JAPANESE HLW DISPOSAL PROGRAM - WHERE WE STAND

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ABSTRACT

The Long-term Program formulated by the Atomic Energy Commission (AEC) of Japan specifies that HLW separated during reprocessing of spent fuel is vitrified, stored for a period of 30 to 50 years for cooling and finally disposed of in a stable geological environment deep underground. In the year 2000, geological disposal program in Japan stepped up into the phase of implementation from the phase of generic research and development (R&D). Following legislation of "Specified Radioactive Waste Final Disposal Act" in June 2000, the "Nuclear Waste Management Organization of Japan (NUMO)" was established in October 2000 as an implementing organization. The assigned activities of NUMO include selection of the repository site, demonstration of disposal technology at the site, relevant licensing applications as well as construction, operation and closure of the repository.

INTRODUCTION

In the year 2000, geological disposal program in Japan stepped up into the phase of implementation from the phase of generic research and development (R&D). The Atomic Energy Commission (AEC) of Japan specifies in its Long-Term Program in 1987 [1] that high-level radioactive waste (HLW) separated during reprocessing of spent fuel is vitrified, stored for a period of 30 to 50 years for cooling and finally disposed of in a stable geological environment deep underground. Pursuant to the overall HLW management program, the Nuclear Waste Management Organization of Japan (NUMO) was established in October 2000 for implementing geological disposal of HLW. The assigned activities of NUMO include selection of the repository site, demonstration of disposal technology at the site, relevant licensing applications as well as construction, operation and closure of the repository. According to the present time schedule, repository operation will start as early as 2030s. This paper briefly describes the evolution of Japanese geological disposal program, focusing on the recent developments.

PROGRESS IN THE GENERIC PHASE

Since the initial stage of HLW management program in Japan, the focus has been placed on geological disposal[2]. Relevant R&D activities were carried out for a variety of geological environment, not specifying any particular area or type of rock[3]. The endorsed a multi-barrier system consists of robust engineered barriers and stable geological environment in deep underground as the concept of geological disposal.

The Power Reactor and Nuclear Fuel Development Corporation (PNC) was assigned a role to plan and lead the R&D activities[1] to provide a firm scientific and technical basis for the geological disposal on which a higher degree of confidence among experts involved is built and hence to promote the deserved level of trust among the public in general. One of the most important elements of the R&D program is to integrate the results from a wide range of science and technology into an overall assessment of the reference repository system in a form of

documentation at appropriate intervals[4]. As a major milestone, PNC submitted its First Progress Report, referred to as H3[5], in September 1992 which summarized 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) [6] was submitted by Japan Nuclear Cycle Development Institute (JNC, successor of PNC) to the AEC on November 26, 1999. The objective of H12 was to demonstrate the technical feasibility and reliability of the reference disposal concept, still on a generic basis, in more rigorous and transparent manner. The report was also expected to provide technical basis for the repository siting and regulatory processes as assigned by the "Guidelines on Research and Development Relating to Geological Disposal of High-Level Radioactive Waste in Japan" (the AEC Guidelines)[7].

The AEC organized a review group for H12 in accordance with the AEC Guidelines. As an overall conclusion of the review, AEC remarked in the review report[8] issued in October 2000 that the technical basis integrated in H12 sufficiently satisfies the technical requirements prescribed in the AEC Guidelines. In H12, the long-term safety of a repository system has been evaluated by a rigorous performance assessment method that includes a comprehensive evaluation of uncertainties involved. Despite remaining uncertainties at the stage of generic R&D program, it has been demonstrated and evaluated that a geologic repository would lead to negligible level of doses calculated to be sufficiently lower than the safety guidelines established in the relevant countries and international organizations.

In parallel with technical development, the activities for promoting understanding HLW management have been carried out. The Government have been taking the way in the process of policy making by calling for public comments on the draft documents, for example, the AEC Guidelines, the review report of H12, the revised Long-term Program, etc. In order to have dialogue with the public, the Science and Technology Agency (now, Ministry of Education, Culture, Sports, Science and Technology) organized "Radioactive Waste Symposium" at major cities around Japan 23 times from December 1998 to December 2000. JNC, on the other hand, held a forum on HLW disposal four times, and provided a space in their Web-site to facilitate the public opinions. JNC is also active in providing information services on H12. The report has been already distributed to all public libraries (2,750 libraries) in Japan. Moreover, H12 Internet Library was developed and opened to the public to assess detailed information.

Throughout the progress in the HLW disposal program in Japan, a tremendous amount of experience has been accumulated both in technical and societal domains which is considered as an integral part of the inventory for our future activities. Lessons learned from these experiences can be summarized as follows.

- Stakeholder confidence is the basis for public trust
- A robust safety concept, based on a combination of an appropriate geological environment, an effective engineered system and a reliable safety assessment is essential, but may not always be enough, by itself, to justify stakeholder confidence.
- An independent, technically competent regulator, working as a bridge between stakeholders and the repository implementing organization, may help to gain increased public trust in a fair, equitable and safe process

- Dialogue is desirable to identify stakeholder concerns and to increase public trust of the disposal concept in advance of starting the site-selection process

NEW FRAMEWORK FOR THE PROGRAM

Implementation

Considering the technical achievements of H12, the "Specified Radioactive Waste Final Disposal Act" was legislated in June 2000. The Act specifies the overall implementation scheme (Fig. 1) and defines the roles and responsibilities of the Government and relevant organizations including NUMO, the funding management organization (i.e. RWMC: Radioactive Waste Management Funding and Research Center) and owners of power reactors.

Under the Act, the Government (i.e. METI: Ministry of Economy, Trade and Industry)* is responsible for settling on the basic policy and final disposal plan for 10-year term in every 5 years. NUMO and RWMC are supervised by METI.

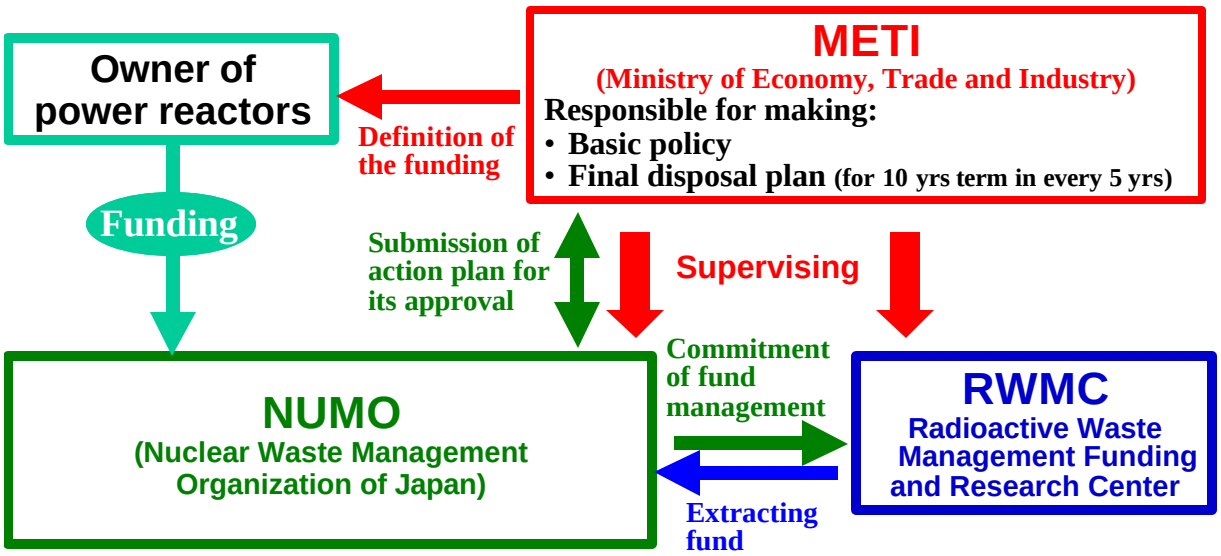

Fig. 1. Framework of implementation scheme

In accordance with the Act, NUMO is responsible to plan and conduct site selection followed by site characterization at the disposal site and relevant licensing application for repository construction/operation and closure. The site selection will be proceeded in a stepwise manner (Fig. 2), taking account of guidelines for site selection specified by the Nuclear Safety Commission (NSC) described in the following section. At the first step, the potential candidate sites will be selected at nation-wide scale mainly by literature survey from the viewpoint of long-term stability of geological environment. The candidate site(s) are then to be eliminated

* Reorganization of the Japanese Government was made on January, 2001. Concerning HLW disposal, the policy making and regulation are mainly managed by Ministry of Economy, Trade and Industry (successor of MITI). These activities are supervised by Atomic Energy Commission (AEC) and Nuclear Safety Commission (NSC) respectively, both which belong to the Cabinet Office.

among selected potential candidate sites where surface based investigations using boreholes will be made to evaluate the characteristics of geological environment for a repository. In the final step, a detailed site characterization will be conducted to nominate a final disposal site by using an underground facility to be constructed at the eliminated candidate site(s). A series of these siting processes carried out by NUMO are supervised by the METI. The METI will call for opinions to a governor and a head of the concerning municipalities for the decisions made in the processes. The opinions shall be respected in terms of reconsidering of the final disposal plan.

In particular in the siting procedure, it is essential to promote the public understanding of geological disposal and to obtain their trust. Thus, it is significant to keep the decision making process on site selection to be a transparent. NUMO will open a variety of information obtained from their siting activities through, for example, the publication of documents, Web-site, etc., and to provide opportunities to take opinions of inhabitants around the (potential) candidate sites. The Government is also in charge to open various type of information on final disposal, and to clarify its policy to ensure the safety of final repository.

As a generator of HLW, owners of nuclear power reactors are responsible to share the cost for final disposal and to provide it to the funding system in accordance with the amounts of electricity generated. The budget for NUMO program should be authorized by METI and assigned from the fund. Management of the funding system is conducted by RWMC, and its activity is also supervised by METI. The total cost is currently estimated at approximately 3 trillion yen (corresponding to 0.13 yen/kWh) for the repository with 40,000 waste forms by the Advisory Committee for Energy, METI[9].

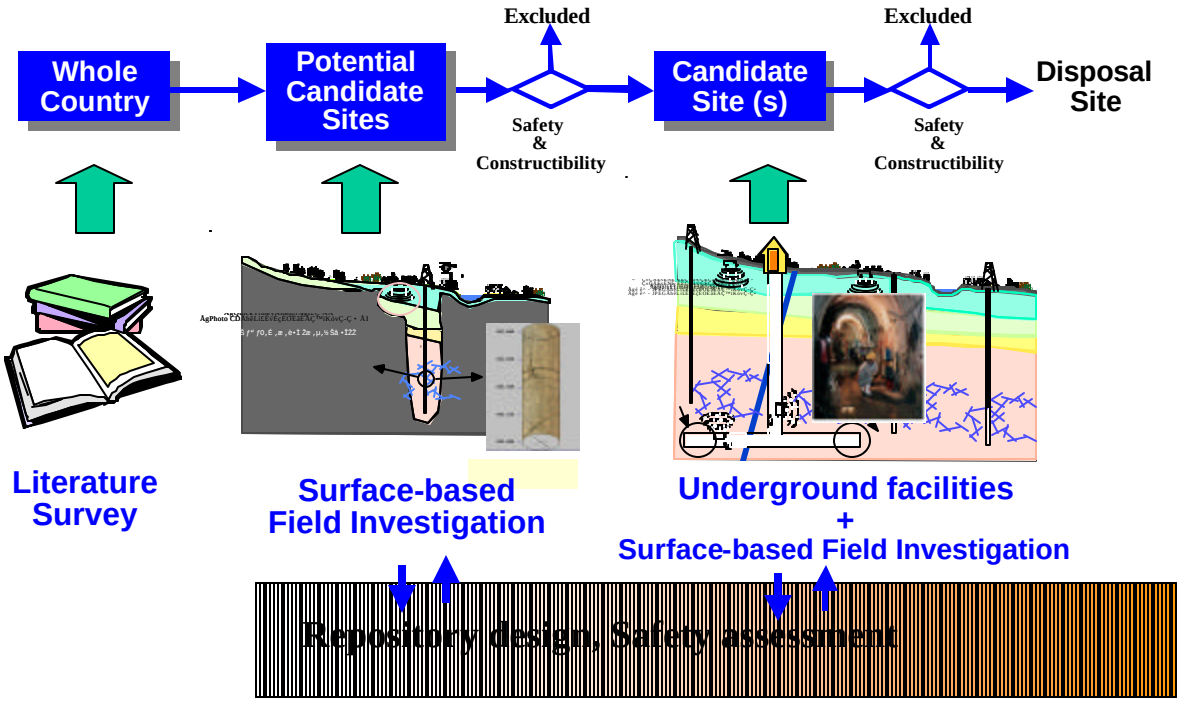

Fig. 2. Stepwise site selection procedure

Regulatory Aspects

The Advisory Committee on Radioactive Waste Safety Regulations of the Japanese Nuclear Safety Commission (NSC) has been carrying on discussions on the safety regulations for the geological disposal system referring to the output of H12. The first report on the basis for safety standards of HLW disposal[10] was published in November 2000 taking account of public comments on its draft. The report mainly specifies safety fundamentals, guidelines for site selection, basic considerations for safety assessment and management of disposal site. As to the safety fundamentals, the safety case should be based on the intrinsic safety features of the system provided by appropriate site and design coupled with qualified safety assessment to illustrate robustness of an overall barrier functions. Guidelines for site selection specify favorable geological conditions which are stable geological environment, and no sign of natural resources underground at present time. It is stressed that two types of scenarios should be developed for safety assessment, namely groundwater scenario and isolation failure scenario. Concerning the management of disposal site, it is emphasized that QA system for the repository development should be established. The report also emphasizes need for monitoring changes in the geological conditions due to repository development to confirm the baseline conditions for safety assessment and need for retrievability over the performance confirmation period. According to the report, NSC is planning to issue the safety guidelines for license application prior to the potential disposal sites will be selected.

R&D Activities

Concerning the R&D in the implementing phase, AEC specifies its framework in the revised Long-Term Program[11] issued on November, 2000. NUMO is responsible for conducting more focused R&D for safe implementation of the repository with best available technology taking the economical and practical aspects into consideration. The Government should proceed independent R&D for establishing safety regulation framework, other fundamental issues related to safety assessment, geoscientific studies and improving repository technology from the viewpoint of increasing confidence. Relevant organizations will support either or both R&D activities carried out by the Government and NUMO. Among these, JNC is required further to ensure the reliability of repository technology and establish safety assessment methodology based upon the experiences from H12 and its technical achievements, utilizing URL projects in Mizunami and Horonobe, and QUALITY facility in Tokai. The Horonobe URL project was approved to proceed by the agreement between the local Governments and JNC in November, 2000.

SUMMARY

Taking account of lessons learned from the generic phases and newly established institutional framework for the geological disposal program, it is recognized that the following aspects are of prime importance for the way forward.

- Assuring traceability and transparency of the safety case
- Evaluate options such as retrievability and extended institutional control

- Demonstration of repository technology developed in H12
- Incremental approach as a basis for siting and repository development

Last but not least, Japan has been active in promoting international cooperation in connection with its R&D program, based on both bilateral and multilateral approaches. The lessons learned from the collaboration have proved to be very valuable to improve R&D structure by identifying areas of strength and weakness and also to generally enhance R&D credibility. Because the R&D program for HLW disposal will continue over a long time period, the preparation and maintenance of key infrastructures such as URLs are very important. From this point of view, international collaboration is also very valuable, ensuring that resources are utilized more effectively by sharing such facilities with appropriate partners.

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