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Multinational Cooperation in Geological Disposal: Sharing of Concepts, Results, Research Projects and Facilities

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Abstract

Since the earliest days of research into geological disposal of radioactive wastes, multinational cooperation has played a prominent role. The early concepts developed by some nations have been adopted and/or adapted by many programmes that started later. The repository design work and the analyses of the safety of these facilities depend on a vast range of data that was being produced in parallel in laboratories across the world. In practice, the most intensive collaboration between nations in the area of disposal related R&D may be the work carried out in underground laboratories (URLs). In addition to the specific technical tasks, there are key strategic challenges in geological disposal where multinational collaboration has also played a major role. These include the development of siting strategies, approaches to communicating with the public, and in preparing and presenting convincing arguments on the safety of repositories. Multinational cooperation in repository construction and operation will also occur by sharing technology and expertise. Furthermore, although, in many national repositories, cooperation involving the acceptance of foreign wastes is not foreseen, there is increased interest in expanding the possibilities for operation of multinational repositories, either as a service or as a regional partnership between willing countries.

1 INTRODUCTION

Since the earliest days of research into geological disposal of radioactive wastes, multinational cooperation has played a prominent role. One reason for this was that commercial restrictions were very much less than in other areas of nuclear technology. Developments of nuclear power plants and of fuel cycle facilities for the front-end and for reprocessing were competitive commercial fields. Ensuring that wastes could be disposed of safety and economically was increasingly recognised as a common challenge that, although not a major contributor to its costs, is a pre-requisite to obtaining the necessary public acceptance of nuclear power. Solving this universal problem was seen to be more important than trying to exploit commercially the advances being made. In addition, in many countries, including the USA, UK, France, Japan and Germany, development work has been led by government organisations with little interest in commercially exploiting the work.

The specific aspects of geological disposal programmes that have been, and are being, strongly influenced by multinational cooperation are many and varied. Since intensive cooperation in waste disposal has been taking place for decades, it is impracticable to document here the numerous specific projects that have been carried out. Instead, this overview identifies the principal types of collaboration that take place between national programmes and illustrates these with examples. The following activities that can benefit from cooperation are addressed:

- Developing strategies and concepts for geological disposal
- Knowledge exchange and transfer
- Jointly developing methodologies and producing experimental results
- Organising large scale joint research projects
- Communication activities
- Implementing waste management facilities

The very close relationships between national programmes can also result in potential disadvantages that must be guarded against. These risks are also discussed.

2 DEVELOPING STRATEGIES AND CONCEPTS

The very principle of geological disposal has become almost universally accepted largely due to cooperation between nations. The original idea can be traced back to the US National Academy in 1957, but in the 50 intervening years it has been consolidated and refined in innumerable multinational efforts, including those organised by the IAEA and the NEA. Today, it is almost universally accepted that geological disposal is the only available approach to ensuring very long term safety and security for certain types of radioactive wastes. Of the major nuclear nations, the UK and Canada were the most recent ones to reaffirm this formal conclusion after extensive public consultation processes.

At the more specific level of repository design concepts there have been strong influences of international cooperation. The early concepts developed by some nations have been adopted and/or adapted by many programmes that started later. The pioneering work was sometimes a reaction to public or political pressures tied to continued use of nuclear power. In such countries, reference disposal concepts were established that have been taken up widely, e.g. the KBS3 design developed in Sweden for hard rock or the horizontal emplacement in small diameter tunnels proposed by Switzerland for hard rock or clays. Other examples are German concepts for repositories in salt domes or the US work on bedded salt which led to the implementation of the first custom-built deep geological repository at WIPP. All these basic designs were published openly. The choices of potential host rocks for a deep repository have also been affected by international trends – although local geology obviously also determines preferences strongly. Early work in granite in Scandinavia and salt in the USA led many countries to look first at these options. Later, increased interest in clays could be observed as various countries moved in this direction.

These technical aspects are less affected by societal considerations than are the challenges of choosing a repository development strategy. Despite the frequent references to “cultural differences” between nations that affect societal issues, however, there has still been a convergence of approaches. There are key strategic and policy challenges in geological disposal where multinational collaboration has clearly played a major role. These include the development of siting strategies (where a staged approach has become common), approaches to communicating with the public (where dialogue rather than one-way information flow is now preferred) and in preparing and presenting convincing arguments on the safety of repositories (where the term “Safety Case” is now common). Many of these developments have been the

result of direct cooperation between nation programmes in the framework of joint projects or of bilateral or multinational working groups.

Specifically, siting programmes in many countries have progressed from a “decide, announce, defend (DAD)” strategy to an approach requiring local acceptance or even community volunteering. Repository implementation plans have evolved from relatively short, one-off construction projects run by experts to extended staged programmes requiring continuous interactions with the public. The growing consensus on these strategic issues results, in large measure, from the exchange of positive (and negative) experiences between national disposal programmes.

A final, very topical, strategic issue that is increasingly affecting multinational cooperation on waste disposal strategies relates to the growing global concerns about nuclear security. There is wide realisation that national and global security depends on maintaining tight control over nuclear materials, including spent fuel and HLW. This encourages multinational cooperation efforts aimed at emplacing such sensitive materials underground in secure repositories in either a national or a multinational context.

3 KNOWLEDGE EXCHANGE AND TRANSFER

As pointed out in the introduction, there has always been a very free exchange of knowledge in the waste management field. A key mechanism for this is open publication of results, including comprehensive report series published by implementers, detailed reviews by regulators and independent studies by research labs. In addition there are numerous workshops and conferences (which some believe to be almost too frequent throughout the year), and exchanges in the scope of bilateral agreements (of which a typical implementing body may have 5-10) and also through international organisations (most prominently the IAEA and the NEA).

Exchanging polished final results in journal articles and conference proceedings does not, however, suffice to transmit the in-depth knowledge that is gained more when projects fail than when they are successful. Accordingly, various national programmes have established international advisory groups which include chosen experts with detailed knowledge of foreign programme developments. The International Technical Advisory Group (ITAC) of the Japanese implementing organisations, NUMO, is a good example of this with its members having been heavily involved in 8 different national programmes. In practice virtually all major national waste disposal programmes have engaged experts from other countries as sub-contractors, advisors or reviewers. Another mechanism for transferring in-depth knowledge is by exchange of personnel between programmes. This has, however, been used to a relatively limited extent.

Finally, commercial approaches are also employed to transfer knowledge, in particular to young disposal programmes. Some of the larger national implementing bodies have a fully commercial consulting wing of their own (e.g. SKB, Nagra, Posiva, Nirex) or else combine their resources to provide consulting services (e.g. the CASSIOPEE group of waste management organisations). At a more generic level there are also various initiatives today aimed at transferring knowledge by means of formal tuition in courses. These are sometimes provided by fully commercial organisations, sometimes by not-for-profit organisations (e.g. ITC in Switzerland or the WNU in the UK) and occasionally funded or organised by the IAEA.

4 DEVELOPING METHODOLOGIES AND PRODUCING EXPERIMENTAL RESULTS

The repository design work and the analyses of the safety of these facilities depend on a vast range of data that has been produced in laboratories across the world – and again, virtually all of these data were freely available. In fact, since a large subset of the data is generic, it was soon realised that cooperative efforts between national could generate such data more efficiently. Joint efforts on defining data collection needs and on sharing the work have been encouraged by international organisation like the EC, the IAEA and the NEA

Many of the experimental or theoretical methodologies used in geological disposal programmes have been developed in one country and then shared with others. Laboratory techniques for measuring leach rates, sorption values, diffusion rates, etc. have been refined by continuous exchange of experience between organisations in different countries. Key in-situ field measurements e.g. in seismics, hydrology, rock mechanics and core-mapping have been similarly shared, As a result, a rather universal state-of-the-art has been established in such areas.

One of the most successful vehicles for encouraging multinational cooperation in the area of in-situ measurement has been the underground research laboratory (URL). This type of facility was developed at an early date in several countries and in various host rocks. Sweden hosted multinational research projects in granite at the STRIPA mine and now does so at Aspo; Germany ran Asse as an experimental facility in salt; Switzerland operates the Grimsel laboratory in granite and also the Mont Terri facility in clay; Belgium inaugurated the underground facility in the Boom clay at Mol. These early facilities led to other underground laboratories in Canada, Japan, France, etc. and in most cases the experimental programmes were extremely international. The early URLs were generic in nature, aimed at investigating the basic properties of different potential host rocks and at developing investigation tools that could be used at later site-specific URLs. Therefore, the results could be widely applied, which made this a fertile area for multinational projects. Many of these were (or are being still) carried out in facilities in relatively few countries to which teams of researchers travel from partner nations. For some nations, an added incentive for seeking access to a URL in a foreign country has been that these facilities are expensive and that it has not always been straightforward to achieve that local acceptance from a host community. This latter aspect led to the abandonment of URL plans in a number of countries, including Spain, France, the UK and the Czech Republic.

On the theoretical side, the most intensive interactions have occurred during development and testing of the suite of calculational models needed to analyse the safety of a repository. Included are specific process models for hydrogeology, geochemistry, nuclide transport, and biosphere transport. Equally important has been the joint development of the fundamental framework of safety analysis, involving scenario, consequence and risk analyses. In practice, the still wider framework for judging and communicating repository safety – now commonly known as safety case development - is today a widely accepted approach that has been developed in a real multinational effort.

5 ORGANISING JOINT RESEARCH PROJECTS

In addition to the numerous multinational projects centred on underground research laboratories, there have been many other joint projects with participation of organisations from different countries. The driver for such collaboration has often been the wish to share the high cost of projects. One early example was the joint Japanese-Swedish-Swiss (JSS) Project on the leaching of HLW glasses, involving expensive experimental work in active laboratories. In a

similar fashion, the complexities of working with real HLW materials led to a proposed ASSE project involving 30 full-sizes HLW glass cylinders produced in the USA. Unfortunately, this particular experiment was never completed because German priorities switched to disposal of un-reprocessed spent fuel, but the handling and emplacement systems were constructed and tested underground. Further examples of experimental projects that are so large that they virtually necessitate multinational participation are full scale underground tests such as the FEBEX experiment at Grimsel, the heater and buffer mass tests at Stripa and the prototype repository projects at Aspo.

In other cases, wide international participation in specific studies has emerged because of the uniqueness of the actual study objects. The most obvious examples here are the natural analogue studies on geological anomalies around the world. Investigations of this type have taken place at, for example, Poços de Caldas in Brazil, Oklo in Gabon, Oman, Jordan and Alligator River in Australia. These studies were all organised, funded and performed by ad-hoc multinational groupings involving scientists from many nations.

Today major multinational research efforts are organised most often through the international bodies concerned with waste management. Foremost, because of its substantial budget, is the European Commission. A long list of collaborative projects has been run under its Framework programmes. The types of collaboration supported by the EC have evolved over the years and in FP6 emphasis was placed on new structures, such as integrated Projects (IP) and Networks of Excellence, which are designed to encourage very wide international involvement. In practice these have certainly resulted in large participation; for example the FUNMIG IP has 51 participating organisations and 28 Associated Groups. The large administrative overheads in organising such collaborations are, however, a drawback and the difficulty in maximising coverage of the topics studied while minimising overlap are considerable.

6 COMMUNICATION ACTIVITIES

It is obvious that approaches for communicating with national and local publics and politicians will be dependent on national cultures in ways that make developing common methods less straightforward than in the scientific and technical arenas. Nevertheless, there are many initiatives making use of multinational experience to aid communication in national programmes. Standard methods have been to share documentation produced for communication purposes, to inform in-depth on experience, and to provide foreign speakers for national public events. On rare occasions, a joint product has been developed for use in communication activities in a range of countries. A good example is the film of natural and archaeological analogues produced in a joint project involving organisations from 8 countries and dubbed into different languages.

One extremely successful example of collaboration on communication is the study visits of foreign groups that many advanced disposal programmes have hosted over the years. Representatives of many nations have toured the Swedish SFR repository, the Grimsel, Mol and Asse underground laboratories, the repository excavations at Yucca Mountain, Gorleben and Onkalo, etc. A direct viewing of the benign conditions in an actual deep underground facility can be more informative for the public and politicians than thick documents on technical issues.

In recent years, there has been a move to developing more structured multinational projects aimed at exploring approaches to involving the public in waste disposal issues. Work of this kind has been encouraged by the EC which is supporting a number of studies on the governance of

waste management programmes. In addition, the EC publishes periodically on its Eurobarometer a survey of public attitudes towards a variety of waste management issues.

7 IMPLEMENTING GEOLOGICAL DISPOSAL FACILITIES

Today, repository programmes in some countries are finally moving towards the implementation phase. The prime candidates for a first geological repository for HLW or spent nuclear fuel are Finland, Sweden, France, and the USA. Will multinational cooperation continue into the era of repository construction and operation? Certainly, in the first three of the countries mentioned, cooperation involving the acceptance of foreign wastes is not foreseen. The USA does accept spent fuel from research reactors and has proposed in its recent GNEP initiative extending this take-back service to commercial fuel. With the growth in interest in nuclear power, there is increased interest in expanding the possibilities for operation of multinational repositories. A prime driver is the security concerns of the major countries if spent nuclear fuel and HLW is to be held at numerous places around the world, including in countries starting new nuclear programmes. From the point of view of small or new nuclear nations, the main attraction is spreading the high costs of geological disposal. Multinational repositories may eventually be implemented, either as a service (as in proposals made in Russia and the USA) or as a regional partnership between willing countries (as proposed in the EC supported SAPIERR studies).

The issue of multinational disposal remains controversial, however, and there are also other less far-reaching approaches that may offer help, in to particular less advanced nuclear countries that choose to implement national repositories. These include sharing technology, and expertise and perhaps even access to expensive facilities other than repositories (e.g. to waste encapsulation plants). These types of approaches are the subject of the CATT project currently being carried out in the EC FP6 framework.

8 POTENTIAL DOWN-SIDES TO MULTINATIONAL EXCHANGES

The long list of the different aspects of multinational cooperation discussed above make it obvious that all national waste management programmes – especially in new or small nuclear nations – stand to gain considerably from open exchanges. Are there any possible drawbacks resulting from the close interactions between countries?

Some negative aspects can certainly be perceived by individuals directly engaged in national programmes – in particular by scientists involved in the development work. If knowledge or developments can be taken over from foreign countries, this may result in less work for nationals. This should not be a real problem for any country that will develop a national repository since the generic aspects that can be taken over are counterbalanced by the extensive in-situ work on siting that must be done locally. However, for the ultimate form of cooperation on geological disposal, multinational repositories, there would certainly be a much reduced need for national capacity – and this realisation has led to some scientists opposing multinational facilities, even though their country, as a whole, would benefit economically.

But there are also potential drawbacks from the point of view of the repository implementer, be it the government or a private entity. One real danger is that the free flow of all information can lead to a “one size fits all” mentality. For example, if site characterisation costs in the USA are known to be several billion dollars, how can smaller programmes justify programmes costing a tenth of this? If the much admired Swedish and Finnish repository concepts use copper containers, how can one justify steel overpacks, or even no overpack? Of course, the opponents of geological disposal are practised at making such comparisons and at using these to attack

their national programmes. It is not only in small countries that this occurs. For example, the State of Nevada tried to have the Yucca Mountain safety assessments disqualified because USDOE did not use the exact terminology “safety case” that has been introduced in many national programmes.

However, perhaps the most serious potential danger in intense international cooperation is that free thinking will be limited and flexibility reduced. Even today there is a noticeable tendency for waste disposal concepts to be chosen to a too great extent on the basis of their current “popularity”. If the KBS-3 disposal layout is being adopted in so many programmes, why look at fresh ideas? If the currently favoured host rocks are clays and granites, why should we consider salt? The freedom of thought can potentially be endangered also in another way. Communication and exchanges of views are so common, that really independent review of scientific work can be lacking, unless special measures are taken. For example the well-known national disposal programme reviews organised by the NEA and the IAEA are often performed by committees staffed with key participants of other national programmes with which the subject country has a long history of collaboration.

9 CONCLUSIONS

The development of geological disposal strategies, concepts and technologies across the world has unquestionably been helped by the extremely open collaboration between national programmes. The non-commercial approaches adopted widely at the outset by waste management organisations that were primarily interested in ensuring the availability of safe solutions to a common problem encouraged the spread of knowledge and the free transfer of data. Nevertheless, there has also been considerable duplication of effort on research issues that are of a generic nature and need not be reproduced at multiple locations. Small waste management programmes would be better advised to concentrate their studies on the site-specific aspects that can not be taken over from other countries or else tackled in a multinational framework.

Very successful multinational projects have been organised on an ad-hoc basis by groups of countries with common interests. International organisations have also strongly encouraged cooperation between their members. This has been very positive when information and experience are exchanged in working groups, committees or conferences. Some large experimental projects organised by international bodies such as the EC have also been successful, but the explosive growth in participation in some recent joint projects presents great challenges for efficient and cost-effective organisation.

The need for collaboration in waste management between countries will grow as the revival of interest in nuclear power leads to wider demands for safe and affordable disposal facilities. The more advanced nations are continuing to collaborate with each other and with newer waste programmes. However, commercial goals are becoming somewhat more apparent as countries that have invested heavily in developing mature disposal concepts begin to consider whether some of the costs can be recouped. Discussions on intellectual property rights are a relatively recent feature of interactions between programmes. How will these issues develop in the future?

The positive news is that, still today, the major nuclear nations realise that it is in the interest of all countries to ensure that the technology is recognised as safe, secure and environmentally acceptable. Waste disposal continues to be recognised as a key element in this respect. Failures resulting in conventional or radiation harmful effects to persons in any region of the world will impact on all other countries. Accordingly, collaboration will still be a key component

and will continue to be relatively open. Advanced waste disposal programmes will exchange information and will transfer expertise to newer programmes without excessive commercial constraints. International organisations are intensifying their efforts to support collaboration.

However, the big step – the actual construction and operation of geological disposal facilities – has scarcely begun. Disposal concepts, repository designs, experimental data and project plans are not enough. Eventually, all countries that produce long-lived radioactive wastes will need to have access to state-of-the art deep disposal facilities. This will be possible only if the long history of multinational collaboration in this area leads on to further intensive transfer of expertise and technology that enables every nuclear nation to emplace its wastes in a national or multinational disposal facility.