

# **Preparation for Participating in an Abbreviated Application of the NWMO Assessment Team Model**

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A one-day workshop will be held Saturday, September 24, 2005 to conduct an abbreviated application of the process and model used by the NWMO Assessment Team to aid its evaluation of 3 alternative approaches for managing Canada's used nuclear fuel. The workshop objectives are to:

1. First and foremost, provide participants with a thorough understanding of the assessment process used by the NWMO Assessment Team.
2. Also, obtain an independent evaluation and comparison of the 3 management alternatives that were previously evaluated by the Team.

This document provides background information and describes work that participants must conduct prior to the meeting to enable the abbreviated application to be completed within the time frame of the workshop.

## **BACKGROUND**

The NWMO report "Assessing the Options" describes the underlying methodology (known as multi-attribute utility analysis) and how it was applied by the Assessment Team.

### **Purpose of the Assessment Methodology**

The assessment methodology was intended to help the Assessment Team:

- Provide a thorough, disciplined, and well-documented comparative evaluation of the alternative management approaches.
- Discriminate among the options (facilitate identification and understanding of important differences among the alternatives).
- Clarify the Assessment Team's assumptions, judgments, opinions, and reasoning.
- Be sensitive to alternative values (by allowing weights to be varied to show how the choice might depend on the value judgments that are made).

### **Overview of the Methodology**

The application required several steps (Figure 1):

1. Create a hierarchy of (non-overlapping, fundamental, and value-independent) objectives for selecting Canada's approach to managing used nuclear fuel.
2. Construct influence diagrams documenting the factors and relationships that determine the ability of alternatives to achieve each objective.
3. With the aid of the influence diagrams, estimate how well each approach would perform against each objective.

4. Assign sample weights indicating alternative value judgments regarding willingness to tradeoff the various objectives.
5. Aggregate the performance estimates and weights.
6. Use the analysis as an aid for drawing conclusions.

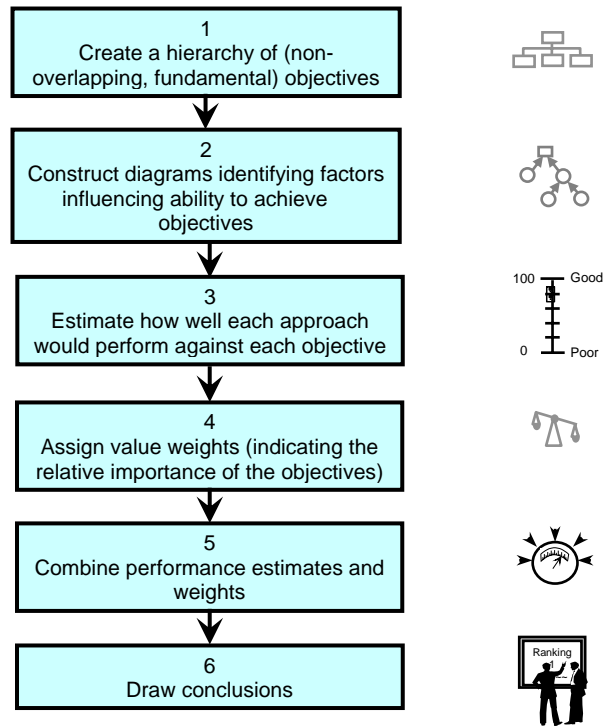
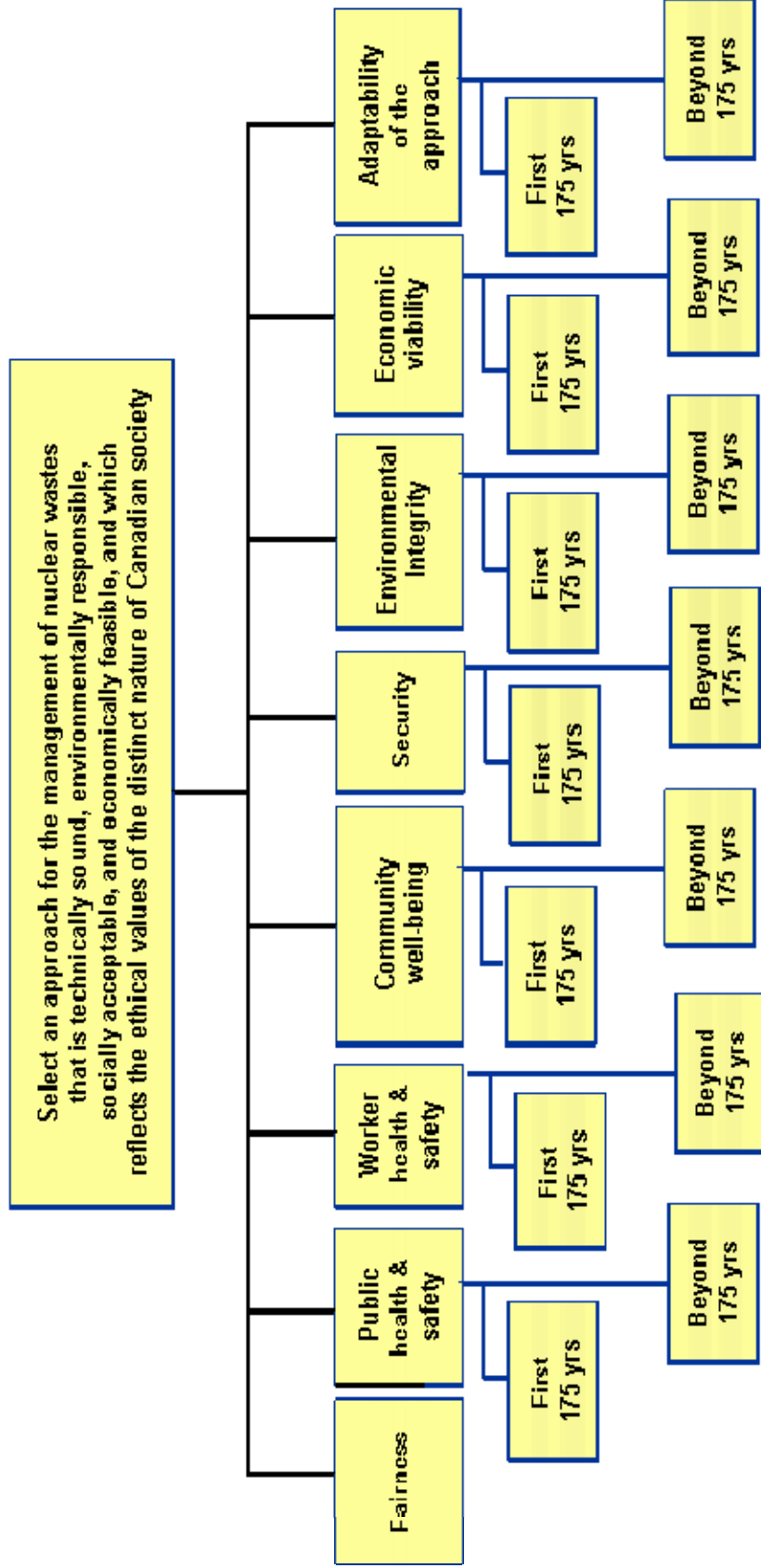


Figure 1: The methodology was applied in a series of steps.

As indicated, the methodology attempts to separate technical judgments (how well would each alternative perform against each objective) from value judgments (how important is each objective). Technical judgments are captured through a “scoring process” designed to (1) manage group interactions, (2) promote comprehensive consideration of relevant factors and considerations, (3) encourage information, and (4) document the information and reasoning for technical judgments.

### **Hierarchy of Objectives that Served as Criteria for the Assessment**

Figure 2 shows the objectives selected by the Assessment Team to provide criteria for the comparative evaluation of approaches. As illustrated, with the exception of the fairness objective (which considers intergenerational fairness) the performance of each approach was assessed against the objectives separately for two time frames.



**Notes:**

1. Performance on highest-level objectives is assumed to be solely a function of the achievement of the lower-level objectives.
2. Regulatory/legal compliance is viewed as a constraint, not an objective. Each approach would be implemented so as to meet such requirements.
3. We will need to consider performance under both normal and unexpected (risk) outcomes (see influence diagrams).
4. Each approach is assumed to be technically feasible in the sense that, with enough time and costs, it can be built. The performance level of the various approaches will, however, differ.
5. By "future generations" we mean generations sufficiently in the future that it is not reasonable to try to estimate what their objectives and weights might be.

Figure 2: Except for the fairness objective (which considers intergenerational fairness), performance against the objectives was assessed separately for two time frames.

## **Influence Diagrams**

The influence diagrams provided visual “road maps” of the factors to be considered when evaluating each approach against each objective. Figure 3 provides an example influence diagram.

## **Documenting the Basis for Judgments**

The Assessment Team used the influence diagrams as “scoring ballots” to summarize their individual beliefs. Specifically, each Assessment Team member prepared for the assessment process by:

1. Considering each factor in the influence diagram and expressing a judgment regarding whether that factor discriminates the approaches.
2. Writing down (as notes near the relevant bubbles) the logic for concluding which factors are important discriminators.
3. Colouring the factors (bubbles in the diagram) to summarize the nature and significance of the differences that were regarded as important. See Figure 4 for the colour code.
4. Colouring the top box (the objective) in each influence diagram to indicate the judged overall assessment of the performance of each approach on the corresponding objective.

Figure 5 provides an example of the judgments recorded for one alternative (on site storage) for one influence diagram (public health and safety) for one time frame (0-175 years).

## **Quantitative Scoring of the Alternatives**

Quantitative scores on a zero-to-100 performance scale (Figure 6) were assigned by each Team member for each approach for each objective using the following steps. First, initial scores were derived from each individual’s colour assignments. An assessment of “red” was assigned a score of zero and “green” assigned a score of 100. The other colours were assigned intermediate scores distributed linearly on the scale between 0 and 100. To obtain final scores, the Team discussed differences of opinion as represented by the initial scores. Each member then assigned “final” scores, (1) taking into account the arguments raised by other team members and (2) adjusting scores to reflect the definition of the quantitative scale as being linear in the value of performance (e.g., a score of 50 was defined as representing a level of performance whose value was halfway between the unacceptable performance and ideal performance).

The Team provided its collective opinion regarding the potential performance of each alternative in the form of a range of scores and an average. For computing the ranges of scores, single outliers were dropped (the highest and lowest scores when assigned by only one person were not included when computing the high and low ends of the range). At any time in the process, Team members could change their scores. At the conclusion of the process, each Team member verified that the resulting ranges accurately reflected the collective view of the Team. The NWMO report “*Assessing the Options*” documents the scoring results.

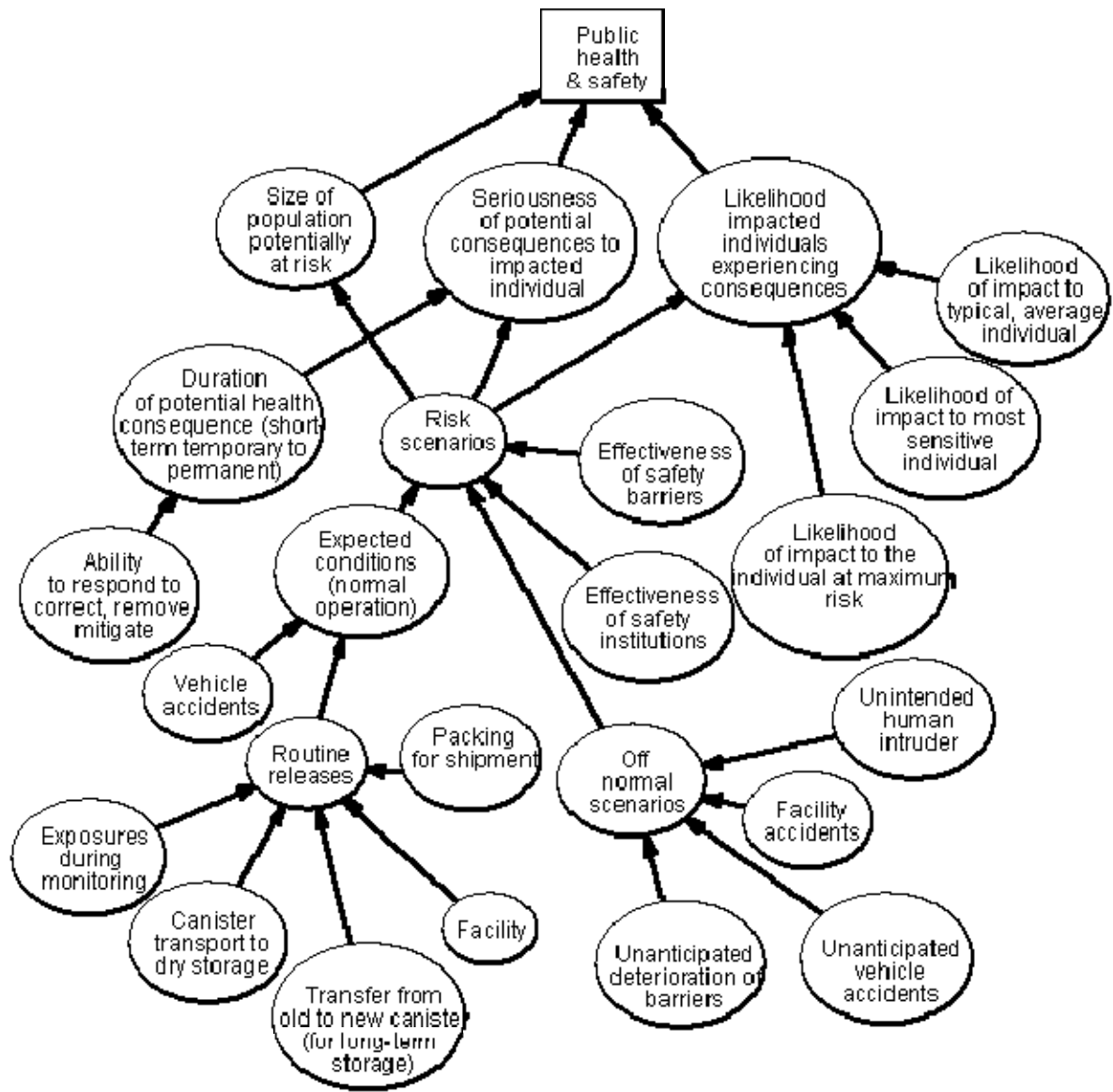


Figure 3: For each objective, an “influence diagram” was constructed summarizing important factors to be considered when assessing the performance of each approach against that objective.

<i>Colour Code</i>	<i>Numerical Scale</i>	<i>Description</i>
green	8	Not a significant issue or problem; essentially no impact or effect; ideal; about as good as can be expected; in the top 1% of possibilities.
Green-aqua	7	
aqua	6	A small issue or issue of lesser significance; very low impact or effect; the factor cannot or ought not to be ignored but it is not as important as it is in other contexts or alternatives; it is at the more favourable (say 25%) range of possibilities.
Agua-blue	5	
blue	4	A moderate or moderately important issue; the factor represents a magnitude or level of importance in the middle (say 50 %) of possibilities; although it may be of a magnitude to raise concerns, the factor is a bigger or more important concern in other alternatives or contexts.
Blue-yellow	3	
yellow	2	A relatively high or adverse magnitude; within the higher, more adverse (say 75%) range of possibilities but not necessarily extreme or unacceptable in and of itself.
Yellow-red	1	
red	0	Very high or among the most extreme (say top 99%) of possibilities or alternatives; deserving of significant attention. Depending on related or interacting considerations, possibly unacceptable
Un-coloured	Un-scored	Information insufficient for assessment or for differentiating the alternatives; not formally assessed.

Figure 4: "Colour scale" used to summarize judgments on the influence diagrams.

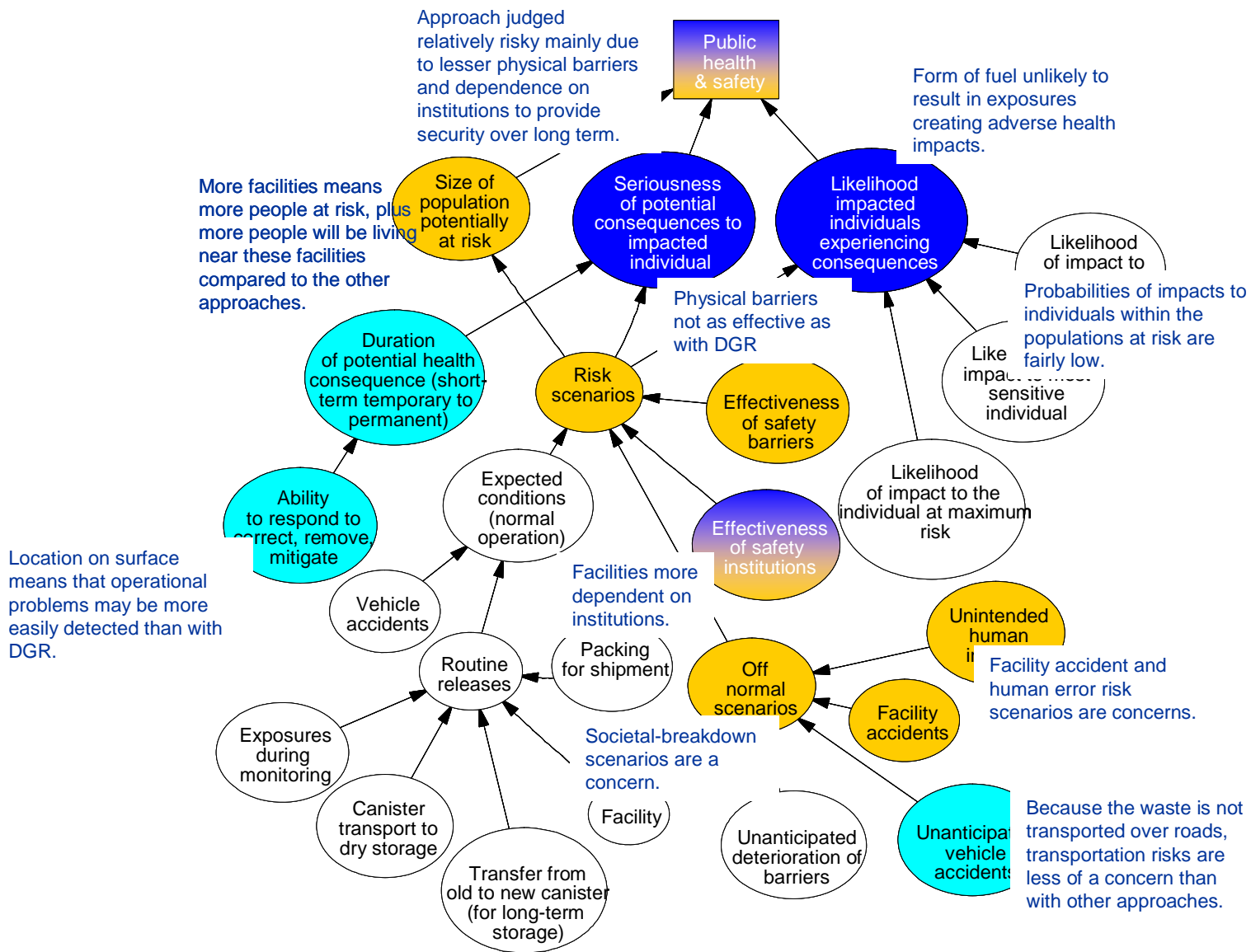


Figure 5: Example of the judgments recorded by an Assessment Team member (on site storage, 0–175 years).

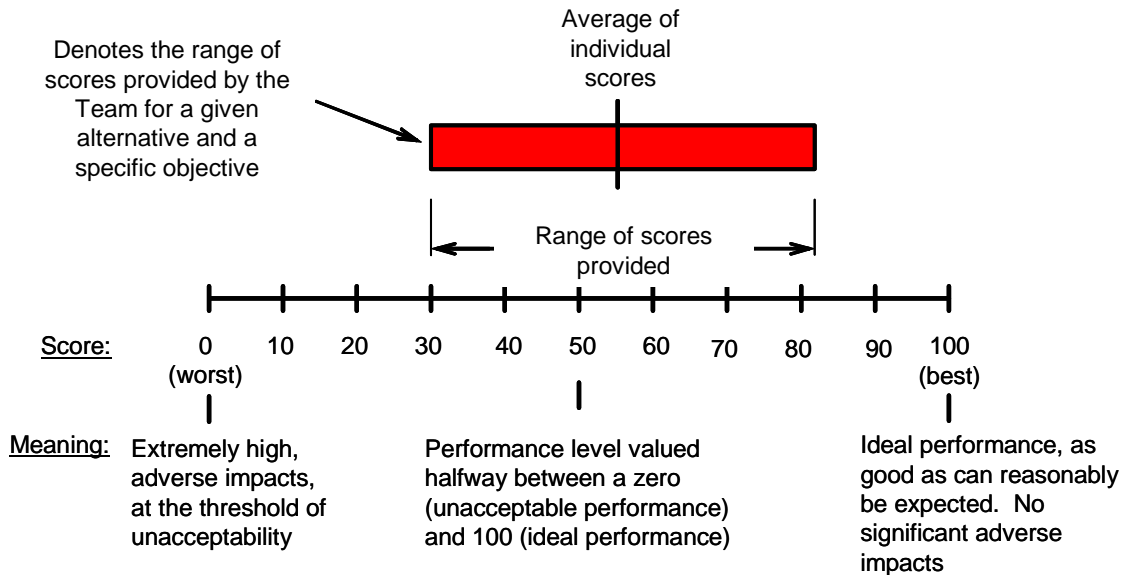


Figure 6: Scale used for quantitative scoring.

## Weighting

Because one alternative (deep geologic repository) was scored more favorable than the other alternatives on nearly every objective, the weighting of the objective ended up being a less significant step in the assessment process than originally anticipated. Nevertheless, the Assessment Team elected to assign weights so as to further analyze the implications of the scores that they had assigned.

The method for assigning weights is known as the “swing weight method.” The concept is to compare how a specified “swing” from a low to high score on the scale for one objective compares with a swing on another scale. In each case, the swing was defined as going from the worst score (low end of the range) for the approach that scored worst on the objective to an (ideal) score of 100 (in other words, the weights represent that relative value of eliminating the anticipated adverse impact of the worst-performing alternative with respect to each objective in each time frame).

Weights were derived reflecting the average values of the Assessment Team members, plus several alternative “illustrative weights” were assigned for the purpose of reflecting different values that might be expected within Canada’s diverse society. The NWMO report “*Assessing the Options*” presents the results (including the ranking of alternatives) produced when the weights are combined with averages and ranges of scores assigned by Team members. These and other analysis results served as input for conclusions and recommendations as presented in the other report.



## **ABBREVIATED ANALYSIS TO BE CONDUCTED SEPTEMBER 23**

The Assessment Team conducted the work described above in a series of meetings over a period of several months. Obviously, it will not be possible for participants to replicate this analysis in a one-day workshop. Accordingly, constraints and assumptions are required for the abbreviated analysis:

- Since there will not be time to revise the basic structure of the model, the objectives for selecting Canada's approach for managing used nuclear fuel (Figure 2) must be accepted as given.
- Prior to the meeting, participants will need to review information regarding the 3 alternatives, document their personal judgments regarding the factors shown in the influence diagrams, and "score" the alternatives. At the workshop, each participant will be asked to report and explain the assigned scores. Participants may change their scores based on discussion.
- Based on discussions at the workshop, participants may change their assigned scores. Weights will be assigned. The ranges of scores and weights will be used to rank the alternatives, and various sensitivity analyses will be conducted.

## **WORK THAT MUST BE CONDUCTED BY PARTICIPANTS PRIOR TO THE WORKSHOP**

1. Prior to the meeting, participants should read and understand the report "*Assessing the Options*" (especially Chapter 5).
2. There will be little time at the workshop for discussing the theory and practice of multi-attribute utility analysis. Participants wanting more detailed information regarding this methodology are referred to the literature. Please email me (address on page 1) in advance of the meeting with any further questions that you may have.
3. The assessment process assumes that participants have current, up-to-date understanding of the substantive issues and information important to assessing the alternative approaches. To the extent necessary, review relevant information about the alternative approaches, including NWMO reports and related documents.
4. Print out the "scoring instructions" contained in the appendix to this document. These instructions include the influence diagrams on which each participant should summarize their colour assignments and document his or her reasoning (see Figure 5). These are essentially the same materials used by NWMO Assessment Team to prepare for their scoring workshop.
5. Follow the instructions to complete the "qualitative" scoring of the alternatives. Bring the completed diagrams to the workshop.
6. Following the process used by the Assessment Team, on the day of the workshop, participants will discuss their qualitative scores, assign quantitative scores, assign weights, compute aggregate results, and derive and discuss conclusions from the exercise.
7. Again, please contact me if you have questions or concerns.