Joint Federal Review of Ontario Power Generation's Proposed Deep Geologic Repository for Low and Intermediate Level Radioactive Wastes

DGR Joint Review Panel Hearing Written Submission in Support of an Oral Intervention

WASTE ISOLATION PILOT PROJECT
and
INTERNATIONAL EXPERIENCE
with
DEEP GEOLOGIC REPOSITORIES

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Introduction

Ontario Power Generation (OPG) is proposing Canada's first-of-its-kind Deep Geologic Repository (DGR) for radioactive wastes. The repository project as proposed by Ontario Power Generation would involve the emplacing of an estimated 200,000 m3 of low and intermediate level radioactive wastes approximately 680 metres below the surface of the Bruce Nuclear Generating Station on the eastern shore of Lake Huron, within the municipality of Kincardine, Ontario. While classified as "low and intermediate", the waste types include some which are highly radioactive over very long periods of time.

DGRs are purported to provide "disposal" by emplacing wastes several hundred meters underground with no intention of retrieval, in contrast to "storage" facilities where the wastes can be monitored and retrieved, as necessary. Given the lack of experience with any DGR in Canada, OPG states that a basic rationale for proposing the DGR is "because it is consistent with international best practice."[1] Therefore, consideration of OPG's understanding of "international best practice" and actual "international experience" with such facilities becomes an important consideration in evaluating the proposed DGR.

The international experience of a DGR for radioactive waste is that only three have operated for a decade or longer. Two facilities in mines in Germany – Asse and Morsleben – did not operate as planned and no longer are receiving wastes, but will not be decontaminated and decommissioned for decades; and one facility in the United States of America (USA) – the Waste Isolation Pilot Plant (WIPP) – which began disposal operations in March 1999 and has received about half of its planned capacity.

There are lessons to be learned from those three experiences, some of which are acknowledged in the OPG Preliminary Safety Report (PSR), Environmental Impact Statement (EIS), and Information Responses (IR), but many of which are not. For instance, in the case of the WIPP, OPG does not accurately describe the actual requirements for WIPP; does not provide current

[1] Ontario Power Generation (OPR), 2011. *Deep Geologic Repository for L&ILW - Environmental Impact Statement. p. 1-2.*

information about the many changes being considered or allowed at WIPP; and does not address the unexpected events that have arisen at WIPP.

The basic fact is that there is not yet one example of a DGR that successfully operated to fulfill its mission of safely isolating the wastes from people and the environment for the thousands of years that they are hazardous. Nor is there an example of a DGR that has been closed and decommissioned. Thus, there is no example of a DGR that has safely contained radioactive wastes throughout even its operational phase, let alone for the thousands of years that those wastes pose significant risks to human health and the environment. International experience, including "best practices," demonstrate that there are many uncertainties; it does not establish that a DGR can be successfully operated and decommissioned.

1. OPG's use of international experience

According to the Preliminary Safety Report (PSR)[2], the proposed DGR is "consistent with best international practice." P. 1 of 768.

The PSR also states:

> The DGR would be the first deep geologic repository for L&ILW in Canada and there are no directly comparable Canadian facilities. There is, however, in the U.S. and overseas, good operating experience with geologic repositories for similar wastes. Current repositories are listed in Table 14-1. P. 671 of 768.

Table 14-1 lists five facilities: Forsmark (SFR), Sweden; Olkiluoto and Loviisa[3] in Finland; WIPP, and Konrad, Germany. The first three are less than 115 meters deep and should not be considered DGRs. The fifth is a DGR but is still under development and is not scheduled to begin operations until 2019.

The PSR further states:

> The U.S. WIPP is particularly relevant as it is situated in a sedimentary setting at a depth similar to the DGR, and OPG has gained valuable insight into the construction and operation of its DGR through many visits to WIPP and interactions with WIPP staff. Id.

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[2] Ontario Power Generation (OPG). 2011. *Deep Geologic Repository for Low and Intermediate Level Waste - Preliminary Safety Report*. 00216-SR-01320-00001 R000.

[3] Various documents provide different translations of the site names to English, but here the Finish translation is used, except when quoting from documents. http://www.stuk.fi/ydinturvallisuus/ydinjatteet/en_GB/jatteet/

Regarding institutional controls after decommissioning, the PSR states:

> A period of 300 years is assumed over which such controls, including societal memory, are effective, consistent with international practice. P. 6 of 768.

The EIS states that the DGR is proposed because (among other factors): "It is consistent with international best practice." P. 1-2.

In IR EIS-08-366, OPG states:

> Utilization of international experience has been, and will continue to be, an important aspect in the development and future operation and decommissioning of the DGR.

Nine insights were also listed in that IR:

- comprehensive public engagement programs are an important part of attaining public acceptance of repository projects;
- geological conditions as well as the roles of various natural and engineered barriers are unique at each repository site and strongly influence the safety case at each site;
- the efficacy of specific site characterization methods;
- the importance of ensuring no significant groundwater flow paths into a repository;
- concurrent room excavation and waste emplacement, versus having these activities sequential is an important design and operational consideration;
- the importance of maintaining the safety case consistent with actual waste inventories;
- approaches to preclosure and postclosure safety assessments;
- issues with certain waste conveyance methods, in shaft and underground; and
- plans for shaft seal design.

In IR EIS 09-410, OPG added four more facilities to the five included in the PSR, which are Asse and ERAM (Morsleben) in Germany, Wolsung in the Republic of Korea, and Bátaapáti in Hungary. The latter two facilities are much closer to the surface (less than 250 meters deep) than other DGRs and have begun operations in the past year. Table 1 (of IR EIS 09-410) provided a summary of key features of the nine facilities compared with OPG's DGR.

In IR EIS-11-503, OPG states:

> There are a limited number of international geologic repositories in operation or construction. These are outlined in OPG's response to Information Request (IR) EIS-09-410 (OPG 2013a) which provides information on each of the repository projects regarding description, location, status, host rock, depth, size, development technique, waste type, waste treatment, key design features, key

> safety features, water management, backfill, and community engagement and acceptance. A number of these projects; two in Finland, one in Sweden and one in the USA have been operating successfully for many years. Another, Asse II in Germany, in which drums of low and intermediate level waste were placed in a former salt and potash mine in the 1960s and 1970s, has been experiencing inflows of water (brine) since the late 1980s and is under decommissioning by the German government.
>
> OPG's response to IR EIS-08-366 (OPG 2013b) lists insights gained from international low and intermediate level waste repository projects that have been incorporated or considered in the DGR project. In response to this IR, additional information is provided below on the known aspects of these repositories that might be categorized as 'successes or failures'….
>
> More generally, each of these facilities provides useful information with respect to the rationale for design decisions, and with respect to the development of the safety case. This rationale and supporting data provides information to check or
>
> inform the comparable design decisions and safety case approach adopted in the OPG DGR.
>
> This IR also asks for a response to "explain how the extent of remaining uncertainties has been respected". It should be noted in this regard that with the exception of the Asse II repository listed above, all of the other repositories are licensed for operation under the current licensing processes of the individual countries. Any 'uncertainties' that might exist with respect to these repositories would necessarily have been deemed not sufficiently significant to prevent their current or future operation. One area of future uncertainty that applies to most if not all repository projects is the final design and construction method of shaft seals. Optimization of these aspects will undoubtedly occur over the coming decades with opportunities for sharing of new information and lessons learned. The main approach with respect to uncertainty in safety assessment is to make conservative assumptions and conduct sensitivity studies to demonstrate that any lack of certainty surrounding a particular parameter is shown to be insignificant to the overall repository safety case.

That response also includes "successful" and "failure" aspects of six sites – Loviisa, Olkiluoto, SFR, WIPP, Asse, and Konrad. Three "successful" aspects are stated to be incorporated in the DGR. From WIPP, "[a]spects of the WIPP room closure plug and shaft seal design" and "[u]se of shafts equipped with the Koepe hosting system for waste package transport" and "Konrad design features related to safely moving waste packages into and off of the shaft conveyance." It can be inferred that locating the repository near a reactor site to minimize waste transportation (a success noted for Loviisa, Olkiluoto, and SFR) and "local and regional support" (a success noted for Loviisa, Olkiluoto, SFR, and WIPP) also are deemed by OPG to be aspects of the DGR.

Presumably, OPG is trying to avoid the noted failures of lengthy certification (WIPP) or licensing (Konrad) processes because of lack of support; using out-of-date waste inventories (SFR); not locating a repository "in a complex geological setting where shifting of ground (in salt) can lead to large and continuous water inflows that need to be managed" and "[c]hallenges involved in using an existing mine, rather than a built-for-purpose repository" (Asse).[4]

The IR response provided no explanation of why other sites, especially Morsleben, were not included in the "successes" and "failures" presented. Regarding the nine insights, OPG has not detailed how those generalities are incorporated into or avoided in the DGR.

2. Staff review of relevance of six international repositories

On May 28, 2012, Canadian Nuclear Safety Commission (CNSC) staff issued a report (CEAR #521) discussing six facilities - Forsmark, Sweden; Olkiluoto and Loviisa in Finland; WIPP; and Morsleban (ERAM) and Konrad in Germany. The areas for the general comparison were:

> Status (licensed activity at the site, or activity undergoing licence review)
> Size (volume of packaged waste approved or planned)
> Waste Type (source, radiation protection needs, repository significant nuclides)
> Depth (approximate depth waste emplacement)
> Geology (general description)
> Facility Design (general: access; requirements; package handling & emplacement)
> Safety Case (basis for long term performance)
> Local Public Support (general support established during some stage of development).

The report states:

> *For this comparison, CNSC staff considers repository depth, rock type, waste volume, and basis for safety in the long term to be generally of greater importance in establishing relevance to OPG's DGR project than the other areas identified for comparison….*
>
> *In brief, the available information indicates that Olkiluoto, Lovissa, and FSR at Forsmark are comparable with each other as repositories. Therefore they can be grouped and compared with OPG's DGR as follows. While the three repositories are all for the disposal of low and intermediate level radioactive wastes from*

[4] OPG Response to IR EIS 11-503.

nuclear reactor operations (with or with out refurbishment type wastes and the associated longer-lived nuclides), similar to the DGR, and are all in proximity to a large body of water, similar to the DGR, they have the following important differences to OPG's DGR:

- *They are at much shallower depth;*
- *They are in crystalline and not sedimentary rock; and*
- *They are developed for relatively small volumes of waste.*

The difference in depth and rock type also indicates the very different basis for safety in the long term from that of OPG's DGR….
Konrad, WIPP, and Morsleben can also be grouped by some common traits, with the advantage that these traits are also similar to OPG's DGR. They are all:

- *at depths of several hundreds of metres;*
- *founded in sedimentary rocks; and*
- *developed for large volumes of low and intermediate level radioactive waste. P. 2 of 8.*

The origin of the wastes that are proposed for Konrad and are at the WIPP and Morsleben repositories are different from the DGR. While these sites may or may not include some power reactor waste, they have wastes that may include research, medical, industrial and defence origins, and are expected to have significant volumes of long lived nuclides. In CNSC staff's opinion, this difference with OPG's DGR is not overly important because, regardless of the origin of the wastes and variations in the amount of long lived nuclides, portions of the waste at the three repositories require radiation protection similar to that needed for OPG's DGR. Also, the primary basis for safety in the long term at both Konrad and WIPP is the repository depth, low permeability natural barriers, and the lack of any circulating groundwater; which is similar to the basis of long term safety at OPG's DGR.

Of additional interest, is the fact that the Konrad and WIPP facilities are generally representative of the next phases of OPG's DGR should it be issued a licence. The Konrad is currently constructing waste emplacement rooms within the former mine. WIPP is currently at a full operational phase and can demonstrate operations with some similarities to that proposed by OPG. Morsleben, while having similarities in terms of depth and sedimentary rock, is of much less relevance to the DGR because it was not built as a repository, and is now closed to further operation and undergoing review of its closure plans.

<u>CNSC Staff Conclusions and Recommendations</u>

Six repositories were examined by CNSC staff for their similarities and relevance to OPG's DGR project. On the basis of this review, CNSC staff has concluded that the WIPP site (for general operations) and the Konrad site (for general construction and proposed operations) have the most relevance to the DGR project based on their depth, general geology, and the volume of low and intermediate level waste for disposal. The FSR site would, in CNSC staff's opinion, be an alternate site from the WIPP to demonstrate operations.[5]

[I changed the font o this, as it I think it's an excerpt…]

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[5] CEAR #521, page 3 of 8.

The CNSC staff report does not mention Asse, nor provide any explanation for that omission.

3. Asse and Morsleben

Although OPG provides little discussion of Asse and Morseleben and the DGR is not a previously used mine site, those German sites are the world's first DGR-type facilities and provide relevant experiences. Both of the mine sites were intended, and waste was emplaced, for the purpose of permanent disposal of low and intermediate level radioactive wastes. Both sites received tens of thousands of cubic meters of waste for more than a decade. Both sites were found to not be operating safely, which resulted in waste shipment and disposal being terminated before the proposed capacity limits were reached. Both sites now have difficult decontamination and decommissioning processes. Further, both facilities contain significant amounts of low-level and ILW, though much less volume than proposed for the DGR or WIPP.

Asse.

From 1909 to 1964, Asse was mined for potash or rock salt. From 1967 to 1978, 125,787 drums and waste packages containing low-level and intermediate level radioactive waste (ILW) were emplaced in 13 chambers. Twelve chambers were at depths of 725 and 750 meters below the surface, and one chamber at 511 meters was used exclusively for ILW.[6] The waste is estimated to be about 47,000 cubic meters by volume and 2,900,000 gigabequerels of radioactivity, though there are significant uncertainties about the inventory.[7] Water leaks into the mine (about 12 cubic meters per day) and the salt creep creates instability problems in the mine.[8] In January 2010, the Federal Office for Radiation Protection determined that all of the waste should be retrieved because other options, including backfilling and relocating the waste to deep parts of the mine, would not meet long-term safety requirements.[9]

Morsleben.

[6] http://www.endlager-asse.de/EN/2_WhatIs/History/_node.html
[7] http://www.endlager-asse.de/EN/2_WhatIs/RadioactiveWaste/_node.html
[8] http://www.bfs.de/en/endlager/endlager_morsleben/stilllegung/genehmigungsverfahren/Erstbewertung_Einwaende_ERAM
[9] http://www.endlager-asse.de/EN/2_WhatIs/RadioactiveWaste/_node.html

The complex was used for potash and rock salt mining, ammunition storage during World War II, and chicken farming.[10] From 1971 to 1998, 36,753 cubic meters of LLW and ILW in drums and waste packages were emplaced in the salt mine.[11] Waste emplacement ceased in September 1998 because of a court order issued on application of an environmental organization. In 2001, the Federal Office for Radiation Protection stated that no more radioactive waste disposal was acceptable because of safety reasons.[12] The mine is being stabilized with backfill and water inflow (about 12 cubic meters per year) is sealed off while decommissioning planning and implementation is to being carried out on an undetermined schedule.[13]

4. <u>Aspects of WIPP's experience used in DGR</u>

OPG documents generally refer to the WIPP experience as "particularly relevant" and that the DGR specifically incorporates "[a]spects of the WIPP room closure plug and shaft seal design" and "[u]se of shafts equipped with the Koepe hoisting system for waste package transport."

Regarding shaft seals, in its Certification for WIPP in 1998, the USA Environmental Protection Agency (EPA) found:

> Shaft Seals. In the CCA, DOE described the seals to be used in each of the four shafts and included the design plans and the material and construction specifications for the seals. (Docket A-93-02, Item II-G-1, CCA Chapter 3.3.1, Chapter 8.1.1, and Appendix SEAL). The purpose of the shaft seal system is to limit fluid flow within the shafts after the WIPP is decommissioned and to ensure that the shafts will not become pathways for radionuclide release. The shaft seal system has 13 elements that fill the shaft with engineered materials possessing high density and low permeability, including concrete, asphalt, clay, compacted salt, cementitious grout, and earthen fill. The compacted salt column component of the system within the Salado is intended to serve as the primary longterm barrier by limiting fluid transport along the shaft during the 10,000 year regulatory period. The EPA proposed that DOE's shaft seal design is adequate because the system can be built and is expected to function as intended….
> The technology planned for constructing the shaft seals has been tested in the real world. The construction equipment and procedures necessary to emplace the seal materials are in large part the same as those used to excavate the WIPP, but used in reverse. Except for salt, the shaft seal component materials are commonly used in construction. Salt has been extensively tested to determine its properties and behavior in the conditions which will exist in the shafts after the WIPP is closed.

[10] http://www.bfs.de/en/endlager/endlager_morsleben/morsleben_einstieg/historie.html
[11] http://www.bfs.de/en/endlager/endlager_morsleben/stilllegung/genehmigungsverfahren/planfeststellungsverfahren.html
[12] See footnote 10.
[13] http://www.bfs.de/en/endlager/endlager_morsleben/stilllegung/genehmigungsverfahren/Erstbewertung_Einwaende_ERAM

> The EPA finds that the shaft seal design has undergone extensive technical review and testing by DOE that shows it is feasible to construct and is expected to perform as intended.[14]

It will be decades after the EPA certification before shaft seals would be used, and DOE could decide in the future to request a change in the approved shaft seals. Thus, the final shaft seal design is not determined, and installation is not yet scheduled. Therefore, there is no approved, much less an installed, shaft seal design upon which the DGR shaft seal design can be based.

Regarding closure of the panels (ten are proposed), the EPA Certification found:

> Panel Closure System. Panel closures are needed primarily during active disposal operations at the WIPP and during preparations for final closure of the entire facility. Relative to long-term performance, they can serve to block the flow of brine between panels. The DOE provided four options for a panel closure system in the CCA, but did not specify which panel closure option would be used at WIPP. The EPA reviewed the four panel closure system options proposed by DOE and considered that the intended purpose of the panel closure system is to prevent the existing disturbed rock zone (``DRZ'') in the panel access drifts (tunnels) from increasing in permeability after panel closure (which could allow greater brine flow). The EPA considers the panel closure system design identified as ``Option D'' to be the most robust panel closure design. (Docket A-93-02, Item II-G-1, CCA Chapter 3 and Appendix PCS; Item V-B-2, CARD 14, Section 14.E; Item V- B-3, Section F.2) The EPA based its evaluation of compliance for the proposed rule on the Option D panel seal design and proposed to establish a certification condition requiring DOE to implement the Option D design. The EPA believes that the proposed design on which compliance was based should be actually implemented at the site. The EPA also proposed to require DOE to use Salado mass concrete (concrete made with Salado salt) for construction of the concrete barrier component of the panel closure. This substitution eliminates the potential for degradation and decomposition of fresh water concrete by infiltration of brine. The EPA determined that implementation of Option D is adequate to achieve the long-term performance modeled in the PA, since DOE shows that the use of a concrete barrier component is capable of providing resistance to inward deformation of the surrounding salt and prohibiting growth of the DRZ from its initial state….
>
> The Option D design shall be implemented as described in the CCA, except that DOE is required to use Salado mass concrete rather than fresh water concrete. Nothing in this condition precludes DOE from reassessing the engineering of the panel seals at any time. Should DOE determine at any time that improvements in materials or construction techniques warrant changes to the panel seal design, DOE must inform EPA. If EPA concurs, and determines that such changes constitute a significant departure from the design on which certification is based,

[14] http://www.gpo.gov/fdsys/pkg/FR-1998-05-18/pdf/98-13100.pdf (p. 27361).

> the Agency is authorized under Sec. 194.65 to initiate a rulemaking to appropriately modify the certification.[15]

Although five panels have been filled and preliminarily closed, DOE has not implemented the required Panel Closure System in any of the panels. Instead, DOE has carried out various measures, including installing bulkheads and (in Panels 1, 2, and 5) a 12-foot-thick explosion-isolation wall to restrict access by people and prevent air flow through the panels. DOE has requested that EPA approve a substantially revised closure system of bulkheads and salt, unlike any of the four options included in the certification application.[16] EPA plans to begin its rulemaking on the matter later in 2013. Thus, the currently approved Panel Closure System design will not be implemented. What the replacement design will be is subject to future proceedings by the EPA (and the New Mexico Environment Department pursuant to the state Hazardous Waste Permit). When the final panel closure design is installed is uncertain. Thus, the DGR cannot base any room closure on the WIPP closure system.

Regarding the WIPP shaft and hoist system, there are four shafts: Waste Handling Shaft; Salt Handling Shaft, the Exhaust Shaft, and the Air Intake Shaft. Thirty years ago, reducing the shafts to three was considered as a cost-saving measure, but ultimately four shafts were deemed preferable for safety and redundancy. In contrast, the DGR would have two shafts. The WIPP experience has shown the need for preventative maintenance and periodic interruption of disposal operations while the waste hoist is being maintained.

5. <u>Aspects of WIPP's experience not accurately described by OPG</u>

Institutional controls, backfill, and community engagement and acceptance are aspects of the WIPP experience that OPG's documents do not accurately describe.

A. Institutional controls after decommissioning.

The PSR states:

> A period of 300 years is assumed over which such controls, including societal memory, are effective, consistent with international practice. P. 6 of 768.

[15] http://www.gpo.gov/fdsys/pkg/FR-1998-05-18/pdf/98-13100.pdf (p. 27362).
[16] http://www.epa.gov/radiation/news/wipp-news.html (Panel Closure Redesign).

The EPA Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations state:

> 40 CFR § 194.41 Active institutional controls (AIC).
>
> (a) Any compliance application shall include detailed descriptions of proposed active institutional controls, the controls' location, and the period of time the controls are proposed to remain active. Assumptions pertaining to active institutional controls and their effectiveness in terms of preventing or reducing radionuclide releases shall be supported by such descriptions.
> (b) Performance assessments shall not consider any contributions from active institutional controls for more than 100 years after disposal.[17]

In its Certification of WIPP, EPA found:

> The DOE proposed to: construct a fence and roadway around the surface footprint of the repository; post warning signs; conduct routine patrols and surveillance; and repair and/or replace physical barriers as needed. The DOE also identified other measures that function as AICs, such as DOE's prevention of resource exploration at the WIPP and DOE's construction of long-term site markers. The DOE will maintain the proposed AICs for at least 100 years after closure of the WIPP, and the WIPP PA assumed that AICs would prevent human intrusion for that period.
>
> The EPA reviewed the proposed AICs in connection with the types of activities that may be expected to occur in the vicinity of the WIPP site during the first 100 years after disposal (i.e., ranching, farming, hunting, scientific activities, utilities and transportation, ground water pumping, surface excavation, potash exploration, hydrocarbon exploration, construction, and hostile or illegal activities) and examined the assumptions made by DOE to justify the assertion that AICs will be completely effective for 100 years. The DOE stated in the CCA that the proposed AICs will be maintained for 100 years, and that regular surveillance could be expected to detect a drilling operation in a prohibited area that is set up in defiance or ignorance of posted warnings….
>
> Contributions from AICs in the PA are considered as a reduction in the rate of human intrusion. The EPA reviewed the CCA and the parameter inputs to the PA and determined that DOE did not assume credit for the effectiveness of active institutional controls for more than 100 years after disposal. The EPA found DOE's assumptions to be sufficient to justify DOE's assertion that AICs will completely prevent human intrusion for 100 years after closure. Because DOE adequately described the proposed AICs and the basis for their assumed effectiveness and did not assume in the PA that AICs would be effective for more than 100 years, EPA finds DOE in compliance with Sec. 194.41.[18]

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[17] http://www.gpo.gov/fdsys/pkg/FR-1996-02-09/pdf/96-2721.pdf (p. 5243)

The WIPP site is surrounded by active oil and natural gas production. There are approximately 100 active wells within a mile of the site boundary and more than 1,100 wells within 10 miles of the site.[19] Institutional controls to prevent mining activities that could affect the site's post-closure performance are necessary. Thus, the DOE and EPA require institutional controls for 100 years after decommissioning, not the 300 years that OPG proposes and states is "consistent with international practice."

B. Backfill.

In IR EIS 09-410, Table 1, regarding the DGR, OPG states:

> None planned in emplacement rooms or connecting tunnels to allow room for gas from waste and container decomposition.
> Shaft services area to be backfilled at closure with mass concrete to ensure support for shaft seals.

In that same Table 1, regarding WIPP OPG states:

> No backfill.
> Surrounding salt is allowed to naturally creep, collapse and fill in void spaces.
> Sacks of MgO added on top of waste stacks to absorb CO2 from waste decomposition (to control solubility of actinides).

The EPA Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations state:

> § 194.44 Engineered barriers.
> (a) Disposal systems shall incorporate engineered barrier(s) designed to prevent or substantially delay the movement of water or radionuclides toward the accessible environment.
> (b) In selecting any engineered barrier(s) for the disposal system, the Department shall evaluate the benefit and detriment of engineered barrier alternatives, including but not limited to: Cementation, shredding, supercompaction, incineration, vitrification, improved waste canisters, grout and bentonite backfill, melting of metals, alternative configurations of waste placements in the disposal system, and alternative disposal system dimensions. The results of this evaluation shall be included in any compliance application and shall be used to justify the selection and rejection of each engineered barrier evaluated.[20]

In its Certification of WIPP, EPA found:

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[18] http://www.gpo.gov/fdsys/pkg/FR-1998-05-18/pdf/98-13100.pdf (p. 27395).
[19] http://www.wipp.energy.gov/library/DSA/DOE_WIPP_07_3372_Rev_3a_DSA.pdf, p. 1-26.
[20] http://www.gpo.gov/fdsys/pkg/FR-1996-02-09/pdf/96-2721.pdf (pp. 5243-5244)

The DOE's assumption of high pH (about 10) is consistent with data on the use of magnesium oxide (MgO) backfill. Because DOE has committed to using MgO backfill in the repository in the CCA, EPA finds it reasonable to assume this pH in the repository. (See the preamble section ``Engineered Barriers'' for further discussion of MgO backfill.) Furthermore, even if the MgO were not fully effective and the pH were to drop from near 10 to between 7 and 8, the enhanced corrosion rate expected at that lower pH is already reflected in the probability distribution for the corrosion rate parameter. DOE's experimental data show that MgO backfill will function as assumed in the CCA. Therefore, EPA concludes that DOE considered the issue of pH and realistically incorporated it into the model…. [21]

An important factor influencing actinide solubility is the magnesium oxide (MgO) backfill DOE proposed to emplace in the WIPP. The DOE indicated that MgO backfill emplaced with transuranic waste would mitigate the solubility-enhancing effects of carbon dioxide from waste degradation. The DOE proposed to emplace a large amount of MgO in and around waste drums in order to provide an additional factor of safety and thus account for uncertainties in the geochemical conditions that would affect CO2 generation and MgO reactions….[22]

The EPA concluded that DOE's qualitative justification was sufficient to show that the emplacement of MgO backfill in the repository will help prevent or substantially delay the movement of radionuclides toward the accessible environment by helping to maintain alkaline conditions in the repository, which in turn favors lower actinide solubilities.…[23]

The EPA agrees with the conclusions of the Waste Characterization Independent Review Panel ``that under the conditions of MgO backfill, chelating agents (e.g., organic ligands) will have a negligible effect on repository performance….”[24]

Section 194.44 of the compliance criteria requires DOE to perform a comparison of the benefits and detriments of waste treatment options (referred to as ``engineered barriers'' by EPA and as ``engineered alternatives'' by DOE). DOE's evaluation incorporated such treatment methods as vitrification and shredding. Based on this evaluation, DOE selected the use of MgO as an engineered barrier. The EPA determined that MgO will be an effective barrier, based on DOE's scientific evaluation of the proposed barrier's ability to prevent or substantially delay the movement of radionuclides toward the accessible environment.[25]

Regarding post-operational backfill, the EPA Certification found:

Monitoring (Sec. 194.42) Section 194.42 requires DOE to monitor the disposal system to detect deviations from expected performance. The monitoring

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[21] http://www.gpo.gov/fdsys/pkg/FR-1998-05-18/pdf/98-13100.pdf (p. 27375).
[22] Ibid. p. 27378.
[23] Id.
[24] Id.
[25] Ibid. pp. 27396-97.

> requirement distinguishes between pre-and post-closure monitoring because the monitoring techniques that may be used to access the repository during operations (pre-closure) and after the repository has been backfilled and sealed (post-closure) are different.[26]

Therefore, the WIPP practice is that backfill in the form of significant quantities of magnesium oxide is used. The purpose is to reduce carbon dioxide and reduce movement of radionuclides. This practice is different that the DGR proposal to use no backfill to reduce gas generation from waste and container decomposition. The nature of backfill in the WIPP panel closure system and backfill in the underground waste drifts during closure is subject to change, but there are no current plans that include OPG's proposal to use mass concrete.

C. Community engagement and acceptance.

In IR EIS 09-410, Table 1, regarding WIPP, OPG states:

> High local support and acceptance (volunteer site).
> Initial opposition at state level led to ~10 yr delay to opening of facility.
> State support now good.

In the early 1970s, a few Carlsbad, New Mexico community leaders did volunteer that area for waste disposal. Their motivation was "to make a buck." The method was secrecy and to not involve the general public.[27] The USA Atomic Energy Commission chose the initial site (which was later abandoned) with no public notice. In the late 1970s, when public meetings and hearings began, opposition was significant. The federal government promised that New Mexico would have a veto over whether WIPP proceeded. In 1979, the House Armed Services Committee approved legislation to cancel WIPP. When the bill came to the House floor, the Chairman changed the bill to authorize WIPP, replace the state veto with a "Consultation and Cooperation (C&C) Agreement," and prohibit licensing by the Nuclear Regulatory Commission. In 1980, President Carter cancelled WIPP. In 1981, the Reagan administration DOE decided to proceed with WIPP. The State of New Mexico filed suit, which resulted in a settlement that included a signed C&C Agreement, future public participation opportunities, and allowed WIPP construction to begin. In 1987, Congress began considering the WIPP Land Withdrawal Act (LWA), which was finally enacted in 1992. During those five years of debate, there also was

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[26] Ibid. p. 27395.
[27] McCutcheon, Chuck. *Nuclear Reactions: The Politics of Opening a Radioactive Waste Disposal Site*. University of New Mexico Press, 2002, pp. 21-27.

litigation by the New Mexico Attorney General, citizen groups, and others to prevent WIPP from opening and to require additional state regulatory authority and limitations on WIPP. Since WIPP opened in 1999, the state's permitting authority has several times rejected DOE proposals, based on community engagement and concerns. During public comment periods and at hearings by DOE, EPA, and state agencies, it has generally been the case that the highest levels of engagement and participation are not from Carlsbad residents, but from other communities around the state.

Thus, the level of state support has not been constant over time and is based on the existing WIPP mission, continuing safe operations, and compliance with state authority. Community engagement has not been limited to the local Carlsbad area, but has included people and organizations from throughout the state.

6. <u>Aspects of WIPP experience relevant to DGR, but not discussed by OPG</u>

A. Mission changes.

WIPP's mission is limited to disposal of USA defense transuranic waste. In 1979, Public Law 96-164, Section 213(a) stated:

> Notwithstanding any other provision of law, the Waste Isolation Pilot Plant is authorized as a defense activity of the Department of Energy, administered by the Assistant Secretary of Energy for Defense Programs, for the express purpose of providing a research and development facility to demonstrate the safe disposal of radioactive wastes resulting from the defense activities and programs of the United States exempted from regulation by the Nuclear Regulatory Commission.

The 1992 WIPP Land Withdrawal Act (LWA) reiterated that mission in Section 2(19):

> WIPP.— The term "WIPP" means the Waste Isolation Pilot Plant project authorized under section 213 of the Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980 (Pub. L. 96-164; 93 Stat. 1259 1265) to demonstrate the safe disposal of radioactive waste materials generated by atomic energy defense activities.[28]

Because of State and community engagement, the LWA further limited the WIPP mission, including:

[28] http://www.wipp.energy.gov/library/cra/baselinetool/Documents/Regulatory%20Tools/10%20WIPPLWA1996.pdf

CAPACITY OF WIPP.— The total capacity of WIPP by volume is 6.2 million cubic feet of transuranic waste. Section 7(a)(3).
REM LIMITS FOR REMOTE-HANDLED TRANSURANIC WASTE.—
(A) 1,000 REMS PER HOUR.— No transuranic waste received at WIPP may have a surface dose rate in excess of 1,000 rems per hour.
(B) 100 REMS PER HOUR.— No more than 5 percent by volume of the remote-handled transuranic waste received at WIPP may have a surface dose rate in excess of 100 rems per hour. Section 7(a)(1).
CURIE LIMITS FOR REMOTE-HANDED TRANSURANIC WASTE.—
(A) CURIES PER LITER.— Remote-handled transuranic waste received at WIPP shall not exceed 23 curies per liter maximum activity level (averaged over the volume of the canister). Section 7(a)(2).
TOTAL CURIES.— The total curies of the remote-handled transuranic waste received at WIPP shall not exceed 5,100,000 curies. Section 7(a)(2)(B).

BAN ON HIGH-LEVEL RADIOACTIVE WASTE AND SPENT NUCLEAR FUEL.
The Secretary [of Energy] shall not transport high-level radioactive waste or spent nuclear fuel to WIPP or emplace or dispose of such waste or fuel at WIPP. Section 12.

Although those legal limits have been in effect for more than two decades, DOE is currently proposing numerous changes and expansions of WIPP's mission, including:

(1) Greater-Than-Class C Waste. All commercial waste is banned from WIPP, yet the February 2011 *Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* proposes disposing commercial waste at WIPP. That waste includes more than 160,000,000 curies of commercial GTCC waste. That amount is more than 30 times more radioactivity than the entire WIPP inventory and far exceeds the LWA radiation limits. That EIS also proposes to rename some DOE waste as "GTCC-like" (for which there is no legal definition and which is not TRU waste). The Final EIS has been scheduled for several months, but has not yet been released.[29]

(2) Commercial waste from West Valley, New York. In January 2004, DOE's *Final West Valley Demonstration Project Waste Management Environmental Impact Statement* stated that WIPP was the preferred option for disposal of TRU waste from commercial reprocessing in the late 1960s and early 1970s. Because of public opposition, DOE's June 16, 2005 Record of Decision (ROD) deferred a decision to implement that preferred

alternative.[30] But DOE retains the option to issue a revised ROD and proceed with that alternative.

(3) Elemental Mercury Storage. In 2012, DOE announced that WIPP would be included in a Supplemental EIS for the long-term surface storage of 10,000 metric tons of elemental mercury. The Draft Supplement was released in April 2013, and the Final Supplement is scheduled for release in the Fall 2013.[31]

(4) Remote-Handled (RH) TRU waste in shielded containers. Because WIPP has been mis-managed, it now has space for about only about one-half of 7,079 cubic meters of RH waste planned. DOE proposes to put some RH waste in lead-shielded containers and manage it as if it were contact-handled (CH) waste.[32] That proposal has been approved by EPA and the New Mexico Environment Department (NMED), but is being challenged in the New Mexico Court of Appeals.[33] Shielded containers have not yet been used.

(5) Rename high-level tank waste. In 2003, DOE proposed to rename high-level waste in up to 20 tanks at Hanford, Washington as TRU waste and ship it to WIPP. Then New Mexico Governor Bill Richardson strenuously objected and instituted a public process that resulted in 2004 in a provision in the NMED's WIPP Hazardous Waste Permit regarding waste from any of the 243 high-level waste tanks at Hanford, Savannah River Site in South Carolina, and the Idaho National Laboratory. Permit Section 2.3.3.8 states:

> Excluded Waste
> TRU mixed waste that has ever been managed as high-level waste and waste from tanks specified in Permit Attachment C are not acceptable at WIPP unless specifically approved through a Class 3 permit modification.[34]

On March 11, 2013, DOE announced that its preferred alternative in the *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland Washington* would be to rename waste in up to 20 tanks as TRU and ship it to WIPP.[35] Those were the same 20 tanks proposed in 2003. In addition, DOE submitted a request to change the excluded waste permit provision so that it only prohibits high-level waste, but not

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[29] http://www.gtcceis.anl.gov/
[30] http://www.gpo.gov/fdsys/pkg/FR-2005-06-16/pdf/05-11882.pdf (p. 35076).
[31] http://mercurystorageeis.com/
[32] http://www.epa.gov/radiation/news/wipp-news.html (Shielded containers).
[33] http://www.sric.org/nuclear/nuclear2.php
[34] http://www.nmenv.state.nm.us/wipp/finaldet1104.pdf
[35] http://www.gpo.gov/fdsys/pkg/FR-2013-03-11/pdf/2013-05509.pdf

renaming waste. The request also would eliminate the class 3 requirements for a detailed demonstration that waste has never been managed as high-level and for a public hearing.[36] The new request was submitted so as to preclude a public hearing, even though the State's 2004 approval stated that class 3 procedures, including a public hearing, were required to change the provision. On July 2, 2013, the NMED determined that it would not approve the request and that it would instead consider it using class 3 procedures, including public hearing.[37]

Thus, the WIPP experience is that the approved Certification (safety case) is not binding regarding the types and amounts of waste. Further, no matter what are the legal requirements and limitations, substantial mission changes have been proposed over the past decade. Additionally, any changes may or may not be subject to renewed community or state "support," which is not a specifically defined legal requirement.

B. Unplanned operational changes and events.

(1) Instability of Panel 1 and tunnels.

The characteristic of salt creep has long been recognized as an important repository element in that underground void space would gradually be filled in by salt movement. The nature and speed of such salt creep at WIPP was presumed to be well understood.

Panel 1, the first underground disposal area of seven rooms, received its first waste in March 1999 and was supposed to operate for three years and dispose of approximately 18,000 cubic meters of TRU waste.[38] In actuality, Panel 1 received 10,500 cubic meters of waste over four years, but only four of the seven rooms were used. Salt creep was more rapid than expected, causing roof sag and floor upheaval, as well as wall movement. Despite previous claims that the panel was stable, DOE closed Panel 1 when it was less than 60 percent filled.

E-140 Underground Waste Transport Route.

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[36] http://www.wipp.energy.gov/library/Information_Repository_A/Class_2_Permit_Modifications/13-0727_ENCL.pdf

[37] http://www.nmenv.state.nm.us/wipp/documents/NMEDPMRDetermination7-2-2013.pdf

[38] http://www.nmenv.state.nm.us/wipp/documents/Part411-1-2012.pdf, Table IV.A.1

The underground tunnel for waste transport is designated E-140. Because of the rate of salt creep, the WIPP operators have not been able to safely maintain it during ongoing WIPP operations and during the six-week to two-month annual maintenance periods when no waste is handled. Thus, tunnel W-30 is being expanded so that it can be used as an alternative underground waste transport route while E-140 is closed for remining.

(2) Panels 9 and 10.

For more than 15 years, the WIPP design has included using the area between Panels 1-4 and 5-8 as Panels 9 and 10. Because of instability issues in that area, DOE has now decided to change the design to place Panels 9 and 10 to the south of the existing panels 4 and 5.[39] The change would extend the operational footprint of the facility further south and closer to operating natural gas wells just outside of the 16-square-mile boundary. The changes have not yet been approved.

(3) Unexpected underground releases of Carbon Tetrachloride.

It was long known that significant amounts of Carbon Tetrachloride were used in some of the manufacturing processes at the Rocky Flats Plant which generated a substantial amount of the TRU waste designated for disposal at WIPP. The NMED WIPP Hazardous Waste Permit includes limits on the amount of that and other volatile organic compounds and requires monitoring and reporting of exceedances.

But DOE never expected that those limits would be exceeded or that any reporting would be required. However, on July 24, 2009, DOE informed NMED that there was an exceedance. Other notices of exceedances were submitted in September, October, and November, 2009. On November 17, 2009, DOE reported to NMED had it had been submitting incorrect information about the exceedances, which were actually significantly higher than reported because the air flow monitors were not accurately calibrated. In fact, exceedances actually occurred starting in December of 2008.[40] Those higher-than-expected-levels of Carbon Tetrachloride persist until the present. As a result, some workers have been exposed to

[39] http://www.epa.gov/radiation/news/wipp-news.html (Repository Reconfiguration).

[40] http://www.sric.org/nuclear/docs/VOC%20-%20December%2023%20to%20CBFO.pdf

unexpected levels of a carcinogen. Shipments of some wastes with carbon tetrachloride from the Idaho National Laboratory were delayed in 2010 and some waste containers were overpacked to reduce emissions. Additional costs and measures to reduce carbon tetrachloride levels included installing a granulated activated carbon system and zeolite filtration in filled Panel 4 and installing new bulkheads in both closed and active panels.

(4) Emplacement of empty or "dunnage" containers.

Leaving more than 40 percent of Panel 1's capacity empty is one reason WIPP's existing design will not accommodate the entire legal capacity of 175,564 cubic meters. Another reason is that thousands of empty, dunnage containers have been emplaced in the underground. That practice is because of various factors. Transportation limits on the amount of radioactivity and truck weight limits sometimes mean that shipping containers have to be filled with empty containers. In other circumstances, shipping sites have only partial loads ready so dunnage drums are added rather than delaying shipments. The result is that only one of six panels has actually been filled to its full capacity of waste. In addition to the substantial capacity shortfall for RH waste, there may not be available space for all of the CH waste.

(5) Simultaneous construction and operation.

Because of salt creep and the instability of Panel 1 that was mined a decade before it was first used, the current WIPP practice is to mine new panels as they are needed. Waste emplacement has been on a slower schedule than planned. Additionally, the need for on-going maintenance of surface and underground operational areas has resulted in both simultaneous construction and operation and the need for more substantial maintenance than can be done during operations. Thus, during the past several years, there has been a six-week to two-month operational shutdown during which time no waste is received and emplaced so that major maintenance and repairs can be done.

Thus, the WIPP experience indicates that there will be unexpected operational changes and events that were not addressed in the original certification applications and approvals. Such occurrences can affect operations, as Panel 1 and tunnel instability and carbon tetrachloride emissions have done. The experience also demonstrates that even when there is significant information about WIPP's geologic properties, rates of closure and the amount of instability can be more than predicted. Waste inventory information may not result in all measures necessary to limit worker and public exposures. Established air monitoring systems may not be adequately operated.

7. <u>Some lessons from that WIPP experience</u>

A. The initial Certification regarding Panel Closure System is subject to substantial change, including options not included in the application.
B. Active institutional controls after closure are not presumed to be effective for more than 100 years.
C. Magnesium Oxide backfill in significant amounts has been required and emplaced to reduce carbon dioxide and potential movement of radionuclides.
D. Community acceptance in the Carlsbad area has been strong. Community engagement has often been higher in other areas of New Mexico than in the local area.
E. State support changes and is not constant. Support has required safety, federal acceptance of state authority, and adherence to the WIPP mission.
F. The initial Certification (safety case) does not prevent future changes in the amounts and types of waste that can come to WIPP.
G. Despite more than 15 years of investigations before WIPP opened and decades of experience with potash mining in the vicinity, mine instability and maintenance requirements have been more than expected. Operational changes have been required.
H. Releases of carbon tetrachloride have been higher and more persistent than expected.
I. Monitoring equipment is not always adequately operated.
J. Actual operations have left significant underground disposal area unused or underutilized, resulting in the repository not having actual capacity for the legally established waste amounts.

Some of these lessons may have direct relevance to the OPG DGR. Some likely do not because of the different waste types and amounts and different legal and regulatory requirements in the USA compared with Canada.

Conclusion

OPG does not accurately describe the relevant international experience with the only three DGR-type facilities that have operated for more than a decade. Actual international experience is that no DGR has operated to fully dispose of the planned waste capacity. The Asse and Morsleben mines were closed prematurely because of safety concerns and have yet to have the waste retrieved (Asse) or decommissioned (Morsleben). The continuing experience of WIPP includes that the planned permanent room closure methods have not been installed and will be changed, so they do not provide actual experience for the DGR. The WIPP shaft seal design will not be implemented for decades and could also change, so it does not provide actual experience for the DGR. The four shafts and hoist system at WIPP is not being used in the proposed OPG two-shaft design. Institutional controls, backfill, and community engagement and acceptance are other aspects of the WIPP experience that OPG's documents do not accurately describe. International experience demonstrates that there are many uncertainties; it does not establish that a DGR can be successfully operated and decommissioned.

The WIPP experience raises additional questions that could be relevant for the DGR, including:

- At WIPP, basic design features have changed or may change after the initial EPA certification, which aspects of the DGR could be changed after licensing?
- Since WIPP is failing to fulfill its mission for defense RH transuranic waste, is OPG being overly optimistic about how much and what type of wastes it can handle?
- If the WIPP mission can be fundamentally expanded beyond disposing of 175,564 cubic meters of defense TRU waste included in the state "consent" and legal requirements, what should be the basis for community acceptance for the DGR?