2009 Report of the NWMO Independent Technical Review Group

Kaj Ahlbom (SKB, Sweden),
Alan Hooper (Alan Hooper Consulting Limited, UK),
Lawrence Johnson (Nagra, Switzerland),
Derek Martin (University of Alberta, Canada)

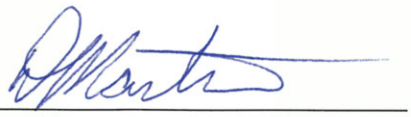
October 2009

Signed 

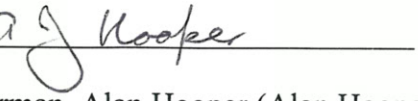
Kaj Ahlbom (SKB, Sweden)

Signed 

Lawrence Johnson (Nagra, Switzerland)

Signed 

Derek Martin (University of Alberta, Canada)

Signed 

Chairman, Alan Hooper (Alan Hooper Consulting Limited, UK)

2009 Report of the NWMO Independent Technical Review Group

Summary

The NWMO Technical Programme has undergone significant development in the past year. The planned programme covers the full range of scientific and technical topics that are relevant to the current stage of implementation of the APM approach. The recommendations by the ITRG in 2008 have either been implemented or their implementation is underway. In a few areas, identified below, there is a need for greater clarity on the objectives of programme activities.

1. Introduction

The Independent Technical Review Group (ITRG) met at NWMO Offices on 17-18 September 2009. Brief biographies of the ITRG members are given in Annex 1.The meeting was conducted according to the agenda proposed by NWMO (Annex 2). ITRG members had received the briefing material listed in Annex 3 in good time before the meeting.

This is the report of the ITRG on its findings from the review of the NWMO Technical programme that it was able to undertake on this basis. Whereas the review did not involve detailed technical evaluations the ITRG wishes to confirm that the information provided in the briefing documents, presentations and oral responses to questions was sufficient to enable it to form a view on the Technical Programme in the context of NWMO's overall planning. Furthermore the ITRG wishes to confirm that it was able to conduct its business with the required level of independence. It would also like to thank the NWMO team for their clear and comprehensive answers to the many questions posed by its members, including the provision of copies of reports that responded to specific points raised in the review meeting.

NWMO staff members have checked the final report for factual accuracy but, subject only to a small number of resulting factual corrections, the report presents the independent findings of the ITRG.

2. Terms of Reference

The ITRG welcomed the acceptance of its 2008 recommendation to revise the wording of one part of the Terms of Reference (TOR). It was agreed that the revised TOR distributed in February 2009 provide a sound basis for the ITRG to provide the NWMO Board with the advice that it requires on the Technical Programme.

As in 2008, the ITRG found that its current membership covers the range of knowledge and skills necessary to comment meaningfully on all aspects of the current Technical Programme. This will be kept under review and the ITRG will advise NWMO if it believes any further specialist should be added to its membership in the future.

3. Review Findings on the Technical Programme

The ITRG presents its findings in this report on the basis of the evaluation factors that are derived from the TOR.

3.1 Based on appropriate scientific and technical approaches and methodologies:

a) The ITRG welcomed the improved clarity that is achieved by the revised Technical Programme Objectives. However, it recommends that NWMO should consider rewording two of the six stated objectives and adding a seventh.

- In the case of objective #3 "Further increase the margin of safety in the deep geological repository safety cases" it believes that this implies contentious issues that are not in fact relevant, in particular that the safety afforded currently may be inadequate and that the concept of margin of safety is readily applicable to geological disposal of long-lived wastes. It recommends that the intent of the objective would be better served by the wording "Further increase confidence in the deep geological repository safety cases".
- In the case of objective #6 the ITRG recommends that context is necessary, which can be achieved by the wording "Meet the requirement of the Nuclear Fuel Waste Act in maintaining awareness of alternative methods for long-term management of used nuclear fuel". The ITRG also observed in relation to this objective that the main focus of the work that has been conducted recently is on reprocessing and partitioning and transmutation and that these are not alternative methods for long-term management but rather treatment methods for spent fuel that, if implemented, would produce other radioactive residues that would require long-term management. The ITRG commended the final report of the European Commission/ Euratom Framework Programme REDIMPACT Project as a soundly based analysis of the potential impacts of such treatments methods.
- Following a useful discussion on the need for the Technical Programme to continue to support the underpinning scientific basis for development of safety cases and designs, to ensure that this continues to reflect current, sound science, the ITRG recommends a seventh objective "Enhance scientific understanding of processes that may influence repository safety". It further recommends that NWMO should make clearer which programme activities respond directly to issues arising from a current development of safety cases and designs and which are in support of enhancing the underpinning scientific basis.

b) In the report on its 2008 review the ITRG welcomed the information that NWMO is developing a comprehensive technical research, development and demonstration programme report that will document the status of research and provide the rationale for conducting research in each area of study. A first draft of this report was made available for the 2009 review, comprising context-setting sections and a small number of examples of areas of study. The ITRG believes that, when complete, this report will be of value to all parties and individuals with an interest in the planning of the technical programme. It recommends that the context-setting sections would usefully be enhanced by inclusion of descriptions of the safety functions associated with the crystalline and sedimentary rock repository conceptual designs. This will

make clear the features and processes that are relied upon to provide safety and how the technical programme is testing and confirming their reliability.

c) The ITRG welcomed the initiatives taken by NWMO, in line with the recommendations of its 2008 review, to develop networking arrangements with the oil and mining industries in relation to its work on limestones and claystones.

d) Following discussions on the acquisition of data on sedimentary rock properties, involving in one case a university department that is unlikely to have the relevant materials testing accreditations for its equipment and procedures, the ITRG recommended that such data should wherever possible be provided by accredited laboratories. There have been a number of cases in other programmes where the regulators have later rejected data from non-accredited sources, causing costly replication work and delays. It was further recommended that the procedures and experience from the L/ILW DGR Project, particularly in the area of qualifying data and information, should be transferred into the APM Project. There are valuable synergies between the two projects that NWMO should exploit to the full.

e) The ITRG welcomed the information provided on the Special Project Arrangement that has been agreed with the Canadian Nuclear Safety Commission (CNSC). This should be valuable in informing NWMO of the regulatory expectations of the Technical Programme that can then be aligned accordingly. The engagement is likely to be strengthened by the synergies with the regulatory review of the L/ILW DGR Project as it progresses through the licensing process.

f) In all other respects the ITRG continues to be impressed with the scientific and technical approaches and methodologies that NWMO is using in its Technical Programme.

3.2 Addresses range of technical issues and challenges associated with design and development of used fuel storage, transportation and placement in a deep geological repository in either crystalline rock or sedimentary rock:

a) The ITRG remains of the view expressed in its 2008 report that NWMO has identified all the relevant issues and challenges and proposes a comprehensive programme of work to address these. There have been significant and impressive developments in the programme in the past year, in particular the planning of work to build understanding of Canadian sedimentary rock formations in relation to used fuel disposal, in line with the relevant recommendation made by the ITRG in 2008. The findings in the remainder of this section represent recommendations on how work might be planned in key areas identified by the ITRG.

b) The ITRG supported the strategy that NWMO is proposing with respect to research into the structural integrity of fuel bundles following long-term, interim storage. The research that has been conducted into the relevant processes, in particular delayed hydride cracking, with the potential to affect structural integrity is now sufficient to give NWMO the required level of understanding to bound the likelihood of any problems and therefore can be considered complete. The ITRG recommended that examination of dry-stored fuel bundles should be planned in the

future, of order ten years, to confirm that the integrity remains consistent with predictions that can be made on the basis of the research work.

c) Following discussions on the different types of used fuel and different storage arrangements used by the various owners of Canadian used fuel it became clear that issues of structural integrity might result from the different handling methods that would be required to prepare the used fuel for eventual emplacement in a repository. Therefore the ITRG recommended that NWMO should work with the fuel waste owners to develop preliminary waste acceptance criteria. These would be designed to minimise the technical and financial risk to the overall APM Project and to the management of Canadian used fuel by ensuring a clear definition of the preferred fuel storage configuration and its relationship to fuel integrity and fuel handling at the encapsulation facility.

d) In 2008 the ITRG commented on the absence of any information specific to used fuel transportation to a repository and noted the likely availability of existing information that would provide a basis for work in this area. NWMO has now prepared a report on national and international used fuel transportation experience that the ITRG found to be of a high standard and to provide an excellent starting point for future case studies specific to the APM Project.

e) The ITRG recommended in its 2008 report that NWMO should establish a specific technology assessment capability to ensure that it can demonstrate in the future that it has selected the most appropriate technologies for the relevant site conditions and waste characteristics in the repository concept that will be implemented eventually. ITRG members initially raised concerns that some NWMO documents give the impression of prematurely fixed repository concepts. However, following discussions, the ITRG welcomed information on the use that NWMO plans to make of information collated in a report on the range of repository technologies that are under consideration internationally and that are potentially suitable for application in the APM Project. This is particularly valuable in the case of a possible sedimentary rock repository where the host rock may be less geotechnically competent than the limestone currently considered as the reference case. In view of the uniqueness of this potential host rock to the Canadian programme the ITRG supports the NWMO strategy of developing this as the reference case when it can refer to repository concepts and technologies developed in other countries (e.g. France and Switzerland) for less competent host rocks such as claystones which might be present at potential sites in Canada.

f) The ITRG recommended previously that design development should be clearly based on a systematic approach and recommended a requirements management approach. It therefore welcomed evidence provided at the review meeting that a set of system requirements documents is available to support repository design, although members have not had the opportunity to review these documents in detail.

g) NWMO now has a comprehensive work programme underway or planned to investigate key properties of sedimentary rock formations, in line with the scope recommended by the ITRG in 2008. The ITRG looks forward to evaluating the various activities once they have been commissioned and/or defined in more detail.

h) When discussing the crystalline rock reference design the ITRG felt that a careful review was required of the thermo-mechanical criteria that have been used in determining the spacing between emplaced canisters since intuitively the closeness of the spacing raises questions about rock integrity. However, no formal recommendation is required since NWMO has recently produced a report [NWMO TR-2007-14, *Numerical Modelling of a Deep Geological Repository Using the In-Floor Borehole Placement Method*] that was made available to the ITRG, which provides the substantiation for the spacing in the reference design.

3.3 Able to initiate technical site evaluation and characterisation at potential candidate sites:

a) The ITRG previously expressed concern that the in-house geoscience resources to support site characterisation needed to be built up; it therefore welcomed the addition of four geoscientific specialists in the past year. It further welcomed the evidence of transfer of knowledge and experience from the L/ILW DGR Project to inform preparations for site characterisation. Nevertheless, one concern remained. Based on experience in other organisations such as SKB in Sweden, the Siting Project that is currently in the transition stage of preliminary public and stakeholder consultation has the potential to make considerable and increasing demands on staff responsible for technical site evaluation. The ITRG welcomed the information that a Siting Project Execution Plan is being prepared and recommended that it should spell out very clearly any technical resources and inputs that will be required to support the Siting Project. This will allow NWMO to undertake the necessary planning to ensure that these requirements can be met without adversely affecting the execution of the Technical Programme.

b) The only area of preparation for site characterisation that appears to require more work than is currently planned concerns the development of a system for the management and quality control of data and information that will be obtained from the future site investigations. Experience from other countries shows that planning in this area requires a long lead-in time if the system is to deal with the large amounts of data generated, including qualifying the data for use in engineering design and safety assessments. There are examples of potentially suitable data management systems that have been developed in international waste management programmes, for example the SICADA database used by SKB in Sweden. The ITRG recommended that NWMO should develop a specification of its requirements and evaluate the functionality of existing systems against this specification.

3.4 Able to develop illustrative safety assessments:

a) NWMO has continued to build on the strong foundations noted previously in the safety assessment area and is making good progress towards the delivery of illustrative safety assessments for crystalline and sedimentary rock formations. The ITRG noted in particular the progress towards establishing a project-specific database of relevant features, events and processes, building on past work in Canada and internationally, in line with its 2008 recommendation.

b) The ITRG questioned some activities that seemed to replicate work carried out in other international programmes, as follows:

- Development of safety assessment models for radionuclide release from a failed copper canister. The justification for the work is the importance of this release mechanism to the overall modelling of radionuclide releases in groundwater from a repository. In line with ITRG questions, it was confirmed that the work is expected to produce a similar model to that developed by SKB in Sweden and that it will be important to provide an explanation of any significant differences.
- Measurement of uptake factors for iodine-129 in the biosphere. The reason for this activity is the significance of iodine-129 behaviour in the biosphere in determining the calculated radiological consequences of releases from a used fuel repository. NWMO has determined that the biosphere transfer factors currently used internationally are based on a limited dataset. The work in this area will produce additional data which will increase confidence in these uptake factors. In view of the stated importance of this initiative, the ITRG recommended that, when published, the results of this work should be incorporated into international benchmarking projects such as BIOPROTA.

3.5 Consistent with international practice:

a) NWMO continues to have an appropriate level of involvement with relevant international activities to ensure a good awareness of the latest developments in repository science and technology.

b) A discussion on the topic of the procedure for review of NWMO Technical Reports revealed that the present arrangements are *ad hoc*. While the ITRG views the quality of NWMO reports to be very good, the present situation is not consistent with best practice. The ITRG notes that organisations such as SKB, Nagra and Posiva have a hierarchy of report categories, with the highest level requiring independent peer reviews and disposition of comments prior to approval and the lowest level, involving technical notes or reports intended to disseminate information rapidly in the project, with approval by the project leader and line management. The ITRG understands that a similar well established set of protocols exists in the DGR Project for report reviews and recommends that this or a similar approach be adopted for the APM Project.

c) The ITRG previously recommended improvements in the accessibility of technical reports on the NWMO website, to bring it more into line with good practice in other countries and to facilitate informal review and feedback by international peers. It therefore welcomed the improvements that are evident in this respect, having readily accessed background reading in preparation for this review.

d) The ITRG noted the reviews of site characterisation techniques that have been commissioned by NWMO and recommended that NWMO should take account of the reports on equivalent reviews published recently by the UK Nuclear Decommissioning Authority, which is engaged in similar preparatory studies for siting a geological disposal facility.

3.6 Broaden and advance NWMO's technical knowledge to adequately support implementation of APM:

a) The reporting of NWMO's strong involvement with Canadian universities in the 2008 Annual Report is welcomed as an excellent response to the ITRG's previous recommendation in this respect. In the 2009 review meeting the ITRG noted that there are some areas of science in which specialised expertise is likely to be required for many years and that some such areas (for example microbiology in relation to repository behaviour) are unlikely to be adequately served by the consulting sector. It recommended that it would be beneficial for NWMO to build a long-term relationship with a university in relation to each of such areas.

b) The ITRG also commended the recent NWMO initiative in obtaining approval by the Natural Science and Engineering Research Council of Canada for joint funding of post-graduate students: this will enhance the profile of geological disposal science and technology and help to draw the interest of well-qualified early career professionals.

c) The ITRG commented in 2008 on the absence of a commitment to develop a coherent programme of technical work in the area of monitoring and retrievability, which is of key importance to Adaptive Phased Management. This was discussed at length at the review meeting with the result that the ITRG felt able to support the NWMO strategy in this area. The ITRG agrees that NWMO should first evaluate the objectives and implications of retrievability at various stages of repository development, using international experience and projects as key inputs, before embarking on potentially costly demonstration tests that are designed to be specific to Canadian used fuel wastes and associated repository concepts.

3.7 Has sufficient technical resources:

a) The ITRG made a number of comments on technical resources in its 2008 report. These all appear to have been addressed in terms of the build-up of in-house capability in terms both of numbers, and of qualifications and experience that has been achieved in the past year and is planned for the future. For example, progress has been made in repository technology assessment capability and resources have been added to support siting geoscience and safety assessment. The ITRG recognises that there is a limit to the rate of introduction of new technical programme staff beyond which an organisation cannot support their professional development. The planned rate of build-up of staff appears reasonable in this respect also while being sufficient to support delivery of the demanding future programme. As noted in 3.3(a) above, the ITRG is concerned that the Siting Project may make significant demands of technical programme staff, and in particular the geoscience staff: careful planning will be required to ensure that this is not detrimental to the overall activities in the Technical Programme.

Annex 1

Brief Biographies of the ITRG Members

Alan Hooper is the Chair of the ITRG. Since 2007 he has been an independent consultant who specializes in the safe, long-term management of radioactive waste for the UK and other national programmes. In 2008 he was appointed Visiting Professor in the Department of Earth Sciences and Engineering at Imperial College London. He also currently acts as the Chief Scientific Advisor to the UK Nuclear Decommissioning Authority Radioactive Waste Management Directorate.

On joining the electricity supply industry, Alan Hooper researched the operational safety of advanced reactor designs before transferring into early research on decommissioning nuclear power stations and radioactive waste management. He joined Nirex, the UK radioactive waste management agency in 1988, holding a number of senior management positions including Director for Science. Professor Hooper holds a Bachelor of Science and Ph.D. in Chemistry from Nottingham University, UK.

Kaj Ahlbom has 30 years of experience in the Swedish radioactive waste programme concerning site selection, site characterisation and interaction with stakeholders. Since 2002, he has been the Site Manager for SKB's (Swedish Nuclear Fuel and Waste Management Company) site investigation for a repository for spent nuclear fuel at Forsmark, Sweden. He has been involved in all aspects of site selection from formulating site selection criteria to participating in the site selection process and investigating candidate municipalities and sites. All phases of this process have involved interactions with stakeholders such as government agencies, municipal officers, the geoscientific community, nearby residents, landowners, general public and media.

Mr. Ahlbom received his bachelor's degree in Precambrian Geology from the University of Gothenburg, Sweden, and master's degree in Applied Geophysics from Imperial College, UK.

Lawrence Johnson is a senior scientist and research and development coordinator at Nagra (Swiss National Cooperative for the Disposal of Radioactive Waste), where he has worked since 1999 on various aspects of engineered barriers performance.

Mr. Johnson received a bachelor's degree in Chemistry with Great Distinction from the University of Lethbridge, Alberta, in 1977. He joined Atomic Energy of Canada Limited (AECL) at Whiteshell Laboratories in 1978, where he studied the dissolution of spent fuel and vitrified high-level waste for several years before becoming Manager of Engineered Barrier Studies in the Canadian Nuclear Fuel Waste Management Program. He also managed the technical studies of durability of spent fuel in interim wet and dry storage.

Mr. Johnson is the author of over 110 reports and journal papers covering many areas related to materials performance aspects of engineered barrier systems, as well as a number of studies dealing with long-term safety assessment. He is a member of the International Scientific Advisory Board of the CEA PRECCI Programme and has

acted as advisor and reviewer for nuclear waste management programs in Finland, Sweden, Japan and the U.S.

Derek Martin is a professor in the Department of Civil and Environmental Engineering at the University of Alberta, Edmonton, since 2000. Prior to joining the University of Alberta, Dr. Martin served as Senior Advisor to the Director of the Canadian Nuclear Fuel Waste Management Program, as well as head of the Geotechnical Research Section of AECL's Whiteshell Underground Research Laboratory.

Professor Martin holds a BSc in Geology from Memorial University, a Masters of Engineering from the University of Alberta and a PhD from the University of Manitoba in Civil/Geotechnical Engineering. He has reviewed nuclear waste programs for various countries. He is a scientific advisor to the Swedish nuclear fuel and waste management program, as well as member of the Geoscience Review Group for Ontario Power Generation's Deep Geologic Repository project for Low and Intermediate Level Waste. Professor Martin has published over 150 articles related to geotechnical engineering and deep geological repositories and underground excavations.

Annex 2

Agenda for the September 2009 Meeting of the Independent Technical Review Group

Date:	September 17-18, 2009
Location:	NWMO Board Room, 22 St. Clair Ave. East, 6th Floor, Toronto CANADA
Attendees:	**ITRG:** Alan Hooper, Kaj Ahlbom, Derek Martin and Lawrence Johnson **NWMO:** Ken Nash[1], Sean Russell, Ben Belfadhel, Paul Gierszewski, Atika Khan and Alan Murchison
Contact:	Sean Russell – Ph: 647-259-3022. Cell: 647-272-6442. E-mail: srussell@nwmo.ca

DAY 1 – Thursday September 17, 2009		
Time	**Item**	**Lead**
08:30	Refreshments [NWMO office]	
09:00	Welcome & Introductions	All
09:05	NWMO Developments	K. Nash
09:20	Overview of Technical Program & Status of Progress in 2009	S. Russell
10:15	Break	
10:30	Repository Engineering	S. Russell
12:00	Lunch [NWMO office]	All
12:20	L&ILW DGR Project Update (*lunch time presentation*)	M. Jensen
12:45	Repository Safety Assessment	P. Gierszewski
14:15	Break	
14:30	Repository Geoscience	M. Ben Belfadhel

[1] Part time.

DAY 1 – Thursday September 17, 2009		
Time	**Item**	**Lead**
16:00	Regulatory Affairs	A. Khan
16:30	ITRG Discussion of Technical Program (*in camera*)	ITRG
17:30	Adjourn	
18:30	Dinner [TBD]	All

DAY 2 – Friday September 18, 2009		
Time	**Item**	**Lead**
08:30	Refreshments [NWMO office]	
09:00	ITRG Discussion of Technical Program (*in camera*) (NWMO staff available for discussion, as required)	ITRG
09:45	Break	
10:00	ITRG Feedback on Technical Program	A. Hooper
	- Comments, Questions & Discussion of Issues	ITRG
12:00	Lunch [NWMO office]	
13:00	Next Steps - Preparation of ITRG Report to NWMO Board - Presentation to NWMO Board on November 24, 2009 - Presentation to Advisory Committee on November 25, 2009	S. Russell
13:15	Closing Comments	K. Nash
13:30	Adjourn	S. Russell

Annex 3
Documents Sent for Review by the Independent Technical Review Group

No.	Item
1	Draft Agenda for September 2009 Meeting
2	ITRG 2008 Report – NWMO Action Plan: Status Report. July 2009
3	NWMO Technical Program Activities for the Period 2010 to 2014, Revision 1. June 2009
4	RD&D Program 2010 – NWMO's Program for Research, Development and Demonstration for Long-Term Management of Radioactive Waste. (Table of Contents, Introduction, sample sections). Draft July 2009
5	Technical Research and Development Program for Long-Term Management of Canada's Used Nuclear Fuel – Annual Report 2008. NWMO TR-2009-01
6	Moving Forward Together: Designing the Process for Selecting a Site. Invitation to Review a Proposed Process for Selecting a Site. May 2009
7	Adaptive Phased Management Technical Program, Quarterly Progress Report, April to June 2009