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Summary of Activities for
the Mizunami Underground Research Laboratory

(A final report)

April 2002

Tono Geoscience Center

Japan Nuclear Cycle Development Institute

Summary of Activities for the Mizunami Underground Research Laboratory

A Final Report on a JNC International Fellowship by

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Activity and output

Chapter 1 : Introduction

Chapter 2 : The Mizunami Underground Research Laboratory Project

Chapter 3 : International Participation in the MIU

Trip report

9th International High-Level Radioactive Waste Management Conference
(Las Vegas, Nevada, U.S.A. / April 29th – May 3rd, 2001)

8th International Conference on Environmental Management
(Bruges, Belgium / September 30th – October 5th, 2001)

Final presentation

Activity and output

Contributions :

Contributions have been made in the following general areas:
- Geoscience activities on going and planned for the Shobasama MIU
- Geoscience activities planned for the Togari MIU
- Assist with many international peer review and consultation meetings specific to the investigations for the MIU programme;

Specific work has included:
- Co-chaired JNC Workshop with NAGRA on the MIU-4 Borehole Investigations held in Mizunami in Nov. 2001.
- Contribution to investigations in MIU-4 borehole drilling programme ; assisted with prompt news reports and many technical discussions;
- Presentation of results at conferences and seminars;
- Reviewed many (>60) papers/reports/abstracts prepared by staff at TGC
- Contribution to geosynthesis methodology for the surface-based investigation phase
- Contribution to the geological/hydrogeological modelling and groundwater flow simulation in the MIU project (site scale modelling)
- Contribution to initiation of and development of methodology for the Joint Study on Faulting and Fracturing project (JSFF)
- Contributions to development of a structural atlas and overview of faults rocks in MIU-4 research

Conferences Papers and Posters :

For each of the presentations listed below, an abstract of one or two pages and a paper of five to ten page was written and published in the relevant conference proceedings volume.

Presentations have been given at the following international conferences outside Japan:

- The 9th International High-level waste Management Conferences, Las Vegas, Nevada, USA, 29th April – 3rd May 2001. (Title: Mizunami Underground Research Laboratory In Japan, Pre-Excavation Site Characterization And Influence On Design Concepts)
- The 8th International Conference on Radioactive Waste Management and Environmental Remediation, Bruges, Belgium 30th September – 4th October,2001.(Title : Mizunami Underground Research Laboratory In Japan, Pre-Excavation Site Characterization And Influence On Design Concepts.)

At the latter conference, on behalf of JNC, I organized and co-chaired Session No. 9, "Final Disposal Site Selection and Underground Research Laboratories" , with Sten Bjurstrom (ex-president, SKB). This also included technical review of all papers in the session.

Presentations describing the MIU facility and plans were presented to AECL at the URL and at the Whiteshell Laboratories and to Ontario Power Generation, the major nuclear utility in Canada during a business trip to U.S.A. and Canada.

Presentations were given at the following conference within Japan :

- Annual Conference of the Geological Society of Japan, Kanazawa, 21-23rd September 2001(Title: the Mizunami Underground Research Laboratory: Design Concepts, Engineering and Science Challenges);

Contributions were also made to the following presentations made at the above conference:

Development of geological investigations for the identification and classification of water conducting features in crystalline rocks (Part1: Current status of the research programme in the Toki granite) K. Amano, K. Maeda, N. Kumazaki, T. Mizuno, H. Saegusa, S. Takeuchi, K. Hama, K. Nakano, **G. McCrank**, R. Metcalfe.

Development of geological investigations for the identification and classification of water conducting features in crystalline rocks (Part3 : Trial from geophysical viewpoint using geophysical logging) 2001, N. Kumazaki, K. Maeda, T. Mizuno, S. Takeuchi, K. Nakano, **G. McCrank**, K Amano

Development of geological investigations for the identification and classification of water conducting features in crystalline rocks (Part4 : Trial from structural viewpoint) 2001. T. Mizuno, N. Kumazaki, K. Maeda, S. Takeuchi, K. Nakano, **G. McCrank**, K. Amano

- Presentations were given at meetings to plan the Joint Study on Faulting and Fracturing, held in Hokkaido, in Ehime University and in Tokyo.
- Presentations were given at two International Fellowship Review Meetings, one in October 2000 and one in October 2001

Papers :

Glen F. McCrank, Kenji Amano, Kaoru Koide, Hiroya Matsui, Shinichiro Mikake, Katsushi Nakano, Kunio Ota, Hiromitsu Saegusa, Kozo Sugihara, Seietsu Takeda, Shinji Takeuchi : (2001), Mizunami Underground Research Laboratory In Japan, Pre-excavation Site Characterization And Influence On Design Concepts. In Proceedings, The 8th International Conference on Radioactive Waste Management and Environmental Remediation (ICEM'01)

G.F.D. McCrank, K. Sugihara, K. Ota, S. Mikake, T. Amano, K. Koide and S. Takeda, (2001). The MIU Research Laboratory, Japan, Geoscience Activities During Construction And Operation. In Proceedings of the 9th International High-Level Radioactive Waste Management Conference (IHLRWM)

H. Saegusa, K. Maeda, A. Sawada, K. Inaba, K. Nakano and **G. McCrank** (2003) Hydrogeological Modeling and Groundwater Flow Simulation for Effective Hydrogeological Characterization in the Tono area, Gifu, Japan in Proceedings, OS-

Okayama 2003, International Symposium on Groundwater Problems related to Geo-Environment, held at Okayama University, Japan May 29-30th 2003.

Posters :

G McCrank, K. Amano, K. Nakano, S. Takeuchi, K. Hama, H. Osawa and K. Sugihara (2001), The Mizunami Underground Research Laboratory : Design Concepts, Engineering and Science Challenges, Annual Conference of the Geological Society of Japan, Kanazawa, 21-23rd September 2001.

A.E. Milodowski, M.R. Gillespie, R.P. Barnes, R. Metcalfe, K. Hama, K. Amano, T. Mizuno and G. McCrank (2002), Generic implications for engineered barriers from a study of the Tsukiyoshi Fault, Tono, Gifu-ken, Japan. Poster Presentation, 18th General Meeting of the International Mineralogical Association, IMA 2002, September 2002 Edinburgh, Scotland.

JNC Reports :

Synthesis Methodology Constructed Based On The Results Of Surface-Based Investigations In The Shobasama Site, (in prep.) JNC Report.

Geological/Hydrogeological modelling and Groundwater Flow Simulation in the MIU Project (Site Scale Modelling) (in prep.). H. Saegusa, K. Maeda, K. Inaba, G. McCrank and M. White.

A structural atlas and overview of fault rocks and fractures in boreholes MIU-2, MIU-3 and MIU-4 in the Shobasama Valley (2002). M.R. Gillespie, R.P. Barnes, A.E. Milodowski, R. Metcalfe, K. Hama, K. Amano, T. Mizuno and G. McCrank. Commercial report, CR/02/65 British Geological Survey, prepared for JNC.

1. Introduction

This report provides a snapshot of some activities and projects on which I worked during my International Fellowship at the Tono Geoscience Center. The report also itemizes some of the main observations on the geoscience programme and plans for the MIU project made during my fellowship. During the two years of working at the Tono Geoscience Centre I was afforded the tremendous opportunity to work and interact with a number of individuals from several geoscience disciplines.

Objectives of the Fellowship

The principal task initially identified for my Fellowship at TGC was to review the geoscience plans at the MIU, advise on "how to standardize and improve" the geoscience research plans at the MIU based on experience obtained in the Canadian Nuclear Fuel Waste Management Programme (CNFWMP) and in related work in the investigations at the Canadian Underground Research Laboratory (URL). With this in mind, I have reviewed many of the documents describing activities performed for Phase I at the MIU and background studies performed at the Tono Mine and for the RHS. I have also looked at the conceptual geoscience plans for the Phases II and III at the MIU and the English version of the engineering design report.

The study was approached from several perspectives. Initially, familiarization with the research that had been done within the TGC Geoscientific Research Programme was necessary; this included historic and ongoing geoscience work at the Tono Mine and research in the surrounding regional area. This initial work involved reviewing the documentation research activities performed in the programme to date. My first observation was that there had been substantially more activity than I had anticipated. Additionally, most reports on activity, as expected, were available only in Japanese. Though many have English abstracts, these were not very detailed.

The second approach was to have been given the opportunity to interact closely with many of the research staff responsible for the performance of the activities; this included participation in many, many discussions, drafting and reviewing documents and attending many meetings with international consultants visiting to review many aspects of the MIU activities.

Outline of Report

In addition to this introductory section the report consists of several sections. The first section is a brief synopsis of the MIU and some relevant comparisons to the Canadian URL where appropriate. The second section is a brief discourse on International participation on the MIU project. This is followed by a section listing the papers presented and the reports prepared, including some still in draft form for JNC to finalize. The appendix comprises a record of the various work I have been involved with while at TGC and I have chosen to use copies of the correspondence to complete this record.

Acknowledgements :

I am extremely gratefully to all the staff at Tono Geoscience Center and at JNC Head Office. The support and assistance I received was outstanding. There are too many her to mention individually but I would like to specifically mention Koyama san at Head Office who provided support in many ways. At TGC I must thank in particular, Saito san whose help was invaluable. I must also thank the staff of the groups in which I worked, initially the Geoscience Planning and Management Group and then the Geoscience Research Integration and Dissemination Group; each and every one was a pleasure to work with. I must also thank the scientists and engineers of the Geoscience Research Group, with whom I interacted almost daily. Everyone shared their work freely and openly and was always available for discussions. I am especially thankful that I was welcomed into their working activities, in particular on the MIU-4 drilling project and other projects such as the modelling of groundwater simulations, the Geosynthesis planning and the Joint Study on Faulting and Fracturing, and formulating new plans for the new MIU site. It was a wonderful opportunity to be involved with this exciting project and I wish JNC and the staff of the TGC good luck in the years ahead. May the work proceed smoothly and safely and results exceed your expectations.

Special support from others at TGC includes the many office assistants and the professional drivers at the site. To all I am grateful.

2. The Mizunami Underground Research Laboratory Project

Introduction

Underground Research Laboratories are a fundamental element of the Japanese nuclear fuel cycle policy. This position is clearly stated in Atomic Energy Commission of Japan documents on Long-Term Program for Research, Development and Utilization of Nuclear Energy, published in 1994 June and November, 2000. "Based on these policy statements, JNC has proceeded with development of a research facility for deep geological environments, the MIU Research Laboratory.

The MIU research laboratory will be an underground laboratory dedicated to geoscience research needed to develop an understanding of the deep geological environment in Japan. It will be constructed in an undisturbed volume of crystalline rock, in contrast to earlier underground research sites in Japan that made use of existing mines. The geoscience activities are multi disciplinary, including the disciplines of hydrogeology, geology, geophysics, hydrochemistry, rock mechanics and geotechnical engineering. The Phase I work includes extensive characterization activity to define the undisturbed geological conditions and to predict the changes to these conditions due to excavation of the facility.

The Master Plan developed for the MIU states that the main goals for the projects are :

1. To establish comprehensive techniques for investigating the geological environment
2. To acquire data on the deep geological environment, and
3. To develop a range of engineering techniques for deep underground application.

Location and description of the MIU and URL sites :

The location of the MIU site has been changed since I began my Fellowship and the change has significant implications for the geoscience research. The original MIU site was the Shobasama-bora site, Akeyo-cho, Mizunami-city. This site is approximately 140,000-m^2 area, trapezoidal shaped, approximately 525-m north to 430-m across the north boundary and about 100-m across the southern boundary.

The new MIU site at Togari in Mizunami is smaller, 75,000-m^2 area. There are restrictions on activities that impact on the scientific programme. Borehole drilling and excavation is not allowed beyond the site boundaries. The new site is bounded on the west side by a steep ridge (a local topographic divide) that trends approximately north-south. The east side is a valley with a southward gradient. The bedrock granite is not exposed anywhere on site.

Atomic Energy of Canada Limited's Underground Research Laboratory (URL) was constructed in central Canada, in the province of Manitoba, on land leased from the provincial government in 1980. It is about 120km ENE of Winnipeg, Manitoba. The Canadian site is 3.8-km^2 in area. The optimum location for the underground facility was determined by detailed geological mapping and geophysical surveying.

Geological Setting :

MIU

The MIU research laboratory will be excavated through a thick sedimentary sequence into the Toki Granite. This Cretaceous granite pluton is located near the boundary between the Mesozoic Mino Terrane and the Cretaceous Ryoke Metamorphic Belt. The Miocene sedimentary rocks of the Toki Lignite-bearing, Akeyo and Oidawara Formations unconformably overlie and completely cover the basement granite. The granite has had a complex geological history ; emplaced along the coast of Asia before opening of the Japan Sea, subjected to several uplift and subsidence events and variations in the stress regime through time, resulting in a complex and challenging geological site for research. Typical of Japanese geology, the granite has likely been subjected to several deformations during successive tectonic events.

The Canadian URL is built in well-exposed Precambrian granite, which made surface characterization of the bedrock possible and provided a basis for predictions of subsurface geology and conceptualization for modelling purposes. The absence of bedrock granite exposures at the MIU mean that predicting subsurface geology is more difficult and will be based, in part, on remote sensing and regional geological mapping for conceptualization of the structural geology. Therefore, the experience developed by the JNC staff on the MIU Project will be very valuable in future repository siting.

Selection of the MIU and URL sites :

The basic rationale for selection of an underground laboratory site in Japan was similar to the rationale followed by AECL. First, the sites meet the requirement that the site rock mass and the hydrogeology by essentially undisturbed by man. Each site has a variety of geological structural and lithological conditions meaning a range of geoscience activities can be performed. All the sites are relatively easily and economically accessible ; thus development costs can be kept low and more funds are available for scientific work. Each site is close to an established, associated facility that can provide technical expertise and support to the underground labs. Each site is in granite, one of the candidate host rock types for geological disposal in Canada and Japan. The selection of the new MIU site was due to intransigence of the local opposition at the Shobasama site and the imperative to begin underground research in a meaningful timeframe for the Japanese programme.

PROJECT MANAGEMENT

Organization of the MIU and URL Projects :
The MIU :

The JNC organizational structure established for the MIU project is into these planning and execution groups : (1) the Geoscience Facility Construction Group, responsible for engineering design and construction of the surface and subsurface facilities; (2) the Geoscience Research Group, responsible for execution of the research ; and (3) the Geoscience Integration and Dissemination Group, responsible for coordination of the geoscience planning process, performance of some of the site research work and documentation of the research. I expect that these groups will be coordinated and integrated closely as Phase II approaches. When construction is underway, a strong construction management system should be in place to coordinate all construction and science activities to ensure the science objectives are met without comprising the overall project schedule.

The Canadian URL :

AECL was organized along branch lines to perform the Canadian Nuclear Fuel Waste Management Program (CNFWMP). The organizational structure that was eventually established for performing the operating phase science program at the URL was based on the line management branch structure. The main branches were the Geotechnical Science and Engineering, Fuel Waste Technology, Applied Geoscience and the URL Operations Branches. These branches were an integral part of the line management structure managing the CNFWMP. The Geotechnical Science and Engineering Branch was the lead branch responsible for planning, coordinating, integrating and controlling the implementation of experiments. All the components of the CNFWMP were located and managed from the Whiteshell Laboratories site, including all engineered barrier research and performance assessment activities.

Planning for the URL :

In the early days a URL Project Management Committee (PMC) was formed to plan and manage the URL experimental programme. In addition to AECL, membership on the PMC included Ontario Hydro, the Technical Advisory Committee, the Geological Survey of Canada and Environmental Canada. Two subcommittees of the PMC were formed to organize and develop the experimental programme ; the Surface Evaluation Subcommittee (SEC) and the Underground Experiment Subcommittee (UEC). AECL's Design and Engineering Branch at Whiteshell Laboratories handled the design of the physical plant and the underground facilities. Design contracts were also issued to engineering firms with extensive experienced in the construction of underground facilities.

The URL PMC and the UEC evolved into the URL Experiment Committee (URL EC). The coordination and integration of the Operating Phase Experiments Programme was managed and controlled as a project through the URL EC. Within the URL EC there were two functional subcommittees, the URL Project Management Subcommittee and the URL Operations Committee.

In building the URL in Canada, strong construction and project management and integration of the science and construction activities was key to success of the project. It was fundamentally important to integrate all the science activities within AECL across disciplines and secondly to ensure that the contractors were well aware of the science requirements of the project and not to treat it as a simple construction project. This required careful coordination and understanding. Science requirements were included in all construction contracts and coordination during shaft excavation was extremely important. Contracts were structured to minimize economic risks for the contractors and ensure cooperation with the science teams

Schedule, Planning and Design:

The implications of the relocation on the MIU are discussed briefly in this section. The new section is smaller than the original and the schedule is compressed.

In terms of the schedule, it is generally acknowledged to be very tight. There has not been an extension in the deadline beyond 2015 yet, despite the need to be additional characterization work and installation of monitoring equipment before excavation. Some characterization work cannot and should not be done quickly. Drilling will be done in a controlled manner to the maximize core recovery and minimize negative borehole history effects. Disturbances made to the groundwater system need time to dissipate before excavation of the shaft.

The need for additional characterization work has resulted in a one-year delay in start of shaft excavation. This delay may require a reduction in total scope and compressed schedules and scopes for some experiments in Phases II and III. Successful completion of the science programme will depend on strong project managements: sound management of the geoscience programmes and careful intention of research activities with the engineering design and construction is needed. Therefore, JNC should consider the establishment of a strong project management group to coordinate all the engineering design and geoscience planning and activities.

Division of the schedule into three phases is common to the URL and the MIU and other laboratories. However, note the significant difference in terms of durations in the Phase III operations phase and total operating lifetime.

		MIU	Yrs	URL	Yrs
Phase I	Surface-based investigations	1996-2004	8	1980-1984	4
Phase II	Construction	2002-2011	9	1982-1988	6
Phase III	Operations	2006-2015	9	1986-2011	25

The URL site was initially leased for a period of 21 years (to 31 December, 2000) and thus the initial plan was to complete all the experimental activities, from the start of site evaluation, within this time frame. However, it was realized early in the planning of the underground experimental programme that the original schedule would be inadequate to perform the full plan of experiments. Therefore, an extension of the URL lease was sought and obtained in order to continue the operational phase until the end of 2011, an additional 11 years. When appropriate, extension to the MIU site lease should be sought by JNC.

Comments on Schedule and Planning :

From the scheduled start of shaft excavation in late 2004 there will only be 12 years to construct and perform the suite of underground characterization and experimental activities (9 years at the 500-m level, six years at the 1000-m level). This restriction will limit the type and duration of geoscience activities during Phase II & III (see JNC design reports TJ1400 99-001(3) & TJ1400 2000-007(3)). Given the current schedule, JNC will need to optimize activities and individual experiment schedules, especially in Phase III. With strong project management and appropriate contracts, it should be possible to ensure optimized integration of the engineering design and construction activities with the geoscience programmes

With respect to scheduling and planning, the design, the contracting and the geoscience activities are inter-related. For one thing, because the site has been relocated, there is much less knowledge of the subsurface conditions at the new site on which to base subsurface facility designs. This knowledge should be developed as soon as possible and the geoscience staff is working hard to do so. However, data and interpretations from the new geological studies and drilling work will probably only be available for input to design, (and understandably so), about 12 months before shaft excavations is scheduled to begin ; and only if there are not delays in the programmes, especially the drilling.

.At the same time, the Geoscience Facility Construction Group (CFCG) must proceed with preparations for excavation. Due to the lead-time needed to get contracts and contractors in place, it is necessary to proceed now, before details on site geology at depth are available, to avoid any negative impact on the schedule. In the absence of details on the subsurface geology and the geoscience plans for Phase II and III, simplified assumptions on these elements will be necessary for contract development. Therefore, contractual agreements on the scope of work should be flexible. This means adopting an observational approach to design and including the procedures for resolution of design and construction changes in the construction contracts.

Thirdly, unless the current plans for the excavation change, most of the science activities will occur during Phase III. However, there may be some yet to be decided science activities during shaft sinking. These include, as a minimum, shaft mapping. They could also include installation of water collecting rings, exploratory drilling, installation of monitoring equipment and instruments, (hydrogeological and rock mechanics), and geophysical surveying. Therefore, if any of these are to be done, these activities should be factored into the shaft construction schedule as early as possible, procedures considered on how to integrate science and construction activities and these should be based on advice and if possible, the plans of the group responsible for performance, the Geoscience Research Group. Therefore, contracts developed should be based on input from the geoscience group and knowledge of their expected scientific requirements.

In addition, consideration should be given to forming an underground experiment committee to develop and review the Phase II and III experiment plans. The committee would develop an expanded Master Plan for the new MIU designed to serve as a project management and preliminary planning document. It would include preliminary scoping of Phase II & III science programme requirements and activities, including specific experiment objectives (perhaps consistent with expected NUMO needs), an outline of experiment activities with estimated durations and resourcing requirements.

The core members of the committee would come from the stakeholders, the Geoscience Research, the Geoscience Research Integration and Dissemination and the

Geoscience Facility Construction Groups at TGC. This committee would also include peer reviewers from outside TGC/JNC, such as for example, representatives from Japanese utilities and NUMO and international representatives, if possible, including representatives from organizations with direct experience in building underground laboratories.

Phase II Excavation :

To successfully perform the science programme that meets the stated objectives, under the constraints JNC is facing, it will be essential to integrate the science activities effectively into the construction activities in order to maximize the geoscience output. Given the tight schedule, there will be pressure to expedite the shaft excavation. But if shaft excavation is fast-tracked, it should be at the cost of the science programme or the project's scientific objectives. Any improvement to the construction activities will improve the science and the activities.

According to the JNC Design Report, excavation of the shaft is based on a 48-hour cycle consisting of drilling, blasting, mucking, and stabilizing of the shaft with concrete and scientific investigations. There are only three hours set aside for research science activities; research is the shortest duration of all scheduled activities. Under this schedule, the output from the geoscience programme will be minimal and could negatively impact the geoscience programme objectives.

Therefore, unless JNC has made a decision to forego the geoscience programme in Phase II, an increase in the available time for science activity in the shaft during excavation is needed. One way is to optimize the excavation schedule activities. Currently the plan is to completely line the shaft with concrete, which adds considerable time to the schedule. From the scientific perspective, the concrete in the liner can induce undesirable changes to the groundwater chemistry. Also, the performance of the shaft drawdown experiment could be made more difficult by impeding placement of water collecting rings and flow monitoring equipment. There is potentially a cost advantage of not installing a liner. For example, the shaft diameter could be reduced, with associated cost saving.

The design report for the MIU stated that there is no need for a liner from a stability perspective. Therefore, unless there is an absolute requirement from a safety perspective, alternative such as screening and rock bolting can be considered.

Other points: with the current schedule, there is no exploratory drilling planned in advance of excavations to identify important features, before excavating through them. Drilling and instrumenting boreholes from Spare Stages could be done concurrently with and in advance of the shaft sinking operation. Secondly, there dose not seem to be any scope to halt excavation if a particularly significant geological feature is identified and that requires detailed study. This is particularly important to avoid excavating into and causing major disturbance to features/structures that should be left undisturbed for future experimental reasons.

Another consideration that can impact on achieving geoscience objectives is the relationship with the construction contactors. It is necessary that the contractor and the eon-site staff know and appreciate that this is a science project and the gathering of scientific date is a major objective. The best way to handle this directly is via the contract process, in which the integration of science activities and construction are included. The contract could for example, include procedures of ensures that the science team has full access to the site in a timely manner, including site preparation to avoid loss of time. Performance bonuses are one way to ensure, for example high quality drill and blast to minimize damage to the shaft walls and rapid turnover of the shaft for geological mapping, in clean conditions for science activities. The contract would clearly state JNC's expectations such as for example how many hours the contractor has to do his work; when the shaft must be handed over to the science team and in what condition. Building in QA/QC procedures, including inspections and oversight by JNC staff would also be included in the contract.

At times during construction, important decisions may be necessary. Establishment of the construction management group discussed elsewhere can provide the mechanism to do in a timely and project sensitive manner.

Design :

The current design for the new MIU site is a simplified adaptation of the design originally proposed for the Shobasama site. The difference is that, because of the lack of information, consideration of geological characteristics has been removed from the design. The current design includes two operational levels at 500-m and 1,000-m depth, without the original spiral ramp. This design appears robust and adaptable to geological conditions. Depending on actual conditions, no changes may be necessary, though optimization of the Main, Middle and Spare Stages locations is possible. To ensure its adaptability, in terms of drift shapes, orientations and locations and layout, design flexibility should be retained. Use of the observational approach to maintain flexibility and to accommodate geological conditions such as major faults or water conducting features.

In terms of design of the research programmes during Phase II and III, it is not clear how this will be done. The group responsible for doing the work is fully committed to Phase I activities. The facility design report commissioned by JNC outlined very generally a shopping list of possible experiments but did not provide scopes or details of a schedule. In light of this, JNC could consider commissioning of Experiment Design Studies that would outline an experimental programme, including the constraints of schedule, site size and the objectives.

AECL commissioned design reports early in the programme. Included in the reports were suggestions for experimental activities in all phases, including activities and methods to possibly use. AECL also used the observational method and modified the facility layout significantly, as new geological data became available. AECL was also constrained, initially, to drilling only within the URL site boundaries.

Site size :

The relocation of the MIU is to a site one half the size of the Shobasama site. Original ideas on the experimental program will need to be reconsidered in terms of experiment scopes, locations and layout. Some aspects of the reduced size and restriction on research beyond site boundaries that will influence the experimental programme are :

- Hydrogeological boundaries are most likely to be outside the accessible volume of rock
- The excavation disturbance may extend to or beyond the site boundaries, given the size of the site and the diameter of the main shaft and drift layouts
- Possibly reduced options for accessing a variety of rock types

- Experiments will be closer together, will potential for interference
- Competition between groups for experiment locations and rock volumes
- Potentially reduced scale of experiments, such as groundwater flow studies, including tracer tests

Access to the rock volumes beyond the site boundaries in the subsurface would make design and performance of experiments easier and provide better results for analyses and interpretations.

Peer review :

Two committees, an advisory committee and an evaluation committee have done peer reviews. The "Evaluation Committee for Waste Treatment and Disposal" met in 1999 for a total programme review of the MIU and again in 2000 to evaluate the first results of MIU Phase I review. The committee is composed of 13 members, including several technical and social science professors, a journalist, representative from CRIEPI and JAERI, a national environmental laboratory, and an environmental specialist. The "Advisory Committee for Research Programme in Underground Research Laboratory" met in March and December 2000. This committee is composed of 16 technical members from various Japanese universities. They advise on programme content but do not evaluate in a strict peer review sense.

JNC's Principal Investigators also have more or less informal peer reviews in the presentations of programme plans and discussions with a variety of international consultants such as the NAGRA representatives and others when they visit the site.

Peer Review processes were established early in the Canadian Program. Peer reviews of all the URL programmes were extensive, by internationally renowned specialists in each of the disciplines. As well, each experiment during the operations phase had an international expert as an advisory member of the team.

Meeting MIU Geoscience Objectives :

Managerially, JNC could do two things to help achieve geoscience objectives. JNC could establish a project management group for the entire MIU project. The group would be responsible for coordination of all geoscience planning and execution, facility design and construction management. The other would be to ensure that there is a continuity of technical staff and technical management of the project.

In terms of technical programmes, advances are being made iteratively by the geoscience staff. The technologies developed and employed at the MIU are progressing in terms of field techniques, analytical techniques and documentation. This is particularly evident on the recent work on the MIU-4 drilling programme, which I am most familiar with, and which provides the basis for the following comments.

In terms of the geoscience objectives to develop technology and to acquire data, work is progressing well in several areas. This is because the geoscience research team is clearly focused and integrated and has a good grasp of the technology and improvements needed to meet international standards of performance.

One method implemented is in the area of technical management and record keeping. Daily meetings to review progress and activities are an excellent management method and should be continued throughout the project. Decision-making is systematic and thorough, though at times, time consuming. The process is documented and provided to all as a record for reference in minutes and in prompt reports. The documentation is essential given the movement of staff between programmes and the need for traceable decision-making on projects. If possible, these meetings should be expanded to include the Design Engineering Group and during excavation, the shaft sinking contractor as well.

Significant effort is also made to keep records in English. This will be a significant accomplishment if continued and will make any international peer reviews easier and more valuable.

The use of project management tools such MS Project is beginning and will be useful and needed for project control in future.

The MIU-4 Working Programme Report is an exceptional document ; high quality and thorough. Some improvements could be made in terms of documenting basis for interpretations and predictions.

Field Techniques :

Geological work is being done increasingly better and improvements are actively sought. Some basic improvements could be still be made. For example, documenting the basis for all interpretations. Lineament analyses should include recording the exact imagery used, the analysts and how the statistical interpretations were made. Since this data provides an important contribution to the conceptual geological modelling, reduction of the uncertainty can begin with good records of the basic analyses. As well, all field checks of lineaments should be documented to avoid duplication by future workers and to understand the basis and limitations or uncertainties for all interpretations.

Core mapping methods are at a high standard; core logging and core photography is high quality and provide valuable records and imagery for analytical and decision making . Some improvements could be made by :

- More rapid digitization of core data in the field,
- Acquisition of directly oriented core, orientations determined as the core is recovered and used for planning and quicker structural analysis.
- More rapid determination of orientation of structural features from BTV data
- Establish an activity to correlate oriented core with the BTV data to increase certainty in structural analysis
- Establish core sampling protocols and a control on core sampling to avoid loss of potentially valuable core.

Hydrogeological field and analytical techniques are improving. Hydraulic-testing methods are systematic. Equipment deficiencies are being addressed and well testing analytical methods are being improved. State-of-the-art analytical tools such as FlowDim are used. JNC might consider the acquisition of borehole simulation software.

Limitations in some field methods are recognized and corrective measures planned. Fore example, better packers systems are being developed, higher sensitivity flow meter logging tools are being considered; in situ geochemical testing tools are being sought. One other to consider is the use of an Acoustic Televiewer, which supplements the BTV method and is useful in boreholes in which water is not clear and BTV results are poor.

The rock mechanics component of the project does not seem to be a high priority but the rock mass response to excavation is of considerable importance in repository design and PA modelling . The rock mechanics component should be strengthened. Monitoring of the rock mass response to excavation of the shaft can provide valuable information for understanding and commendable. The data flow analysis is high quality and will improve. The actual methodology is a basis for analysis of data flow and the inter-relationship of disciplines. It can provide a basis for management of future programmes such as a site selection and evaluation programme. The synthesis could also provide a basis for development of a WBS for managing geoscience projects.

The multi-team hydrogeological modelling comparison study is an important and major part of the project. The international and broad base of expertise involved in the project ensures that modern methods of modelling groundwater systems are included. Multi-team modelling exercises have been done in other programmes.

A study of the variations in structural style in granites is getting underway. This is the Joint Study on Fracturing and Faulting. This type of project was recommended for the Canadian programme and used to confirm representativeness of, for example, the URL geology

Team effort of the part of the geoscience team is considerable. The team is integrated, leadership is strong and the Principal Investigations on the team works together to solve problems. I believe that continuity of staff on the project team is essential to success. The individual members are aware of geoscience and waste management issues, and to a large extent of the need of the technology.

Recommendations To Consider For Possible Improvement Of Geoscience:

1) Establish a strong project management structure, with objective to plan and integrate all activities; especially need close integration of science activities with construction activities
2) Closer integration of programmes (MIU and RHS) to optimize resources, planning and performance
3) Try to have the termination date of the operation phase, Phase III extended to allow a more comprehensive experimental programme
4) Being efforts to obtain access to a larger volume of rock in the subsurface; at a minimum, get permission to drill and monitor the larger volume of rock beyond the site boundaries for experiment purposes
5) Experiment Design Reports could be commissioned that outline a complete experimental programme, within the constraints of schedule, site size and objectives
6) Begin to plan Phase II & III science activities now to optimize scheduling and scopes
7) Library : more journals are needed to support geoscience research ; electronic subscriptions to some journals are less costly and more efficient,
8) Documentation/Reporting is obviously important and essential for communicating results. However, it will be difficult to perform the work and properly document the results under the current schedule. Recommended reports now are :
    a. Investigation methods used or developed at the MIU during Phase I

b. Equipment used/developed during Phase I
c. QA/QC procedures and a manual for activities and reporting

9) Continuity of the technical know-how in the program is important. The regular staff turnovers can be counterproductive and result in a loss of historical knowledge. Development of reputation by increased exposure of staff internationally. Increase the technical support staff : For example,
   a. An in-house core logging team
   b. An in-house geophysical logging team
10) Drilling is a keystone technology of the JNC technical programme and should be highest quality possible :
   a. For future field campaigns, reconsider the strategy in selecting borehole locations and targets after detailed mapping, if possible. As well, consider clustered boreholes at each location to optimize structural studies
   b. Obtain oriented core logging, for example, the Craelius core orientation method. This will provide possibility of cross checks on BTV orientation data and more rapidly available information for structural analysis and interpretations during drilling
   c. Drilling contracts include bonus for high quality core
   d. Consider now what size boreholes will be used in U/G work and what equipment and tools will be needed

Consider use of the original MIU site Borehole Test Facility for developing and teaching hydraulic testing methods, developing new equipment and/or testing and calibrating of borehole geophysical tools.

Communication

I think it is possible for non-Japanese speakers to underestimate the programme underway in terms of the depth, breadth and quality of work being done because most technical documents have been in Japanese. Therefore, translating documents into English and as close as possible to the Japanese version may avoid such misunderstandings. Significant effort is being made now by geoscientists to communicate in English and there are some outstanding examples to be highlighted. These include

- MIU-4 Working Programme
- Tono Mine Report
- MIU-4 Raw Data base report
- Prompt reports of MIU-4 activities and progress
- Technical workshops held in English

THE MIU GEOSCIENCE PROGRAMME :

The following is a brief summary of the geoscience programme based on a review of JNC Reports on activities by contractors and observations during the MIU-4 drilling programme. It is not complete as not all documents were in the library or had meaningful English abstracts.

Regional Investigations for the MIU

The Regional Hydrogeological Study (RHS) provided geological information surrounding the MIU. Regional investigations were performed at two map sizes: 30-km X 10-km. All the boreholes have been drilled in the latter map area

Geological studies at surface:

A local lineament/surface fracturing study at selected outcrops in and near the NE trending Hiyoshi River lineament and the NW trending Garaishi River lineament. Structural mapping showed there are strongly developed NE and NW striking joint sets coincident with there lineaments.

Regional geological mapping to outline the surface extent of the Toki Granite indicated that the regional orientation of fracturing is dominantly NNW and NE. Structural areas were identified from lineament distributions; fracture orientations and lineaments are concordant within each area.

Geophysical surveys performed:

i. High density electrical investigations

ii. High frequency tensor magnetotelluric (CSMY&MT)

iii Helicopter and fixed wing surveys: include electromagnetic ((EM); Magnetometer; VLF-EM and Radiometric) gamma were performed

The DH borehole series has been drilled: boreholes range from 500m to 1030m depth and all are vertical, 100-mm diameter, except DH-9, which is 123 mm diameter. The following has been done.

i. Logging of core, with lithological and structural descriptions

ii. Laboratory study of core, petrographic analysis, rock physical properties,

iii. Geophysical logging, standard methods and flowmeter logging,

iv. Borehole TV logging,

v. Hydraulic testing, pulse, slug and pumping tests

vi. In situ measurement of physico-chemical parameters of groundwater, groundwater sampling and chemical analysis.

vii. Petrophysics lab tests,

viii. Rock mechanical laboratory tests

Hydrochemistry forms a major component of the regional studies. Measurement of groundwater physico-chemical parameters; Eh, pH, electrical conductivity, and chemical composition, major and minor elements, heavy metals, environmental isotopes (D, ^{3}H, ^{12}C, ^{13}C, ^{14}C, ^{16}O and ^{18}O) has been done. Sampling has been done using the Westbay MP system.

Characterization of microbial population has also been attempted, for example in DH-5.

Regional Investigations for the URL:

Reconnaissance investigations were done to determine a suitable site for the underground laboratory c within the Lac du Bonnet Batholith, followed by detailed studies to evaluate and assess the site and to optimize the location of the underground laboratory. Concurrently, regional surface and airborne investigations were initiated to characterize the lithologic and structural setting of the URL in the Lac du Bonnet Batholith and the surface hydrology in the watersheds surrounding the lease site.

Initially, AECL was only authorized to perform regional geological mapping; drilling investigations were only possible on the URL lease and at the Whiteshell Laboratories prior to 1986 access. In 1986, 10 areas were selected for geological mapping and five of these were selected for drilling. Selection of sites was cross-section for hydrogeological modelling .

Activities included :

1. Regional geological mapping to confirm batholith boundaries and structural style of fractures and major features. Lineament analysis and field checking to provide basis for structural interpretations and conceptualization of groundwater flow simulations. In addition, detailed geological mapping, including field examination of topographic lineaments, was done at selected sites, Permit Area, surrounding the URL prior to locating boreholes.
2. Geophysical surveys, airborne (EM, mag, radiometric) and ground (mag, gravity).
3. Drilling Investigations at the Whiteshell Laboratory Site and at the Permit Areas. Most boreholes were diamond drilled, 76mm NQ size, using triple-core barrel, wireline method, which enhanced core recovery. The boreholes were inclined to facilitate intersection of subvertical features, including subvertical NE strike fractures sets, the diamond set, and other defined drill targets, such as suspected faults expressed as topographic lineaments. Core was oriented using the ABEM Craelius, gravity based, core orientation method.
4. Hydrochemical investigations ; groundwater from all boreholes were sampled and analysed.

The general strategy in regional investigations by AECL and JNC is similar, but differs in an important aspect, the borehole drilling strategy. JNC's regional boreholes are distributed singly throughout the regional area and are vertical. They provide data on regional head distributions and in some cases structural information on faults that can be correlated to nearby lineaments.

The Canadian approach to drilling strategy at the URL was to select an area that would first be mapped, drill targets defined and then several boreholes were drilled in close proximity to intersect the targets, generally nearby lineaments.

PHASE I : SURFACE-BASED INVESTIGATIONS

Site characterization work at the original MIU site :

Meteorology and Hydrology Studies :

Several meteorological monitoring stations at and around the MIU are used to develop baseline meteorological data. Also, boreholes for long term monitoring of piezometric conditions have been drilled. Data from these are used in developing water balance information for input to the hydrogeological flow simulations. Work includes :

i. Analysis of JNC's long-term meteorological database for the Tono Mine and the Shoba Rover basin allowed for study of the entire Hiyoshi River basin (Saito and Sakamori, 2000)

ii. A stream flow measuring system consisting of two parshall flumes and a meteorological monitoring system (precipitation and evapotranspiration) has been installed in the upstream Garaishi River, several kilometres north-northwest of the MIU site (Toyama et al, 1999a). An associated groundwater level monitoring well (99RT-01) has also been installed (Toyama et al, 1999b).

iii. Several shallow boreholes were drilled to quantify permeabilities in the sedimentary sequence and the upper part of the granite at the MIU site. This included installation of a shallow piezometer in borehole 99MS-05 mid-way between MIU-1 and AN-1, installation of monitoring wells with water level recorders for long-term monitoring have also been established in the northeast corner of the MIU site (97MS-01 & -02 ; 98MS-03 & -04 ; MWT-1a and MWT-1b) and an automatic data collection system at the MIU site.

Lithological and Structural Studies:

Airborne Geophysical Surveys:

Aeromagnetic survey to delineate the shape and depth extent of the Toki Granite and to correlate magnetic linear features with known or suspected faults. Unfortunately the granite has a low magnetic susceptibility compared to the overlying Mizunami Group, the Seto formation and rhyolites in the area. Thus diagnostic magnetic variations are sparse. Some lineaments with low magnetic signature correlate with known regional scale fault lines. Helicopter borne surveys used EM, magnetic, VLF-EM and gamma-ray spectrometric methods: a distinct, linear VLF anomaly aligns with the Shoma River.

Surface Geophysical Surveys:

A 1,700-m long seismic refraction survey was conducted across the northern part of the MIU site The purpose was to determine the geometry of faults and fracture zones in the bedrock granite and to define the depth and shape of the unconformity at the base of the sedimentary rocks. Four velocity layers were detected. The upper three correspond with the sedimentary rocks; the lowest layer is considered to be the granite and has a velocity of 4.0 to 6.0 km/s. In addition, three low velocity zones were detected in the granite and are considered to be fracture/fault zones. One of these is believed to correspond with the Tsukiyoshi fault and associated rock.

A seismic reflection survey and vertical seismic profiling, using a vibrating source at surface were done along N-S lines roughly following the stream channel through the MIU site. The main objectives were definition of geological structure in the granite basement. Results indicate several reflective events that seem to correspond to fracture zones.

Magnetotelluric surveying was done in the Tono area. The granite basement was recognized to be a high resistivity layer.

Borehole Investigations

Diamond drilling is done with continuous coring to target depths. Borehole pressure history is recorded and used in subsequent analysis.

Boreholes:

The following boreholes have been drilled at the MIU site. They are all completely cored. A triple-tube coring method using wire-line core recovery has been adopted staring with MIU-4. The inner core barrel is a transparent acrylic tube that is split lengthwise to remove core. The method has resulted in improved core recovery.

Boreholes	AN-1	AN-2	AN-3	MIU-1	MIU-2	MIU-3	MIU-4
Drilled	1998			11/97-07/98	7-11/98	02-07/99	2000/2001
Depth(m)	1010	180	408	1011.8	1012.0	1014.0	
Trend/plunge	V	V	V	V	V	V	$N25^0E/60^0$
Type	HQ	HQ	HQ	PQ	PQ	PQ	PQ

Geological studies

- core logging has been improving since the first boreholes were drilled. The core logging standard for MIU-4, the latest borehole was to a very high, internationally accepted standard
- Details of the investigation methods are provided in MIU-4 working Programme document.

Geophysical studies:

- Micro Resistivity logging,
- Calliper logging; calliper (mm)
- Electric logging; S.P. (mV) and resistivitiy,
- Natural gamma logging,
- Neutron logging; gamma ray (API) and porosity (%)
- Sonic logging; S-and P-velocity (km/sec),
- Density; bulk density (g/cc),
- Temperature logging; actual (℃) and gradient (℃/m),
- Borehole TV,
- Radar; RAMAC system; single borehole and cross-hole (AN 1 and 3)
- Laboratory analysis of core porosity, density and velocity,
- Cross-hole seismic survey
- Two trails of vertical seismic profiling (VSP) to generate tube-waves in a water-filled borehole were done

Hydrogeological studies:

- Straddle packer testing, single and double

(Pulse, slug and pumping tests with pressure recovery)
- Flow-meter and temperature logging
- Installation of Westbay MP38 or MP55 systems installed in each borehole on completion and used to monitor groundwater pressure responses during drilling of other boreholes

Hydrogeochemistry studies:
- Conductivity
- pH
- Eh (mV)
- Groundwater sampling
- Major oxides analysis
- Discrete zones sampled
- Major elements analysed in packed off zones
- δ D (‰), $\delta\,^{18}O$, ^3H (TR)

Rock Mechanics studies:
- Borehole Jack Test
- Hydraulic fracturing
- Differential Strain Curve Analysis (DSCA) applied to core from boreholes
- AE and Deformation Rate Analysis (DRA) used to determine initial stress
- Laboratory measurements of sound velocity, determination of uniaxial compressive strength and compressional wave velocity and other physical properties of the granite

JNC produced the document "Working Program for MIU-4 Borehole Investigations". This document sets out the details of the MIU-4 investigations in considerable detail. This document will be the benchmark for planning future borehole investigations.

It would be extremely useful if JNC documented all techniques and equipment used in a single document. At present all information is in many JNC reports and/or resides with certain key staff. This will have to be done if JNC is to have any role with the regulator or with the NUMO.

Site Characterization At The New MIU Site :

Surface geological investigations include rechecking topographic lineaments for evidence of a structural character for development of conceptual models and subsurface predictions. Surface geophysics planned include seismic profiling across the site and VSP surveys.

At the new MIU site, several new boreholes are planned ; four shallow boreholes tentatively planned to be 200-m depth each to investigate the sedimentary rocks and the upper granite weathered zone. A 1,500-m deep borehole is intended to investigate the granite at depth.

The selection of borehole depths has initially been made for budgetary and planning purposes. If possible, JNC will retain flexibility so that changes in the plan are possible as each hole is drilled. Borehole depths should be selected with definite targets in mind and as more information on targets develops with each new borehole it may be advisable to adjust the program depending on the actual geology intersected.

Similarly, for the 1,500-m borehole, the reason to drill to 1,500-m was based on reasoning applicable to the Shobasama site. However, there may be better options : getting 3-D information from the surface to 1,000-m depth is high priority. Consider the option of drilling two boreholes totalling 1,500-m instead of a single 1,500-m one for characterizing the site. Then, a deep borehole could be part of the experimental programme from the Main Stage at 1,000-m, to investigate deeper bedrock.

URL Site Characterization :

Site evaluation activities included regional geological mapping of the area surrounding the URL, surface geological mapping of the site, airborne and ground geophysical surveys, installation, of shallow overburden piezometers, surface water instrumentation, meteorology instrumentation, drilling of deep cored boreholes to check geological inferences from the surface data, drilling of a shaft borehole based on targets determined from drilling information, and drilling cored and an array of percussion boreholes to establish a hydrogeological monitoring network. Extensive hydrogeological testing was done, including monitoring groundwater pressure responses to new boreholes. Together with the geological and geophysical log data and the hydrogeological information, a conceptual model of the hydrogeological conditions was developed.

An extensive borehole network was planned to surround the planned shaft prior to excavation, for hydrogeological monitoring purpose. Determination of in situ stress was done using borehole hydro-fracturing tests.

Airborne Geophysics:

Airborne surveys (helicopter) at the URL consisted of:

1. Magnetic (700km^2-400m line spacing)
   - Total field (target deep features)
   - Vertical gradient (3-m spacing of sensors-target shallow features),
2. Electrical (40km^2-100-m line spacing)
   - EM (Dighem electromagnetic-depth of overburden)
   - VLF-EM (possibly conductive structures)
   - Total field magnetic field

Surface based Geophysics:

Surface-based geophysics included four principal methods,

1. Gravity-pluton depth and contacts-160 stations N-S profile across the batholith
2. Magnetic
   - Total field
   - Susceptibility (in situ and laboratory measurements)
3. Electrical
   - Magnetotelluric (deep structures)
   - Magnetometric resistivity (deep structure-bulk resistivity)
   - VLF-EM (resistivity-degree of fracturing near surface 100m)

- Pulse EM (transient EM)
- Resistivity/IP

4. Seismic
   - Reflection-Mini-Sosie (4 profiles surveyed, subhorizontal reflector detected-FZ-2)
   - Tube wave (fracture zones)

JNC and AECL followed similar approaches to site characterization using geophysical methods. Techniques are conventionally employed for mineral exploration work or geotechnical characterization.

URL Boreholes:

Several series of boreholes were drilled at the site into surficial and shallow bedrock to determine water table configuration and the details of groundwater recharge/discharge occurrences. The O-Series were drilled to study the surface hydrogeology. A series of 40 boreholes, the B-Series, were drilled to investigate groundwater conditions in within the shallow beneath these areas. Others were 152-mm diameter percussion boreholes. These were drilled through overburden deposits and at least 50 m into bedrock. These were drilled specifically to determine the interactions between groundwater in the unconsolidated deposits and the groundwater in the upper part of the granite.

Drilling of the URL-Series boreholes (include, about 75^0, NQ-size using triple tube core recovery techniques), commenced in February 1981. Initial drilling was exploratory, intended to find a volume of rock in which to locate a single, horizontal development at 250 m to 350 m depth to allow experimental, access to unfractured grey granite and fractured pink granite. Fourteen, M-Size boreholes (percussion, 152-mm boreholes, 163 m to 443 m depth) were drilled close to the URL site to refine understanding of the site conditions as well as to monitor groundwater perturbations due to shaft and other underground excavation. Borehole drilling strategy: almost all AECL boreholes are inclined. They are NQ and HG. A combination of diamond core drilling and rotary drilling was done.

PHASE II : CONSTRUCTION OF THE UNDERGROUND LABORATORIES

This section is a simplified outline of the general activities planned or possible for the MIU. *In italics are the actual activities performed by AECL.*

Potential Geoscience Activities during Construction of the MIU :

Geology :

The geological structures predicted will be compared with the actual observations possible during excavation. Further study and/or model refinement are possible. Detailed investigation will provide fundamental information to other studies.

1. Mapping of geological features such as fracture zones and lithofacies boundaries in 3-D
2. Observatoins of geological structures and comparison with the predictive models, with, potentially further study and/or model refinement
3. Model refinement and new predictions

Detailed geological mapping and stereophotography of the shaft and drift walls and comparison of actual conditions with the predictions made before excavation began ; Testing of geophysical methods (eg, radar, EM) and equipment in particular to assess blast damage and define structures beyond the excavation faces.

Hydrogeology :

The main tasks will the evaluation of the investigation methodology by verifying the hydrogeological model developed in Phase I and the predictions made of changes to the groundwater flow caused by the excavation, such as pressure responses and discharge into the excavations. The study programme for the next phase will be planned during this phase. Investigation and characterization of changed hydraulic characteristics of the rock mass in an excavation disturbed zone will be done.

1. Evaluate the investigation methodology by :
   a. Verifying the hydrogeological model developed in the first phase and
   b. Verifying the prediction of the changes in groundwater flow caused by excavation
2. Monitoring of hydrogeological response in the borehole network during excavation
3. Hydrogeological characterization of the near field rock mass for planning the study programme of the next phase
4. Data from this phase will be used to improve the existing hydrogeological model and the groundwater flow analyses
5. Predictions of the hydrogeological characteristics to be encountered and the changes in groundwater flow in the next phase
6. Test of predicted changes in hydraulic pressure and discharge rate of groundwater into drifts on each stage by comparison with observations
7. The degree to which the hydrogeological model and methodologies for the hydrogeological investigations and analysis are appropriate will be evaluated and the results used to improve the hydro geological model and/or characterization methodology

8. Estimate the extent of changes in the hydrogeological characteristics of the excavation disturbed zone induced by shaft/drift excavation

Monitoring of the groundwater conditions as the shaft was excavated (the Shaft Drawdown Experiment) was done. Installation of hydrogeological instrument arrays, drilling and instrumenting of hydrogeological boreholes and installation of water collecting rings was done.

Hydrochemistry :

Data obtained will be used to assess the model developed in Phase I and the chemistry caused by excavation will de studied.

1. Hydrogeochemical data collection
2. Predictive model(s) will be verified by comparison with actual measured data.
3. Sampling of rock and groundwater for baseline hydrogeochemistry information
4. Changes induced by excavation will be determined
5. Predicted changes in groundwater chemistry and redox condition will be compared from the long-term hydrochemical monitoring

Sampling of all inflowing groundwater for chemical analysis, especially from water-producing fractures was done and a groundwater sampling/monitoring system was established for long-term data collection of water for geochemical analysis.

Rock Mechanics:

The mechanical response of the rock mass to excavation will be monitored. Data will be necessary for planning Phase III activities. The predictions of rock mass response to excavation will be compared to observe responses and the model(s) improved.

1. The mechanical response of the rock mass to excavation of the shafts and drifts will be measured,
2. The response will be compared to the predictions from the previous-phase,
3. Models will be improved,
4. Mechanical properties of the rock mass in future work will be made,

Installation of instrument arrays at several locations to monitor stress change and ground movement (rock mass displacement) as excavation proceeded past the installed locations.
Convergence pins installed and measured. Baseline conditions were determined.

Engineering techniques:

The design adopted during Phase I will be assessed. As well, modification to design can be done if geological conditions are not as expected and changes are necessary. As well, studies on the safety and infrastructure of the underground facilities will be carried out during construction. Operational health and safety and long-term safety with respect to rock mass stability will be studied in detail.

1. Verification of techniques for design and construction,
2. Studies on safety and environmental control,
3. Design modification if expected geological conditions are not encountered

4. Construction materials will be assessed

Excavation techniques were studied to assess the impact on development of damaged zones along the walls of the excavation. Controlled blasting techniques were assessed for different sections of the development.
Drilling of subhorizontal boreholes for testing and monitoring purposes were done.
Full-face shaft excavation method employed.

Investigation techniques and equipment:

1. Use, assessment and development of high precision, robust equipment for detailed investigations in the excavation walls
2. Assessment of new equipment needs to meet investigation requirements.

AECL modified a number of commercially available rock mechanics and hydrogeological tools to improve accuracy and calibration. AECL also developed its own groundwater flow simulation and modelling code.

PHASE III : OPERATIONS

MIU – Potential Geoscience Activities

Studies in this phase will focus on mass transport, engineering techniques and earthquake activity aspects. The scale of investigations will be similar to that in the construction phase. The EDZ will be studied in detail to understand the changes that may have occurred. Strategies for restoring the EDZ will be evaluated. It is expected that by the end of Phase II, the underground facility design and the components of the study programme will be determined. The study programme presented below from the Master Plan is preliminary.

<u>Geology :</u>
The drifts will be excavated at depths appropriate for study of key geological features. Structures will be investigated and Phase II predictions verified.

<u>Hydrogeology :</u>
Predictions made in Phase II will be verified. A detailed hydrogeological model will be constructed based on new information about the geology determined in this phase. One of the main issues to be studied is the resaturation process after backfilling the drifts.

<u>Hydrogeochemistry :</u>
Studies will be carried out on long-term chemical changes in the groundwater, the redox conditions in the EDZ and the redox buffering capacity of the rock surrounding the drifts. Investigations will provide background for mass transport studies and allow the prediction of chemical conditions after groundwater resaturation.

<u>Mass Transport :</u>
The mass transport study is one of the most important tasks in this phase. Potential migration pathways will be characterized, supported by laboratory investigations. Migration experiments will be performed and a model of mass transport developed and tested using the in situ experimental results.

<u>Rock Mechanics :</u>
Experiments will be done to identify excavation effects. Investigations of undisturbed rock properties will include installation of measurement equipment before drift excavation. Vibration effects, displacement phenomena and change in rock stress will be measured will be determined during excavation. Predictions of excavation effects and EDZ development will be verified.

<u>Engineering Techniques :</u>
Techniques will be developed for ensuring worker safety, performance of coupled T-H-M experiments and for restoring the EDZ. Methods for measuring and analysing T-H-M responses will be evaluated. New construction materials and techniques and methods for ensuring drift stability will be evaluated. Groundwater resaturation behaviour will be studied. The effect on the geological environment of a controlled environment in open drifts will also be studied.

Earthquake activity :
Seismic activity and resultant changes to the geological environment will be monitored using discharge rate meters and seismographs. Effect on rock mass stability will be evaluated.

From Design Report JNC TJ1400 99-001[1]

Plan at Middle Stage :

1. Long-term observation of hydraulic pressure/hydro-testing,
   i.Hydro-testing at 4 corners
2. Testing at fault
   i. Hydro-testing
   ii. Migration testing
3. Geological surveys
   i. 3-D surveys at 4 locations; corners of plan
   ii. Deep surveys using boreholes
4. Hydrogeological monitoring
   i. Discharge rate into the drifts
   ii. Water quality monitoring at the main shaft
5. Seismic monitoring
   i. In 3 parallel tunnels and the EDZ drifts
6. Long-term evaluations
   i. Effect of artificial materials interaction with rock
7. Thermo-hydro-mechanical coupled experiment; in EDZ drifts
8. Research along 100 m drifts
   i. Geological surveys
   ii. Water quality surveys
   iii. Water quality monitoring during excavation
   iv. Long-term water quality monitoring
   v. Core sampling
   vi. Joint migration tests
9. Research in EDZ drifts
   i. Geological surveys-mapping
   ii. Mine-by test (1)
   iii. Stability monitoring post-excavation
   iv. Engineered test in boreholes
   v. Rock mechanics tests
   vi. Influenced evaluation by construction of URL

Main Stage Experimental Activities :

1. Groundwater monitoring and permeability tests
   i. Groundwater monitoring at 2 locations
   ii. Permeability tests – 3 locations
2. Hydrogeological and Stability studies at the Tsukiyoshi fault
   i. Permeability tests
   ii. Migration tests
   iii. Seismic monitoring

3. Geological Surveys
   i. 3-D surveys at 2 locations
   ii. Deep geological surveys
4. Water quality monitoring
5. Bentonite-groundwater coupled monitoring in horizontal drifts
6. Rock behaviour
   i. Seismic monitoring
   ii. Strain monitoring
7. Permeability tests
   i. Rock permeability along drifts
   ii. Heated permeability tests
8. Construction technology
   i. Performance of engineering materials
   ii. Drift maintenance technology
9. Research at Tsukiyoshi Fault
   i. Fault survey
   ii. Seismic monitoring
   iii. Mine-by test?
   iv. Performance assessment of fill & plug materials
10. Research along spiral drifts
   i. Geological surveys – mapping
   ii. Joint permeability tests
   iii. Redox monitoring
   iv. Redox potential monitoring
   v. Water quality monitoring
   vi. Environmental monitoring for migration
   vii. Core sampling
   viii. Large-scale migration test
   ix. Construction technology – counter-measures
11. Research in EDZ drifts
   i. Geological surveys – mapping
   ii. Mine-by test
   iii. Groundwater/rock interaction
   iv. Post-excavation stability monitoring

[1] The plan above is conceptual only. It incorporates designs and studies specific to the Tsukiyoshi fault and will need updating to accommodated new MIU site information

3. International Participation in the MIU

This chapter presents some ideas, concepts and potential issuesb for JNC to consider with respect to JNC providing access to the Mizunami Underground Research Laboratory by the international research communities, including researchers from waste management organizations, universities and private industry. Implicit in this discussion is that the Japanese research community is also a potential participant.

JNC may wish to consider two approaches to international participation in the MIU: building on the existing international ties established with national waste management organizations in other nations and also development of the laboratory as a centre of excellence. Both can be very different.

JNC should carefully consider the implications of outside involvement in the MIU Project, assess the potential for impact on the schedule, the resources and the JNC experimental programme.

International Participation:

International participation at existing underground research facilities (URF) presently operational, in Canada (URL), Sweden (Äspö), and Switzerland (Grimsel, Mt. Terri) is extensive. A principal benefit of international participation for these facilities is to ensure that some of the world's best expertise and most up to date technology is available to meet programme objectives. This can be important in selecting a programme of experimental activities, in their design and performance and in their analysis. A related benefit has to do with economic aspects. Operation of an URF can be an expensive undertaking. Many experiments that are relevant to waste management programmes are done at an engineering or full scale relative to a repository environment; hence they are expensive. Realistically, some of these experiments would not be feasible without international participation to share the costs.

Centre of Excellence:

Quoting from the 1999 JNC Master Plan, "It is JNC's intention that the facility should become an internationally leading centre of excellence in earth sciences". This statement implies a high quality of research that meets or exceeds international standards.

Although a Centre of Excellence does not have a strict definition, it is reasonable to say that if JNC wishes to call the MIU a Centre of Excellence, then it is so defined. Many CoEs around the world are research, teaching and learning centres. If JNC were to establish the MIU as a CoE, research collaboration and teaching activities between JNC and other research institutes, universities, companies and individuals would be expected.

International Network of Centres of Excellence:

At this time, the IAEA is promoting the establishment of an International Network of Centres of Excellence in waste disposal technologies. At the end of this chapter is an extract from my trip report on a meeting attended to inaugurate the IAEA Network and minutes from the meeting.. Briefly stated, the purpose of this initiative is for nations with existing URFs to make their facilities available to other national waste management programmes as teaching centres in waste disposal technologies.

JNC's Long-term Goals:

JNC should consider the long-term goals of international participation. Some suggestions are itemized below for consideration by JNC, in terms of interest and consistency with the overall MIU objectives?

1. The MIU will become an internationally recognized centre for geoscience research; that is, it will be a location that develops new, innovative ideas and techniques for geoscience,
2. To provide an international training centre for other national institutions in need of underground facilities for geoscience research, and this can be research not necessarily intended for waste management or engineered repository purposes,
3. To provide a location for university level research in the geosciences and engineering fields and,
4. To provide an information centre that disseminates knowledge on the geosciences and provides a location to demonstrate aspects of the underground to the public in Japan

Benefits of International Participation:

There are several benefits that include:

- Opportunity to learn from the experience of other national programmes; considerable opportunity for value-added to JNC's experiments,
- State of the art technology may be made available,
- Opportunity to share ideas and exchange information with other world experts;
- Demonstrates to public and regulators that state of the art technology is being developed;
- Possible opportunity to save time and effort; especially with an experienced group or groups the impact and contribution can be positive and immediate;
- Share cost of large-scale experiments; and, for example, offset operational costs to expand scientific programme.

Disadvantages of International Participation:

- Possibility of delaying schedules and requiring more effort than available if a group is inexperienced or unable to contribute immediately;
- Possibility of competition for underground experiment locations;
- Possibility of being a financial drain, if not planned and managed within the scope of the entire project.

Some Considerations:

- JNC should consider the need for criteria to assess or decide on involvement by others. For example, JNC could make it a requirement that research by others must be of direct relevance to the JNC programme during the construction or operation phases,
- Experiment planning is very important, given the relocation of the MIU and the very tight schedule. It is of critical importance to reduce or minimize any delays to implementation of the science programme that might be introduced by allowing outside participation,
- Participants objectives should be clearly understood to avoid any false expectations by others,
-

- Participation by others may include some variation on the idea of attached staff; it might be teams of researchers or individuals depending on the activity. If there are to be attached staff or teams from other organizations, ground rules will need to be established. Access to the underground facility, the actual activities performed, office space are some of the aspects to consider. As well individuals should be carefully selected so they may contribute immediately. It may be desirable to have an initial trial period for attachments, with a review after some period (one to three months) to assess if attachments are satisfactory to all concerned.,
- Safety aspects of working in an underground facility must be considered, especially for attached staff. This may require a special training programme.

Potential Participants:

Internationally, the various waste management and environmental protection organizations are interested in geoscience research. Those nations with underground research facilities may be interested in research in the MIU owing to some of the unique aspects of the geological setting, for example, in terms of structures and seismic activity. Those nations without underground research facilities can be interested for a variety of reasons, likely related to their national or programme priorities.

In the western Pacific region there are several national organizations with nuclear power programmes but without underground laboratories to research the necessary technology, that may be interested; that is Korea, Republic of China and China, India, Pakistan and Russia.

Other than the national waste management organizations, there may be other organizations interested in access to the facility. Some organizations may be interested for academic reasons, such as national geological surveys, the US Geological Survey for example, that have an interest in understanding global tectonics and in situ responses to seismic events.

The mining industry of course has a great interest in underground research, and potentially for the application of techniques in the rock mechanics field and novel excavation and mining techniques, might get involved.

Japanese universities should also be interested. This could be an excellent location for the performance of undergraduate and graduate research.

Methods of Participation:

There are several ways that JNC may wish to consider for establishing financial arrangements and for arranging to share intellectual knowledge. These include but are not limited to the following:

1. Joint research, in which all participants share equally in the costs, including performance of much of the scientific work. If costs are shared it is reasonable that rights to all information should be shared. An assumption is that the work is of technical merit and interest to JNC and hence willing to share in the costs.

2. Joint research, in which all participants share equally in the costs, but JNC performs much, if not all, of the scientific work. If costs are shared it is reasonable that rights to all information should be shared. An assumption is that the work is of technical merit and interest to JNC and hence willing to share in the costs.

3. Joint research, but fully funded by an outside agency. JNC may or may not perform any of the work. The assumption is that JNC would not have a technical interest in the research.

4. JNC provides free access to the site for researchers from domestic and / or foreign universities

Contractual Arrangements

There are a variety of contractual types that may be considered. I am not really familiar enough with this aspect from a Japanese perspective to offer any insight.

A major contractual issue JNC is probably well aware of is the rights to information; that is intellectual property rights, patenting, and technology transfer are issues that JNC needs to consider, and perhaps avoid completely.

Implementation:

In terms of implementation, some aspects that should be considered are:

With respect to international participation, I believe the bilateral Agreement processes would be useful. If the Bilateral Agreements allow for the development of special subsidiary agreements, perhaps URL information exchange agreements could be developed if not already done so.

Establishment of a CoE will require some consideration in terms of:

- Guidelines, what will be the terms of reference for any involvement,
- Responsibility, who takes the lead, how is it managed, how is it coordinated within the research programme, on a daily or longer-term basis,
- What staff training will be necessary

RECOMMENDATIONS:

1. As early as possible, clearly define JNC's overall programme of activities planned for the construction and operating phases of the MIU. This is considered necessary to evaluate the impact any outside involvement could have on the schedule and resources, especially manpower requirements, the actual performance of experiments and the longer-term impact on successfully completing JNC's programme of experiments.

2. JNC should decide on optimization of participation. For example, participation by the international waste management community with demonstrated experience in performance of underground research can be a benefit and therefore desired during the construction and operation phases. Other types of involvement may have less direct benefit and should occur after the actual JNC Phase III is completed.

3. JNC has participated for many years with all the national waste management organizations and the Bilateral Agreements are a good basis for expanding the relationships to include these organizations as direct contributors to the MIU. Information exchange agreements should be continued and if not already in place, expanded to include the MIU. Flying the national flags of all participants is also recommended.

4. Increase JNC visibility, internationally. One way is the effective use of conferences. There are options to have representation from JNC on the organizing committees of several conferences, namely International High-Level Waste Management Conference, held bi-annually in Las Vegas; Waste Management, held annually in Tucson, Arizona and the ICEM conference held bi-annually in different venues. In addition JNC could make sure to be included in Plenary Session presentations at these conferences. I have included some information at the end of the chapter on some conferences.

5. In terms of a CoE, I would recommend participation in the International Network of Centres of Excellence for strategic planning reasons and to remain connected and supportive of the waste management community in general. However, I would also recommend moving cautiously in making the facility available for training and demonstration. The potential impact on JNC's programme must be carefully evaluated; especially considering the tight schedule and the strain this may place on the manpower at the site. If the impact is too severe, I recommend against using the MIU as a training facility during the construction or operational phases of the MIU.

6. If JNC pursues the CoE concept, financial incentives such as research grants could be considered:

7. Plan an opening ceremonies event and involve all international participants. Consider an anniversary events at a significant milestone, say the 10^{th} anniversary of the opening.

Appendix 3-1
Extract from my Trip Report to:

The 8th International Conference on Environmental Management held in Bruges, Belgium, September October, 2001

and

Technical Committee Meeting to initiate a programme for Training And Demonstration Of Waste Disposal Technologies In Underground Research Facilities

An IAEA Network of Centres of Excellence

IAEA Headquarters, Vienna International Centre, Vienna, Austria
8, 9, 10th October 2001

Rationale for Attendance :

My principal reason for attending the meeting was because I considered that doing so would be complementary to some of my planned work at TGC; which is to suggest definite concepts and methods by which the MIU may be made use of internationally. Attending would allow me to get a better understanding of the Centres of Excellence concept proposed by the IAEA, the potential interest in participating in underground research facilities by nations without such facilities.

I attended as an observer (as did Dr. Sakuma) and thus did not have a formal role, in terms of making presentations on Japan/JNC's plans for underground research facilities. It is unfortunate that this was the case because JNC's plans were not presented by the official representative for Japan nor was the current status of JNC's international cooperation that does involve active participation in all the Underground Research Facilities in the world.

The Network of Centres of Excellence Concept :

The International Atomic Energy Agency is promoting the development of a Network of Centres of Excellence (Network) for training and demonstration of waste disposal technologies in underground research facilities (URF). It is envisaged that, under the auspices of the IAEA, member states with URFs will join in forming the Network (to be known as *Network Members*) and make their facilities available, with a financial commitment, for experimentation and demonstration. It is further envisaged that member states without URFs would be interested in participating in these activities (*Network Participants*). The IAEA will not be a major funding source for the work but will have a coordinating and facilitators role.

What is a Centre of excellence (CoE)?: It was felt that a specific definition was neo necessary and any MS could designate their facility as a CoE.

A copy of the draft "Terms of Reference" is attached (No. 5). The terms discuss a combination of items relevant to both the establishment of the Network and the basis for discussions at the meeting. Also, minutes of the meeting will be issued and provided to all attendees, including observers such as myself who did not have an active role. These will be circulated upon receipt.

Agenda :

The meeting was organized so that presentations could be made from the IAEA perspective, from the committed and potential Network members and from potential Network participants. Meeting participants also formed working groups to discuss specific aspects relevant to the formation of a Network and, in a final plenary session discussed the working group findings and conclusions. The agenda is attached (No.6).

Participants :

The attendees' list is attached (No.7). Presentation material by various participants is available from the author if anyone is interested. The official representative for Japan was Ai Fujiwara san from the Radioactive Waste Management Funding and Research Center. A copy of his presentation is attached (No.8). It presents the RWMC's interest in a URF Network.

Meeting Objectives (IAEA) :

The meeting was organized to formally initiate the network and hopefully to give rise to shared interest and basis for future co-operative activities. An earlier meeting had been held in April, 2000

The Network :

At this time there are three URF owners committed to making their facility available: WIPP (Waste Isolation Pilot Plant), Carlsbad, USA, the URL Canada and the HADES URF, Belgium. Other owners of URF present (NAGRA and SKB) expressed an interest in the Network concept but there was some uncertainty expressed by Nagra and therefore a decision about potential participation at the meeting.

The centres are intended to be open to MS with developing WM programmes or those lacking underground R&D facilities of their own.

Working Group Sessions and Topics : (and outcome of sessions)

1. Management and Organization
    a. Role of the IAEA/Secretariat
        i. Coordinate individual requests – match making
        ii. Evaluate requests – does it make sense; are requirements fulfilled
        iii. Disseminate information on requests to Network Members
        iv. Funding (IAEA)
            1. Matchmaking: Coordinated Research Projects (CRP) $5,000/a
            2. Project making: Technical Cooperation (TC)
        v. Disseminate information on activities in URLs at regular intervals (eg. annual meetings)
        vi. Continuity provided via an IAEA Secretariat
        vii. Quality check of facilitated projects
        viii. Training – follow-up; flexibility to adjust assignment if necessary
    b. Role of Network Members –
        i. Minimum requirements
            1. Facility available for training & demo
            2. Availability of experts
            3. Member of core group

            ii. Minimum obligations
                1. In-kind contribution → to be defined
                2. When a project has been defined, willingness to contribute/assist with financing
    c. Role of Participants
            i. Minimum obligations
                1. Identify clearly their goals/objectives
                2. Identify available resources appropriate to the project (manpower, funds)

2. Application of Current Knowledge Base
    a. Provide information network to make existing information/technology accessible
        i. Information includes
            1. Science and technology
            2. Management and operations
            3. Communication methods
    b. Training and development set different requirements
    c. State-of-the-Art Review
        i. Objective: to provide a decision-making framework accessible to participants and regulators, scientists/engineers, public concerning development of multi-barrier concept
            1. Identify outstanding questions
                a. Host rock specific
                b. Focus on issues not treated in iterative, multi-disciplinary manner
                c. Rank issues according to type/significance cost is important
                d. Propose method/timescale for resolution (new test, extension to test, desk-based extrapolation)
    d. Identified themes
        i. Selection of waste container/host rock for a given waste form
        ii. Extrapolation of large-scale demonstration tests to different geometries/heat outputs etc
        iii. Implications of "Retrievability" for (eg) operational safwety; waste form specification in different host rocks.
        iv. Monitoring strategies (principles for identifying parameters; instrumentation/measurement requirements)
    e. How to achieve "Information Network"
        i. "Clever" summaries of current status under auspices of IAEA
        ii. Training courses, covering selected topics, for staff from "new programmes"
        iii. Expert group evaluation of planning/implementing stages of new programmes
        iv. Benchmarking experiments in URLs/new programmes for techniques/methods
        v. Attachment of new programme specialists to URL projects
        vi. Ranking studies on outstanding questions
    f. Key Challenges
        i. How to exploit/complement existing networks e.g. Crystalline Group; NEA Clay Club; NEA Salt Club; EC CLUSTER
        ii. Requirement for dedicated IAEA staff member
        iii. How to maximize benefit of existing knowledge/facilities; avoid duplication
        iv. Narrow remit? Key issue for new programmes is concept development/siting studies – underground research at a later stage

v. Network to be more effective than single MS-TCP

g. New projects in Existing URLs – assuming funding is available, options include
   i. Involvement of "new programme" experts in planned projects
   ii. Alteration/extension of planned projects
   iii. Creation of specific, educational projects
   iv. Conduct of projects specifically proposed and run by new programmes
   v.

3. Timeframe - Short, Medium and Long-term Priorities
   a. Two levels
      i. Training in programme development from concept to URL design
      ii. Training in specific topics from experiment design to "field testing"
   b. Some relevant issues identified
      i. Social studies – public acceptance
      ii. Regulators involved ??
      iii. Programmes by individuals should be target oriented
      iv. Peer review critical at all levels including both work done and planned

Major observations and positions taken :

i) AECL was the only owner of a URF willing to make a financial commitment, reflecting the strong commitment by the Canadian government to back the IAEA Network of Centres of Excellence project. AECL indicated it would provide a budget of one million dollars per year if this would leverage other funds from participants to perform demonstration experiments.

ii) Several potential Network participants indicated that hey would be interested to do work in URFs but, because they often do not have a programme, they did not have definite needs at this time nor in some cases an idea of what might be needed and could be done in any URF.

iii) ANDRA, although constructing a site specific URF, considered they would best be considered a potential Network participant because their facility will not be available for several years.

iv) Several Network members and potential Network members raised the issue of rights to information and proprietary data, especially for pre-existing and on-going work with other WM organizations.

v) Amongst the several potential Member participants who made presentations, the following summarizes some of the key comments:

   a. Training of staff and planning a URL is most important
   b. Too early to know technical needs as the programmes are just getting started, they are under-funded. Training and staff attachments important
   c. Already participating in all or most of the URFs in the world
   d. Need to participate in a URF to move to large-scale experiments
   e. Considerable value to have an "international integration of technology"
   f. The world has enough "generic" URFs and should focus resources on "site specific oines"
   g. Several nations left the impression they are in a siting stage and thus would move to a site specific URF in the future, if their programmes crystallized.

Summary of Meeting Conclusions :

1. There is a perceived need for a programme/project on Training and Development in URLs to be "coordinated" by the IAEA
2. For those MSs with less well developed programmes the initial emphasis should be on training and learning

3. Joint projects currently being or shortly to be carried out by member states with developed programmes can be used to meet the training as well as demonstration needs
4. funding mechanisms for the project need further clarification
5. the programme/project should be developed consistently and with cognizance of the needs of member states

Summary of Meeting Recommendations :

1. URLs should be the central focus
2. Revise the terms of reference
3. Establish a permanent secretariat
4. Member States should identify needs, associated funding strategy and constraints, including timing, for participation.
5. URFs should identify commitments and schedules and clarify ongoing programs that may be used for interactions
6. Establish a time scale and procedures for participation
7. Steering Committee = URLs and representatives of users
8. As the programme is developed, due consideration should be given to the Technical Committee Meeting working Group recommendations
9. Interested member states should submit (TC) program plans by end of December each year as required.

Next Meeting :

In about one year's time and probably in Canada at AECL's URL

Relevance to JNC :

These are preliminary and will be addressed more thoroughly in future work.

- The actual "need" for a Network of Centres of Excellence was never adequately addressed,
- JNC is already actively participating in URFs around the world so the Network itself is not a necessary vehicle to enhance the JNC activities,
- JNC, once it has a facility to offer, should consider becoming a *Network Member* for a variety of reasons, including social and technical reasons,
- JNC could "go it alone" and develop the MIU as a CoE independently of the IAEA. This option should be seriously considered as it uncertain that the Network will actually function.
-

If JNC decides to participate, it should not wait until a facility is completely constructed. A URF in the construction phase is still a URF and has a lot of added value for potential participants. Having active participation by others during the construction phase should be carefully considered as it will require a balance between doing the work and supervising participants. Observer status might be a suitable arrangement.

Appendix 3-2

Notes

of an IAEA

TECHNICAL COMMITTEE MEETING

on

Training in and Demonstration of Waste Disposal Technologies

in Underground Research Facilities -

An IAEA Network of Centres of Excellence

Date:	8th -10th October 2001
Place:	Conference Room C07IV, Vienna International Centre
Attendees:	See Attachment 1
Agenda:	See Attachment 2

The meeting was convened as planned at 09:30 h on 08 October 2001. The tentative agenda was approved without significant alteration and the approved agenda was followed without significant deviation.

Agenda Item 1 - Introductions

Mr. Arnold Bonne, Director of the IAEA's Division of Nuclear Fuel Cycle and Waste Technology, welcomed the participants on behalf of the Director General and the Agency and introduced the Chairman for the meeting, Mr. Charles Fairhurst. A copy of the welcoming address is provided in Attachment 3.

Representatives and observers introduced themselves and domestic matters for the meeting were organised.

Agenda Item 2 - Purpose of Meeting

The Terms of Reference (TOR) for the TCM were presented. These had been circulated to participants prior to the meeting and met with little significant discussion. The following items were emphasised:

- Centres of Excellence are defined by Member States and are accepted as such when offered to the IAEA for inclusion in the Network.
- The purposes of the meeting were to:
  1. Present the committed Centres of Excellence and introduce facility owners and potential users;
  2. Divine the needs and interests of participants;
  3. Develop a *modus operandi* for the Network; and
  4. Recommend future actions for an IAEA based programme.

Agenda Item 3 - Presentations from Core Group members

Descriptions of four Centres of Excellence that have been offered for inclusion in the Network were made by facility/Centre representatives.

The four Centres are:

The Underground Research Laboratory (URL), Lac du Bonnet, Canada (Atomic Energy of Canada Limited - AECL).

The Hades facility, Mol, Belgium (SCK/CEN)

The WIPP facility, Albuquerque, New Mexico (US/DOE)

The Geo-Environmental Research Centre (University of Wales, Cardiff, UK)

Informal agreements have already been reached between IAEA and AECL, the IAEA and SCK/CEN and the University of Wales and the IAEA. A memorandum of understanding between the US/DOE and the IAEA was well under development.

These four Centres will be the core group forming the Network. Countries with similar Centres were invited to consider the nature of their possible contributions and participation.

At the time of the meeting only Canada had identified special funding for its involvement with the Network. A sum of C$ 5 million (US$ 3.3 million) for a period of five years was announced. This would be used to expedite Network related activities at the URL.

Other committed Centres indicated that they would use ongoing national scholarship programmes and the like to encourage work at their facilities. Special funding may be sought as the Network programme expands and advances.

Agenda Item 4 - Other Network Initiatives

Advances towards the development of Networks of Centres of Excellence within the context of the EU were presented. Two of the IAEA's core facilities the Hades facility and the Geo-Environmental Research Centre could be involved with the EU Networks and could receive funding from the EU administration.

Evolution of the EU's programmes over the next number of years (2002-6) should be followed and where the synergies that exist between the EU's and the IAEA's networks can be used to advance programmes this should be done.

The EU's CLUSTER initiative, when fully operating and defined has high potential to be linked with the IAEA's Network.

It was observed that the Statute of the IAEA necessitates broader involvement with Member States (MS) than the limited number that forms the current membership EU. Particularly, there is a requirement for the Agency to involve countries with less well-developed programmes. Common goals, such as maintenance of technologies and optimum use of resources including the minimization of duplication, could form the foundation for common work between the EU and the IAEA.

Agenda Item 5 - Associated facilities

The representative from France deferred discussions of the French national position for Agenda Item 7.

Representatives from Switzerland and Sweden presented details of the facilities at Grimsel and Aspo and described ongoing international activities along with some of details of the national programmes. It was clear that access to the experience gained at these facilities could considerably benefit the IAEA Network. Both facilities are developed in granite rock-masses and care must be taken both to avoid duplication in the Network and to minimise possible unwanted interferences between the activities of the Network and the ongoing activities in the facilities.

In the latter context, it was clear that the work at Aspo in Sweden was very much dedicated to the Swedish national waste disposal efforts and interest in the IAEA's Network was very much generic in character. Possible opportunities would need to be developed further. The representatives for the Grimsel test facility openly expressed interest in participating in the IAEA's Network yet were restrained to determine the mechanism by which this goal could be achieved.

A facility in Switzerland, the "Mont Terri" facility was briefly mentioned as an example of a URL in clay. Organizational and managerial issues would need to be further discussed in more detail exploring the possibility of advancing the facility as a possible component of the IAEA's Network.

The current situation of URL in Japan was described. Currently, although development work is in progress, there are no facilities in Japan that can be offered for inclusion in the Network.

Agenda Item 7 - National Interests of possible facility users.

The Agenda was slightly altered so that all those Member States either without URLs or offering to be included in the Network as a facility owner presented their national positions. This was done variously both, generally, with regard to waste disposal and, specifically, with regard to specific involvement with the Network..

Member States without URL's range from countries with very advanced and well funded programmes to those with waste disposal programmes that are only beginning. Reflecting this range of positions, the needs of the Member States without URLs varied from involvement with simple training programmes to active participation in major underground experiments/demonstrations to address various techno-socio-political issues. Generally the need for a Network was clearly identified. The activities to be undertaken by the Network required clearer definition.

A general census indicated that the majority (about 70%) of the potential facility users were interested in programmes in granite rock. For all intents and purposes, the other 30 % was split evenly between work in URLs in salt and clay formations.

Agenda Item 8 - IAEA Mechanisms for programme funding and management

The Agency will not provide the major funding for the Network. This is expected to come from the interested Member States. However, two mechanisms for funding and managing the Network present themselves. These are:

- Co-ordinated Research Programmes (CRP); and,
- Technical Co-operation Programmes (TC).

To a limited degree, both of the mechanisms allow the Agency to fund those Member States requesting and qualified for assistance. The CRP mechanism is more flexible than the TC mechanism but the TC may be able to provide more funding.

For TC programmes, the fact that donating Member States may be able to ascribe donations to a particular activity needs to be explored. Also, for TC programmes, Member States that are eligible for funding should ensure that requests for funding are made in appropriate time (normally there is 1 or 2 years between the request for funding and its assignment). Member States with TC programmes need to assure that the correct priority is placed on requests for funding.

It is likely that the use of CRPs will be the easiest mechanism by which to advance the Network's activities. By developing the technical objectives of these Co-ordinated programmes, the Agency is immediately able to provide funding for meetings and the associated travel. Small amounts of funding may be made available for equipment, materials and supplies.

In addition to the funding mechanisms, the Agency is developing the application of an Internet Virtual Office. It is likely that this system could be used to encourage interchange between Member States and Member States and the Agency. This would be particularly effective if, first, it was set up to give communication between the Core group of four Centres of Excellence and the Agency. It could then be expanded to include participating MSs. The system provides for the high level of security needed for communications at international levels.

The concept of a Virtual URL was mooted and taken under advisement.

Agenda Items 9, 10 and 11 - Working Group Discussions

With the preceding background, the meeting divided into three approximately equal sized working groups to resolve and provide guidance for the Agency on the following subjects:

- The mechanisms that can be best used to organize and manage the Network;.
- The themes that can followed to progress the Network; and
- The strategic development of the Network as it relates to the short, medium and long term priorities of the participants.

Agenda Items 12 and 13 - Conclusions

Based on the outcomes of the Working Group Sessions the following major conclusions were drawn.

- There is a clear and definite need for a project on Training and Demonstrations in URL's to be co-ordinated by the IAEA.
- For those Member States with less well-developed programmes the initial emphasis should be on Training.
- Programmes being carried out currently in URL's by Member States with well-developed programmes can be used to meet training needs.
- Funding mechanisms for the project require further clarification.
- The project should be developed consistently with developments by other international agencies.

Agenda Item 14 - Recommendations

The development of the Network was seen to be a long-term initiative. To progress the project immediately, the following major recommendations should be considered and acted on.

1. A permanent secretariat that is dedicated to the project should be established.

2. URLs should form the central focus of the project. The corollary is that other Centres of Excellence that are not URLs are needed and can be admitted.
3. Member States shall identify needs, associated funding strategy and constraints, which include scheduling factors, for participation.
4. A time frame and schedule for the project should be defined.
5. A Steering Committee consisting of representatives of both facility owners and users should be elected.
6. Member States should ensure that URL work is included and appropriately prioritised in the TC program plans and requests.

Recommendations 1, 4 and 5 require action by the Agency. Other items require action by the Member States.

Participants were asked to expeditiously effect the required actions.

Item 15 - Next Meeting

Mr. Gadsby of AECL kindly offered to host the next meeting at the Canadian Underground Research Laboratory.

Item 16 - Other business

Taking into account comments received on the lack of clarity of the Terms of reference, the Technical Secretariat undertook to review and revise the document provided for the meeting. The revised Terms of Reference for the Network are attached (Attachment 4)

Item 17 - Chairman's concluding remarks

The Chairman thanked participants for their contributions and closed the meeting.

POST-MEETING NOTES

The following comments and opinions were received after the meeting:

1. Attempts should be made to encourage work at all of the three URLs in Granite. In this regard the Agency will attempt to establish a "Granite Bloc" and to define potential Network activities at each of the three major existing URLs in granite (i.e. the Canadian URL, the Swiss Grimsel facility and Swedish Aspo laboratory).
2. The IAEA is uniquely qualified and through its Statute is required to provide a forum for training and encouraging the development of trained individuals who are capable of executing waste disposal programmes. The Network will provide access to a well established and qualified set of resources for these purposes. National and international organisations will be available to offer guidance and interact at different levels.
3. There is no longer a critical need to develop and operate a URL in each and every Member State. Generic studies can be undertaken and training and demonstrations can be affected in an international forum such as the Network. Such an approach has the potential to encourage technology transfer and to save on costs.
4. Attachment 5 provides the post-meeting summary and comments of the Chairman, Professor Charles Fairhurst.

Appendix 3-3

Information on Waste Management Conferences for JNC Record:

1. The 9th International Conference on Environmental Remediation and Radioactive Waste Management ICEM' 03.

Oxford England; September 14-18, 2003 –

2. 29th Waste Management Symposium, WM 03.

Tucson Arizona, USA; February 2003

3. 10th International High-Level Radioactive Waste Management Conference (IHLRWMC).

Las Vegas, Nevada, USA. April 13-17, 2003.

4. Spectrum 2002 9th Biennial International Conference on Nuclear and Hazardous Waste Management..

Reno, Nevada, USA. August 2003

5. Material Research Society

A trip report

9th International High-Level Radioactive Waste Management Conference
Las Vegas, Nevada, U.S.A.
April 29th to May 3rd, 2001

And

Visit to Atomic Energy of Canada, Ltd. & Ontario Power Generation

A TRIP REPORT

9th International High-Level Radioactive Waste Management Conference, Las Vegas, Nevada, U.S.A. April 29th to May 3rd, 2001,

Visits to Atomic Energy of Canada, Ltd. & Ontario Power Generation

Introduction:

This document reports on the trip made to the 9th IHLRWM Conference held from 29th April to the 3rd May, 2001 and on several meetings attended by myself to present information on the MIU project to Canadian researchers at Atomic Energy of Canada Ltd (AECL) and at Ontario Power Generation (OPG). A separate meeting was held in Las Vegas with US DoE staff regarding Centres of Excellence being promoted by the IAEA. Depart Japan on 28th April. Attended conference from 29th April to 03 May, inclusive. Met with US DoE representatives on 04 May. Meetings with AECL on the 7th May and with OPG on the 9th, and returned to Japan 11th May.

The Conference:

The IHLRWM Conference is one of the major international conferences addressing the management and disposal of high-level nuclear waste. This conference will be held bi-annually in Las Vegas, Nevada, USA. The first 8 conferences were annual events, also in Las Vegas. A copy of the Official Program is attached (Attachment no 1) and a CD ROM of the Proceedings is available and will be placed with the TGC library after circulation within the Geoscience Research (GR) and the Geoscience Research Integration and Dissemination (GRID) Groups at TGC. As well, a number of papers considered of direct interest to individual research staff at TGC have been printed and provided.

The primary purpose in attending the conference was to present a paper titled

"The MIU Research Laboratory, Japan
- Geoscience Activities During Construction And Operation"
G. McCrank, K. Sugihara, K. Ota, S. Mikake, T. Amano, K. Koide, and S. Takeda.

A copy of the paper and OHPs used for the presentation are attached (Nos. 2 & 3). Questions from the audience included:

- "Why was the MIU site selected in the first place?
  Although I was obviously not part of any selection effort, I responded that the reasons included the fact that the site is representative of some geological settings in Japan and secondly, it is in proximity to the TGC and the support infrastructure located there.
- How was it selected if there is no bedrock exposure?
  Based on knowledge from earlier uranium exploration boreholes and regional borehole drilling.
- Will the site ever be a future waste repository?"
  No, it is a generic laboratory.

Two other presentations were made by representatives from Japan. Dr. S. Masuda (Director of NUMO) gave a presentation titled "Evolution of Geological Repository Program in Japan" which included information on NUMO. Dr. Masuda kindly provided me with duplicate copies of his OHPs for presentation during my trip to Canada (Masuda san's paper is attachment no. 4. His OHPs are on file with the GRID Group). In a different session, H. Kuma Sakuma served as a panelist for discussions on International Collaboration.

The conference had a solid international flavour, with 40% of participants from outside the USA.

There was an open invitation to delegates to attend a post-conference meeting to begin to plan for the next conference in 2003.

Post-Conference Field Trip: Yucca Mountain Exploratory Studies Facility (ESF)

A full day field trip to the Yucca Mountain site was organized as part of the conference. This afforded an excellent update on the US DoE characterization program at the site (Attachment No. 5). Russ Dyer, YMP Project Manager was our guide and his explanations of the geological setting, geological and social issues they have had to deal with were excellent. The underground visit was to their large-scale heater test. The surface tour included a visit to the crest of Yucca Mountain, discussions about the geological setting and characterization methods and challenges and examination of their TBM, which is for sale.

The Yucca Mountain Site Recommendation Report (SR) is set for imminent release.

Post-Conference Meetings:

1. Meeting with US Doe representatives for the WIPP facility: Mark Mathews International Program Manager, WIPP and Leif Eriksson, GRAM Inc. (04 May, 2001).

Dr. Eriksson requested the meeting. The purpose was to inform of some recent WIPP initiatives. The WIPP is now operational and must monitor system response during operation and provided a performance report every 5 years to the regulator. The US DoE is inviting other waste management organization to share all aspects of the knowledge developed at the WIPP. Further to this initiative they are seeking strategic partnerships with other waste management organizations and have established the Center for Applied Repository and Underground Science (CARUS) to support the R&D activities. (A copy of their prospectus is included as attachment no. 6).

Also, WIPP is one of the strategic partners in an IAEA initiative along with Canada/URL and Belgium/MOL to establish a "Network of Centres of Excellence for Training, Development and Demonstration of Technologies for the Geological Disposal of Radioactive Wastes". The centres are intended to be open to nations with developing WM programmes and lacking R&D facilities on their own turf. They were curious to know if this idea would comport with the JNC plan to establish MIU as an International Centre of Excellence. I indicated this might be clearer once JNC has permission to excavate the MIU but until then it would be better to differ any such discussions with respect to the MIU. This comment does not preclude any discussions that might be possible with respect to the QUALITY or ENTRY facilities at Tokai Works, which they also are interested in.

2. AECL – Underground Research Laboratory and Whiteshell Laboratories:

I made presentations at the URL (7th AM) and the WL (7th PM) to all staff and managers currently working on the WM programme. The main focus of the presentations was on the MIU programme and included a supplemental presentation using the information on NUMO that were provided to me by Masuda san.

There were a great many technical questions from the staff, as I expected. They ranged from questions about drilling techniques, hydrogeological testing, design basis, excavation plans for the shaft, excavation sequence/cycle, cementing of shaft and why, surface mapping methods, type of geophysics performed, approach to groundwater flow modelling. There was also significant interest in the formation of NUMO

3. Ontario Power Generation (OPG): meeting with Sean Russell, Manager, Long-term Waste Management Technology; Helen Leung, Manager LLW Safety Assessment; Paul Gierszewski, Manager, Used Fuel Safety Assessment; and Gary Simmons, Long-term Waste Management Technology.

The group managed by Sean Russell are expected to form the core of the Canadian version of NUMO and it may be called the Waste Management Organization (WMO). The Canadian Government is now considering legislation for the formation of WMO. Information on the OPG waste management activities is provided in attachment no 7.

The OPG group was not well aware of recent developments in the Japanese programme nor of the plans for MIU so the visit was very timely. They were very interested in the MIU project and specifically in the progress that JNC was making and difficulties encountered in trying to secure permission to begin excavation. They were very interested in NUMO and specifically on roles and responsibilities and financing. Questions raised included issues of funding arrangements, technology transfer to NUMO from JNC, supporting R&D for NUMO by JNC and schedules for implementation.

The next conference will be in spring 2003.

A trip report

8^{th} International Conference on Environmental Management
Bruges, Belgium
September 30^{th} to October 5^{th}, 2001

And

Technical Committee Meeting
Network of Centres of Excellence
International Atomic Energy Agency, Vienna, Austria

A TRIP REPORT

8th International Conference on Environmental Management, Bruges, Belgium, September 30th to October 5th, 2001,

Technical Committee Meeting
Network of Centres of Excellence
International Atomic Energy Agency, Vienna, Austria

Introduction:
This document reports on the trip made to the 8th International Conference on Environmental Management (ICEM) held from the 30th September to the 5th October, 2001 and attendance at the IAEA meeting on the development of a "Network of Centres of Excellence for Training in and Demonstration of Waste Disposal Technologies in Underground Research Facilities.

The Conference:
The ICEM Conference was held in Brugge, Belgium from 30 Sept to 05 October, 2001. It is organized for global information exchange on radioactive waste management and environmental remediation problems. Previous conferences were held in Nagoya, Berlin, Seoul and various other venues. Details on the organizers and sponsors and papers presented may be found in the Official Program and Abstracts Book attached (No. 1 and 1a respectively).

The conference had a strong international flavour, with 38 nations represented. However, attendance was reduced from previous years due to repercussions from the recent terrorist activities in the USA. Foe example, 25 US attendees were refused permission to attend. Indirect impacts were felt due to for example closure of the Brussels airport for a day, a strike by Sabena and the near bankruptcy of Swissair, all of which impacted on attendees travel to or from the conference. The list of attendees is provided (attachment No. 2)

Purpose in Attending:

The primary purpose in attending was to present a paper on the MIU Underground Research Facility in the session, "A Final Disposal Site Selection and Underground Research Laboratories which I co-chaired with Sten Bjurstrom (ex President of SKB).

The paper presented is:

"Mizunami Underground Research Laboratory In Japan
Pre-Excavation Site Characterization and Influence On Design Concepts"

It was co-authored with the following JNC staff:
Kenji Amano, Kaoru Koide, Hiroya Matsui, Shinichiro Mikake, Katsushi Nakano, Kunio Ota, Hiromitsu Saegusa, Kozo Sugihara, Seietsu Takeda, Shinji Takeuchi

A copy of the paper and B&W copies of the presentation material are attached (Nos. 3 & 4).

- The presentation was reasonably well attended, with approximately 30 persons in the audience.

As well a post-meeting (Oct 05) field trip to visit the Belgoprocess facility reprocessing isotope production waste and the SCK-CEN Institute was planned. The morning involved a trip to a LLW treatment facility (CILVA) and in the afternoon to the SCK/CEN visitor's centre E.I.G. EURDICE.

A CD ROM of the Proceedings with full conference papers will be available by about December. It will be placed with the TGC library after circulation within the Geoscience Research (GR) and the Geoscience Research Integration and Dissemination (GRID) Groups at TGC. As well, a number of papers considered of direct interest to individual staff at TGC will be provided once the CD is received.

Several papers were presented that should be of interest to TGC staff. One in particular on public acceptance is recommended reading and I will provide a copy when the CD-ROM is received. The paper was in session 48 and called "Local Partnership: Towards a New Approach in Nuclear Waste Management in Belgium"

It presented some ideas on obtaining community involvement in the siting process with a real example from the Belgium experience. The paper should be of interest to the TGC team responsible for public interaction and securing permission to begin excavation of the MIU.

Technical Committee Meeting to initiate a programme

for

Training And Demonstration Of Waste Disposal Technologies In Underground Research Facilities

An IAEA Network of Centres of Excellence

IAEA Headquarters, Vienna International Centre, Vienna, Austria
8, 9, 10th October 2001

Rationale for Attendance:

My principal reason for attending the meeting was because I considered that doing so would be complementary to some of my planned work at TGC; which is to suggest definite concepts and methods by which the MIU may be made use of internationally. Attending would allow me to get a better understanding of the Centres of Excellence concept proposed by the IAEA, the potential interest in participating in underground research facilities by nations without such facilities.

I attended as an observer (as did Dr. Sakuma) and thus did not have a formal role, in terms of making presentations on Japan/JNC's plans for underground research facilities. It is unfortunate that this was the case because JNC's plans were not presented by the official representative for Japan nor was the current status of JNC's international cooperation that does involve active participation in all the Underground Research Facilities in the world.

The Network of Centres of Excellence Concept:
The International Atomic Energy Agency is promoting the development of a Network of Centres of Excellence (Network) for training and demonstration of waste disposal technologies in underground research facilities (URF). It is envisaged that, under the auspices of the IAEA, member states with URFs will join in forming the Network (to be known as *Network Members*) and make their facilities available, with a financial commitment, for experimentation and demonstration. It is further envisaged that member states without URFs would be interested in participating in these activities (*Network Participants*). The IAEA will not be a major funding source for the work but will have a coordinating and facilitators role.

What is a Centre of excellence (CoE)?: It was felt that a specific definition was neo necessary and any MS could designate their facility as a CoE.

A copy of the draft "Terms of Reference" is attached (No. 5). The terms discuss a combination of items relevant to both the establishment of the Network and the basis for discussions at the meeting. Also, minutes of the meeting will be issued and provided to all attendees, including observers such as myself who did not have an active role. These will be circulated upon receipt.

Agenda:
The meeting was organized so that presentations could be made from the IAEA perspective, from the committed and potential Network members and from potential Network participants. Meeting participants also formed working groups to discuss

specific aspects relevant to the formation of a Network and, in a final plenary session discussed the working group findings and conclusions. The agenda is attached (No.6).

Participants:
The attendees' list is attached (No.7). Presentation material by various participants is available from the author if anyone is interested. The official representative for Japan was Ai Fujiwara san from the Radioactive Waste Management Funding and Research Center. A copy of his presentation is attached (No.8). It presents the RWMC's interest in a URF Network.

Meeting Objectives (IAEA):

The meeting was organized to formally initiate the network and hopefully to give rise to shared interest and basis for future co-operative activities. An earlier meeting had been held in April, 2000

The Network:

At this time there are three URF owners committed to making their facility available: WIPP (Waste Isolation Pilot Plant), Carlsbad, USA, the URL Canada and the HADES URF, Belgium. Other owners of URF present (NAGRA and SKB) expressed an interest in the Network concept but there was some uncertainty expressed by Nagra and therefore a decision about potential participation at the meeting.

The centres are intended to be open to MS with developing WM programmes or those lacking underground R&D facilities of their own.

Working Group Sessions and Topics: (and outcome of sessions)

1. Management and Organization
    a. Role of the IAEA/Secretariat
        i. Coordinate individual requests – match making
        ii. Evaluate requests – does it make sense; are requirements fulfilled
        iii. Disseminate information on requests to Network Members
        iv. Funding (IAEA)
            1. Matchmaking: Coordinated Research Projects (CRP) $5,000/a
            2. Project making: Technical Cooperation (TC)
        v. Disseminate information on activities in URLs at regular intervals (eg. annual meetings)
        vi. Continuity provided via an IAEA Secretariat
        vii. Quality check of facilitated projects
        viii. Training – follow-up; flexibility to adjust assignment if necessary
    b. Role of Network Members –
        i. Minimum requirements
            1. Facility available for training & demo
            2. Availability of experts
            3. Member of core group

ii. Minimum obligations
1. In-kind contribution→to be defined
2. When a project has been defined, willingness to contribute/assist with financing

c. Role of Participants
i. Minimum obligations
1. Identify clearly their goals/objectives
2. Identify available resources appropriate to the project (manpower, funds)

2. Application of Current Knowledge Base
a. Provide information network to make existing information/technology accessible
i. Information includes
1. Science and technology
2. Management and operations
3. Communication methods

b. Training and development set different requirements
c. State-of-the-Art Review
i. Objective: to provide a decision-making framework accessible to participants and regulators, scientists/engineers, public concerning development of multi-barrier concept
1. Identify outstanding questions
a. Host rock specific
b. Focus on issues not treated in iterative, multi-disciplinary manner
c. Rank issues according to type/significance cost is important
d. Propose method/timescale for resolution (new test, extension to test, desk-based extrapolation)

d. Identified themes
i. Selection of waste container/host rock for a given waste form
ii. Extrapolation of large-scale demonstration tests to different geometries/heat outputs etc
iii. Implications of "Retrievability" for (eg) operational safwety; waste form specification in different host rocks.
iv. Monitoring strategies (principles for identifying parameters; instrumentation/measurement requirements)

e. How to achieve "Information Network"
i. "Clever" summaries of current status under auspices of IAEA
ii. Training courses, covering selected topics, for staff from "new programmes"
iii. Expert group evaluation of planning/implementing stages of new programmes
iv. Benchmarking experiments in URLs/new programmes for techniques/methods
v. Attachment of new programme specialists to URL projects
vi. Ranking studies on outstanding questions

f. Key Challenges
   i. How to exploit/complement existing networks e.g. Crystalline Group; NEA Clay Club; NEA Salt Club; EC CLUSTER
   ii. Requirement for dedicated IAEA staff member
   iii. How to maximize benefit of existing knowledge/facilities; avoid duplication
   iv. Narrow remit? Key issue for new programmes is concept development/siting studies – underground research at a later stage
   v. Network to be more effective than single MS-TCP
g. New projects in Existing URLs – assuming funding is available, options include
   i. Involvement of "new programme" experts in planned projects
   ii. Alteration/extension of planned projects
   iii. Creation of specific, educational projects
   iv. Conduct of projects specifically proposed and run by new programmes
   v.

3. Timeframe - Short, Medium and Long-term Priorities
   a. Two levels
      i. Training in programme development from concept to URL design
      ii. Training in specific topics from experiment design to "field testing"
   b. Some relevant issues identified
      i. Social studies – public acceptance
      ii. Regulators involved ??
      iii. Programmes by individuals should be target oriented
      iv. Peer review critical at all levels including both work done and planned

<u>Major observations and positions taken:</u>

i) AECL was the only owner of a URF willing to make a financial commitment, reflecting the strong commitment by the Canadian government to back the IAEA Network of Centres of Excellence project. AECL indicated it would provide a budget of one million dollars per year if this would leverage other funds from participants to perform demonstration experiments.

ii) Several potential Network participants indicated that hey would be interested to do work in URFs but, because they often do not have a programme, they did not have definite needs at this time nor in some cases an idea of what might be needed and could be done in any URF.

iii) ANDRA, although constructing a site specific URF, considered they would best be considered a potential Network participant because their facility will not be available for several years.

iv) Several Network members and potential Network members raised the issue of rights to information and proprietary data, especially for pre-existing and on-going work with other WM organizations.

v) Amongst the several potential Member participants who made presentations, the following summarizes some of the key comments:

   a. Training of staff and planning a URL is most important

b. Too early to know technical needs as the programmes are just getting started, they are under-funded. Training and staff attachments important
c. Already participating in all or most of the URFs in the world
d. Need to participate in a URF to move to large-scale experiments
e. Considerable value to have an "international integration of technology"
f. The world has enough "generic" URFs and should focus resources on "site specific oines"
g. Several nations left the impression they are in a siting stage and thus would move to a site specific URF in the future, if their programmes crystallized.

Summary of Meeting Conclusions:

1. There is a perceived need for a programme/project on Training and Development in URLs to be "coordinated" by the IAEA
2. For those MSs with less well developed programmes the initial emphasis should be on training and learning
3. Joint projects currently being or shortly to be carried out by member states with developed programmes can be used to meet the training as well as demonstration needs
4. funding mechanisms for the project need further clarification
5. the programme/project should be developed consistently and with cognizance of the needs of member states

Summary of Meeting Recommendations:

1. URLs should be the central focus
2. Revise the terms of reference
3. Establish a permanent secretariat
4. Member States should identify needs, associated funding strategy and constraints, including timing, for participation.
5. URFs should identify commitments and schedules and clarify ongoing programs that may be used for interactions
6. Establish a time scale and procedures for participation
7. Steering Committee = URLs and representatives of users
8. As the programme is developed, due consideration should be given to the Technical Committee Meeting working Group recommendations
9. Interested member states should submit (TC) program plans by end of December each year as required.

Next Meeting:

In about one year's time and probably in Canada at AECL's URL

Relevance to JNC:

These are preliminary and will be addressed more thoroughly in future work.

1. The actual "need" for a Network of Centres of Excellence was never adequately addressed,
2. JNC is already actively participating in URFs around the world so the Network itself is not a necessary vehicle to enhance the JNC activities,
3. JNC, once it has a facility to offer, should consider becoming a *Network Member* for a variety of reasons, including social and technical reasons,
4. JNC could "go it alone" and develop the MIU as a CoE independently of the IAEA. This option should be seriously considered as it uncertain that the Network will actually function.
5. If JNC decides to participate, it should not wait until a facility is completely constructed. A URF in the construction phase is still a URF and has a lot of added value for potential participants. Having active participation by others during the construction phase should be carefully considered as it will require a balance between doing the work and supervising participants. Observer status might be a suitable arrangement.

A Final Presentation for International Fellowship

Tono Geoscience Center

April 3rd, 2002

International Fellowship

Geoscience at the MIU

Glen McCrank
Tono Geoscience Center
April 2002

Outline of Presentation:

- **Selected aspects of the Canadian URL**
- **Relevance to Geoscience at the MIU**

International Fellowship

Acknowledgements:
To all the staff at TGC who freely shared with me their time and knowledge, scientific and otherwise, I am grateful. I will miss working with the groups here. I wish everyone a great deal of luck and success in the coming years and my all the work p[roceed safely. Thank you all.

Geoscience in 2000 when I arrived:

- **Phase I activities well advanced**
- **AN-1, 2, 3 drilled**
- **MIU- 1, 2, 3 drilled; MIU-4 starting**
- **MIU-4 Working Programme document written**
- **Surface & airborne geophysics had been completed**
- **Regional Activities nearly complete DH-boreholes 1-11 drilled; DH 12 & 13 starting**

Some activities

- Reviewing activities in the Geoscientific Research Programme – Tono Mine, Regional and MIU
- Assisting with geosynthesis analysis
- Assisting with some aspects of the G/W flow simulation modelling
- Assisting with planning for the JSFF in Japan; meetings, field trips,
- Assisted with aspects of MIU-4 drilling programme
- Assisted with planning new MIU site work
- Review and comment on several JNC papers, reports, abstracts
- Prepared two papers on the MIU for presentation internationally and a poster at the GSJ in Kanazawa

MIU SCHEDULE

- **One of most critical elements:**
- **Probably require a year for GW system to equilibrate and stabilize before excavation**
- **12 years maximum from end 2003**
- **Phase III 2006-2015**
- **Consider impact on duration and type of operations phase experiments**
- **Develop & prioritize activities, especially most time consuming activities**
- **With tight schedule it will be difficult to document research**

Some issues at the MIU Project

- ***Schedule***
- ***Size***
- ***Design***
- ***Project Management***
- ***Planning experimental programme***
- ***Staffing***
- ***Quality A methods***

MIU – Site & Regional studies

- *What would / could be done differently*
  - *What would be the approach to developing and applying an integrated technology at a new site or to developing a site selection strategy*
    - *Rethink strategy for locating boreholes*
    - *Cluster boreholes radial or intersecting patterns*
    - *Combine percussion and cored*
    - *What detailed mapping would be done*
    - *What geophysics would be most effective*

Drilling Technology

- Consider alternatives; costs , drilling rate, etc
- NQ vs. HQ vs PQ
- Cored and percussion in combination
- Continue Inclined boreholes
- Look at the range of international experience in Canada, Sweden, Switzerland, UK

MIU Phase II Science activities

- Construction Phase Experiments
  - develop in some detail soon
  - Needed to integrate with construction plans

Shoma Boreholes

- Borehole test facility
  - testing and calibrating of borehole geophysical tools
  - Testing hydraulic equipment
  - Teaching facility

Current Design of MIU U/G

- Keep design ideas flexible observational approach
- Design team stay informed of important new site information and interpretations (models)
  - Close integration with geoscience team essential – layout must be based on science needs
- Current design is based a simplified assumptions about geology; may need to be revised to accommodate new understanding & ideas

Planning of the Experimental Programme for MIU Phases II and III

- Start now
- Implement a project management approach
- Develop a Work Breakdown Structure – use geosynthesis flow analysis
- Assess what work can reasonably be done in the time available - prioritize
- Assess resourcing needs
- Scoping: major tasks include activities, durations, resourcing, equipment needs
- Need to properly assess schedule requirements- can it be done?

Staffing as it impacts on performance of the geoscience programme

- Organization
  - AECL-Branches/Sections
  - JNC - Groups/Teams
- AECL Sections
  - Geology – 7 professionals
  - Geochemistry – 6 professionals
  - Hydrogeology – 4 professionals
  - Geophysics – 4 professionals
  - Rock mechanics – 4 professionals
  - Hydrology 1 professional

Master Plan

- Include descriptions of science programme requirements and activities
  - Objectives
  - Details of experiment plans
  - Schedules
    - Feasibility
  - Manpower requirements
- Needed to derive budgets

Consider an Experiment Committee?

Peer reviewers identified

- Get input from outside TGC/JNC
  - Utilities; NUMO; International, including URLs

Staffing impact on performance of Geoscience Programme

- Can existing staff do all expected of them now & in upcoming phases
- To assess need details of:
  - Work programmes
  - Schedules
  - Milestones etc
- Does your professional staff have the technical support staff required? For example,
  - an in-house core logging team
  - An in-house geophysical logging team
- Professional development; time to publish?
- Staff turnover!

Some Considerations: are any of these possible

- Establish strong project management structure to plan and integrate science within construction activities
- Integrate MIU and RHS to optimize resources, planning and performance
- Try to extend termination date of operation phase, Phase III
- Obtain access to a larger volume of rock from the subsurface; try to get permission to drill and monitor the larger volume of rock beyond the site boundaries
- Begin to plan Phases II & III science activities, if no time, commission Experiment Design Reports
- Documentation/Reporting: essential for communicating results. However, it will be difficult to perform the work and document results under the current schedule.

Examples of high quality work

- **Working programme document**
- **Prompt reporting of results, including problems**
- **Documenting meetings and decisions, including basis**
- **Leading to a QA plan**

- **Geosynthesis Flow analysis**
  - **Sound analysis of data flow, inter-relationship of disciplines**
  - **Provides a basis for management of future programme; Basis for a WBS**

Considerations cont'd

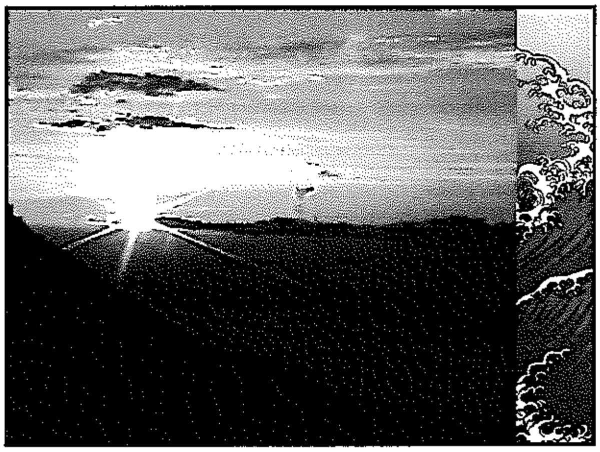
- **Continuity of the technical know how in the program is important to develop maturity. The regular staff turnovers can slow the project - result loss of historical knowledge**
- **Staff considerations such as need to publish and professional development can these be higher priority**
- **Development of reputation by increased exposure of staff internationally.**
- **Increase the technical support staff: For example,**
  - **An in-house core logging team**
  - **An in-house geophysical logging team**

Examples, cont'd

- **Six Team G/W Model Comparison Studies**
- **Joint Study on Fracturing and Faulting**
- **Team effort – conscientious effort to succeed.**

FINALLY, almost

- Take an experimental approach to trying some new technologies/equipment
- Begin to plan Phases II & III science activities now
  - Details of major tasks
  - Prioritize
  - Close integration of teams during Phases II & III
- Scheduling is a key element to understand –
  - Do you really need a concrete liner
  - need to define programme to do science right. There will probably not be slack time if things go wrong.
- Make documentation and publishing a high priority



FINALLY, at last

- Write documents in English and as close as possible to the Japanese version to avoid misunderstandings on content/scope/depth
- Challenge concepts, assumptions
- This is an exciting, challenging project
- ENJOY; you are in one of a small international group who will have built a URL!!