of the debris that remained unconsumed was?

DR. GREENING: Frank Greening, for the record.

These are Sandia reports that I have copies of. They were using zircaloy cladding. And from my recollection and from reading those reports, I do believe that the vast majority of the zirconium was converted to zirconium oxide, which means it was combusted.

Thank you.

MEMBER ARCHIBALD: And therefore, by combusted, that was a deflagration process, not a detonation process?

DR. GREENING: Yes, deflagration.

MEMBER ARCHIBALD: Following up,

you had mentioned that the science of explosives, making cluster bombs and so on, makes use of pyrophoric materials such as zirconium with explosives to enhance the capacity.

Does such weaponry describe the making use of large aggregate size or finely-powdered material, or is it specific to the elemental aggregate size for making an explosive material?

DR. GREENING: Frank Greening, for the record.

There are two papers I am familiar with, and the PANT is one of them. And there they describe a range of particle sizes and they describe it as, depending on the effects that are desired.

The other paper I am familiar with they use two millimetre washers is what they specifically say.

I would have to go back to give you a better answer.

MEMBER ARCHIBALD: I would like to address the next question to OPG and to you also if you feel you would like to answer.

Under a disruptive case scenario,

does OPG believe that reaction of zirconium will create an enhanced release of contaminants or would it only be marginally enhanced?

And by that I mean with the addition of a certain weight of zirconium dust, a very fine aggregate in a way storage container, and knowing the zirconium coupon would not likely be reactive in the event of an explosive external charge, would only a marginal addition of an energy release occur due to deflagration?

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

Sorry, I was making some notes there. Just to be clear, could you repeat the scenario you are asking about?

MEMBER ARCHIBALD: Would OPG believe that the reaction of zirconium will create an enhanced release of contaminants or would it only be marginally enhanced knowing the effect of having an external charge on the fine aggregate material would be a deflagration, not an explosive process?

DR. GIERSZEWSKI: Again, Paul Gierszewski, for the record.

For context, you are considering

in a disruptive scenario if some of the zirconium fines were to also ignite or burn, would that have an effect on the conclusions of the kind of disruptive scenarios that we have considered so far?

I am just pausing for a minute to see if I can think of any -- you have to go back now to the different disruptive scenarios, and you have to then consider in the context of those.

And my reaction is that it would not have a significant effect. But it is something I would want to just consider a little more carefully.

But in principle, the fines themselves, by definition, are a very small fraction of the amount of retube material. So the amount of radioactivity contained in that is proportionately very small. And so I am pretty sure that that would have a very minimal effect.

I will just ask Richard Little behind me there if he has any additional thoughts on that.

MR. LITTLE: Richard Little, for the record.

I think the two disruptive scenarios are probably most relevant are the human intrusion scenario and the shaft seal failure scenario.

Now, if we look at the human intrusion scenario we see that the key radionuclide there is niobium-94, and zirconium is not a significant contributor. So I don't really see that your hypothesis would actually be correct with regard to that particular scenario. The key radionuclide is niobium-94.

With regard to the shaft seal failure scenario, again the key radionuclide there is carbon-14, that dominates the releases. So again, zirconium is not a key radionuclide.

We only find zirconium coming in for some of the alternative calculations that we have done for the normal evolution scenario where the doses are significantly below any dose criteria.

MEMBER ARCHIBALD: I have to be clear. This would be the human intrusion and the use of explosives scenario on one of the waste packages.

Would the presence of finely

ground zirconium dust enhance the explosivity, if you wish, of that scenario? Would it cause a greater dissemination or distribution of contaminant materials because of its capacity to potentially detonate or deflagrate in that process?

MR. LITTLE: Thank you for the clarification --

THE CHAIRPERSON: I am sorry, Mr. Little, before we proceed I think I would, on behalf of my Panel members, would like to get a little more clarity about what exactly we are talking about.

I think the conversation started with the malevolent acts, not the disruptive scenarios.

So the malevolent act is what we are actually referring to here, and the scenarios around the malevolent acts.

We understand the human intrusion and severe shaft is a disruptive event, and, yes, you have made yourself clear in terms of that.

But if we could please return back to the malevolent act scenarios. And I think that, Dr. Archibald, is really what the

Panel was seeking for clarification.

DR. GIERSZEWSKI: Okay thank you, yes, that helps clarify the scenario in my mind. But again, just to restate it. So now the question is in a malevolent act scenario, if the dust were to ignite, would that significantly change the conclusions that we have reached?

So the analysis that we have had in this, we have estimated that about 1 per cent of the radionuclide content in these malevolent acts would be released. And the consequences are based on 1 per cent of most radionuclides, but all of the volatiles, the tritium and carbon-14.

So now what you are saying, if .1 per cent, whatever the approximate fine fraction is, if that were additional -- I would say it would be within that 1 per cent estimate, but even if it were additional that would be, at most, a 10 per cent change.

MEMBER ARCHIBALD: I believe one of the attempts that I am trying to make here is that the use of weaponry or charges and so on would not be enhanced in any way by the storage of these materials in the waste containers.

Is that in fact a valid

conclusion to make?

MS SWAMI: Laurie Swami.

I believe that you are correct, that is a valid conclusion to reach.

I guess what I would add is just to -- one of the things we were asked to look at was the percentage of material available, and maybe that would help in this conversation to some extent.

So in a container, so we have a number of these containers stored at our facility already from the Bruce A retube that was recently completed.

So we have about -- less than 0.05 per cent is available as dust which, if you calculate that, would be about less than 500 grams per container. The total weight of zirconium in a container would be 1,225 kilograms. So that is grams versus kilograms, sorry for the change in units.

We have 48 of these containers at our site. So it is a very small amount of dust.

And when we look at the paper that the CNSC referenced this morning in terms of what is the critical mass, the critical mass --

and again, I am sort of generalizing here because it is not quite so simple as one number equals one critical mass.

So we took an assumption of a three 3 micron size of dust particle. We would expect the dust particles to be much larger than that from the work that is done when we chop these into small pieces. That would require a critical mass of 30 kilograms, so versus the 500 grams.

MEMBER ARCHIBALD: Thank you very much.

And, Dr. Greening, what I was trying to also read from your presentation based upon the enhancement of explosives using zirconium was that, yes, this is in fact a possibility.

But it is not a possibility for the storage situation because the zirconium materials would not be physically incorporated into any explosives in one of the malevolent act scenarios and, therefore, would not act to enhance.

Is that a correct assumption?

DR. GREENING: For the record,

Frank Greening.

Yes, I would agree with that.

One point I would like to note though, the comment about niobium-94, niobium is alloyed with the zirconium. The alloy in question is zirconium, 2.5 per cent niobium. So the niobium would be carried with the zirconium and would behave in an identical manner to the zirconium.

MEMBER ARCHIBALD: You also note on page 4 of your presentation that a possible source for a release event at the WIPP site, for example, was from spontaneous overheating with a nitrate waste container and ion exchange resin containing up to 15 per cent nitrates.

This is to OPG. Are the nitrate waste containers or are the nitrate contents of typical ion exchange resins typically low or could they be as high as this 15 per cent that they noted to occur at WIPP?

MS SWAMI: Laurie Swami, for the record.

I am going to ask Dr. Evans to reply to that question please?

DR. EVANS: Dave Evans, for the

record.

I have quite a bit of experience with process resins over the course of my 30 years. And we have done calculations and measurements on the ion exchange resins from our processes. They contain nitrates, but they are typically in the 2 per cent range for moderator resins. We have measured the highest value that we have seen is 1.5 weight per cent. More typically, they are less than 1 weight per cent nitrate.

MEMBER ARCHIBALD: Have any of the ion exchange resin materials in storage at the Western Waste Management Facility ever suffered fire initiation procedures?

MS MORTON: Lise Morton, for the record.

No. Those containers have been in storage since approximately 2006 or so or 2008. We have not experienced any kind of situation like that at all.

MEMBER ARCHIBALD: And Dr. Greening, I bring your attention back to these measurements. Would you feel the would still be of concern for a potential fire hazard?

DR. GREENING: Frank Greening, for the record.

Yes, I do. The thing is that these resins are literally a mixed bag and they do have a process called a gadolinium pull where they are removing substantial quantities of gadolinium nitrate. But that resin then can be mixed with more normal operating resin, therefore the net result is -- I believe the resin is extremely inhomogeneous and there could be pockets of high nitrate within a container of ordinary average ion exchange resin.

MEMBER ARCHIBALD: Thank you. And one last question. On page 5 you mention, it is a suggestion and recommendation, that professional standards for establishing the rules and policies governing scientific information disclosure to the public such as national instrument 43-101 should be in effect or should be utilized.

This in fact is a standard of disclosure for mineral projects required by the Canadian Securities Commission.

Would you think that this is an appropriate standard for use in regulating the

disclosure of scientific information as we see in our venue based upon an entirely different field of science?

DR. GREENING: Frank Greening, for the record.

While it is a suggested standard, I am not saying it is the only standard, but I believe that a standard of that type would be extremely useful.

MEMBER ARCHIBALD: Thank you very much.

THE CHAIRPERSON: Before I turn the microphone over to Dr. Muecke, I did have a follow-up arising out of Dr. Greening's response around the nitrates.

Dr. Greening, as I understand your response, you are stating that the nitrates may be actually very inhomogeneously distributed in among the resins.

So I want to redirect to OPG to pursue that a bit more please.

MS SWAMI: Laurie Swami, for the record.

I am going to ask Dr. Evans to reply to this. I think he has a lot of

background in this area. However, before he does that, Ms Morton would like to just correct something she said earlier.

MS MORTON: Lise Morton, for the record.

Yes, sorry, I realized I was answering slightly the wrong question. We still have not had any fire is correct in any of our resin liners. The history date I gave is actually incorrect though. We have had resins in storage for decades. We repackaged many of them in 2006 and similarly saw no evidence and obviously have not had any fires.

So we have actually had a longer history than what I indicated. Sorry.

DR. EVANS: Dave Evans, for the record.

The use of gadolinium nitrate is for reactivity control in the reactors. We add it in very dilute concentrations to the moderator, typically about 25 parts per million nitrate and about 30 parts -- pardon me, 25 parts per million gadolinium, 30 parts per million nitrate.

The gadolinium pull typically

takes about two days. We use two columns. We could calculate the maximum theoretical loading on the resins. If we exhaust these resins in the nitrate form they are no higher than 5 weight per cent. We typically don't run them to exhaustion because of the way we configure the columns.

The 2 per cent figure would represent moderator resins as a separate stream. We have sampled for moderator resin tanks, so we haven't found levels in excess of that and we don't expect to see levels in excess of 2 per cent.

Blending with other resins would reduce that concentration further. So I would say highest local concentration one would encounter would be about 2 per cent.

THE CHAIRPERSON: May I ask what the level of confidence is that you have in your upper estimate of percentages in terms of the intensity of your sampling effort?

DR. EVANS: There are two elements here. One is the process knowledge. We have a finite amount of gadolinium nitrate we remove with these columns so we can calculate the actual loading on the resin from process

knowledge.

And then we can supplement that with the sampling. The sampling has been relatively sparse for resins that we can fully identify as moderator resins. But the calculations have a firm physical basis. In as much as we know, we had X amount of gadolinium in the moderator, it has been removed on the ion exchange resin, so we know where it is.

THE CHAIRPERSON: Thank you.

Dr. Muecke? You have no further questions?

Dr. Archibald?

Well, I think at this point we are finished with questions for the information you provided to us previous to the hearing and in your written submission, Dr. Greening.

And as I mentioned earlier, the Panel will be determining the additional information that we heard today, which -- any or all of that information will be accepted. And we will announce in due course, as soon as possible, how we will deal with that information and allow for further time for examining the information you have put forward.

So thank you very much.

And we will now be proceeding with the next 30-minute presentation.

While we are changing seats, I understand CNSC has a number of items you would like to bring to our attention?

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, Bruce Power 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 implementation by Bruce Power of their management system and engagement with international workshops on safety culture are all data points that suggest that Bruce Power is striving to improve their safety culture and that safety culture was not an issue with the Bruce alpha event.

There were questions as well in terms of workers not being notified or not appropriately dealt with. CNSC staff did a thorough review of all the events after it was reported.

It was brought to the Commission's attention on a number of locations and, in all cases, the communication between Bruce Power and their employees was always timely and it was one of the things that were noted as a good practice.

THE CHAIRPERSON: Thank you.

DR. THOMPSON: If you are okay, the item this morning was our use of international experience in terms of waste

characterization or waste inventory.

So international experience and data from five countries on homogeneous and heterogeneous waste streams, soot and reactor coolant, spent resins, concentrates, cartridge filters and dry active waste were used to develop and validate the recommended approaches in the ISO standard that we spoke about this morning.

The CNSC used that international experience in setting the standard as a requirement for OPG's project.

Additionally, CNSC staff attends and participates in international working groups on repository safety cases. From international experience, the deeper the facility is or is planned to be, the higher the safety margin will be and, in that case, the lesser are the requirements for detailed characterization of waste.

On that basis, the CNSC G-320 is in line with this and specifies the degree of characterization be commensurate with the level of risk and that this information is updated as we move forward in the project.

In Sweden, for example, the

facility is located 50 m below the seafloor and, in that case, since the depth doesn't provide as much of a safety margin, there is a requirement for the waste activity description to be approved by the regulator.

CNSC staff also looked at other international experience through a research contract we issued in 2013. From that contract we obtained information on how the ISO standard is being applied in other countries and this was the basis for staff's recommendation No. 2 to the Panel last year.

THE CHAIRPERSON: Thank you, Dr. Thompson.

So our next 30-minute oral presentation is from the International Institute of Concern for Public Health, which is PMD 14-P1.34 and 34A.

Ms Tilman, the floor is yours and you have 30 minutes.

PRESENTATION BY / PRÉSENTATION PAR:
INTERNATIONAL INSTITUTE OF CONCERN FOR PUBLIC HEALTH, ANNA TILMAN

MS TILMAN: Thank you very much and good afternoon to the Panel and OPG, CNSC and the public that are here. My name is Anna Tilman and I am presenting on behalf of the International Institute of Concern for Public Health.

The presentation that we are delivering is stressing a few factors, one is the inventory which I believe is one of the most critical parts of this whole project, because that determines what is being proposed to be buried -- it is critical -- the expansion plans for including decommissioning waste, which also affects the inventory; and WIPP, which is also a matter of an inventory situation, what was in the container to which there purportedly was an accident?

In terms of the inventory itself, in our 2013 submission last year to the JRP, one of the points that was stressed was the lack of completeness of the inventory that I could

determine on the basis of even what was stated in the documents. Key radionuclides were absent or somewhere, I don't know which ones. I'm part of the public, so I'm not sure what was missing or not.

So it was a letter from Dr. Greening on January 6, 2014 that revealed serious issues, underestimations and errors in the inventory related to pressure tube wastes and garter -- whatever they're called now, I forget the name, but I will come to it in a minute.

And subsequently to this, as a result of the statements by Dr. Greening, OPG did a revised interim inventory in response to the Information Request.

Now, in this revision some startling errors were found. Here is a highlight on this slide referring to tritium content, cesium, curium, which was completely missing, most active transuranic in the waste -- now I got it, and the garter springs, which were omitted and resulted in increased concentrations of nickel isotopes. Other nucleotides were also increased.

Now, here is a reference table I

put together based on the Appendix A in OPG's consolidated response indicating what the difference was for some of the isotopes in the waste compared to what their original inventory was and the ratio of this waste.

Now, I want to make a point here that is very critical from a public perspective. Dr. Greening is an expert in this field, he was able to detect these errors. In my own field, if such errors were made by my engineering students in an exam that I set, I would know the answers and if they made these kind of responses they would get a grade of "F". But how do we, the public who are not experts, know that errors were made? We don't know and we need to trust OPG to get this information correct, but we need to trust them, but I'm afraid that trust is not there. And if OPG can't get this present inventory correctly and as complete as possible, how can they get their projections correct for the future? So that is a huge concern.

Also, these are errors we are not sure if they are -- I'm not sure if the other elements of the radioactive inventory were also checked. What other errors have been made in the

inventory that have not been detected because nobody has had that expertise from outside to go and check this?

So these are some of the issues and we wonder how this transfers to other errors made in reports.

Now, specifically OPG has said that DGR was developed, the case was developed knowing the inventory was uncertain. In a newsletter -- a community newsletter from the Western Waste Management Facility, it stated OPG was aware that the waste inventory was an estimate and the DGR case was developed knowing the inventory was uncertain. These statements are not reassuring to the public.

In OPG's response, they also minimize the impact of the underestimations by saying, well, it doesn't reflect -- if you look at the total inventory these were particularly relatively small changes, but we again cannot trust that because we don't know what other errors are made. They are large enough to disturb any confidence that we may have had in this.

Now, specific issues in the

inventory beyond the numbers themselves.

Pressure tubes. The nuclear facilities at Pickering, Bruce and Darlington may be operating well beyond the end of life of the pressure tubes. Has OPG considered what the impact would be on the inventory, what the concentration of radio nucleotides might be? Would it be increased?

Neutron activation. I am not sure how well or what models are used and how appropriate they are to result in the concentration of activation products.

Then there is the matter of non-radioactive components in the waste streams. The list of these components is incomplete and OPG noted that their list was not intended to include all stable end products of all radionuclides, only elements that are important for overall chemical composition.

I question how OPG judges what chemicals are important, especially in the case of a DGR over a very long term.

Another issue that's come up is, besides the list being incomplete, is metals in the waste and that has been mentioned. Some of

these metals are pyrophoric, it could lead to fires and there have been zirconium fires in industrial settings, but there is no discussion as to concern to the containment of these wastes.

Nitrate salts has come up for discussion, but there is no mention of that in their reports as to any concerns that this might have. We'd only hear it now at the hearing.

Now, has OPG reviewed this component of the inventory, especially organic waste, especially after the WIPP radiation release incident? And this is a question to OPG.

Now, turning to expansion plans. OPG plans to double the capacity to accommodate decommissioning wastes as well as the typical wastes that were originally planned. They deem this to be feasible and will be seeking regulatory approval much, much later, not now.

There are some serious concerns about this. Do we even know if that size is appropriate? We don't know the inventory for decommissioning waste. It will be higher in activity than refurbishment, particularly operational waste, but we don't know. Will this proposed expansion be going on while waste is

being emplaced, which would be a very dangerous situation. We don't know, because this has been pushed to the future and that is rather disconcerting.

And then, does such an expansion open the door for potentially storing high-level waste spent fuel in this DGR? What other things might happen in the future that aren't on the table right now?

Just a note about decommissioning waste, because the activities of some of the key radionuclides are significantly greater it could lead to an increase of gas generation within the repository, but OPG seems to be confident that this increase would not significantly adversely impact -- contribute to adverse dose impacts from disruptive scenarios and they are always considered unlikely. Questioning, on what basis are they considered unlikely? Acts of terror are unpredictable, you can't reliably estimate their probabilities. So here we have no inventory, nothing presented, nothing can happen.

So I just conclude that OPG has this extraordinary crystal ball that the rest of us don't have that they can foresee in the future

without having any facts to depend on.

Now, because we don't have an inventory of decommissioning waste, any inventory that is presented here are projected for 2062 is incomplete. You can't just say we are going to add this and then have a projection to '62 that doesn't include the potential, even if it doesn't happen, of storing decommissioning waste.

One issue, too, as we move into the future, we have heard a lot of talk about waste acceptance criteria and how these change on a regular basis, they are reviewed and they are changed in a few years. Again, from the public perspective, I'm not sure what that can imply as to what is allowed to be in the waste in this DGR. It's a very vague statement to make that, yes, we do change these and in what way do the definitions of the type of waste change because they are not exactly clear either. Do you establish clearance levels more so, so you don't have to look after this waste? So these are problems here.

Now, I would like to now turn to WIPP. And we heard a lot about WIPP yesterday, of course, but because it was part of my

presentation I will go ahead and move with it.

This is just a slide giving the background to WIPP and I will go through slides that repeat some of the same messages, so we don't hear them twice or more.

The two incidents of concern, of course, are the salt truck fire, the underground fire and the radiological release event and, as we know, WIPP has been closed pending further investigation.

In terms of the underground fire, we know that soot was released into the underground and still lingers there. We know 86 workers were there when the fire occurred, were evacuated, but there was some confusion and some of the workers were transported to the Carlsbad Medical Center for treatment.

In terms of the radiological release event, there are elevated levels of americium and plutonium aboveground, a radioactive cloud plume was observed over a number of states shortly afterward. The wastes have spread through, over 900 m of underground tunnels and through the exhaust shaft, 600-metre exhaust shaft into the environment.

Now, information hasn't been exactly forthcoming to help us. I understand CNSC has made use of the WIPP website, as had most of us in the public, but there is a lot that isn't coming forward.

So this was a plume map done by the National Oceanic and Atmospheric Administration shortly after the radioactive release. The issue here -- and the other one I will also show you was the trajectory of the waste done also shortly after the release.

Now, what these slides demonstrate, the previous one here and this one, is the extent of the spread of radioactivity. Now, this is due potentially to one container and there are thousands of containers. It took just one container to be breached to create an issue of great public concern.

How would this situation translate at the DGR at the Bruce site if there was just one? What areas might be affected? How would Lake Huron be affected? How would terrestrial aquatic habitat be affected? How would workers immediately at the site and communities nearby and distant be affected and

for how long?

Now, OPG has responded to these incidents and we keep hearing about degraded safety cultures; whereas OPG has a deep-rooted safety culture. And we can argue about that.

OPG is also confident that their measures will prevent similar incidents and they also indicate their wastes are different characteristics, no design changes are required and the potential impact on worker and public safety were assessed to be below criteria. This is right out of their responses.

Now, here are comments concerning OPG's response. How does OPG safety culture, how is it superior to WIPP's? And I will say that there is no such thing as a fool-proof safety culture when we're dealing with this kind of material.

The other issue is the difference in wastes. Now, if you look at the inventories, which I have, I have looked at inventories at Los Alamos, at the Argonne Labs and Sweden as well, just comparing. Quantities may differ, but the waste at -- OPG's waste does include transuranic, includes organic/inorganic material, so the

nature of the material may be similar, the concentrations could be different.

Sorry. In terms of no effects on workers, I have not come across any data that is specific to workers or to public health. There has been released data from the Carlsbad Center, but no independent testing has been carried out on the workers. You cannot conclude that these events have had or will not have any effect on human health in the future.

What we do have available, the knowledge we do have is the number of workers that have been contaminated, but internal contamination with alphas. DOE has concluded there is no adverse health consequences. Their conclusion is not warranted. You don't know, we have to realize that the dangers of internal contamination, the latency period for the development of diseases, especially cancer. These workers need to be independently assessed and tracked over a long time. You cannot dismiss this within the short period.

Another issue is, there is work going on right now in maintenance and repair, entering areas where radioactive releases

occurred. These containers, some of them are labelled "contact handled", which means you can actually touch them as opposed to remote handled.

What efforts are being made to track the health of these workers over time? And this is a question because I simply don't know. I haven't been able to find out what tracking will be done.

Another issue is the monitoring data that is now available and now it has gone down in the areas near and away from the site, but does not translate to that these releases are not having an impact on health. The radiation may have been dispersed, but the radiation has not disappeared, not in the months involved.

And one of the issues in terms of the worker health, detectable amounts of radioactivity are released when the filters, contaminated filters are changed. The workers do need to wear protective equipment. So this is dangerous work and as yet the level of radioactive contamination in the underground tunnels through which the release has travelled is not known, at least I'm not aware of it. And

again, I am a public person in this, there is only so much information one gets from a public perspective.

Now, the local communities concerned, if you follow some of the meetings that are going on there, the lack of transparency and accountability, uncertainty as to the cause of the explosion; are other containers at risk of being breached and the risk of short and long-term to the public and workers.

There are other issues that haven't been clarified and still need to be worked on and that is the suspect barrels from the Los Alamos National Labs.

What is the level of radioactivity in that panel room where the breached container, if it's -- maybe there's more than one located. And very importantly, what is the future of WIPP? Will it be decontaminated? Is it possible? Do we know how to decontaminate this? Does anybody know? Will it reopen? Will it shut down or how?

This is a huge mess in the U.S., but it translates to an important mess that we should all be avoiding.

Everybody likes to talk about lessons learned, so I thought I better say it too. Human error, mechanical failure are not only possible, they are inevitable no matter what precautions you take. You cannot create a safety case that will consider or prevent all accidents. Unintended, unpredictable accidents can occur and have occurred in DGRs and we know WIPP, Asse II and Morsleben.

In fact, I was looking through the risk assessments that were done on WIPP before it opened up and I cannot find any indication of an analysis of an accident such as the one that occurred, even though we don't know. Any further probabilities that they estimated for fires and so on were in the order of 1:200,000 frequency. So it shows you, we do not know how to account for all possible accidents and we may not necessarily be able to assess them.

Now, a study example that I pulled out of VOCs in WIPP's waste concluded they do not represent a credible threat of explosion, but the explosion or, as they like to call it, the breach has occurred and it might have been due to VOCs. That's not known.

Okay. In terms of conclusions, I think it's really important to state even if you have the most complete and accurate inventory, which is an absolutely essential thing, these inventories alone cannot determine the long-term safety of the repository. There are too many unknowns, unpredictable factors can influence the safety of repository in the short and long term. Nevertheless, this does not excuse the uncertainties, underestimations, omissions and errors in OPG's waste inventory.

Another issue dealing with inventory is the contents in each container, a factor which might not have been appreciated at WIPP. We have heard of waste characterization, we heard what -- different containers for different kinds of waste, but how sure are we with all these categories that something hasn't been missed or overlooked?

Okay. WIPP is not functional, it may not be for quite some time and it clearly has demonstrated the DGR technology as we presently know it is not safe.

OPG has no sound scientific basis for claiming that its DGR can be safely isolating

these wastes for the hundreds of thousands of years. There is as yet no technology for containing radioactive waste that is scientifically proven to be safe.

And I will say that the plan to double the size of the DGR is unwarranted level of entitlement and arrogance on the part of OPG. We are concerned what that might lead to.

And, in conclusion, our recommendations are that the JRP reject OPG's proposed project. We further urge that JRP recommend that further research and study be conducted to develop the safest possible means of isolating these wastes and to ensure that there is public transparency and consultation in this process.

In the interim, the best that can be done is to store this waste aboveground so that it can be inspected, monitored and retrieved in case repairs are needed.

Thank you very much.

--- Applause

THE CHAIRPERSON: Thank you, Ms Tilman.

Panel Members, did you have any

questions?

Yes, Dr. Muecke...?

MEMBER MUECKE: Could we go back to the two diagrams you had of maps showing the WIPP plume. I guess I'm addressing this to Ms Tilman, as well as CNSC and OPG.

Are these -- particularly the first one showing the plume, is this map based on actual aerial measurements or is this a hypothetical map which has been derived from having a point source emitting and then using atmospheric conditions to predict a plume?

MS TILMAN: As I got the map from NOA I am not 100 percent sure and I don't want to commit to saying that they measured or how they developed it. So I can't honestly answer on what premise. If it was a model, I could conjecture that it could have been a modelled situation based on the amount that was found to be released. That's all I can say about that.

MEMBER MUECKE: OPG?

MS SWAMI: Laurie Swami, for the record.

I understand Dr. Gierszewski would like to respond to this.

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

So I'm not certain, but my understanding from trying to find the origin of this on the Internet is that this isn't actually a calculation by NOA, it's a calculation done using their model, but that's my understanding, I don't have evidence of that.

MEMBER MUECKE: So it is based on a concentration from a source point and then using a dispersion model to get the concentrations that are shown?

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

Since I don't actually -- haven't seen it, I can't actually assert that with any confidence, but that was my impression that that is what happened here.

MEMBER MUECKE: Yes.

THE CHAIRPERSON: Dr. Muecke, may I interject because I have a follow-up question to this figure as well, unless you have -- since it's already up on the screen. Would you mind?

MEMBER MUECKE: No. I just would like to hear CNSC.

THE CHAIRPERSON: Oh, yes. Certainly the methods by which this figure was produced are of interest, but I also wanted the CNSC in particular to comment, if you squint really hard and look at the concentrations which are in the minus many, 15, 16, 18.

For the benefit of the people in the room who are seeing this, with very obvious colours, putting those concentrations into perspective with respect to background, for example, because the Panel would be interested in having some perspective on this.

DR. THOMPSON: Patsy Thompson, for the record.

I was going to say unfortunately you are better at squinting than we are. I can't see the numbers. So if you give us a few minutes we will try to find a website, read the numbers, we can put things in perspective.

THE CHAIRPERSON: The Panel would appreciate that; thank you.

MS TILMAN: May I say something on that?

THE CHAIRPERSON: Yes, of course, Ms Tilman.

MS TILMAN: It's just very difficult to try to capture this and get the numbers right, but you are quite right, they go to 10 to the minus 13 at the high, 10 to the minus 14, minus 15, minus 16, okay, in mass per metre cubed. So if that helps the squinting, which is including my own as well, it was difficult to get this.

And if I can say something in defence of having this, in terms of the public information out on what's happening, there has been so little in terms of being able to get information on this for understanding the effects, the dispersion and so on, so you end up trying to find out something that helps visually explain what might be there.

And the intention of using the slide is to indicate a dispersion of radioactivity. The levels are below what is traditionally background levels. I will say this uncategorically -- you know, categorically that's the case.

Then, one goes further into the reasoning, that doesn't mean that they are necessarily safe, they add to already existing

levels. This is one container out of, what, 7-8,000 containers, and so one has to look at it from what does it represent, and to me what it represents is the dispersion from one container that can be quite extensive.

If there were more containers, if there was a bigger explosion, what could we expect?

But I don't think there has been any proper explanations or studies enough out of DOE in the U.S. to help people understand what is happening so far.

THE CHAIRPERSON: Dr. Muecke...?

MEMBER MUECKE: Yes. Just in terms of this puzzle, the second slide may provide a hint as to how it's derived, because if you look at the points along that graph they are evenly spaced, which it would be rather curious if they were measurements, yes.

Now, coming back to Ms Tilman's concerns, there is one which I would like to raise with OPG, and that is, how will the proposed extension of the Pickering and Darlington operations beyond the 10,000 hours before pressure tubes are replaced affect the

waste inventory and has this been factored into the short-term worker safety considerations and the long-term safety case?

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

So the waste inventory which would drive these is based on a projection and the projection in 2010 was for the assumed end of life at that time. If it is changed in future, then it would be updated as part of any update of the system plans.

And it has changed in the sense that at the time of 2010, for example, the reference inventory was based on assuming Pickering B would be refurbished. That's not the case, so now if I were to redo the calculations I would take out the Pickering B retube inventory because it's no longer in the plans.

So to the extent that these are projections, until we have actually got to the end of life there will always be that final factor to include.

But just putting some kind of scale on it, I'm not sure what the life extension is on them, but if you are on the order of 20

years and you extend them for another two years, that's a 10 percent increase in inventory in that waste stream and then the associated level waste with it.

MS TILMAN: Can I respond? Sorry. Or am I out of order?

THE CHAIRPERSON: Ms Tilman, if it adds to the information that the Panel has, but I am not interested in engaging in debates. So if you could add some clarity, but not an opinion, please, just some clarity.

MS TILMAN: The issue is that Pickering, a few of its units are known to be granted a licence to operate another 35,000, you know, hours or EP, whatever the initials are, and Bruce now units -- two of the units will be allowed to operate beyond their end of life, so from 210 to 245 and also Darlington.

So I would ask that these are factors because this is dealing with pressure tubes. I'm not sure. I don't know what factors this would have on affecting the inventory or increasing that level of intermediate level waste in the inventory and I would suggest that OPG do a projection on that.

THE CHAIRPERSON: If I may, Ms Tilman, I would suggest that we are covering the expansion plans at a later day in our schedule where OPG did formally incorporate a re-analysis as per our Information Request of the cumulative effects of an earlier than planned placement of decommissioning waste.

They explain it quite a bit of detail how they did that and they explain the rationale for their results.

So I would suggest to you that if you would like to come back with more questions, review that, and perhaps it will either allay or add to your questions.

Ms Swami...?

MS SWAMI: Laurie Swami, for the record.

Perhaps I could just add a little bit. I think Dr. Gierszewski did discuss this, but there are changes over time in the operating strategies within the plants and beyond the expansion that we are going to be talking about later which is not part of this licence application.

We do know now that Pickering

will operate until the end of 2020. We understand that Bruce -- that decisions have been made sort of more recently and so, obviously, as we get new information we have to go back and reconsider what the inventory would be and that was what Dr. Gierszewski was referring to.

So Ms Tilman does raise a valid concern and it is something that would be factored in and had already been considered as we go forward through the waste inventory process.

THE CHAIRPERSON: Thank you very much, that was helpful.

Dr. Muecke, are you finished?

Dr. Archibald...?

MEMBER ARCHIBALD: Thank you very much.

Ms Tilman, in terms of waste inventory characterization you have noted that underestimations convey a degree of carelessness and the question was posed by your organization that OPG does not indicate whether it has reviewed the concentrations of these radionuclides in waste streams other than pressure tubes.

So to OPG I would ask: Have

concentrations of similar elements been evaluated in other inventory sources that may exist? Are other source streams considered to be significant?

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

So the nature of the -- as I said earlier, these were estimates of the surface base radionuclides on pressure tubes and the particular nature of those estimates we have considered whether they would apply to other cases, but they are specific to pressure tubes.

MEMBER ARCHIBALD: I have a question concerning your slide that dealt with impact on worker health -- I forgot the slide number, I couldn't read it there, but this is to CNSC and OPG -- and describing the need to have workers decontaminate at the WIPP site. This is a follow-up on the WIPP occurrence.

Would worker exposure and permissible limits for occupational activity in the WIPP remediation process be any different than for regular nuclear workers such as uranium miners?

Would the activity posed by Ms

Tilman for cleanup at the WIPP site pose any activity worker health hazard?

MS SWAMI: Laurie Swami, for the record.

We would apply the normal radiation protection program principles to any activities where there was a potential exposure of a worker. We have, as we described yesterday, a number of elements of our radiation protection program where we monitor workers, we would offer them protection, of course, which we would expect them to use and they would use. There could be, for instance, breathing protection, there are many different aspects of our program. It could involve shielding, it depends on what the activity would be, but we would certainly implement the normal process, we would protect workers from exposures, we would monitor what their exposure would be, all of the exposures that an employee would receive would be reported through the normal processes where it is tracked by the regulatory agencies.

So there is a fairly fulsome program on radiation protection that would apply regardless of what that activity might include.

MEMBER ARCHIBALD: And to CNSC, is this your understanding also based upon your experience with supervising uranium mine activity?

DR. THOMPSON: Patsy Thompson, for the record.

I would suggest that comparing the activities of going back into the WIPP following a contamination incident is probably not directly comparable to work in a uranium mine where the hazards are known, the protective measures are in place and routinely the workers are trained, they have been tested, validated, inspected and the hazards are assessed on an ongoing basis but are fairly narrow in nature.

One of the things that we noticed when we looked at the investigation reports, the information available to date is that there were several deficiencies in the radiation protection program at the WIPP, including the measures that were taken to handle the workers following the event.

I will ask Ms Christina Dodkin to speak to the CNSC requirements for dealing with issues like the WIPP where workers are, you know,

the work needs to be planned to deal with a situation that's basically unknown from the start.

MS DODKIN: Christina Dodkin, for the record, Radiation Protection Specialist.

In line with what Dr. Thompson has mentioned, in a uranium mine and looking at the WIPP event the hazards are unique and the expectation would be that, say, if an event such as the WIPP occurred the radiation protection program would come into play to ensure that the workers are protected and a key part of that would be in the work planning before actually executing decontamination activities so that doses and hazards are adequately managed to ensure that workers are safe, the appropriate protective equipment is being used and, above all, the workers are trained and qualified to do the work.

MEMBER ARCHIBALD: Thank you.

And just one last point. This is all based upon your written submission. In your description of the waste container breaching event at WIPP -- and again, this was based a lot on what we heard yesterday in the presentations,

too, the terms "container breached", "drum of waste overheated and burst", "an explosion of one container of waste occurred", and then on your slide 22 you had stated that "an explosion has occurred" also.

My question to OPG is: Is there any evidence that an explosion did, in fact, occur or that breaching event was caused by heat-related defects within the waste container or some other potential process?

But was an explosion, in fact, the cause of this accident, to the best of your knowledge?

MS SWAMI: Laurie Swami, for the record.

I guess my answer is not going to be complete then. To the best of my knowledge, we don't have the final root cause of what caused the actual release underground at this point in time. I know there has been some speculation around what that might be, but that's why we are interested in seeing Phase 2 of the report which will provide that level of detail to us.

MEMBER ARCHIBALD: Thank you very much.

THE CHAIRPERSON: Further to that, I also had a question about the specific wording that was chosen in your written submission and also in your oral presentation, Ms Tilman.

Are you privy to information that the Panel has not yet received regarding the root cause?

MS TILMAN: No, I am not privy to it, but perhaps in my English translations of the -- just I have seen pictures the same as anybody else would have seen. I don't see anything more than is available.

The breaching, I have heard those expressions myself, there is a breaching. There seems to be a reluctance to use the word "explosion", because it's explosive in itself. So I have used the word and it may not -- it doesn't mean that I know that is exactly what happened, because we don't know exactly what caused this breach of the container. If it were an internal explosion, I cannot verify obviously. I wouldn't know any more than anyone else here would.

So I apologize if that created

any confusion. I guess it's my English translation myself that put the breach, okay.

THE CHAIRPERSON: Thank you for that clarification, Ms Tilman.

I do have some questions for you. You focus very much on the seriousness with which you take the criticisms of the original waste inventory and the need to update the waste inventory, but you didn't explicitly comment on OPG's reassessment using the revised waste inventory and their assertion that the safety case there did not materially change due to the incorporation of the revised waste inventory, and they explained this because of the levels of the conservatism already in the analysis; so, in other words, it was founded.

Would you concur and, if not, why not?

MS TILMAN: I can't concur completely because I don't know what the conservatism was. I don't know. And that was part of my point, I don't know if -- I cannot re-evaluate their inventory, I don't have that ability. I don't know if anybody else, an independent person has gone in to look at that

inventory to see if there are any problems. I can't tell.

The point is, one part of the inventory, and some of that would be the higher-level waste, was affected by certain emissions. So I do not know. And that's the point I was trying to make. Maybe I didn't make it as clearly as that, I can't tell, but I understand from the questions that I don't think these other inventory issues were re-evaluated or looked at to see if there were.

They have said there is that safety, they are sure it's a small percentage. When I looked at the tables a small percentage with these corrections of the total waste, but the point was there were still errors, are there other errors that could be significant that have gone unnoticed? That is the point, I don't know.

THE CHAIRPERSON: Thank you, Ms Tilman.

I believe the Panel would appreciate a clarification for the record today regarding how the revised waste inventory was indeed incorporated as per our Information Request into re-calculations for post- and pre-

closure, because the Panel remains concerned that there seems to be a fundamental lack of understanding of the answer to the question, so what, in terms of the differences between the original and the revised waste inventory.

--- Pause

THE CHAIRPERSON: And while you're conferring, I would strongly encourage you to be as clear as possible in your answer so that the people in the room that are not modellers can understand what you're talking about.

--- Pause

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

So the information request asked us to consider the effects of revised inventory following on questions that had been raised by an intervenor. And there were some specific requests in that as to what we should use for the revised inventory.

We redid all of the post-closure assessment level calculations with that increased inventory. We also increased -- redid the relevant operational safety with those.

The results was that the

differences were either very small or certainly, in all cases, the results were well below criteria with those revisions.

The larger point is that -- and the reason why that is true is because these are generally -- the consequences are generally dominated by a small number of radionuclides that are important for operational safety or are important for post-closure safety, and those nuclides we -- we've always tried to get as accurate as we can, and those aren't affected by any of the uncertainties that we've been discussing in the course of today.

THE CHAIRPERSON: Thank you.

As a follow-up to OPG, in your communications recently with the public, have you attempted to translate that information into common plain language such that the information you've just communicated to the Panel is more readily understood?

MS SWAMI: Laurie Swami, for the record.

Mr. Powers will come forward and discuss the public communication that's been done on this particular issue.

MR. POWERS: Kevin Powers, for the record.

As you noted, it is a difficult subject to simplify. We have done what we can in order to make our point understood. We have done that through our web site postings with Qs and As, through our Neighbours newsletters and through, recently, a number of interviews with the media to help create a more general understanding of the -- of our case for this.

THE CHAIRPERSON: Thank you.

Ms Tilman, is it your position that, to be safe, in your terms, radionuclide releases, no matter how small, must never happen from a DGR?

MS TILMAN: Yes.

THE CHAIRPERSON: If so, then how do you view existing surface storage facilities?

MS TILMAN: Concern arises over any method where you're storing dangerous materials, be it radioactive, be it hazardous compounds. It's always a problem.

The difference when they're stored above surface is they can be easily -- much more readily repaired, monitored and

checked. They're not left alone if there is a problem and we've heard that there's been repackaging done, maybe, you know, for safety's sake and so on.

So efforts are being made, or easier made than if they were underground and not being able to be reached or so.

Because we are -- have nuclear power plants, we have -- and so on, and a nuclear industry, we have these radiations, that doesn't mean I like them or want them or -- no, that's not the question you want.

But if you look at it in terms of safe, it would be safer to leave things on surface storage. It may not be in the best surface right now, but on -- where -- on top where we can maintain them until if we find a technology that may work in the long term to safely encapsulate, incorporate this waste.

I'm not saying what that technology is. I'm saying we're not there yet in our technology to find it, but we need the time.

In the meantime, are we better off, as a society or if -- for this area, for this neighbourhood, to maintain above storage

waste till we find a better solution?

Like I said, we may have to be not on a flood plane, whatever, as it currently is.

We are getting -- there are releases inevitably, with any of these activities, but we can repair easier, access easier because we're not there yet in putting this away. And this is what -- one of the demonstrations of WIPP.

We can't just pretend that we have that solution. We don't have it.

And so to be safe and avoid any dangers of a breach, an explosion or something that is uncontrollable that we don't know what to do with that we can't solve, if that same kind of container were breached or exploded and if it were above surface, would that have been easier to track, maintain?

It's not healthy, it's not good, but would that have been easier to contain? And I would contend most likely, yes.

THE CHAIRPERSON: Thank you, Ms Tilman.

I have a question to OPG, and

this arises out of Ms Tilman's written submission on page 6 where Ms Tilman states that, apparently, retubing Pickering A, the refurbishment waste from that, according to Ms Tilman, at least, is not intended to be shipped to the DGR?

Could you confirm, or not, that statement?

MS SWAMI: Laurie Swami, for the record.

That material is currently stored at the Pickering site and it's planned to be stored there until the plant is actually into decommissioning, and so we consider that part of our decommissioning waste stream.

THE CHAIRPERSON: Thank you. That clarified that.

Back to Ms Tilman. On page 9 of your written submission, you state:

> "To not even acknowledge that unforeseen accidents can happen and not even consider them in their safety analysis is tantamount to ignoring the simple fact that human error

is unavoidable."

The Panel would appreciate some clarification here, Ms Tilman, because we are puzzled that you're not aware of the accidents, malfunctions and malevolent act analyses in the EIS and in response to IR 13-514 where OPG explicitly analyzes the consequences of the changes in the inventory under accidents, malfunctions and malevolent acts scenarios.

MS TILMAN: In the presentation from the year ago -- from a year ago, I did a chapter on that, on that particular issue. So I wasn't going to -- I was trying to focus this one specifically.

But I think I was working into the waste -- into the accidents, for example, at WIPP, where accidents can happen that are unforeseeable.

I've said this before in my previous submission in 2013, we cannot predict -- they did, for example, did the accident, was that accident, whatever it was, we don't know yet. The cause, was that a predicted cause? We don't -- I don't know.

Can we always -- can we predict

any possible, all possible ways in which there could be human error?

It's a general statement I'm making, and --

THE CHAIRPERSON: Would you clarify the context, though, on page 9 because it's not under your heading of WIPP?

You're actually referring to OPG|

MS TILMAN: Yes, it's OPG's. Right.

The DGR safety case was developed knowing the inventory was uncertain. That was in the previous paragraph.

THE CHAIRPERSON: Yes. And on to my quote of --

MS TILMAN: And that followed that.

The role of uncertainty in the waste inventory and the presence of organic matter mixed with trans-uranics may have played. This is -- this is critical in the radioactive release at WIPP, so I refer to WIPP in terms of an inventory.

That's the paragraph above the quote that you had read.

So in that sense, I was linking that potential to say that's unforeseeable. That is an unforeseeable event.

So there's a linkage between WIPP there.

THE CHAIRPERSON: Thank you for those clarifications, Ms Tilman.

MS TILMAN: Sorry, but --

THE CHAIRPERSON: It can be somewhat difficult for the Panel always to follow the reasoning, so you've helped very much.

MS TILMAN: Likewise, it's difficult sometimes for us to follow.

THE CHAIRPERSON: That would be the end of the Panel questions for Ms Tilman, unless my colleagues have any follow-up.

Therefore, we will be proceeding with the -- no, we will be proceeding with a break, is what we'll be proceeding with.

Fifteen (15) minutes, approximately 20 minutes to 4:00.

--- Upon recessing at 3:23 p.m. /
Suspension à 15 h 23
--- Upon resuming at 3:40 p.m. /

Reprise à 15 h 40

THE CHAIRPERSON: Welcome back from the break, everyone.

If everyone could please take their seats.

Our final 30-minute oral presentation today is from Stop the Great Lakes Nuclear Dump, which is PMD 14-P1.43 and 43A.

Ms Fernandez, the floor is yours.

PRESENTATION BY / PRÉSENTATION PAR:
STOP THE GREAT LAKES NUCLEAR DUMP,
BEVERLY FERNANDEZ

MS FERNANDEZ: Good afternoon, Members of the Joint Review Panel. My name is Beverly Fernandez, and I am the spokesperson for Stop the Great Lakes Nuclear Dump.

Thank you for granting our group the opportunity to address the Panel on this matter of national and international importance.

My comments today are directed not just to Members of the Panel, but, importantly, to members of the public and the

media.

Today, I stand before you not as the voice of one person, but with the voices and support of almost 70,000 concerned citizens who have signed Stop the Great Lakes Nuclear Dump petition, more than every man, woman and child living in Bruce County.

When our organization appeared before this Panel in September 2013, we indicated then, and we maintain today, that Ontario Power Generation's selection of the proposed DGR site one kilometre from the shore of Lake Huron is ill-conceived, non-compliant and controversial.

During the course of the 2013 public hearings, it became obvious that OPG did not consider any other sites, even though it was required to do so under the EIS guidelines.

During the course of the 2013 public hearings and thereafter, many people and organizations questioned why OPG had not, as part of its due diligence, investigated a site in the Canadian Shield.

OPG told the Panel they did not consider an alternate site in the Canadian Shield, or anywhere, because OPG already had a

willing host with the community of Kincardine.

We said it during the 2013 public hearings, and we will say it again today. This is not good enough. One does not select a site to bury lethal radioactive nuclear waste because a town who is being paid large sums of money by the proponent says okay.

At the conclusion of the 23(sic) public hearings, this Panel asked OPG to provide information about a hypothetical site in the Canadian Shield. The key word here is "hypothetical".

What was obvious then and remains obvious today is that OPG did not and cannot present an analysis or any site characterization work for an actual alternate site whether in the Canadian Shield or anywhere. The best they can do is provide modeled information about a hypothetical site.

This is not good enough.

Let's be clear. The information provided by OPG about a hypothetical site in the Canadian Shield does not allow OPG to achieve compliance with the EIS guidelines.

OPG's site selection is clearly

and fatally deficient, and this deficiency can never be remedied by assembling and submitting information about a hypothetical site.

I will now continue -- now outline some of the significant concerns with the relative risk analysis report.

In information request EIS 12.513, the Panel states:

> "Analysis of risks to socio-economic factors is not required because the conceptual DGR in granite is not located in a specific geographic location."

This statement is very problematic. If OPG had identified an actual granite site, OPG would have been able to conduct an analysis of risks to socioeconomic factors for such actual site.

Why did this Panel excuse OPG from having to produce this critical piece of analysis?

OPG's failure to provide an analysis of socioeconomic factors for an actual granite DGR site is evidence of another fatal

deficiency in OPG's work and in the case before you.

The most glaring deficiency in the relative risk analysis report has to do with the assumed location of the hypothetical granite DGR site. Let me explain.

This Panel has heard from many citizens, environmental organizations and elected officials who are very concerned that the proximity of the proposed DGR to Lake Huron, one of our Great Lakes, creates a risk of contamination to these precious waters should the DGR fail in any respect to perform as expected.

Think about this for a moment. If one had a choice between two options, a DGR situated right beside a Great Lake or a DGR situated far from people and far from large bodies of water, it is common sense that a DGR situated far from people and far from large bodies of water would be considered less risky and, hence, more optimal.

Notwithstanding how many reports from paid consultants are filed, no one can escape the very basic common sense conclusion of not burying and abandoning radioactive nuclear

waste beside North America's largest supply of fresh water.

We know that some of the waste OPG plans to bury in the DGR remains radioactive for over 100,000 years. Locating a DGR in the Great Lakes basin exposes the Great Lakes to risk of radioactive contamination for 100,000 years.

A significant concern with the IEG report is that it assumes the granite DGR would be located right beside a Great Lake. This assumption is the foundation upon which the relative risk analysis report has been built.

We all know what happens if you build a home on a faulty foundation, the home or, in this case, the relative risk analysis report, collapses.

The Canadian Shield covers a vast area in east and central Canada, and stretches north from the Great Lakes to the Arctic Ocean, covering over half of Canada, and also extends south into the northern reaches of the United States.

OPG and the IEG know this. By assuming the granite DGR site and the Bruce DGR site would be located a similar distance to a

Great Lake, both would, therefore, be equally risky in terms of their potential to contaminate the Great Lakes.

This is a convenient outcome if one's goal is to provide evidence that would support a decision to locate the DGR right beside Lake Huron.

The written submission from the Saugeen Objiway Nation describes it perfectly:

> "By mischaracterizing or misconstruing the information request, the IEG creates a paper tiger, a granite repository with the same key failings as the DGR project."

Nothing prevented the IEG from assuming that the hypothetical granite DGR site in the Canadian Shield would be located outside of the Great Lakes basin.

If a granite DGR was located somewhere in a remote area of the Canadian Shield outside of the Great Lakes basin, this would eliminate the risk of contamination of the Great Lakes in the event of a DGR leakage.

OPG, the IEG and the CNSC knew or

should have known this.

So why, then, did the IEG choose this more risky and less optimal location? Did the Panel instruct the IEG to do so or did OPG and the IEG simply decide this on their own?

If OPG's goal was to provide evidence that would support its decision to locate the DGR right beside Lake Huron, then it is understandable why they would want to assume the granite DGR would likewise be sited right beside a Great Lake. By assuming so, the Bruce DGR option wouldn't look so bad.

The fact of the matter is that the Panel's direction did not say that the granite DGR site should have "similar hydrological disposition to the real Bruce site".

These are the IEG's words, not the JRP's words.

We assert that the IEG incorrectly interpreted the JRP's direction, and we are not alone in our thinking.

Our thinking agrees with statements contained in the written submission of the Saugeen Ojibway Nation when they state:

"The IEG either misunderstood

> the meaning of the request and clarification or chose to interpret the direction as requiring the consideration of a granite-based DGR that had the same water surface conditions as the DGR at the Bruce site, including proximity to a large body of water or Great Lake."

We also fully agree with SON statement:

> "Siting the granite DGR near a Great Lake is not a reasonable or defensible assumption."

Although it was the responsibility of OPG and the IEG to seek clarification on the intent of the JRP direction, OPG and the IEG chose not to do so. The IEG based their entire report on an assumption which is neither reasonable nor defensible, and by misconstruing the JRP's direction, conveniently avoids the questions asked.

As a result, the IEG report is

not objective, nor is it responsive to the JRP direction, and should be dismissed.

Again, we are in full agreement with SON's submission where they state:

> "The pre-Cambian Canadian Shield is a very large formation, certainly with many locations suitable for the placement of a repository that are geographically remote from large bodies of water, agricultural lands or large population centres. Given the broad public concern with locating the DGR project adjacent to a Great Lake, which the IEG itself notes it is unjustifiable to assume a granite DGR would be similarly located."

Given the large outcry of concern and opposition of a DGR right beside the Great Lakes, it is unclear why the JRP did not direct OPG to provide information about a hypothetical granite site located far from people and far from

large bodies of water outside of the Great Lakes basin.

It is also very disturbing that the CNSC failed to provide any comments on the lack of appropriateness of this fundamental assumption underpinning the IEG report.

I will now discuss the comparative analysis of community acceptance of each of the DGR options.

As you know, the Panel had requested that the relative risk analysis include a review of community acceptance in the local and regional study area as well as outside the regional study area.

I want to emphasize the words "outside the regional study area" because this area includes communities not situated in Bruce County, including, for example, communities in Ontario and elsewhere in Canada and the U.S. in the Great Lakes region.

When faced with this requirement, OPG informed the Panel that insufficient information was available for the IEG to properly perform a distinguishing risk assessment of community acceptance of the four options.

As a result, OPG asked the JRP to clarify what would be an acceptable response to this requirement.

The Panel clarified by asking for a comparison of risk perception for the four options. The Panel noted it did not expect the expert group to include social and ethical trade-offs in its analysis.

The Panel also clarified that the requirement that the analysis be defensible and repeatable, should not be interpreted as a requirement for evidence-based analysis. The Panel's intent was that the analysis be transparent.

This Panel confirmed the importance of comparing the relative degree of community acceptance of the Bruce DGR option versus the granite DGR option when it originally included this as a requirement in information request EIS-12-513. Surely if unimportant, the community acceptance element would not have been requested in the first place.

Let's be clear, the fact that OPG and the IEG purportedly don't have sufficient information to perform the community acceptance

analysis does not diminish or eliminate the critical importance of this information.

The Panel required this information to be provided so that it could determine OPG's compliance with Section 7.3 of the EIS guidelines, but OPG and the IEG have failed to provide it.

We are very concerned with the JRP's direction that the relative risk analysis of community acceptance need not be evidence based. We assert that evidence-based analysis is fundamentally required to produce defensible, transparent and repeatable study results, and any tribunal, howsoever constituted, makes decisions based on evidence.

So let's look at the actual evidence that OPG and the IEG have either ignored or failed to identify and consider.

OPG's evidence presented during these proceedings very clearly demonstrates that OPG did not gather evidence from citizens living outside of Bruce County concerning their acceptance of a DGR in the proposed Kincardine site location or any other location, including potential locations in the granite of the

Canadian Shield.

This represents an extremely large gaping hole in OPG's information base concerning the issue of community acceptance.

Claims by OPG or the IEG that there is insufficient information directly relevant to the issue of community acceptance for the various options, at best, lacks substance.

It is very clear that information is readily acceptable -- readily available that does provide an indication of community acceptance or non-acceptance outside of the regional study area for both DGR options.

We would ask the Panel to view the image that I would like to have put up on the overhead screen, please. As they say, a picture is worth 1,000 words.

This image depicts current formal resolutions that have been duly resolved, voted on and passed by communities in Canada and the U.S., all around the Great Lakes, in opposition to the proposed DGR.

The total population of these communities is almost 11 million people.

This resolution map, together

with a list of all resolutions passed, has been regularly updated and publicly posted on the Stop the Great Lakes Nuclear Dump web site for all to see, including OPG and the IEG, for over one year.

This information was available during the preparation of the IEG report.

The almost 70,000 signatures and over 23,000 comments found on our public petition are readily accessible for all to see, including by OPG and the IEG.

Again, this petition information was available during the preparation of the IEG report.

Anyone can see that all claims by OPG and the IEG that information concerning community acceptance of the Bruce DGR option and the granite DGR option was not available are false, and must be rejected out of hand.

The IEG's failure to comment on the petition signed by 70,000 people and the 125 resolutions passed by concerned cities and communities is a blatant material omission in the IEG report. In addition, it was also missed a second time, and was not addressed in the CNSC's

review of the IEG report.

There are many other concerns with the IEG report that were covered in our written submission. However, our limited time today does not allow us to cover all of them now.

I would like to turn to the issue of WIPP.

WIPP is the only operating DGR in the world, although it is currently closed and under investigation.

WIPP was constructed as a pilot plant, meaning it was a test facility. The goal of the test was to determine that nuclear waste could be safely buried and contained in a DGR for not less than 10,000 years.

Well, we all know how that went. WIPP leaked, is contaminated, 22 workers suffered radiation contamination, and radioactivity was released into the environment, all of which were never supposed to happen.

As this Panel is aware, WIPP featured prominently in the OPG's safety case a shining example of a successful DGR with a solid track record.

Today, OPG is downplaying the

significance of the failure of WIPP because the optics of this failed DGR are problematic for OPG.

OPG has assured this Panel that its measures and processes will prevent or mitigate a similar event from happening at the DGR. OPG's message is basically, "We are smarter than the folks at WIPP. Don't worry; be happy. We have it all figured out".

When this Panel visited WIPP in 2012, you heard presentations from expert Dr. Abraham Van Luik.

Dr. Van Luik's presentation included steadfast assurances that human intrusion is the only credible disturbance scenario that can lead to nuclear waste being brought into the acceptable environment.

So much for Dr. Van Luik's assurances. On February 14, 2012, radiological contaminants were brought into the accessible environment not as a result of human intrusion and not due to seismic or volcanic event but due to reasons yet to be explained. Fifteen years into its operation Dr. Van Luik’s expert opinions have been turned upside down.

Members of the panel, your lives would have changed forever if you had been in the tunnels when the explosion and radiation release at WIPP occurred. In an instant, you would have been exposed to high levels of radiation, and all the expert assurances in the world that this could never happen would be meaningless.

OPG is purporting they have a fully proven concept that will safely contain its toxic nuclear waste for 100,000 years. Let's be clear, the Kincardine DGR is a trial run. It is an experiment. OPG and the CNSC remain confident that this experimental DGR will succeed despite the international experience of failed DGRs at Asse II, Morslebin and now WIPP. We cannot afford the Kincardine DGR to be added to the list of failed DGRs when the Great Lakes and the lives of 40 million people who drink their fresh waters are involved.

We know today with certainty that no geologists, scientists or multibillion dollar corporation can provide a guarantee that the DGR will not leak and contaminate the Great Lakes. Meanwhile, opposition to OPG's plan continues to mount. Given the enormity of what is at stake,

the fresh water of the Great Lakes, the acceptability of OPG's plan must reach the highest degree of social acceptability and broad community acceptance. OPG claims a high degree of community acceptance because the small town of Kincardine provided its consent on behalf of its 11,000 residents, but what about the 40 million people residing in the provinces of Ontario and Quebec and the states of Michigan, New York, Indiana, Ohio, Pennsylvania, Illinois, Wisconsin and Minnesota, whose drinking water will be affected if this ill-conceived plan fails?

This panel is being asked to make a 100,000-year decision without guarantees from the proponent and with deficiencies in its case and in its responses to requests from this panel. OPG and this panel have a moral, ethical and legal duty to ensure that the 40 million people living in the Great Lakes region are consulted and have provided informed consent as part of demonstrating the social acceptability of OPG's plan. The 40 million are the community and their voices must be heard. This decision must not be allowed to proceed on the basis of the municipality of Kincardine, our community

receiving $21 million in exchange for their support, saying okay.

This panel has a profound responsibility to protect the interests of present and future generations. You have a responsibility to protect the environment and the Great Lakes, Canada's most important natural resource, 21 percent of the world's and 84 percent of North America's freshwater supply vital to human and environmental health.

You have a responsibility to recognize that the people and their elected leaders are speaking out loudly and are saying that any risk of contamination of the Great Lakes is too great a risk to take and must not be taken.

Let there be no mistake. This plan has not passed the test of social acceptability. This plan has failed completely and utterly to gain social acceptance. This failure is evidenced by statements of opposition from numerous individuals, politicians and environmental organizations who have appeared before this panel. It is evidenced by the voice of Dr. David Suzuki, Canada's most influential and famous environmentalist, calling for a halt to this

nuclear waste dump. It is evidenced by almost 70,000 people from every Canadian province and territory and from all 50 U.S. states who have signed the Stop the Great Lakes Nuclear Dump Petition. It is evidenced by the 125 resolutions of opposition passed thus far by communities in Canada and the U.S., representing almost 11 million people. This is a staggering number, 11 million people. The vast majority of resolutions urge that neither the Kincardine nuclear repository nor any underground nuclear waste repository be constructed in the Great Lakes Basin.

It is evidenced by the Michigan Senate, passing a legislative package on behalf of Michigan's 9.9 million citizens calling for public hearings in Michigan and urging intervention by President Barack Obama and Secretary of State John Kerry. It is evidenced by U.S. Congressman Dan Kildee interceding this past July with Canada's Minister of Foreign Affairs to express concern about the proposed site because of its proximity to Lake Huron and questioning if the Canadian government will seek the express consent of the U.S. government before

granting final approval to any permanent nuclear waste sites within shared water basins.

Finally, it is evidenced by Congressman Kildee, introducing this past Monday Resolution 716 in the U.S. House of Representatives resolving that: one, the Canadian government should not allow a permanent nuclear waste repository to be built within the Great Lakes Basin; two, the President and the Secretary of State should take appropriate action to work with the Canadian government to prevent a permanent nuclear waste repository from being built within the Great Lakes Basin; and, three, the President and the Secretary of State should work together with their Canadian government counterparts on a safe and responsible solution for the long-term storage of nuclear waste.

Members of the Joint Review Panel, the evidence before you clearly shows that OPG's plan is fatally flawed and that its significant deficiencies can never be remedied. The overwhelming lack of social and community acceptance of OPG's plan is undeniable. The voices of opposition are speaking loudly and clearly, saying no to OPG's plan or any DGR in

the Great Lakes Basin.

We call upon you to recommend that OPG's plan for the Kincardine nuclear waste repository or any nuclear waste repository in the Great Lakes Basin be rejected.

Thank you.

THE CHAIRPERSON: Thank you, Ms Fernandez.

Panel members, did you have any questions for Ms Fernandez? Dr. Muecke.

MEMBER MUECKE: Ms Fernandez, could you provide the panel with additional information to support your assertion that the panel's guidelines require OPG to evaluate an actual alternative site?

MS FERNANDEZ: What I would like to do is take the time today and come back with an answer for your tomorrow.

THE CHAIRPERSON: Ms Fernandez, we're the panel that's trying to avoid any delay in responding to questions, but if you could get back to us in the morning, that would be appreciated.

MS FERNANDEZ: Thank you.

THE CHAIRPERSON: Dr. Muecke.

MEMBER MUECKE: In the independent expert

group's analysis of risk the group uses the assumption that upon closure of the DGR, of any DGR, there are no longer the requirements for active management. Could you clarify whether you consider this assumption to be conservative or not?

MS FERNANDEZ: We would view the burial and abandonment of the waste as problematic because there will be no way to tell if a leak occurs after the abandonment until it's too late.

MEMBER MUECKE: Just to repeat my question, in terms of risk analysis, is it a conservative --

MS FERNANDEZ: Could you repeat the question, then, please?

MEMBER MUECKE: Is it a conservative assumption in terms of a risk analysis, because that's what we're talking about in terms of the independent expert --

MS FERNANDEZ: I'm not understanding the question. Sorry. Could you repeat that?

MEMBER MUECKE: The independent expert group made the assumption that upon closure of the DGR there are no longer requirements for active management. In terms of a risk analysis, is this

a conservative assumption or not?

MS FERNANDEZ: As far as I understand the question, I don't consider that to be a conservative analysis. I know that from the information contained on our petition and from the information contained by the resolutions that we believe that it is very risky to place this by the Great Lakes and, therefore, it's a risk that need not be taken.

THE CHAIRPERSON: Dr. Muecke, did you have any more questions?

MEMBER MUECKE: Just one final one.

How would you and do you factor familiarity with the project, or lack thereof, into your determination of community acceptance?

MS FERNANDEZ: I do know that OPG has provided quite a bit of information on this issue. I do know that OPG provided a presentation to the Great Lakes and St. Lawrence Cities Initiative. Despite the fact that they provided their experts and their presentation, the Great Lakes and St. Lawrence Cities Initiative has come out in opposition to the Kincardine DGR.

I also know that when a resolution was being

considered in Thunder Bay that OPG knew that the resolution was being considered and sent experts up to Thunder Bay to provide their side of the plan. Despite OPG having appeared there, Thunder Bay still passed a resolution in opposition to the DGR.

I know that Congressman Dan Kildee met with OPG to get more full information about the proposed DGR. Despite meeting with OPG, Congressman Dan Kildee is very concerned about this proposal and has taken it forward to the House of Representatives and has written a letter to Canada's Minister of Foreign Affairs.

I do not think that it is a matter of information. I think in fact when the public and the politicians find out about OPG's plan they are opposed on the very commonsense level that a deep geological repository to hold the most lethal waste ever created by humans about a kilometre from the Great Lakes defies common sense, provides risk and danger to the drinking water of the Great Lakes, to the drinking water of 40 million citizens, to their agriculture, to their transportation.

It is viewed, as you can see by looking at

the resolution map, as a risky and dangerous proposal.

MEMBER MUECKE: Would OPG like to comment on the dispersion of the information in the area shown on the map by Ms Fernandez?

MS SWAMI: Laurie Swami, for the record.

Mr. Powers is coming forward to respond to that information. I think it's important to note that we reach out to many communities and there are many communities on the map that have not actually passed a resolution, but Mr. Powers will discuss that.

MR. POWERS: Kevin Powers, for the record.

As Ms Swami noted, we do have a very active government relations program. As part of that we have followed the progress of the non-binding resolutions that are illustrated there on the map in front of us.

In part, we do that in order to assess the level of political and true political engagement on this issue. We're trying to determine whether these are deep and abiding policy concerns or are they part of the council process whereby a template resolution is given by a constituent to their councillor, who then submits it and it

passes through council, which is often how non-binding resolutions are passed.

We have been following these, as I said, and not a single one of the 125 communities has come to us when they've received the resolution to find out any information about it, with the exception of Thunder Bay. I happened to be in Thunder Bay, so I went to the council meeting. We don't know of any debate that has ever taken place with any of these resolutions. Not a single one of the 125 communities there on that map have come to us after the resolution to find out more about the project. No municipality has responded to a request to find out more about the project from OPG. Not a single mayor, not a single councillor and not a single clerk from any of those communities has come to our website and asked to be put on our list to find more information about this.

THE CHAIRPERSON: Ms Fernandez, unless it's a question or you're adding more information -- as I said in my opening statement, this is not for making statements, it is for adding information for the benefit of the panel.

MS FERNANDEZ: Yes. That is what I would

like to do. I would like to add information for the benefit of the panel.

We can speak from personal experience because Stop the Great Lakes Nuclear Dump itself approached 32 communities in Ontario to have these resolutions passed. I can tell you that the normal course is to approach a councillor. The councillor brings it forward. The resolution then normally goes to an environmental committee, which will research the issue. Then the issue will be brought forward to council.

I will point out that as OPG has stated numerous times in the hearings in 2013, they have a very extensive website that provides very detailed and complex information. The cities and towns have accessed the website to find information about OPG's plan when the research has been done in the environmental committees. It is not a matter of a councillor bringing it forward and a council ruling simply on a whim. There has been research gone into these resolutions.

I will note further that many of these resolutions have been passed unanimously, including the City of Toronto, which has, I

believe, more than 35 councillors. These are councillors and mayors that are representing their constituents and are thinking about the risks and dangers that such a plan poses to their communities.

THE CHAIRPERSON: Dr. Archibald, did you have any questions?

MEMBER ARCHIBALD: Yes. I have one.

Ms Fernandez, you mentioned during your presentation that the OPG should have been required to compare the characteristics of an actual granite site several times and yet on page 12 of your written presentation there's a statement that appears:

> "An appropriate comparison requires that the Bruce site be compared with an optimal granite DGR site." (As read)

Could you please clarify why an optimal site must be compared to the Bruce site and how would this be an accurate reflection of the terms of reference for this project?

MS FERNANDEZ: I think because of the very large amount of concern that has been expressed about the location of this DGR being

right beside the Great Lakes and, as we've described in the presentation, an optimal site could be a site in the granite DGR outside of the Great Lakes Basin. What we are saying is that sites outside of the Great Lakes Basin are more optimal than sites right beside the Great Lakes because those outside of the basin eliminate the risk of the contamination of the Great Lakes.

We're also saying that a granite site right beside the Great Lakes cannot be optimal because it faces the risk of contamination of the Great Lakes, and I gather the Saugeen Ojibway Nations also agrees because they arrived at the same conclusion.

THE CHAIRPERSON: Ms Fernandez, just one more question. This is a little more general. I understand your group really is focusing on the proposed DGR, but I'm just curious, in terms of you and your membership, have you had a chance to step back and review the overall risks to the Great Lakes in terms of the primary risk to the Great Lakes and provide the panel with an understanding of your view with respect to what those primary risks are, including but not limited to the proposed DGR?

If you feel that you can't really answer that, that's just fine. I'm just wondering if your membership or in your interactions with cities and towns you've had a broader discussion of the broader concerns around the health of the Great Lakes.

MS FERNANDEZ: You mean the broader concerns of the Great Lakes aside from a deep geological repository on the shores?

THE CHAIRPERSON: Yes, because you probably have heard the panel ask for context and perspective on a number of occasions both last year and this year. Certainly, for example, last year on the record we heard from some of the Ontario ministries concerns around the Great Lakes. It's just a question to provide a little bit of perspective for the panel, but we understand if you're not in a position to answer.

MS FERNANDEZ: I think you have to understand that OPG is a multibillion dollar corporation. Stop the Great Lakes Nuclear Dump is a very small organization of volunteers. It has taken a tremendous amount of volunteer commitment, a tremendous amount of work, a tremendous amount of ability to reach out to that

many communities with the small number of people that we are. No, we have not discussed broader issues with respect to the Great Lakes. We are concerned with one thing only.

THE CHAIRPERSON: Okay. That's sufficient. Thank you, Ms Fernandez. You've been very clear with your response.

Thank you again. That concludes the 30-minute presentations.

We will now move to our next two presentations which are both 10 minutes. We will have both presentations before we entertain questions from the panel. Then, time permitting, we'll move on to questions proposed by registered participants.

Our first 10-minute oral presentation is from Peter Storck, which is based upon PMD 14-P1.11.

Dr. Storck, as per usual, when the little amber light comes on it means you have one minute left.

PRESENTATION BY / PRÉSENTATION PAR:
PETER STORCK

MR. STORCK: Thank you, Madam Chair.

For the record, my name is Peter Storck. I'm speaking today, as I did last fall, in opposition to the proposed DGR for low and intermediate level nuclear waste.

I will be addressing responses by OPG to questions from the Joint Review Panel arising from the close of the first session of the public hearing.

My remarks concern three of the six topics identified by the Panel as needing additional consideration and an extension of the public hearing.

My first remarks concern a potentially serious weakness in the geoscience Verification Plan, which is the identification of so-called triggers that would prompt changes in the design of the DGR.

The weakness stems from the fact that the Verification Plan is inherently optimistic, as reflected by the use of the word

verification and other words such as support and reaffirm, and is based on the prediction that any variance from what is already known will be minor in nature and readily compensated for by changes in design and other measures.

The danger in this overall approach is that there is no clearly defined go/no-go, decision point for the project as a whole and beyond which it will not proceed.

This means that once construction, even waste emplacement has begun, OPG may feel compelled to continue with the project despite indications it should instead be abandoned.

The chief technical danger, according to the geoscience update, and thus the ultimate trigger, occurs during the excavation process of the ventilation in main shafts. The danger is "greater than expected groundwater inflows" from permeable units in the upper 400 metres of the geologic column above the emplacement rooms.

The long-term risk is that groundwater from those units would percolate downward into the repository through the

excavation-damaged zone that will remain around the perimeter of the seals in the two shafts after decommissioning.

In short, during constructing of the DGR, and even emplacing waste, there is no geotechnical trigger for abandoning the project.

My second set of remarks concern the alternative means risk analysis requested by the Joint Review Panel and which was conducted by an independent expert group.

In their report the independent expert group acknowledges important limitations to their study. Two of the four options enhance surface storage and, secondly, a granite DGR are poorly defined. A facility for enhance surface storage based on broad design criteria and the granite DGR, hypothetical only, a transference of the design and hydrologic setting of he Bruce DGR to the Canadian Shield.

In short, there are no preliminary engineering drawings for enhanced surface storage at the Western Waste Management Facility or for a granite DGR at a selected location in the Canadian Shield.

Thus, for purposes of the

alternative means risk analysis the DGR in sedimentary rock is the only option for which extensive geoscience studies are available.

Other limitations stem from the fact that the risk analysis of the hypothetical granite DGR did not incorporate data arising from the European experience with crystal and rock, nor did it include a detailed assessment of Canadian work that has been conducted in that bedrock type.

Aside from discussing in an appendix to its report, OPG and Nuclear Waste Management Organization case studies have a hypothetical site in the Shield.

Because of these limitations, I believe the comparative risk analysis of the four options, however well it was done, is simply another model. And like all models, its utility is defined by the precision of the data that created it.

To me, this model seems very generalized and, thus, would have low predictive power, certainly not enough to select burial as an option or to choose between sedimentary rock and crystal and rock.

Thus, the fallback option, surface management over the short-term, less than 100 years, is clearly the safest.

The report of the independent expert group intended to fill gaps in the EIS, instead further highlights those gaps and makes the case for a Bruce DGR appear to be an ex post facto argument, in other words justified after the fact.

My final set of remarks concern the relevance to the DGR of incidents at the Waste Isolation Pilot Plant in New Mexico.

Based on reports issued by the U.S. Department of Energy OPG reported that the incidents at WIPP involved a fire truck -- a fire and truck engine fluids and a radiological release.

OPG also concluded that the two incidents had a common cause, "largely related to a degraded safety culture, ineffective programs and program implementation, as well as training." OPG states further that they "are confident the measures and processes we have established will prevent or mitigate a similar event." This is not reassuring.

In fact, there can be no assurance because in crucial aspects the proposed DGR would be as vulnerable as the WIPP facility. Leaving the geology and design issues aside, the vulnerability arises from human procedures.

In explanation, I would like to point out two sources of danger and a lesson from history. The two dangers: first, the services area on the main level of the DGR would contain a maintenance shop for vehicles as well as diesel fuel, lubricants and batteries, two electrical substations, a diesel fuel bay, and an explosive's room.

The second danger is the fact that low and intermediate-level waste would be emplaced in the DGR during construction activities, including blasting, to expand the facility by doubling its size in the mid-2040s or 2060s as currently anticipated.

In addition to the dangers there is an important lesson from history. In the mid-1990s the four Bruce A and four Pickering reactors were shutdown because an independent report indicated that maintenance and modifications of the reactors were not

appropriate to their design.

The problem was corrected, but the lesson is that standards, regulations and procedures are not infallible, they cannot be relied upon to guarantee safety, they change in response to human behaviour and improvements and knowledge from experience and scientific research.

The conundrum is that knowledge becomes outdated. And herein lies the inherent flaw in attempting to apply experience and science to a DGR, a tragedy arising from a failed DGR, designed and operated on the basis of knowledge that is later shown to be faulty or limited cannot be erased.

This extension of the public hearing in connection with a proposed DGR is yet another attempt to understand what OPG intends to do and what the risks are. Over the course of several years culminating in the environmental impact statement and supporting documents and the records of this hearing, thousands of pages of evidence and testimony have been presented in support of the project.

And yet, after the first session

of this hearing in the fall of 2013, there were still questions. And no doubt, there will still be questions after this extension of the hearing.

Indeed, this could continue indefinitely with the scientific technical component of the DGR because our knowledge will always be incomplete and possibly flawed introducing an element of uncertainty, risk into our predictions.

An international nuclear organization said this about risk:

> "Accidents in any field of technology provide valuable knowledge enabling incremental improvements in safety beyond the original engineering. Cars and airlines are the most obvious examples of this. But the chemical and oil industries can provide even stronger evidence." (As Read)

The implication is that this same approach to risk can be taken in a nuclear industry, in this case the burial of nuclear

waste.

I reject this. I ask the Joint Review Panel to reject this as well. And on the basis of ambiguously or unsatisfactorily answered questions, knowing that our generation can be blindsided, just as others have been by overconfidence in presumed knowledge, to refuse unconditionally OPG's application for a licence to construct a DGR.

The anticipated burden to the future of ongoing stewardship of nuclear waste that is of such concern to critics of service management would be far less of a burden than a human and environmental catastrophe caused by a failed DGR.

Our bequest may also, on the positive side, stimulate the development of a cleaner nuclear technology and more effective recycling.

Furthermore, the stewardship of nuclear waste is certainly no greater a burden, ethically and morally, than the ongoing responsibility of managing nuclear weapons and preventing a nuclear war. And only one of many stewardships that we hope future generations will

continue, the protection of human rights, species at risk, and the global environment.

Let us not in our self-assurance of our role in history make a historical mistake.

Thank you.

--- Applause

THE CHAIRPERSON: Thank you, Dr. Storck.

We will now proceed directly to the presentation from Gordon Albright, which is PMD 14-P1.24

Dr. Albright?

PRESENTATION BY / PRÉSENTATION PAR:
GORDON ALBRIGHT

DR. ALBRIGHT: Thank you.

WIPP has now become the third DGR in recent times, after Schacht Asse II and Morsleben, to quickly lose containment of the radioactive waste that it was supposed to keep isolated for hundreds of thousands, if not millions of years.

This is one of the facilities cited by OPG as being most similar to the DGR

facility they have proposed.

Even though the precise cause of the breach of containment at WIPP is not known, it was clearly the result of unforeseen reactions between different kinds of wastes stored in the same container.

OPG has claimed that a similar breach of containment could never occur in the DGR they have proposed, because they have a very strong "safety culture." But they did such a bad job on their waste inventory that they have had to make major revisions to it.

Their failure to provide a complete and accurate overall waste inventory, let alone an inventory of each container, means that they cannot possibly guarantee that no container will ever be breached by unforeseen reactions among its contents.

This shows the very opposite of a strong safety culture. It shows a culture of entitlement in which OPG expect all their proposals to be routinely approved, whether or not they have done everything necessary to protect public safety.

So much is at stake here that it

cannot be exaggerated. Many radioactive atoms remain deadly for hundreds of thousands and even millions of years. The DGR would contain vast numbers of them, and each individual one could cause a fatal cancer.

Any significant breach of containment could cause death, disease, and environmental harm for countless generations affecting the lives, health and wellbeing of countless people.

This is far too much responsibility to place in the hands of a corporation which has not done due diligence in ensuring that no waste container could ever be breached by interactions among its contents or between its contents and the container itself.

The inadequacy of OPG's waste inventory was only revealed by the intervention of an independent expert, Dr. Frank Greening, who had the specialized knowledge required to do this.

Who knows how many other parts of OPG's safety case have been equally badly prepared? But we can't tell, because they have never been properly evaluated by an independent

specialist with the necessary expertise.

OPG's failure to properly prepare their waste inventory makes it impossible to trust them on anything else, especially when any error on their part could have devastating consequences.

But even if OPG had prepared a perfect waste inventory, over the hundreds of thousands or even millions of years for which containment must be maintained, the interactions between all the waste components and between the waste components and the container would still be far too complex to predict.

Not only is it impossible to guarantee that a breach of containment could never occur, there is no logical reason why it couldn't, as it did at WIPP in someway that couldn't be foreseen.

Both this simple logic and or past experience at three recent DGRs, including WIPP, have rapidly lost containment, are overwhelming scientific evidence that no safe DGR technology yet exists.

Under these circumstances, approving any DGR proposal, let alone one from a

corporation like OPG that has lost credibility though its lax preparation of vital safety information, would open the doors for a humanitarian disaster.

On the other hand, even high-level nuclear waste has been safely stored above-ground for a long time. OPG has stated that for another 50 years they can continue to safely store above ground all the waste that is intended for their proposed DGR.

If OPG really had a safety culture, they would acknowledge that the technology to keep radioactive waste safely contained in a DGR does not yet exist and would withdraw their proposal until further research developed a technology to keep radio active waste securely isolated for an indefinite time. This might or might not involve a DGR.

This DGR proposal is nothing more than an attempt by the nuclear industry to fool the public into believing that it can safely dispose of its radioactive waste when in fact this is not yet possible.

Radioactivity cannot be disposed of because it cannot be destroyed or neutralized,

it can only be contained. And it must be contained permanently, because the worst of it remains deadly for the lifetime of the earth.

So far we have no way to contain it permanently, but we can keep it contained as we have been for the foreseeable future until we can find a way to contain it permanently. Any other course of action will expose us to completely unnecessary risk of disaster.

What really lies behind this proposal is an insidious cult of science that arrogantly presumes that our scientific knowledge gives us complete control over everything that might ever happen. But it is absolutely impossible to predict, let alone prevent, every possible failure of OPG's proposed DGR that could cause serious harm to countless people over countless generations.

This means that no safety culture, however strong, no precautions, nor even the very strictest regulations with the very strictest enforcement can ever save us from devastating harm if we allow this project to go forward without absolute scientific certainty that it is completely safe.

Such scientific certainty must be based on logic and experience, which are the sole basis for sound science. So far all logic and experience show that DGR technology is completely unsafe. The wise saying of the French physiologist Claude Bernard could not apply more strongly, "True science teaches us to doubt and, in ignorance, refrain."

Thank you.

--- Applause

THE CHAIRPERSON: Thank you, Dr. Albright.

Panel members, did you have any questions for either of the two presenters?

Dr. Muecke?

MEMBER MUECKE: Dr. Albright, to quote you from your presentation, you say, "When we are trying to protect ourselves from radioactive materials that are so toxic that a single," that is a key word, single, "radionuclide can cause a fatal cancer."

How do you reconcile this statement with the medical radiation treatment used for cancer?

DR. ALBRIGHT: Well, surely

treatment of cancer is not at all the same thing as prevention of cancer. Once the cancer has been caused, then possibly it can be treated, and possibly it can't.

You know, we are still fighting very hard to find a cure for cancer or the many many cures for cancer that are necessary for the many many different kinds of cancer.

So I don't see -- as I say, the connection between cause on the one hand and treatment on the other, surely the best is not to cause the cancer in the first place. And not all cancers can be treated.

MEMBER MUECKE: I don't want to argue points here. But radiation treatment involves many exposures to radionuclides. And one way of interpreting what you have been saying is that it could actually cause more harm than good, but I don't want to argue the point.

DR. ALBRIGHT: This raises a very common issue with radiation exposure that is often ignored, and that is the difference between external exposure and internal exposure.

An individual atom, or an individual radionuclide can cause a cancer by

getting into a cell giving off say an alpha particle and causing damage to the cell's DNA which then renders it cancerous. That is internal exposure.

Radiation treatment for cancer is external exposure, and this is quite a different thing. This is not exposure to radionuclides from within, this is actually radiation from without.

And of course it is not alpha radiation, which is the most devastating internal radiation, it is in fact x-rays or gamma radiation which are essentially the same thing. And this is totally different from the internal alpha radiation which is the mechanism by which a single radionuclide causes cancer.

MEMBER MUECKE: Thank you, Dr. Albright.

THE CHAIRPERSON: I believe that would be it for the questions from the Panel for the previous two presenters.

So the Panel will now entertain questions from hearing participants.

Ms Martin?

MS MARTIN: Thank you. Good

afternoon, Dr. Swanson and panellists, it has been a very interesting day.

I had three quick questions. The first one is to do with the presentation that CNSC gave this morning. And in EIS 12-510 OPG was asked to avoid phrases such as "may not be significant" and, instead, to explain their level of confidence.

So I expected percentages attached to these types of phrases in order to better judge the level or risk in an updated RWI.

So when I heard things like "sufficient evidence" and "sampling unlikely to have significant effects of workers, reasonable confidence and as low as reasonably achievable, ALARA," I was hoping that I could understand better.

And I am wondering why CNSC didn't actually put some percentages to those things so we would know how good they thought their recommendations were or what their phrases were in explaining their level of confidence. Why was that not done this morning?

THE CHAIRPERSON: Ms Martin, I am trying to understand the part of this morning you

are referring to. I know that at one point I was asking both OPG and CNSC questions about what I referred to as the tolerable limit, upper limit.

I asked them to explain how sure they needed to be about their sampling. And in that case it was specifically the 95th percentile. Is that what you are referring to?

MS MARTIN: Well, I was very pleased to hear you say the 95th percentile. But I just -- I am sorry, I don't know the doctor's name in the front who gave the presentation, doctor...? Beside Patsy.

THE CHAIRPERSON: Goulet.

MS MARTIN: Yes. And he used a lot of these phrases, but he didn't quantify them.

So I am wondering, you know, how we are supposed to judge what was said was, you know, adequate or accurate if they weren't quantified. Like, you know, fairly sure. Like, 80 per cent sure, 65 per cent sure? See what I mean?

THE CHAIRPERSON: Yes, I do now. Thank you.

So Dr. Goulet, Dr. Thompson, I

think what Ms Martin is asking for is on your slides you repeated several times that the CNSC, I am paraphrasing, were satisfied with their analysis and it was reasonable, you accepted their results, it did not change your recommendations.

And so what Ms Martin is asking is, so how sure are you about those?

DR. THOMPSON: Patsy Thompson, for the record.

I will show how technologically challenged I am, but I will try to do this anyway.

So one example of the issues we talked about this morning in terms of the assessment results for the updated radioactive waste inventory, the slide actually shows the numbers, and in our speaker notes we expressed what that meant in terms of the assessment conclusions.

And so when we said, or Dr. Goulet in his presentation mentioned that the updated radioactive waste inventory did not materially change the results of the closure assessments. Essentially it was on the basis

that the updated radioactive waste inventory changed the dose assessment, either reduced the dose by 0.6 per cent or increased the dose by about 7.5 or 8 per cent.

And so it is on that basis of that tight range of changes relative to I believe it is the -- in relation to the criteria we had where in some cases there was 100,000 difference between the calculated doses and the dose criterion.

And in other cases where we explained this morning that we still, through the updated reference inventory, radioactive inventory, we are still within the acceptability criteria of an increase in health risk less than 1 in 100,000.

So it is on the basis of those numbers. But I would agree that, you know, the slides were probably not as clear as they could have been.

THE CHAIRPERSON: So, Dr. Thompson, if I could paraphrase you for the benefit of the Panel as well in understanding. So because the estimated exposure was 100,000 times below the public dose limit, a change of

that dose estimate of only between negative .6 and about 8 per cent really pales in comparison to how low that dose already is?

DR. THOMPSON: Couldn't have said it better myself.

THE CHAIRPERSON: All right. So then, logically though, the closer you would get to the annual dose limit for the public the more stringent you would become. And perhaps if you were much closer to the dose limit, those same differences would have become more significant, is that correct?

DR. THOMPSON: Patsy Thompson, for the record.

That is correct. And in such a situation we would have done a lot more detailed assessment and would expect that the information provided would have been tighter and probably with less uncertainty in terms of the information that is provided.

We explained last year and somewhat today that the safety case is based on a phased approach with bounding scenarios. And at this stage we felt that the information available with the bounding assumptions were sufficient to

draw conclusions in terms of the safety of the project.

We also recognize that moving forward, if the project is approved, the work by OPG will continue both in terms of the inventory verification in terms of the geoscientific verification plans. And that information is expected to be used to update the safety case for the next phase of the licence.

THE CHAIRPERSON: Ms Martin, bear with me, but I am on a bit of a logical string of questions myself based on your question.

So, Dr. Thompson, given what we have just discussed, which is the closer you get to the public dose limit, the more stringent your requirements will be.

Now if we switch over from normal operations to the disruptive scenarios, in particular the severe shaft failure and the human intrusion, both before and after the revised inventory, we are not just at the dose limit we are above it.

Was that the trigger for your original commissioned recommendation to the Panel that we did indeed need a verification plan for

inventory or are there other recommendations arising out of that, how close we are or exceeding the public dose limit?

I will rephrase that question. Since the public annual dose limit approached or exceeded, notwithstanding the fact that we are still within the 10 to the minus 5 risk acceptability, does this change the CNSC's view of how tight the estimates need to be for the disruptive scenarios?

DR. THOMPSON: Patsy Thompson, for the record.

It is a combination of factors. The review that was done of the radioactive waste inventory was done in relation to the normal operations post-closure assessment and some of the disruptive scenarios.

The data available, the assessments done for the disruptive scenarios lead to fairly significant numbers in some cases. And we recognized at that time that the assumptions of, for example, failures of containers, gas generation, flooding of the DGR were all conservative assumptions that lead to disruptive scenarios that were significant in

terms of consequences. And we balanced those with the probability of occurrence.

That also lead us to require additional verification information and lead, in part, to the recommendation for the recommendation number 2, to improve the inventory information.

So the requirement, the recommendation 2, was based on the results of the disruptive scenarios, but also reviewing what is being done in other countries and looking at the ISO standard and the information we receive from our expert consultant.

THE CHAIRPERSON: Thank you.

Sorry about that, Ms Martin, I just wanted to get that question out before I forgot it.

MS MARTIN: I like that.

THE CHAIRPERSON: Please proceed.

MS MARTIN: Thank you.

So I just, again to talk to Dr. Thompson on this and her cohorts, is it too much to expect that when we hear things like sufficient evidence sampling and unlikely to have significant effects on workers, that there

actually is a scientific or a numerical number put -- like a number put to it?

In other words, it unlikely had significant effects on workers, 75 per cent. Like, how are we to judge if that is acceptable? Because that is just words, that is not -- there is no quantification.

THE CHAIRPERSON: Dr. Thompson?

DR. THOMPSON: Patsy Thompson, for the record.

The classification was done in terms of the dose criterion used by OPG of 10 millisieverts per year, which is a fifth of the public dose -- of the worker dose limit of the CNSC.

And we know from epidemiological studies and other work that that dose would not lead to measurable health effects in workers. We have done assessments, there has been published literature.

And so it is on the basis of the criterion used by OPG that we accepted and the fact that it is much lower than the worker dose limit and the epidemiological evidence in the literature.

We did provide some of that information this morning, the comparison with the occupational dose limits. And we had presented a lot of information last year in our presentation on health. But of course it has been a year, right?

THE CHAIRPERSON: So, Dr. Thompson, I think what the Panel is understanding is that the word "unlikely" in this specific instance with respect to the workers relates to the fact that, at least as much as we know about their exposures, is that they are very much lower -- we are talking about WIPP right now -- much lower than the occupational threshold?

DR. THOMPSON: Patsy Thompson, for the record.

Our understanding from the WIPP events is that the doses to workers were less than the public dose limit, and in that case it is very much lower than any evidence that we have in terms of health effects of radiation exposure.

THE CHAIRPERSON: Ms Martin?

MS MARTIN: Thank you.

And then I also wanted to ask, I noticed that there was -- we were talking this

morning about a third-party independent review of the waste characterization program. And CNSC said they contracted an independent third-party review.

So I am just wondering what our interpretation is of independent. Because I know the independent study done by Dr. Gleese was considered an independent study, but it was paid for by OPG I am assuming

So I am wondering how do we assure ourselves that people are really independent? Because when you hire them they really are wanting to please you. So yow do we know that we have independent studies that are believable and someone is not just coming up with what they think we want to hear because we have hired them?

THE CHAIRPERSON: Thank you, Ms Martin. I am going to ask both OPG and CNSC to comment, because this is a very common dilemma.

MS SWAMI: Laurie Swami, for the record.

It is a very interesting question actually and I think an important question.

For the case where we hire the

independent expert group, that was a very specific case where while we hired the group, they were to meet the requirements of the Joint Review Panel. We provided them the direction that the Joint Review Panel provided to OPG. We provided them information. But in essence, they worked independently from OPG.

While we did see their report before it was filed, we certainly were not in a position to revise it because it was to meet the requirements of the Joint Review Panel.

When we hire independent groups, which we do routinely as part of our normal processes, we bring in experts to review our work in various areas across our business. We are always looking for people that will give us very honest feedback and keep that independence for us because, in fact, it is an important part of receiving information so that we can improve our performance.

So it is a normal course of doing business, but I can understand how the public, when you hear someone funds something, would imply that they are there to provide the answer you are looking for, as Ms Martin has mentioned.

That is not the intent of an independent expert group, whether it is through the Joint Review Panel direction, whether it is through senior management direction, we are always looking for that feedback because that is an important part of any process.

THE CHAIRPERSON: CNSC, would you care to comment?

DR. THOMPSON: Patsy Thompson, for the record.

I will speak to two processes the CNSC has in place to review the work that we do. In the case of the expert that we contracted to help us review the waste inventory from OPG and look at its suitability essentially for post-closure safety assessments, we looked to the scientific literature to identify an expert in this area to compliment CNSC staff's expertise.

We had reviewed the information, had a sense that it was incomplete and probably did not align with international best practices. We wanted to make sure that this was indeed the case before we submitted to the Panel an information request.

So we sought to have an expert to

compliment our expertise to make sure that, if we were moving forward, we had a strong technical basis for doing that.

So we have, and Dr. Nguyen is also familiar with, his team is setting up a group of experts to support CNSC staff in our assessments, for example, of the APM project that NWMO's putting forward.

And so those are some types of experts that the CNSC seeks on the basis of they are recognized experts to compliment our expertise and give us advice.

The other process we have in place is, for example, if we conduct studies that could lead to regulatory actions or recommendations for significant changes in the way a licensee will handle situations, for example.

We have used the U.S. EPA recommendations and guidance in terms of seeking peer review of reports and documents that could lead to decision making. And so we have done that on a number of occasions where in this case they are usually not people that we pay to do to the peer review.

But we identify through review of the scientific literature experts in fields that are relevant to give us advice on whether we should be moving forward with regulatory actions and certain issues.

THE CHAIRPERSON: Thank you.

Dr. Muecke, did you have a follow-up question on this?

MEMBER MUECKE: Yes. It is basically to OPG. What role would OPG see a community liaison committee playing in the choice of third-party oversights?

MS SWAMI: I think that is also a very interesting question. We have community liaison committees where we seek advice on various pieces of information. This would be one other area that we could seek that type of advice. I don't see an issue with doing that.

I think the difficulty you run into is that a lot of the experts in these areas are perhaps not known to the community anymore than someone else is, but it certainly would be something that we could take under consideration, given the interest.

THE CHAIRPERSON: Thank you.

MS MARTIN: Thank you.

Because I did offer last year to be on such a committee and I wasn't approached, and I know that Uta was too, so we are ready, we are available.

THE CHAIRPERSON: Did you have any further questions, Ms Martin?

MS MARTIN: No. Thank you so much. Merci beaucoup.

THE CHAIRPERSON: Thank you.

Ms Lloyd?

MS LLOYD: Thank you, Dr. Swanson.

My first question is around the pre-closure safety implications. It is AIS 13-514. And my question is for OPG. And these were questions that arose for me as I reviewed the documents, and I had thought they might be touched on today, but I didn't hear them being addressed.

So in this I have a question generally. The context is an interest in how OPG develops the scenarios or frames the scenarios for their assessments. And in particular, the scenario for total dose to workers, assumed a

cage fall, a total breach of containers, and an exposure period of five minutes.

So my questions for OPG are how do they select a five-minute timeframe for exposure? And how does that compare to sort of average experience with cage failure? I assume that that also means entrapment. How does that compare to average periods of entrapment in other underground experience?

And then what would the number look like if you used that average period of entrapment in cage failure and underground operations and applied it -- substituted that for the five-minute exposure?

THE CHAIRPERSON: OPG?

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

I think last fall we did have some discussion around the basis for the times that were assumed in the pre-closure assessment. Obviously when you are talking about accidents involving workers there is quite a variety of locations where the workers could be relative to where the accident is. So it is somewhat of a stylized approach that gives you a sense of the

relative importance of the accident.

The five-minute timeframe was generally related to the time that we felt would be sufficient for workers to be notified of an accident and to get to the portable refuge stations, which in the DGR design would be near the working face.

I just also want to point out that the comment to you related to entrapment and cage fall, no workers would be present in a cage that was carrying waste packages. So that would be, if there was such an accident with a worker in a cage, it would not be involving radioactivity.

THE CHAIRPERSON: Thank you.

Ms Lloyd?

MS LLOYD: Thank you.

My next question is around the waste acceptance criteria. And it is a very short question. I have looked through the documents filed for this assessment and more generally I have just done an online search, and I haven't been able to locate the waste acceptance criteria or the reference documents which OPG referred to yesterday.

And it does seem to be a pretty central document to our discussions yesterday and today. So I am wondering where that could be found or if it could be provided?

THE CHAIRPERSON: OPG, can you point us to where they can be found, please?

MS SWAMI: Laurie Swami.

We don't have the reference readily available, so we will just have to get back to you tomorrow morning, if that is acceptable.

THE CHAIRPERSON: That is, yes, thank you.

Is that all right, Ms Lloyd?

MS LLOYD: Yes. Thank you, Dr. Swanson.

My next question is for CNSC. And Dr. Thompson discussed it sort of more generally when she was talking about selection of consultants. But this morning they referred to in talking about the waste inventory verification.

On slide 30 there was a statement or a reference to the independent third-party review. And Dr. Thompson, I believe it was Dr.

Thompson making the presentation, perhaps not, indicated that it was D.W. James Consulting they had retained.

And I want to be sure I understood correctly that they -- because there is also a reference to D.W. James, a report by D.W. James. Did they retain D.W. James for an additional review or was she meaning a reference? And if D.W. James was retained specifically, what kind of criteria was used?

We have reviewed their credentials and they seem more to be an industry service group than a regulatory agency support -- service group. So that is roughly put.

THE CHAIRPERSON: CNSC?

DR. THOMPSON: Patsy Thompson, for the record.

The consultant was chosen on the basis that they had participated in the development of the ISO standard that was of interest to us and also had extensively published in the literature.

THE CHAIRPERSON: So, Dr. Thompson, that is indeed the D.W. James firm that you are referring to?

DR. THOMPSON: Patsy Thompson. Yes, it is.

THE CHAIRPERSON: Ms Lloyd?

MS LLOYD: Yes, Dr. Swanson, I am wondering if that report could be made available to the Panel and the interveners?

THE CHAIRPERSON: The Panel will consider that and, if we feel that we need to, we may.

MS LLOYD: Okay. Thank you, Dr. Swanson.

THE CHAIRPERSON: Mr. Mann.

MR. MANN: Thank you, Dr. Swanson.

For the panel to suggest that it may not allow Dr. Greening's information about extremely serious accusations and problems with OPG's safety case is alarming to the citizens of our community, violates due process and the charter.

THE CHAIRPERSON: Mr. Mann, that is not a question; that is a statement. We made it very clear that we are going to consider Dr. Greening's new information as soon as we can later on.

MR. MANN: I'm asking that OPG answer Dr. Greening's submissions immediately and not have time to prepare --

THE CHAIRPERSON: Mr. Mann, that is not your call; that is my call. My call is, as I expressed earlier this afternoon, because it was brand new information, in the interests of fairness and following the amended hearing procedures the panel requires time to review the new information and to give the CNSC and OPG time to respond to any questions we have; and that's the end of that.

MR. MANN: As a citizen of this community, I want to know why were the presentations by OPG and the CNSC this morning not presented a year ago. After all, OPG had prepared for the Joint Review Panel hearings for over 10 years now, over a decade. Now, one year later, after the five weeks of presentations where they were unable to convince you to approve their application, we are in a position where no one, including this panel, can have a memory of what the witnesses actually said a year ago. You can't determine what demeanour they had at this point, after a year. It's impossible for any

human to judge the demeanour, which is an important part on credibility that you have to weigh and consider when you do your -- for your findings and conclusions. It makes the whole hearing unfair because the proceedings have been adjourned for over a year and you can't figure out what happened a year ago now.

THE CHAIRPERSON: Is your question why -- what is your question?

MR. MANN: My question is since OPG couldn't convince you to approve it in the regular hearings, what has changed in the year and what are they presenting now that will convince you to approve it, because in my experience if you can't convince it at the original hearing you lose the case? The safety case --

THE CHAIRPERSON: Mr. Mann, it is not the function of the hearing to start getting into the deliberations of the panel. We are here to provide new information to the panel and examine that new information, so unless you have a question that adds something materially to our record I would ask you to take your seat.

MR. MANN: The new information

that you have is that the WIPP disaster has ruined OPG's safety case, Saugeen Shores has unsafe geology for a DGR just a few kilometres away, and there are countless questions that need to be still answered by us and the community, and we don't have time for them by you obviously, from the questions we've already seen from the panel.

I want to know what the year has accomplished here, what new information they're presenting to you that will now convince you that, hey, this is a good idea, because everything has been negative since the hearings adjourned last year.

THE CHAIRPERSON: That is a rhetorical question and, as I've just explained to you, it is not the reason for this hearing. Our deliberations will follow once we have all the information sufficient to our duties.

MR. MANN: According to OPG --

THE CHAIRPERSON: Mr. Mann, if you don't have another question your mic will not come on, so please, it must be a brief question and to the point of today's proceedings.

MR. MANN: All right. OPG

indicates that the decommissioning review will take place in 30 years, in 2035, yet this panel wants to hear about the decommissioning waste. I want to know why we also aren't hearing about the high-level spent fuel, because with the stroke of a pen Kincardine can approve high level to go into the DGR.

THE CHAIRPERSON: Mr. Mann, we've been through this. We've been through this last fall and I'm going to say it again. This hearing is for low level and intermediate level waste. That is the scope of this hearing. I would ask that you now take your seat since you don't seem to be capable of asking a question that adds to the information. Please take your seat. Please take your seat, Mr. Mann.

Dr. Greer.

DR. GREER: Thank you, Dr. Swanson.

Dr. Sandy Greer, for the record.

I have a question in regard to the waste inventory verification plan in reference to Slide No. 7 that was presented by the OPG this morning. I wanted to inquire about more details in regard to the accredited

laboratories that would be examining the waste and the various radionuclides.

In terms of the waste characterization, could you please identify whether these accredited laboratories are arm's-length from the nuclear industry or when you refer to inter-laboratory comparisons would that include, for example, two laboratories, perhaps one more closely aligned with the industry and then other more independent laboratories looking at the same data to determine the characterizations?

THE CHAIRPERSON: OPG.

DR. GIERSZEWSKI: Paul Gierszewski, for the record.

These are accredited laboratories. They comply with the relevant standards, and I don't recall the particular number offhand, the CSA standard or ISO standards to do their work. They're reputable labs. The inter-comparison is to ensure that there's no experimental bias or uncertainty at one laboratory, in their implementation of procedure, compared to another one that provides that verification, but they're following -- these are

recognized, respected laboratories following accredited -- they're accredited by the Canadian Standards Association or equivalent organizations.

THE CHAIRPERSON: Thank you.

Dr. Greer.

DR. GREER: I have a follow-up question.

THE CHAIRPERSON: Yes.

DR. GREER: In regard to the data that is made available by these laboratories that would be published eventually, could you please clarify how accessible this information would be to the wider public for concerned individuals who would like to know this information sooner than later as such a project progresses?

The reason I ask is because of my own research as a citizen, even as a graduate from a university. I had to make two trips down to Toronto to gain access to very important information that was only available through academic journals that are not readily available to the public because they're hugely expensive for people to purchase and basically not accessible, so I want to know whether such

information would be only limited to such restricted journals or would there be websites that perhaps these laboratories have themselves, or what other sources could people go to to have access to this information?

THE CHAIRPERSON: Dr. Greer, I'm assuming you're referring to the analysis in support of the referenced waste inventory.

DR. GREER: Yes. Thank you.

THE CHAIRPERSON: OPG.

MS SWAMI: Laurie Swami, for the record.

If you could just hold on for one moment?

--- Pause

MS SWAMI: Obviously, a good question. It caused a lot of discussion.

The information would be provided in the waste inventory report obviously when it gets updated. It would certainly be part of the operating licence application, so it would be available certainly to the public through that forum. We would also take information and publish that in peer review journals, et cetera, that would make it available. I think it's

difficult to judge because of the amount of data, et cetera. We'd have to assess how that could be even possibly released to the public at this point in time.

THE CHAIRPERSON: Thank you.

Dr. Greer.

DR. GREER: Thank you for the clarification, but it does point out, I think, a dilemma for the wider public and even people trying to do diligent research to keep up with things. You know, we're really challenged. It's not an equal playing ground.

Thank you very much.

THE CHAIRPERSON: Thank you, Dr. Greer.

MS SWAMI: Could I clarify? Laurie Swami.

We did talk at the last set of hearing days about the community liaison committee, community advisory committee, however you would phrase that, and that would be an opportunity to have a good discussion of what materials should be released and things of that nature. I think that, you know, could be one of the topics that could help in this particular

circumstance so that we get a better understanding of what the public would be interested in.

THE CHAIRPERSON: That ends the question period based on the previous presentations.

According to the panel's public hearing procedures persons not previously registered might be granted an opportunity to make a brief oral statement at the end of the hearing day, time permitting. This opportunity is limited to individuals who did not previously register to participate and have not filed a written submission.

The secretariat staff have informed me that we have Mr. Joseph Leung here who has asked to make a brief statement. We do have a bit of time. Thank you for waiting until the very end of the day. You have 10 minutes. Please proceed.

M. LEUNG: Madame Swanson, la présidente, et members du panel, merci pour votre opportunité.

My name is Joseph Leung and I come from the Municipality of Meaford in Grey

County, which is part of the Great Lakes.

This is for long-term thinking, food for thought. Since the conception of nuclear experiments at Ralston, Chalk River, Ottawa in the '40s we have not given serious consideration to nuclear waste. I trust this panel will do just the opposite.

From a legal perspective:

Three agreements with the United States, a boundary water treaty, 1909.

Second, a key environmental event in Canada, the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and Their Disposal, ratified by Canada August 28, 1992. The conditions: parties may not carry out or authorize transboundary movements, import/export transit of hazardous waste or hazardous recyclable materials to states that are not parties to the convention unless they have a bilateral agreement under Article 11. Such is the case with the Canada and United States agreement.

Third, a key obligation is the North American Free Trade Agreement, NAFTA, and its companion, the Commission for Environmental

Cooperation, the CEC. Their mandate is to address regional environmental concerns and trade conflicts.

Since OPG has mentioned expansion plans for the DGR, a question for low and intermediate level waste. I heard it was 20 percent. Since the U.S. Yucca Mountain DGR is closed after nine years of construction, since Gentilly-2 in Quebec was closed in December 2012, and the Quebec government has put $1.2 billion for decommissioning and they have not chosen a site yet, since 2014, early this year, the U.S. government has asked Japan to send all their nuclear waste to the U.S. After 3,000 communities were solicited to host a DGR, all declined. The reason the United States wanted to have the waste in here, they didn't want the waste to get into the hands of not so good people.

My question: is it possible that the U.S. -- in the future, nuclear waste might end up in Canadian soil?

THE CHAIRPERSON: Mr. Leung, I do have to interrupt you now.

MR. LEUNG: Thank you.

THE CHAIRPERSON: You apparently informed the secretariat that your brief statement would be with respect to at least one of our six hearing subjects.

MR. LEUNG: Yes.

THE CHAIRPERSON: Would you please explain to me which of the subjects this is actually addressing?

MR. LEUNG: Expansion.

THE CHAIRPERSON: Expansion. Expansion for low and intermediate level waste?

MR. LEUNG: Yes, because in history I think Canada has been exporting our waste to Michigan, so I'm talking about NAFTA so that there's a possibility that company-to-company they might ask -- in the future, I said, if we do have a DGR, they might ask the same favour. I don't know. I see it that way.

THE CHAIRPERSON: Very well. If I could ask you to, you've made your point, just wrap up very quickly then, please?

MR. LEUNG: Yes. Thank you very much. I have five minutes it says in here.

I'm interested in the WIPP now. The WIPP DGR is carved in a salt department.

Southwestern Ontario has many salt caverns. Is our DGR subjected to salt deposits?

Carlsbad, New Mexico -- this is from the web, I don't know how good it is -- one mile from the boundary of the WIPP fracking is happening and there are companies testing fracking or talking about fracking around Collingwood and also in Kincardine.

In 1988, Ontario Hydro recommended the stable granite of the Canadian Shield, away from large populations and the Great Lakes. That's why uranium, thorium, rare earth uranium, Th-232, is found there, not here.

To close, I would like to inform the panel that the Municipality of Meaford, after having deliberated last month, seven to nothing they decided to pass a resolution to join those 50 counties and municipalities around the Great Lakes in Canada and the United States.

Thank you very much.

THE CHAIRPERSON: Thank you, Mr. Leung.

We have one more item, a very quick one, to deal with before we adjourn today.

Mr. Haddon.

MR. HADDON: I thought I could just answer one of the earlier questions about the waste acceptance criteria. The question was where in the documentation it could be found.

In the preliminary safety report, section 5.5, page 268, you'll find the waste acceptance criteria. There is also a summary table, Table 4.5.1-3 in Volume 1 of the EIS.

THE CHAIRPERSON: Thank you very much, Mr. Haddon.

We understand that there are also further comebacks of information from both OPG and CNSC, but given the time I would suggest we deal with those right away in the morning.

Ms Swami, just one little one, then.

MS SWAMI: Laurie Swami, for the record.

Only because some of our experts won't be here tomorrow morning, if I could answer one of the questions? I will ask Dr. Brett and Dr. Evans to provide the information.

There was a question about the availability of oxygen with respect to zirconium. I provided some of the information earlier, but I

didn’t address that specific point. If I could ask them to address that very briefly I’d appreciate it.

THE CHAIRPERSON: Yes, of course. Please go ahead.

MR. EVANS: Dave Evans, for the record.

This is in follow up to Dr. Muecke’s question about the availability of oxygen and the extent of consumption of zirconium in the pressure tube waste containers.

The calculations show that the amount of oxygen in the pressure tube waste container could oxidize slightly less than 0.1 percent of the available zirconium in that container.

THE CHAIRPERSON: Dr. Archibald, did you have any follow up to that?

Is that sufficient, Dr. Muecke?

MEMBER MUECKE: I think so.

THE CHAIRPERSON: We think so.

Thank you very much. We'll adjourn for today and we'll see you all tomorrow at 9:00 a.m.

--- Whereupon the hearing adjourned at 5:33 p.m., to resume on Thursday, September 11, 2014 at 9:00 a.m. / L'audience est ajournée à 17 h 33 pour reprendre le jeudi 11 septembre 2014 à 9 h 00