

**NWMO Response and Action Plan for the
2011 Report of the Independent Technical Review Group**

February 2012

NWMO Response to the 2011 Report of the Independent Technical Review Group

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 Adaptive Phased Management (APM) Technical Program.

In September 2011, the ITRG held its annual meeting at the NWMO offices in Toronto and in December 2011, the ITRG presented its findings to the NWMO Board and Advisory Council.

The ITRG noted impressive development in the APM Technical Program over the past year and indicated that the program has identified all the relevant issues and challenges and proposes a comprehensive work program to address them.

NWMO staff have reviewed and considered the recommendations of the ITRG 2011 Report and prepared a response and action plan to address those recommendations in Appendix A.

The status of the previous ITRG recommendations and NWMO action plan are listed in Appendix B.

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

Appendix A

ITRG 2011 Recommendations and NWMO Response & Action Plan

No.	ITRG 2011 Report Recommendation	NWMO Response & Action Plan	Status
1	Section 3.1 b) ITRG recommends that in future, when the next version of the RD&D Report is published, a brief explanation of what is meant by confidence building and process understanding should be added to the relevant introductory section of the report.	Recommendation accepted. NWMO will incorporate an explanation of “confidence building” and “process understanding” in the RD&D 2014 Report. Due Date: Dec 2013	
2	Section 3.1 b) ITRG further recommends that, if the ITRG or its equivalent exists at the time the next RD&D Report is developed, NWMO should consider requesting it to review the report prior to publication.	Recommendation accepted. NWMO will include an ITRG review of the RD&D 2014 Report. Due Date: Sep 2013	
3	Section 3.2 b) ITRG recommends that future work should be conducted with reference to a hierarchy of relevant requirements and that this hierarchy needs to be established and documented.	Recommendation accepted. NWMO will update the APM repository system requirements and preliminary design requirements. Due Date: Dec 2012	
4	Section 3.2 c) ITRG recommends that NWMO should obtain convincing evidence of the capability to hoist repeated payloads of order 75 metric tons with an appropriate level of reliability.	Recommendation accepted. NWMO will review operational evidence for mining shaft experience with large payloads (~ 75 tonnes), pending the outcome of the used fuel container sizing study. Due Date: Dec 2014	
5	Section 3.2 c) ITRG further recommends that NWMO should give careful consideration to the option of using an inclined ramp to transfer used fuel to the repository horizon, noting that, in addition to avoiding a dropped load accident, a ramp gives greater flexibility both in recovering from a handling incident and in transferring various sizes of machinery underground.	Recommendation accepted. NWMO will review and compare the shaft and ramp options for transferring used fuel containers to repository depth in crystalline rock, and in sedimentary rock. Due Date: Dec 2014	
6	Section 3.2 c) If a community in an area underlain by sedimentary rock comes into the site selection process, NWMO will very soon have to develop demonstrations that it can implement the relevant repository design. Therefore the ITRG recommends that NWMO should start planning the work that will be required to achieve this objective, taking account of relevant work in this area that is underway or planned in other countries, and in particular by Nagra.	Recommendation accepted. NWMO will include, in its technology development plans, collaborative activities that enable the viability of proposed repository designed in sedimentary rock to be demonstrated at full scale. Due Date: Jun 2012	

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7	<p>Section 3.2 c)</p> <p>ITRG recommends that these [APM cost estimating design] assumptions need to be made clear when presenting cost information and that NWMO should assemble the necessary technical information to be able to understand the dependence of costs on design responses to possible site conditions.</p>	<p>Recommendation accepted.</p> <p>NWMO has already prepared a listing of the major design assumptions for the APM cost estimate and has included this information in its communication (e.g., APM Cost Estimate Summary Report).</p> <p>NWMO has a program in place for examining APM cost optimization. Further, NWMO will address the potential variability of the APM cost estimate when communicating project costs with communities.</p> <p>Due Date: Dec 2012</p>	
8	<p>Section 3.2 c)</p> <p>[ITRG] recommends that NWMO should prepare more specific information on the topic [of retrievability] so that it can provide information to support the relevant discussions with communities that have expressed an interest in the siting process.</p>	<p>Recommendation accepted.</p> <p>NWMO is already preparing a specific report on used fuel container retrieval technology.</p> <p>Due Date: Mar 2012</p>	
9	<p>Section 3.4 a)</p> <p>ITRG questioned an aspect of the approach used [to select geosphere parameters for the 4th case study safety assessment in crystalline rock], which appears important given that the implementation programme is moving towards identification of possible candidate sites and it recommends that this should be considered carefully before finalising the case study report.</p>	<p>Recommendation accepted.</p> <p>NWMO has already reviewed the range of geosphere parameters for possible candidate sites in the crystalline rock.</p> <p>NWMO will incorporate this information in preparation of the 4th case study safety assessment and pre-project report.</p> <p>Due Date: Dec 2012</p>	
10	<p>Section 3.4 a)</p> <p>[ITRG] recommends that the [permeability] values selected for the case study should be placed in an appropriate geoscientific context by reference to knowledge of the likely range of hydrogeological characteristics of Canada's crystalline bedrock.</p>	<p>Recommendation accepted.</p> <p>NWMO will ensure that the permeability values selected for the 4th case study safety assessment will be in an appropriate context to best illustrate and communicate repository performance within the final 4th case study pre-project report.</p> <p>Due Date: Dec 2012</p>	

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11	<p>Section 3.4 a)</p> <p>Further, [the ITRG] recommends that the 4th case study should consider including fractures with advective flow in the host rock which may intersect the plane of the repository</p>	<p>Recommendation accepted.</p> <p>NWMO has already incorporated a major water conducting fracture which intersects the plane of the repository in the hypothetical 4th case study safety assessment and has adjusted the layout of the repository. NWMO will accommodate this major water conducting fracture in the site description in the 4th case study pre-project report.</p> <p>Due Date: Dec 2012</p>	
12	<p>Section 3.4 b)</p> <p>[ITRG] recommends that gas migration should not be treated as a process directly within the overall radionuclide transport model to be developed for the 5th case study. Rather, the 5th case study should treat this issue through an analysis structured to represent the uncertainties in the description of the evolution of a discrete gas phase, with the purpose of communicating with regulators and interested communities at the level of the gas transport-relevant features (such as backfills, seals and the excavation disturbed zone in the rock) and processes (such as supply of groundwater or metallic corrosion).</p>	<p>Recommendation accepted.</p> <p>NWMO is already including, for the 5th case study in sedimentary rock, separate analyses on the potential build up and release of corrosion gases in the repository. The results of the gas analyses in sedimentary rock will be used in developing the 5th case study safety assessment.</p> <p>Due Date: Dec 2012</p>	

Appendix B

Previous ITRG 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>	Complete
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.</p> <p>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>	<p>Complete</p> <p>On track</p> <p>On track</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. 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>	Complete
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>	On track
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>	Complete

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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>	On track
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>	Complete
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. 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 	On track

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		<p>(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> <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 assessment 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>	On track
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>	Complete