INTERNATONAL INSTITUTE OF CONCERN FOR PUBLIC HEALTH

May 23, 2013

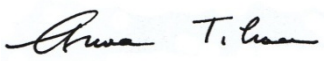
Debra Myles, Panel Co-Manager
Darlington Joint Review Panel
c/o Canadian Environmental Assessment Agency
160 Elgin Street, 22nd Floor
Ottawa, ON K1A 0H3
Email: DGR.review@ceaa-acee.gc.ca

Dear Ms Myles;

Re: Deep Geologic Repository Project for Low and Intermediate Level Radioactive Waste

Please find attached IICPH's comments to the Joint Review Panel on the adequacy of information provided by OPG's Environmental Impact Statement (EIS), of documents in support of OPG's licence application, and in particular, of OPG's responses to specific information requests, in relation to the requirements of the EIS Guidelines.

Sincerely,



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INTERNATONAL INSTITUTE OF CONCERN FOR PUBLIC HEALTH

Submission to the Joint Review Panel

with respect to

Ontario Power Generation (OPG)'s Deep Geological Repository (DGR) Project for Low and Intermediate-Level Waste (L&ILW)

May 23, 2013

Prepared by
Anna Tilman
Vice-President, IICPH

Introductory Comments

In this submission, IICPH is providing its views to the Joint Review Panel [Panel] as to whether OPG's Environmental Impact Statement (EIS) and documents in support of OPG's application for a Licence to Prepare a Site and Construct the DGR and the additional information provided by OPG in its responses to information requests, adequately address the requirements set out in the EIS Guidelines and are sufficient to proceed to a public hearing.

On May 28 2012, IICPH submitted 23 information requests citing relevant sections in the EIS Guidelines (Document Number 509) which are appended to this submission. Information requests (IRs) on many of these items have also been submitted by the Panel. This submission reviews a number of these requests, the responses by OPG, where given, comments on the adequacy of these responses, and raises additional questions that require clarification.

Part A: Reference Low and Intermediate Level Waste Inventory for the Deep Geological Repository [Reference Inventory Report]

Request # 1 (IICPH): Delineation between low and intermediate level radioactive waste

IICPH asked whether there are explicit definitions of and delineation between low and intermediate level radioactive waste (LLW&ILW). It was noted that Table 2.2 of the Reference Inventory Report specifies waste categories based on types of material (rags, mops, resins, reactor components etc.). However, no reference is provided as to the level of activities of the various radionuclides in each category of waste.

Comments:

Neither the Reference Inventory Report nor the EIS has given explicit definitions for LLW and ILW, nor has OPG responded directly on this issue.

As to the definition of these wastes, we note that in OPG's Proposed Environmental Assessment Screening Report for Darlington Refurbishment September 2012, E-doc 3917932, p.22, provided the following definitions for LLW and ILW:

> "LLW is defined as waste with contact radiation fields less than 10 mSv/h at 30 cm, and is routine waste that results from day-to-day reactor operations and maintenance, and subsequently categorized as incinerable, compactable, or non-processible."
>
> "ILW is defined as waste with contact radiation fields greater than 10 mSv/h at 30 cm and typically consists of spent ion exchange resins, disposable filters and certain non-processible wastes."

Do the definitions for ILW and LLW as stated in the Darlington Refurbishment Screening Report also apply to OPG's proposed DGR? If not, we require an explanation for this.

If, in fact, ILW is defined as waste with contact radiation fields >10 mSv/hr at 30 cm, what is the upper boundary for radioactivity in waste considered to be ILW? This is a crucial matter.

Is there a defined level of activity at which waste deemed to be ILW becomes equivalent to high-level waste in terms of activity?

IR EIS-04-105: Request # 7 (IICPH): Description of waste EIS Guideline Section 8.1

According to the Guidelines, information in the EIS must include (among other items):

> "a description of the waste characteristics including source, chemical hazard, radiological hazard, and the non-fissile nature of the material, including the halflife of each isotope, and how the properties, chemical and radiological hazards will change with time".

Comments:

The tables in the Reference Inventory Report on the various radionuclides in the wastes provide only limited information on the inventory and activity of radionuclides. To satisfy the guidelines, the information in this inventory must include the following:

- A complete list of all radionuclides in the waste, along with their half-lives ($\tau_{½}$) and activity (in Becquerels (Bq) or Bq/m^3)
- The ionizing particle (s) emitted by each radionuclide (α, β, and γ).
- The decay chain progeny

In addition, due to concerns about internal exposure to alpha particles and about the number of alpha emitters in the waste, the total alpha activity in the waste should be provided.

To our knowledge, the Reference Inventory Report of December 2010 has not been updated to include more information. This is a critical technical report. It is vital that it be as complete and as up to date as possible.

IR EIS-04-107: Request # 10 (IICPH): Section 8.1 General Information and Design Description

The Reference Inventory Report (page 23, Table 2.8) provides the inventory of non-radioactive components in the waste (in kg at the year 2052). OPG was asked to clarify whether some of the substances listed in the Table are stable end products of the decay of the radionuclides in the wastes.

OPG's Response:

"The list is not intended to include all stable end products of all radionuclides - only elements that are important for overall chemical composition or are otherwise important for the non-radiological safety case."

Comment:

It is important to include all stable end-products, particularly as the composition of decay products will change over time, many of these products are hazardous, and they affect the chemical activity within the repository.

IR EIS-04-108: Request # 11 (IICPH): Table 2.8

This section refers to uncertainties in the packages for newer "hotter" pressure tube wastes that will arise from future refurbishment. Likewise, section 3.2 refers to the "hot" ends of end fittings. IICPH asked for clarification as to the use of the terms "hot" and "hotter".

OPG's Response:

"Hot" refers to radioactivity.... "Hotter" in reference to newer pressure tube wastes indicates that these wastes will initially have higher radioactivity compared to current older refurbishment wastes since there will have been less time for radioactive decay. As such, additional shielding may be required for future station refurbishment wastes compared to the waste packages currently in use for Bruce A Unit 1 and 2 refurbishment wastes.

Comment:

The terms "hot" and "hotter" to describe radiation levels in the waste are not scientific and are inappropriate. Quantitative descriptors are needed. In addition, a description of the nature of "additional shielding" is required.

IR EIS-04-102: IICPH # 3: Scope of Project EIS Guidelines Sections 1.2, 4.1, EIS Summary p. 50

Clarification was sought as to whether Low and Intermediate Level Waste from pending or approved OPG new build, refurbishment or closure operations (i.e. decommissioning) will be placed in the DGR.

The Reference Inventory Report notes that "waste projections from any proposed new-build reactors in Ontario are not included in this report." (Section 1.3, p. 9)

OPG's Response (abbreviated):

OPG's licence application is for a DGR for 200,000 m^3 (disposed volume) of L&ILW from the operation and refurbishment of OPG-owned or operated nuclear reactors in Ontario. This could include L&ILW from the operation and refurbishment of OPG-owned or operated new-build reactors. " It would need to be demonstrated to the Canadian Nuclear Safety Commission (CNSC), prior to the emplacement of any new-build L&ILW into the DGR, that the safety case for the DGR remains valid for such wastes and there were no significant additional environmental effects."

OPG's current licence application does not include decommissioning waste. If in future OPG decided it wished to put some forms of decommissioning waste into the DGR then it would need to apply to the CNSC for a licence amendment to allow this activity, and the associated regulatory process would be triggered.

Comments:

<u>Re inclusion of waste from new build</u>: Projections of this waste must be included in the inventory stage and not postponed until this waste is generated.

<u>Re decommissioning waste:</u> The EIS Summary (p. 10) notes that "an additional 135,000 m^3 of L&ILW is expected to be produced during the decommissioning of the reactors and the associated nuclear waste storage facilities." If the DGR is to store decommissioning waste, then the components of this waste, and the activity of the radionuclides, must be included in the inventory. Especially because the characteristics of this waste and its level of activity could be similar to those for irradiated fuel, it is essential that projected decommissioning wastes be included in the inventory on which approval of the DGR is based. That would also significantly change the projected capacity of 200,000 m^3 of the project.

The inventory of wastes is estimated to be 17,000 TBq at repository closure (assumed to be in 2062). That amount could be a serious underestimation, especially, if new-build and decommissioning wastes are not considered. This is also an issue in examining cumulative impacts of this project.

It is essential that the inventory be complete and accurate before proceeding to a hearing.

Part B: Human Health Issues

Request # 2 (IICPH) Section 11.5.6 Human Health of the Guidelines states:

> The EIS must provide a discussion on the potential effects of the DGR on the physical, mental, and social well-being of workers, the public and communities.

Comments:

Several items were listed in the guidelines pertaining to human health. However, as IICPH commented in its submission of May 28, 2012, there is no stand-alone document focussed on human health. In light of the critical issue of the impact on human health of this project during the phases described and in the very long term, IICPH requested that OPG be required to produce such a document. But it has not done so.

There are a great many human health effects, throughout all the stages of the project and for a very long time after, that need to be addressed. These include:

- The potential generational, long-term and cumulative effects from exposure to both radiological and hazardous non-radiological substances from contaminated groundwater, food and air. Specifically addressed should be references to studies in the scientific and medical literature explaining how radioactive particles and gases kill or injure cell membranes and DNA inside the cell nucleus.
- The effects of exposure to radioactivity on specific populations for which it could cause particularly high health risks, including but not limited to:
    - Repository workers who are exposed to occupational radioactivity;
    - Families of workers who are exposed through direct contact or genetic harm;
    - Local communities who live in closest proximity to and downwind of the proposed DGR;
    - Populations particularly vulnerable to the toxic properties of radioactivity, including foetuses, infants, the elderly, and the immune compromised.
- Protection against the conditions which are most readily caused by radiation, including childhood cancer, thyroid cancer, leukemia, breast cancer, birth defects, and infant mortality (among others).
- The failure of the EIS to recognize that health hazards to humans from relatively low-dose exposures have been documented in the medical literature. This is a huge obstacle to objectively addressing potential health threats from the Repository.
- The adverse health impacts on workers and communities that would result from the accidents that could occur during every stage of the project, from construction, rock falls, the transfer of the waste, and any breach of containment.

- Many of the radionuclides in the waste are alpha emitters. Internal exposure to alpha particles is particularly dangerous. This factor alone deserves consideration, especially for workers who may be at greatest risk of internal exposure to alpha particles.
- How are potential adverse health effects on transient populations to be monitored? This is especially the case for workers brought in at various stages of the proposed project who would not necessarily live within any of the boundaries of the study areas. It is also the case for people who move in or out of the areas over time.
- Is there even a baseline against which adverse health effects can be monitored? What morbidity and mortality studies for cancer and other disorders have been done on the local, regional, and national communities and when? In the case of the proposed Repository, there could be many baselines, such as the period before the Bruce reactors began operating, and/or the current period, before the Repository opens. Is there an elevated risk posed by siting the proposed DGR at the Bruce Nuclear Generating Station?
- The potential impact of drinking water contamination, due to the potential migration of toxic waste to groundwater, poses a threat to human health and the environment for countless future generations. Even if the level of radioactivity diminishes over time, enough will remain to cause serious harm for a million years or more. Potential geological changes over time, that may increase the chance of releasing radioactivity into the environment, have also not been adequately addressed.
- Many of the resulting stable progeny from the decay of radionuclides are heavy metals, such as mercury, lead, and thallium, which are very toxic to human health and the environment. Has OPG examined the impact of this?
- The EIS gives no comparative information on the experience with environmental contamination and health hazards from other, comparable repositories, such as the ASSE II facility in Germany, and the Barnwell and Richland facilities in the U.S.

Most importantly, a failure in any part of the repository, to say nothing of a complete failure of the repository, will have far-reaching consequences on human health and the environment that extend well beyond the areas being considered in the EIS (regional study areas). They must be fully addressed.

Each of these items, and many others, must be dealt with in a fulsome, synergistic and cumulative manner. The EIS is inadequate if it does not address these matters.

IR EIS 08-390: Human Health: Sections 10.2.6 and 11.5.6

Provide a review of radiation-related cancers in the county over time using correct statistics, such as Standardized Incidence Ratios (SIRs). Provide also a discussion of ecological study designs and the known cancer-related risk factors within the area.

Context: CNSC indicated that the Grey Bruce Public Health Unit conducted a cancer incidence report in 2008 for the period 1986-2004 which compared cancer rates with the general Ontario population. Likewise, they have also conducted a risk factor survey for the county. These two pieces of evidence should be used in the response.

OPG's Response:

There are no available studies that relate exposures to ionizing radiation and cancer rates within the Grey Bruce Health District.

Comment:

Not having such studies available is a serious matter. Without such a base, there is no way to assess whether and to what degree the local areas are being adversely affected by exposure to ionizing radiation during the various phases of the project.

Part C: Potential of the Proposed DGR to Store High-Level Waste

IICPH Request #22: What guarantee do we have that the proposed DGR will never be used to store High Level Radioactive Waste, i.e., used fuel from reactors?

IR EIS-04-99: Discuss the technical and regulatory factors that would prevent the transformation and use of the DGR for high-level waste disposal.

OPG's Response to the Panel's IR in brief, is:

- It could not transform the DGR to a facility for high-level waste (i.e., used nuclear fuel) disposal because it has no legal ability to establish a DGR for used fuel, because the mandate for that lies with the Nuclear Waste Management Organization (NWMO);
- the application for a site preparation and construction licence is for a DGR for OPG's L&ILW, and the submitted safety case is for L&ILW; and
- OPG has publicly committed that used fuel will not be placed in the L&ILW DGR.

OPG further states that "neither OPG nor the NWMO have evaluated the technical potential for OPG's DGR to be transformed to take used nuclear fuel, nor are there any plans to conduct such an evaluation."

Comments:

OPG's technical and legal factors are not carved in stone in perpetuity. Legal changes can always be made. Organizations change. An evaluation of technical changes could be made at any time. So a "public commitment" that used fuel will not be placed in the L&ILW DGR at this time does not guarantee that the proposed DGR could not be used in the future for nuclear fuel waste.

Likewise, OPG cannot guarantee (as requested) that the proposed DGR for L&ILRW will be limited to OPG's reactors.

Part D: Incineration - LLW

IR EIS-04-106, 121: Request # 6 (IICPH): EIS Summary p.10 Section 8.1

According to the EIS Summary, "the majority of these wastes [LLRW] are processed through incineration or compaction for volume reduction".

- Is it assumed that incineration of LLRW will continue for the duration of the proposed Project?

- Has any allowance been made for shutdowns, breakdowns, upgrades, etc. of the incinerator?
- Have the health and environmental hazards from incineration been addressed?

OPG's Response:

Radioactive waste incineration is currently used for waste volume reduction at OPG's Western Waste Management Facility (WWMF). As well, from time to time, radioactive liquids and low level radioactive waste solids are shipped to a licensed waste incinerator in the US with resulting ash returned to the WWMF for storage. It is not intended to have an incinerator on the DGR site.

Comments:

OPG has not addressed the questions regarding incineration. The proposed DGR for storing L&ILRW depends very much on incineration of LLW to reduce the volume of this waste. If the incinerator breaks down, is out of service, as has happened, does OPG then plan to ship this waste to the US for incineration? If so, that should clearly be stated.

The health and environmental issues associated with incinerating radioactive waste have still not been addressed.

Part E: Abandonment

IR EIS-05-181: Request # 5 IICPH

The Guidelines (Section 8.6) state that "an abandonment plan is required to determine the safety of the facility and its potential impact on human health and the environment."

IICPH requested more information as to what constitutes an abandonment plan. We questioned whether abandonment is even feasible, especially given the long half-lives of many isotopes, the potential for seepage into groundwater, and the potential for unforeseeable accidents and environmental changes (climate, glaciation, earthquakes etc.) in the very long term.

Furthermore, according to the EIS Summary (p. 18), "Abandonment begins when decommissioning is complete and includes institutional controls for a period up to 300 years."

We requested clarification as to what institutional controls are being considered. We also questioned the rationale for having such controls for at most 300 years, especially when the half-lives of many of the radionuclides are much longer than this. Furthermore, how will any accidents, natural disasters etc., be dealt with after that period.

OPG's Response (abbreviated):

Abandonment Plan: At this time only an outline of the abandonment plan can be presented at a conceptual level, as most of the information required to prepare an abandonment plan will not be available until the time of closure of the facility. The detailed abandonment plan will be prepared after a final end-state report has been submitted to the CNSC on completion of decommissioning of the DGR. "The end-state report will demonstrate that the intended end state has been achieved in accordance with the Detailed Decommissioning Plan and regulatory

requirements, and will identify what further work, if any, remains to be done prior to abandonment."

Institutional controls: The institutional controls, assumed to be in place for up to 300 years for safety assessment purposes, could include passive controls such as local land use controls, preservation of knowledge and memory through public records/archives, and use of durable surface and/or subsurface markers. Active controls could include activities requiring action by some authority to conduct monitoring, surveillance, maintenance of the monitoring equipment, remedial work, maintenance of some aspects of the site features, etc. "Beyond the period of 300 years, there are no expectations in the DGR safety assessment with respect to any ongoing societal control, monitoring or memory of the site. The assumed period of 300 years for institutional controls is consistent with current international practice."

Comments:

These responses do not address our concerns at all. OPG must be required to prepare detailed abandonment plans right away for a number of circumstances, and not wait until closure. For several reasons, it might be necessary to abandon the repository during its operational period.

Similarly, a period of 300 years as a maximum for institutional controls (ongoing societal control, monitoring or memory of the site) is totally inadequate. It is precisely the very long-term potential impacts on human health and the environment of the contents of the repository that would require continual monitoring, and memory of the site.

These responses are totally inadequate, unsatisfactory and very disconcerting.

In IR EIS 09-460, with respect to Section 13.1 of the EIS Guidelines on Long-Term Safety of the DGR, OPG was asked to "Include and evaluate additional disruptive scenarios that have a reasonable likelihood of occurrence" that are not included in the disruptive scenarios that OPG has evaluated so far. These scenarios included abandonment before the complete filling of the repository; the loss of ability to administer/ service/maintain operations (such as, for example, an inability to put the shaft seals in place) for a limited time period (years), and for an extended time period (decades).

OPG's Response (abbreviated):

a) Abandonment Before Completely Full, with Closure

In this case, since the repository volume is fully excavated before operations begin, there will be more void volume available at closure than currently planned. As the repository is partially full, there will also be less waste, and therefore less radioactivity and less gas generation potential. The gas generation rate will be slower, the gas pressure buildup rate will be slower, and there will be less gas ultimately within the repository. The gas pressure will still build up towards hydrostatic pressure in the long term, as the water slowly seeps back in and compresses the existing gas. The dose impacts would be smaller for this scenario than for the reference case with a full repository.

b) Temporary Loss of Service to the Repository

The scenario considered is one in which the repository has been filled with wastes; however, before the repository is properly closed and the shafts are sealed, there is a loss services to the

DGR that lasts for years to decades. In particular, it is assumed neither electrical power nor maintenance is provided. In this case, the most important consequence would be buildup of water within the shaft bottoms. Since the repository is sloped upwards away from the shaft station, it is only after this time that accumulating water would start to fill the repository level and potentially contact the wastes.

However as the repository is filled, the waste-emplacement rooms are progressively isolated with closure walls. When the repository is full, but before shaft sealing, the waste panels are all isolated by these closure walls, which would delay contact between the water accumulating in the shaft station area and the wastes. Up to this time, the wastes and waste packages would not be affected. Conditions within the panels would remain largely dry, with slow changes in gas composition and pressure due to the expected corrosion and degradation reactions.

After this time, there would be an increased amount of water permeating around the closure wall (through the more permeable damaged rock around it) coming from the accumulated water on the shaft side of the closure wall. However, this rate would depend on the characteristics of the rock and the closure wall, and the pressure difference across the closure wall. The net flow would be inwards into the waste panels. Radioactivity releases from the repository would be very low.

c) Long-term 'Abandonment' of the Repository

Here it is assumed that the repository is 'abandoned' indefinitely, i.e. without shaft sealing. "It is noted that this would require a breakdown in Ontario and Canadian society within the next 50 years, which is the time frame for repository closure. This is very unlikely. (Note also that there would be consequences from a breakdown in society if there were no DGR and the wastes remain stored on surface structures at the Bruce nuclear site.)"

Comments:

OPG's responses do not answer the critical questions asked. As to abandonment prior to closure of the DGR, OPG responds that "As the repository is partially full, there will also be less waste, and therefore less radioactivity and less gas generation potential." In terms of temporary loss of service, OPG assumes that "Radioactivity releases from the repository would be very low," even though water would penetrate into the waste. And in reference to long-term abandonment, OPG assumes that there will be no breakdown in society within 50 years, the timeframe of the repository.

These responses are totally inadequate to the questions concerning abandonment. Not only are institutional controls not specified, but OPG's assumptions have no scientific or technical basis.

- In terms of loss of service, OPG has not provided a case for no permeability, and even acknowledges the release of radioactivity, albeit a "very low" level. In other words, they are admitting that water would get in, which means that radioactivity would get out.
- Furthermore, OPG fails to address the long-term impact of long-term abandonment by only taking into account a very short time period of 50 years.

Part F: Cumulative Impacts

IR EIS-08-360: Section 14, Cumulative Effects Assessment

Section 7.3 of the EIS Guidelines states that the EIS "must also describe the environmental effects of each alternative means. In describing the preferred means, the EIS should identify the relative consideration of environmental effects, and technical and economic feasibility. The criteria used to identify alternative means as unacceptable, and how these criteria were applied, must be described, as must the criteria used to examine the environmental effects of each remaining alternative means to identify a preferred alternative."

OPG's Response to the question "How did the cumulative affects assessment inform the evaluation of alternative means of carrying out the Project?" (EIS Guideline section p. 14) is as follows:

"The cumulative effects assessment did not inform the evaluation of alternative means of carrying out the project or the selection of the preferred project. The Canadian Environmental Assessment Agency (CEAA 1999, Section 3.1) states that the substantive work in a cumulative effects assessment (CEA) is often done after the initial identification of effects has been completed in an EIS. In this way, the early identification of direct project effects "paves the way" for cumulative effects to be assessed.

If the cumulative effects assessment for the DGR project had identified significant adverse impacts, then looking at alternative means of carrying out the project could have been considered to mitigate those impacts, but this situation did not arise."

Comments:

There is a clear need to examine alternatives for storing this waste, such as, and most obvious, the status quo, that is, the WWMF.

It is unfortunate that cumulative effects assessments "are often done after the initial identification of effects have been completed in an EIS." If cumulative effects are not identified early, because the EIS has not been thorough, then adequate measures cannot be taken against them before it is too late. This is the case with this EIS, because it does not include synergistic effects and eliminating interactions among VEC and multiple stressors.

The integration of multiple stressors from all relevant human activities within the temporal and spatial boundaries for the assessment must be considered, at least at a conceptual level, and then examined for their combined potential to produce significant adverse effects.

With reference to Section 14 of the EIS guidelines, the "EIS must include different forms of effects (e.g., synergistic, additive, induced, spatial or temporal) and identify impact pathways and trends." Section 11 of the EIS guidelines states that "specific attention must be given to interactions between the project and the identified VECs." However, in Section 10 of the EIS, OPG does not describe whether or how complex effects (e.g., synergistic, interactive) were considered.

OPG's Responses:

Human exposure to radiation and radiation dose to non-human biota were included for the purposes of cumulative effects assessment even though no residual adverse effect was identified.

Of those residual adverse effect(s) on each of these valued ecosystem components (VECs), (Table 10.3-1 of the EIS) "only adverse effects to the air quality, noise levels, socioeconomic environment and human health environmental component VECs extended beyond the Site Study Area."

For each of the residual adverse effects, the projects considered in the cumulative effects assessment were examined to determine whether there was potential for cumulative effects with those VECs. In the event that a cumulative effect was identified, both the direct and indirect (synergistic) cumulative effects would have been carried forward. As summarized in Section 10.8 of the EIS, no likely adverse cumulative effects were identified.

Comments:

The analysis of cumulative effects by OPG falls far short of what needed to be considered under the umbrella of cumulative effects. Certainly in terms of the cumulative effects on human health, the cumulative assessment arguments put forth by OPG are not in the spirit of what constitutes cumulative assessment. They are dealt with singly rather than synergistically, and in the short-term rather than the long-term.

It is our view that the information on this topic is clearly inadequate.

Part G: Long-Term Safety of the DGR

IR EIS-08-335: OPG was asked to provide an evaluation of the possibility of interrelated failure modes and their consequences, including an evaluation of the 'What-if' scenario of basement faulting leading to disruption of the shaft seal(s) thereby providing two pathways to the surface environment (fault line and shaft).

Context: Cascading failures of complex systems (e.g., the Fukushima Daiichi nuclear accident) can lead to unanticipated and enhanced adverse consequences. The 'What-if' scenarios considered in the Post-closure Assessment do not include an evaluation of such occurrences.

OPG's Response (abbreviated):

The possibility of interrelated failure modes and their consequences is very remote. The DGR is based on a passive approach to safety to minimize the risk of failure.

The key feature of the 'what if' scenario of basement faulting plus disruption of the shaft seals is that it results in release of contaminants through creation of a direct pathway from the high-pressure Cambrian Formation to surface through the repository. This was already identified as a higher-dose consequence case, with peak impacts of around 30 mSv/a. Separate analysis of the consequences of extreme shaft seal failure indicate peak dose rates to someone living directly above the repository of around 80 mSv/a.

In summary, the results from the Severe Shaft Seal Failure Scenario and the Inadvertent Human Intrusion Scenario provide perspective on the consequences of the suggested 'what-if' case.

These scenarios indicate potential dose consequences of the proposed scenario to someone living on the repository site in the range of 10 -100 mSv per year. For reasons as noted above, this proposed scenario is very unlikely, and it remains within the DGR risk criterion of 10^{-5}.

Comments:

According to Section 13.1 EIS Guidelines:

> "The safety assessment is central to the safety case. It involves an analysis to evaluate the performance of the overall waste disposal facility and its impact on human health and the environment."

By stating that "the possibility of interrelated failure modes and their consequences is very remote", OPG has made a pre-determination that this scenario, despite its consequences, is not plausible and dismisses it.

Likewise, the what-if scenarios that OPG projects would result in annual doses anywhere from 10mSv to 100 mSv for someone living directly above the repository are also dismissed as "very unlikely".

OPG's responses lack scientific rigour. Furthermore, they fail to follow the precautionary approach as set out in Section 2.5 of the EIS Guidelines, which states:

> "The Precautionary Principle informs the decision-maker to take a cautionary approach, or to err on the side of caution, especially where there is a large degree of uncertainty or high risk."
>
> "The proponent must demonstrate that all aspects of the project have been examined and planned in a careful and precautionary manner in order to ensure that they do not cause serious or irreversible damage to the environment and/or the human health of current or future generations".

Similar concerns about the failure to apply the precautionary principle were also raised by IICPH (IICPH Request # 23).

Conclusion

Based on our review of this material, we have found many very serious deficiencies in the EIS and supporting documents, most specifically with respect to human health, the inventory of radionuclides and other hazardous substances in the waste, and other overriding issues, including the lack of a fulsome assessment of cumulative impacts, and an excessively narrow interpretation of the precautionary principle raise very serious doubts about the scientific and technical merit of some of this material.

We have also found OPG's responses to requests, where given, to be very limited and unsatisfactory.

If these very serious inadequacies and deficiencies are not corrected, we conclude that the information that has been provided is insufficient to proceed to a hearing.

Request Number	EIS Guideline Section	EIS Section or other reference	Comment/Information Request	Context
1		Reference Low and Intermediate Level Waste Inventory for the Deep Geological Repository [Reference Inventory Report], EIS Summary p. 10	What are the explicit definitions of and the delineation between low and intermediate level radioactive waste (L&ILRW)?	Table 2.2, Inventory Report, specifies waste categories based on types of material (rags, mops, resins, reactor components etc.). However there is no reference to the nature and/or activities of the various radionucleides in each category of waste.
2	Human Health 8.1, Sections 10, 11		There is no stand-alone document on human health. This means that intervenors and the public have to search through numerous lengthy documents to find mention or discussion of the effects of the Project on human health, rather than having a consolidated "Technical Support Document" (TSD) or an equivalent document focussed on human health. Given the significant concern about the impact of the proposed DGR on human health, both in the short term and in the very long term, we are requesting that OPG be required to produce a document specifically on the potential impact on human health, including worst-case scenarios.	There are many aspect to human health effects – workers, the public, local communities, native communities, sensitive (vulnerable) populations, generational and long term effects, radiological hazards, hazards from non-radiological substances, routes of exposure (ingestion, absorption, inhalation), accidents and malfunctions, cumulative effects from multiple exposures, including the various phases of the project and concurrent projects, etc. A comprehensive report on health effects is needed to address all these concerns.

Request Number	EIS Guideline Section	EIS Section or other reference	Comment/Information Request	Context
3	Scope of Project Sec. 1.2, 4.1	Reference Inventory Report Sec. 1.3 Executive Summary	Scope of project (Sec. 1.2, 4.1) lacks clarity. • What does "continued operation" mean? Does it include L &ILRW from any new build at OPG's nuclear stations? • We are requesting that OPG clarify whether new-build L&ILRW is included in the proposed project. If not, a rationale should be provided for not including it in the proposed project and/or the Inventory Report, and the plans for disposing of this waste.	The Reference Inventory Report specifically notes that "waste from any proposed new-build reactors in Ontario are not included in this report" (Section 1.3). The Executive Summary of this report states that "future operational L&ILRW will be shipped" (to WWMF for processing). This statement could be interpreted as including waste from any new build.
4	Scope of Project Sec. 1.2, 4.1	EIS Summary p. 40	What will be the status of the WWMF during the various phases of the proposed Project? We are requesting that OPG explicitly describe its plans for WWMF over all phases of the proposed Project, including what "upgrading" the facility involves, and how this activity will be done while waste is also being removed from the facility to be placed in the proposed DGR. Furthermore, the WWMF cannot be decommissioned until the used fuel presently stored there can be safely removed to a suitable facility.	P. 40 of the EIS Summary indicates that the facility is to be "upgraded", and then decommissioning is to begin around 2045.

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5	8.6 Abandonment	EIS Summary p. 18	• What constitutes an abandonment plan? Is abandonment for this project even feasible, especially given the long half-lives of many isotopes, the potential for seepage into groundwater, and the potential for unforeseeable accidents and environmental changes (climate, glaciation, earthquakes etc.) in the very long term? • Can OPG clarify what institutional controls are being considered and what are the institutes? What is the rationale for having such controls for at most 300 years, especially when the half-lives of many of the radionuclides are much longer than this? How will any accidents, natural disasters etc. be dealt with after that period?	The Guidelines state that "an abandonment plan is required to determine the safety of the facility and its potential impact on human health and the environment." According to the EIS Summary, abandonment begins when decommissioning is complete and includes " institutional controls for a period up to 300 years".
6		EIS Summary p.10 Incineration -LLRW	• Has OPG produced a specific section on incineration in the EIS or any supporting documents? • Is it assumed that incineration of LLRW will continue for the duration of the proposed Project? • Has any allowance been made for shutdowns, breakdowns, upgrades, etc. of the incinerator? • Have the health and environmental hazards from incineration been addressed?	The EIS Summary states that "the majority of these wastes are processed through incineration or compaction for volume reduction".

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7	8.1 General Information and Design Description	Reference Inventory Report	• Please indicate whether there is an analysis as to how the radiological hazards will change over time and if so, where it is to be found. If there is no such analysis then we are requesting that this be done. • The type of emissions (i.e., alpha, beta, gamma radiation) given off during the decay of these radionuclides needs to be identified in the Inventory Report.	According to the Guidelines, information in the EIS must include (among other items) "a description of the waste characteristics including source, chemical hazard, radiological hazard, and the non-fissile nature of the material, including the halflife of each isotope, and how the properties, chemical and radiological hazards will change with time". However the tables in the Reference Inventory Report on the various radionuclides in the wastes do not provide information on the type of emissions of the radionucleides (i.e., alpha, beta, gamma emitters) or their progeny.
8	8.1 General Information and Design Description	Reference Inventory Report tables 2.4-2.7 providing estimates of total decay	• How has OPG accounted for the total decay of the radionucleides at two dates -2018 and 2062? What are the start dates? • What is the degree of accuracy of the information in the tables?	
9	8.1 General Information and Design Description	Reference Inventory Report pages 76, 78	• We are requesting that OPG review the Inventory Report and clear up inconsistencies and incompleteness in the inventory. • Are all "potential hazardous constituents" of bottom ash included in the description on pp. 76, 78?	For example, there is an inconsistency in the description of waste types in the volume of bottom ash in 2018 in the Report. Tables 2.4 and 2.5 indicate 1352 m^3 while pp. 76, 78 Appendix E of the Report indicate a different volume of bottom ash for 2018.

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10	8.1 General Information and Design Description	Reference Inventory Report Table 2.8	Are some of these substances stable end products of the decay of the radionuclides in the wastes? This should be clarified.	Table 2.8 shows the Inventory of non-radioactive components in the waste (in kg at the year 2052).
11	8.1 General Information and Design Description	Reference Inventory Report Section 3.1 Waste Volumes and Package Inventory Section 3.2 Radionuclide Inventory	Can OPG clarify what is meant by “hotter” in reference to newer pressure tube wastes arising from future refurbishment? Likewise, what is meant by "hot" in reference to the “hot” ends of end fittings?	In this section, reference is made to uncertainties related to the packages for newer “hotter” pressure tube wastes that will arise from future refurbishment. Likewise, section 3.2 Radionuclide Inventory refers to the “hot” ends of end fittings.
12	9.1 Spatial Boundaries and Scale		• How has the study area incorporated the full extent of the impact on groundwater and air? • Is it even possible to place spatial boundaries on the potential effects over a time scale of even a million years?	
13	9.2 Temporal Boundaries		What worse-case scenarios have been developed to determine the temporal boundary?	
14	4.2 Factors to be considered in the EIS	EIS Summary p.7 re alternatives	• Have there been recent independent studies on alternatives to a deep geological repository for storing these wastes? Has there been an independent study on the "status quo" that is, the WWMF? • Have these studies evaluated the impact of natural disasters and human-induced environmental changes on alternatives to the DGR (climate change, drought, etc., worst-case scenarios) in comparison with the impact on the DGR?	

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15	10 Existing Environment	Re: Baseline description of the environment	• What is the level of "reasonable confidence" assigned to predict the long-term performance of the proposed DGR? What period is considered to be long-term? • How can the reliability of these assessment models be validated? For example, – Have the effects of accidents, climate change (e.g. drought, flooding) been incorporated? – Have cumulative impacts been considered on the value-added ecosystem components (VECs) identified, for example, long-term human health effects?	According to this section, "The subsurface environment will play a dominant role in containing and isolating the waste from humans and the environment in the long term. It is therefore expected that the information on subsurface site characterization will be sufficient to allow the development of site specific assessment models that will predict with reasonable confidence the long-term performance of the proposed DGR."
16	10 Existing Environment		How have transient populations been identified? How will potential adverse health effects on transient populations be monitored over the very long term?	"Information on existing and projected population densities and distributions in the region, including resident populations and transient populations, must be provided by project phase, and for the entire life of the project."
17	Section 13.2 of the Guidelines, Long-term safety of the DGR, states "The safety assessment should demonstrate that the set of scenarios developed is credible and comprehensive. Some scenarios may be excluded from the assessment because there is an extremely low likelihood that they would occur or because they would have trivial consequences."		The proponent should provide a list of which scenarios have been excluded and for which of the two reasons indicated, that is, low likelihood and/or trivial consequences, with an explanation.	

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18	13.4 Confidence in Mathematical Models		These models are supported neither by logic nor by long experience, which are the only bases for scientific proof. Can OPG explain how these models can be scientifically validated given the uniqueness of this Project?	Validation of models Because many of the complex processes involved are poorly understood and many model assumptions impossible to verify, we do not see how computer predictions can be a reliable guarantee for the very long-term (hundreds of thousands, millions of years) safety of the repository.
19	14 Cumulative Effects	EIS Summary Chart on p. 40	• The EIS Summary p. 40 indicates that the transfer of used fuel to a long-term repository is a reasonable foreseeable project. Does this refer to NWMO's development of a potential long-term repository for storing all of Canada's used fuel? If not, please explain. • We are requesting clarification as to why "the DGR for decommissioning Bruce Power waste" is "not a planned activity, but is included to meet guideline requirements", specifically because the EIS Guidelines indicate that the management of decommissioning waste would be a potential future project that should be included in an assessment of cumulative effects. • Other operations and potential projects that should be addressed but are missing include but are not limited to: – Wastes from any new build of nuclear reactors; – The potential for storing wastes from reactors other than OPG's fleet. – Possible changes to the operations for minimizing waste, in particular, incineration.	The chart lists cumulative impacts with other projects over the lifespan of the DGR. Past, Existing and Planned Projects (certainty) identified include for example, Decommissioning Bruce A and B, "WWMF upgrades" and Reasonably Foreseeable Projects.

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20		Radon Assessment Prepared by NWMO DGR-TR-2011-34 March 2011	We do not note any section on diffusion of radon (and its progeny, in particular, polonium 218 and 214, all alpha emitters) from waste packages. Has this been addressed?	This document only examines diffusion of radon from host rock and waste rock piles.
21		EIS Summary p. 31, 45 Groundwater contamination-	The potential impact of drinking water contamination, due to the contamination of groundwater by seepage, and the potential migration of toxic waste to groundwater, poses a threat to human health for future generations. Even if the radioactivity is greatly diminished over time, enough will remain to cause serious harm for a million years or more, and the resulting stable progeny (heavy metals for example) are toxic to human health and the environment. Has OPG examined this matter in any document?	This section discussed groundwater contamination from intrusion by drilling, migration of radiological and nonradiological contaminants over time, and effect on potable water.
22			• What is the guarantee that the proposed DGR for L&ILRW will be limited to OPG's reactors? • What guarantee do we have that the proposed DGR will never be used to store High Level Radioactive Waste, i.e., used fuel from reactors?	

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23	2.5 Precautionary Approach The Guidelines state: "The Precautionary Principle informs the decision-maker to take a cautionary approach, or to err on the side of caution, especially where there is a large degree of uncertainty or high risk." Furthermore, "The proponent must indicate how the precautionary principle was considered in the design of the project in at least the following ways: • Demonstrate that all aspects of the project have been examined and planned in a careful and precautionary manner in order to ensure that they do not cause serious or irreversible damage to the environment and/or the human health of current or future generations; • Outline and justify the assumptions made about the effects of all aspects of the project and the approaches to minimize these effects; • Alternative means of carrying out the Project are evaluated and compared in light of risk avoidance, adaptive management capacity and preparation for surprise; • That in designing and operating the project, priority has been and will be given to strategies that avoid the creation of adverse impacts; • That contingency plans explicitly address accidents, malfunctions and malevolent acts and include risk assessments and evaluations of the degree of uncertainty; • Identify any proposed follow-up and monitoring activities, particularly in areas where scientific uncertainty exists in the prediction of effects; and • Present public views on the acceptability of all of the above."	Where in the EIS has each of these guideline requirements been met?