# OBJECTIVES AND CURRENT STATUS OF THE IAEA NETWORK OF CENTERS OF EXCELLENCE: TRAINING IN AND DEMONSTRATION OF WASTE DISPOSAL TECHNOLOGIES IN UNDERGROUND RESEARCH LABORATORIES

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## ABSTRACT

Underground Research Laboratories (URLs) to develop and demonstrate technologies for the safe geologic disposal of radioactive wastes have been established for national purposes by several Member States of the International Atomic Energy Agency (IAEA). Under the auspices of the IAEA, nationally developed URLs and associated research institutions are being offered for use by other nations. These facilities form a **Network of Centers of Excellence** for training in and development of waste disposal technologies. Experience gained in the operation of the facilities, and through associated experimentation and demonstrations, will be transferred to participating Member States through hands-on work at the facilities.

The Network consists of Network Members and Network Participants who share co-operative activities. Network Members are owners of facilities who have offered them to be part of the Network. At this time there are eight Members consisting of six underground facilities, a laboratory, and a university. Network Participants can potentially come from any interested IAEA Member State having spent nuclear fuel for disposal, with or without an established program for geologic disposal. There are presently about 15 Network Participants.

A significant Network activity beginning in 2003 will be a Coordinated Research Project (CRP) on characterization and evaluation of swelling clays for use in engineered barrier systems of geologic repositories. At the end of this project, every involved Member State should be able to identify and characterize a swelling clay that is suitable for use in a geologic repository. As the Network grows, additional CRPs to be carried out in the Underground Research Facilities of the Network Members will be defined.

## INTRODUCTION

Over about the past two years, the International Atomic Energy Agency (IAEA) has worked with many of the world's owners and operators of underground research facilities (URFs) to create a Network of Centers of Excellence to develop and demonstrate waste disposal technologies. Under the auspices of the IAEA, nationally developed URFs and associated research institutions are being offered for use by other nations. Experience gained in the operation of the facilities, and through associated experimentation and demonstrations, will be transferred to participating Member States through hands-on work at the facilities. The Network was formally established at an IAEA Technical Coordination Meeting in Vienna in October 2001.

The principal objectives of the Network are:

- To encourage the transfer and preservation of knowledge and technologies,
- To supplement national efforts and promote public confidence in waste disposal technologies, and
- To contribute to the resolution of key technical issues.

The Network consists of Network Members and Network Participants who share co-operative activities. Network Members are owners of facilities who have offered them to be part of the Network.

At this time there are eight Network Members; six underground facilities, a laboratory, and a university:

- **Belgium**. The HADES URL at Mol, in clay
- **Canada**. The Underground Research Laboratory at Lac du Bonnet in Manitoba, in granite
- **Switzerland**. The NAGRA facility at Grimsel, in granite
- **Switzerland**. The Mont Terri Project in claystone
- **USA**. The WIPP facility in New Mexico, in bedded salt
- **USA**. The Yucca Mountain facility in Nevada, in volcanic tuff
- **USA**. The Lawrence Berkeley National Laboratory in California
- **United Kingdom**. The The Cardiff University, which operates the Geo-environmental Research Centre (GRC), in Cardiff
- **Network Participants** can potentially come from any interested IAEA Member State having spent nuclear fuel for disposal, with or without an established program for geologic disposal. States with less well-developed infrastructures may have their nations and program participants undertake work in one or more of the Network's Centers of Excellence. There are presently about 15 Network Participants.

The IAEA co-ordinates and facilitates the activities of the Network and acts as Secretariat to the Network, including maintaining records of its activities.

At present the Network is involved in three principal activities; a Coordinated Research Project (CRP) on swelling clays, a Technical Coordination Project (TCP) on training, and the development of a virtual network. The Network also conducted a weeklong meeting in Winnipeg, Manitoba, Canada in September 2002.

This paper will emphasize the results of the meeting in Winnipeg and the CRP on swelling clays. It will describe the other two topics briefly. The TCP on training and the virtual network are discussed at greater length elsewhere (1).

## WINNIPEG MEETING

The Network Members and Participants met to finalize Network project plans over about the next ten years. The meeting began with discussions of the capabilities of the Members and the needs of the Network Participants. Each of the six attending Network Members described its Underground Research Facility, the history of how it was developed, and any important ongoing experiments. Each member also described how it might participate in the Network. Presentations were made by Belgium, Canada, Switzerland – Grimsel, Switzerland - Mont Terri, the USA – Berkeley National Laboratory, and the USA -Yucca Mountain.

Next, each of the fourteen attending Network Participants presented its waste management infrastructure and legal status, the technical status of its spent fuel and high-level radioactive waste management, its geological repository development milestones, the goals it plans to reach in 2012 program, and finally, its associated training needs.

Through these presentations, followed by working groups and plenary discussions, Participants and Members identified seven issues for the Network to consider. They are discussed below.

### Viability of Deep Geologic Disposal

The attendees recognized that there is a question as to whether deep geologic disposal is the best option for some countries. It was noted that the conclusion that deep geologic disposal is the best

option was reached by countries with large waste inventories and generally strong disposal programs. It may not be the best answer for all countries.

For example, there is a very wide range of anticipated waste inventories. One Participant anticipates operating as many as forty nuclear power reactors over the next twenty years, while another Participant shares with another nation the responsibility for disposing of the wastes of a single power reactor. Further, there appear to be some countries that don't have locations that are suitable for a repository.

One Member said that since there is a minimum cost for a deep geologic repository, [due to items such site characterization and licensing that are largely independent of the amount of waste that will be emplaced] it makes no sense for some small countries to develop repositories. There is a need to ask what can be done in countries that have small inventories and cannot afford to develop a 'classical' repository.

**Differences Among Disposal Programs**

There is a very wide range of geologic disposal programs among the Participants. Some Participants' programs are well developed, with tens of staff and budgets several million dollars a year. By contrast, some nations do not yet have formal high-level waste disposal programs, and other nations have not even enacted legislation that addresses high-level waste disposal.

There are also a wide range of Participants' program's schedules. Some Participants have site characterization programs that are well underway. Other Participants with established programs, but are a decade or more away from site selection and a quarter century from beginning their own URFs. For these latter programs, some skills may not be needed for another 10 to 15 years. In those cases, transfer and maintenance of knowledge is important. It may be appropriate for the Network to guidance on what activities are needed and what their timing should be as these nations develop their programs.

Clearly, nations without disposal programs are unable to take advantage of the training opportunities that the Network can offer. However, the meeting attendees identified several guidance items that would assist Network Participants that would also be useful to nations who are presently considering initiating geologic disposal programs. These are discussed below.

Guidance needs of nations that are still developing waste disposal legislation were briefly discussed. It's desirable to help governments avoid specific legislation that might drive a program in unachievable directions.

**Geologic Disposal Resource Requirements**

Cost estimates for developing and operating geologic disposal facilities varied widely among the Participants. Further, some nations have set levies on electric power generated by nuclear reactors to pay for disposal that do not seem to reflect the likely costs of disposal. It was agreed that all countries that will develop geologic disposal facilities would need to perform certain similar activities such as site selection and characterization, facility construction, development and fabrication of engineered barriers, and facility operation and closure. Several Participants said that it would be very useful to have some information on the likely costs of such a program.

It was suggested that the Network develop cost estimates for individual phases of a program. For example, estimates could be developed for the cost of getting a license, and for the cost of what would be needed to be able to start construction. It is recognized that the costs of items such as labor, materials and excavation will vary among nations. Therefore, estimates should show how specific resource needs contribute to costs, so nations can have a basis for adjusting costs for their particular circumstances.

One outcome of the meeting is a recommendation to locate existing cost estimates and develop them as appropriate to meet the above needs.

**Need for National URFs**

The attendees discussed the circumstances under which individual nations might need to have their own URFs. It was agreed that once a site and geologic medium have been selected, a site-specific URF is appropriate. However, prior to site selection, the need for a URF is less certain, particularly if there is already a URF available in the planned geologic medium.

Some Participants said they need access to URFs to help train their scientists and are participating in the Network to avoid constructing generic URFs. To be able to do this, they will seek complete access to the generic knowledge available from the URF.

A useful Network product may be guidance on what kind of a URF is needed and when in a development program it is needed.

**Participant Program Evaluation**

It was recognized that in addition to the state of development of Participants' programs, there are also significant differences in the particular areas those programs emphasize. It was not clear that every Participant's program is focused on the issues and activities that Members might find most effective for the state of that program.

Attendees discussed the value of peer reviews of Participants programs. While it was agreed that reviews would be very useful, resource constraints would appear to limit the number of reviews that can be done. The Network Members meet among themselves in the spring of each year. They will consider whether they can review one or two Participants programs at those meetings.

**Communication**

Several Participants asked for help in public communication. They recognize that public acceptance is a significant, perhaps the most significant part of a geologic disposal program.

It was recognized that public acceptance is a country-by-country effort; a nation with enough land to site a disposal facility in a virtually uninhabited desert is unlikely to face as many public acceptance concerns as a small nation that will have to site a facility in a relatively populated area.

Members said that when members of the public visit a URF, they come away with a very positive perspective. This is in fact a significant benefit of a URF.

It was agreed to consider including public communication as part of the Network training program.

**Resources**

Both Members and Participants are concerned about how some attributes of the Network will be supported. In particular, Network Members have limited resources to develop and present training courses, Network Participants have limited resources to pay for training, and IAEA training support at this time is limited to paying for trainees travel expenses and accommodations.

**CRP ON SWELLING CLAYS**

In response to requests from a number of Network Participants, a significant Network activity beginning in 2003 will be a CRP[a] on characterization and evaluation of swelling clays for use in engineered barrier systems of geologic repositories.

Swelling clays placed between the excavated rock and the waste containers can swell to seal the containers from the geologic setting, buffer the chemistry around the containers, and retard radionuclide migration. Of course, it is necessary to understand how the properties of particular clays affect their ability to perform these functions. For example, while many types of clay could be used as backfills, Bentonite, or more accurately the Smectite fraction of the Bentonite, is noted for its ability to swell and to retard radionuclide migration. However, Smectite's swelling and buffering properties will be affected by variables such as the temperature of the repository and the salinity of groundwater that contacts it. Further, *in-situ* tests of swelling clays have revealed that a number of their properties need to be measured under conditions approximating a repository, such as simulated groundwater at very high pressure. Thus it is necessary to have a good understanding of both the physical and chemical behavior of any clay proposed for use as an engineered barrier.

The relative abundance of swelling clays and the cost of transporting them strongly suggests that nations developing geologic disposal systems obtain these materials within their own borders. To do that, they need the tools and capabilities to characterize these clays. Therefore, this project will assist developing Member States in:

- Selecting, within their territory, suitable swelling clays to be used as engineered barriers,
- Developing skill and learning material characterization techniques,
- Developing their own concept to integrate the characterized clay in a national repository project.

Resources and competence provided by the Network of Centers of Excellence will facilitate the transfer of knowledge and technology to developing Member States, by supporting training and development of competence and – in some cases – help them to develop laboratories equipped for swelling clay characterization studies.

At the end of this project, every involved Member State should be able to identify and characterize a swelling clay that is suitable for use in a geologic repository.

The IAEA received over twenty contract proposals from within fourteen developing nations and three agreement proposals from advance nations to participate in this CRP. Due to the limitations of IAEA funding and the availability of Network Members, the CRP will be limited to about eight to ten participants. Their selection is scheduled for early 2003.

This particular CRP is the first of a series that will be associated with the Network. As Network Participants' needs become better defined and as they change with time, additional CRPs that make use of the Underground Research Facilities will be carried out.

**TRAINING**

In 2003, IAEA expects to begin to provide training opportunities through its Technical Cooperation Program. The training is intended to transfer knowledge and technology from Network Members to Network Participants. The IAEA's goal is to train specialists in the use of methodologies for geological disposal, in repository siting and site characterization and in the technologies associated with URFs. At the end of this effort, participating Member States should have trained specialists who can address the issues that arise in making an inventory of candidate host rocks within the Member State; selecting a host rock; selecting a repository site; and characterizing a site.

Training will include general and specific training, fellowships and scientific visits to the Centers of Excellence, including associated research institutions. The first training session will be a two-to-three week training course in June-July 2003 on methodologies for geologic disposal, supported by Canada and the United States.

## VIRTUAL NETWORK

The last project is a virtual network that IAEA has initiated to supplement its more common practice of exchanging information among Member States through technical meetings. Initially the virtual network will simply be a web site that will make information available to individuals in Member States and give them a place to post comments, questions and answers. The web site is being developed for the IAEA by Belgium, along the lines of its web site[b] for the HADES URL at Mol. The site is being initiated in January 2003 with information about URL training opportunities. In April, the course material and references for the June-July course on methodologies for geologic disposal will be posted on the site.

## SUMMARY

The IAEA, together with owners and operators of six underground research facilities, a laboratory and a university, has created a Network of Centers of Excellence to develop and demonstrate waste disposal technologies. The Network is now well established, with approximately 15 Participants who will receive technology and knowledge that will supplement their own national efforts. At this time the Network's principal activities are a Coordinated Research Project (CRP) on swelling clays, a Technical Coordination Project (TCP) on training, and the development of a virtual network.

## Footnotes

**a** A CRP is a joint effort among about seven to fifteen Member States to investigate a particular topic. It is initiated and funded by the IAEA, in consultation with Member States. Funding consists of paying the travel costs of CRP investigators to the approximately three research coordination meetings (RCMs) that are held in connection with the CRP over its three to four year lifetime. CRP investigators in developing nations also receive around $5,000 per year from the IAEA toward their research. The usual product of a CRP is an IAEA technical document (TECDOC) that records the results.

**b** See for example http://www.ec-decom.be/contacts/belgium/sckcenprofile.htm and http://www.sckcen.be/

## Reference

**1** M. J. BELL, A. BONNE, and M. R. KNAPP**, "**Training in Waste Disposal Technologies in Underground Research Laboratories," to be presented at the *International High-Level Radioactive Waste Management Conference*, Las Vegas, NV, March 30-April 2, 2003