NWMO Funding Formula Review

Expert Report

29 October 2007

1. Terms of Reference and Process

A group of independent experts (the "Panel") has been retained by the Nuclear Waste Management Organization ("NWMO") to review the proposed funding formula for the Adaptive Phased Management ("APM") approach to the long term management of used nuclear fuel in Canada. The scope of the review is limited to the proposed funding formula in addressing the requirements specified in the Nuclear Fuel Waste Act (the "NFWA") s. 16(2)(d) and the cost sharing percentage of the NWMO operating cost (NFWA s. 16(2)(e)). The intent of this review is to assess whether the major assumptions contained in the formula are reasonable.

The objective of the funding formula is to build a pool of funds from annual contributions by existing nuclear waste owners (Ontario Power Generation Inc. ("OPG"), New Brunswick Power ("NBP"), Hydro Quebec ("HQ") and Atomic Energy of Canada Limited ("AECL")), commencing in 2008, and from investment income earned on those contributions that will pay for the future cost of the APM approach.

The APM approach contemplated by the NWMO is characterized by central containment and isolation of used nuclear fuel in a deep underground repository, with the option of an interim shallow-underground storage facility at the site, and continuous monitoring of the long term management of the used nuclear fuel. The timetable and scheduling for the APM approach are laid out on pages 316 and 317 of NWMO's 2005 report "Choosing a Way Forward – The Future Management of Canada's Used Nuclear Fuel". Cost estimates for this approach were developed in 2002 constant dollars and escalated forward. These cost estimates remain unchanged for this review by the Panel.

The Terms of Reference for the Panel call for this report to address the following Deliverables:

1.0 Assess the reasonableness of the approach proposed in funding APM (the "funding formula"), in particular,
   1.1 Economic assumptions (escalation rates, discount rates);
   1.2 Funding method of committed costs;
   1.3 Funding method of future bundles;
   1.4 Funding period of committed costs; and
   1.5 Dates used for start of operation of repository.

2.0 Assess the reasonableness of the approach in determining the cost sharing percentages amongst the waste owners of NWMO operating costs.

3.0 Survey practices of other jurisdictions regarding funding of nuclear waste liabilities as compared to the NWMO proposed funding formula.

The Panel was provided with a copy of the proposed funding formula and copies of the formula specifications, a draft of the Financial Section of the NWMO 2007 Annual Report, excerpts from the Nuclear Fuel Waste Act, the University of Toronto Economic Forecast used in developing the proposed funding formula, and a copy of the NWMO 2005 report "Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel". The Panel met with NWMO staff on three occasions to discuss the funding formula and to gather information about the funding mechanism. The Panel drafted a report which was reviewed by NWMO and comments were provided to the Panel which then prepared this final report. This report is the sole responsibility of the Panel.

2. Criteria for Evaluation

The Panel has applied three criteria in its evaluation of the reasonableness of the proposed funding formula. The Panel considered economic efficiency – whether the funding formula tends to impose a cost on the party that was responsible for it. The Panel also considered fairness – whether the formula allocates costs fairly among the waste owners. It considered whether the proposed formula allocates costs fairly over time, looking to see that one generation does not unreasonably impose costs on a future generation. The Panel considered financial security – whether the proposed formula gives a high probability that the funds required to care for nuclear waste in the manner recommended in the NWMO 2005 report will be available when they are needed.

3. Reasonableness of the Proposed Method of Funding the APM

3.1 Economic Assumptions (Escalation Rates, Discount Rates)

The proposed funding formula computes all costs in current dollars and then projects them into the future using escalation rates from a macroeconomic forecasting model. This is a good approach and the use of escalation rates from a single model ensures that those rates are consistent with each other. Whether the forecast inflation rates turn out to be accurate predictions is less important than that they be consistent, in part because the proposed funding formula calls for re-estimation of the escalation rates and the formula every five years and in part because if both inflation and discount rates turn out to be, for example, higher than forecast, the present value of the final costs would be little changed. That is, the present value of the final cost is not very sensitive to parallel and consistent movements of escalation rates and discount rates.

The proposed funding formula employs escalation rates for labour (Average Hourly Earnings All Industry-Canada), materials (GDP Deflator-Canada) and other

(Consumer Price Index (CPI)-Canada) derived from the University of Toronto's Institute of Policy Analysis January 2007 Economic Forecast. The economic forecast covers the period 2007 to 2025 and produces annual escalation rates for the three categories above. The rates being used to determine the future costs of the APM approach are 3.6% for labour, 1.8% for materials and 1.9% for other based on the forecast for 2025. These rates are the values that the UofT model converges to by 2010 and they are used as constant rates by the funding formula for the entire funding period. These are in fact the only inflation indices produced by the UofT model. One might prefer to use an index for industrial machinery and equipment to inflate the materials costs, if such were available, but it is not. Therefore the use of these three escalation factors seems reasonable.

The Panel considered whether the proposed formula should rely on a single model or should use a consensus forecast as many regulatory bodies in Canada do. The National Energy Board and the Ontario Energy Board, for example use a consensus forecast, currently based on 16 different economic forecasts, in order to determine appropriate levels for future economic benchmarks. However available consensus forecasts typically extend for only ten years. While such a forecast might provide better short-term accuracy, no significant costs are going to be expended under the proposed formula for more than a decade, so short-term accuracy is less important than the duration of the forecast period which is greater for the UofT model. We have concluded that the longer-term single forecast used in the proposed formula is appropriate and reasonable.

The discount rates, or rates of return (ROR), used to calculate the present values of each owner's cost share are based on their actual financial rates of return given their financial situation. They vary, for the first 5-year period, from 5.15% for OPG to 4.25% for HQ. The 5.15% ROR for OPG is based on a government guarantee of a 3.25% real rate of return added to the 1.9% inflation rate predicted by the UofT forecast. This means that the discount rates in the proposed method are in fact consistent with the escalation factors used in the proposed method. This consistency ensures the validity

or reasonableness of this set of assumptions. Another check on consistency is that the UofT model includes two government bond rates for each year: a 3-month t-bill rate, which stabilises at 4.7% and a 10-year bond rate which stabilises at 5.4%. So, the rates of return assumed for the four owners are all less than the government long bond rate and they straddle the t-bill rate. If these utilities are in fact able to borrow and invest at essentially government short-term rates, which is a plausible assumption given their government ownership, this is another measure of consistency between the UofT model and the proposed funding formula.

The funding formula is to be updated with new escalation rates every 5 years. We believe that the cost estimates for the facility itself should be updated periodically as well to reflect changes in the current dollar cost of inputs into the disposal facility and any changes in anticipated facility design. This will require the periodic re-estimation of the base costs which was last carried out in 2002. This re-estimation of current dollar costs should be carried out on a 5 year basis.

The Panel asked the NWMO to test the sensitivity of the present value of the facility cost and the owners' cost shares to a 1 point increase in all escalation factors starting in 2008 and to a 1 point increase in the rates of return five years later. This sensitivity analysis showed an increase in the 2007 present value of the facility cost of 4.90% but no change in the cost shares of the owners. This demonstrates that if escalators increase without a corresponding increase in rates of return the present value of the total cost increases, however the cost shares are quite robust to changes in the escalation factors and rates of return.

3.2 Funding Method of Committed Costs

Committed costs are assigned to bundles which have produced electricity or have been removed from a reactor through June 30, 2006. Committed costs consist of all fixed costs of the facility (these costs include the construction cost of the facility and its non-variable operating costs) as well as all variable costs associated with the bundles already used or placed in the reactors. The division between committed costs

for existing bundles and future variable costs for future bundles makes some sense because: (i) if all nuclear generation was stopped as of today, the committed costs must be incurred and would be funded on a cost per bundle basis such that the committed costs would be available by 2035 which is the earliest possible operating date for the facility; and (ii) if the committed costs, as determined for the funding formula, include all fixed costs, subsequent to their funding, only the variable cost per bundle would be required. While the June 30, 2006 date is somewhat arbitrary it seems reasonable. It pre-dates the funding formula and is a fixed date so that each owner's contribution does not shift as the expected effective date of the funding formula moves around. Furthermore this date avoids creating any incentive for the owners to engage in strategic behaviour regarding these bundles during the negotiation of this agreement. All of the electricity generated by the bundles removed from the reactors prior to June 30, 2006 will have been consumed before the first payments are made under the funding formula.

Fairness might require that the consumers of electricity pay for the disposal costs associated with their consumption. In this case, the committed costs associated with the facility should have been paid by consumers commencing when the first unit at Pickering came online and continuing until the end of the economic useful life of the current fleet of reactors. This is not possible as one cannot now go back to past consumers and ask for additional contributions. However, commencing with the formation of OPG and the signing of the Ontario Nuclear Funds Agreement ("ONFA") in April, 1999, OPG has collected from its customers $3.2 billion (as of December 31, 2006) which is currently held in OPG's Used Fuel Fund. OPG has made annual payments since 2002 from the ONFA account to the NFWA Trust account. The $1.2 billion in the NFWA Trusts as of December, 2006 does therefore represent a partial payment by past customers for the committed costs of the facility.

The construction and operating costs for committed bundles are costs incurred after the date that the facility is licensed. They are allocated among the owners in equal present value payments for all bundles. This means that the total future value of those

costs is calculated as of the in-service date 2035 and each owner pays a share based on its share of committed bundles. The share is spread over the time from the effective date of the funding formula until the forecast in-service date of 2035.

The concept of equal present value means that payment per bundle in nominal dollars increases each year in the amount of the discount rate. This equalises the final year value of each contribution – each year's contribution per bundle constitutes an equal portion of the cost of that bundle in the final year. An alternative would be to equalise the real cost each year, adjusting for inflation, or to equalise the nominal cost in each year. Among these three methods of allocation over time, none could be said to be either right or wrong, they just represent different methods of spreading the cost over time. Equal present value minimises the contributions in early years and maximises the contributions in later years. Equal nominal contributions would do the reverse, while inflation-adjusted contributions would be in the middle. Since costs are being allocated to customers who did not cause them, we could ask which of these is the "fairest" way to allocate such costs. Increasing the payments annually in accordance with the CPI (inflation-adjusted contributions) would equalise the real financial burden on customers in each year and might therefore seem most fair. Equal present value imposes a higher real cost on later customers, which might seem unfair except that, as real wages are likely to be increasing during this period, those future customers will be more wealthy than early ones and better able to afford the cost. Still, the discount rate is greater than the expected increase in wages, so these payments will represent an increasing share of a worker's wages over time if the equal present value method is used.

If the proposed funding formula is applied, contributions will be back-end loaded with greater amounts being collected in the latter years than in the early years. This should not be too great a burden for consumers as their wealth will have increased over the period as will the price of other forms of energy. Alternatively, contributions could be indexed to inflation such that the "real" value of the contribution would remain constant over time. Either approach would be reasonable.

While back-end loading the contributions usually increases the risk of financial inadequacy, the existing provincial and federal ownership of the waste producers largely mitigates this risk in our opinion. We suggest that the government sponsors of each of the waste producers undertake to NWMO that, in the event that the waste producer is sold, the selling government shareholder would assure that the waste producer continue its contributions following such sale and, if the waste producer is unable to make its contribution at any time following the sale, the previous government owner of the waste producer would make such contribution.

An issue which has not been contemplated is the changes that would be made to the funding formula if new producers of nuclear waste begin operations during the period 2008 to 2035 when committed costs are being funded. In particular, while new producers should have no obligations with respect to the bundles removed from reactors up to June 30, 2006, such producers should bear their fair share of the fixed costs related to the construction of the facility. Therefore the funding formula should be expanded to include the protocols that would be employed if a new producer were to be licensed. This would allow the prospective producer of nuclear waste and its regulator to estimate the fixed cost associated with nuclear waste management that it would bear as well as the future per bundle cost. Given the time period required to initiate and license a new nuclear reactor in Canada, NWMO has a substantial period of time to expand the funding formula to accommodate a new entrant.

3.3 Funding Method of Future Bundles

Bundles generated after June 30, 2006 are considered future bundles. The report provides an estimated cost per future bundle including both fixed and variable costs. These costs are recognized when the bundles are placed into the facility, and since the expectation is that bundles will be kept on the reactor site for several decades before being sent to the facility and that interim storage costs will be borne directly by the producing waste owner, the actual facility costs will be incurred in years following the first bundle delivery in 2035 for OPG and 2050 for the other owners.

The cost per bundle is based on the present value of the escalated cost estimates based on the number of bundles to be processed in each of the forecast years. Each owner pays a contribution equal to the number of bundles delivered to the facility during a particular year multiplied by the escalating present value cost per bundle. The present value cost per bundle is increased each year by the particular waste producer's discount rate.

The method of allocating the costs of future bundles to owners and bundles is equal present value contributions, the same as with committed bundles. This raises an equity issue among customers but one that is a bit different from that arising from committed bundles. Fairness would call for electricity customers in any year paying for the future cost of disposing of the fuel used to generate their electricity. This supports a payment in the year in which the bundle is placed in use which is, in fact, the method used. Equal present value means that in each year, customers in that year pay an amount which, if invested at the ROR, will be sufficient to pay for disposal of their fuel. These customers are paying for the marginal cost of their fuel use, which is efficient in economic terms. However this also implies that the real cost, adjusted for inflation, of fuel disposal will rise every year, since inflation is less than the ROR, and later customers will pay more, in real terms, than earlier customers. Later customers might consider this unfair. Whether equal present value or equal real cost is more fair to customers is a matter of judgement. From an economic efficiency point of view, each customer should pay the incremental or marginal cost that their electricity consumption causes. If each customer pays an amount such that when invested it will fully pay for fuel disposal, that should be efficient.

We can also consider the certainty that the funds will be available when needed. It is possible that the current waste owners will not be in existence in 2035 or 2050 or that these owners will not be able to make financial contributions until that time. Government ownership of the waste producers mitigates this risk in our opinion; however, the governments should be required to stand behind the waste producers if such producer were sold prior to making all of its contributions.

Funding of the variable costs of operation on a present value per bundle basis is reasonable provided that the costs of operations are truly directly variable with the number of bundles processed. In some cases, operating costs may not be directly variable with the number of bundles processed. In this situation, if the number of bundles processed falls below the estimated level, costs may not be fully recovered. Every five years prior to the determination of the present value cost per bundle, a cost sensitivity analysis should be performed to confirm that costs expected to be recovered are directly variable with bundles processed.

3.4 Funding Period of Committed Costs

The funding period for committed costs is from the signing of the agreement until 2035, the assumed in-service date for the repository.

Considering security of funding for the repository, this funding period seems reasonable, since it ensures that sufficient funds will be accumulated at the time when they are needed to construct the facility and to fund all costs necessary to deposit all waste produced until June 30, 2006. Assuming that the funding formula is approved in 2008, the facility is licensed in 2029 and placed in-service in 2035, then it may be prudent to maximize NWMO's flexibility under the APM approach, by reducing the funding period for construction costs for the facility to the period 2008 to 2029 while the committed costs with respect to bundles removed from reactors up to June 30 2006 would be funded from 2008 to 2035. In addition, specifically identifying the construction costs and the funding associated with the facility will also be helpful in the event a new producer of nuclear waste must assume a funding obligation with respect to the facility.

3.5 Dates for Start of Repository Operation

We understand that the 2035 date represents the earliest practical date for starting the operation of the repository and that OPG would like to start placing its waste in the repository at that date or sooner if possible. We are not in a position to judge the feasibility of a 2035 start date, but NWMO's Final Study "Choosing a Way Forward" says that it is feasible. Placing waste in the repository at an early date would allow early

testing of the storage method and could identify any problems at an early date. We see no problem, from a funding formula point of view, with this date, so long as it is technically feasible.

4. Reasonableness of Cost Sharing Approach

Pre-construction costs are covered under the terms of the Membership Agreement and include all costs up to the date that facility is licensed. These are the annual operating costs of NWMO which are paid by the owners. The share of the annual cost paid by each owner is a percentage determined, according to the algorithm set out in Appendix A of the NWMO Funding Formula Specifications dated August 29, 2007, based on the owner's expected volume of committed bundles and the owner's required in-service date for the facility. The common costs and the long-term management costs are estimated and the present value of those costs computed assuming first an in-service date of 2050 and then an in-service date of 2035. Each waste owner's cost share is based on its share of committed bundles. OPG pays the present value of Committed Common Costs for a facility in service in 2035 less the other owners' shares of the present value of Committed Common Costs incurred for the facility in 2050. Discounting reduces the present value of the 2050 operating costs relative to the present value of the 2035 costs as the discount rates all exceed the escalation rates, so while OPG owns 87.19% of the committed bundles, its share of the common costs is 90.78%. Thus OPG pays 90.78% of the operating costs in each year until 2035. This is a reasonable allocation if, as appears to be the case, OPG wants or needs to use the facility by 2035 while the other owners do not need it until 2050. Essentially OPG pays the marginal cost of having the facility available 15 years earlier than is needed by the others. This seems to be an equitable and reasonable allocation of these costs.

5. Comparison with Funding of Nuclear Waste Liabilities in Other Countries

The importance of establishing and securing funding for nuclear waste liabilities is well-recognized internationally. For example, the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*, to which most countries with nuclear power programmes (including Canada) are signatories, requires in its Article 22 that: "Each Contracting Party shall take the appropriate steps to ensure that ... adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning; [and] financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility."

There are several common fundamental features underlying the funding approaches in most countries, including:

- Application of the "polluter pays" principle;
- Identification and reporting of all nuclear waste liabilities;
- Establishment of mechanisms to ensure that funds are available to meet the liabilities.

However, the ways in which these features are expressed and implemented vary considerably among countries, reflecting a wide variety of social, political and economic histories and practices.[1]

Among these differences are different choices of allocation of responsibility (centralized waste management agency or individual waste producer, public sector or private sector or a combination); method of evaluation of the liabilities (current value or net present value); funding methods (centralized or individual funds, segregated funds

[1] "Future Financial Liabilities of Nuclear Activities", OECD Nuclear Energy Agency report NEA14, Paris 1996; "Schemes for Financing Radioactive Waste Storage and Disposal", European Commission report EUR 18185, Brussels 1999; "Financing the Management of Radioactive Waste and the Dismantling of Nuclear Facilities in Several Countries", ANDRA, Paris 2005

or accounting provisions or irrevocable guarantees or a combination); financing of the funds (levies on electricity generation or scheduled payments or payments upon transfer of wastes); duration of the build-up of funds (fully funded or funded over a fixed time period or funding over the anticipated lifetimes of the facilities); management of the funds (investment policies); and scope of the activities covered by the funds (spent fuel or all radioactive waste or all decommissioning and dismantling costs, and whether associated activities such as interim storage, transportation, research, and licensing costs are included).

A brief survey of practices in several countries is attached in the form of an Annex. Because of the wide range of these practices and the broad range of economic, social and cultural environments in which they are situated, an in-depth comparison is not considered appropriate or necessary for this report, particularly as regards those aspects that have already been determined in Canadian legislation (the *Nuclear Fuel Waste Act*).

With respect to economic assumptions, the majority of countries appear to base calculations on the net present value method, with a variety of assumed discount rates (either real or nominal) depending on individual national circumstances. Owing to the different economic conditions in each country, direct comparisons of these rates would be of limited usefulness.

Cost estimates are often reviewed on timetables ranging from one to ten year intervals, and funding formulas adjusted as a result of these reviews. This is also a feature of the NWMO approach.

Funding for committed costs is generally based on the "polluter pays" principle, reflecting the amount of waste produced by each producer, but the ways in which this is implemented vary widely. In some cases, fixed and variable portions of the costs are identified separately, while in others they are combined. Contributions from individual

waste producers may be based on actual waste volume produced, on production capacity (planned production), or on a combination of the two.

Regarding funding periods, in several countries a fixed time period (e.g. 25 years or 40 years after the initial startup of the reactor) has been prescribed over which fund contributions are made so that the fund becomes fully funded at the end of the prescribed time period. In some other countries, the time period is based on the design life of the nuclear reactors, i.e. so as to reach the fully funded condition at the end of the planned operating lifetime of the reactor.

A few funds are required to be fully funded (i.e. capable at all times of paying for all costs committed to the present time or to the end of the current year, corresponding to a zero-length funding period). On the other hand, these funds often accept business guarantees from the utility and may even allow the company to borrow back a significant part of its contributions.

In this connection, it should be noted that the Canadian Nuclear Safety Commission has required the nuclear utilities to provide fully-funded financial guarantees. For the nuclear utilities in Canada, these financial guarantees are in the form either of invested funds or of government guarantees, or a combination of the two. The existence of these financial guarantees is a significant backup to the funds under the *Nuclear Fuel Waste Act*, as recognized by the fact that the Act requires the NWMO to include information on these guarantees in its annual reports to Government.

While there are some features of individual national programmes that might merit further investigation for adoption by the NWMO, in general we find that the NWMO's funding formula is not dissimilar to practices used in other jurisdictions, with one exception. This exception is the funding period. In most other jurisdictions, the period over which funds are to be built up is related fairly directly to the operating lifetime of the facility or reactor that generates the waste. The time period in the NWMO's proposed funding formula is based instead on the timetable for in-service operation of the

centralized waste repository, specifically the dates when it is expected that spent fuel would first be delivered to the site. The difference is particularly notable in the case of AECL, where the difference between the shutdown dates of its three demonstration power reactors and the period for building up the funds for the spent fuel they produced exceeds 50 years.

The NWMO funding formula has the virtue of simplicity. This is particularly so in the case of OPG. OPG is responsible for the spent fuel from 20 power reactors, each with its own planned shutdown date. A funding formula that was based on the operating lifetime of each of these individual reactors would be unnecessarily complex and unwieldy. Contribution rates would have to be adjusted each time a decision was made on refurbishment and life extension of an individual reactor.

To the extent that the funding period deviates from the operating lifetime of the reactors, it also deviates from the "polluter pays" and intergenerational fairness principles, in the sense that a utility's ratepayers (or in the case of AECL, taxpayers) might be expected to make contributions to the fund regardless of whether the reactors that created the spent fuel were still in operation. However, even in a system where contributions are tied directly to the operating lifetime, changes in cost estimates may arise towards the end of or even after the funding period, so that contributions to the fund will be required to continue beyond the originally envisaged period. Moreover in the case of OPG, refurbishment of many of the existing reactors will extend their operating lives so that they coincide fairly closely with the funding period.

6. Key Findings of the Report

The Panel has concluded that the funding formula, as proposed, is reasonable. The following summarizes the Panel's comments and suggestions:

- Escalation and discount rates to be used in the funding formula are very likely to be consistent and appropriate given that they are drawn from the same long term economic model and are updated every five (5) years during the period 2007 until 2035. The Panel has recommended that the current dollar costs (last estimated in 2002) of construction of the disposal facility reflecting any changes in anticipated design and the fixed annual operating costs should also be updated every five (5) years, as well.

- The funding method of committed costs is generally reasonable. The funding formula has been designed to back-end load the contributions of existing nuclear waste producers and this approach raises the potential issues of intergenerational equity for customers and the financial security of the future cash flow from the waste producers. The first issue is a matter of judgement without a definitive right or wrong answer while the second issue is largely mitigated by the government ownership and/or support of each of the existing waste producers. The Panel believes that the funding formula should be expanded to contemplate the inclusion of new nuclear waste producers during the period 2008 to 2035 and during the period thereafter; however, given the period required to license a new nuclear facility in Canada, this expansion to the funding formula may not be required for a substantial period of time.

- The funding of future bundles appears to be reasonable. The Panel has some concern that all costs to be funded will be directly variable with the number of bundles delivered to the facility. In this event, contributions could be insufficient to meet on-going operating costs placing NWMO in an unsustainable position.

The Panel has recommended that, every five (5) years, a revised present value cost per bundle should be derived based on a cost sensitivity analysis with respect to the number of bundles processed.

- The funding period for committed costs appears to be reasonable. However, to maximize NWMO's flexibility under the APM approach, the funding period for construction costs for the facility could be shortened to 2029 while the committed costs with respect to bundles removed from reactors up to June 30 2006 would be funded until 2035.

- In general, the Panel has found that NWMO's funding formula is not dissimilar to practices used in other jurisdictions, with one exception being the determination of the length of the funding period for committed costs. In other jurisdictions, the funding period is usually directly related to the expected operating life of the reactor producing the waste. In NWMO's case, the funding formula covers 22 major reactors and three demonstration reactors of various ages, some of which may be refurbished to extend their useful life. The NWMO funding formula is based on a well-defined, justifiable funding period which has the virtue of simplicity and therefore, in the Panel's view, is reasonable.

- The Panel has concluded that the proposed sharing of NWMO's operating costs between the nuclear waste producers prior to the completion of the facility is equitable and a reasonable allocation of costs based on each owner's expected volume of bundles and required in-service date.

Panel Members

Jean-Paul Baillet	Secretary-General, ANDRA (French National Agency for Radioactive Waste Management).
Donald Carmichael	Financial Consultant, former Investment Banker, Power and Energy Group, Scotia Capital Inc. (1996-2005); Financial Advisor to OPG.
Donald Dewees	Professor of Economics, Professor of Law, University of Toronto; former Vice-Chair Market Design Committee - Ontario electricity sector.
Richard Ferch	Nuclear Consultant; formerly Director, Wastes and Decommissioning, Canadian Nuclear Safety Commission.

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ANNEX: Nuclear Waste Funding in Other Countries

Belgium

The WMO (ONDRAF/NIRAS) is a centralized public-sector agency.
Fixed costs and variable costs are charged to waste producers - fixed costs are based on committed volumes, for which capacity is guaranteed in the repository; variable costs are paid by fees based on delivered volumes.
Disposal costs are managed in a centralized fund. Contributions to the fund are based on a fixed 40-year assumed period of operations. The difference between the amounts in the funds and the fixed costs (guaranteed capacity) is covered by financial guarantees from the producers.
The funding agreements are renewed periodically (formerly every ten years, since 2003 every three years). The fund is managed by a utility-owned company in which the government has a "golden share" (veto power).
Contributors may borrow back up to 75% from the fund.
There is also a special fund to cover contingent costs associated with failed producers; 5% of the fund contributions are assigned to this special fund.
Present value calculations are based on an assumed a 2% real rate.

Finland

The WMO (Posiva) is a centralized private-sector company owned by the utilities.
Fixed costs are allocated to waste producers on a fixed ratio; variable costs are allocated according to the amounts of fuel produced. Cost estimates include a 20% contingency.
There is no discounting of future costs; they are re-evaluated annually.
The fund is managed by the government. Contributions to the fund are based on a fixed 25-year period of assumed operation. If there are not sufficient funds to cover all future expenses assuming the reactors were shut down at the end of any year, the producer must supply a guarantee to make up the difference.
Contingencies such as bankruptcy and unforeseen costs (set at 10% of the total cost estimate) are covered by guarantees from the producers.
Contributors (75%) and the government (25%) may borrow back from the fund.

France

The WMO (ANDRA) is a centralized public-sector agency.
Fees are charged to waste producers based on quantities delivered. Producers also pay for current operations and research and development activities via contracted payments.
Costs are estimated based on present value calculations.
Future liabilities are covered by provisions in the waste producers' balance sheets; there is no centralized fund.

Germany

The WMO is a centralized public-sector agency (BfS) which contracts engineering and operations to the private sector.

Waste producers are required to build up internal reserves. These reserves may be balance sheet provisions or separately managed funds. Present value calculations are based on an assumed 5.5% discount rate.
Research, development and operational costs are charged to operators by fees established in legislation.

Netherlands

The WMO (COVRA) is a centralized private-sector company (the government is a 10% owner).
Fees are charged to waste producers based on waste delivered. Fees include a component contributed to a fund for future disposal costs. This fund is managed by COVRA. Fees are guaranteed not to be adjusted retrospectively.
Estimated costs are based on net present value calculations. Cost estimates are reviewed periodically.

Spain

The WMO (ENRESA) is a centralized public-sector company.
Costs are paid through a levy on the price of electricity (nation-wide). The size of the levy is fixed by the government. Money collected is placed in a fund managed by ENRESA.
Cost estimates are reviewed every four years.
Estimated costs are based on net present value at an assumed real rate of return of 2.5% on the fund.

Sweden

The WMO (SKB) is a centralized private-sector company owned by the utilities.
Costs are paid through a levy per kWh assessed on each nuclear utility. The levy is based on a fixed 25-year assumed period of operation. Funds collected are managed by a government-appointed board of management.
Cost estimates and levies are adjusted annually.
Operators must pledge securities on the portion of estimated costs not yet funded, as well as a contingency amount in respect of unexpected costs.
The assumed rate of return on the fund is re-evaluated annually, as are the levies. The target rate is 4% real.

Switzerland

The WMO (NAGRA) is a centralized private-sector company owned jointly by the utilities and the federal government.
A segregated fund has been established, supervised by a government-appointed Commission.
Contributions are based on electricity production capacity and an assumed operational period of 40 years for the power stations. Utilities have been required to retroactively pay the contributions that would have been required if the fund had been in existence from the beginning of facility operation.
Cost estimates and contribution rates are reviewed every 5 years.

In case of default by one producer, the other producers are jointly and severally responsible.

United Kingdom

The WMO (NDA/Nirex) is a centralized public-sector agency.
Future liabilities are covered by provisions in the waste producers' balance sheets.
Discounting rates vary between 2.5% and 3.5%.
Cost estimates and funding arrangements are reviewed by the regulator every five years.

United States

The WMO (DOE OCWRM) is a centralized public-sector agency.
Nuclear utilities pay a fixed levy per kWh to a Nuclear Waste Fund. However, this fund is not kept separately from government accounts, i.e. it is a bookkeeping entry on the government's books. Future costs will be funded from government appropriations.
The amount of the levy is evaluated annually, but these evaluations have historically not resulted in changes to the amount.