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An Assessment Method for Long-term Management of Canada's Used Nuclear Fuel

by
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Abstract

The nine-member Assessment Team, assembled by the Nuclear Waste Management Organization in early 2004, reported the results of its work in the NWMO document, "Assessing the Options: Future Management of Used Nuclear Fuel in Canada (June 2004)."[1] The team was responding to the challenge to develop a rigorous and credible evaluation of multiple options, and one which would also satisfy a complex set of objectives: a solution that would be "socially acceptable, technically sound, environmentally responsible, and economically feasible." This paper describes the special challenges faced by the Assessment Team in seeking to respond to this multi-faceted assignment. I open by discussing the implications of the institutional and legal framework inherited by the NWMO from the Seaborn Panel (including the government's response to the Seaborn Panel report), which in effect set a new standard for the practice of risk management decision making in Canada. I then review the highlights of the Assessment Team's report, including its chosen method, namely, multi-objective utility analysis. I conclude with a discussion of the longer-term implications of the assessment work done to date for the next stages in the process of finding a credible solution for the long-term management of used nuclear fuel in Canada.

The long-term management of used nuclear fuel in Canada and other nations is in one sense a straightforward risk management challenge. As such, it falls within what I call the "conventional paradigm" for health and environmental risk management in a

regulatory setting, as it has evolved in Western nations from the 1970s to the present.[2] This is a formal, step-wise process that has the following components, among others:

- Hazard characterization,
- Exposure assessment,
- Risk estimation,
- Option Analysis,
- Risk Management decision,
- Risk Communication.

Typically, this procedure separates risk assessment from risk management: The former is regarded as a strictly scientific and technical procedure (the first three steps in the list above), whereas the latter (the last three steps) incorporates social, economic, political, and policy considerations. Over the course of the past thirty years governments and industry gradually became committed to this approach, and both accepted its application in a wide range of formal regulatory settings and for a broad range of risks – chemicals, radioactive substances, food- and water-borne pathogens, environmental contaminants, and so forth.

But also over the course of the past thirty years it was this "separation" that was challenged more and more frequently by groups outside of the formal regulatory framework – public-interest groups, community-based associations, and citizens among the general public. Certainly this challenge had a basis in resistance against the frequent use of complex technical jargon and statistical expressions in the risk assessment exercises, and also in the common failures of risk managers to make any decent effort to communicate effectively with the public.[3] Second, risk managers

failed to realize that their decision making exercises had the characteristics of a "black box": the decision inputs may have been described in detail, but all too often the logical connections between the inputs and the output (the decision) were not at all self-evident. Finally, this resistance had another, more general grounding in the decreasing level of trust on the public's part towards the institutions of industry and government. The result has been that risk managers regularly face the threat that the public will disavow or resist their elaborate attempts to rationalize regulatory decisions by using the language of risk assessment and management.

Examples abound. Quite recently, Health Canada's reassessment of the health risks of the pesticide 2,4-D, some fifteen years in the works, has been largely ignored by municipal officials and citizens who are determined to banish lawn pesticides from their cities. There are long-running controversies about what experts believe are small risks, such as those arising from dioxins or endocrine disruptors, a belief that is not shared by many citizens. Public health officials in many countries face tremendous challenges in the face of widespread public skepticism about the safety of vaccines, where the societal risk / benefit calculus appears to greatly outweigh the small individual risks of adverse effects. And large segments of the public in Canada and elsewhere do not appear to accept the experts' case for the safety and operational integrity of nuclear energy plants.

Increasingly, therefore, risk managers in government and industry are faced with public reactions to the risk management approach which are far more complex than has been generally imagined. They are obliged by regulatory requirements to carry out risk assessments within a standard risk management framework, but more and more they must also be prepared to engage the public directly on a larger set of issues surrounding the risk-based approach, issues that are framed by types of concerns that are deeply rooted in popular opinion. In more technical terms, risk managers face the situation where the public perceptions about risks can deviate substantially from their own – and, increasingly, risk managers are unable to simply take refuge in their expertise and remain indifferent, or hostile, to those public perceptions. Competence in *risk management* must be complemented, these days, with a very different type of expertise – namely, competence in engaging the public on matters of *risk issue management*.[4]

The final report of the Seaborn Panel is a perfect expression of what has just been described.[5] At least some members of the nuclear engineering community were profoundly shocked by the Panel's conclusion, based on its distinction between what has been demonstrated in a technical sense and what is "socially acceptable." Yet, from my standpoint, the Panel had its "ear to the ground" in this respect; in other words, it recognized the changes in the climate of public opinion as I have described them above. So far as I am aware, this is the first time in Canada that an officially-constituted environmental review body acceded to the view that social acceptability is

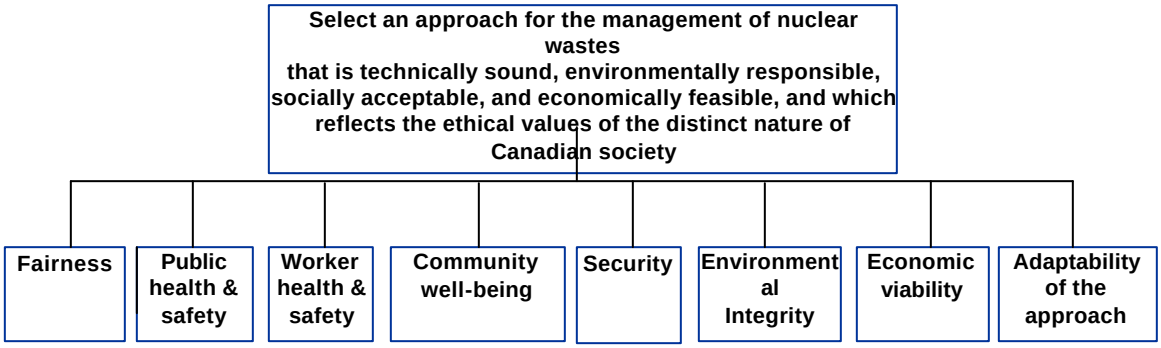
a necessary ingredient in a credible environmental assessment decision. It was also highly significant, in my view, that the federal government's official response to the report did not challenge the panel on this point – thus providing additional sanction for the panel's standpoint.

But what on earth does it mean to say that a risk management option must be socially acceptable? I suggest that the answer to this question lies both in the NWMO's approach to public engagement, on the one hand, and in the Assessment Team's integration of that approach into its formal methodology.

In its first discussion document, *Asking the Right Questions?* the NWMO assembled the results to date of a number of significant public engagement initiatives, including intensive dialogue sessions with selected members of the public right across the country. These initiatives enabled NWMO to get a good feel for some of the basic, underlying values and concerns among members of the public who had thought carefully about the issues concerning the management of used nuclear fuel. The Assessment Team then accepted the obligation to try, to the best of its ability, to integrate as much as possible of those insights from the public meetings into the formal structure of its assessment methodology.

The method known as multi-attribute utility analysis [MUA] requires its users to begin by establishing a hierarchy of objectives. The Team took the four-part

statement referred to earlier ("socially acceptable, technically sound, environmentally responsible, and economically feasible") as its top-level starting-point. Then the method asks its users to operationalize the highest-order set of objectives; in other words, to convert them to a set of discrete, limited, and mutually-exclusive criteria that can be "measured." This means, at a minimum, that each criterion may be judged as to how well ("more or less") an option is expected to perform in satisfying what it demands. The completed hierarchy we developed looks like this:



You will notice at once that this set of eight objectives (or criteria for the assessment of performance) is a bit unusual, in that it combines – at *the same level of importance* – both "hard" and "soft" items. We can define the "hard" category as those which can, in principle, be expressed in quantitative terms, e.g., for worker health and safety, compliance with regulatory limits for radiation exposure. "Soft" items, such as fairness and adaptability, are those which have primarily a qualitative or discursive expression, although it is possible to have a mixture of both (as the objective of "community well-being" does). Especially in the "fairness" objective, the Team

sought to incorporate fundamental value principles, such as appropriate distribution of responsibilities across present and future generations, into an assessment framework which has a legitimate claim to methodological rigour.

We then back-checked our set of objectives against the results of the public dialogues, fine-tuning our set so that we got (1) as much "resonance" as possible with the public values disclosed in the dialogues, while also (2) preserving the integrity of the objectives hierarchy from a methodological standpoint. The results of this work are shown in the diagram in the Appendix at the end of this paper. I hasten to add, that others can decide for themselves how well we succeeded, or how badly we failed, in this endeavour; my only point is to show you that we tried.

What I am arguing here is that we incorporated both criteria that are essentially technical in nature (such as environmental integrity), on the one hand, and criteria that are at least pertinent to social acceptability (such as fairness), on the other, into a single, comprehensive assessment framework. Then we scored the management options – continued storage at reactor sites, centralized storage (above ground or shallow underground), and deep geological repository – as to how well we thought they would perform, over the shorter (up to 175 years) and longer (after 175 years) time frames, with respect to each of our eight objectives.

Specifically, each team member was asked to rate the expected performance of each of the three options, against each of the eight objectives, in two time frames (except for fairness, where time was not specified), on a scale of 0 – 100. In its scoring mode the MUA method we used incorporates the Bayesian logic of "subjective judgment." In other words, although all the team members had some acquaintance with the detailed technical assessments related to the various options – for example, the "safety case" –, we did not demand that everyone justify a score with specific reference to one or more pieces of evidence in the technical literature, whether it be ethics (for fairness) or radiation dose limits (for worker health and safety) or groundwater contamination (for environmental integrity). To be fair, such references to the evidence base often were made, by team members, in the intensive discussions that accompanied every scoring exercise; but in the end each member's score is tallied on an equal basis.

What the MUA method seeks to mimic here is, in fact, the real process of societal decision making, where highly-condensed summaries of technical information reach the level of senior policy makers and legislators, who are not normally technical experts, and who in the usual course of events have final responsibility for risk management decisions.

The MUA method proceeds from the scoring tally to a weighting exercise, in which overall scores – which are displayed both as a range and an average – are tested

for robustness by relaxing the requirement that all objectives are equally important and by experimenting with a number of scenarios for differential weighting. Finally, we performed a sensitivity analysis which showed that overall scores were related significantly to varying degrees of optimism or pessimism regarding the long-term future of Canadian society in its present form.

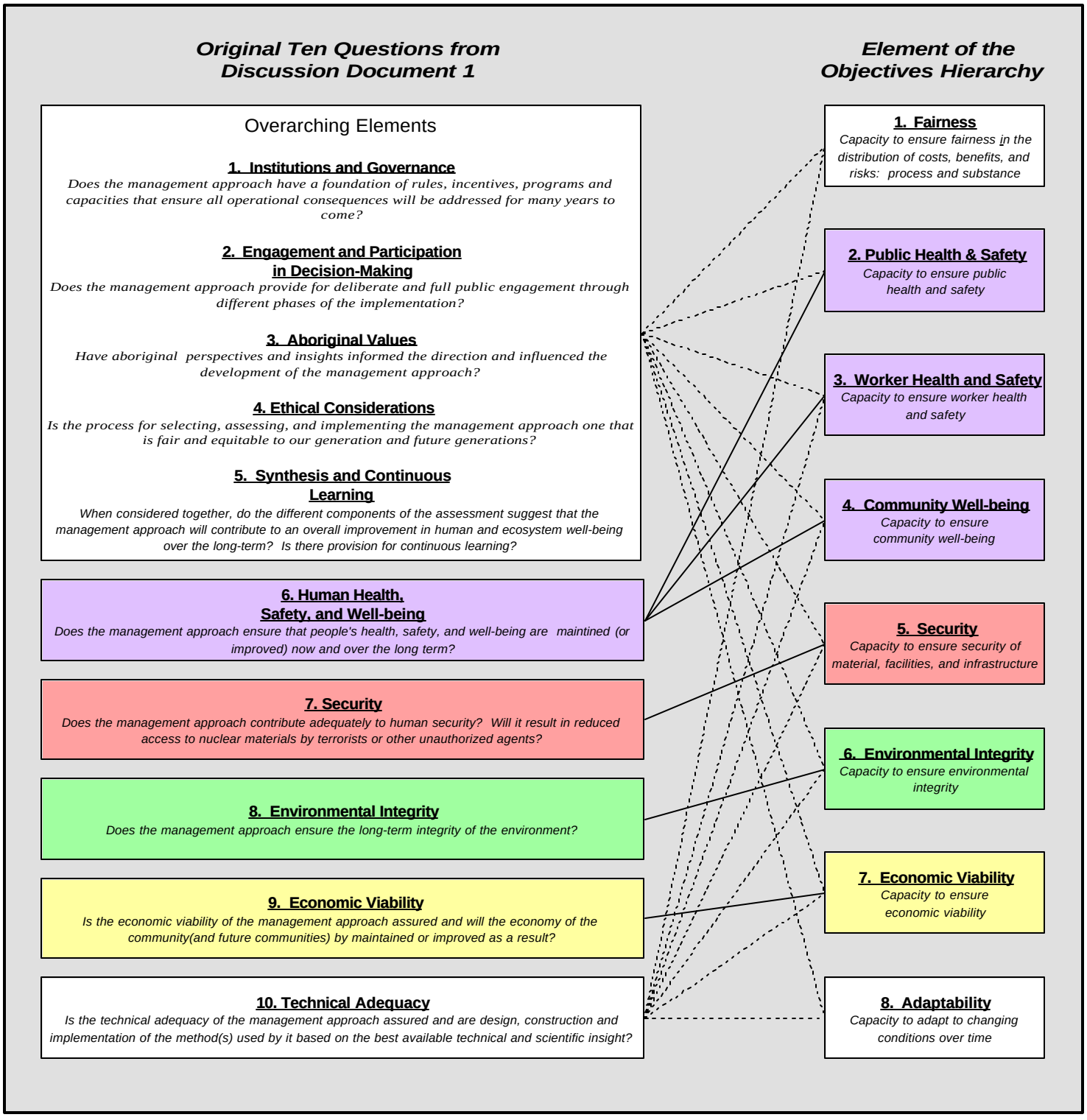
There is little doubt that this specific risk management issue poses special dilemmas for citizens when they are engaged in dialogues on it. The most pertinent is the difficulty most people have in thinking about a time horizon that stretches for a minimum of 10,000 years into the future – a period equivalent to approximately twice the length of settled human civilizations to date. This example alone shows why it is necessary for risk managers to be sensitive to the genuine complexities of decision making and the legitimacy of public concerns for assurance of safety that extend far into the future and that will be, therefore, matters of genuine concern to many generations of their descendants.

The approaching completion of the NWMO's current obligation – to deliver a recommendation to government in late 2005 – is also the beginning of the next phase in this long journey. However, on the basis of the work already completed, I believe that we can give a fuller account of what a "socially acceptable" risk management decision is. First, an intensive effort must be made, in a variety of different ways, to uncover the basic drivers of public attitudes, seeking the "broad middle ground" of

reasoned opinion across the range of issues of greatest concern. Second, the public must be able to see, in the published documentation, clear evidence of the following: (1) that the organization has listened carefully and represented what it heard fairly; (2) that opportunities for extended dialogue have been provided; and (3) that the final report demonstrates the impact of received opinion on the process of *reasoning* – not the decision itself, on which reasonable people can differ – through which the organization has arrived at its conclusions.

Thus my conception is, that a decision can be regarded as "socially acceptable" if most of those who have participated in the process can see the product of their involvement in the way in which the authors of a final report have taken up the issues of importance to the public and given them fair consideration. In this sense, the situation is very much like that of a well-crafted judicial opinion, in which the parties on both sides expect to see that the judge has fairly represented its case, including the evidence brought before the court and the arguments made for and against various points at issue.

I believe a good start has been made on this journey, which will, one hopes, now move expeditiously towards considerations of siting and impact assessment.


Original Ten Questions from Discussion Document 1
Element of the Objectives Hierarchy
Overarching Elements
1. Institutions and Governance
Does the management approach have a foundation of rules, incentives, programs and capacities that ensure all operational consequences will be addressed for many years to come?
2. Engagement and Participation in Decision-Making
Does the management approach provide for deliberate and full public engagement through different phases of the implementation?
3. Aboriginal Values
Have aboriginal perspectives and insights informed the direction and influenced the development of the management approach?
4. Ethical Considerations
Is the process for selecting, assessing, and implementing the management approach one that is fair and equitable to our generation and future generations?
5. Synthesis and Continuous Learning
When considered together, do the different components of the assessment suggest that the management approach will contribute to an overall improvement in human and ecosystem well-being over the long-term? Is there provision for continuous learning?
6. Human Health, Safety, and Well-being
Does the management approach ensure that people's health, safety, and well-being are maintined (or improved) now and over the long term?
7. Security
Does the management approach contribute adequately to human security? Will it result in reduced access to nuclear materials by terrorists or other unauthorized agents?
8. Environmental Integrity
Does the management approach ensure the long-term integrity of the environment?
9. Economic Viability
Is the economic viability of the management approach assured and will the economy of the community(and future communities) by maintained or improved as a result?
10. Technical Adequacy
Is the technical adequacy of the management approach assured and are design, construction and implementation of the method(s) used by it based on the best available technical and scientific insight?
1. Fairness
Capacity to ensure fairness in the distribution of costs, benefits, and risks: process and substance
2. Public Health & Safety
Capacity to ensure public health and safety
3. Worker Health and Safety
Capacity to ensure worker health and safety
4. Community Well-being
Capacity to ensure community well-being
5. Security
Capacity to ensure security of material, facilities, and infrastructure
6. Environmental Integrity
Capacity to ensure environmental integrity
7. Economic Viability
Capacity to ensure economic viability
8. Adaptability
Capacity to adapt to changing conditions over time

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[1] http://www.nwmo.ca/Default.aspx?DN=1091,1090,199,20,1,Documents

[2] See generally U.S., Presidential Commission on Risk Assessment and Risk Management, *Final Report, 1997*, Volume 2*: Risk Assessment and Risk Management in Regulatory Decision Making*, available online at: http://www.riskworld.com/Nreports/1996/risk_rpt/RR6ME001.HTM

[3] Some case studies of such failures are presented in W. Leiss & D. Powell, *Mad Cows and Mother's Milk: The Perils of Poor Risk Communication* (Montreal: McGill-Queen's University Press, 1997), 2nd edn. (2004).

[4] This is the burden of my most recent book, *In the Chamber of Risks: Understanding Risk Controversies* (Montreal: McGill-Queen's University Press, 2001).

[5] Seaborn: http://www.ceaa.gc.ca/010/0001/0001/0012/0001/report_e.htm Government response: http://www.nfwbureau.gc.ca/english/View.asp?x=616&oid=21