

## Comments by J.A.L. Robertson on

### “Assessing the Options”

#### by the Nuclear Waste Management Organization

“Assessing the Options” is useful in complementing the Nuclear Waste Management Organization’s (NWMO) Discussion Document 2 (DD-2), by answering some of the points raised in my Commentary on DD-2 as a submission to the NWMO website, posted 2004 October 12. The comments in this submission are organized under Methodology, Application and Details: the last of these is subdivided into Major and Minor. Serious problems are identified in both Methodology and Application.

#### **Methodology**

The first and major consideration is the validity and value of the methodology. The Report (p.58) claims that the present methodology, “multi-attribute utility analysis”, has been “conducted on a wide variety of decision problems in Canada” and elsewhere. Six examples are cited. However, examination of the very small print of the footnotes reveals that two have not been implemented, and there is no evidence whether the other four have been implemented, and if so with what success. Such theoretical constructs are usually controversial but there is no mention of what criticisms have been levelled against this methodology. Since the Assessment Team (AT), that apparently contains nobody with practical experience of managing major projects, presumably endorses this methodology it cannot be expected to provide this critical information. According to a sound precept: “If you want to know whether you need a haircut, don’t ask your barber.”

Scepticism about this methodology can be attributed to experience in other similar theoretical analyses, e.g., the complex computer model on which the Kyoto Protocol on climate change is based. From the claims of proponents, including the Canadian government, one would not know that the model is not in accord with observations and that many, if not most, scientists are critical of it. My personal experience is that simpler analyses intended to make decision making a logical process have failed in practice.

The eight complicated Influence Diagrams, collectively involving about 200 “influences”, give the impression of a logical process. On closer examination, however, it appears that no quantitative analysis is involved and all steps are determined by the feelings, beliefs and prejudices of the AT members. The process is therefore a glorified opinion poll with the AT members neither qualified in the subject under examination nor representative of the Canadian public. For six of the eight objectives the Canadian Nuclear Safety Commission (CNSC), with roughly 500 experienced staff, is much better qualified to perform this analysis, quantitatively where applicable. Analyzing the decision-making into a multitude of steps does not make it any less prone to subjective value judgements. It may only provide an opaque screen behind which those *responsible* for making the decision can hide.

The Influence Diagrams bear a superficial resemblance to the fault trees and event trees developed to assess reactor safety. However, these trees represent decades of work by hundreds of analysts, all qualified in some particular and relevant subject. At each stage, the consequence and its probability are quantified based on much experience of the constituent components. A

more direct comparison would be the Environmental Impact Statement (EIS) developed by Atomic Energy of Canada Limited (AECL) for review by the Blair Seaborn (BS) Panel. This took 15 years to prepare from a large body of existing information and consisted of ten volumes supported by hundreds of specialist papers. The work was reviewed year by year by a Technical Advisory Committee composed of independent experts in relevant disciplines. The final EIS was reviewed by BS Panel participants, including the Atomic Energy Control Board's (now the CNSC) staff, and the Panel's Scientific Review Group. The BS Report does not provide the information to tackle the Influence Diagrams. Compared with the EIS for deep geological disposal the AT Report is little more than guesswork. Proposals for on-site storage at reactor sites have also been subject to thorough regulatory scrutiny and environmental review involving public participation.

When one realizes that there is no factual basis for the various steps connecting the 200 Influences, only personal opinions of nine members, there is a further realization that not one of these steps is justified anywhere in the Report. Thus if any of any of the roughly 2,500 opinions is based on erroneous or misleading information this fact is concealed and cannot be challenged. The very large range of performance scores in each objective, even when outliers are excluded, is attributed by the AT to complexity of the subject (p.78) and differing views on future environmental and social conditions (p.105). It appears more likely, however, that it represents differing prejudices within AT members on the risks of radiation and nuclear energy. It is well established that the general public, i.e., those not familiar with nuclear energy, have a greater fear of it than those who are familiar. This interpretation would confirm that the methodology is little more than an uncontrolled opinion poll dressed up to appear logical.

The methodology does not allow for the possibility that for any objective the adverse effect, or risk, may be so low to be negligible. For instance, if the annual fatality risk to members of the public in the remote future is one in a million for one option and one in ten million for the other two, this should not mean that the one is preferable to the others: rather this objective should be given a weight of zero, i.e., it should be disregarded in any comparison.

The objective of Economic Viability is concerned primarily with ensuring that the necessary Financial Resources will be available, not in minimizing costs. Throughout the Report there are references to "maximizing" and "best available". This aim for the best is counterproductive: where one activity is made safer than the average it is drawing limited resources from improving the safety of less safe activities, and thus reducing the overall safety. As Voltaire wrote: "Le mieux est l'ennemi du bien". For each objective the aim should be to achieve adequate, not maximum, performance. Where two or more options are adequate that objective does not discriminate between them.

The Report is ineffective in helping the NWMO communicate with the public. It is stated (p.57) that one of the goals of the methodology is: "Is effective in its ease of understanding, transparency, and communicability; and one of its seven Goals (p.57) is: "Is effective in its ease of understanding, transparency, and communicability". Of the minute fraction of Canadians who have expressed any interest in the NWMO, very few will read the AT Report, and of these even fewer will pursue the 200 Influences through the eight Influence Diagrams. The statement (p.8) "the Team encourages each reader to examine closely the detailed explanation of the results provided in its report and to reflect on the implications of the assessment framework and its results" cannot be taken seriously. It is difficult to imagine anything less appropriate for communicating with the general public.

There is no recognition in the Report that Flexibility/Adaptability and Robustness (p.20), both admirable characteristics, are mutually inconsistent. Flexibility renders a project vulnerable to volatile changes in public opinion and political fortunes: political interference by all three parties were responsible for most of the delays and cost overruns in constructing the Darlington Nuclear Generating Station – see “Can CANDU estimates be trusted?” at my website [www.magma.ca/~jalrober](http://www.magma.ca/~jalrober).

It is notable that, despite these criticisms of the methodology, the AT’s conclusion, that a Deep Geological Repository is the preferred option, confirms the conclusion of the 1977 Hare Commission and the 1978 decision of the governments of Canada and Ontario directing AECL to develop deep geological disposal. AECL’s 1994 Environmental Statement provides a far more thorough justification of the concept than the present methodology that purports to be logical. To be positive, it can be reassuring that all these approaches reach the same conclusion, i.e., it is robust.

Despite the flaws in the methodology, the AT Report can still be of value to the NWMO. It has explicitly stated an Overall Objective and has established a structure of eight subordinate Objectives. It has identified roughly 200 “Influences” that should be considered in any assessment. It has demonstrated the extent to which the opinions of reasonable people can differ in such unquantified assessments. It has illustrated how the weights accorded to different objectives can affect the overall preference. However, the NWMO should make it clear in its publications, particularly its Final Report, that this methodology is merely an aid to decision making and not a means of decision making. What is needed now is a review of the methodology in the light of comments such as mine, followed by a statement by the NWMO, not the AT, of what it concludes from application of the methodology *in readily understood language*.

## **Application**

The wording of the AT’s Terms of Reference are confusing. In “Background” (p.129), “The Assessment Team will apply an assessment framework for comparing the alternative management approaches ...”, and one of the AT’s “Tasks” (p.130) is “Apply the Assessment Framework”. However, elsewhere it is made clear that this application is preliminary, is a means of testing the proposed assessment framework and should *assist* the NWMO in decision-making, not make the decisions, e.g.

- The Report describes the methodology as “a process in *support* of decision-making” (emphasis added) (p.55).
- “Their (the AT’s) comparative review of the options *tested* the methodology.” (emphasis added) (p.3 of DD-2).
- “The Team was asked to further develop an assessment framework ... and then, in a *preliminary* way, apply this framework ...” (emphasis added) (p.39 of DD-2).
- The AT was “required ... to perform a *preliminary* assessment” (emphasis added) (p.7).
- The Report should “Document the refined assessment framework and the results of the *preliminary* assessment ...” (emphasis added) (p.130)

It is the NWMO that has the responsibility for making the recommendation and this presumably cannot occur until after it has reviewed comments on the methodology. The purpose of the application at this stage should be illustrative only, to allow informed criticism of the methodology. The AT should not be drawing conclusions (p.104) from a *preliminary* assessment. On a semantic level, the AT’s two statements (pp.9 & 23) on what the process *must* do again overstep its authority. As the Report itself states, there is a “need for a well-managed, dialectic process in which solutions emerge as a result of a broad, respectful and fair dialogue among those involved” (p.18).

The most serious criticism of the application of the methodology illustrates why final application of the methodology should await comments and revision. The AT's assumption (p.14) about the volume of wastes is controversial:

*“For the purpose of this assessment, the volume of used fuel which needs to be managed was assumed to be limited to the projected inventory from the existing fleet of reactors.”*

This is one possible scenario. Another is that a continuing and expanding reliance on nuclear energy would, during the 175 years short-term perspective, require recycling of the used fuel. A consequence would be the need for a large plant, ideally integrating recycling, new fuel production, waste immobilization and disposal of the true waste. From Canadian experience, employment in such a nuclear plant would be safer than many other jobs, and the surrounding people and environment would not be harmed. Unlike the management method assumed by the AT and scored low for “boom and bust”, this one would provide permanent employment and a stable community. AT members may not like the idea of working in such a plant but it could look attractive to some of the population of the regions under consideration, especially when people understand the facts about nuclear energy. For instance, a mining community in Northern Ontario faced with mine closure and hence emigration or welfare could welcome the opportunity. This alternative scenario could provide a powerful incentive to volunteer communities during the siting stage, something that the NWMO has yet to consider. While siting is not an explicit item in the NWMO's mandate, an attractive process for siting would contribute to public acceptance of the total package. Conversely, the NIMBY (Not In My Back Yard) reaction to siting causes much of the opposition to any waste management proposal.

The direct significance of this is that selection of the scenario would affect all Influence Diagrams, particularly Community Well-being, Fairness, Economic Viability and Adaptability. Indirectly it could affect the relative preference of options. This omission thus demonstrates the vulnerability of the methodology to implicit assumptions. It is also an example of the AT making decisions beyond its mandate: not even the NWMO has the authority for deciding energy policies throughout Canada. Another example of the AT exceeding its mandate is its conclusion (p.108) that the deep geological repository is the preferred option.

From the fact that the AT does not even warn of the implicit assumption suggests that the members are not familiar with the nuclear issues. On “Estimating Performance” (p.60) the Report states “These assessments are made ... through the application of *best professional judgment* ...” (emphasis added). However, most of the AT members do not have professional qualifications in any aspect of nuclear energy. The Report as a whole suggests that the AT regarded its task as simply finding a solution to the waste problem without consideration of the implications. The irony is that if the AT's recommendation is implemented much of the reason for opposing nuclear energy will be removed so that more nuclear stations can be expected, contrary to its assumption.

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103 Other examples of the TA's ignorance of, or even mild antipathy to, nuclear energy are: The end of nuclear energy is regarded as a characteristic of an “optimistic scenario”, and vice versa. As well as revealing prejudice this scenario is unrealistic. “Alternative energy technologies” cannot supply society's energy needs, even without the assumed doubling of human lifespan. No amount of R&D can make the sun shine or the wind blow 24/7. The more expensive energy would damage the economy leaving fewer resources for health care and social programs. The failure to mention the several studies by energy experts, e.g., the World Energy Conference, that show “alternative energy” sources can provide only a small fraction of the demand suggests that the AT is not competent on energy matters.

83 Here and in many other places there is reference to “polluter pays” in connection with nuclear energy. If any aspect of nuclear energy is unique it is that it is pollution free. If the AT’s recommendations are implemented nuclear wastes will be contained permanently and so unable to pollute.

17 “A number of unique aspects characterize the management of used nuclear fuel. ... They include complexity, long time-horizon, special hazards, negative public image, controversy ....”, and later “Lack of Precedence” and “Uncertainty”. These are not unique. The issue of nuclear wastes is less complex and more easily understood by the public than other current issues, e.g., genetically modified foods, climate change and missile defence. Many hazardous wastes last for ever; others, e.g., biological wastes, present “special hazards” without the benefit of radioactivity that allows detection at very low concentrations. “Negative public image” and “controversy” affect any waste management project, but the NWMO’s own activities have confirmed that only a minute fraction of Canadians is concerned over nuclear fuel wastes. There is “Precedence” – see comment on p.109 later. There is probably less “Uncertainty” over the current proposals than over comparable non-radioactive waste management proposals.

27 A large new industrial plant is regarded as a “limitation” for nuclear energy but a large new industrial plant in Oshawa for GM’s automobile manufacturing is announced with pride.

33 “Bundle power” is meaningless without the time at which it applies. Burn-up is not a rate.  
49 If after 100,000 years, when the wastes have decayed to the same level as an ore body, the land is covered by an ice sheet preventing habitation, concern over the potential for trivial leakage from the wastes represents paranoia. This is just one example of something that appears scary until it is examined critically, ideally quantitatively.

65 The requirement to maximize safety and minimize risk (p.75) regardless of how safe the situation is already, suggests an irrational fear of radiation, i.e., one that is not quantified and not put in the context of other risks.

69 This is one place where the “information and inputs from other NWMO activities” are listed: a more comprehensive source is the Bibliography (p.155). Nowhere are cited the many Submissions to the NWMO, posted on its website. The AT is apparently unaware that much of the material on which it relies has been criticized for containing erroneous and misleading information.

71 “... not be handicapped socially or culturally ....” shows prejudice in not allowing for benefits in these areas. Deep River, built to accommodate workers at the Chalk River Nuclear Laboratories, enjoys more social and cultural activities than most towns of its size. The same could happen for a community established to manage nuclear waste.

90 “Some may see living near a radioactive waste management facility as placing a stigma on their community.” True, but there is no recognition that some communities, such as North Renfrew have listed the Chalk River Nuclear Laboratories as a tourist attraction. Similarly, the only inputs to “Real estate values” are stigma and property damage, i.e., the possibility of property value enhancement is ignored.

109 “Advance ‘proof’ that such a system works is not scientifically possible because performance is required over thousands of years.” This ignores the evidence of the prehistoric natural reactors in uranium ore bodies at what is now Oklo in West Africa. Furthermore, the existence of all uranium mines, consisting of uranium oxide chemically similar to nuclear fuel, is evidence of the material’s resistance to leaching over geological times. The following sentence ignores the multitude of laboratory and in-field tests performed to validate the models. Readers are not informed that the assessment methodology employed for the EIS, in contrast to that of the AT, makes quantitative allowance for uncertainties in the input data.

On the whole the Report is predominantly negative in considering every possible adverse effect but few beneficial ones. The notable exception is a grudging: “the economic effects that do occur would have some positive attributes” (p.92). As already discussed there is no credit for a healthy, prosperous community based on a comprehensive fuel fabrication plant. In “Smaller more remote communities may be more vulnerable to impacts” (p.91) the implication is that the impacts are negative. If a cure for cancer is discovered in the next thousand years the risk from radioactive releases would be greatly reduced. If the current debate over hormesis shows that low doses of radiation are beneficial even that small risk would become a benefit. There is no mention of either of these possibilities.

The Assessment Team is composed of nine prestigious individuals, recognized for their abilities in their respective disciplines. However, there is no evidence in their biographies of management of design, construction and operation of major engineering projects, certainly nothing comparable in magnitude to the proposed repository. According to the Report’s Appendix 1, team members are essentially academics, analysts and consultants whose achievements are mainly committee memberships. Only three have experience in nuclear energy, and then only in administration or regulation: it would be instructive to learn if the scores of these three differed significantly from those of the other six.

Under “Additional Insights” (p.107) the AT recommends a staged approach to a DGR (Deep Geological Repository). This resembles the compromise that I have been advocating. If the NWMO confirms the AT’s assessment after review and revision of the methodology I still believe that there are aspects of the compromise worth incorporating. The generation responsible for preparing the repository should also develop the technology and stockpile the materials needed for final closure. Used fuel should be emplaced in the first rooms to be ready and the rooms and passage closed to permit monitoring of this as a demonstration. Also, gaining public acceptance is a major objective of the NWMO. With many of those who have expressed an interest in the issue having taken sides in the storage versus disposal debate, it would probably be easier for both sides to accept a compromise recognizing the validity of both their arguments, than for one side to be a “winner” and the other a “loser”.

## ***Details***

### **Major**

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| 11 | The Report quotes the BS Report for the need for “broad public support” as a measure of acceptance. See also page 112. In the absence of any comment the implication is that the NWMO endorses this position. I have repeatedly warned that this definition is illogical and unattainable – see, for instance, <a href="http://www.magma.ca/~jalrober/Blunder.htm">www.magma.ca/~jalrober/Blunder.htm</a> .   |
| 21 | Here and elsewhere there is reference to public “participation” without definition of “participation”. If it means an opportunity to be informed and to be heard, that would be acceptable, but it is likely that activists will interpret it as having a say in the decision-making which would be unacceptable. This is fundamental to our democracy and should not be changed for a particular issue. The belief (p.22) that participation and transparency will have any effect on the public’s confidence in government and industry is naïve. |
| 28 | “Exposure risk would increase appreciably due to the complexity of the fuel cycle ....” Since exposures to workers and the public would still be controlled to safe levels by the regulator, since nuclear workers are generally as healthy or healthier than those in most other industries, and since exposures to the public are negligible, the relevance of this factor is questionable.   |

- 38 All three Project Timelines show absurd lengths for Siting & Approvals (S & A) and Design & Construction (D & C). These are probably realistic, or even optimistic, given the present stagnation of decision-making due to environmental impact reviews involving lengthy public participation, reviews of the reviews, “political delays” (p.51) and low government priority. The BS Panel that lasted eight years after two years of preparation made the Mills of God look like a snap decision, but its decision was to decide nothing. The NWMO cannot change this but it should draw attention to the effect on waste management and the cost to society. For on-site storage the estimate is based on experience at Pickering (Footnote 2), but this was for a first-off proposal: repeats should take less time.
- 41 S & A plus D & C is now 20 years!
- 44 Reasons for changing the specifications of the DGR should be justified. The new version is apparently derived from a consultant’s report that has received negligible external review compared with the original EIS.
- 44 S & A plus D & C is now 27 years!
- 65 As explained elsewhere, maximizing the safety of any one activity reduces society’s overall safety. The objective should be to ensure adequate safety. Note the correct use of no “undue risks” on page 68.
- 76 “... each person’s subjective assessment of the likelihood and seriousness of the risk scenarios ...” is of little value compared with the detailed quantitative analyses performed elsewhere.
- 79 Key Assumptions fail to mention the volume of fuel, the eventual need to transport used fuel from storage and decommissioning of the storage sites.
- 81 Experience has shown that when people assess the benefits of nuclear energy several are overlooked. For instance, all electricity customers benefit from reliable and affordable electricity; everybody, even those not on the grid, benefit from a healthy economy that pays for health, education and social programs and a lack of pollution; future generations will benefit by having nuclear energy as a developed technology; and even if they do not exploit it, they will benefit from our having used it in the same way as we have benefited from those in the Industrial Revolution having burnt coal. By the nature of this assessment a reader is unable to determine which benefits have been taken into account, and what weight has been given to them. The possibility of a comprehensive fuel processing plant representing a major benefit cannot have been considered due to the unjustified assumption regarding volume of used fuel, discussed earlier.
- 84 For the same reason a reader is unable to determine whether, in assessing the risk from road and rail accidents, the AT was cognizant of the extensive analysis and testing done to simulate these events, or was just reacting to gut feelings. The same comment applies to the assessment of transportation under the Security objective (p.89).
- 96 The AT is simply parroting conventional “wisdom” in attributing the cost overruns for large nuclear projects to the nuclear industry. An analysis of the facts shows that most of the delays and consequent overruns for the Darlington construction and the Pickering refurbishment was due to political interference. CANDU reactors abroad have been constructed by AECL within schedule and budget. (See “Can CANDU estimates be trusted?” already cited.)

### **Minor**

#### **Page**

- 20 “Acceptability” should not be equated to “supported by the public”.
- 26 Here is the only reference to the submissions to the NWMO, but none is listed at page 144 or in the Bibliography and there is no evidence in the Report of the AT having read any of them.

27 The Report fails to recognize that reprocessing can be separate from partitioning and transmutation and is more likely to be adopted alone than in combination. Both fissile and fertile materials would probably be recovered in recycling. The method of reprocessing described here is only one of several, including at least one that does not involve aqueous solutions.

28 In an International Repository Canada would probably be a minor partner in one dominated by the US or European Union.

29 The Report notes assessments by the NWMO and “in other countries” but ignores those in Canada over earlier decades.

31 Ha abbreviation for hectare.

35 Facility Refurbishment should include eventual decommissioning.

39 Unexplained reference to “Phase 1”.

41 “Sheilding”

43 In Canada, “meter” is an instrument: the measure is “metre”. This occurs in many places.

56 First, the diversity of Canadian values is said to constitute a major challenge then, in the same paragraph, the NWMO is reported for finding that these values have much common ground.

64 In my submission on the Citizens’ Dialogue I argued why the “450 participants” do not “generally reflect Canadian society”.

66 For the same reason, and because only a minute fraction of all Canadians have participated in any NWMO activity, “broad support” cannot be claimed.

72 Without *unduly* infringing on the freedoms of individual Canadians .... – we all have some infringement of our freedoms.

72 There is need for a definition of “Environment” in this context. The definition of “environmental effect” in the Canadian Environmental Assessment Act includes “socio-economic conditions” and other factors covered in other Objectives of the AT’s assessment. “Integrity” should not be equated to “immutability”: any human activity will have some effect on the environment, as will the passage of time.

73 There is no recognition that Adaptability, if exercised, involves a cost. There is an argument, not given, that once a firm decision is reached only a major unforeseen change in circumstances would warrant review of that decision. If something is adequate there is no need to improve it – “If it ain’t broke, don’t fix it.”

75 Any effects of climate change would occur over a time scale sufficient to allow remedial measures so that it might affect costs but not safety.

77 Colour codes are useless and confusing in a black and white report.

85 “lessened”

88 “Thus, *adequate* security is a fundamental objective ....”

91 Since the BS Panel’s SRG has confirmed that transportation of used fuel presents no unusual risk it is questionable that any weight should be given to fears based on false assumptions.

92 There is no evidence that the AT was aware of the survey of potential sites performed for the EIS. Also, there is no recognition that DD-2 found that Aboriginal values were nearly identical to those of other Canadians.

97 Adaptability is an objective but there is no recognition for Robustness.

98 The influence “Opportunity for public to influence decision making” is much preferable to the “Participation in decision making” elsewhere.

99 The “dominance of DGR” should not have been “somewhat unexpected” by the AT given that this has been the recommendation of far better qualified bodies since the 1970s. “Weights” is not *defined* in Section 4.7 and the footnote does not help.

100 In Figure 6-17 the vertical scale is not labelled, it is poorly explained and only a quarter of it is used, suppressing the magnitude of the differences.



- 116 Not all electrons orbit nuclei. Radioactive decay transforms, it does not separate. Fissile and fissionable are synonymous. If neutrons *of any energy* can cause fission, <sup>239</sup>U and others are fissile. Fertile should be defined.
- 117 It is not just gain/loss of protons that results in ionization. “Possibly” should appear earlier in the sentence. “Management” also includes storage and disposal.
- 118 Reprocessing does not necessarily involve recycling of fission products, although some may be recycled.
- 148 “... from *some* climate-change scientists ...”
- 149 “thee”

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