UNDERTAKING No. U-21:

from the

Canadian Coalition for Nuclear Responsibility

to the

Joint Review Panel

Examples of Rolling Stewardship Beyond One or Two Generations.

by

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and

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All Photos and Graphics by Robert Del Tredici

October 30 2013

INTRODUCTION

Repository versus Dump

Ontario Power Generation (OPG) is seeking permission to construct a Deep Geologic Repository at Kincardine Ontario, less than a mile from Lake Huron, to store all of the nuclear wastes from all of Ontario's 20 nuclear power reactors, except for the irradiated nuclear fuel which is subject to a federal law called the Nuclear Fuel Waste Act.

The Canadian Coalition for Nuclear Responsibility (CCNR) is urging the Joint Review Panel to decouple two quite different aspects of this proposal: the first is OPG's plan to construct a Deep Geological Repository (DGR) where nuclear waste can be securely stored and monitored in a safe and retrievable fashion; the second is OPG's plan to abandon those wastes at some time in the future, closing and sealing the underground facility, thereby creating a Deep Underground Dump (DUD) which will forever after remain unmonitored, unmanned, unregulated – eternally beyond human control, right beside Lake Huron.

CCNR believes such a DUD should not be approved. CCNR believes it is both unethical and unscientific to abandon nuclear wastes – many of which will remain dangerous for hundreds of thousands, indeed even millions of years – based on the hope that radioactivity will never find a way to migrate out of the dump at some future date, entering the Great Lakes and thereby endangering the environment of living things.

Link for CCNR written submission: http://www.ccnr.org/CCNR_CEAA_DGR.pdf
Link for CCNR oral presentation: http://www.ccnr.org/DGR_GE_Transcript.pdf

The Concept of Rolling Stewardship

In both its written and oral submissions, CCNR has urged the Joint Review Panel to firmly reject the abandonment option in favour of Rolling Stewardship – an intergenerational waste management concept whereby each successive generation passes on the knowledge and provides the necessary resources to the next generation, so that nuclear wastes are never placed beyond human control and are never left unattended.

Rolling Stewardship is not intended as a mere caretaker operation, but as an active, fully involved effort to continually improve security by retrieving, recharacterizing and repackaging the waste in ever more protective ways, until such time as a genuine solution to the waste dilemma is found – perhaps in the form of a new technology that can destroy the waste, or render it harmless, or remove it permanently from the Earth.

Rolling Stewardship is a relatively new concept. It was first introduced in the 1995 National Research Council study, "Improving the Environment." In that report, the Regulatory Measures Subcommittee called direct attention to the concept of "Rolling Stewardship" as an important option for addressing contaminated sites that pose significant cleanup challenges. "Rolling stewardship" means planning for stewardship one generation ahead; by doing it one generation at a time, continuity of knowledge and effort is possible.

This approach came to the attention of CCNR through the efforts of Jim Werner, who collaborated with Robert Del Tredici – under the auspices of the U.S. Department of Energy – to document the daunting multibillion dollar waste management and decontamination problems afflicting the US nuclear weapons complex. Their collaboration resulted in three important DOE publications: Closing the Circle on the Splitting of the Atom, Linking Legacies, and From Cleanup to Stewardship – all dealing with formidable nuclear waste management challenges.

Rolling Stewardship is discussed in a 1999 publication of the U.S. National Environmental Policy Institute entitled "Rolling Stewardship: Beyond Institutional Controls: Preparing Future Generations for Long-Term Environmental Cleanups", produced as part of the "How Clean is Clean?" project. It can be found on-line at: http://tinyurl.com/ljbwdv5

Examples of Rolling Stewardship

The Joint Review Panel has asked CCNR to provide examples of Rolling Stewardship. That request has given rise to the present document. Evidently, examples are not easy to come by – because of the newness of the concept and the newness of the challenges that spawned the concept: how to manage persistent highly toxic materials over the long term.

Nevertheless CCNR has succeeded in identifying examples in the nuclear field where the failure of the "disposal" concept has led to a more responsible approach – in one way or another, some version of Rolling Stewardship. One might call this Rolling Stewardship by default – not planned ahead of time, but implemented as a fall-back position after misguided disposal efforts have backfired, causing extensive environmental impacts.

It is encouraging to note however that nuclear waste managers (and others) are increasingly adopting the philosophy of Rolling Stewardship – at least for a period of a few centuries at a time – although they do not refer to it as such. Nevertheless, that is encouraging progress.

CCNR has been pleased to respond to the Panel's request. But the burden of proof regarding the safe management of nuclear wastes should not be on us, as citizens, but on the nuclear corporations and their government owners who continue to mass produce this waste on a daily basis without having developed any proven reliable method to eliminate it or isolate it forever from the environment of living things.

CCNR calls on the Joint Review Panel to demand that OPG provide examples of successful abandonment schemes involving long-lived persistent toxins – schemes that can be proven to have worked to protect humans and the environment for at least one or more centuries. If OPG cannot provide such examples, then OPG's project for a DGR and a DUD at Kincardine should be rejected.

Gordon Edwards, Ph.D., President,
Canadian Coalition for Nuclear Responsibility.

Maids of Muslyumovo

Women from the village of Muslyumovo in Chelyabinsk watch Western scientists measure radiation in the Techa River by their town. The Chelyabinsk reactor, upstream, made plutonium for the first Soviet atomic bombs. From 1949 to1953 the plant dumped liquid high-level waste directly into the Techa – a crude attempt at radioactive waste disposal. Forty years later, these women are discovering that the illnesses all around them are related to the radioactive contamination that was dumpoed in their river.
Village of Muslyumovo, Chelyabinsk, Russia. 17 March 1991

CONTEXT

The Nature of the Waste

At first, OPG planned to put into its Deep Geologic Depository only radioactive wastes that are low-level and short-lived. Then OPG threw caution to the winds, announcing that it would include many more varieties of waste – objects that are far more radioactive and incredibly longer-lived – such as refurbishment wastes.

Refurbishment wastes include all the intensely radioactive metallic components that make up the primary cooling system – 7 to 9 kilometers of small-diameter pipes that conduct superheated water from the core of the reactor to several nuclear boilers.

The nuclear boilers, called steam generators, are the furthest away from the core. They are a lot less radioactive than the pipes in the core. Nevertheless, each steam generator has thousands of narrow tubes inside , and these tubes become heavily contaminated during decades of use. They are all part of the refurbishment wastes.

1) Many radioactive materials in refurbishment wastes are extremely long-lived.

The CNSC list of radionuclides contaminating the internal pipes of a used steam generator from the Bruce plant [See Appendix A] includes 8 substances with a half-life of over a million years, 13 with a half-life of over 100,000 years, 19 with a half-life of over 1000 years, and 21 with a half-life of over 100 years.

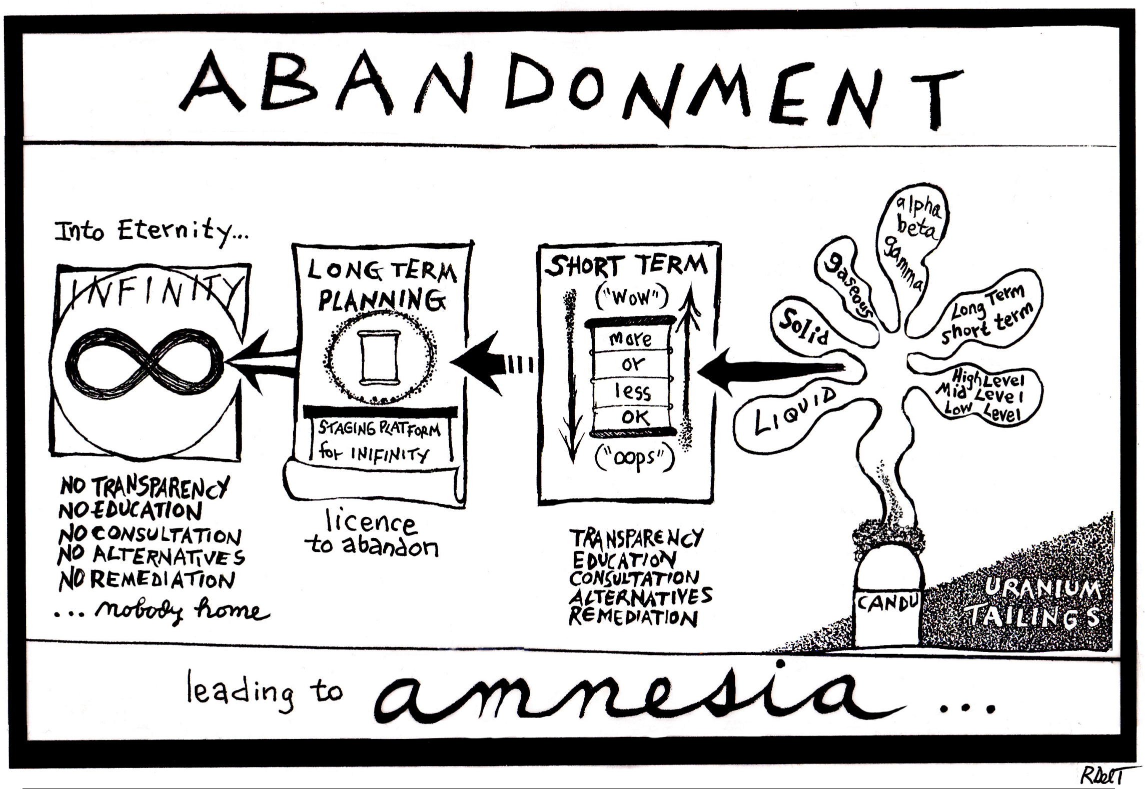
2) Many of these waste materials are extremely radiotoxic even in minute amounts.

The maximum permissible body burden of plutonium-239 for an atomic worker is 0.7 micrograms. Inside each used steam generator there are about 2.3 grams of plutonium-239. [See Appendix B.] Counting 128 steam generators from the Bruce NPP alone, there is enough plutonium-239 from the steam generators alone to overdose more than 420 million atomic workers. This is not counting the additional plutonium contamination from thousands of pressure tubes and feeder pipes. Since plutonium-239 has a 24,000 year half-life, the danger will not be significantly reduced by the time the steam generator tubes have completely disintegrated and released their inventories of plutonium.

3) NWMO acknowledges that dilution is not a solution to the nuclear waste problem.

Frank King of the Nuclear Waste Management Agency stated in his testimony to the Joint Review Panel, "Dilution simply doesn't work with nuclear material. It's out." Just as there is no safe level of cigarette smoking, and no safe level of asbestos, so too there is no safe level of exposure to atomic radiation. It is a characteristic of all carcinogenic and mutagenic substances, such as radionuclides, that even small exposures can cause deleterious health effects (i.e. cancers) if a large enough population is exposed. Since the Great Lakes provide drinking water for 40 million people, diluting long-lived radioactive poisons in Lake Huron will ensure that a very large number of people will be exposed for a very long time.

Since there is no practical method known to science that can destroy any of these radioactive wastes or render them harmless, sequestering them is essential.



Abandon (n) : to cease to support or look after; to desert.

Disposal (n): the process of throwing away or getting rid of something.

Management (n): the process of dealing with or controlling something.

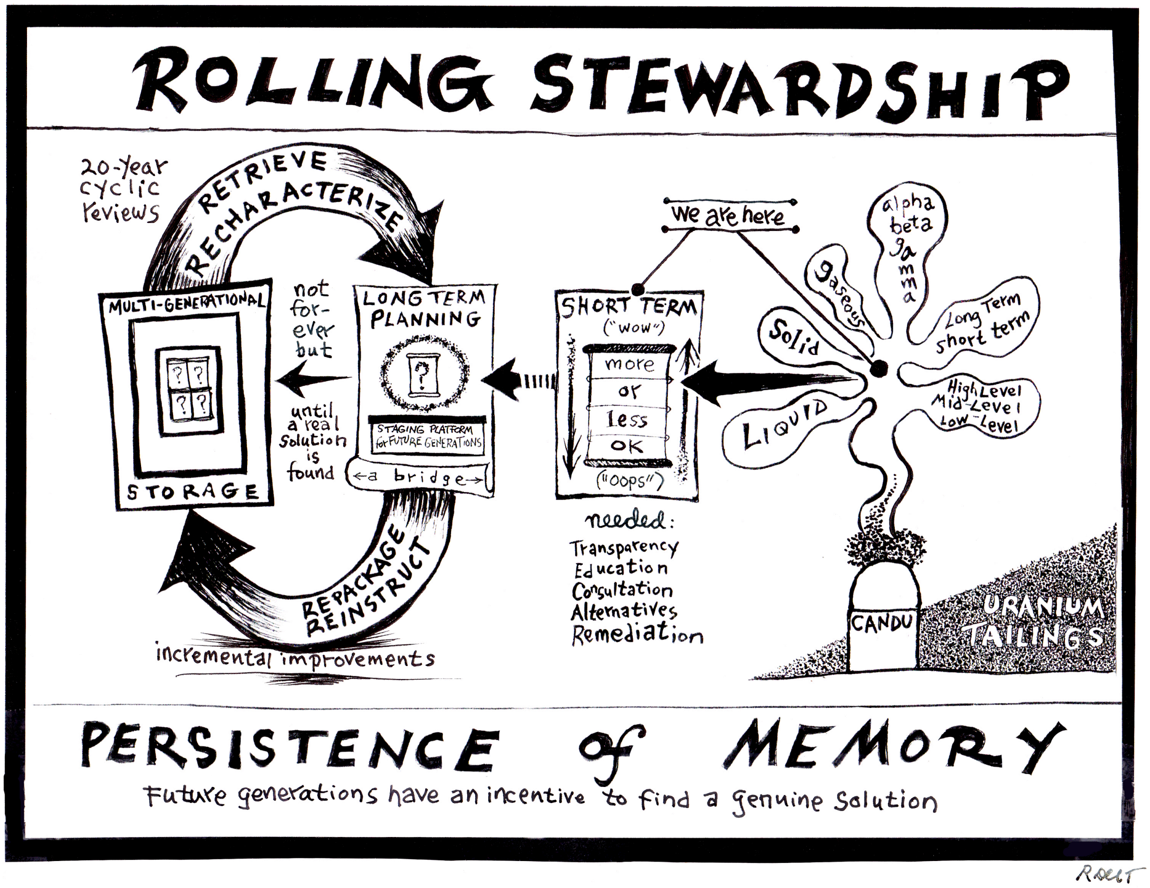
The nuclear industry and its government owners are responsible for the long-term management of nuclear waste. This means dealing with the waste and controlling it so that it does not endanger the health and safety of people or the environment.

To abandon nuclear waste, as proposed by OPG in its current proposal to build a Deep Geological Repository (DGR) beside Lake Huron, is to cease to look after it. As such it is a breach of governments' fundamental moral & legal obligations to society.

> *"The DGR Project includes the site preparation and construction, operations, decommissioning, and abandonment and long-term performance of the DGR."*
>
> *EIS Volume 1, second paragraph, Executive Summary*

Abandonment is intended to dispose of nuclear waste – to get rid of it by throwing it away. But no one knows how to truly get rid of long-lived nuclear waste or any other persistent toxic material in this manner. A corporation may rid itself of toxic waste but only at the risk of burdening others – present or future generations – with the obligation of coping with the waste or living with the harmful consequences.

Abandonment eventually leads to amnesia. Future generations have no adequate knowledge or resources to deal with leaks that may go undetected for long periods.



Realizing that there is as yet no genuine solution to the nuclear waste problem – we do not know how to destroy this waste or render it harmless – the only responsible alternative to abandonment is Rolling Stewardship. There is a growing awareness on the part of those who have struggled with this problem that this is the way to go.

> *"The word "disposal" has come to mean permanence and irretrievability in the minds of the public, and that raises questions about our stewardship of the waste. For that reason we do not use the word disposal."*
>
> *NWMO, Choosing A Way Forward, Final Study (2005), Page 21*

Nuclear waste remains harmful for unimaginably long periods of time. Until the waste can be eliminated, it must be managed on a multigenerational basis. This implies continual monitoring and periodic episodes of retrieval & repackaging.

Rolling Stewardship implies persistence of memory : the accurate transmission of information and transfer of responsibility from one generation to the next. For example, there could be a ceremonial "changing of the guard" every 20 years or so, accompanied by a thorough refamiliarization with & recharacterization of the waste.

Rolling Stewardship will ensure that leakages can be rapidly detected and corrected. It will also provide a constant incentive to improve containment and find a solution to the waste problem. But it requires meticulous planning and commitment to succeed.

The Concept of Abandonment	The Concept of Rolling Stewardship
1. Humans have never permanently disposed of anything.	1. Humans can contain waste securely for decades at a time.
2. Assumes a permanent solution to waste problem exists.	2. Recognizes a solution to the problem does not yet exist.
3. Monitoring the waste ceases after abandonment.	3. Continual monitoring of waste is essential.
4. Retrieval is difficult or impossible.	4. Retrieval is anticipated and actively planned for.
5. Containers will inevitably disintegrate.	5. Periodic repackaging is an integral part of the process.
6. If leakage occurs timely corrective action is not likely.	6. If leakage occurs timely corrective action will be taken.
7. Abandonment will eventually result in amnesia.	7. Rolling Stewardship is based on persistence of memory.
8. Difficulty in communicating to unknown future societies.	8. Information is readily transmitted to the next generation.
9. No intention to truly solve the problem of nuclear waste.	9. Ongoing reminder that the problem remains to be solved.

The concept of abandonment and the concept of disposal are intimately related. According to the IAEA "disposal" means that there is no intention to retrieve the waste in the future –although such retrieval may be possible with great difficulty.

When disposal attempts fail – as in Port Hope Ontario, the Asse-II salt mine in Germany, the Love Canal in New York State, or DOE's "Pit 9" in the USA –cleaning up the mess and consolidating the waste is often exceedingly costly & difficult because of the damage done, inadequate packaging, and lack of waste characterization.

Ironically, the end result of failed disposal efforts is usually some version of Rolling Stewardship – by default, not by intent. Had Rolling Stewardship been planned from the outset the ultimate damage, cost and difficulty would have been greatly reduced.

When abandonment of a repository occurs, the repository becomes a dump. Even in cases where the repository is well managed and monitored, the dump will not be. No matter how well designed a large nuclear power reactor might be, it would be foolish and irresponsible to licence it for operation, start it up and then abandon it. Yet that's what OPG hopes to do in the case of the Deep Underground Dump (DUD).

The Great Lakes did not even exist 15,000 years ago. The pyramids of Egypt are 5,000 years old. But the half-life of plutonium-239 is 24,000 years, and plutonium-239 gradually changes into uranium-235 which has a half-life of 700 million years.

Science is unable to make reliable predictions over hundreds of thousands of years, since mathematical predictions can't be verified against experience. As the rollout of Obamacare has shown in the USA, computer bugs cannot reliably be eliminated.

Geology is primarily a descriptive science, not a predictive one. And it is impossible to place wastes in an undisturbed geological formation without disturbing it.

Canadians have great expertise in mining, but when we mine we take the ore out – and the deserted mine inevitably floods. We do not know how to put a rock formation back together again so that it recovers its original strength and integrity.

Examples of rolling stewardship:

“Adaptive Phased Management”

The Nuclear Waste Management Organization (NWMO) has put forward a strategy for Canada’s nuclear fuel waste called “Adaptive Phased Management”. This strategy, adopted by the Government of Canada in 2007, is described in the 2005 NWMO Final Study entitled “Choosing A Way Forward”.

The NWMO strategy includes a recipe for Rolling Stewardship for the next 100 to 300 years. If a generation is counted as 20 years, then the NWMO evidently believes in the practice of Rolling Stewardship for at least 5 to 15 generations.

In an illustrative implementation schedule (page 27) NWMO assigns 20 years to site a central storage facility, 10 more years to build a characterization facility, 30 years for transportation of used fuel to the central facility, another 30 years for emplacement of irradiated nuclear fuel in deep underground chambers, followed by extended monitoring for up to 300 years. That’s a great many generations.

The question inevitably arises: if Rolling Stewardship can work for 300 years, why not for another 300 years if need be? And then for another 300 years, if desired? In this way we are getting close to a millennium.

In its Final Study, NWMO explicitly refrains from using the word “disposal” except in the context of the specific AECL proposal for abandoning the nuclear fuel waste for eternity in a DGR specifically built for that purpose:

“For purposes of this report we have defined storage as a method of managing the waste in a manner that allows access under controlled conditions for retrieval or future activities -- while disposal is conclusive without any intention of retrieval or further use…. Note that the only time we refer to disposal as a possible Canadian approach is in reference to this specific AECL proposal.” Page 21

NWMO clearly envisages the eventual “decommissioning” (closure and sealing) of its underground facility at some future date.

“Once a societal decision was made and the necessary approvals were obtained, decommissioning would commence and all underground access tunnels and shafts would be backfilled and sealed.”

But it is not presupposed that such permission has been granted already; it is simply too early for this generation to decide. In fact, it isn’t assumed that abandonment will ever be regarded as acceptable. It is for future generations to decide, based on new knowledge and technological advances, whether to abandon the waste or to continue searching for a genuine solution to the problem

CONCLUSION

The Canadian Coalition for Nuclear Responsibility urges the Joint Review Panel to make it very clear that it cannot give approval to OPG's proposal to abandon the inventory of low and intermediate level nuclear waste from all of Ontario's nuclear power reactors.

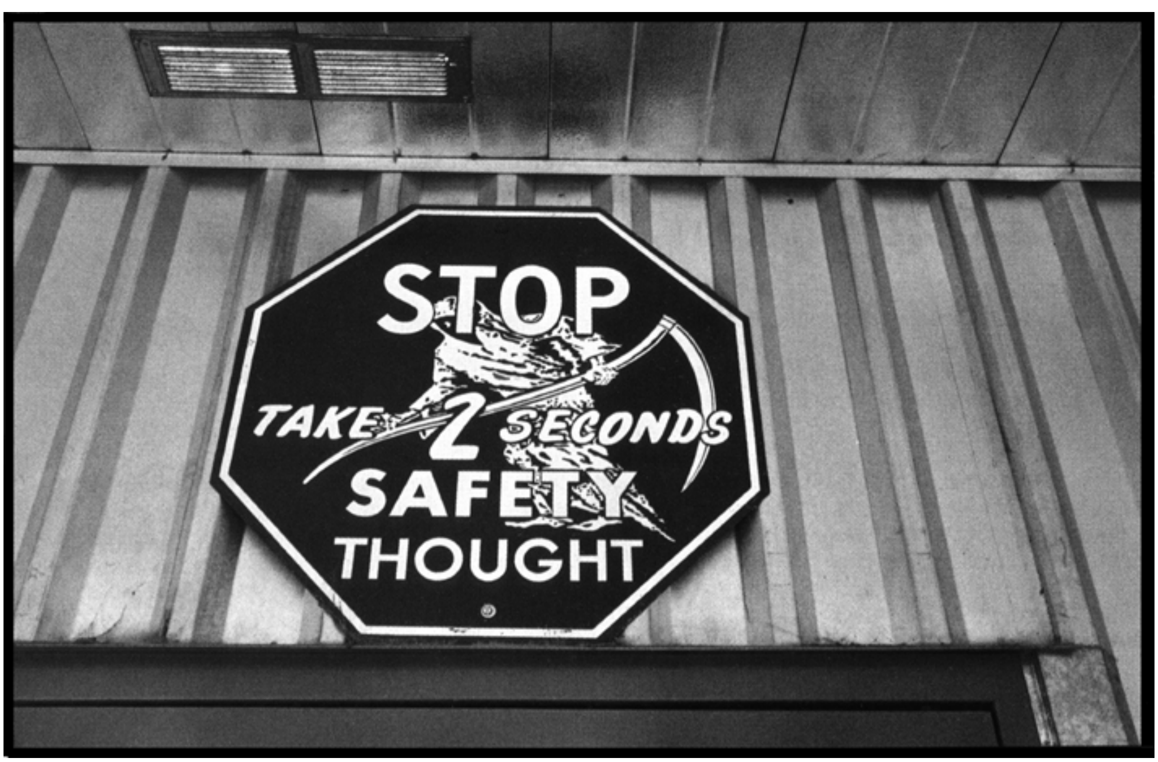
There are so many scientific uncertainties associated with the long term future that the Seaborn Panel, having its own scientific advisory committee and a ten-year mandate, could not bring itself to recommend the abandonment of nuclear waste in a DGR.

The Nuclear Waste Management Organization has been careful to avoid forcing a decision now on the subject of the possible ultimate abandonment of nuclear waste.

OPG has made it clear that its current waste storage practices can be safely extended for decades. With continual monitoring and aggressive improvements in packaging the waste, security can be improved dramatically at less cost than the proposed DGR.

CCNR respectfully submits that, since OPG has made the abandonment of nuclear waste an integral and inseparable part of the DGR project, the Joint Review Panel should reject the proposal in its entirety.

The nuclear industry worldwide is increasingly realizing that it needs a social licence as well as a regulatory licence to pursue sound nuclear waste management decisions. The fact that OPG wants to abandon nuclear wastes so close to the Great Lakes is, for millions of people living around the Great Lakes on both sides of the border, a non-starter.



Appendix A : Radioactive contaminants in used nuclear steam generators

*Here is a **partial** list of radioactive contaminants inside a used steam generator from one of the Bruce reactors. The amount of radioactivity is expressed in becquerels per cubic metre; one becquerel corresponds to one radioactive disintegration every second. (Source: OPG)*
http://www.nwmo.ca/uploads_managed/MediaFiles/539_ReferenceLowandIntermediateWasteInventoryfortheDGR.pdf (p. 50)

For Scientists/Engineers			For Citizens/ Decision Makers		
Symbol	Half-Life	Amount	Name	Half-Life	Amount
Ag 108	1.3E+02	2.3E+02	Silver-108	130 y	230
Am-241	4.3E+02	5.9E+07	Americium-241	430 y	59 000 000
Am-243	7.4E+03	3.8E+04	Americium-243	7 400 y	38 000
C-14	5.7E+03	7.6E+07	Carbon-14	5 700 y	76 000 000
Cl-36	3.0E+05	1.4E+04	Chlorine-36	300 000 y	14 000
Cm-244	1.8E+01	1.4E+07	Curium-244	18 y	14 000 000
Co-60	5.3E+00	1.2E+09	Cobalt-60	5.3 y	1 200 000 000
Cs-134	2.1E+00	1.9E+06	Cesium-134	2.1 y	1 900 000
Cs-135	2.3E+06	2.2E+01	Cesium-135	2 300 000 y	22
Cs-137	3.0E+01	2.2E+07	Cesium-137	30 y	22 000 000
Eu-152	1.3E+01	1.8E+06	Europium-152	13 y	1 800 000
Eu-154	8.8E+00	1.6E+07	Europium-154	8.8 y	16 000 000
Eu-155	5.0E+00	3.0E+07	Europium-156	5 y	30 000 000
Fe-55	2.7E+00	5.8E+09	Iron-55	2.7 y	5 800 000 000
I-129	1.6E+07	6.3E+00	Iodine-129	16 000 000 y	6.3
Nb-94	2.0E+04	2.9E+05	Niobium-94	20 000 y	290 000
Ni-59	7.5E+04	2.0E+05	Nickel-59	75 000 y	200 000
Ni-63	9.6E+01	2.9E+07	Nickel-63	96 y	29 000 000
Np-237	2.1E+06	1.8E+03	Neptunium-237	2 100 000 y	1 800
Pu-238	8.8E+01	1.0E+07	Plutonium-238	88 y	10 000 000
Pu-239	2.4E+04	1.2E+07	Plutonium-239	24 000 y	12 000 000
Pu-240	6.5E+03	1.7E+07	Plutonium-240	6 500 y	17 000 000
Pu-241	1.4E+01	5.5E+08	Plutonium-241	14 y	550 000 000
Pu-242	3.8E+05	1.7E+04	Plutonium-242	380 000 y	17 000
Ru-106	1.0E+00	8.4E+08	Ruthenium-106	1 y	840 000 000
Sb-125	2.8E+00	2.1E+07	Antimony-125	2.8 y	21 000 000
Se-79	1.1E+06	7.6E+01	Selenium-79	1 100 000 y	76
Sm-151	1 9E+01	7.6E+01	Samarium-151	19 y	76
Sn-126	2.1E+05	1.2E+02	Tin-126	210 000 y	120
Sr-90	2.9E+01	1.8E+07	Strontium-90	29 y	18 000 000
Tc-99	2.1E+05	2.8E+03	Technetium-99	210 000 y	2 800
U-234	2.5E+05	1.9E+04	Uranium-234	250 000 y	19 000
U-235	7.0E+08	3.2E+02	Uranium-235	700 000 000 y	320
U-236	2.3E+07	3.6E+03	Uranium-236	23 000 000 y	24 000
U-238	4.5E+09	2.4E+04	Uranium-238	4 500 000 000 y	24 000
Zr-93	1.5E+06	3.8E+02	Zirconium-93	1 500 000 y	380
TOTALS					
Long half-lives only		**8.7E+09**		**(long-lived)**	**8 700 000 000**
Including short half-lives		**1.6E+10**		**(all radionuclides)**	**16 000 000 000**

According to this OPG document (see the last 2 lines), there are over eight BILLION radioactive disintegrations taking place every second in each cubic metre, if we consider only the long-lived radioactive contaminants. Each disintegration releases an alpha particle, a beta particle, or a gamma ray; so there are more than eight billion of these subatomic projectiles emitted every second. That's more than 28 trillion per hour, and over 245 quintillion per year.

In particular, there are five plutonium isotopes found in the steam generators. There are about 580 million alpha rays given off each second, in each cubic metre, from these five plutonium isotopes alone. If the steam generators are just stored on-site as radioactive waste for one thousand years, these plutonium isotopes will still be giving off about 30 million alpha particles per second, per cubic metre.

Gordon Edwards, Ph.D

[NWMO = Nuclear Waste Management Organization; OPG = Ontario Power Generation]

Appendix B. Plutonium in Bruce "A" nuclear steam generators

*Here is a **partial** list of radioactive contaminants inside a **single** used steam generator from each one of the two reactors (Units 1 and 2 of Bruce A), according to CNSC (document CMD-10-H19B). The mass (in grams) of each radioactive material listed is estimated by CNSC staff.*

RADIONUCLIDE		***MASS***	
Name of Isotope (with Atomic Mass)	Half-Life (years)	Unit 1 (grams radioactive material)	Unit 2
Americium-241	430 y	0.103412	0.102412
Americium-243	7 400 y	0.002162	0.002432
Carbon-14	5 700 y	0.009065	0.072501
Curium-244	18 y	0.002644	0/000347
Cobalt-60	5.3 y	0.001781	0/000881
Cesium-137	30 y	0/000249	0.000238
Europium-154	8.8 y	0.000027	0.000290
Iron-55	2.7 y	0.000272	0.000290
Hydrogen-3 (Tritium)	13.0 y	0.000057	0.000051
Hafnium-181	2.7 y	0.000001	0.000001
Iodine-129	17 000 000 y	0.000060	0.000060
Niobium-94	20 000 y	0.002159	0.002158
Nickel-59	75 000 y	0.173601	0.036723
Nickel-63	96 y	0.030194	0.006526
Neptunium-237	2 100 000 y	0.028703	0.033295
Plutonium-238	*88 y*	*0.007507*	*0.004703*
Plutonium-239	*24 000 y*	*2.124977*	*2.471769*
Plutonium-240	*6 500 y*	*0.827304*	*0.957105*
Plutonium-241	*14 y*	*0.021309*	*0.030809*
Plutonium-242	*380 000 y*	*0.048762*	*0.056317*
Antimony-125	2.8 y	0.000001	0.000001
Strontium-90	29 y	0.009097	0.007581
Technetium-99	210 000 y	0.000143	0.000092
TOTALS			
Long-lived (> one year half-life)		**3.416108**	**3.787315**
Mass of plutonium isotopes only		**3.029859**	**3.520703**
Percent plutonium		**88.7%**	**93.0%**
TOTAL MASS			
(Source: CNSC document		*CMD-10-H19B)*	

There are 5 plutonium isotopes present in the steam generators.
In addition there are 18 other long-lived isotopes listed.

In the 16 Bruce A steam generators from Units 1 and 2 (8 from each) the total mass of radioactive material is estimated to be about 57.6 grams, of which 52.4 grams is plutonium. So the 5 isoptopes of plutonium make up 91.0 percent of the mass of radioactive material in all 16 vessels.

Plutonium is extremely dangerous even in minute quantities. For example, the maximum permissible "body burden" of plutonium-239 for an atomic worker (e.g. someone working in the U.S. nuclear weapons industry) is 0.7 micrograms. Inside the steam generators there are 36.8 grams of this one particular isotope – enough, in principle, to give over 52 million atomic workers their maximum permissible body burden of plutonium-239 . If we include all five isotopes of plutonium, the number of atomic workers who could be overdosed, in principle, is about doubled.

Plutonium isotopes also have very long half-lives, ranging from decades to hundreds of thousands of years. This means that anyleakage of these materials can pose long-lasting dangers.

- Gordon Edwards, Ph.D., November 8, 2010

Appendix 3.

An Evaluation of Atomic Energy of Canada Limited's "Environmental Impact Statement on the Concept for Disposal of Canada's Nuclear Fuel Waste"

(AECL-10711, COG-93-1)

by the *Scientific Review Group (SRG)*

Advisory to the Federal Environmental Assessment Review Panel

Taken from the Executive Summary

Summary and Conclusions

The AECL postclosure reference case study raises problems. In addition to the fact that it is site specific and has not been demonstrated to be applicable to various other potential fuel waste repository sites in the Canadian Shield**, there are problems with unclear objectives, with methods of analysis, and with the validity of the results of the postclosure reference case study itself.**

The assessment is based on predictions from numerical models. The SRG notes with concern that reliance on SYVAC has inhibited the introduction or use of more modern and flexible software and up-to-date data and has, to a degree, undermined the effectiveness of the assessments.

The SRG concludes that the results of the postclosure performance assessment are not reliable because:

- the reference case is too narrow a representative of the disposal concept;
- the conceptual framework for the reference case model is flawed;
- the choice of input parameteres, initial and boundary conditions, and source terms for the model are not satisfactory;
- the uncertainty analysis is not convincing; and
- the modelling of the exposure of humans and other living organisms to contaminants passing through the biosphere does not accomodate the likelihood of environmental or ecological changes over a 10,000 year period.

On the basis of these shortcomings, and its review of the detailed descriptions of the concept presented in the EIS and the supporting primary reference documents, **the SRG disagrees with AECL's conclusion** that:

> *"The methodology to evaluate the safety of a disposal system against established safety criteria, guidelines and standards has been developed and demonstrated to the extent reasonably achievable in a generic research program."*

Appendix 4.

An Evaluation of AECL's

"Environmental Impact Statementon on the Concept for Disposal of Canada's Nuclear Fuel Waste"(AECL-10711, COG-93-1)

by the *Scientific Review Group (SRG)* advisory to the Federal Environmental Assessment Review Panel

(Taken from the Executive Summary)

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