Browning

ORGANISATION FOR ECONOMIC
CO-OPERATION AND DEVELOPMENT

NUCLEAR ENERGY AGENCY

RWM/DOC(88)5

RESTRICTED

Paris, drafted: 24th February 1988

distr.: 29th February 1988

Or. English

RADIOACTIVE WASTE MANAGEMENT COMMITTEE

Progress Report on the International Stripa Project

1. This note is intended to inform the Committee of progress within the International Stripa Project. Since the last meeting of the RWMC, Phase II of the project has been completed and Phase III activities have progressed.

Phase II

2. Phase II of the project was started in 1983 and was completed at the end of June 1987. Its primary objectives were to develop techniques to assess the geology, hydrology and hydrogeochemistry of potential sites for the disposal of radioactive waste, and to perform tests to examine groundwater flow within fractured rock and assess properties of backfilling and sealing materials.

3. Based on the conclusions available from Phase II, it is clear that these objectives have been achieved. An executive summary of the results and conclusions from Phase II of the project will be prepared.

Progress of Phase III

4. Canada, Finland, Japan, Sweden, Switzerland, the United Kingdom and the United States are funding the Phase III programme, which will complement the results of research conducted under Phases I and II. The following areas are being studied:

(i) Site Characterization and Validation - This activity involves the characterization of geologic and hydrologic conditions in a previously undisturbed block of Stripa granite and the development of validated models for the site, using current investigative techniques and numerical models. A five-stage programme of investigations, predictions and validation is being conducted to test the ability to predict groundwater flow within fractured crystalline rock.

(ii) Groundwater Flow-Path Sealing - This task involves the testing of fracture sealing candidate materials by: (a) reviewing candidate grouting materials and techniques; (b) selecting candidate materials for study; (c) investigating their physical properties; (d) assessing their longevity; and (e) conducting a pilot-scale test at Stripa. The two main candidate materials are cement-based and montmorillonite-rich, clay-based grouts.

(iii) Fracture-Flow Channelling Experiments - The objectives of this task are: (a) to estimate groundwater residence times in fractures; (b) to investigate dispersion mechanisms and mixing properties; and (c) to determine the available sorption surface of fractures. Achieving these objectives will involve single - and double - borehole testing of single fractures to provide indications of transmissivity variations and the frequency and configuration of fracture-flow channels.

(iv) Development of High-Resolution and Directional Radar - The objective of this task is to provide further development of single-hole and cross-hole radar techniques, in order to: (a) estimate dip and strike (orientation) from single-hole measurements; (b) delineate the structural details of fracture zones; and (c) further evaluate 3-D investigation and interpretation techniques.

(v) Development of High-Resolution Borehole Seismics - This activity is designed to develop improved high-resolution seismic equipment for both single-hole and cross-hole investigations.

5. The first year of the 5-year Phase III programme has been completed.

The first phase of the site characterization and validation task has been completed, using fracture mapping, borehole radar and single-borehole hydraulics to define the basic structure and characteristics of a network model of the site. Initial network modelling has concentrated on sensitivity studies and ensuring the efficient operation of the computer code. Integration of the techniques is in progress.

In the geophysics technology development programme, a directional radar has been tested in the field and efforts are being concentrated on extracting the directional data from the complex series of results. With respect to the seismic improvement task, a new borehole source has been constructed and tested in the laboratory. Construction of a complex single-borehole testing apparatus has been completed for the fracture-flow channelling experiments, and is currently being deployed in the field.

The two-stage programme on sealing of fractured rock has progressed to the design and construction of a series of laboratory tests for evaluating clay-type compounds and cement-based gels. Currently, a site within the Stripa mine for the field test is being sought.

Task Force Groups

6. A proposal has been made to establish a Task Force Group for Fracture Flow Modelling, in addition to the existing Task Force Group on Sealing Materials and Techniques. The purpose of this new group would be to guide and

co-ordinate the modelling activities being conducted using data generated from the Stripa Project. An ad-hoc co-ordinating group has been established, and formal formation of the Task Force group will be sought at the next meeting of the Joint Technical Committee (JTC).

Future Meetings

7. The next meeting of the Technical Sub-Group (TSG) will be held in the United Kingdom on the 22nd-24th March 1988. The next JTC meeting is planned for the 6th-8th June in Sweden.

ORGANISATION FOR ECONOMIC
CO-OPERATION AND DEVELOPMENT

NUCLEAR ENERGY AGENCY

RWM/DOC(88)7

RESTRICTED

Paris, drafted: 24th Febr. 1988

distr.: 1st March 1988

Engl. Text Only

COMMITTEE ON RADIOACTIVE WASTE MANAGEMENT

Proposal for a Possible RWMC Appraisal of the Geologic Disposal Concept

1. As indicated in document RWM/DOC(88)6, a small RWMC Consultant Group was convened in Paris in October 1987 to consider a US proposal for an NEA initiative in documenting the status of waste disposal programmes in Member countries. Although the issue under discussion by the consultants primarily involved the distribution of information to a relatively restricted technical and policy audience, consideration was also given to the usefulness of the NEA releasing "positive statements" on certain waste management issues to a broader audience. In particular, the consultants proposed to consider issuing a statement by the RWMC supporting the concept of geologic disposal.

2. Both the Consultant Group and the RWMC Bureau recognised that such statements could be made only on a significantly well-established and documented technical basis. Such RWMC statements would therefore take the form of overviews or appraisals of specific issues already studied in the NEA waste management programme and should be released to the extent possible in conjunction with the publication of NEA reports.

3. Accordingly, as a Report on Geological Disposal of Radioactive Waste - In-Situ Research and Investigations in OECD Countries, was being finalised by the Advisory Group on In-Situ Research and Investigations (ISAG) [see point 8 of the Agenda of the March 1988 meeting of the RWMC], it was decided, in agreement with the Bureau, that an attempt should be made to prepare a draft text for a possible RWMC appraisal of the geological disposal concept. Such a draft, which has already been reviewed by the consultants and the RWMC Bureau, is attached to this document.

4. After further review by the Committee, it is proposed to include this text as a preface in the ISAG Report on In-Situ Research and Investigations in OECD Countries. In addition, as the objective is a relatively wide distribution to an non-professional audience, it could be used (either totally

or in parts) as background information for an NEA press release announcing the publication of the Report and as a basis for short articles in the NEA Newsletter and the NEA Nuclear Waste Bulletin, keeping essentially a technical character to the information presented.

5. The RWMC is therefore invited to:

a) Agree in principle to prepare, whenever is considered appropriate, short technical overviews or appraisals on specific issues in radioactive waste management for the information of a broad audience;

b) Discuss and approve the attached draft appraisal of the geologic disposal concept;

c) Agree with its publication as a preface to the Report on In-Situ Research and Investigations in OECD Countries; and

d) Agree with its use in the preparation of a press release to announce the publication of the report and of articles in the NEA Newsletter and Nuclear Waste Bulletin.

PREFACE

(To the Report on Geological Disposal of Radioactive Waste: In-Situ Research and Investigations in OECD counries)

APPRAISAL OF THE GEOLOGICAL DISPOSAL CONCEPT BY THE RWMC

Three years ago, the Radioactive Waste Management Committee (RWMC) of the OECD Nuclear Energy Agency (NEA) published a report providing an appraisal of the technical status of radioactive waste management [1]. That report presented the collective view of the RWMC on the main scientific and technical issues in the field of radioactive waste management, particularly from the point of view of the disposal and the associated long-term safety aspects. The fundamental conclusion of the RWMC was that detailed short- and long-term safety assessments were feasible, which would give confidence that safety criteria and requirements could be satisfied with available technology, and at a reasonable cost. The RWMC also recognised that R&D would have to continue to collect site-specific data and to refine safety studies, and that periodic re-assessments of waste management practices and policies would need to be made to account for evolving knowledge.

More recently, a report has been prepared by the NEA on the status of in-situ research and investigations for geological disposal in OECD Member countries [2]. The report notes that considerable national and international progress has been made since publication of the "Collective Opinion" [1] in furthering the development of the geological disposal concept for radioactive waste. Significant programmes and activities have been initiated and enhanced in the inter-related areas of in-situ research, data analysis and modelling, repository engineering design and performance assessment. In particular, in-situ research and investigations have become an integral and essential part of national programmes for concept assessment, site selection and repository development.

Geological Disposal-Concept and Rationale

The objective of geological disposal is to immobilize and isolate radioactive waste from the human environment for a period of time and in conditions such that any possible subsequent release of radionuclides from the repository will not result in unacceptable radiological risks, even in the long term. This can be achieved by designing multi-component systems, where the waste package, the repository and the specific characteristics of the geological system (geology, hydrogeology) provide multiple barriers to

radionuclide release and transport. The emplacement of packaged long-lived waste at depth in stable, low-permeable geological formations can ensure that the waste will remain immobilized and isolated until radioactive decay has reduced its radioactivity to negligible levels.

Geological disposal is designed to be a totally passive disposal system with no requirements for continued human involvement for its safety after closure of the facility. It will not be necessary to maintain post-closure surveillance or monitoring systems because of the inherent safety of geological isolation based on such factors as long-term stability of the host formation, sufficient depth for long-term isolation, sufficient impermeability, and lack of mineral worth of the host formation, all of which decrease the likelihood of inadvertent intrusion in the future. In practice, underground water circulation is the main natural phenomenon which can return radioactive materials to the biosphere, and the careful choice of a geological site coupled with suitable waste package repository engineered features can reduce the risks associated with this phenomenon. Predictive modelling of possible radionuclide transport by groundwater, including retardation by various geochemical processes and its radiological consequences, forms the basis for evaluation of the long-term safety.

Geological disposal is also a flexible concept, due to the variety of suitable geological media, such as salt, crystalline rocks, clays, shales, basalt and tuff. It can be implemented with current technology based on the extensive experience available in underground mining and civil engineering.

Current Status and Role of In-Situ Investigations

In the past, relevant research has been concentrated on generic issues involved in the long-term safety and feasibility of geological disposal, including development of investigation techniques. Increased emphasis is now placed on site selection and on concept implementation, i.e., identification of a suitable site and feasibility of construction at this site of a facility which could be operated and closed safely at an acceptable cost. This emphasis includes the development of procedures for conducting site investigations, detailed design and feasibility studies and performing safety assessments. An integral part of each of these involves the need to conduct in-situ studies at either reference or actual repository sites, so that appropriate site investigation techniques are made available, detailed designs can be shown to meet design standards and sufficient information is available for performance assessment models to predict post-operational safety with confidence. In this respect, a distinction can be made between underground research laboratories, such as Asse, Stripa, Grimsel, and the Canadian URL facilities where generic research and investigations are conducted, and those facilities where in-situ characterisation and qualification of a potential repository site are conducted, such as Mol or Gorleben.

A first benefit of in-situ research involves the development of methods and instrumentation for specific site investigation and characterisation techniques. Detailed characterisation of proposed repository sites is necessary to develop site-specific designs and performance assessment models incorporating the appropriate data. The geological, hydrological, geochemical and geomechanical features relevant to design and safety analyses require the development of specific, non-destructive site investigation techniques.

As noted in the NEA "Status Report on In-Situ Research and Investigations" [2], demonstration of concept feasibility is becoming increasingly dependent upon in-situ investigations conducted on a host-formation or a site-specific basis. In-situ experiments and investigations can help increase confidence in geological disposal in four main ways.

Secondly, in-situ research and investigations are essential for providing data for use in performance assessments. Extensive field studies are being conducted to provide data on a variety of environmental parameters, such as groundwater flow patterns and geochemical conditions. Information on interactions between repository environments and waste packages is also being obtained from in-situ studies, as a complement to the traditional laboratory studies.

In-situ experiments and investigations also provide field data to facilitate the validation of performance assessment models, i.e., comparing site-specific observations with numerical model predictions to test the ability to predict specific phenomena as part of a safety assessment. With the recognition that possible variations in conceptual assumptions and parameter values can yield major differences in results of performance assessments, it has been found desirable to reduce these process and parameter uncertainties and obtain more accurate data. This can be addressed by specifically designed model validation exercises conducted through laboratory experiments, large-scale in-situ experiments and the study of natural analogues. In-situ experiments are particularly valuable in addressing complex effects related to thermal- mechanical-chemical-geochemical-hydraulic phenomena, as well as waste form and packaging properties, and behaviour of backfilling and sealing materials. Excavation effects on geological media can also be evaluated.

A final aim of in-situ investigations concerns evaluation of the feasibility of repository design, construction, operation and closure. Such activities are to show that specific technologies exist to implement a given disposal concept at a specific disposal site or in a particular host formation and also to optimise the components of a disposal system.

In-situ investigations are, therefore, viewed as essential in order to accumulate data and knowledge on host formations being considered for disposal facilities, and to characterise and qualify potential repository sites. Investigations and tests in underground laboratories constructed in different geological formations have, and will continue, to yield valuable information for evaluating detailed disposal concepts. The RWMC views the increasing emphasis being placed on in-situ research and investigations as being appropriate and necessary to enhance the level of confidence placed on the deep geological disposal concept.

Site Characterisation and Selection

The RWMC notes that decision criteria for repository site characterisation and selection are becoming increasingly important. These issues involve not only decisions on concepts, host formations and specific

sites, but also decisions on the limits of information needs. As well, decisions are not solely influenced by technical and scientific findings, but also involve consideration of political and social factors.

A variety of disposal systems can be envisaged, since there is a diversity of suitable host formations, and engineered barriers can be adapted to the specific properties of the host formation. Each potential host formation offers advantages and limitations which should be assessed in terms of the total disposal system, including engineering design possibilities.

The basic issues involved in site selection generally will be similar amongst repository systems, host formations and candidate sites. For example, formations for geologic disposal will be evaluated on their geological stability and hydrogeological and chemical properties which govern their isolation capability. Site-specific factors subsequently become important for defining necessary in-situ and laboratory tests needs and for confirming the suitability of the site.

With respect to such site information needs, it is essential that appropriate methods and criteria be developed to enable regulatory authorities and those responsible for disposal to make decisions on how much, and at what level of detail, data and information need to be collected. Clearly, a balance needs to be achieved between demands for site information and possibilities to provide the desired information with available resources and techniques. Continued work on safety assessments of the complementary functions of engineered barriers and host formation properties are essential for the formulation of such criteria. As well, technical, socioeconomic and political factors relevant to a particular site need to be considered together.

The RWMC notes that potentially suitable sites for radioactive waste repositories have been identified in a number of countries in several types of host formation and geological environment. The selection of an actual host formation and a repository site will depend on technical as well as non-technical factors. Among these, safety may appear to be the overriding criterion - one which in theory would determine that the "safest" site should be selected. However, in practice it may not be necessary or possible to distinguish between sites or formations solely on the basis of such safety considerations. This would be the case when, for example, specific properties of the host medium differ between different sites, but their waste isolation and immobilisation capabilities nevertheless fully satisfy safety requirements. Other factors would then logically have a larger influence in arriving at a decision on which site or formation is considered to be the most suitable, or the "best".

Concluding Remarks

Based on its review of the current R&D programmes and the results of the feasibility studies already available, the RWMC reaffirms its confidence in the geological disposal option, for long-lived radioactive waste. This option is considered to be both feasible and safe in the long-term and the Committee recommends strongly that in-situ investigations be actively pursued to further contribute to the timely implementation of the concept. The Committee also notes that the diversity of potentially suitable geological

environments and the need to adapt and optimise repository designs to specific site conditions may result in apparent differences in the disposal systems finally adopted in various countries without, however, appreciable differences from the safety and environmental point of view.

[1] OECD/NEA, Technical Appraisal of the Current Situation in the Field of Radioactive Waste Management - A Collective Opinion by the Radioactive Waste Management Committee, OECD/NEA, Paris (1985).

[2] OECD/NEA, Geological Disposal of Radioactive Waste: In-Situ Research and Investigations in OECD Countries. OECD/NEA, Paris (In press).