Projet de modification des installations de stockage des déchets radioactifs et réfection de Gentilly-2

Mémoire de

Regroupement pour la surveillance du nucléaire (RNS)

déposé au

Bureau d'audiences publiques sur l'environnement

Décembre 2004

To: Le Bureau d'audiences publiques sur l'environnement (BAPE)
E-mail: gentilly2@bape.gouv.qc.ca

From: Le Regroupement pour la surveillance du nucléaire (RSN)
a/s Gordon Edwards, Ph.D., président
E-mail: ccnr@web.ca
Fax: (514) 489-5118

Date: le 10 décembre 2004

Re: projet de modification des installations de stockage des déchets radioactifs et réfection de Gentilly-2 par Hydro-Québec

---

Who is RSN?

Le Regroupement pour la surveillance du nucléaire (RSN) is a federally-incorporated not-for-profit organization with a mandate to conduct research and education on issues of public concern related to nuclear power, nuclear weapons, uranium mining, radioactive materials, and alternative non-nuclear energy options.

RSN Activities ~ Quebec Nuclear Moratorium

RSN has been active on nuclear issues in Canada since its establishment in Montreal in 1975. In 1977 RSN submitted a major memoir on the subject of nuclear power to the Energy Committee of the National Assembly in Quebec City. One year later, in 1978, the government of René Lévesque declared a moratorium on the construction of any further nuclear power reactors in the province of Québec.

RSN Activities ~ Ontario Royal Commission

In 1977 and 1978, RSN was a major participant in the Ontario Royal Commission on Electric Power Planning. In its Interim Report on Nuclear Power entitled "A Race Against Time", published in September 1978, the Royal Commission reported that:

- The extreme lethality of a freshly removed spent fuel bundle is such that a person standing within a metre of it would die within an hour. During the next forty years (and probably for thousands of years), the management of hundreds of thousands of such bundles (in Ontario alone), which at all times must be isolated from the earth's ecosystem, will clearly present a problem of massive proportions. (A Race Against Time, p. 87)
- An independent review committee should be established to report to the Atomic Energy Control Board (AECB) on progress on waste disposal research and demonstration. If the committee is not satisfied with progress by 1985, a

moratorium on additional nuclear power plants would be justified. (A Race Against Time, Major Findings and Conclusions, p. xiii)

- Uffen *[Dr. R. J. Uffen, then Dean of Applied Science at Queen's University and former Vice-Chairman of Ontario Hydro]* is unequivocal in recommending that no nuclear programme be committed in Ontario, of "capacity greater than 20,000 MW", until "it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of the long-lived, highly radioactive waste for the indefinite future."

  We endorse the Uffen conclusion. However, we go further and conclude that continuous monitoring of waste disposal research should be undertaken by an independent panel of experts reporting to the AECB. This corresponds to the Uffen proposal for a "Canadian Nuclear Waste Management Advisory Council." If adequate progress is not being made, say, by 1985, the nuclear power programme should be reassessed and a moratorium on additional nuclear stations should be considered. (A Race Against Time, p. 95)

RSN Activities ~ Vermont Geologic Repository

In the 1980's, RSN was in the forefront in opposing the establishment of a permanent repository for high-level radioactive wastes in Vermont. At that time, the U.S. Department of Energy was searching for a site for a geological repository in crystalline rock in the Northwest region of the United States of America to house irradiated nuclear fuel and post-reprocessing wastes left over from the American military and civilian nuclear programs.

Jean Charest, then a federal MP from Sherbrooke, intervened with the Government of Canada to arrange for a diplomatic note to be delivered to the U.S. Government by the Canadian Ambassador in Washington expressing the great concern felt by Ottawa over the prospect of having such a potentially dangerous waste repository situated on the borders of Quebec. For his part, Premier Robert Bourassa made it known that Québec would never permit the establishment of a permanent repository for high-level radioactive wastes (i.e. irradiated nuclear fuel) anywhere within the territory of Québec or on its borders.

Eventually the US Department of Energy discontinued its efforts to site a permanent repository for high-level radioactive waste in the Northwest United States.

Hydro-Quebec's proposal to refurbish the G-2 reactor

The proposed refurbishment of the Gentilly-2 reactor will commit Hydro-Québec and therefore the province of Québec to the continued production of high-level radioactive wastes (irradiated nuclear fuel) for decades to come, despite the fact that the government of Québec is opposed to the permanent storage of such wastes in Québec.

RSN believes this would be a major mistake for both pragmatic and ethical reasons.

Moreover, RSN believes that the proposed refurbishment of the Gentilly-2 reactor violates the spirit of the long-standing moratorium against any new reactors in Québec.

In effect, the proposed refurbishment is the creation of a new nuclear reactor inside the shell of the old one.

Hydro-Québec has determined that the Gentilly-2 nuclear reactor cannot continue to operate safely and reliably without major modifications. These modifications are mainly to the core area of the reactor, involving specifically the primary heat transport system which has become significantly degraded over time.

Put simply, the Gentilly-2 reactor core is reaching the end of its useful lifetime because of premature aging of crucial components. Although the reactor was intended to last for forty years, it has barely lasted for twenty years.

For safety reasons, the reactor core and other parts of the primary heat transport system will have to be completely rebuilt if continued operation is to occur for many more years. The proposed modifications involve replacing all of the zirconium-niobium pressure tubes in the core of the reactor as well as the steel feeder pipes which are connected to the pressure tubes at each end of the calandria vessel.

These modifications are expected to cost well over a thousand million dollars, a figure which comes quite close to the original cost of construction of the Gentilly-2 reactor. This is not entirely surprising, because in effect, Hydro-Québec intends to build a new nuclear reactor within the shell of the existing one, thereby circumventing the existing moratorium on the construction of new nuclear reactors in Quebec.

Recommendation 1: RSN recommends that the Québec government not allow Hydro-Québec to proceed with its proposed modifications to the radioactive waste storage facilities at Gentilly-2, because such modifications are predicated on assumptions which are completely repugnant to the expressed policies of successive Quebec governments:

- not to build any new nuclear reactors in Quebec, and
- not to allow Québec to be a long-term repository for highly radioactive, extremely long-lived, nuclear waste materials.

Hydro-Quebec's proposal to prolong the production of irradiated nuclear fuel

It must be recognized that irradiated nuclear fuel is the most toxic waste material produced by any industry on earth. Each irradiated fuel bundle contains hundreds of different radioactive poisons, created inside the reactor in the course of nuclear fission.

Most of these "fission products", "activation products" and "actinides" were never present in the natural environment prior to the advent of nuclear fission reactors (see Exhibits A and B). They constitute an entirely man-made legacy.

It must also be recognized that this waste material remains toxic for many hundreds of thousands of years. Exhibit C is a graph taken from the 1978 Interim Report on Nuclear Power by the Ontario Royal Commission on Electric Power Planning, entitled A Race Against Time. It shows the toxicity of an irradiated CANDU fuel bundle for the first 10 million years after it has been removed from the reactor. It will be noted that the toxicity declines for the first 100,000 years, but then it increases again because of internal changes that continue to take place within the irradiated fuel (namely the in-breeding of more toxic radioactive byproducts as a result of radioactive decay).

A 1978 report from the US Geological Survey pointed out that even after a million years of storage, irradiated nuclear fuel from US nuclear reactors is so toxic that if it could all be dissolved in water, it would be sufficient to render all the water in the Great Lakes water system unfit for human consumption. This theoretical calculation was intended by the authors to emphasize the vital importance of perpetual safe storage of these largely man-made radioactive materials at an extremely high degree of perfection. (Geologic Disposal of High-Level Radioactive Wastes -- Earth-Science Perspectives, U.S. Geological Survey, Circular 779, by J.D. Bredehoeft et al.)

If Hydro-Québec plans to produce more of this highly toxic, long-lived material, it should be required to justify how it will manage this nuclear waste for hundreds of thousands of years to come in case the waste stays in Quebec.

Currently, the Nuclear Waste Management Organization has been created by order of the federal government to study three specific options for the long-term management of irradiated nuclear fuel in Canada, and one of those options is "on-site storage". (The other two are "centralized monitored storage" and "irretrievable geologic storage".) Thus Québec must be prepared, if necessary, to manage this nuclear waste on-site in perpetuity, or at least for a very long time.

- Nuclear fuel that has been used to generate electricity remains highly radioactive.. Unless it is properly managed it can be dangerous to people and the environment for a very long time. (NWMO, Understanding the Choices, p. 16)
- The Nuclear Fuel Waste Act . . . provides a framework for the Government of Canada to make a decision on the long-term management of used nuclear fuel. It requires the NWMO to develop and recommend an approach to the government by November 15 2005. At a minimum, the NWMO must study approaches based on three technical methods:
    - deep geological disposal,
    - centralized storage – above or below-ground, and

- reactor-site storage. (NWMO, Understanding the Choices, p. 16)

The cost of each of the three options being studied by NWMO is estimated to be in the neighbourhood of $16 billion or more. Hydro-Québec's share of that debt would no doubt increase if Gentilly-2 proceeds to produce twice as much irradiated nuclear fuel as it has already produced. And it may well be that the $16 billion estimate is far too low. Already the estimated cost of geologic storage has doubled from $8 billion a few years ago to $16 billion today, without any site having been chosen as yet!

Extended on-site storage also poses many daunting challenges. The containers that house the irradiated nuclear fuel are only temporary containers. They will have to be replaced every fifty years or so. If the wastes are to be stored on-site for hundreds or thousands of years, then many generations of containers will be required. Moreover, each time the irradiated nuclear fuel is moved from one container to the next, it will likely be in a more corroded and degraded state, making the transfer that much more difficult and dangerous in terms of potential environmental contamination.

The dangers of terrorist attack on the exposed waste containers is another question, which is compounded by the close proximity of the high-level radioactive wastes to the St. Lawrence River.

Unless and until Hydro-Québec provides complete details on how it plans to manage the irradiated fuel in perpetuity here in Québec, if necessary, there should be no permission granted for expanding the production of this problematic waste material.

Recommendation 2: RSN recommends that the BAPE not allow Hydro-Québec to proceed with its proposed modifications to the radioactive waste storage facilities at Gentilly-2, because there is no currently acceptable method for the permanent safe storage of high-level radioactive wastes (irradiated nuclear fuel) and therefore there is no justification for the continued production of such highly toxic materials.

Recommendation 3: If however the BAPE is not inclined to disallow the project, Hydro-Québec should be required to produce a detailed contingency plan for the perpetual maintenance and protection of the radioactive waste materials long after the Gentilly-2 reactor has been permanently retired.

Nuclear Safety and Nuclear Waste ~ The Politics of Denial

It is worth remarking that when the Gentilly-2 reactor was first approved for construction in 1973 or thereabouts, there was no official acknowledgment of the monumental problems associated with the perpetual safe storage of high-level

radioactive wastes from nuclear reactors. Politicians and the public alike were told that nuclear power was an inherently safe and clean technology, which was not the truth. At that time, only those in the nuclear industry knew of the problems associated with irradiated nuclear fuel, and the possibilities of catastrophic nuclear accidents. They did not share this information with the public.

Catastrophic nuclear accidents are possible in CANDU reactors just as they are in other types of reactors. The reason is straightforward. Not only is a nuclear reactor a machine for generating electricity, but it is also a repository for an enormous inventory of intensely radioactive materials which, if released to the environment, can have catastrophic consequences. As the Select Committee on Ontario Hydro Affairs reported in 1980:

- It is not right to say that a catastrophic accident is impossible . . . . The worst possible accident . . . could involve the spread of radioactive poisons over large areas, killing thousands immediately, killing others through increasing susceptibility to cancer, risking genetic defects that could affect future generations, and possibly contaminating large land areas for future habitation or cultivation. (The Safety of Ontario's Nuclear Reactors, 1980, p. 37)

And as the Atomic Energy Control Board reported to the Treasury Board of Canada in 1988:

- It is recognized now that, through the combination of a series of comparatively common failures which, on their own, are of little consequence, accidents can develop in a myriad of ways (as demonstrated most vividly at Three Mile Island and Chernobyl). This makes the calculation of consequences of potential accidents very difficult. Research to simulate accident consequences is often incomplete, and, perhaps most significant, human errors are an unquantifiable element. . . .
- Reports of significant events that have occurred in Canadian reactors show that human error plays a part in more than 50 percent of all such events. Both the nature and the probability of human error is difficult to quantify, and hence the probability of serious accidents which are a combination of system failure and incorrect human response is difficult to predict. . . .
- The consequences of a severe accident can be very high. The accident at Chernobyl has cost the Soviet economy about $ 16 billion including replacement power costs. The accident has generated anti-nuclear sentiment in the USSR and throughout the world. Three Mile Island has cost the USA $ 4.8 billion even though the Three Mile Island accident had essentially no radiation impact on the public. The accident was a major contributor to the public distrust of nuclear power in the USA.

- The years of successful accident-free operation which are a hallmark of the Canadian nuclear program are not, by themselves, proof of adequate safety. . . . CANDU plants cannot be said to be either more or less safe than other types.

  (Submission to the Treasury Board of Canada by the
  Atomic Energy Control Board Ottawa, October 16, 1989.)

And, as the Ontario Royal Commission on Electric Power Planning reported in 1978:

- When we talk about the safety of a nuclear reactor, we are referring essentially to how effectively the fantastic amount of radioactivity contained in the reactor core can be prevented from escaping into the ground and atmosphere in the event of major malfunctions.

  Clearly, if a major release of this accumulated radioactivity occurred, as discussed in the previous section, the consequences would be extremely serious and could involve several thousand immediate fatalities and many more delayed fatalities. (A Race Against Time, p. 76)

- An uncontained complete core meltdown would almost certainly give rise to a large release of radioactivity, the consequences of which were discussed previously. (A Race Against Time, p. 78)

- Assuming absolute independence of the process and safety systems, the probability of a core meltdown per reactor at Pickering is said to be in the order of 1 in 1,000,000 years *[once in a million years]* . (A Race Against Time, p. 78)

- However, two well-informed nuclear critics who participated in the hearings, Dr. Gordon Edwards and Ralph Torrie, have argued that the probability of a dual failure could be about 100 times higher than the theoretical levels. This estimate is based on failure rates in the high pressure piping of the primary heat transport system being 10 times higher than has been assumed, and also on the fact that the availability of the Pickering ECCS *[Emergency Core Cooling System]* has been demonstrated to be 10 times lower than postulated by the designers.

  We believe that the Edwards/Torrie estimate *[of 1 in 10,000 per reactor per year]* is more realistic than the theoretical probability, not least because the Rasmussen Report *[Reactor Safety Study, US Nuclear Regulatory Commission, 1974]* has concluded that the probability of an uncontained meltdown in a light water (U.S.) reactor is 1 in 20,000 per reactor per year. It has been suggested, moreover, that this figure could be out by a factor of "5 either way".

  Assuming, for the sake of argument, that within the next forty years Canada will have 100 operating reactors, the probability of a core meltdown might be in the order of 1 in 40 years, if the most pessimistic estimate of probability is assumed.
  (A Race Against Time, pp. 78-79)

Even to this day, Hydro-Québec representatives often deny in public that such catastrophic accidents are possible at a CANDU reactor such as the Gentilly-2 reactor.

Nevertheless, they are required to distribute iodine pills to the population to be used in the event of just such an accident, and to publish evacuation plans for the same reason.

While such accidents are indeed highly improbable, they are unfortunately possible. Moreover, such "accidents" could be precipitated by a terrorist attack or by sabotage from inside or outside the plant. The consequences of such an event could be a catastrophe of unimaginable magnitude for the province of Quebec, for it could contaminate the St. Lawrence River and render large areas of land unfit for human habitation for a very long time. It could also affect more distant population centers such as Quebec City:

- . . . if a substantial quantity of radioactivity were to be released to the atmosphere, the radioactivity would collect in a "cloud" and would be carried down wind. . . . At distances of two or three kilometres, depending on wind velocity, the cloud would begin to disperse (the dispersal zone could extend to distances of several hundred kilometres) and radioactive materials would be deposited on the ground. In consequence, both prompt and latent cancers would be produced. (A Race Against Time, p. 73)

It is important to realize that the radioactive poisons referred to in these hypothetical accident scenarios are essentially the same radioactive poisons that Hydro-Quebec intends to deposit in the radioactive waste storage sites that are the subject of discussion in these BAPE hearings.

Recommendation 4: RSN recommends that the Government of Quebec carefully consider the advisability of accepting the risk of massive and irreversible radioactive contamination of the environment, regardless of how small the probability of such an event may be estimated to be. What kind of economic benefits would be sufficient to justify taking such a chance on the future, when the nuclear technology that poses that risk is not needed in Quebec?

Recommendation 5: RSN recommends that the BAPE require Hydro-Québec to provide a detailed inventory of the various radioactive species contained in the different waste streams, together with pertinent biological and environmental information on each one, indicating how each of these radionuclides is likely to behave if it were to be released into natural ecosystems or if it were to enter into the human body through ingestion, inhalation, or absorption through the skin. In the absence of such detailed information, RSN recommends that approval for the proposed modifications of the radioactive waste storage sites be withheld because an environmental assessment of any hypothetical failure of containment is impossible to carry out.

The Opportunity Cost of Continuing to Produce High-Level Nuclear Waste

As already remarked, the problem of safely containing high-level radioactive waste for millions of years was not acknowledged by either the nuclear industry or by the Government of Canada when Gentilly-2 was conceived.

The Government of Canada began producing irradiated nuclear fuel in 1945 at Chalk River Ontario, and accelerated the production of irradiated nuclear fuel through its promotion of civilian nuclear electricity generation in Ontario beginning in 1954.

The Government of Canada received permission from Quebec to build the Gentilly-1 reactor at Bécancour, apparently without ever informing Québec about the long-term problem of managing irradiated nuclear fuel. That reactor (Gentilly-1), and the irradiated nuclear fuel produced by that reactor, are the sole property and responsibility of the Government of Canada despite the fact that both the reactor and its irradiated fuel are situated within the territory of Quebec (beside Gentilly-2).

The Government of Canada then induced Quebec to build the Gentilly-2 reactor (following AECL specifications) by offering to pay half the estimated cost of construction (about one-eighth of the actual cost of construction).

Gentilly-2 is a CANDU-6 reactor. The CANDU-6 is a particular model designed by Atomic Energy of Canada Limited for export purposes. It is distinctly different from any of the CANDU reactors operating in Ontario. The Point Lepreau reactor in New Brunswick is also a CANDU-6 design, and, there too, the Government of Canada offered to pay half of the estimated construction cost. CANDU-6 reactors have also been sold overseas to India, Pakistan, Argentina, Korea, Romania, and China.

Having CANDU-6 reactors operating in Quebec and New Brunswick was a great help in assisting AECL to sell similar reactors in other countries, at the behest of the Government of Canada. As far as RSN has been able to determine, none of these CANDU customers were advised of the problem of the safe long-term management of irradiated nuclear fuel.

Consequently, whatever irradiated fuel has been produced in Québec to date has been in large part the result of a deception perpetrated by the federal government and by its crown corporation Atomic Energy of Canada Limited (AECL).

If the Government of Quebec decides not to allow the refurbishment of the Gentilly-2 reactor, a strong case can be made (given the history) that these existing wastes are principally the responsibility of the Government of Canada. However, if Quebec allows the refurbishment of the Gentilly-2 reactor to proceed, thereby guaranteeing that additional irradiated nuclear fuel will be produced in Quebec, there can be no other

conclusion but that Quebec has willingly embraced the responsibility for producing this toxic material and is willing to be solely responsible for it.

Recommendation 6: RSN recommends that the Government of Québec seriously consider the opportunity cost of making a conscious and deliberate decision to allow Hydro-Québec to produce more high-level radioactive waste, in full knowledge of the enormous problems associated with finding an acceptable method for the safe permanent storage of such radioactive wastes. If the Government of Québec wishes to ensure, insofar as it is possible to do so, that Quebec will not become a permanent repository for such waste, it may be wiser to disallow the further production of such waste henceforth.

The Failure to Require Public Hearings on the Entire Project

If the proposed billion-dollar reconstruction of the reactor core is not carried out, then the present BAPE hearings are completely superfluous. There is no need to modify the radioactive waste storage sites if the life of the reactor is not going to be extended.

As a result, the current BAPE hearings run the risk of making a mockery of environmental assessment law in Quebec and the public hearings process associated with it. The main billion-dollar project – involving the dismantling of intensely radioactive structural components, stirring up radioactive dust, releasing radioactive corrosion, contaminating equipment and uniforms, irradiating and possibly contaminating contract workers, producing huge volumes of radioactive materials which must be handled, compacted, and packaged – is not being reviewed. The public hearings only cover the storage of these radioactive materials once they have been neatly packaged.

Hydro-Quebec has not yet made publicly available all the relevant documents associated with the refurbishment project. Even the financial estimates have not been finalized and itemized. Under such circumstances it is not possible to evaluate the environmental impacts of the refurbishment, nor to challenge the financial viability of the refurbishment, nor to compare the refurbishment with other more cost-effective energy policy alternatives.

Recommendation 7: RSN recommends that the BAPE not approve Hydro-Québec's proposed modifications to the radioactive waste storage facilities at Gentilly-2, because it is a case of "project-splitting" whereby the proponent is seeking environmental approval for a small part of a larger project rather than submitting the entire project to a full environmental assessment with a public hearing

on all aspects of the proposed refurbishment of the Gentilly-2 reactor.

The Failure to Require a Federal Panel Review of the Refurbishment

In effect, the modifications to the reactor core and the primary heat transport system currently proposed by Hydro-Québec amount to a "mini-decommissioning" operation. The word "decommissioning" is used in several different senses in the context of nuclear reactors; we are referring here to the most complete form of decommissioning, which is the total dismantlement of the radioactive structures of the reactor in order to return the reactor site to "green field" status.

In a complete decommissioning operation, the reactor is first de-fuelled: that is, all of the irradiated fuel is removed from the reactor core and placed in a water-filled spent fuel bay. Next, the reactor vessel is drained of its heavy water moderator, and the primary heat transport system is drained of its heavy water coolant. Chemical treatments are then used to remove as much of the radioactive contamination within the pipes as possible, in order to reduce radiation fields for the workers. This of course produces radioactively contaminated liquid wastes. Then the highly radioactive pressure tubes and the somewhat less radioactive feeder pipes are removed, creating the bulk of the radioactive solid wastes.

All of this work is intended to be carried out by Hydro-Québec in order to extend the lifetime of the reactor. Of course, total decommissioning would involve several additional steps, notably the dismantling of the huge irradiated calandria vessel itself. Nevertheless, the steps listed above are exactly the same as the initial steps that must be taken during any final and complete decommissioning operation.

But all CANDU decommisioning plans suggest postponing the work of dismantling the radioactive structures for forty years or more in order to minimize worker exposures. The passage of time allows for the intensely penetrating radiation fields around the core of the reactor and the primary heat transport system to decline significantly due to radioactive decay. This, however, is not what Hydro-Quebec is proposing. Hydro-Quebec does not want to wait forty years to refurbish the reactor, so the work-force will be sent into highly radioactive areas that have not been allowed to "cool down".

Workers are thus exposed to high radiation fields and the ever-present possibility of radioactive contamination which could be tracked off-site. During the retubing of the Pickering A reactors, some Ontario Hydro workers became contaminated with radioactive carbon-14 dust and tracked it into their homes. For some days the very existence of this radioactive dust was not recognized by Ontario Hydro authorities because the weak beta radiation given off by carbon-14 did not register on the regular radiation monitors. When the fine carbon-14 dust was finally detected suspended in the atmosphere inside the plant, the contamination was traced to workers' homes. Some

furniture and bed-sheets had to be confiscated and treated as radioactive waste material,

Clearly, the retubing of an old reactor is a major operation which has a far greater potential for environmental contamination than the construction of a brand-new reactor. When a new reactor is being built, the construction materials are not radioactive; but when an old reactor is being retubed, most of the materials are intensely radioactive.

In the case of nuclear facilities, The Canadian Environmental Assessment Act requires a full environmental assessment process for the construction of a new nuclear reactor or for the decommissioning of an old nuclear reactor. Clearly, it is the intent of the law that such an environmental assessment should also be carried out for the "mini-decommissioning" operation known as retubing.

However, the Canadian Nuclear Safety Commission (CNSC) – successor to the Atomic Energy Control Board (AECB) –does not see it that way. CNSC has decided to classify the refurbishment of the Gentilly-2 reactor as a regular "maintenance" operation, which is clearly inappropriate, given the scope of the operation, the amount of radioactive materials involved, and the radiation fields to which the workforce will be exposed.

Recommendation 8: RSN urges the BAPE to recommend that the Quebec Environment Minister, Thomas Mulcair, contact his federal counterpart in order to arrange for a joint federal-provincial panel review of the potential environmental impacts associated with the proposed refurbishment of the Gentilly-2 reactor. Meanwhile, Hydro-Quebec's proposed modifications to the radioactive waste storage facilities should not be approved pending the outcome of such a provincial/federal initiative.

The Cost and the Adequacy of the Proposed Reactor Modifications

Expensive as the proposed modifications to the core of the Gentilly-2 reactor are expected to be, they will not succeed in restoring the reactor to a condition which is "as good as new". Indeed, the entire primary cooling circuit of the Gentilly-2 reactor has undergone significant degradation, due to:

- intense neutron bombardment,
- unremitting exposure to high temperatures and pressures
- repeated chemical and physical stresses which have had a serious deteriorating effect on the smaller pipes especially, and
- lack of adequate inspection and maintenance due to the intense radiation fields surrounding these pipes – which makes direct contact very difficult, extremely costly, and indeed in many cases impossible.

It has come to the attention of RSN that much of the degradation in the primary cooling circuit has neither been studied nor documented in adequate detail. Because of this, it is entirely likely that within a decade or less, further expensive modifications may have to be made to the reactor's primary cooling circuit. Of course, this will make the total cost of all these modifications much higher than presently estimated, thereby compromising or negating any economic justification for the project that is offered at the present time.

For example, it may be that one or more of the 92-ton steam generators at Gentilly-2 will have to be replaced in years to come, as has been done in some nuclear reactors operating in the USA (e.g. the Turkey Point reactor in Florida). [See Exhibit D] Each steam generator is an integral part of the primary cooling system of the reactor, containing approximately 50,000 small pipes which simply cannot be inspected or repaired directly. The only known way to replace the degraded pipes in a steam generator is to replace the entire steam generator.

There has never been a replacement of a steam generator in a CANDU reactor, and the Gentilly-2 reactor building was never designed to allow for such an operation. To remove a steam generator will be very costly, necessitating the creation of a large hole in the containment wall to allow for the removal of the old steam generator and the installation of the new one. Needless to say, this will also result in a very large and bulky piece of radioactive garbage (the old steam generator) for which there are no radioactive waste storage facilities in place or even contemplated.

Moreover, it is likely that the proposed modifications to Gentilly-2 will be much more costly than anticipated, even in the absence of any future unpleasant surprises. Already the cost estimate has escalated from around $800 million to $1,200 million – an increase of 50 percent before the work has even been started!

Recently we have witnessed the spectacle of Ontario Power Generation attempting to restart the four Pickering A reactors near Toronto, which were shut down in 1997 for safety reasons. OPG originally estimated the cost of restarting all four reactors at $800 million, but so far they have only succeeded in restarting one of them, namely Unit 4, at a cost of $1.4 billion. In other words, that one reactor cost almost double the estimated cost for restarting all four reactors! And, let it be noted, all four of these reactors were retubed two decades ago! The current estimated cost of restarting all four reactors is between $3 billion and $4 billion – more than 4 times the original cost estimate of $800 million. [See Exhibit E, Introduction, page 4]

The problem is that the radiation fields around the pipes are so intense that direct observations are extremely limited. As a result, unanticipated cost escalations and time delays (which also add significantly to the cost) are frequently experienced. Thus the original cost estimate may be off by a factor of two, or three, or even four. But once a

few hundred million dollars have been spent, it becomes virtually impossible to stop just because the project is going over budget.

There is no complete cure for this problem. However, recognizing that there may be a built-in bias within Hydro-Quebec's nuclear division which tends to underestimate costs in order to get the project approved, RSN recommends that the Government of Quebec ensure that an independent assessment be carried out prior to project approval.

It will be remembered that in 1997 the Ontario Hydro Board of Directors did something comparable; they brought in an outside team of nuclear experts in order to give an independent assessment of the status of Ontario's nuclear reactors. As a result of this investigation, seven of Ontario's 22 reactors were shut down for safety reasons. It was the largest shut-down of reactors in the history of nuclear power around the world.

Recommendation 9: Given the enormous sums of money involved, and the high degree of financial uncertainty surrounding the estimation of the final cost of Hydro-Québec's proposed modifications, CCNR urges the BAPE to recommend that Hydro-Québec not be allowed to proceed until an independent team of experts from outside Canada is engaged by Hydro-Québec to assess the adequacy of the proposed modifications and the accuracy of the associated cost estimates. In particular, this external review should examine the possibility that steam generators or other components may have to be replaced at some future date.

A New Category of Long-Lived Highly Radioactive Wastes in Quebec

As indicated earlier, in preparation for these elaborate and costly modifications to the reactor, Hydro-Quebec is seeking permission to store ever-greater quantities of radioactive waste materials at the two existing storage sites which are located away from the reactor buildings – the one for irradiated nuclear fuel (high-level radioactive waste) and the other for diverse radioactive waste materials (low- and medium-level radioactive wastes).

But that's not all. In addition, Hydro-Québec is seeking permission to create a third radioactive waste storage site, a brand new one, also away from the reactor buildings, to house the intensely radioactive pressure tubes, feeder pipes, and other materials removed from the primary cooling circuit of the Gentilly-2 reactor.

These wastes represent an entirely new category of radioactive waste materials – they will be the most radioactive and the longest-lived radioactive wastes in Quebec other than the irradiated nuclear fuel itself.

It is important to note that the irradiated pressure tubes remain dangerously radioactive for a very long time – tens of thousands of years – because of the creation of numerous radioactive materials in the zirconium-niobium alloy resulting from neutron activation.

Some of these "activation products" are intense gamma-ray emitters having a significantly long lifetime, in some cases measured in millennia.

It is a significant fact that these new radioactive wastes are solely the responsibility of Hydro-Québec, and not at all the responsibility of the Government of Canada. Gordon Edwards, President of CCNR, was recently in Toronto meeting with Elizabeth Dowdeswell, President of the NWMO. He asked her whether the irradiated pressure tubes and other debris extracted from a reactor undergoing modifications would be covered by the NWMO mandate or by the Nuclear Waste Act which created the NWMO. Her response was a categorical "No".

Recommendation 10. It is essential that Hydro-Québec elaborate detailed plans for managing the irradiated pressure tubes, feeder pipes, and other radioactive debris from the refurbishment of the reactor, for many millennia to come. In the absence of a full environmental assessment covering the long-term (perpetual) management of these highly radioactive and long-lived nuclear wastes, RSN urges the BAPE to disallow the creation of a new waste site designed to house these retubing wastes.