NUMO'S OPEN SOLICITATION OF VOLUNTEERS FOR A POTENTIAL FINAL REPOSITORY SITE FOR HLW: RECENT ACTIVITIES

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ABSTRACT

NUMO announced the start of open solicitation of volunteer municipalities for a potential HLW repository site with publication of an information package on December 19, 2002. To provide scientific and technical support for the messages in this information package, two technical documents have subsequently been published. "Repository Concepts" includes the basic principals involved in developing a repository design, under the assumption that suitable volunteers will come forward, which emphasizes flexibility in the range of options to be considered and introduces the concept a design filter which allows this range to be narrowed down for specific siting environments. The associated strategy for iterative development of the basic repository concept as the process of site selection and characterization progresses is also outlined. "Siting Factors" explains the factors which will guide site appraisal and comparison at various stages of the site selection procedure and how they have been derived. It also provides geological and tectonic background information on Japan and describes how the key issue of geological stability is addressed. Public relations activities and the output from discussion with international experts are important to promote public understanding and to ensure a sound technical basis. This paper describes recent progress in NUMO's open solicitation of volunteers for a potential repository site and some highlights in the associated scientific support program.

INTRODUCTION

The Nuclear Waste Management Organization of Japan (NUMO) was established in 2000 as the implementing organization for vitrified HLW disposal in Japan, following legislation entitled the "Specified Radioactive Waste Final Disposal Act" (hereafter "the Act"). The assigned activities of NUMO include repository site selection, developing relevant license applications and construction, operation and closure of the repository. The Act specifies that the siting process shall consist of three steps. Firstly, Preliminary Investigation Areas (PIAs) for potential candidate sites are nominated based on site-specific literature surveys focusing on long-term stability of the geological environment. Secondly, Detailed Investigation Area(s) (DIAs) for candidate site(s) are then selected from PIAs following surface-based investigations, including boreholes, carried out to evaluate the characteristics of the geological environment. Thirdly, detailed site characterization, including underground experimental facilities, leads to selection of the site for repository construction. According to the present schedule, repository operation may start as early as the mid-2030s.

NUMO promotes public involvement in decision-making in the site selection procedure based on fundamental policies which include "adopting a stepwise approach", "respecting the voluntarism

of municipalities" and "ensuring transparency". On this basis, NUMO has chosen an "open solicitation" approach for finding candidate sites, in the belief that the support of local communities is essential to the success of this highly public, long-term project extending over more than a century. NUMO has therefore invited municipalities throughout the country to consider volunteering as candidate areas for exploring the feasibility of constructing a repository for HLW.

At the first milestone of the siting process, NUMO announced the start of open solicitation of volunteer municipalities for PIAs with publication of an information package on December 19, 2002. The structure of the documents supporting this call for volunteers is shown in Fig. 1. The package aims to provide basic information for supporting and promoting discussions of municipalities on deciding whether the repository plan could be accepted and was therefore sent to all 3,239 municipalities in Japan. It consists of a general information brochure on open solicitation entitled "Open Solicitation for Candidate Sites for Safe Disposal of High-Level Radioactive Waste" and four separate documents, entitled "Instructions for Application"[1], "Repository Concepts"[2], "Siting Factors for the Selection of Preliminary Investigation Areas"[3] and "Outreach Scheme"[4], as shown below. Informal English translations of these Japanese documents can be found (and downloaded) on the NUMO website.

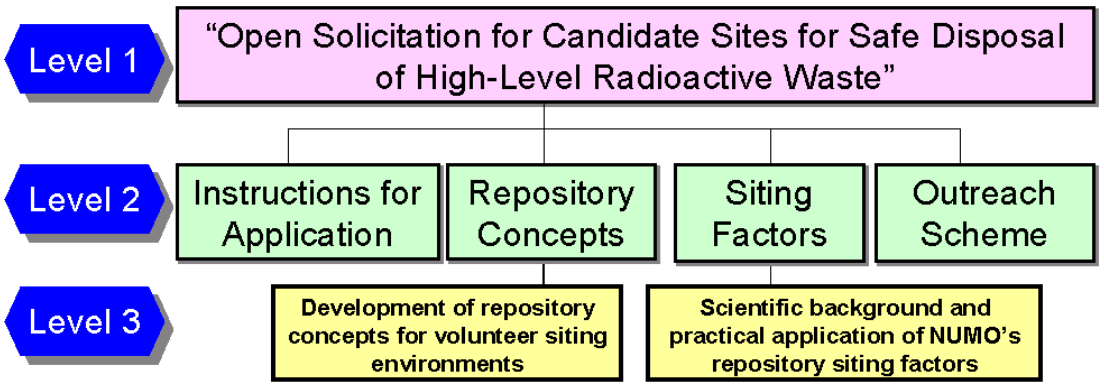

Fig. 1. Structure of documents supporting the call for volunteers

Technical Documents

The two level 2 documents with technical content, Repository Concepts and Siting Factors, are supported by more detailed technical reports, which were published in 2004 [5, 6]. These Japanese language reports are aimed at stakeholders who want more information on the scientific, technical and socio-economic basis for the assertions made in the information package. As such, they record the technical development of NUMO's program and complement material presented by NUMO staff at many national and international conferences, symposia and workshops and published in technical journals.

To communicate this work also to a wider international audience, English language versions of the reports [7, 8] have also been published (and can be downloaded from the NUMO website – www.numo.or.jp). These reports are not simple translations, but provide a wider perspective on

the NUMO program with a focus on the issues most likely to be of interest to a foreign readership.

The following sections provide more details on the content of the Repository Concepts and Siting Factors technical reports and an indication of latest progress in these technical areas.

Development of Repository Concepts for Volunteer Siting Environments

At NUMO, we have chosen to implement a volunteer approach to siting. This is constrained by the use of "Siting Factors" which ensure that only locations which have sufficient geological stability are considered – an important factor in a country like Japan which lies in a tectonically active region. The potential diversity of volunteer sites places particular constraints on the process of repository concept development – requiring that we maintain a range of possible options to ensure maximum flexibility in tailoring concepts to the conditions found at a particular site.

Our term "Repository Concepts" includes not only the design and layout of the disposal system, but also the associated evaluation of operational and long-term safety and an assessment of socio-economic aspects. A particular challenge lies in the development of such concepts in an open and transparent manner, which allows all key stakeholders to become actively involved, particularly the community hosting the facility and its neighbors. A logical structure allowing systematic development of repository concepts has been established, taking into account the close link between site information, repository design and safety assessment. We believe it is very important to identify such a logical structure from the outset of the siting program, which can then be applied consistently to later site investigation stages.

The technical report [7] documents the basic principles involved in developing the repository concept, under the assumption that suitable volunteers will come forward, and introduces the concept of the "design factor" filter. It also focuses on the process of tailoring repository concepts to the environment found at a particular volunteer site and, in particular, on how to involve all relevant stakeholders in this process. The critical aspect of safety is discussed with special focus on the timescales of most concern to the volunteer community. From the basis thus provided, it outlines the planned supporting program of R&D. Finally, it outlines how we expect the program to develop as volunteer sites are characterized in increasing detail by desk and field studies and the site-specific concepts are iteratively optimized for the particular environments involved.

We have drawn up a strategy for iterative development of the basic repository concept as the process of site selection and characterization progresses, as shown in Fig. 2. This structured approach extends step by step during the siting process, construction / operation and, finally, closure of repository. Although long-term safety is an essential requirement of all designs, we also take explicit account of further principles, such as operational safety and practicality, protection of the environment, public acceptability, etc. In order to assemble repository design options from the various sub-components, we temporally examine a set of "Design Factors", each of which addresses an issue with direct bearing on the chosen design:

- Long-term safety,
- Operational safety,

- Engineering feasibility / quality assurance,
- Engineering reliability,
- Site characterization / monitoring,
- Retrievability,
- Environmental impact,
- Socio-economic aspects.

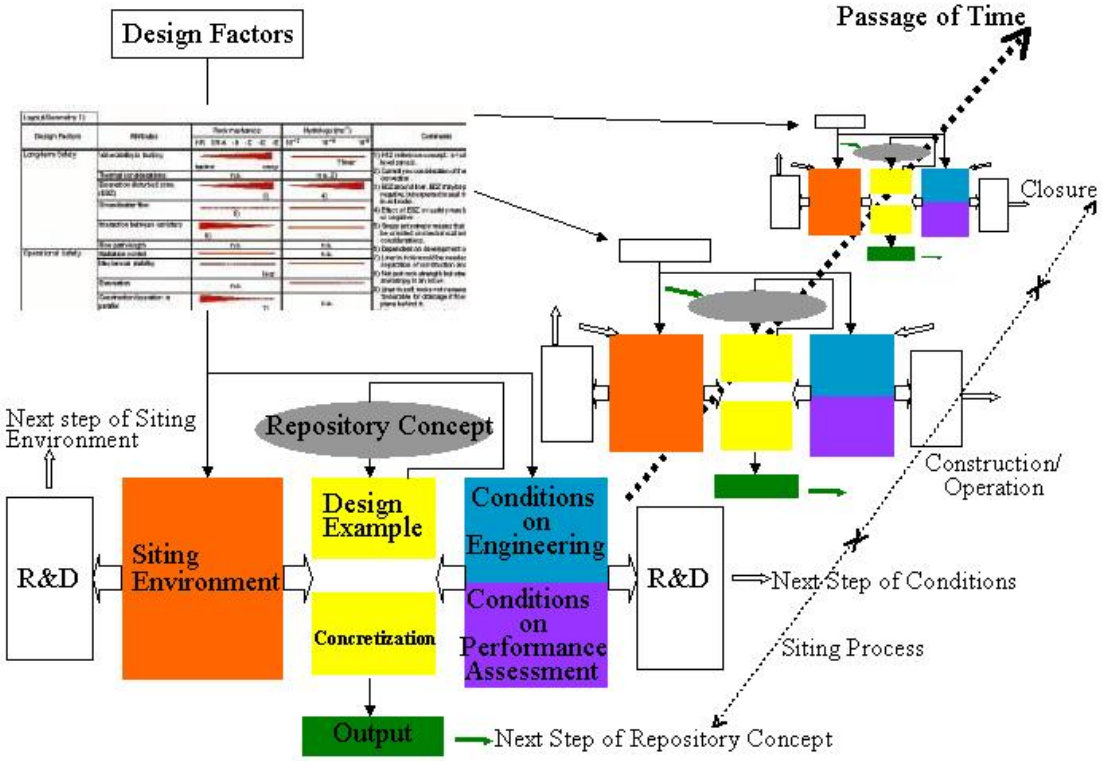

Fig. 2. Illustration of the structured approach

The design factors require consideration of long-term safety based on the starting-point provided by the reference H12 study [9], in addition to assessing the technological feasibility of constructing the repository. This consistent design policy optimizes long-term flexibility and allows practicable designs to be obtained in a transparent manner.

It is worth noting that the aspect of transparency – particularly with regard to decision making – has been a major focus for NUMO. We have developed tools for both top-down and bottom-up analysis of different repository design options which allow us to evaluate the effects of changing the weighting of different design factors. This forms the basis for an ongoing study of the implementation of a formal requirements management system which would not only ensure a record of all decisions made, but would also flag such decisions in the event that the boundary conditions or program assumptions used to justify them change in the future.

Finally, it should be emphasized that such structured planning is also a valuable tool to define the supporting R&D program. We recognize that NUMO's program is ambitious in terms of its time plan and will clearly lead to high pressure on limited resources of experienced manpower and specialist technical infrastructure. It is thus critical to ensure that best use is made of both the national resources spread between a number of involved organizations in Japan and the opportunities for optimization provided by collaborative ventures with international partners (an example of the latter is a recent topical workshop co-hosted with Posiva of Finland [10]).

Evaluating Site Suitability for a HLW Repository

Japan lies in a region of active global tectonics characterized by dynamic geological processes and events such as volcanism and earthquakes. One of the first things that we need to ensure is that a repository is not located where it could be adversely affected by such events and processes over a long period of time in the future, which means that we need to take account of tectonic mechanisms and how they change with time. The first application of the Siting Factors addresses this issue.

Selecting a suitable site is one of our biggest challenges at NUMO, not only technically but also socially. We have adopted an open and inclusive approach to siting. It begins by seeking volunteer communities prepared to work with us to see whether they would be willing to act as hosts for a repository and to find out whether their location is technically suitable. Communities will thus become involved in the selection and development process and in the evaluation of the Siting Factors.

As well as being safe and secure, the chosen location needs to be in an environment that is feasible for the construction and operation of the repository using available engineering technology, with reasonable expenditure of resources. Location, design and operations must also satisfy the requirements of the communities that host the facility. The Siting Factors described in this document are eventually intended to address site characteristics comprehensively and to provide a clear and transparent route to how we achieve these aims through the staged site selection process.

This technical report [8] introduces the Siting Factors that NUMO is using to select PIAs. It also provides geological and tectonic background information on Japan and describes how the key issue of geological stability is addressed. This arises early in the siting program and will have to be considered at the PIA selection stage. The document also describes the practical implications of using the Siting Factors and how they will be handled, as volunteers come forward, under actual site-specific geological and geographical constraints. It also looks at the tectonic setting and geology of Japan and the scientific basis for the application of the Siting Factors in a staged manner, as required in the various laws governing the current phase of the HLW disposal program. We have chosen to focus on this issue for two reasons – first, the Siting Factors that cover tectonic stability are applied from the very beginning of our siting program and, second, because, given Japan's tectonic situation, they have more prominence than in other waste management programs.

At NUMO, we have used a systematic approach to developing Siting Factors so that they will first meet the requirements of the law and then provide a logical, comprehensive and progressive basis for the staged identification of a suitable site for a repository. In particular this includes:

- Nationwide Evaluation Factors (NEF): designed to identify, at the very start of the evaluation process, only those areas where a repository (of any design) could not be directly disrupted or destroyed by volcanic activity or would not inevitably be transected by known active faults within the next hundred thousand years. Whether an area qualifies with respect to these factors can be readily established using information on the nationwide distribution of volcanoes and active faults. These factors are a decisive means of excluding clearly unstable locations and will be applied in a simple "first-pass" screening process.
- Site-specific Evaluation Factors (SSEF): designed to assess those areas that meet the NEF qualification factors in more detail, with respect to potential volcanism, seismicity, rock deformation and faulting, land uplift and erosion, and the presence of unconsolidated sediments or mineral resources.
- Favorable Factors (FF): allow us to assess much wider aspects of site suitability and to compare alternative areas, should we have several volunteers that qualify with respect to the legal evaluation factors.

The Siting Factors are thus intended to go beyond the strict requirements of the law, to help us in our discussions with communities and to guide our decisions with respect to future site characterization.

A schematic figure showing how the legal evaluation factors for qualification affect the identification of the location and geometry of a PIA described in the document is shown in Fig. 3.

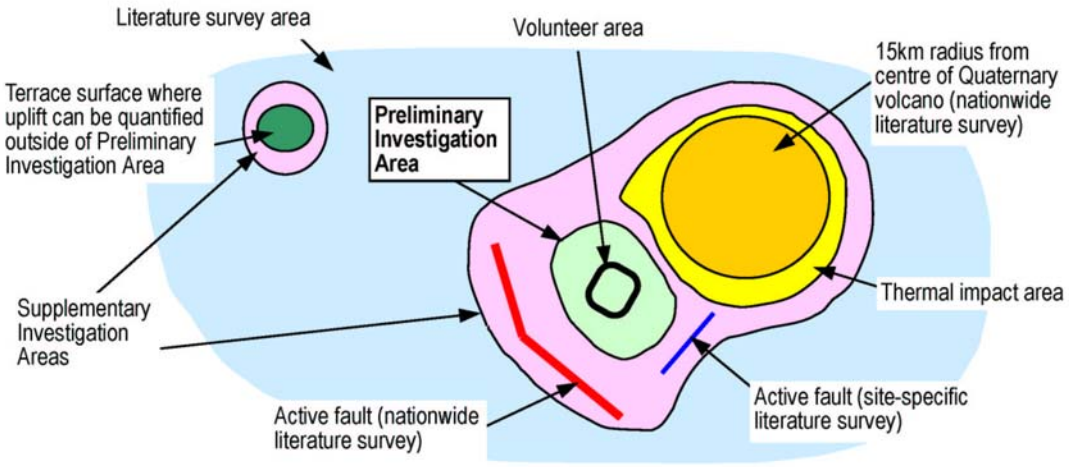

Fig. 3. Schematic figure showing how the legal evaluation factors for qualification affect the identification of the location and geometry of a PIA

The Japanese Islands lie at the junction of four major tectonic plates and interactions of these plates, by subduction, collision, lateral movements and accretionary processes, drive the seismic, thermal and volcanic activity that characterizes the region. Such mechanisms are not unique to Japan – several other regions of the world are in island arc environments and there are many examples of island arc tectonics in geological records, stretching back over hundreds of millions of years. Over the last decades, earth scientists have built up a broad understanding of the geometry and driving mechanisms of such tectonic systems by combining geological,

geophysical and geochemical observations. The latest satellite geodetic measurement techniques allow monitoring of crustal movements to test and calibrate models of the deformation of the surface in response to tectonic strain. Compelling models exist for the controls on the distribution of earthquakes and volcanoes and for controls on crustal deformation. These have been developed and tested in a large integrated database. The main conclusions that have been drawn on stability are:

- the fundamental structure of the present tectonic plate system around the Japanese Islands was established approximately 15 Ma ago, when the spreading of the Japan Sea back-arc basin ceased;
- the directions of plate movement have not changed over the last 2.5 Ma for the Pacific Plate and 1.5 Ma for the Philippine Sea Plate;
- the movement of the plate system around Japan has been in a steady state since 15 Ma ago;
- it takes more than 1 million years for a significant change to take place within the plate system and it is unlikely that any rapid change would occur within the relatively short time period of 0.1 million years;
- it is therefore reasonable to extrapolate knowledge about the main tectonic controls and patterns over the last 0.5 million years to predict the long-term stability of the geological environment for at least the next 0.1 million years.

We recognize, nevertheless, that seismic and volcanic activity will continue to be issues of national and international concern for any repository situated in Japan. NUMO has thus established research groups in these topical areas – including recognized world experts from Japan, Europe, North America and New Zealand. Study topics include both improved methods to extrapolate from the geological record in order to predict future fault movements and volcanic activities and also more fundamental modeling of the key tectonic processes which drive such events. Preliminary results have already been reported in the geological literature and caused considerable interest in this work [11].

Activities with Respect to Public Relations and Involvement

To promote public understanding, NUMO has carried out various publicity activities. NUMO considers that the initial and critical milestone in the process is the first applicant for a PIA. To encourage application, it is essential to initiate and develop nation-wide discussion on HLW issues, which requires sufficient understanding of the characteristics of HLW and disposal options. Once these are understood, subsequent discussions should become more smooth and constructive.

An open forum discussion to further publicize the technical documents was held in Toyko on June, 2004 with 499 participants. The forum was aimed at providing a better understanding of the technical documents and a wider technical perspective on future developments.

Since June 2003, NUMO and local newspapers have jointly hosted round-table talks with local opinion-leaders at 20 locations to date. The objective of these talks was to inform on HLW issues and to initiate dialogue with the public. Local newspapers reported the results of these activities as feature articles.

In order to promote public understanding, NUMO has been conducting information campaigns in leading newspapers, on TV, in magazines and so forth. The TV campaign has been broadcast since October 2002 and NUMO's program has been advertised in magazines and major newspapers, including more than 40 local newspapers, corresponding overall to more than 80% of Japan's total readership. An example of a newspaper advertisement is shown in Fig. 4. Additionally, NUMO is planning to develop an interactive website for public dialogue. The information package, technical documents, booklets, videos and pamphlets, some of which have been produced in English, are available from our website www.numo.or.jp.

Fig. 4. Newspaper advertisement (discussion between NUMO President Fushimi and Prof. Kitano of Shukutoku University, an environmental expert)

International Collaboration

NUMO has concluded general collaboration agreements with both domestic and overseas organizations, for example Posiva (May 2001), Nagra (June 2001), SKB (September 2001), ANDRA (December 2001), U.S.DOE (July 2002) and Nirex (June 2004). The collaboration areas covered by these agreements include:

- Approaches to site selection
- Methodology and techniques for characterization of geological formations, repository design and performance assessment
- Quality assurance

- Public acceptance and confidence-building

NUMO became a member of EDRAM (International Association for Environmentally Safe Disposal of Radioactive Materials) in May 2001. NUMO's project activities are also discussed with international experts who have specific knowledge and expertise in relevant subject areas, for example the International Technical Advisory Committee (ITAC). The output from such collaboration is very valuable in improving NUMO's repository program, by identifying areas of strength and weakness and generally ensuring a sound technical basis. This will also be the case for confidence-building for implementation of HLW geological disposal, as the repository development program will continue over a long time period. Bearing this in mind, and recognizing that success in one country's program is positive for other countries, NUMO will further promote international collaboration in its program, sharing its experience with other countries in moving towards the final goal of implementing repository projects.

CONCLUSIONS

We expect that there are many sites that could host a repository in Japan, despite the active tectonic environment. NUMO's volunteer approach to site selection presents particular challenges for the repository concept development program. Thus, we intend to provide regular updates on how we are pursuing and applying repository concept development and our site evaluation techniques.

In order to ensure that the decision-making process is transparent, NUMO will make available a variety of information relevant to its siting activities through the publication of documents, websites, etc., and will provide opportunities for residents surrounding the PIAs to voice their opinions. To promote this communication, NUMO has been carrying out a range of public relations activities.

NUMO recognizes that international collaboration will be essential to the success of the Japanese HLW repository program. Indeed, even longer-established organizations are increasingly building partnerships to optimize use of limited resources and reduce costs. Such collaboration is a two-way process and we accept that there are some areas where NUMO should take the lead. Because of the nature of our volunteering program – and the geological setting of Japan – our repository concepts, siting factors and public relations activities are moving rapidly to an advanced level and could form a focus of our contributions to the international nuclear waste management community.

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