

2010 Report of the NWMO Independent Technical Review Group

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Summary

There has been an impressive development of the NWMO Technical Programme in the past year. There is a new focus to the technical work as implementation of the APM approach is entering the stage of site identification and subsequent site selection. The planned programme generally reflects a clear understanding of the issues that are relevant to the current stage of implementation and a well-focused approach to addressing those issues. The plans for work on repository design are still being developed; the ITRG considers that these plans are very important and has made a number of recommendations in this area of the programme. Recommendations made previously by the ITRG have either been implemented or their implementation is underway.

1. Introduction

The Independent Technical Review Group (ITRG) met at NWMO Offices on 21-22 September 2010. 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 and other documents 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 agreed that the revised Terms of Reference distributed in February 2009 continue to provide a sound basis for it to give the NWMO Board the advice that it requires on the Technical Programme.

The ITRG reaffirmed that its current membership covers the range of knowledge and skills necessary to comment meaningfully on all aspects of the current Technical Programme. However, it noted that the Programme is entering a new phase in respect

of implementation of Adaptive Phased Management (APM), where site investigations and associated site-specific designs and safety assessments will be undertaken. Therefore it recommended that NWMO should consider enhancing the membership of the ITRG at the appropriate time, or possibly establishing a review group specifically to review, and advise on, the site investigations.

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 Terms of Reference.

3.1 Based on appropriate scientific and technical approaches and methodologies:

a) The ITRG welcomed the revisions made to the Technical Programme Objectives in the light of the recommendations it made in 2009. The objectives are clear and comprehensive in defining what should be achieved.

b) The ITRG previously 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. In line with previous recommendations, it recommends that the finalised report should make clear where research is conducted in direct response to a requirement of the developing engineering design or safety case and where it is conducted to build confidence in an important aspect of the underpinning science.

c) 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) There is a new focus to the programme as NWMO enters the site identification and site selection phase of implementing APM. The ITRG remains of the view expressed in its previous reports that NWMO has identified all the relevant issues and challenges and proposes a comprehensive programme of work to address these. There is a good balance in the programme. Much of the work is designed to provide inputs required for engineering design and safety assessment and this is complemented by a selective underpinning of the science of important aspects such as glaciation. There have been further significant and impressive developments in the programme in the past year, in particular concerning the 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 strongly supports the strategy of maintaining the option of using either copper or carbon steel containers for the disposal of used fuel. In order to maintain that option, it believes that the programme needs to be strengthened in some areas.

Some sedimentary rock formations in Canada are characterised by high salinity groundwater. In the recent reviews published by NWMO of the mechanisms and rates of corrosion of copper and steel, some important uncertainties have been identified. Continuing work in these areas would appear to be necessary to support lifetime predictions for the use of these materials, in particular carbon steel under these geochemical conditions. Furthermore, the programme currently shows design and development work only for the option of a copper container; an equivalent work stream is required for a steel container, particularly given the plan to achieve a final design of used fuel container and used fuel packaging plant by 2018.

c) By contrast, the ITRG does not believe that further work is required on the corrosion of copper or steel in lower salinity groundwaters. NWMO has an adequate understanding from its own work and that of other national programmes, in particular SKB (Sweden) and Posiva Oy (Finland), to support container lifetimes in design and safety assessments with respect to corrosion under such geochemical conditions. NWMO also has a good understanding of work conducted in other programmes on the principal potential mode of mechanical failure, involving container shearing that might occur as a result of movement on a fracture during an earthquake.. The ITRG recommends that NWMO should establish an appropriate protocol for dealing with this failure mode in the context of Canadian geology.

d) Closely coupled to the option of using steel containers in tight sedimentary formations with highly saline groundwater, the ITRG recommends that more attention is given to the generation of gas from steel corrosion under these conditions and the potential for elevated gas pressures in the engineered barrier system and host rock. It notes that this will be considered to some extent in the fifth case study that is to be developed for a repository in sedimentary rock, but it is unlikely that the corrosion mechanism of steel will be elucidated on the relevant timescale to provide an input to this case study.

e) The ITRG made a number of recommendations in the area of repository design, where NWMO is still developing its plans:

- It is strongly advised that NWMO establishes reference designs as the planning basis for site investigations in crystalline and sedimentary rocks respectively. This will enable NWMO to identify design issues that will guide the objectives and scope of the investigations. A good example is the potential depth of the disposal horizon, which would influence the depth to which borehole drilling would be undertaken.
- It will also be necessary in taking the repository design programme forward to show how the design can be adapted to site conditions without losing any of the required safety functions to be afforded by the design. In particular NWMO needs to identify the range of geological and hydrogeological settings that may emerge from the siting process now underway and to ensure that it has a design response. This could be particularly important in the event of identifying a site with a mechanically weak sedimentary host rock. Similarly it will be important to anticipate the potential extent of spatial variability in the various rock types that might be encountered.

- Given its importance to APM, the designs need to show how account is to be taken of retrievability. This might, for example, require linings for disposal tunnel particularly in rock formations where excavations could be unstable if left open for extended periods.
- Whereas the ITRG recommends that reference designs are in place to guide the site investigations, it will be important to understand what design options could be implemented at a given site. Examples discussed with NWMO at the review meeting included the use of an alternative buffer material to surround horizontally emplaced containers in a repository in sedimentary rock and the use of “multi-layer disposal”, involving disposals at two or more different underground horizons, to give a reduction in the plan area of the disposal system.

f) As noted in the general comment under (a) above, NWMO continues to make impressive progress in addressing the issues raised by the possibility of locating a repository in a sedimentary formation with highly saline groundwater. Two key developments in this area that the ITRG commended are aimed at achieving an improved understanding of radionuclide behaviour in such a system. NWMO is establishing a sorption database from an experimental programme using rock cores and is establishing a thermo-chemical database by adapting that developed for the Yucca Mountain Project in the USA, which appears the most appropriate of those available.

g) Future glaciations are an important consideration for a repository to be sited in Canada. NWMO has clearly thought carefully about the necessary programme of work to ensure sufficient understanding of the impacts on groundwater flow, groundwater chemistry and mechanical stability of the rocks and engineered barriers at depth. NWMO confirmed its awareness of equivalent work in other national programmes and is ensuring that its research is complementary to this. By commissioning work in this area NWMO is ensuring that scientific competence in this field is being maintained and will be available to engage in the evaluations of this aspect of repository siting.

h) Closely associated work on deep groundwater flow systems is appropriately pitched to improve modelling capability in relation to factors influencing the dynamics and evolution of deep groundwater flow systems while ensuring that scientific capability in this important area is maintained.

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

a) The ITRG previously expressed concern that staff resources required for technical site evaluation were likely also to be required to support the Siting Project. Therefore it welcomed the information that a review of resources has been conducted in the light of a finalised Site Selection Project Execution Plan and that as a result a further appointment has been made of a member of staff to manage the R&D element of the technical evaluation area. It also welcomed further information on the planned transfer of staff across from the ILW/LLW Deep Geological Repository Project.

b) The ITRG previously recommended that more consideration should be given to the data management system that will be used once the site investigations are underway. It therefore welcomed the information that a technical specification for the management and control of data is being prepared and that this will be compared with the capabilities of existing data management systems, including that used in support of the ILW/LLW DGR Project.

c) The ITRG commented in 2009 on the need to ensure availability of competence in scientific fields such as microbiology. It therefore welcomed the information that NWMO is looking to add this competence to the geochemistry section of its geoscience team and is commissioning a study of the relevant aspects of far-field microbiology to ensure that this is appropriately considered in the future site investigations.

d) Generally the ITRG concluded that NWMO has made remarkable progress in this area such that it is in a good state of readiness for the forthcoming site identification and site selection phases of its implementation programme.

3.4 Able to develop illustrative safety assessments:

a) As noted previously, NWMO has continued to build on the strong foundations that it has established in the safety assessment area and is making good progress towards the delivery of illustrative safety assessments for crystalline and sedimentary rock formations. As noted under 3.2 above there are likely to be some information requirements that cannot be met by 2011 in the case of the assessment of a repository in a sedimentary formation with highly saline groundwater. This is likely to require the use of scoping assumptions. The ITRG repeats its support for maintaining the option of using copper or steel containers, in which case consideration will have to be given to the treatment of the options in the safety assessment.

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. It is actively involved in highly relevant projects at the Äspö Rock Laboratory in Sweden (crystalline rock) and at the Mont Terri Underground Rock Laboratory in Switzerland (sedimentary rock). Its involvement with SKB and Posiva Oy in the Greenland Analogue Project will help ensure that it is at the forefront of the science concerning the effects of glacial cycles on deep rock-water systems and repository engineered barrier systems. There is a need to provide an appropriate level of support through direct participation in planning meetings and conferences related to this international work, in order to be able to fully utilise the understanding in NWMO's own programme.

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

a) The reporting of NWMO's increasing involvement with Canadian universities in the 2009 Annual Report is welcomed as a sustained response to the ITRG's previous recommendations in this respect. The award of industrial postgraduate scholarships in

collaboration with the Natural Sciences and Engineering Research Council of Canada is an encouraging development, particularly since these scholarships are in important areas of science where it is highly desirable that competence should be maintained over the long term. In its 2009 report, 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 and therefore welcomes the information that NWMO is moving towards such an arrangement in the field of microbiology.

3.7 Has sufficient technical resources:

a) The ITRG made a number of comments on technical resources in its 2008 report. Since then there has been an impressive, controlled build up of in-house capability in terms both of numbers, and of qualifications and experience. The planned additions to the in-house staff in future years look to be adequate for the delivery of the Technical Programme. The 2009 Annual Report on the Technical Programme shows that NWMO is establishing commercial relationships with highly competent research companies, consultants and university departments that offer the combined capabilities required to deliver the programme. In the current review the ITRG gave a great deal of attention to the repository design area within the Technical Programme. It considers that the in-house repository design team will have to undertake most of the strategic analysis identified under Section 3.2 above and was reassured that this competence is available within the current team.

4. Key questions for ITRG comment

The ITRG was asked to comment specifically on three questions posed by NWMO as follows:-

Q.1 Is the overall approach for focussing on specific design and safety case development appropriate given the current stage of NWMO's repository program?

As noted above, the ITRG considers it is appropriate that NWMO should develop reference designs and associated safety assessments for a used fuel repository to be located in crystalline and sedimentary rock respectively. This is to provide the required basis for the design of forthcoming site investigations. Not inconsistently with its understanding of NWMO's plans, the ITRG does, however, recommend that design options should continue to be considered, and that the presentation of the reference designs acknowledges the need for their adaptation to site conditions as these are characterised in the site investigations.

Q. 2 Do we have adequate work focussed on confidence building in the following three areas:

- a) Improved lifetime predictions of copper and steel used fuel containers in a deep geological repository.*
- b) Maintain and improve process understanding, i.e. various processes affecting the safety assessment model (UF-EBS-geosphere-biosphere).*

c) Advance understanding of the evolution of groundwater flow and the impact of glaciation on a deep geological repository.

Concerning (a), the work relevant to lifetime prediction in respect of corrosion is adequate except in the case of highly saline groundwater such as is found in certain Canadian sedimentary formations where new information is required for steel and to a lesser extent for copper containers. The question does principally concern corrosion lifetime but the ITRG notes the need to also consider mechanical shear failure of containers.

Concerning (b), the ITRG considers that generally NWMO has correctly identified, and has a good understanding of, all relevant processes. Closely related to (a), it recommends that more attention should be given to gas generation by corrosion of steel containers and the potential for elevated gas pressures in engineered barriers and the host rock in a tight sedimentary formation.

Concerning (c), the ITRG believes that NWMO is doing all that is necessary to understand these aspects and to have available the capability to analyse them in relation to real site information when this becomes available.

Q.3 Do we have adequate internal technical capability to direct external work and ensure value for money?

As noted in Section 3.7 above, NWMO now has the numbers of staff with appropriate qualifications and experience to be “informed clients” for the planned Technical Programme. The documents describing the programme are characterised by statements of specific and measurable objectives, thereby building confidence in control of the programme. The transfer across of staff previously engaged in the ILW/LLW DGR will further strengthen the control of supply chain costs.

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 2010 Meeting of the Independent Technical Review Group

Independent Technical Review Group September 2010 Meeting		
AGENDA		
Date:	September 21-22, 2010	
Location:	Conference Room #402, 2 St. Clair Avenue East, 4 th Floor, Toronto CANADA	
Attendees:	ITRG: Alan Hooper, Kaj Ahlbom, Derek Martin and Lawrence Johnson NWMO: Ken Nash ¹ , Ian Prichard, Sean Russell, Alan Murchison, Ben Belfadhel, Sarah Hirschorn, Paul Gierszewski, Neale Hunt, Atika Khan and Lisa Lang	
Contact:	Sean Russell – Ph: 647-259-3022. Cell: 647-272-6442. E-mail: srussell@nwmo.ca	
DAY 1 – Tuesday September 21, 2010		
Time	Item	Lead
08:30	Refreshments [NWMO office]	
09:00	Welcome & Introductions	All
09:10	NWMO Developments	K. Nash
09:30	Overview of APM Technical Program & Status of Progress in 2010	S. Russell
10:15	Break	
10:30	Design Development & Safety Case Project - repository design updates - postclosure safety assessments - CNSC pre-licensing reviews	S. Russell / P. Gierszewski / A. Khan
12:00	Lunch [NWMO office]	All
12:30	L&ILW DGR Project Update (<i>lunch time presentation</i>)	F. King
13:00	Confidence in the Safety Case	P. Gierszewski / M. Ben Belfadhel

¹ Part time.

DAY 1 – Tuesday September 21, 2010		
Time	Item	Lead
14:30	Break	
14:45	Siting Geoscience	M. Ben Belfadhel
15:30	ITRG Discussion of APM Technical Program (<i>in camera</i>)	ITRG
17:00	Adjourn	
19:00	Dinner [Earth]	All

DAY 2 – Wednesday September 22, 2010		
Time	Item	Lead
08:30	Refreshments [NWMO office]	
09:00	ITRG Discussion of APM Technical Program (<i>in camera</i>) (NWMO staff available for discussion, as required)	ITRG
09:45	Break	
10:00	ITRG Feedback on APM Technical Program - Comments, Questions & Discussion of Issues	A. Hooper ITRG
12:00	Lunch [NWMO office]	
13:00	Next Steps - Preparation of ITRG Report to NWMO Board - Presentation to Advisory Council on December 1, 2010 - Presentation to NWMO Board on December 2, 2010	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 2010 Meeting
2	APM Technical Program Activities for the Period 2011 to 2015, Revision 0. June 2010
3	Technical Program for Long-Term Management of Canada's Used Nuclear Fuel – Annual Report 2009. NWMO TR-2010-01. March 2010