

STATUS OF THE HIGH-LEVEL RADIOACTIVE WASTE DISPOSAL PROGRAMME IN JAPAN

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ABSTRACT

The Japan Nuclear Cycle Development Institute (JNC, successor to the Power Reactor and Nuclear Fuel Development Corporation - PNC) has been active in research and development (R&D) activities for high-level radioactive waste (HLW) disposal in accordance with the overall Japanese HLW management programme and the Guidelines defined by the Atomic Energy Commission (AEC) of Japan. The aims of the R&D activities are to provide a scientific and technical basis for the geological disposal of HLW in Japan, and to achieve a higher level of understanding of geological disposal in the scientific and technical community as well as in the general public. The progress of the R&D programme is documented at appropriate intervals, to clearly determine the level of progress and promote public understanding and acceptance of the geological disposal strategy. As a major milestone, PNC submitted a first progress report, referred to as H3, in September 1992. H3 summarised the results of R&D activities up to March 1992 and identified priority issues for further study. The second progress report, referred to as H12, is scheduled for submission around the year 2000, and should demonstrate more rigorously and transparently the feasibility of the specified disposal concept. It should also provide input for the siting and regulatory processes, which will be set in motion after the year 2000.

1. INTRODUCTION

As outlined in the overall HLW management programme defined by the AEC of Japan [1], the HLW separated from spent nuclear fuel at reprocessing plants will be vitrified and stored for a period of 30 to 50 years to allow cooling. It will then be disposed of in a deep geological formation (geological disposal). An organisation with responsibility for implementing this HLW disposal will be established around the year 2000. This will be followed by: site selection and characterisation, demonstration of disposal technology, establishment of the necessary legal infrastructure, relevant licensing applications and repository construction. The objective is to start repository operation by the 2030s but no later than the mid 2040s (Fig. 1).

The HLW disposal programme is currently in the R&D phase. Since its establishment in September 1995, the AEC's Advisory Committee on Nuclear Fuel Cycle Backend Policy (the Advisory Committee) has been discussing ways in which future R&D programmes relating to geological disposal should be conducted, focusing on the JNC's second progress report. These discussions are based on the recognition that it is essential to formulate concrete technical measures for geological disposal, to inform the general public clearly and transparently of these measures and to obtain their understanding and acceptance of disposal projects.

The AEC's Special Committee on High-Level Radioactive Waste Disposal (the Special Committee), which was also established in September 1995, has been considering various

issues, including social and economic aspects of HLW disposal. The primary objective is to ensure that such disposal will be acceptable to the Japanese public.

This paper presents the status of the HLW disposal programme in Japan.

2. RESEARCH PROGRAMME

2.1 OBJECTIVE

The Japanese approach to "Disposal Concept Development" has targeted neither a particular type of rock nor a particular geographic area. Japan has complex geology in a fairly active tectonic setting and hence has developed repository designs, which combine deep disposal with a massive engineered barrier system (EBS). The major responsibility for overall barrier performance of the disposal system is borne by the near-field (EBS and a small amount of surrounding rock), while the geosphere serves to reinforce and complement the performance of the EBS [2]. This massive EBS was introduced to ensure long-term performance of the disposal system for a wide range of geological environments. The layout of the EBS involves axial, horizontal emplacement of vitrified waste, encapsulated in a thick steel overpack, in tunnels which are backfilled with highly compacted bentonite-quartz sand buffer (Fig. 2).

JNC has been assigned as the leading organisation responsible for R&D activities. JNC's R&D programme [3] includes three major components focused on the current disposal concept: 1) studies of the geological environment, 2) repository design and engineering technology development and 3) performance assessment. The coordination and integration of activities in these three areas are critical in order to maximise the output from the R&D programme (Fig. 3). In addition, it is felt that systematic geoscientific studies are important. The results obtained from geoscientific studies will be utilised as a basis for R&D projects of geological disposal. Thus, JNC is encouraging participation in relevant projects by researchers both from Japan and abroad. Information accumulated through broad geoscientific studies should be used to understand more precisely the characteristics of the deep geological environment and improve the reliability of performance assessment models of the disposal system.

2.2 R&D ACTIVITIES

A set of carefully designed, relatively large-scale, non-radioactive experiments (ENTRY Project), has been initiated for fundamental data acquisition, model development and model validation [4]. To date, radiogenic experiments have been conducted in a limited number of controlled glove boxes. A new facility, known as QUALITY, is now under construction. It will contain more sophisticated apparatus to help acquire comprehensive data about radionuclide migration behaviour, such as solubility and sorption under simulated geological conditions.

At the Tono Mine (sedimentary rock) and the Kamaishi Mine (crystalline rock), major geoscientific studies have been conducted in the field of geology, rock mechanics, hydrology, geochemistry and seismography, to provide realistic data sets. These data are used to represent generic characteristics of the deep geological environment. The in-situ experiments at the Kamaishi Mine completed with good success by the end of March 1998. In addition, JNC is currently planning to construct a deep underground research laboratory in Mizunami City (MIU: Mizunami URL) in Gifu Prefecture [5]. The main objective of the new facility is to carry out a wide range of geoscientific studies over the next 20 years in a realistic and

undisturbed crystalline rock environment, at depths of up to 1,000 metres. There is a clear separation between plans for such an underground research laboratory and siting studies for a waste repository. In addition to these geoscientific studies, this facility will also be utilised for other projects, including a recently established national seismic observation and research programme, in which JNC will participate. Expectations of the R&D quality are high. JNC intends for the facility to be an international centre of excellence in relevant scientific areas. Meanwhile, to further geoscientific studies in sedimentary rock, a deep URL programme was proposed again for Horonobe Town in Hokkaido, Northern Japan, by the Science and Technology Agency (STA) in February 1998.

Fig. 4 shows the location of JNC's R&D and field test facilities including URLs both operating and planned for tackling geological disposal R&D and geoscientific studies.

JNC has also been active in promoting international cooperation in connection with the Japanese HLW disposal programme, based on both bilateral and multilateral approaches [6]. The lessons learned from collaboration have proved very valuable and are used to improve JNC's programme by identifying particular areas of strength or weakness and to enhance technical credibility.

2.3 SECOND PROGRESS REPORT

The progress of the R&D programme will be documented at appropriate intervals, to determine the level of progress and promote public understanding and acceptance of the geological disposal strategy.

In 1992, PNC published a first progress report (H3) [7], which provided a comprehensive evaluation of the technical relevance of geological disposal. The AEC's Advisory Committee on Radioactive Waste Management (ACRWM, predecessor to the present Advisory Committee) reviewed the H3 and concluded that technical feasibility of the concept of "safe geological disposal of HLW in Japan" had been demonstrated. In addition, ACRWM identified the direction of future R&D activities [8].

Based on the review of H3, the overall HLW management programme and other discussions, the Advisory Committee issued a report entitled "Guidelines on Research and Development Relating to Geological Disposal of High-level Radioactive Waste in Japan" (the Guidelines) [9] in April 1997. These Guidelines specified the direction and technically important issues for R&D relating to geological disposal that must be addressed as part of the next milestone, the second progress report (H12). The current R&D programme aims to provide a scientific and technical basis for the safe disposal of HLW as well as achieve a higher degree of understanding of geological disposal among scientists, decision-makers and the general public. A broad understanding of geological disposal is critical to allow the implementing organisation to initiate its activities.

The second progress report, an extension of H3, will further demonstrate the technical feasibility and reliability of the geological disposal concept and will provide key input for site selection and development of regulations. The H12 report is scheduled for submission to the Japanese Government by JNC around the year 2000.

In order to demonstrate the technical reliability and safety of HLW disposal, the H12 report is required to show that the safety framework provided by a multibarrier system constructed in a suitable host formation is capable of functioning as designed, given the characteristics of the

geological environment in Japan. The R&D requirements for the H12 can therefore, be defined as follows.

- The characteristics of the geological environment that are important for geological disposal must be specified and it must also be shown that suitable rock formations with these characteristics exist in Japan. Information on the near-field properties required to ensure long-term safety and feasibility of HLW disposal should be compiled via appropriate investigations.
- The design criteria for the EBS and other repository components must be specified. The technical feasibility of meeting these criteria must also be demonstrated.
- The performance of the disposal system under the specific conditions of the geological environment in Japan must be evaluated with high reliability.

A critical component in the development of the H12 report is close cooperation with other research organisations including: the Japanese Atomic Energy Research Institute (JAERI), the Geological Survey of Japan (GSJ), the National Research Institute for Earth Science and Disaster Prevention, the Central Research Institute of the Electric Power Industry (CRIEPI), universities and private sector agencies involved in nuclear research R&D activities. This is also necessary for real technical progress to be made in an effective and efficient manner. Consequently, a working group called the "Geological Disposal R&D Coordination Conference" was organised with the aim of sharing results among different organisations and strengthening mutual cooperation.

In September 1998, PNC issued the First Draft of the second progress report, which summarised the provisional results of R&D activities up to July 1998. The aim of the First Draft is to confirm whether current R&D activities have been carrying out in accordance with the Guidelines of the AEC's Advisory Committee, through a series of discussions with experts in various areas concerned with geological disposal. The First Draft also aims to contribute toward the goal of the second progress report by integrating the results of R&D activities. This is necessary because, most R&D addresses specific scientific and technical issues identified in the Guidelines.

To date, the following findings have been obtained from current R&D activities:

- From the viewpoint of the geological disposal, it is possible to select a sufficiently stable geological environment in Japan, such that a repository will not be influenced by disruptive natural phenomena for approximately the next 0.1Ma. The properties of the deep geological environment in Japan are generally appropriate for use as a natural barrier and an environment for emplacing the EBS.
- Considering a wide range of geological environments, it is possible to reasonably design and construct the EBS and disposal facility with existing engineering technology.
- It is possible to establish a methodology for safety assessment to ensure long-term safety of the geological disposal system. The methodology includes developing scenarios, realistic models and assimilating data to evaluate the safety of the geological disposal system. Such a system consists of an appropriately selected geological environment and an EBS designed for the emplacement environment with the system reliability focused on the near-field performance.

As mentioned above, the First Draft of the second progress report has been issued as an intermediate or provisional report. The First Draft includes some parts, which may not be sufficient to respond to the scientific and technical issues identified in the Guidelines. For these parts, the current status of R&D and current goals have been shown in the First Draft with the schedule for completing further studies.

As a first step, the second progress report generally indicates the technical reliability of geological disposal in Japan as specified in the Guidelines. Thus, the First Draft provides a generalized summary of the second progress report and provides its context. The results of R&D activities support describing the First Draft as a "scientific and technical basis" for geological disposal. A series of separate technical reports will be prepared to present the scientific and technical results in the following major R&D areas: 1) studies of the geological environment, 2) repository design and engineering technology, and 3) performance assessment.

3. CURRENT SOCIAL AND REGULATORY ACTIVITIES

According to the overall HLW management programme, an organisation with responsibility for implementing this HLW disposal will be established around the year 2000. The Steering Committee on HLW Project (SHP) has been organised by the Japanese Government, PNC and utility companies, to prepare for establishment of this implementing organisation.

AEC's Special Committee released a draft report on how to implement HLW disposal in July 1997. The report consists of two parts. Part 1 discusses general considerations. Part 2 highlights four specific issues essential to implementing disposal of HLW specially: 1) how to promote public understanding of HLW disposal, 2) how to build public confidence in disposal technology and develop financial and social support systems for implementation, 3) how to coexist with local communities at the disposal site and 4) how to perform site selection.

The draft report was opened for public comment. In parallel, a series of public discussions were held from September 1997 to January 1998. Significant public concerns include: promoting public understanding of geological disposal including energy issues, close and open communication with the public including further discussions as well as early establishment of the implementing institution and the funding base as part of the responsibility of waste generation. After the review period, the final report was published at in May 1998 [10].

A fundamental disposal concept applicable to a variety of geological settings is now being developed in such a way as to maximise flexibility in the subsequent site selection process. At present, neither geological formations nor a site have been selected and no regulatory criteria have as yet been codified. The regulatory criteria will be formulated in parallel with implementation, taking the results of R&D activities into account.

Recently, the Special Committee on the Safety Regulations of Radioactive Waste under the Nuclear Safety Commission of Japan initiated deliberations on the basic concept of safety regulations related to HLW disposal. The Nuclear Energy Subcommittee of the Advisory Committee for Energy to the Ministry of International Trade and Industry (MITI) also started discussions about the cost and funding system, to support the institutions for implementing HLW disposal.

4. CONCLUDING REMARKS

In close cooperation with other organisations and agencies, JNC is performing R&D work and is required to submit the H12 report, including an integrated performance assessment, to the government by the year 2000. The major purpose of the report is to demonstrate more

rigorously and transparently the technical feasibility of HLW disposal in Japan. Current R&D work focuses on development of detailed and realistic near-field models and on improving understanding of key processes and corresponding databases, taking into account a wide range of geological conditions.

Within the national programme, an implementing organisation for HLW disposal will be established around the year 2000 and will initiate the siting process. Future R&D must contribute to both the implementing organisation and regulatory body. JNC's projects such as ENTRY, QUALITY and the two types of URLs are expected to play key roles in this future R&D programme. Participation in relevant projects by researchers both from Japan and abroad in both laboratory facilities and URLs is encouraged in order to accelerate the future progress of research on the geological disposal.

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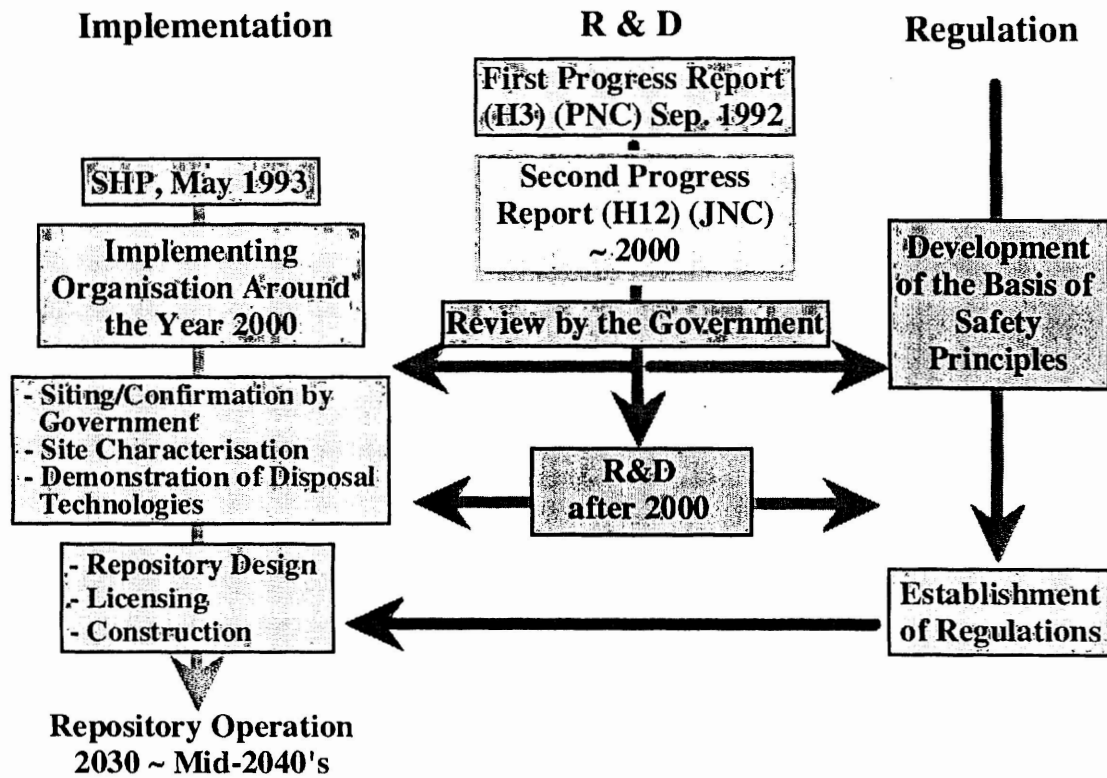


Fig. 1 National Programme for HLW Disposal

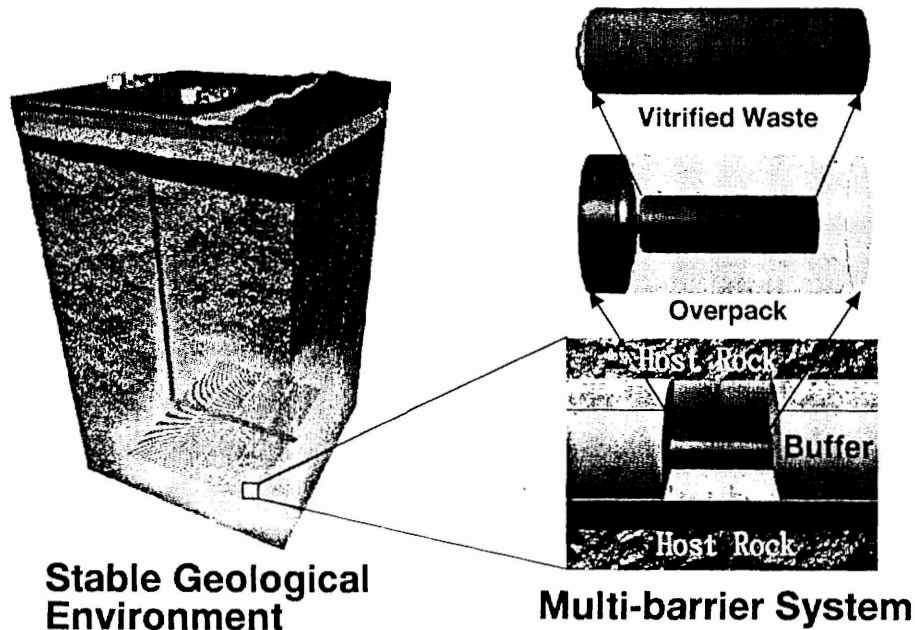


Fig. 2 Disposal Concept

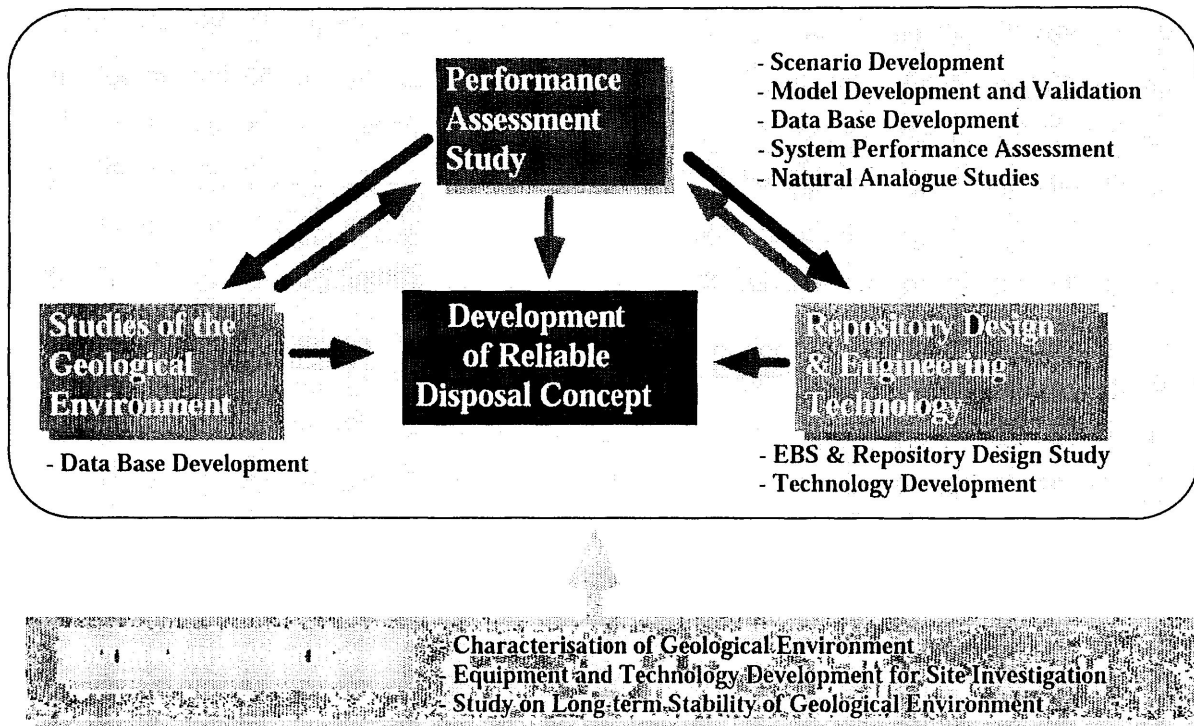


Fig. 3 R&D Structure

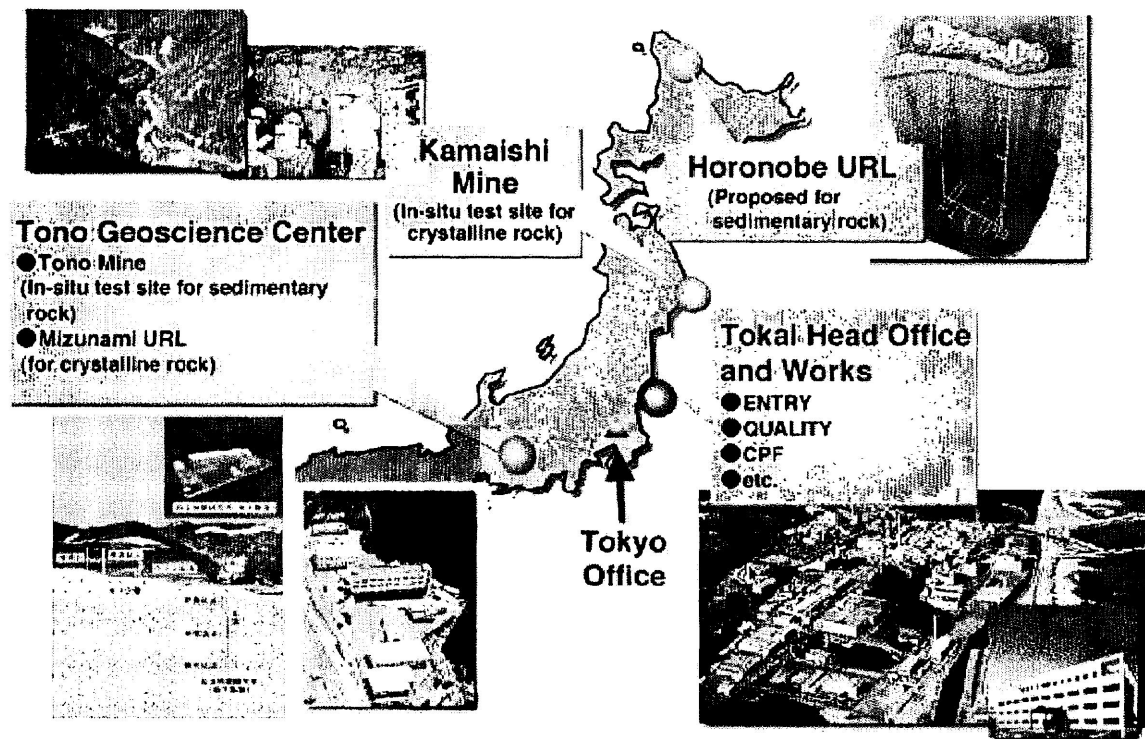


Fig. 4 JNC's R&D Facilities