

**NWMO Response to the
2010 Report of the Independent Technical Review Group**

February 2011

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The Board of Directors of the Nuclear Waste Management Organization (NWMO) established the Independent Technical Review Group (ITRG) to provide an independent review and assessment of the NWMO's technical program.

In September 2010, the ITRG held its annual meeting at the NWMO offices in Toronto and in December 2010, the ITRG presented its findings to the NWMO Board and Advisory Council.

The ITRG noted significant development in the NWMO's technical program since 2008 and indicated that the program covers a full range of scientific and technical topics that are relevant to the current stage of implementation of the Adaptive Phased Management (APM) approach for long-term management of Canada's used nuclear fuel.

NWMO staff have reviewed and considered the recommendations of the ITRG 2010 Report and prepared a response and action plan to address those recommendations in Appendix A.

The status of the ITRG 2009 recommendations and NWMO action plan are listed in Appendix B. The status of the remaining ITRG 2008 recommendations and NWMO action plan are listed in Appendix C.

NWMO will assess progress in addressing the ITRG recommendations and adjust its action plan over time.

Appendix A

ITRG 2010 Recommendations and NWMO Response & Action Plan

No.	ITRG 2010 Report Recommendation	NWMO Response & Action Plan	Status
3.1 b)	<p>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</p> <p>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.</p>	<p>Recommendation Accepted.</p> <p>The RD&D 2010 report was completed in December 2010 but will be updated and finalised as RD&D 2011 to incorporate a clearer distinction between (a) research associated with design development & safety case, and (b) research associated with confidence building and process understanding.</p> <p>Due Date – Complete RD&D 2011 report: April 2011</p>	
3.2 b)	<p>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</p> <p>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.</p>	<p>Recommendation Accepted.</p> <p>NWMO is examining both copper and steel as potential corrosion barrier materials for used fuel containers. In particular, an all-steel container is being studied for possible placement in deep sedimentary rock under high salinity. An enhanced work program on steel container design and steel corrosion under high salinity conditions will be initiated in 2011. The copper corrosion program will focus further work under high salinity and reducing groundwater conditions which may be encountered in the siting process.</p> <p>Due Date – Identify a copper corrosion program under high salinity conditions: October 2011</p> <p>Due Date – Complete preliminary design options for a steel used fuel container: December 2013</p> <p>Due Date – Complete steel corrosion studies under high salinity conditions: December 2013</p>	

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3.2 c)	<p>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.</p> <p>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.</p>	<p>Recommendation Accepted. NWMO will prepare a close out report on the status of copper corrosion under low salinity groundwater conditions.</p> <p>Over the past several years, NWMO has been supporting SKB's work in evaluating the potential impact of earthquakes on a deep repository and preparing a laboratory scale test program for the Rock Shear Experiment. Going forward, NWMO will establish a protocol for assessing the potential for container failure via earthquakes and steps to minimize the risk of this scenario.</p> <p>Due Date – Complete close out report on corrosion of copper used fuel containers under low salinity: August 2011</p> <p>Due Date – Define work program for assessing potential for container failure via earthquakes: September 2011</p>	
3.2 d)	<p>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.</p> <p>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.</p>	<p>Recommendation Accepted. NWMO recognizes the importance of the potential effect of gas pressures on a repository caused by steel corrosion in tight sedimentary formations and high salinity. A steel gas generation program will be initiated under high salinity and reducing conditions (see also 3.2 b)).</p> <p>Due Date – Complete gas generation studies from corrosion of steel containers under high salinity conditions: December 2013</p>	

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3.2 e1)	<p>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.</p>	<p>Recommendation Accepted. NWMO is establishing generic reference designs for a deep geological repository in crystalline rock and in sedimentary rock. These design reports will be completed in 2011.</p> <p>Due Date – Complete reports on reference designs for a used fuel repository in crystalline rock and in sedimentary rock: March 2011</p>	
3.2 e2)	<p>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.</p>	<p>Recommendation Accepted. NWMO has established a generic range of geological and hydrogeological settings associated with the major rock types in Canada: crystalline rock of the Canadian Shield and the large sedimentary basins in Western and Eastern Canada. NWMO's APM siting process was initiated in May 2010 and several communities have expressed interest in learning more about APM and the siting process. As potential host communities progress into the siting process, NWMO will further identify the range of geological and hydrogeological settings of these for potential host rock formations and take these factors into consideration of the design and safety of repositories in these formations.</p> <p>Due Date – Identify range of geological and hydrogeological settings for potentially suitable host rock formations that emerge from the siting process in Canada: December 2012</p>	
3.2 e3)	<p>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.</p>	<p>Recommendation Accepted. NWMO is establishing generic reference designs for a deep geological repository in crystalline rock and in sedimentary rock. These design reports include retrievability. The reports will be completed in 2011 (see also 3.2 e1)).</p> <p>Due Date – Complete reference repository design reports, including retrievability: March 2011</p>	

No.	ITRG 2010 Report Recommendation	NWMO Response & Action Plan	Status
3.2 e4)	<p>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.</p> <p>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.</p>	<p>Recommendation Accepted. NWMO is preparing reference generic designs for a deep geological repository in crystalline rock and in sedimentary rock. NWMO also recognizes that other repository designs are possible for the two major rock types and will depend, in part, on site-specific conditions.</p> <p>NWMO will initiate work in 2011 to investigate alternative repository design options for hypothetical site conditions which may include:</p> <ul style="list-style-type: none"> (a) Crystalline rock with major features: reduce underground repository footprint by examining a multi-level repository; and (b) Very tight sedimentary rock: minimize potential impact of corrosion gas pressures on the host rock by examining alternative buffer and backfill material surrounding containers in the placement rooms. <p>Due Date – Complete preliminary repository design options in crystalline rock and in sedimentary rock: December 2013</p>	
3.4 a)	<p>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.</p> <p>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.</p>	<p>Recommendation Accepted. NWMO recognizes additional analyses will be required in 2011 and 2012 to prepare an illustrative safety assessment for a repository in sedimentary rock and has added an additional year of analyses prior to submitting the sedimentary rock design and safety case to the CNSC for a pre-project review in 2013.</p> <p>Due Date – Perform additional design and safety analyses for a repository in sedimentary rock prior to submission to CNSC for pre-project review: April 2013</p>	

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3.5 a)	<p>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.</p> <p>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.</p>	<p>Recommendation Accepted. NWMO will review and carefully select its participation in joint international programs related to design, siting and safety of deep geological repositories and will ensure that it can support active NWMO staff participation in these programs (e.g., Äspö HRL, Mont Terri Project and Greenland Analogue Project).</p> <p>Due Date – Provide adequate NWMO staff level support to international joint programs through direct participation in planning meetings, workshops and conferences: December 2011</p>	

Appendix B

ITRG 2009 Recommendations and NWMO Response & Action Plan

No.	ITRG 2009 Report Recommendation	NWMO Response & Action Plan	Status
3.1 a)	<p>The ITRG welcomed the improved clarity that is achieved by the revised Technical Programme Objectives but recommends that NWMO should consider rewording two of the six stated objectives and adding a seventh.</p> <ul style="list-style-type: none"> • The intent of Objective #3 would be better served by a change in the wording to “Further increase confidence in the deep geological repository safety cases”. • The context of Objective #6 would be clearer by a change in the wording to “Meet the requirement of the Nuclear Fuel Waste Act in maintaining awareness of alternative methods for long-term management of used nuclear fuel”. • Further, the ITRG recommends a seventh objective “Enhance scientific understanding of processes that may influence repository safety” to continue to support the underpinning scientific basis for development of safety cases and designs. 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. 	<p>Recommendation accepted.</p> <p>NWMO’s objective to maintain awareness of alternative technologies for long-term management of used nuclear fuel is broader than the requirement of the <i>Nuclear Fuel Waste Act</i> and will clarify this situation.</p> <p>NWMO will update the wording of the APM Technical Program Objectives.</p> <p>The NWMO will also update the detailed APM technical programs activities consistent with the revised program objectives in its detailed 5-year plans.</p> <p>Due Date - Updated APM Technical Program Objectives: February 2010.</p> <p>Due Date - APM Technical Program Activities for the Period 2011 to 2015, Revision 0: June 2010.</p>	Complete
3.1 b)	<p>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. The ITRG 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.</p>	<p>Recommendation accepted.</p> <p>A description of the safety functions associated with the conceptual designs for a deep geological repository (DGR) for used fuel will be included in the research, development and demonstration (RD&D) 2010 report.</p> <p>Due Date – Draft RD&D 2010 Report: June 2010</p> <p>Due Date – Final RD&D 2010 Report: December 2010</p>	Complete (see 2010)

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3.1 d)	Following discussions on the acquisition of data on sedimentary rock properties, the ITRG recommended that such data should wherever possible be provided by accredited laboratories. 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.	<p>Recommendation accepted.</p> <p>Procedures on qualifying data from the L/ILW DGR Project will be incorporated into the APM Project and a review of available Canadian accredited laboratories will be conducted and a way forward will be proposed.</p> <p>Due Date – List of Accredited Laboratories: December 2010</p>	Complete
3.2 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 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.	<p>Recommendation accepted.</p> <p>NWMO is completing a summary of findings from its Used Fuel Integrity Program and will consider planned future examinations of used CANDU fuel bundles in dry storage in about 10 years time.</p> <p>Due Date – Summary Report on Used Fuel Integrity: December 2010 April 2011</p>	Deferred
3.2 c)	Following discussions on the different types of used fuel and different storage arrangements used by the various owners of Canadian used fuel, the ITRG recommended that NWMO should work with the fuel waste owners to develop preliminary waste acceptance criteria.	<p>Recommendation accepted.</p> <p>NWMO will prepare the preliminary waste acceptance criteria (WAC) for a used fuel deep geological repository taking into consideration the various used fuel and high-level radioactive waste forms in Canada – existing and planned.</p> <p>Due Date – Draft Preliminary WAC: October 2010</p> <p>Due Date – Final Preliminary WAC: June 2011</p>	On track

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3.2 e)	<p>The ITRG recommended in its 2008 report that NWMO should establish a specific technology assessment capability. ITRG welcomed information that NWMO plans to make use 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. For hard sedimentary rock, ITRG supports the NWMO strategy of developing a reference case when it can also 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.</p>	<p>Recommendation accepted.</p> <p>NWMO will review the used fuel repository design options developed by other national radioactive waste management programs for each potential host rock formation (i.e., crystalline rock, hard sedimentary rock, soft sedimentary rock) and identify repository design alternatives for further evaluation in future years.</p> <p>Due Date – Used Fuel Repository Design Options Report: November 2010</p>	Complete
3.3 a) + 3.7 a)	<p>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.</p> <p>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.</p>	<p>Recommendation accepted.</p> <p>Current staffing levels for the APM technical program include the resources required to support the siting project. Allocation of Technical staff to support siting will be clearly identified as part of the siting work plan in support of the Siting Project Execution Plan.</p> <p>Due Date – Technical support resources to APM siting process identified: February 2010</p>	Complete
3.3 b)	<p>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. The ITRG recommended that NWMO should develop a specification of its requirements and evaluate the functionality of existing systems against this specification.</p>	<p>Recommendation accepted.</p> <p>NWMO is using a data management system (Geosoft-DAP) to support the L/ILW DGR Project. NWMO will develop the requirements and specifications for supporting site characterization for a used nuclear fuel DGR. These will be compared with the capabilities of the Geosoft-DAP system and develop a way forward.</p> <p>Due Date – Technical specifications for management & control of data: December 2010</p>	Complete

No.	ITRG 2009 Report Recommendation	NWMO Response & Action Plan	Status
3.4 b)	<p>NWMO has determined that the biosphere transfer factors [for iodine-129] currently used internationally are based on a limited dataset. The ITRG recommended that, when published, the results of this work should be incorporated into international benchmarking projects such as BIOPROTA.</p>	<p>Recommendation accepted.</p> <p>The results will be published as an NWMO 2009 Technical Report, and submitted as one or more journal articles in 2010.</p> <p>Preliminary results have already been made available to the BioProta project in 2009. The final results will be presented to, and made available to, the BioProta project.</p> <p>Due Date – Posting of NWMO report to website: March 2010</p> <p>Due Date – Presentation to BioProta project at annual meeting: May 2010</p>	Complete
3.5 b)	<p>A discussion on the topic of the procedure for review of NWMO Technical Reports revealed that the present arrangements are <i>ad hoc</i> and 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.</p>	<p>Recommendation accepted.</p> <p>NWMO has well developed review categories for reports prepared for the L/ILW DGR Project and will survey the report review practices at other radioactive waste management organizations and will develop a similar review process for technical reports for the APM Project.</p> <p>Due Date – Identify Framework for Technical Report Review: July 2010</p>	Complete
3.6 a)	<p>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.</p>	<p>Recommendation accepted.</p> <p>NWMO will establish a microbiology work program in a university to support microbiological analyses for a deep geological repository.</p> <p>Due Date – University Microbiology Program: January 2011</p>	Complete

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3.6 c)	<p>Regarding the need to develop a coherent programme of technical work in the area of monitoring and retrievability, which is of key importance to Adaptive Phased Management, 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.</p>	<p>Recommendation accepted.</p> <p>NWMO is developing a preliminary work plan for monitoring and retrievability in a used fuel deep geological repository. A monitoring work plan and a retrievability work plan will be prepared to assess the implications of used fuel retrieval for various repository designs in the Canadian reference geospheres.</p> <p>Due Date – Monitoring Work Plan and Retrievability Work Plan: June 2010</p>	Complete

Appendix C

Remaining ITRG 2008 Recommendations and NWMO Response & Action Plan

No.	ITRG 2008 Report Recommendation	NWMO Response & Action Plan	Status
3.2 e)	<p>The ITRG recommends that NWMO should assess what options exist for rock support technologies in the geological formations of interest and what implications these have for the design and safety of the repository. This should be part of a systematic approach to developing design, for example using a requirements management approach as is being developed in a number of other programmes.</p>	<p>Recommendation accepted.</p> <p>NWMO is developing a design for the rock support system for application in the L&ILW DGR in sedimentary rock. The preliminary design for a L&ILW repository, including rock support technology, will be updated by 2010.</p> <p>NWMO will also review rock support technologies as part of its 2010 update to the conceptual design of a deep geological repository for used fuel in crystalline rock and its 2011 update to the conceptual design of a deep geological repository for used fuel in sedimentary rock.</p> <p>The NWMO does maintain a set of System Requirements documents to support repository design. These will be provided to the ITRG for their 2009 review.</p> <p>Due Date – System Requirements: June 2009.</p> <p>Due Date – Rock Support Work Completed: December 2011.</p>	On track
3.4 b)	<p>The ITRG strongly advises that the illustrative safety assessments should be developed in such a way that by the time potential candidate sites are identified NWMO can make credible statements why such sites may be suitable and use the safety assessments to provide the focus for the design of the site evaluation and characterisation. The ITRG further advises caution in presenting dose or risk calculations at an early stage, when sites are first identified, as these would be misleading since they would necessarily be based on too many uncertain assumptions. However, the ITRG recognises the merit of presenting such calculations for entirely hypothetical sites in order to illustrate the types of results that would be obtained once site-specific information is available.</p>	<p>Recommendation accepted.</p> <p>NWMO will prepare illustrative safety assessments for a hypothetical deep geological repository in crystalline rock by 2010 and in sedimentary rock by 2011, in order to help focus the site evaluation effort and to illustrate the types of results. (<i>Safety case for sedimentary rock will be completed by 2013</i>).</p> <p>Due Date – Illustrative Safety Assessment Completed: December 2011.</p>	On track