Paper #1: Thinking about Risk and Safety

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William Leiss

nwmo
NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Nuclear Waste Management Organization

Nuclear Waste Management Organization
22 St. Clair Avenue East, 6th Floor
Toronto, Ontario
M4T 2S3
Canada

Tel: 416-934-9814
Web: www.nwmo.ca

The Nuclear Waste Management Organization (NWMO) was established in 2002 by Ontario Power Generation Inc., Hydro- Québec and New Brunswick Power Corporation in accordance with the *Nuclear Fuel Waste Act* (*NFWA*) to assume responsibility for the long-term management of Canada's used nuclear fuel.

NWMO's first mandate was to study options for the long-term management of used nuclear fuel. On June 14, 2007, the Government of Canada selected the NWMO's recommendation for Adaptive Phased Management (APM). The NWMO now has the mandate to implement the Government's decision.

Technically, Adaptive Phased Management (APM) has as its end-point the isolation and containment of used nuclear fuel in a deep repository constructed in a suitable rock formation. Collaboration, continuous learning and adaptability will underpin our implementation of the plan which will unfold over many decades, subject to extensive oversight and regulatory approvals.

NWMO Social Research

The objective of the social research program is to assist the NWMO, and interested citizens and organizations, in exploring and understanding the social issues and concerns associated with the implementation of Adaptive Phased Management. The program is also intended to support the adoption of appropriate processes and techniques to engage potentially affected citizens in decision-making.

The social research program is intended to be a support to NWMO's ongoing dialogue and collaboration activities, including work to engage potentially affected citizens in near term visioning of the implementation process going forward, long term visioning and the development of decision-making processes to be used into the future The program includes work to learn from the experience of others through examination of case studies and conversation with those involved in similar processes both in Canada and abroad. NWMO's social research is expected to engage a wide variety of specialists and explore a variety of perspectives on key issues of concern. The nature and conduct of this work is expected to change over time, as best practices evolve and as interested citizens and organizations identify the issues of most interest and concern throughout the implementation of Adaptive Phased Management

Three Discussion Papers on Community Engagement about Used Nuclear Fuel Storage and Disposal

November 2009

PAPER #1: THINKING ABOUT RISK AND SAFETY

1A. Introduction.

Citizens in three of Canada's provinces – Ontario, Québec, and New Brunswick – have for many years depended on nuclear power stations for a portion of their electrical energy. In another province, Saskatchewan, there are some of the richest uranium ores on the planet, which are mined and processed into fuel bundles in order to provide the raw material for nuclear power.

In Canada, after the uranium fuel bundles reach the end of their useful life and are removed from the nuclear power facilities where electricity is generated, they must be first stored temporarily at the plant site and then moved to a dedicated underground facility. And if it is later determined that the used fuel bundles do not have any further useful purpose, then the permanent storage site will become a facility dedicated to permanent disposal of these materials.

Communities throughout the four provinces of New Brunswick, Québec, Ontario and Saskatchewan recently have been asked to consider whether they wish to become involved in discussions about the project for permanently storing used uranium fuel bundles in a dedicated facility, or the planned siting process for the facility, or both. These discussions will encompass many different topics, for example: What kind of material is being stored? What type of facility is going to be constructed? What kinds of impacts is the host community likely to experience over the lifetime of this project? And what kinds of long-term benefits, such as jobs and infrastructure investments, will the community receive?

These are all important questions, as is also the matter of what kinds of risks the project will bring with it – risks to people in the community itself, to people elsewhere in Canada, and to the environment and other species as well. Risks are commonly described as substances and activities that can cause serious harms to the health of people or the environment. People naturally worry about the things that can harm them, which is why the consideration of risks will be a very significant part of all community discussions about the possibility of locating the nuclear fuel waste permanent storage site at any particular location.

This is the first in a series of three papers is designed to assist interested people in communities, who may be less familiar than others are with written materials and debates about risks in general, to determine for themselves the best way to come to

grips with the risks associated with nuclear fuel waste storage and disposal. There are three papers in this series, which are designed to be read in sequence:

- Paper #1: How should matters of risk and safety be discussed?
- Paper #2: How might communities organize their discussions about hosting a site for used nuclear fuel?
- Paper #3: What is happening in other countries where similar issues about used nuclear fuel are being discussed?

In Canada and other countries, what is called a "safety case" has been made for the idea of permanently storing used nuclear fuel waste deep underground in a suitable location, for example, in the granite formations of the Canadian Shield. A safety case is, in effect, an argument that no significant foreseeable harms to people or the environment will occur if the storage facility is properly designed and constructed. The safety case is addressed both to citizens in general and, in particular, to the responsible government agencies which must issue permits for the construction of the facility. In effect, it says that the risks associated with this project should be regarded as acceptable.

The way in which a safety case is made will be described later in more detail. However, no attempt will be made in these three papers to persuade the reader that the existing safety case about the risks associated with the permanent storage of used nuclear fuel should be either accepted or rejected, in whole or in part, by the communities which decide to enter a dialogue about the hosting of this facility. Rather, the sole purpose of this series of short papers is to assist people in communities in determining how they might go about making up their own minds about the safety case as well as other aspects of the repository siting issue.

1B. Managing Risks.

Risks are the things and activities that can harm us. They include a vast range of threats – natural and technological threats, as well as social and political ones. Familiar natural threats include infectious agents such as viruses, diseases such as cancer, violent weather such as tornados and hurricanes, fires, drowning, falls, and excessive exposure to sunlight. Technological threats include many industrial chemicals, motor vehicle accidents, firearms, electrocution, machinery accidents, and devices of warfare.* In addition, the continued viability of a society can be jeopardized by internal conflicts and disorders that arise among its own citizens or that originate in other countries.

* Of course, natural threats usually entail no benefits, whereas our technological devices – many of which exist to protect us against natural hazards – have clear benefits alongside the threats they also represent.

In order to maintain a modern lifestyle none of us can avoid entirely a regular encounter with natural, technological and social risks of many different kinds. Instead, what we try to do is to *limit* either our exposure to the threat or the amount of the damage it can potentially do to us. So, for example, for exposure to sunlight and its damaging forms of radiation, we can limit the time we spend outdoors in summer and also use protective clothing and sunscreens. We can employ good safety practices with respect to threats of fires and drowning and construct buildings that can withstand earthquake shocks. With most other technological threats the protective measures are essentially the same; for example, to guard against the worst consequences of motor vehicle accidents, many new safety features have been required in vehicle construction over the preceding decades.

The strategy of limiting the damage that can be done by our daily exposures to many different technological and natural hazards is what is meant by the phrase "managing risks": We manage risks because, with very few exceptions, we simply cannot eliminate them entirely. Diseases caused by viruses can be controlled by vaccinations, but the diseases themselves persist in natural reservoirs. There are small additional risks caused by our intervention strategies themselves, but these are usually minor in comparison with the benefits gained.

There are, quite literally, thousands of different and specific risks of different kinds, for which we have developed "management" strategies. Through a combination of both *foresight* (anticipating harm) and *precaution* (taking protective action before the harm occurs), we put in place an elaborate network of laws, regulations, policies, and codes of good practices that succeed in making our surrounding environment, and the activities we engage in, far safer than they would otherwise be.

When it comes to the technologies we have developed, however, we do always have the option of simply eliminating certain specific types of risks rather than trying to manage them. Industrial chemicals known by the acronyms PCBs and DDT, for example, have been banned from further production and use in many countries. But since they were developed for important uses in the first place, often (as with PCBs) other, less-harmful chemicals were substituted in their place. In North America we decided we could do without DDT because other pesticides that did less environmental damage could replace it. But in African and other countries where malarial mosquitoes cause terrible disease and hardship, lack of access to DDT comes at a very high price – showing just how tricky it is to balance risk and benefit wisely.

In the context of the risks discussed in these papers, it would be possible to ban further development of nuclear power plants and in this way eliminate entirely the risks that the used fuel wastes from as-yet-unbuilt nuclear plants would otherwise represent. To do so would require both (1) finding other sources for the large quantities of electricity such plants could have generated, and (2) using a complex technical assessment to try to insure that we did not encounter an equal or greater level of risks of different types from the alternative sources of electrical power. And,

of course, citizens would still have to deal with the used nuclear fuel wastes already housed in temporary storage as well as the wastes that would continue to be created until existing nuclear plants ceased operating.

The main point in the preceding paragraph is that such choices are available to citizens who live in a free and democratic society such as Canada. The caveat is that these choices are best made in the light of full knowledge of all of the trade-offs between risks and benefits that are implied in decisions of this kind. Also, the information necessary to make these kinds of informed decisions should be tested in forums where citizens can debate opposing views. In a later section of this first paper, as well as in the second paper, a few suggestions are offered about these requirements.

1C. Frames of Reference for a Discussion about Nuclear Fuel Waste Risk and Safety.

The very first consideration that arises in a risk and safety context is: How wide should the frame of reference be for this discussion? Choosing a particular frame of reference is a way of determining how narrow or how broad the set of questions and issues that need to be debated will be. Obviously, the greater is the breadth of issues, the more complex the discussion will need to be; however, in itself this is not a sufficient reason for choosing a narrower range. The following discussion illustrates what is involved in making a choice about what is the right frame of reference for a discussion in a community about hosting a site for the permanent storage and disposal of used nuclear fuel.

(a) The energy policy frame.

First: If we decide to stay at the narrowest end of this frame, we will put on the table for discussion only a single issue:

- Will a storage facility for used nuclear fuel, as it is built and operated over a very long period of time, be sufficiently safe for the host community so that both current and future generations living there will *never* have to worry about being harmed by it?

As shall be seen in the section on the safety case (in paper #2), even this very limited issue will raise many, many complex technical questions, having to do with engineering design, geological analysis, environmental impact assessment, imaginary scenarios, and the calculation of statistical probabilities of harm over a period of thousands of years. Experts will be asked to give their judgments on these matters and to explain in great detail the reasoning and scientific studies that, they believe, support their judgments. But once that elaborate exercise is concluded, it should be possible for the citizens in a community to summarize an answer to their question about safety in a single word: "Yes" or "No."

Second: If a community decides, on the contrary, that it has an obligation to put the issue of used nuclear fuel in the broadest possible context, a much larger set of issues will be put on the table, including all of the following aspects:

1. The general rationale for a provincial energy policy, that is, the mix of energy-generating technologies (fossil-fuel, hydroelectric, solar and wind, nuclear) that is considered to be optimal for the particular province in which a community is located;

2. The basis for that general rationale, in terms of cost-benefit calculations, as it relates to the values that a particular community wishes to support and promote (e.g., sustainability, environmental protection, energy conservation);

3. How nuclear energy in particular is perceived, in terms of its intrinsic appropriateness, within the mix of energy supply options, considered in terms of the future;

4. How the environmental problems associated with each energy supply option compare with one another (in particular, climate change from greenhouse-gas emissions *versus* radioactive waste from nuclear plants);

5. The adequacy of the safety case for the storage and disposal facility for used nuclear fuel.

In this, more elaborate way of framing the relevant concerns, the single one mentioned earlier (the safety case) is only the last in a series of complex issues. With the exception of number 3, the others in this list would have levels of technical complexity comparable to the fifth. Thus the information and analysis requirements for the whole set could be very large, and the debate about the whole set of issues would be long indeed. Moreover, organizing a set of meaningful discussions on the full set of issues would require a community to seek to raise the necessary resources, from its own and a variety of external sources, to fund it.

Third: A community may decide that its requirements fall somewhere between the two ends of the spectrum as described above. Thus, for example, it might choose not to consider, say, the first one in the list of five above, or perhaps the fourth one. Almost certainly various communities will differ in the choices they make in this regard, and in the amount of financial and other resources they are prepared to commit to this endeavour.

Whatever these choices are, no one can ignore the last-mentioned, namely, the adequacy of the safety case. Therefore this can be regarded as the minimum basis for community attention in every case. This is why the safety case is given additional attention later on.

<u>(b) The risk and safety frame.</u>

As mentioned earlier, risks are the things and activities that can harm us. In considering *how* harmful something might be, we have to consider both the kind of activity it is, and how regularly we engage in it. For example, operating vehicles on roadways involves the chance of serious injury or death through collisions or losing control while driving. This is one of the most serious risks we face in everyday life, both in terms of how likely it is that we will be harmed in this way, and also how serious the health consequences can be if we are unlucky enough to be involved in a vehicular accident.

In this context, there are important choices to be made by members of a community with respect to framing a discussion about risks. For example, many experts encourage the public not to think about specific risks in isolation from others, but rather to compare one set of risks to another. Thus, for example, someone might claim that the risks arising from a proposed permanent waste storage site will be "far lower" than many familiar risks which already exist in a community as a result of collective decision-making, such as the siting of highways and railroads, traffic control schemes, industries, correctional facilities, and other types of waste management and energy generation facilities.

This is called a "relative risk" comparison, and it is one way for people to get a sense of the quite different *levels* of risk that are known to be associated with various substances and activities. On the other hand, when people are worried about a specific type of risk, an argument that brings in a whole lot of other kinds of risks, wholly unrelated to the one of interest, can seem to be irrelevant and a needless distraction.

Whatever the level of risk is thought to be, people need to have a certain level of comfort with it, which is what is known as "acceptable risk" or "risk tolerance." For example, people are regularly reminded through traffic accident reports in their locality, that driving on roadways always involves a fairly significant level of risk. They also know that when teenage drivers (especially male teenagers) are involved, the level of those risks goes up. But most people continue to drive their cars on a regular basis, and we can infer from their behaviour that they are willing to tolerate the relatively high level of risk it involves.

Just as in the case of the energy policy frame of reference, the risk and safety frame can be construed very narrowly, very broadly, or somewhere in between.

A *narrow framework* for discussion of risks associated with used nuclear fuel would be something like the following:

> Used nuclear fuel is dangerously radioactive and therefore must be stored safely, so that neither people nor biota (plants and animals) in their environment come into contact with harmful levels of radiation. In a narrow risk discussion framework, a decision is made to focus *only* on these specific risks and no others. In addition, there will be no comparison

between these specific risks and any others, which arise from other sources, and no attempt to weigh risks against community benefits, for example, the jobs that a storage facility will provide.

The risks associated with long-term storage of used nuclear fuel can therefore be regarded as "acceptable" only on the basis of a convincing demonstration of the safety case, with a clear bottom line: It is very unlikely that harmful levels of radiation will *ever* escape from the designated facility. Nothing else is relevant.

By way of contrast, a *broad framework* would be something like this:

Here the safety case would still have to be made, but it would then be placed in a wider context. For example, a risk comparison matrix might be created, one which would set the overall level of risk associated with the used nuclear fuel storage facility (a new set of risks) against some other sources of risk that already exist in a community, for which there are reliable statistics about levels of risk.

If most people observed from this matrix that the new risk seemed to be a good deal less significant than the ones they already were dealing with on a daily basis, they might conclude that the new risk was nothing to get especially worried about. Or, on the contrary, they might come down on the side of the opposite view, and conclude that they already had too many things to worry about and didn't need another one.

At the same time, or alternatively, some people might advocate the framing of this decision as a matter of benefit – risk tradeoffs. Here the new risks would be juxtaposed against the set of long-term, tangible community benefits that would accrue to a locality that decided to host the storage facility for used nuclear fuel. Secure professional and support employment opportunities, greater property tax revenues, and new infrastructure facilities provided at no cost are examples of benefits that might be expected.

Such benefits can be presented in terms of dollar values, but they can also be seen as a way of reducing other types of risks to community viability: Such things as declining property values and a risk in unemployment-related crime are among the many risks communities face when secure and well-paying jobs disappear and cannot be replaced.

Something in between would be, for example:

Both relative-risk comparisons and cost-benefit tradeoffs undoubtedly add considerable levels of complexity to the already challenging technical description of the safety case. In addition, there will be some who say that *any* consideration of community benefits in this context is a potentially

dangerous exercise, because it means that the community is being bribed to overlook what would otherwise be regarded as unacceptable risks.

The allegation also might be made that vulnerable communities – those facing economic decline and without other good options for reversing the trend – have been deliberately targeted by those searching for a host community, and that this is an unethical act.

There is no easy resolution to these difficulties. What is perhaps clear and indisputable is that being comfortable with the safety case is the basic precondition for any robust community decision in this situation. Thus the wisest course of action might be to start the community deliberations around the safety case and, if that discussion ends with a general sense of comfort with the possibility of being a willing host for the site, a decision could be made to either explore the matter further, in a broader framework, or, alternatively, to stop at that point.

On the other hand, if the review of the safety case does not give rise to a strong feeling of comfort with the proposal, there is really nothing left to discuss.

(c) The overriding values frame.

For many citizens a sense of fundamental values – values so important that they override other important considerations, such as economic benefits – are brought to bear on a wide range of issues, including energy policy. For some, using nuclear energy to generate electricity has never been an acceptable proposition. More recently, others think that few issues are as pressing as doing something about climate change, and in energy policy terms this means rejecting further use of fossil-fuel sources. And, even though strong popular support is building for relying more heavily on alternative energy sources, especially wind and solar, plans to place large wind farms in rural areas run up against strong opposition in the name of protecting the traditional landscapes and amenities of life in the countryside.

Most people who appeal to fundamental values in social decision-making also know that values can conflict with each other, resulting in dilemmas about which one should have the higher priority. Thus communities facing major decisions, such as whether to consider becoming the host community for a permanent storage site for used nuclear fuel, likely will need to find a way to integrate a frame of reference for fundamental values into their deliberations.

Here are some examples of how value considerations might arise into community deliberations about a nuclear waste repository site:

- A values argument can be made to the effect that there is a clear ethical duty to assist in the project to safely store used nuclear fuel, rather than leaving the

issue unresolved into the future, simply because this is the right thing to do, in terms of protecting health and the environment.

- A related argument would connect this duty to resolve the issue, within the near future, to the fact that people now living in certain Canadian communities have benefited from the energy generated at nuclear plants during their lifetimes: In other words, those who have benefited (the "upside") should also accept the responsibility to manage the resulting "downside" (taking care to store the waste in a way that minimizes risk).

- A contrary argument would be to insist that, since using nuclear power to generate energy is wrong in and of itself, then there is no ethical duty to assist in the resolution of the nuclear waste issue unless and until governments in Canada have made an irrevocable, binding commitment to cease using nuclear power within a defined time-frame.

- A different argument could be made as follows: (1) Global climate change resulting from fossil-fuel use is by far the most disturbing legacy that past and present generations are leaving to the future; (2) there is no practical solution, on a global scale, for reining in climate change that does not include continuing, and perhaps expanded, use of nuclear energy; (3) thus there is a duty to continue to use nuclear energy, but in a way that is clearly environmentally responsible, and this necessarily includes starting now to ensure that used nuclear fuel waste is safely and permanently stored.

- Contrary to the argument just made, one can start from the premise that climate change is the most disturbing legacy we are leaving for the future, but this problem must be dealt with solely on its own terms, and cannot provide a justification for continued or expanded use of nuclear power.

- An argument could be made that, since *all* energy-generating technologies have environmental impacts of some kind, the most important value is to ensure that every technology is used in an environmentally-responsible manner, whether it is fossil-fuel, nuclear, or an alternative.

Finding a way to have a reasoned and fruitful set of community discussions about different conceptions of fundamental values, and also about how value positions influence choices among policy options, will not be easy. However, it is a challenge that each community that wishes to consider hosting a nuclear waste repository must be able to respond to successfully.

(d) The geographical frame.

Finally, a less contentious but still meaningful frame of reference has to do with the relation between the specific locality within which a potential host community is located, on the one hand, and the larger regional, national, and international context,

on the other. Some aspects of this frame may be identified by starting at the local community and gradually moving toward the bigger context. The options are:

First, to consider only one's own local situation and nothing else:

> What are the risks and benefits to the community itself, considered over the length of time during which the project will be active?

Second, to consider the regional and provincial situation as well as the local one:

> What are the additional risks and benefits at the regional level? For example, since the used nuclear fuel waste must be transported some distance from its present location to the community's storage site, what will be the situation of other communities that happen to lie in the path of the transportation corridor?
>
> Since municipalities and regional government authorities are creatures of provincial governments, what role will provincial government agencies play at the time when communities are considering the opportunity to host a storage site? Can a community expect that the provincial government will be a partner with the community from the beginning, or will the community be "on its own" until some time later?

Third, to consider the national as well as the local situation:

> Since the federal government has ultimate legal jurisdiction over nuclear-related materials in Canada, should the community expect that there will be any federal role during the community deliberation process? Or will the federal role be restricted to carrying out the official environmental assessment and project approval hearings at a much later time in this whole process?

Fourth, to consider all of the above, plus the international situation:

> Over thirty countries around the world now have nuclear fuel waste in temporary storage, and others are actively contemplating starting up a nuclear power program. Like Canada, a few of those other countries are moving towards finding a site for permanent storage at this time. Is this international situation relevant to the beginning of the search for a willing host community that is now occurring in Canada?

1D. Conclusion.

Interested parties in various communities may very well discover that there are other relevant frames of reference, in addition to the ones discussed above, once they start

thinking about the question of hosting a permanent storage site for used nuclear fuel waste.

There are many complexities attached to this question, as should be evident by now. But it is possible that, by using the idea of frames of reference to structure the various aspects of that question, the choices about what kinds of deliberation each community will need to have can be presented in a systematic way. The issues covered in the preceding discussion can be put into the form of a simple matrix, as shown on the following page, which allows one to see all of the specific topics at a glance; and, when the matrix is filled in, one will also be able to see some of the interrelationships among the various issues and choices.

Frames of Reference for Community Deliberations

	Reasons For	Reasons Against	Other Comments
Energy Policy:			
• Narrow			
• Mid-range			
• Broad			
Risk and Safety:			
• Narrow			
• Mid-range			
• Broad			
• Special Focus*: The Safety Case			
Values:			
• Very Important			
• Somewhat Important			
• Not Very Important			
Geography:			
• Local only			
• Plus Regional and Province			
• Plus National			
• Plus International			

*See Paper #2

This paper was written by William Leiss, McLaughlin Centre for Population Health Risk Assessment, University of Ottawa (www.leiss.ca). Comments are welcome, email to: wleiss@uottawa.ca