To: The Canadian Environmental Assessment Agency and the Honourable Catherine McKenna, Minister of Environment and Climate Change

From: The Canadian Coalition for Nuclear Responsibility (CCNR)

Date: March 6, 2017.

Re: Ontario Power Generation's Proposal for a DGR at Kincardine Ontario, for the burial and abandonment of Low- & Intermediate-Level nuclear wastes

The Canadian Coalition for Nuclear Responsibility (CCNR) urges the Minister of Environment and Climate Change not to approve the proposal by Ontario Power Generation (OPG) to construct a Deep Geological Repository (DGR) at Kincardine, Ontario, for the purpose of interring, and abandoning, all of the Low-Level and Intermediate Level Radioactive Waste (LILRW) from OPG's fleet of twenty nuclear power reactors.

Abandonment is Forever

CCNR is keenly aware and deeply concerned that the OPG project ultimately involves abandoning all these nuclear wastes, as is stated in the opening paragraphs of OPG's Environmental Impact Statement: *"The DGR Project includes site preparation and construction, operations, decommissioning, and abandonment…"* (page v). Indeed, the main difference between the surface and near-surface facility that now exists, on the one hand, and the DGR project now proposed by OPG, on the other hand, is that the new proposal is predicated on the assumption that the wastes will be abandoned, while the existing Western Waste Management Facility (WWMF) is by nature an on-going enterprise featuring constant monitoring, timely interventions in case of leaks, prompt retrieval in case of containment failure, and periodic repackaging if necessary. Once the wastes have been abandoned none of these actions will be possible. The repository will become a dump, and, as OPG admits, all waste packaging will eventually disintegrate. Monitoring, intervention, retrieval, and repackaging will be out of the question.

OPG acknowledges that these nuclear wastes will remain hazardous for 100,000 years, far exceeding the span of recorded human history. That is a period of time 20 times longer than the age of the Pyramids, and 10 times longer than the age of the Great Lakes themselves. There are no principles of science that can be used to forecast with confidence what will happen over such a long time period, because the computer models, scientific hypotheses and quantitative methods used to predict cannot be tested or verified against experience in any convincing manner. We do not have experience in designing for eternity: DGRs in Germany and USA have failed.

In a letter dated February 18, 2016, the Minister of Environment and Climate Change wrote to OPG requiring further information and/or studies on three important aspects of the proposed DGR, having to do with location, cumulative environmental impacts, and mitigation measures. The Minister indicated that a decision on the project would depend upon additional studies by OPG related to:

1) feasible alternative locations for the project, with specific reference to actual locations, accompanied by detailed information on the feasibility criteria employed by OPG, as well as an analysis by OPG of incremental costs and risks for any additional off-site transportation of the nuclear waste;

2) the cumulative environmental impact of the OPG project in conjunction with a nearby DGR for Canada's irradiated nuclear fuel waste at one of three possible locations not far from the proposed location of OPG's project at Kincardine;

3) an updated list of mitigation measures planned by OPG to deal with any and all adverse effects identified under CEAA 2012.

It is the considered opinion of CCNR that OPG has failed to furnish the necessary information to the Minister and that the project should therefore not be approved. A brief discussion of these inadequacies will be outlined below.

The Implications of Saying No

Fortunately, there is no urgent need for this project at the present time. OPG has been very clear in asserting that, in its judgment, the WWMF has been operating satisfactorily and can continue to do so for many decades to come. Thus a decision not to proceed with the OPG DGR project will not have any demonstrably negative environmental or health consequences. Since OPG has shown itself to be unable or unwilling to fulfil the Minister's request in a satisfactory manner, now is not the time for the Minister to make a decision that will be final and, in effect, eternal.

Moreover, there are important policy issues regarding the proposed abandonment of radioactive wastes that have not been adequately addressed at the federal cabinet level. The age of nuclear waste is only just beginning. Canadian citizens and their elected representatives need time to stop and think. Careful deliberation is required. Approval of the OPG project would be an epochal event – it would be the first time in history that the Canadian government will have formally endorsed the twin concepts that (1) it is permissible to place dangerous long-lived man-made radioactive materials beyond human control, and (2) it is permissible to situate such abandoned nuclear waste dumps in close proximity to important bodies of water.

Before any such permission is given, CCNR believes that the Government of Canada ought to take the time to consider its policy options going forward. For the OPG proposal is not an isolated project, in the grand scheme of things. There are other proposals on the drawing boards that the nuclear industry is eager to have approved within the next few years. These are all projects to abandon long-lived nuclear wastes in close proximity to important bodies of water:

- at Chalk River, in a shallow nuclear waste repository designed to hold up to half a million cubic metres of LILRW, situated beside the Ottawa River;

- at the Whiteshell Nuclear Research Establishment (WNRE), where the long-lived radioactivity embedded in the structures of the defunct WR-1 reactor would be buried, grouted and abandoned right beside the Winnipeg River;

- at Rolphton Ontario, where the radioactive remains of the Nuclear Power Demonstration reactor (NPD) would be buried, grouted and abandoned on the west bank of the Ottawa River, just upstream from Chalk River;

- at Port Hope, where a million cubic metres of historic long-lived radioactive wastes (dating back to the WWII A-Bomb project and the post-war nuclear weapons build-up) are to be placed in a surface facility just north of the town, in a marshy wetlands area that slopes down to Lake Ontario.

The only other DGR for LILRW in North America – the WIPP project near Carlsbad, New Mexico – has become radioactively contaminated by the explosion of an underground drum of nuclear waste. The explosion resulted in the contamination of 21 workers at the surface by plutonium-bearing dust that travelled over 650 metres vertically upwards. The dust contaminated the inner workings of the facility to such an extent that WIPP has remained closed since that 2014 accident. Restoring the facility to active use (by 2021 at the earliest) will cost up to $2 billion.

This event occurred in February 2014, during the on-going public hearings into OPG's DGR proposal. It occurred just a few months after representatives from OPG and CNSC had cited the WIPP project as an exemplary example of the safety, affordability and robustness of the DGR concept. Although the WIPP project will continue, the 2014 event stands as a sobering reminder that nuclear wastes are not inert, but are active: thermally active, chemically active, and radioactive. Nobody predicted in advance that organic kitty litter used as a packing material would chemically react under the influence of ionizing radiatiom, generating a flammable gas that would cause a low-level radioactive waste drum to explode and turn into a flame-thrower, deep in the bowels of the WIPP repository.

In Germany, two separate DGR projects for LILRW have failed. Low-level wastes were emplaced in the Aase-II Salt Mine for decades before it was revealed that the repository had failed to prevent radioactive releases. Indeed, leakage of radioactive materials had been occurring for almost ten years before government authorities were notified. The German government has now ordered the removal of all radioactive waste from the Aase-II facility, but it is a difficult job that will take 30 years or more to accomplish, at considerable expense. At the same time, the Morsleben DGR in Germany has also shown signs of failing, as the roof is buckling and the entire repository is in danger of collapsing.

Given these unpleasant experiences with the underground emplacement of low-level and intermediate level nuclear wastes, it would be wise for Canada to refrain from rushing ahead with the unprecedented proposal by OPG to bury and abandon a bewildering variety of nuclear wastes in a DGR excavated in limestone right beside (and below) Lake Huron. The radioactive wastes in question are highly diverse in physical and chemical characteristics. In one form or another they include virtually all of the radionuclides that are found in spent nuclear fuel, but to a smaller degree.

Critique of OPG's Response to the Minister's Requirements

1) Alternate Locations

Instead of identifying specific alternative locations for the DGR project, OPG identified two very large geological tracts characterized by crystalline rock on the one hand (the Canadian Shield), and sedimentary rock on the other hand. However, in terms of "actual locations", OPG provided latitude and longitude coordinates for 14 sites. Three of them are not even in Ontario, and two of them not even in Canada.

Latitude	Longitude	Approximate Location
44.9,	-79.8	Honey Harbour, east shore of Georgian Bay
46.0,	-81.2	Collins Inlet, near Killarney Ontario,
46.6,	-84.5	Prince Township, Ontario
48.8,	-86.6	Marathon, Ontario
48.0,	-89.6	Grande Portage, Minnesota

49.2,	-95.1	Angle Township, Minnesota
52.8,	-95.1	Kenora District, Ontario
55.1,	-91.6	Kenora District, Ontario
53.5,	-87.4	Kenora District, Ontario
50.4,	-85.4	Cochrane District, Ontario
50.8,	-79.5	Quebec -- in the Cree Territory of Eeyou-Istchee
47.2,	-79.6	Ontario ~20km NE of Temagami, <15 km from Quebec
45.3,	-76.4	Mississippi Mills, Ontario, SW of Arnprior, <15 km from Quebec
44.6,	-76.6	Godfrey, Ontario, about 40 km N of Kingston

That OPG would actually specify two sites in Minnesota and one site in the Cree Territory of Eeyou-Istchee in Northern Quebec as feasible locations for a disposal site for Ontario's nuclear waste is almost beyond belief. It is a clear indication that OPG is unfit to be entrusted with the job of guaranteeing saftey and environmental protection for tens of thousands of years into the future. The degree of sloppiness displayed in identifying alternate sites is quite astonishing. Besides the three sites that are not even located in the province of Ontario, two of the Ontario sites are within 15 kilometres of the border with Quebec – a province whose Assemblée Nationale has made it clear that Quebec will not willingly accept the abandonment of nuclear wastes from other jurisdictions in its territory or on its borders. This policy position dates back to a famous public pronouncement by the late Premier Robert Bourassa, when the US Government was searching for a DGR site near the border with Quebec, in a region where the waters flow into Quebec.

In the documents submitted by OPG, again and again we encounter the unsupported claim that "the proximity of a water body to the DGR is not relevant because the movement of water or gas, even if it was released from the DGR, would not reach the water body until the radioactivity of such water or gas had diminished to the levels generally found naturally occurring throughout Ontario." This is an unscientific claim, as it treats a design objective as if it were a scientifically proven fact needing no further confirmation. It is standing the scientific method on its head – hypothesis pre-empting evidence. It is an exercise is wishful thinking. Distance does not matter because OPG does not hypothesize that it will matter. Such a sophomoric approach to an extremely serious concern is hardly reassuring.

It must be evident to OPG as it is to most intervenors that the proximity of a nuclear waste dump to important water bodies is of the greatest of importance to citizens in both the USA and Canada, according to even the vaguest interpretation of the precautionary principle. Since the waste is to be abandoned, and since there will be no mitigation measures that can be relied upon in the distant future when institutional control is no longer in place, common sense alone dictates that one does not willingly risk the possibility that some massive unforeseen containment failure might contaminate vital drinking water supplies. Surely the concept of "multiple barriers" includes distance as one of many considerations. But OPG chooses to dismiss this concern, as if resolutions passed by over 180 municipalities in Canada and the USA, concerns of tens of thousands of citizens who have signed petitions, and alarm expressed by dozens of US lawmakers regarding the DGR project, were of no importance, and therefore not deserving of serious treatment.

2.) Cumulative Environmental Impacts and Mitigationj Measures

In a somewhat contradictory vein, OPG casts some doubt on the crystalline rock option by questioning the adequacy of "the engineered barrier requirements to ensure sufficient retention of Carbon-14. This radionuclide has a long half-life (5700 years), and is relatively mobile in groundwater and as a gas (e.g., methane). In CANDU wastes, there is a significant amount of C-14 sorbed on the ion exchange resins…. In crystalline rock, it is likely that groundwater will contact the ion exchange resins sooner, leading to the release of C-14 sooner than expected in sedimentary rock. Ideally, the rooms containing these resins would be in very low permeability and unfractured volume of crystalline rock to both delay inflow of water contacting the resins, and subsequently the release of C-14. Otherwise, it is likely that additional barriers would be required including (a) surface processing of the resins to make the C-14 less releasable than on as-packaged spent resins, and (b) backfilling the space within or around the packages with cement. These additional barriers would minimize contact with groundwater and mitigate C-14 waste from being released."

Given such clearly identified concerns, it does not inspire confidence to read OPG's seemingly contradictory assertion that, even if radioactivity were released from the DGR, it would not reach the nearby water body until it had diminished to levels "generally found naturally occurring in Ontario". Indeed, the overwhelming majority of the man-made radionuclides to be stored in the DGR do not exist in nature at all in some cases, and so there is no level of contamination with such materials that is "generally found naturally occurring in Ontario". Carbon-14 is an exception since it is a cosmogenic radionuclide that does occur at a low level in nature. However, the naturally-occurring background levels of radioactive cesium, iodine, plutonium, and americium, for example, are essentially zero. They occur in the environment only as fallout from nuclear weapons tests or as releases from nuclear facilities.

The biological harm caused by ingesting radionuclides has as much to do with the biochemical properties – pathways through the ecosystem into the food chain, pathways through the human body into specific organs, bioaccumulation factors, and residence times – as with the nuclear properties of the materials in question. Radioactive iodine, for example, concentrates in the thyroid gland where it can cause developmental abnormalities in children such as mental retardation and stunted growth as well as thyroid cancer. There is no naturally occurring radioactive material that behaves in this way. It is inappropriate to compare natural radioactivity with the man-made inventory of long-lived fission products, activation products and transuranic actinides. Plutonium contamination, for instance, is never a naturally-occurring problem. No level of plutonium contamination can be accurately described as "generally found naturally occurring in Ontario".

The DGR will also house contaminated equipment. Even in the case of equipment that is far removed from the core of the reactor, such as the tube bundle of a steam generator, there is an astonishing array of very long-lived man-made radionuclides. These materials contaminate the thousands of interior tubes, converting the entire tube bundle into radioactive waste. A steam generator is part of the primary cooling

system of the reactor. It is situated at the furthest remove from the core. A steam generator is a nuclear boiler, containing thousands of small diameter pipes that become irrevocably contaminated during use. From data published by the CNSC, we see in each steam generator there are two radionuclides with half-lives of more than 2 million years, six with half-lives of more than 20,000 years, and ten with half-lives of more than 2,000 years, out of a total of 23 radionuclides listed (see Annex 1). Indeed, the CNSC figures show that over 90 percent of the radioactive mass in the tube bundle is made up of plutonium isotopes (see Annex 1, page 1). In particular, plutonium-239, having a 24,000 year half-life, accounts for 70 percent of the total mass of radioactive contamination contained in the 4,200 contaminated pipes of a single 100-tonne steam generator.

There will be 128 such steam generators from the Bruce nuclear complex alone. Each one will have to be partitioned into five segments before being stored in the DGR. The segmentation process runs the risk of liberating the entrained radionuclides, including plutonium. The same contaminants are also found in the thousand or so other pipes that make up the primary cooling circuit – all of them becoming radioactive refurbishment wastes that are intended to go into the DGR.

A few years ago over 500 workers – most of them temporary workers, not Bruce employees – were internally contaminated with plutonium dust that was released into the working area of the plant during refurbishment activities. Neither Bruce Power nor CNSC saw to it that the workers were wearing respirators (none of them were). The workers breathed plutonium-contaminated dust on a daily basis for almost three weeks before the air-borne contamination problem was even detected. None of the staff or supervisors at Bruce or at the CNSC was found culpable as a result of this shameful episode of avoidable exposure. Compared with the WIPP incident, there were 23 times as many men contaminated with plutonium dust.

Some years ago Bruce Power announced plans to send 16 radioactive steam generators through the Great Lakes, along the St Lawrence Seaway, and across the

Atlantic Ocean to Sweden. At that time CCNR calculated that the very small mass of plutonium-239 contained in those 16 steam generators – about 36.8 grams, according to the CNSC data reproduced in Annex 1 – would be sufficient, in principle, to give 52 million atomic workers their maximum permissible body burden of plutonium. The reason for this is that plutonium-239 is so severely radiotoxic that the permissible body burden for an atomic worker is only 0.7 micrograms. It has since been determined that the CNSC inventory figures were seriously underestimated, so the risk is even greater than indicated above.

Since it takes 10 half-lives for a radioactive material to diminish by a factor of 1000, one can see that the biological hazard from the plutonium-239 inventory in the DGR will require about 240,000 years to subside through three orders of magnitude. That does not make it harmless, for if we start with the small mass of plutonium-239 mentioned in the previous paragraph, the amount remaining after 240,000 years would still be enough to overdose 52,000 atomic workers. Moreover, each atom of plutonium-239 that disintegrates is transmuted into another alpha-emitting radioactive material that has a half-life of about 700 million years. Thus the hazard from plutonium-239 is not bounded in time by 100,000 years as OPG has indicated in its literature. Plutonium has ample time to escape into a nearby body of water, either quickly or slowly, if there is a serious breach of containment in the repository. And there are many other radio-isotopes to be considered as well – iodine-129, with its 17 million year half-life; technetium-99, with a 210,000 year half-life; carbon-14, with a 5700 year half-life….

Originally, the DGR at Kincardine was intended to hold only low-level radioactive wastes – materials of low-energy radioactive emissions and of short half-lives. As time went on, the proposed inventory grew to include intermediate-level wastes – much more intensely radioactive and with much greater half-lives. Then the list was extended to include extremely radioactive components like zirconium-alloy pressure tubes and calandria tubes extracted from the core region of the reactor during refurbishment, as well as heavily contaminated equipment such as feeder

pipes, steam generator tube bundles, heat exchangers and resins.. It remains to be seen what will be done with the dismantled reactor vessels, shield plugs, et cetera.

The only reason that these wastes are currently stored beside major bodies of water is because large volumes of water are required to operate the nuclear plants that produce the wastes. To keep those wastes where they are may indeed be cheaper and easier for the waste producers, but such a practice is not guided by what is best for the environment, especially considering the avowed intention by the waste producers to abandon these wastes for eternity. Both the waste producers and the regulators have a vested interest in abandoning these wastes. The waste producers wish to limit their financial and legal liability, and the regulator wishes to limit its obligation to devote scarce resources on a very long-time basis to a facility that generates no revenue.

Conclusion

CCNR urges the CEAA to withhold approval for the proposed DGR, on the grounds that OPG has not adequately addressed the requirements laid down by the Minister. The current practice of managing the wastes at the WWMF can be continued for decades more without environmental penalty. Experience has revealed that overly optimistic predictions of the safety, reliability, and cost-effectiveness of deep geological repositories have not been borne out in practice. Moreover there is a policy vacuum that must be filled at the federal level regarding how best to proceed with the long-term management of nuclear wastes. Until that policy review is undertaken, in the meantime, abandonment of nuclear wastes should not be given carte-blanche by the government of the day. Instead a policy of "Rolling Stewardship" should be instituted, whereby radioactive wastes are maintained in a monitored and retrievable state at all times, with continual improvements being made to the packaging and to the environmental protection measures in place.

CCNR believes that for the very long term, Canada needs to create an independent Nuclear Fuel Waste Management Organization that is not controlled by the nuclear waste producers, as is the case with the present NWMO, or its regulator, the CNSC. Such an independent agency was unanimously recommended many years ago by the Seaborn Panel following a ten year long environmental assessment of AECL's geological repository concept for nuclear fuel waste.

There should be no federal approval given for any proposal to abandon nuclear wastes, particularly in cases where the wastes are to be abandoned beside major bodies of water, pending a thorough policy review at the federal level involving broad consultations with the public. We need an ethical, honest, objective and scientific approach to the problem of how best to manage nuclear wastes, not how quickly to abandon them.

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Annex 1

Plutonium in the 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 of the radioactive materials listed is estimated by CNSC staff.

RADIONUCLIDE		***MASS***	
Name of Isotope (with Atomic Mass)	Half-Life (years)	Unit 1 (grams radioactive material)	Unit 2 (grams radioactive material)
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)*	

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 (8 from Unit 1 and 8 from Unit 2), the total mass of radioactive material is estimated to be about 57.6 grams, of which 52.4 grams is plutonium. So plutonium makes up 91.0 percent of the mass of radioactive material in the steam generators.

Plutonium is extremely dangerous even in minute quantities. The maximum permissible "body burden" of plutonium-239 for an atomic worker (for instance, someone working in the 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 just about doubled.

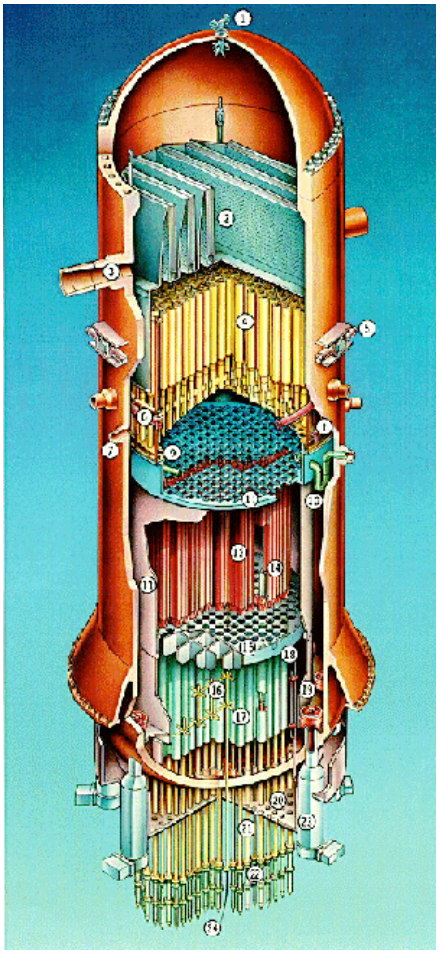
Plutonium isotopes also have very long half-lives, ranging from decades to hundreds of thousands of years. This means that any accident which resulted in a spill could pose long-lasting dangers.

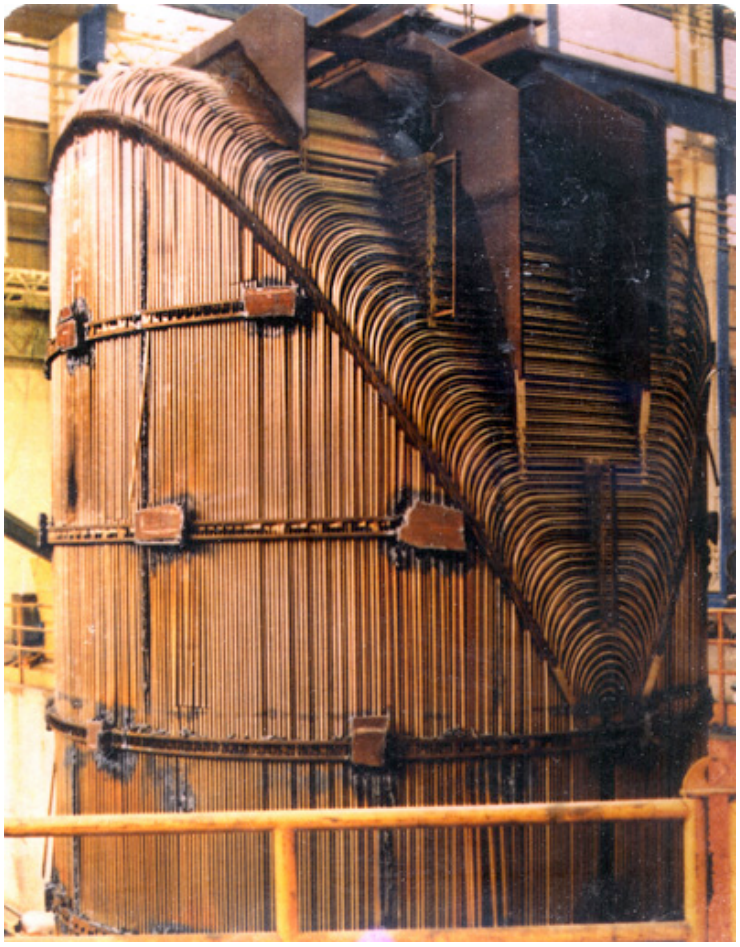
- Gordon Edwards, Ph.D., November 8, 2010

Annex 1

Nuclear Intestines: "The Tube Bundle"

Inside each of the old steam generators from Bruce reactors are 4200 radioactively contaminated tubes, similar to those shown here.





A nuclear steam generator is an enormous vessel with steel walls (this is a US model, not a CANDU). It is a nuclear "boiler".

The water from the core of the reactor ("primary coolant") is not allowed to boil; instead, the primary coolant runs through thousands of small tubes that act as heating elements to boil other water called the "secondary coolant". The steam generated is then used to spin a turbine and produce electricity.

The picture on the right shows the thousands of long narrow tubes inside a steam generator. Laid end to end they would stretch 1000 km or more. These tubes become corroded and radioactively contaminated over time; eventually the entire steam generator has to be replaced.

Radioactive materials are deposited on the insides of these tubes by the primary coolant which comes directly from the core of the reactor. When these tubes spring leaks the radioactive contamination passes from the "primary side" (inside the narrow tubes) to the "secondary side" (outside those tubes).

The Studsvik company brags that it "has recently developed a unique process … to treat and reduce the volume of the **highly radioactive tube bundle.**"

- Gordon Edwards, Ph.D.