General Overview

A. Promoted project subjects/Project subjects

The objectives throughout the research period and the principal results in FY 2006 are described here for the promoted project subjects and project subjects.

1. Nuclear Technology: Supporting Foundations for a Stable Supply

(1) High accuracy prediction of irradiation embrittlement in light water reactors and its code formation (promoted project subject): FY 2006 - FY 2008

[Objectives]

To develop a highly accurate prediction method for the irradiation embrittlement of a pressure vessel and a fracture toughness master curve method to ensure rational and highly reliable operation in preparation for the aging of light water reactors and to propose draft codes for academic societies and industrial associations.

[Principal Results]

- Using the knowledge acquired through the observation of microstructure monitoring specimens of pressure vessels at domestic nuclear power plants, the embrittlement prediction method originally developed by the CRIEPI was further improved so that the draft revision of JEAC4201, one of the Japan Electric Association Technical Standards, can reflect the improved method (Fig.1).
- A master curve fracture toughness test using small specimens was conducted for the steel used for domestic nuclear reactor pressure vessels and the effects of the size and shape of the specimens were clarified.
- A draft standard of the Japan Society of Mechanical Engineers (JSME) was prepared for evaluation of the soundness of low class piping.

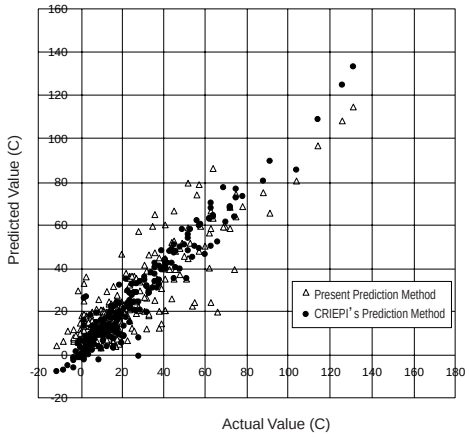


Fig.1 Prediction Accuracy of the CRIEPI's Embrittlement Prediction Method

(2) Comprehensive measures to deal with the deterioration of light water reactors caused by thermal flow: FY 2006 - FY 2008

[Objectives]

To formulate management rules and to develop supporting technologies from the viewpoints of thermal flow and vibration inside a reactor and piping for the purpose of the early realization of the reduced frequency of plant stoppage and an increased nuclear reactor output.

[Principal Results]

- A test was conducted on the diameter of the droplets in high speed steam as the droplet size is important for the prediction of damage by droplet impact erosion. It was found that approximation is possible by the general form of exponential distribution to enable prediction of the maximum droplet diameter.
- Using the BWR's regional stability test facility (SIRIUS-F) which is capable of simulating void reaction feedback in detail and which was developed by the CRIEPI, a simulation test was conducted with ABWR and BWR-5. The results confirm that the impact of MOX fuel installation on the regional stability of the reactor core is small and that the prediction accuracy of ODYSY, which is the licensing analysis code, is sufficiently high.

(3) Advanced assessment technology for SCC crack propagation of LWR materials: FY 2006 - FY 2009

[Objectives]

To contribute to the rational operation of LWR through the wider application of the maintenance standards, in turn based on clarification of the data adoption criteria as the basis for the analysis of the crack propagation characteristics and the maintenance standards, and upgrading of the crack propagation speed evaluation diagramme, etc.

[Principal Results]

・It was found that the SCC crack length and depth distribution of low carbon stainless steel follow the logarithmic normal distribution and that the maximum value is determined by extreme statistics. These findings suggest that the time for SCC cracks to appear can be predicted.

・"SCC Advanced Testing Facility for Environment of high Temperature water in Yokosuka (SAFETY)", a large-scale facility for base research, has finally been installed to establish the testing method to check the long-term soundness of the technology to deal with the SCC of high aged light water reactors.

(4) Assessment of the biological effect of low dose radiation: FY 2006 - FY 2008

[Objectives]

To establish a more rational protection system for radiation by means of acquiring and presenting scientific data based on an epidemiological survey and animal experiments and properly assessing the risk of low dose and low dose rate radiation.

[Principle Results]

・Analysis of the findings of an epidemiological survey in high natural radiation areas in China confirmed that the cancer death rate will not rise even if the radiation level is three to five times higher than that of Japan. The analysis results were presented to the ICRP and IAEA, etc. to contribute to the formulation of protection standards for radiation.

・Data relating to the cumulative nature of the exposed dose was acquired and analysis of the carcinogenic and carcinoma inhibition mechanisms confirmed that the metabolism of cell and other play an important role.

(5) Development of rationalized radiation safety ensuring method: FY 2006 - FY 2008

[Objectives]

To propose a method to judge the suitability of rationalized and advanced safety assessment and measuring technologies for safety assessment standards so that radiation safety measures can be better explained to and understood by the public.

[Principal Results]

・The measurement performance test of the CRIEPI's clearance level measuring equipment (CLALIS) for metal and concrete waste was completed and a plan for a field demonstration test leading to the commercial use of CLALIS was formulated.

・Calculation of the lasting period of an artificial barrier's performance and the shifting time to groundwater was conducted from the viewpoint of the risk theory with radioactive carbon which is important in terms of the extra depth disposal of radioactive waste and the effect of such disposal method on dose assessment was clarified.

・The actual source efficiency which is important for the surface contamination assessment for radiation control was measured at the Hot Laboratory and the compatibility with the surface contamination density criterion under the existing law was verified.

(6) Development of high level radioactive wastes disposal technology (promoted project subject): FY 2006 - FY 2008

[Objectives]

To develop a geological and groundwater environment survey and assessment technique, design and construction technologies for a rational disposal facility and a method to assess the performance and safety of barriers so that high level radioactive waste can be safely disposed of.

[Principal Results]

・By collaboration research on sedimentary rock with JAEA's Honorobe in Japan and Mont Terri project in Switzerland, the applicability of the controlled drilling technology was verified and a method, which takes rock anisotropy due to cracks and other factors into consideration, to measure initial stress was developed (Fig.2).

・The creep test for soft sedimentary rock was conducted under simulated in-situ conditions to clarify the effect of environmental factors on the long-term creep characteristics.

・The heat resistance test was conducted for bentonite under simulated disposal site conditions to establish the degree of the impact of heat.

・The design requirements for a disposal facility were identified for the use of various types of low alkaline cement as barrier materials. In addition, a cement crack control technique was proposed to the Nuclear Waste Management Organization of Japan.

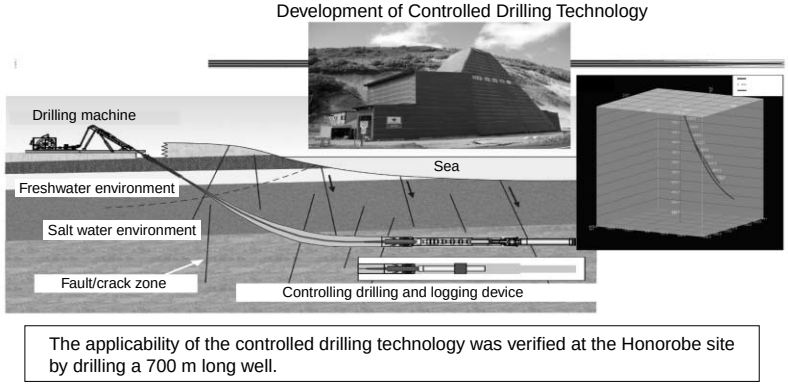


Fig.2 Development of Controlled Drilling Technology and Survey Technique (Entrusted by the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry)

(7) Development of low level radioactive waste disposal technology (promoted project subject): FY 2006 - FY 2008
[Objectives]

To develop a method to assess the radionuclide migration inhibition function and long-term durability, etc. of artificial barrier materials (cement and bentonite, etc.) to contribute to the extra deep disposal of low level radioactive waste and to propose treatment and recycling measures for demolition waste.

[Principal Results]

- Data was acquired on the hydraulic conductivity and swelling characteristic of bentonite which was altered by various ions eluted from cementitious materials and waste materials. The basic alteration mechanism of cementitious materials was clarified.
- Highly dense cementitious materials were produced to further improved the already developed low alkaline cement and the material and dynamic properties of thee materials were evaluated in an experimental manner. In addition, a new flow-type test method was developed to clarify the phenomenon of eluviation relating to the evaluation of the long-term durability of cementitious materials under the conditions of a disposal site environment.
- A business model and local symbiosis plan using a simulator were compiled based on a survey on the local industrial structure and physical distribution, etc. so that a decommissioning and recycling similar for demolition concrete can be used for the disposal and recycling of industrial waste.

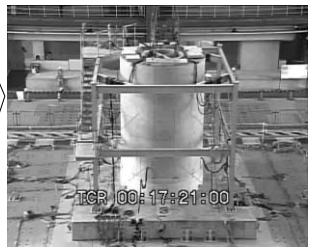
(8) Development of storage and transport technologies for recyclable fuel, etc. (promoted project subject): FY 2006 - FY 2008
[Objectives]

To develop, propose and promote the practical application of an economical and highly reliable long-term large capacity storage technology to assist the stable operation and a flexible pre-processing plan for nuclear power plants.

[Principal Results]

- The feasibility of a reasonable design for shielding for concrete cask storage facilities was verified using the radiation streaming safety assessment method based on the probability theory. In addition, a new design concept for a shallow underground vault storage facility was developed based on the assessment results of the heat removal and aseismic capacities.
- The rust and SCC generation test and the salt deposit test were conducted with canister materials for the concrete cask storage system and the low possibility of SCC generation during a storage period of some 50 years was confirmed.
- Based on the results of the concrete cask earthquake resistance test conduced in FY 2005, assessment of the soundness of the spent nuclear fuel in the storage vessels at an intermediate storage facility supported by pile foundations at the time of an earthquake was conducted (Fig.3).
- In connection with a possible falling accident at the time of the delivery of metal casks to an intermediate storage facility, using the commercial plants scale model, the flat fall and spinning fall tests were conducted from a height of 1 m and no leakage of the filled gas inside the casks was confirmed.

A concrete cask not firmly lashed was tested with three types of seismic wave (El Cento, JMA Kobe and artificial seismic wave. The concrete cask did not fall and it was clarified that the response of the stored fuel would be contained within the elasticity range.



Aseismic test of a real size concrete cask on the large-scale triaxial vibration table at the Research Institute for Disaster Prevention Technology in Germany (E-Defence)

Fig.3 Aseismatic Performance Demonstration Test for Concrete Casks (Entrusted by the Nuclear and Industrial Safety Agency of the Ministry of Economy, Trade and Industry)

(9) Development of metal fuel cycle technology (promoted project subject): FY 2006 - FY 2008
[Objectives]

To proceed with the development of metallic fuels and dry pyro-recycling technologies as optimal technologies for the future fast reactor cycle which promises a high level of nuclear proliferation resistance and reduction of the environmental load of nuclear waste.

[Principal Results]

- As part of the process demonstration test using plutonium, continuous tests to recover uranium and plutonium from the conversion process from oxides to metal and the electrolytic refining process were conducted and the relationship between the uranium and plutonium densities in molten salt and the electrolytic current was clarified under the condition of a material balance of some 95% for uranium and almost 100% for plutonium.
- Cycling data in the transitional period from light water reactors to fast reactors was analysed to clarify the inter-annual changes of the reprocessed amounts of the spent light water reactor fuel required for the transition to fast reactors and of the spent fast reactor fuel and changes of the storage volume of plutonium and the spent fuel over the years.

・Metal fuel containing transuranic nuclides which had undergone the irradiation process at the Phenix Reactor was transported from the French Nuclear Agency to the Transuranic Element Research Institute in Germany to commence non-destructive testing.

(10) Establishment of design assessment technology for its practical application to small fast reactors: FY 2006

[Objectives]

To apply for an advance review by the NRC based on the safety assessment of a sodium cooled ultra-small fast reactor (4S reactor) and the development of innovative technologies with a view to contributing to the establishment of a fast reactor design assessment technology.

[Principal Results]

・Technical documents were jointly prepared with the manufacturers for the application for an advance review of the 4S reactor by US NRC and a technical scenario was created for the safety assessment to obtain the necessary licence.