Short record of the NUMO Open Forum Discussion:

Scientific and Technical Basis for Implementation of Geological Disposal

Keidanren Hall, Tokyo

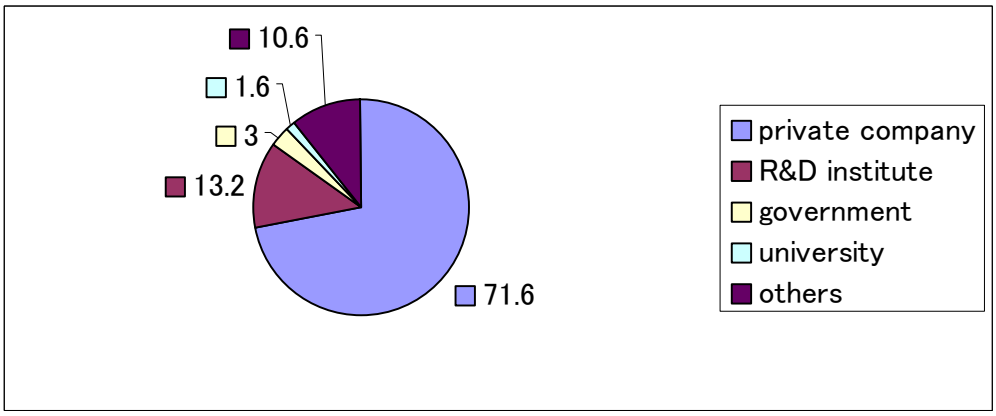
1st June 2004

1. Background

As explained in the opening address by NUMO President K. Tomon, this open forum discussion was scheduled to follow the publication of two technical reports [http://www.numo.or.jp/english/what/message.htm] which support NUMO's call for volunteers to host a geological repository for high-level radioactive waste (HLW). In addition to technical presentations which summarised the general NUMO repository implementation programme and the contents of the "Siting Factors (SF)" and "Repository Concepts (RC)" reports, an invited talk and a panel discussion considered the key role of confidence building in geological disposal programmes.

2. Participants

There were 499 participants, with representation as shown in the pie chart below.



3. Technical Presentations

3.1 General Background

An overview of the general aims, content and time plan for NUMO's technical programme was presented by K. Kitayama. Key milestones associated with the staged implementation process were noted, leading to a planned date to start repository operation in the late 2030s. Particular emphasis was placed on the first stage of soliciting volunteer municipalities to be considered as potential hosts for the first stage of site characterisation. As part of the solicitation process, all municipalities in Japan received a "Level 1" document explaining the procedure involved and four supporting "Level 2" documents providing more information on:

- ⇨ Instructions for Application
- ⇨ Repository Concepts
- ⇨ Siting Factors for the Selection of Preliminary Investigation Areas
- ⇨ Outreach Scheme.

(English translations of these documents can be downloaded from this website – http://www.numo.or.jp/english/publications/main.html)

To allow potential volunteers and other technical stakeholders to review NUMO's programme in more detail, "Level 3" reports, which consider the scientific background and practical application of siting factors and the development of repository concepts for volunteer siting environments, have now been produced. As in the case of the level 1 and 2 documents, production of these reports has benefited considerably from an iterative review involving NUMO's Domestic and International Technical Advisory Committees (DTAC and ITAC; short summaries of ITAC meetings are also available on this site – http://www.numo.or.jp/english/what/message.htm)

To present this work to a wider international audience, English language versions of the level 3 reports have been prepared and will shortly be available on this website. These are not direct translations, but are modified to provide more background on the geology of Japan and the context of the Japanese HLW programme and to focus on more novel technical aspects of NUMO's implementation plan, which may be of particular interest to the general nuclear waste management community.

3.2 Siting Factors

The background, aims and content of the NUMO report "Scientific background and practical application of NUMO's repository siting factors" (NUMO-TR-04-02, in Japanese) were summarised by H. Tsuchi. The particular constraints on siting by a volunteering approach – particularly in the complex tectonic environment of the Japanese archipelago - were outlined. Emphasis was placed on exclusion factors, which aim to ensure that sites selected as "Preliminary Investigation Areas" meet required geological stability criteria.

Key exclusion factors involve ensuring that there is no risk of a repository being perturbed by active faults, volcanic activity or uplift and erosion. As background to explain the basis for prediction of geological stability, the understanding of the long term (30 Ma) plate-tectonic evolution of Japan was used to illustrate how confidence can be derived in the continuation of particular trends over periods in the order of a hundred thousand years in the future. Numerical values derived for exclusion of areas which could potentially be influenced by future activity around Quaternary volcanic centres or by rapid uplift and erosion were also explained.

3.3 Repository Concepts

The background, aims and content of the NUMO report "Development of repository concepts for volunteer siting environment" (NUMO-TR-04-01, in Japanese) were summarised by H. Umeki. The constraints set by the volunteering approach – in particular the wide range of potential geological settings – were explained. This is being addressed by developing a systematic approach for tailoring repository concepts to specific sites.

The starting point for repository concept development is the robust "H12" engineered barrier system which encapsulates vitrified HLW within a thick steel overpack, which is emplaced within a bentonite-based buffer in a repository constructed at a depth of more than 300m below surface. To maintain flexibility, variants of materials, geometry and supporting repository structures can be considered. The benefits and drawbacks of all such variants can be assessed for particular site characteristics by considering their performance with regard to a number of "design factors" – which include operational and post-closure safety, engineering practicality and socio-economic issues such as ease of waste retrieval and total cost.

Long-term safety after closure is assessed by modelling repository behaviour over periods into the distant future - although emphasis is on the period, when the waste toxicity is highest. Such modelling is, however, only one part of making a "safety case"; this needs also a set of more qualitative arguments based on system understanding, robustness, analogues, etc. to ensure acceptance by all key stakeholders.

Preparation for implementing the design processes during the first stage of literature studies of volunteer sites was illustrated, along with its feedback to an associated R&D programme to develop the codes and databases needed to assess such designs.

4. Invited Talk: "Building Technical and Public Confidence in Geological Disposal" by Dr. Charles McCombie (ITAC Chairman)

This presentation consisted of 4 main blocks:

- ⇨ What is confidence?
- ⇨ Technical aspects
- ⇨ Societal aspects
- ⇨ The challenge of siting.

For geological disposal, the key aim of confidence-building is to derive a sufficiently broad consensus that a safe repository can be implemented. This requires confidence in the product (the repository itself), the implementation process, and the responsible organisations (predominantly implementers and regulators). This consensus has to involve many stakeholders – regulators, implementers, politicians, independent scientists, environmentalists and the general public.

Technical confidence requires a consensus in the general technical community (i.e. not only radwaste insiders) that:

- ⇨ The repository system is sufficiently well understood to quantify its evolution over relevant timescales;
- ⇨ Humans and the environment are adequately protected for all reasonably conceivable future developments.

The main challenge is associated with the long times involved. However, the required safety analyses are feasible, as they are based on natural laws of science which do not change with time and are supported by very long-term geological databases. The resultant predictions need not be very accurate or precise, as long as conservative analyses lead to sufficiently high safety margins. Nevertheless, validation of the approach used is very important and this needs integration of information from the laboratory, field and natural analogues, with associated peer review. Within the industry, at least, it is considered that such a technical consensus should be achievable (OECD/NEA – RWMC collective opinions).

Societal confidence-building is more challenging, as many different groups are involved and technical arguments have to be complemented by measures which respond to more emotional (yet equally real) fears and preconceived notions. Key components of a confidence-building programme would include:

- ⇨ Identification and serious consideration of the specific concerns of different groups
- ⇨ Raising the acceptance of the technical credibility and honesty of involved organisations
- ⇨ Encouraging (by both implementers and regulators) of active public participation in the implementation process.

Repository siting is an area where public acceptance plays a particularly key role. It is important to be able to communicate that the requirement is for a sufficiently good site and not an unobtainable “best” site. The national programmes that have recently had most success in this area have had extensive programmes to encourage public involvement. It is noticeable that NUMO’s volunteering approach corresponds to the most modern thinking on this topic.

5. Panel Discussion: Confidence Building in Geological Disposal

The Panel was moderated by H. Nakamura and included a member of DTAC (Prof. Y. Onishi), an independent peer reviewer of SF reports (Dr. S. Yoshida), 3 members of ITAC (Dr. C. McCombie, Prof. N. Chapman and Dr. I. McKinley) and S. Masuda from NUMO.

After an introduction by the moderator, 4 topics were discussed:

- ⇨ The geological environment
- ⇨ Repository design
- ⇨ Safety assessment
- ⇨ Public trust

The following sections do not attempt to provide a record of the individual questions of the moderator and the audience and the responses by individual panellists, but rather to highlight the main issues raised and opinions presented.

5.1 The geological environment

A key question which has to be addressed in any confidence-building programme in Japan is "Is it reasonable to consider disposal in such a geologically unstable setting?"

The understanding of the geological evolution of the Japanese archipelago has advanced to the point of consensus in the Japanese geological community in terms of its major features, even if there may be differences of opinion in terms of fine detail. Thus, major processes can be described and roughly quantified, although mechanisms may not be fully understood. The predictability of developments over a period in the order of a hundred thousand years can be justified by the slow rate of change (high inertia) of such processes. For example, the timescale of development of a new magma chamber and this leading to a volcano is typically in the order of millions of years. From the perspective of geologists examining processes over tens of millions of years or even much longer, the "long-term" of performance assessment is really rather short.

The consensus in the Japanese geological community is supported by the international experts comprising NUMO's ITM (International Tectonics Meeting) group. Although the exact geological settings are not the same, concerns over volcanism, earthquakes & fault movement and uplift & erosion are not confined to Japan (examples being USA – Yucca Mountain, Sweden, Switzerland, respectively). In these cases, analyses are being carried out to allow the probability and consequences of these processes to be assessed. Based on an extensive analysis of the geological history of an area, there is reasonable confidence of being able to bound expected future evolution over repository-relevant timescales.

For the case of Japan, however, the general concern of both non-specialist technical stakeholders and of the general public justifies special efforts into going further in the

development of mechanistic understanding and improvement of models. Such work is a feature of NUMO's ongoing R&D programme.

5.2 Repository Design

A fundamental question which is often raised is "Would extended surface storage not be safer than deep geological disposal?"

Although surface storage is an established, safe technology, this is an interim process which does not provide a solution for wastes that remain potentially dangerous for tens of thousands of years. Such storage would require not only development of new technology, but also an unprecedented social commitment to active control. Development of a convincing long-term safety case based on existing technology is possible only for the passive safety that can be assured in a suitable geological formation. Nevertheless, more easily understood arguments need to be developed to explain the advantages of a low energy, buffered, passive system to a non-technical audience.

Leading on from this, the question becomes "Does the technology really exist to construct a deep geological repository?"

In Japan, the civil engineering industry has very considerable experience in deep construction of tunnels, caverns and mines – often under challenging geological conditions. Based on this, the construction of the type of repository considered by NUMO would be feasible with existing technology. Practicality and cost would, however, need to be carefully assessed for specific sites and designs. Nevertheless, the tools exist to do this and NUMO's plans allow for a period of development and testing of required modifications of methodology and equipment.

The situation in Japan is supported by experience in other countries where deep geological repository programmes for HLW are well advanced. Indeed, a deep repository has already been implemented for long-lived intermediate level waste (often termed "TRU"). A further observation from an international context is that the range of NUMO repository design options does not go beyond the wide range considered elsewhere and that the concentration on a simple robust engineered barrier system is also consistent with other national programmes considering vitrified HLW.

5.3 Safety Assessment

A key concern for all Japanese stakeholders is the safety of a repository – how can this be assessed and the results presented in an understandable manner?

As already mentioned by H. Umeki (section 3.3), the critical factor is building a safety case with a reliable safety assessment. The timescales involved need to be clearly discussed and long-term processes evaluated. Internationally, emphasis is also placed on the set of qualitative argument which supports this case. To access long timescales, this can involve extensive use of natural analogues (previously also addressed by C.

McCombie; section 4). Here the limitations of analogues must also be borne in mind – these generally show that a process can occur, but do not prove that it will actually happen. Nevertheless, multiple lines of evidence from a range of analogues, supported by focused laboratory studies and theoretical modelling, can often lead to very convincing arguments.

From an international viewpoint, the NUMO approach is clearly state of the art. The supporting quantitative models used by JNC for the H12 study were approved during its international review by OECD/NEA and the planned developments to make models more realistic and sensitive to the specific characteristics of potential siting environments are ongoing at both JNC and NUMO. It was also noted that, recently, operational-phase safety is becoming an increasing concern and here also planned work by NUMO (and other Japanese organisations) is consistent with international best practice.

5.4 Public Trust

A direct question arising from the points discussed in the Japanese context is – "Are all the issues raised above covered in NUMO's technical reports?"

Within the specific areas of siting factors and repository concept development, the two technical reports show that NUMO is either addressing all key issues or is, at least, planning to do so. Some of the points raised are, however, wider and relate to the processes that NUMO uses to develop and steer its implementation programme. For example, peer review and maintaining international credibility is facilitated by NUMO's technical advisory groups and network of international partners. Building trust through demonstration of openness is a focus of its public information programme and is highlighted by the publication of these first 2 technical reports and their presentation at this open forum discussion. It should be noted, however, that the process of winning public trust is very slow and that, if it is once lost, rebuilding is very difficult. Finland is currently the only country where a geological repository site has been accepted at local, state and national levels with sufficient confidence. Even for this case, it has taken more than 20 years to earn such public trust.

A further issue which could be of concern is the long timescale associated with implementation – how can developments in science and technology over the intervening period be taken into account?

NUMO is aware of this issue and, via a network of partners in universities and R&D organisations throughout Japan, attempts to keep up to date on relevant developments. This is also an area where collaboration and information exchange with sister waste disposal organisations in other countries plays an important role. On the critical path is certainly geological characterisation technology for the next stage of characterisation of sites. However, as noted in section 5.1 above, NUMO will also actively follow developments in other areas where more fundamental understanding is desirable – e.g. on the mechanisms of earthquake development.

The visibility and transparency of the safety assessment was raised as another issue for increasing public confidence in long-term safety of a repository. The process of the safety assessment is highly technical and difficult for the public to understand. It was pointed out that natural analogues, URLs and realistic computer simulation could be useful tools to support making the safety assessment results more accessible.

Competent regulatory structure and clear regulations and guidelines are essential to drive forward a national programme. It has been found that, in most successful programmes so far, the regulator is recognised to be as competent as the implementer. These two groups must work together, without of course compromising scientific independence. It was stressed that the regulator should keep very close contact with the implementer from the early stage of the repository programme. The regulator thus must be active from beginning of programme.

6. Issues raised by the audience

Because there was significant overlap in the topical areas covered in sections 2, 3, 4 and 5 above, some issues raised by the audience are grouped together in this final section. In most cases these can be resolved, to at least some extent, by the text above. Nevertheless, in a forum focused on confidence building, such issues are worth listing as they reflect topics which may have to be presented more clearly in future NUMO documents. Briefly these are:

- ⇨ Danger of over-interpretation of analogues, especially those for an entire repository (e.g. Cigar Lake)
- ⇨ Comparison of sites; how can relative "goodness" or suitability be clearly assessed or presented
- ⇨ Assessing risk of earthquakes – especially for surface structures
- ⇨ Handling of the very variable biosphere in long-term safety assessments
- ⇨ Site investigations – need for, and handling of, characterisation work in areas surrounding a volunteer site
- ⇨ Emphasis on "safety" in the safety case risks alienation of those concerned about danger; at least in discussions, maybe a "Danger Case" needs to be discussed, even if it focuses on showing danger is negligible.