CONTENTS

1. INTRODUCTION

Current thinking in OECD Member countries on the methods and procedures for the disposal of radioactive wastes arising from nuclear power generation is based on a substantial body of scientific research and development work carried out since the late 1940's. This is particularly the case for research into the disposal of high activity heat generating wastes. It has embraced the exploratory examination of a wide variety of options, through the evaluation of conceptual designs, to the adoption of preferred concepts and, in recent years, the devotion of considerable effort towards concept implementation. The latter includes developing procedures for carrying out site selection, conducting detailed design and feasibility studies and, perhaps of most importance, performing safety assessments. An integral part of each of these is the need to carry out research in situ at either a generic or actual site so that:

(i) the appropriate site investigation techniques are available;

(ii) detailed designs can be demonstrated to meet design standards; and

(iii) that sufficient information is available for performance assessment models to predict post-operational safety with confidence.

This report presents an overview of the status of in situ investigations and research relevant to the deep disposal of radioactive wastes and gives a broad outline of recent developments and progress in OECD Member countries.

2. DEEP GEOLOGICAL DISPOSAL

Although most types of radioactive wastes could be disposed of using deep disposal, more economic alternatives are available for those possessing relatively low levels of short-lived activity. Burial on land at shallow depth in an engineered repository is one such alternative which is currently practiced, for example, in France and the United States. Deep disposal several hundred metres below the surface is considered to be an appropriate solution for wastes arising from nuclear power generation containing long lived and/or heat generating radioelements [see Fig. 1]. In order to fully explain the main aims of disposal of radioactive wastes into deep geological formations, it is first necessary to outline the main features of those radioactive wastes requiring deep disposal. These can be broadly classified as high-level waste from reprocessing operations, encapsulated spent fuel elements (both heat generating) and alpha-bearing waste (non-heat generating). As an illustration, Figure 2 presents the dominant radionuclides in spent fuel and in high level waste [1].

2.1 Objectives of Deep Geological Disposal

The main issue with respect to the disposal of highly active wastes is how to cope with the very long term radiological risk associated with the presence of long-lived radionuclides in spent fuel, high level waste from reprocessing and other alpha bearing waste, and the high radiotoxicity of some of these radionuclides. Therefore the objective of disposal is to isolate waste from the biosphere for as long as necessary to avoid unacceptable burdens on future generations: i.e. until the level of radioactivity has decayed sufficiently so that the eventual return of radioactivity to man and the environment, as a result either of natural processes or of man's activities, presents no significant radiological or toxic risks.

2.2 The Concept of Deep Underground Disposal

As one of the possible solutions for the isolation of long-lived waste from the biosphere, is the concept of deep underground disposal. It has the following features:

1) The emplacement of waste deep underground in sufficiently stable and impermeable rock can ensure that waste will remain undisturbed and isolated for extremely long-time scales;

2) The safety of deep underground 'geologic' disposal relies upon a multi-barrier system, while the repository is characterised by a high degree of reliability and predictability. The Long-term safety performance of geologic repositories can be assessed using existing scientific techniques and methodologies;

3) Geologic disposal involved an entirely passive system of containment with no requirement for continuing human involvement for its safety, and particularly no long-term need for surveillance and monitoring of the site. The geologic barrier is one of the principle elements of the system;

4) The burden on future generations in terms of radiological doses and risks will be minimal, both from the point of view of potential migration of radionuclides through the geosphere with time up to the biosphere due to natural processes, and from the point of view of potential intrusion by man, the likelihood of which depending to some extent on the depth of the repository, and the geological medium chosen to host the site.

In addition to the above positive features of the geological disposal concept is the fact that there is a relative abundance of potentially suitable geological formations and also that there exists, through the International Commission on Radiological Protection (ICRP), a highly suitable basis for judging the acceptability of disposal [2, 3].

From the above it can be seen that several important features have to be taken into account when designing a system for the disposal of radioactive wastes, especially the radio toxic potential of the waste. Radiotoxicity can be derived from a summation of the comparative level of radioactivity of each radionuclide relative to the limit on its annual level of intake by ingestion recommended by the ICRP. Figure 3 gives a graphical representation of the radiotoxicity calculated in this way for high level radioactive waste compared with the risk potential of an equivalent amount of Uranium ore [3]. In the case of spent fuel and high level waste from reprocessing the heat output may also be important, especially where interim storage is of short duration. Table 1 gives the thermal power of spent fuel and high level waste. From this rough guide, it can be seen that, for high level waste, the period of concern extends up to about 1 million years, a period of time far longer than possible institutional control periods.

Fig. 1: Artist Impression of the Deep Geological Disposal Concept for Radioactive Waste

Fig. 2: Dominating Radionuclide Inventory in Spent Fuel and in High Level Reprocessing Waste (Assumes PWR fuel with a burnup of 33 GW.day/tonne, reprocessed after 5 years cooling).

Fig. 3: Typical Toxic Potential of Vitrified High-Level Waste from Reprocessing One Tonne of LWR Fuel as a Function of Time Compared with the Toxic Potential of an Equivalent Amount of a 0.17% Uranium Ore [3]

TABLE 1

THERMAL POWER OF SPENT FUEL AND HIGH LEVEL WASTE
AS A FUNCTION OF TIME *
Watts/tHM of original fuel elements

Time from Reactor Discharge (Years)	Spent Fuel	High Level Waste
10	1 290	1 120
100	284	134
1 000	49.4	6.8
10 000	13.5	0.6
100 000	1.0	0.10
1 000 000	0.3	0.102.3

* Data illustrated are for a PWR with a fuel burn-up of 33 GW day/tonne and subsequent reprocessing after 5 years
Source: Reference 8.

It is these two features that has led to the concept of the disposal of heat-generating and alpha-bearing wastes into deep geological formations being widely recognised as the primary method of disposal [eg. 5 - 10]. Such a disposal system would provide more than adequate shielding against radiation, as well as absorb and disperse heat and provide long term isolation irrespective of human involvement. A deep underground location also decreases the likelihood of inadvertent intrusion by man.

The "deep geological disposal" concept consists of a system of barriers to the release of radioactivity, a general breakdown of which is illustrated in Figure 4. This multi-barrier approach relies upon three main elements: the near-field, the geosphere and the biosphere. The near-field constitutes an engineered emplacement and containment system for the waste, the geosphere comprises one or a sequence of geological formations selected so as to provide adequate isolation or containment of any radionuclides released from the waste, while the biosphere represents the accessible environment for man. The latter, while not being a barrier as such, utilises the decrease in concentration due to dilution and dispersion as its contribution to the effectiveness of the disposal system.

Fig. 4: The General Breakdown of the Isolation System

+ diagram (HYDROCOIN REPORT)

3. PREFERRED GEOLOGICAL ENVIRONMENTS

Different types of rock are being investigated in NEA Member countries both for their general suitability as host rocks and as actual repository sites. The choice of rock type depends strongly on availability within each country. Table 2 gives examples of the countries studying each main rock type.

Table 2

Main Candidate Host Rocks for Deep Repositories

ROCK TYPE	COUNTRIES
Clays	Belgium, France, Italy, Switzerland (Marl), United Kingdom
Crystalline	Canada, Finland, France, Japan, Sweden, Switzerland, United Kingdom, United States
Salt/anhydrite	France, Federal Republic of Germany, Netherlands, Switzerland, United Kingdom, United States
Basalt	United States
Tuffs	Japan, United States
Schists	France

3.1 Potential host rocks

3.1.1 Clays

These range from highly consolidated shales to plastic clays. They are attractive as host rocks mainly because of their low hydraulic conductivity, their chemical reactivity and their plasticity. These attributes restrict the movement of groundwater, attenuate the migration of leachates and enable the host rock to seal around openings. Another aspect of clays which makes them attractive as potential repository sites is their extensive, predictable occurrence within layered sedimentary sequences.

3.1.2 Crystalline rocks

Rocks being considered within this category include all extrusive and intrusive igneous rocks (eg. granites, basalts, etc.) together with high grade metamorphic rocks (eg. schists and gneisses). They are attractive as host rocks because they are strong and hence underground excavations are usually very stable. Where fracturing is infrequent they have low hydraulic conductivity. These attributes tend to result in them being considered suitable for the deepest disposal options. As a result, the risk of subsequent human intrusion is very low.

3.1.3 Salt formations

Salt occurs either in the form of bedded-salt or salt domes (due to diapirism). In either form it has a very low permeability coupled with low strength and high thermal conductivity. These properties mean that it seals openings effectively and shouldn't retain fissuring or faulting to any major extent. It is also capable of dispersing the heat from heat-emitting waste the most effectively of all the candidate host rocks.

3.1.4 Other Rock Types

These include such rock as welded tuffs and anhydrite. In general they possess the same characteristics which make the previous rock types attractive, but in a different combination. For instance welded tuff has the attributes of strength coupled with some of the mineralogical aspects of clays.

3.2 Other Considerations

The different rock types are attractive for the reasons stated though each attribute has its drawback. For instance, lack of strength means good sealing properties but results also in unstable openings and hence a repository would be relatively costly to construct and operate.

A feature which should be borne in mind in all these descriptions is the inherent heterogeneity of each of these types of rock. This manifests itself differently depending on rock type and varies from variable fracture frequency in crystalline rocks to lenses of different mineralogy in clays.

4. CONCEPT FEASIBILITY AND SAFETY

Decisions on the implementation of the geological disposal concept in NEA Member countries will rely heavily on two factors. First, the demonstration of concept feasibility and, to a lesser extent, cost effectiveness and, second, on the level of confidence in demonstrating the long term safety. It is these two areas which are currently the subject of a major research effort in NEA Member countries and two recent NEA reports [7, 8] outlined what must be demonstrated to establish confidence in our ability to manage high level waste safely. This section summarises what is meant by demonstration and what must be demonstrated, particularly from the point of view of in situ research and investigations.

4.1 The Meaning of Demonstration

It is possible to "demonstrate" in a direct way the satisfactory operation, from the safety standpoint, of a high level waste solidification facility and a storage installation, on a representative scale and over a limited period of time, say a few years. This is a direct demonstration which for all practical purposes has already been achieved, notably in France, through the successful operation of the AVM industrial solidification plant and its associated storage facility at the Marcoule Centre. On the other hand, for waste isolation over the very long term, "demonstration" has necessarily to be seen in a different way in view of the very long time factor. A direct demonstration of such a disposal system would require practical experience over a period equivalent to that for which the system is designed to contain the radioactivity. Since the objective is precisely to ensure geological isolation over a considerable length of time, it is impossible to envisage a direct demonstration over so long a period based on any "a posteriori" proof of safety. "Demonstration" of high level waste disposal must therefore be indirect and based ona different approach. The collection of supporting evidence and preparation of a predictive safety assessment can constitute an indirect demonstration of this type and provide the degree of confidence required.

In practice, there is only one possible approach to "demonstration" of a deep underground disposal facility in a suitable geologic medium. This include two steps:

- to prove that the facility could be built, operated and closed safely and at acceptable costs, using available mining and engineering experience; this may involve designing and building one or more in situ experimental facilities or structures of appropriate dimensions, and

- to provide indirect proof by preparing a convincing evaluation of the system's performance and long term safety on the basis of predictive analyses confirmed by a body of varied technical and scientific data, much of it deriving from laboratory in situ experimental work carried out at generic or potential disposal sites.

It is for these reasons that predictive analyses are used as scientific tools to foresee the long term behaviour of individual system components, as well as the long term behaviour of the disposal system as a whole. Backed by results obtained from field experiments and other domains of science such as geology, hydrology, the study of natural historical evidence and archeology, such "system performance assessments" have the potential to provide indirect proof of the suitability and long term integrity of the systems proposed for the ultimate containment of high level waste.

4.2 What must be demonstrated

To establish confidence in our ability to manage high-level waste safely it is necessary to show that:

- Repository designs are feasible in engineering terms;
- Repository operations, backfilling, and closure can be achieved in the manner envisaged in the design without compromising the long-term integrity of the repository;
- Stress fields are sufficiently understood and predictions of distortions below ground can be made to allow stable structures to be created for emplacement; prediction of the impacts of any changes in the zone affected by the repository that will occur after closure can be estimated;
- All significant mechanisms by which radionuclides might return to man can be identified and analysed, and are amenable to predictive modelling;
- Mathematical modelling of repository behaviour and radionuclide transport is feasible, and the results are sufficiently reliable for confidence in their validity;
- The data needed by the models can be acquired, and are sufficiently reliable for their purpose;
- The results of safety assessments for the operating and post-closure periods are consistent with long-term safety objectives;

It can be seen from this list that demonstration of feasibility is closely associated with factors that can only be considered in situ on a host rock or site specific basis. These include:

- developing methods for detailed site investigations to obtain an adequate understanding of the local geology and hydrology for design and construction and as data for detailed safety assessments;
- developing safe handling, transport and emplacement techniques adapted to each type of host rock and disposal concept;
- developing techniques for plugging boreholes and shafts and sealing excavations; and
- conducting specific model validation experiments in order to provide a more realistic and reliable basis for performance assessments.

It is this need for site or host rock specific activities that several NEA Member countries have developed specially designed test facilities, or underground research laboratories (URLs). Such in situ facilities are essential in order to build up a body of knowledge and data about rock formations with very low permeability.

5. UNDERGROUND RESEARCH AND INVESTIGATION FACILITIES

5.1 Aims of In Situ Research

In situ experiments and investigations carried out at likely repository depths can help increase our confidence in a proposed disposal solution in four main ways:

(i) by comparing site specific observations with numerical model predictions to test our ability to predict specific phenomena as part of a safety assessment (validation);

(ii) by testing components of repository design, construction, operation and closure (demonstration);

(iii) by providing testing facilities to develop specific site investigation techniques as well as experience in using a combination of techniques (methods and instrumentation) and

(iv) by providing data for use in performance assessments.

Generic studies of the safety of radioactive disposal systems indicate that the solutions are likely to be safe. However, further work is necessary to make some of the component models more realistic. Heavy reliance is placed on predictive mathematical models to represent the various parts of the disposal system i.e. the vault, geosphere and biosphere, in assessing the radiological consequences of disposal. Such models in turn have to be based on observations made in the laboratory or in situ in order that confidence can be placed on the results. The interaction between modelling and observations is iterative in that detailed process models will be developed based on observations carried out in the laboratory or field. Such models should then be validated by first predicting the performance of specific phenomena and then comparing this with laboratory or field observations. The detailed models, where necessary, are used to develop simpler models which can be used in modelling complete disposal systems.

In addition, further effort has been devoted, where possible, to demonstrating concept feasibility by carrying out full or part-scale testing of particular components of the disposal system. This is particularly the case for the vault or near-field environment which includes a large proportion of engineering design involving civil engineering and geotechnical evaluations.

A further aspect of concept feasibility and assessment is the development of techniques to carry-out field investigations both on a regional and small scale i.e. at the site of a disposal facility. As most potential sites are situated in formerly unproductive rocks of low economic interest, little effort has been devoted to developing methods for measuring their properties and extent. Where previous studies have been carried out these produce often inappropriate or unreliable date. Hence, new techniques have had to be developed for site characterization and evaluation.

In situ research can help reduce uncertainties in parameter values used for performance assessments providing more realistic data. This is important both when generic and when site specific assessments are carried out. If exact data cannot be obtained in situ research may also help reduce the spread of parameter values used in making probabilistic assessments.

An overview of past and present at underground research laboratories is given in Table 3. This indicates the widespread acceptance of the benefits of developing in situ facilities among OECD Member countries by either establishing a test facility at a generic site largely to develop methodologies and test engineering designs or on sites that are potentially suitable as disposal facilities.

Table 3

Past and Present In Situ Research Facilities

5.2 IN SITU R&D ACTIVITIES

5.2.1 Model Validation

Perhaps the most important performance assessment and in situ R&D activities at the current time are those devoted to the validation of models to be used in performance assessments of disposal systems. Recent studies involving global performance assessments of potential disposal concepts such as the Swedish KBS-3 [9] and Swiss Project Gewähr [10] have shown that possible variations in conceptual assumptions and parameter values can give major differences in the results. For this reason it is necessary to seek ways of reducing the uncertainties arising from poor conceptual understanding of relevant processes and seek ways to provide more accurate data. Recent studies [Andersson/Intraval] have shown that the best way to do this is to carry out specifically designed model validation experiments. This can be done in three main ways i.e. (i) performing laboratory scale experiments; (ii) large scale in situ experiments; and (iii) studying specific processes using natural analogues.

A Conceptual model and the numerical model is said to be validated when it is confirmed that the conceptual model and the computer code provide a good representation of the actual processes occuring in reality. Validation is therefore carried out by comparison of mathematical predictions with field observations and experimental results [IAEA-TECDOC-264, 1982]. If this is not possible, for example, due to the long timescales over which predictions must be made, then peer review procedures have to be used based on current experience and historical evidence.

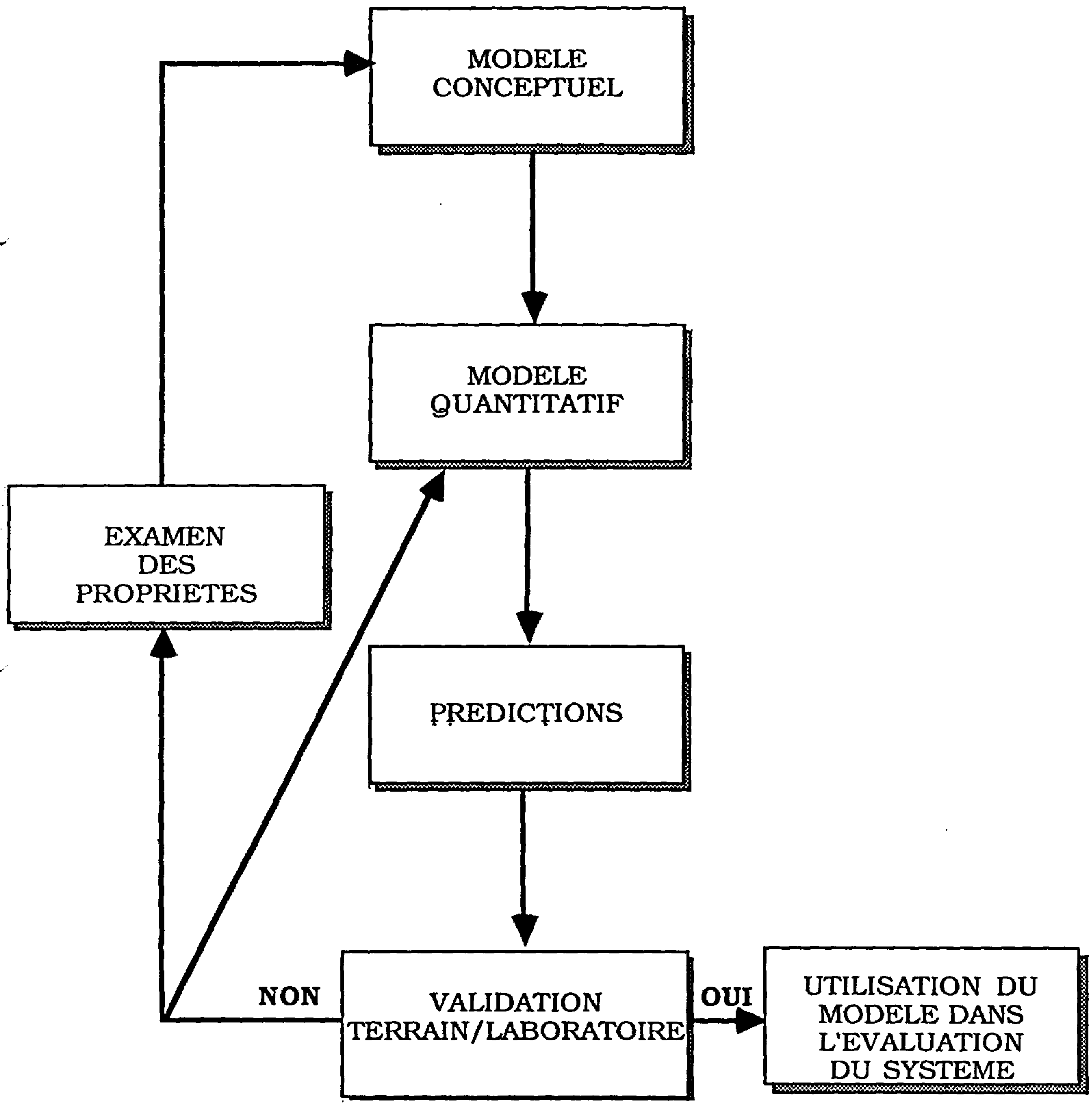
Several initiatives have been taken at national and international level to help coordinate effort devoted to validating performance assessment models. Notable among these is the INTRAVAL project initiated by the Swedish Nuclear Power Inspectorate (SKI). The objective of the INTRAVAL project is to evaluate the validity of different models aimed at describing the transport of radioactive substances in the geosphere.

An illustration of the approach adopted in validating performance assessment models is given in Figure 5. This iterative approach involves broadly the following steps: (a) develop a conceptual model of a specific part of the disposal system, eg. the behaviour of the backfill material; (b) extract from existing literature the necessary input parameters; (c) make predictions; (d) compare these with laboratory or field observations; (e) if these agree it is therefore valid and can be used as part of the overall system performance assessment; if not, the predictive models should be improved and, then, compared with laboratory or field observations until the model can be said to be satisfactorily validated.

Fig. 5: Iterative approach to model validation

FIGURE 5

ITERATIVE APPROACH TO MODEL VALIDATION



The types of phenomena that can be treated in this way are numerous, although a major difficulty exists in conducting validation experiments on processes involving long time scales. In situ experiments are in particular valuable in addressing coupled effects such as thermal-mechanical-chemical-hydraulic phenomena or the following specific areas of study:

- Waste form degradation
- Corrosion of Canister and overpacks
- Behaviour of backfilling and sealing materials
- Radiation effects on host medium
- Thermal effects on host medium
- Chemical and mineralogical changes/reactions
- Mechanical effects
- Hydrological changes

Validation of specific parts of waste repository systems with natural or man-made analogues may be possible if differences in release, transport, and biological uptake mechanisms can be properly taken into account. All the field data that are available to us from ancient artifacts, observations of buried glass blocks in Canada, the Oklo natural fission reactor in Gabon, Africa, the thorium deposit at Morro do Ferro, Brazil, and uranium ore deposits at Alligator Rivers in Australia and Cigar Lake in Canada, demonstrate that leaching rates of such materials under natural conditions tend to be very much lower (sometimes several orders of magnitude) than is indicated by laboratory measurements [16]. A concerted effort is currently being made to use natural analogues for the validation of specific process models. The Natural Analogue Working Group set-up by the Commission of European Communities helps coordinate research in this area [17].

5.2.2 Demonstrations of Engineering Feasibility

Engineering demonstrations of construction, operation and closure of deep repositories have been carried out, or are planned, at a number of in situ research facilities. The aim of each of these activities is to clearly demonstrate that specific technologies exist to implement a chosen disposal concept at a specific disposal site or in a particular host rock and also, to optimise all the components of a disposal system. Examples of these include carrying out actual emplacement of waste in a test site to demonstrate operational capabilities; observing the behaviour of backfill and sealing materials; and testing various excavation methods for shafts, tunnels and underground openings to examine the response of the rock mass to excavations so as to minimise rock damage and not hinder the containment provided by the host rock.

5.2.3 Improving Site Characterisation Methods and Procedures

It is necessary to carry out a detailed characterisation of any proposed site for a deep disposal facility in order to develop site specific designs and performance assessment models and to confirm that no significant geological features remain undetected. The geological, hydrological, geochemical and geomechanical features exhibited by candidate sites that are relevant to design and safety analyses often require the development of specific site investigation techniques. For example, to retain as far as possible the integrity of potential sites investigation techniques should, where possible, be non destructive, remote techniques. It is for this reason that seismic and a radar methods have had to be or are in the process of being specifically adapted for investigating potential disposal sites.

Data in Support of Models

A great deal of scientific information in support of repository models is available, and the amount of this information continues to grow. Most of it is obtained from laboratory studies but a growing amount comes from larger scale in situ tests and from observations of natural analogues. Laboratory studies have provided much information that is essential to an understanding of the interactions between repository environments and components of the waste package. Extensive field studies have been carried out to provide data on a variety of environmental parameters such as groundwater flow patterns and radionuclide migration rates.

In situ investigations at potential sites will play an essential role in providing reliable data for use in performance assessments. This will include surface observations on a regional scale and detailed observations at a proposed site using boreholes and specifically designed in situ testing.

7. NATIONAL AND INTERNATIONAL IN SITU RESEARCH AND INVESTIGATION PROGRAMMES

7.1 INTRODUCTION

The following sections provide broad overviews of in situ research, demonstration and investigation programmes in OECD Member countries. It is clear from these that there exists a widespread acceptance of the integral role played by in situ facilities in demonstrating the feasibility and safety of proposed disposal solutions as well as confirming the suitability of potential disposal sites.

7.2 BELGIUM

INSTITUTIONAL FRAMEWORK [to be written]

OVERALL SCHEME OF RWM [to be written]

IN SITU RESEARCH AND INVESTIGATIONS

The underground laboratory constructed on the site of the belgian nuclear research establishment (SCK/CEN) at Mol, Belgium has been the starting point of an extensive in situ research programme in deep clay [9, 10, 11, 12, 13]. Specific in situ investigations in the field of corrosion behaviour of various structural materials and waste forms are being carried out in representative conditions. Important contributions have been brought to conducting assessments of the hydrology of the clay body and the adjacent layers, the geotechnical aspects of building galleries in clay and radionuclide migration in clay.

The result of all these investigations are very encouraging and the decision was taken to extend the underground laboratory towards a pilot size demonstration facility. The H(igh) A(ctivity) D(isposal) E(xperimental S(ite) project will be developed within the framework of the european atomic energy community's cost sharing research programme on radioactive waste management and disposal.

For reasons of technical convenience the HADES project has been split into two phases:

- in first phase (1986-1992) includes the upscaling of construction capability in non-frozen clay coupled to pilot size experiments on heat transfer, radiolysis and gamma source handling;

- in a second phase (1988-1994) includes the construction of a second shaft with connection tunnels to the existing laboratory. This phase will be started after approval by the National Waste Management authority (NIRAS-ONDRAF).

The full scale underground demonstration gallery will allow to perform mock-up tests on real scale first and retrievable disposal of different waste forms at a later stage.

Concept of the Demonstration Test Drift as it will be Constructed in the Vicinity of the underground Laboratory

7.11 UNITED STATES

INSTITUTIONAL FRAMEWORK [to be written]

Organisations responsible for RWM 1 paragraph

NUCLEAR REGULATORY COMMISSION

OVERALL SCHEME OF RWM - REGULATION OF CIVIL WASTES

Before submitting a license application for a civil radioactive waste repository, the DOE (Department of Energy) is required by the Nuclear Waste Policy Act of 1982 and by 10 CFR Part 60 to conduct a programme of site characterisation [25]. In situ testing is an important element of site characterisation. These tests are to be performed from the exploratory shaft(s) and underground openings on surrounding rock and on other materials and components such as the waste package, engineered backfill, linings, and seals. The conditions under which these in situ tests are to be run should represent, as closely as possible, the realistic repository environment (for example, temperature and stresses). The tests performed under such conditions would provide data to assess the suitability of a particular site and a particular geologic medium to host high-level nuclear waste and realistic input parameters for the design of a geologic repository.

In situ tests can only be conducted for a limited duration compared with the long time span during which the repository must function to isolate the waste. Analytical, experimental, and numerical models must be used to make predictions far into the future; however, models have their own limitations on applicability and are sensitive to the quality of data used as input. Some of the uncertainties in the prediction process can be reduced by conducting appropriate in situ tests on a representative volume of rock and by using appropriate models to account for possible inherent spatial variations of physical, hydraulic, and chemical properties within the rock formation. By comparing in situ test data with modeling results, models can be validated, thereby reducing some uncertainties in the prediction process.

NRC Technical Positions on In Situ Testing

The NRC staff technical positions on in situ testing during site characterisation are:

(i) Before submitting a license application, DOE should perform a necessary and sufficient variety and amount of in situ testing to support, if the facts so warrant, a staff position that the requirements for issuance of a construction authorisation (10 CFR Part 60.31) have been met.

(ii) The in situ testing program should be developed with two major objectives: (a) characterisation of host rock and in situ measurement of its properties prior to construction and waste emplacement; and (b) determination of response characteristics of the host rock and engineered components to construction and waste emplacement.

(iii) DOE should present its site specific and design specific in situ test plans in the Site Characterisation Plan (SCP).

(iv) Before developing the in situ test plan, DOE should develop a rationale for in situ testing and present this rationale with the test plan in the SCP. The overall goal of the rationale should be to ensure that all important parameters are identified and ranked according to their relative importance in supporting 10 CFR Part 60 licensing findings.

(v) For successful site characterisation, DOE should integrate the data from surface borehole testing and laboratory testing on small-scale samples with the in situ test results.

This technical position is general and covers in situ testing for all potential repository sites and designs. It was developed and presented to the Department of Energy in an effort to provide ongoing pre-licensing guidance.

DEPARTMENT OF ENERGY

OVERALL SCHEME OF RWM - DISPOSAL OF CIVIL WASTES

In accordance with the requirements specified in the Nuclear Waste Policy Act of 1982, the Department of Energy (DOE) is developing site characterisation plans for the three potential sites for the first repository [26]. Those sites are the Hanford site in the state of Washington, the Yucca Mountain site in Nevada and the Deaf Smith County site in Texas. As part of the site characterisation plans, the DOE will describe the methodology used to identify the information needed from the characterisation studies and the tests necessary to obtain that information.

The methodology used in developing the site characterisation plans was to first identify a common set of issues that must be resolved to demonstrate compliance with applicable Federal regulations and to support site selection and licensing. The next phase was to develop "issue resolution strategies" for each of the issues. Since the issues are derived from applicable Federal regulations, the information needed to resolve them will be the basis for planning of the work that need to be done to demonstrate compliance with the regulatory requirements. The issue resolution strategy provides a step-wise procedure for identifying and planning the work needed to support resolution of the issues. Because the rock types and conditions at each of the candidate sites are different, the issue resolution strategies and the related site characterisation plans will differ from site to site.

As part of the issue resolution strategy, DOE utilises a process called "performance allocation". Performance allocation entails deciding which items within a geologic repository will be relied upon in resolving a particular issue. The function an item must perform and the processes that affect the performance are identified for each item. Using performance allocation, a testing programme can be developed which obtains the information necessary to demonstrate that an item will perform its particular function as expected. Once the appropriate information needs are identified, DOE can identify what underground tests should be conducted.

IN SITU RESEARCH AND INVESTIGATIONS

The in situ tests currently being considered for site characterisation at each of the three candidate sites are grouped under three broad categories: 1) basic geologic characterisation tests; 2) hydrologic characterisation tests; and 3) near-field and thermally perturbed tests. The objective and/or rationale for performing a test is based on the performance allocation process.

Of the 44 tests currently defined, more than half (27) of the tests will be conducted at all three sites. The differences in the test plan reflects differences in the characteristics of the site (i.e., rock type, in situ conditions, etc.) or differences in the design of the test facility. For example, the perched water test for the Nevada Nuclear Waste Investigations project (NNWSI) and the brine migration test for the Salt Repository Project Office (SRPO) are not planned at the other sites due to the site specific nature of the phenomenon being investigated. The design of the shafts to the exploratory shaft facility at the Basalt Waste Isolation Project (BWIP) prevents the mapping of the shaft walls. The shaft will be blind drilled and the shaft liner installed while the drilling mud is still in the shaft, preventing direct access to the shaft wall.

As part of the site characterisation plan, detailed test plans and procedures are being written for the test at each site. In addition, quality assurance procedures are required to insure the test data is accurate, reliable, and traceable. Consultative drafts of test plans will be reviewed by the NRC and representatives of the States and Indian tribes in the first quarter of 1988. The test plans may change based on review recommendations or to reflect modifications in the information needs and strategies chosen to resolve the various issues.

DEFENCE PROGRAMME

OVERALL SCHEME OF RWM - DEFENCE WASTES

The Experimental Program for the Waste Isolation Pilot Plant (WIPP) has been developed by the Department of Energy (DOE) to address those technical issues that concern the safe disposal of Defense Transuranic (TRU) Wastes and Defense High Level Wastes (DHLW) in underground storage rooms [24]. This program involves technology development through laboratory and theoretical studies and in situ testing done in representative waste storage room configurations for both the ambient (for TRU) and heated (for DHLW) conditions.

IN SITU RESEARCH AND INVESTIGATIONS

The technology development studies, since 1975, have been investigating phenomena associated with radioactive waste emplacement in a rock salt environment and have produced response models and predictive techniques using available laboratory and theoretical data. The in situ testing program at the WIPP has been developed to evaluate these models and predictive techniques through full-size experiments in the actual host rock. The first portion of the in situ tests (underway since 1984) are without radioactive materials and use electric heaters to simulate heat-generating waste where applicable. The second portion of the in situ testing programme, scheduled for the early 1990s, will include the use of actual radioactive wastes and other radioactive sources.

The in situ testing programme includes analyses and evaluations of data obtained from in situ measurements that provide an understanding of the actual behaviour of salt surrounding full-size storage rooms while undergoing creep closure due to overburden stresses and thermal loadings from waste containers. Data analyses and evaluations also pertain to tests that are designed to measure TRU and DHLW container performance, materials interface interactions, and engineered barriers and seals performance in an actual salt environment. These tests are expected to provide a better understanding of the phenomena, provide in situ data to validate models and theoretical studies, and demonstrate the behaviour of the salt, waste packages, and engineered barriers and seals in an actual underground salt environment. An underground layout of the in situ tests at WIPP is illustrated in Figure

OECD 14/10/87

NUCLEAR ENERGY AGENCY

Dr Nataraja, By 26/10/87:

Could you please review this text and the summary of the

With the compliments of the Secretariat

US program. Could you send me a telefax giving a paragraph on the "Institutional Framework" for RWM in the USA.

Best Regards

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See Docket 1 for encl; Green book

WM DOCKET CONTROL CENTER

'87 SEP 30 A11:17

WM Record File 412.2

WM Project ______
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