3. Nuclear Technology Research Laboratory

◆Risk information assessment

[Objectives]

To improve the light water reactor operation and maintenance method based on risk information to optimise the maintenance plan.

[Principal Results]

- A standard method to estimate the common cause failure rate used for failure analysis and probabilistic risk assessment was developed as such data is essential for the utilisation of risk information. The domestic problems of emergency diesel power generators and others were assessed using this method and future development themes were identified.
- Through the application of Bayes' theorem to a small number of inspection data, a program was developed to optimise the inspection timing based on the estimated remaining life of equipment and to assess the inspection effectiveness, etc.

◆Application of fundamental nuclear technologies

[Objectives]

To extend high performance and highly reliable nuclear technologies to other fields to advance the technological base of the electricity industry.

[Principle Results]

- Photoelectron spectrometry of the surface of titanium oxide and thermal desorption analysis were conducted to increase the hydrophilic property and heat removal performance of the fuel rods for light water reactors. It was found for the first time that chemisorption of the hydroxyl group took place due to the irradiation of γ rays or UV rays to increase the said hydrophilic property.
- It was also found that metals with a high melting point, such as Fe and Co, can be expected to become amorphous by means of the rapid cooling and atomisation technology (CANOPUS) which continually mixes molten metal and cold water and sustains steam explosion.

◆Establishment and evaluation of the technical concepts of an innovative energy system

[Objectives]

To identify the technical elements of development required to realise a future energy system,, make recommendations on the prospects of and road map for such development and clarify the development targets.

[Principal Results]

- A technology assessment method based on a new statistical technique (conjoint analysis) was developed. In addition, the utility felt by the public regarding energy technologies was determined and a case study was conducted.
- Dynamic analysis of the advancement of an increased power demand and power source configuration was conducted, taking the introduction of a plug-in hybrid vehicle (PHEV) into consideration, to quantitatively show the effects of PHEV introduction.
- The technical concept for a high speed ignition-type laser nuclear fusion reactor was developed.

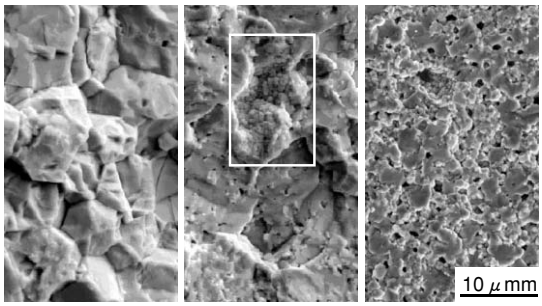
◆Fuel and reactor core technologies

[Objectives]

To clarify the FP gas discharge behaviour of high burn-up MOX fuel, changes of the core characteristics due to a high Pu proportion and the embrittlement/damage mechanism of fuel claddings, etc. in order to assist efficient utilisation up to a high burn-up level.

[Principal Results]

- Irradiation behaviour data (temperature, internal pressure, elongation and FP gas release rate, etc. of the fuel rods) for high burn-up fuel and MOX fuel for light water reactors was obtained through an irradiation test using the Halden Reactor (Fig.7).
- The accelerator ion irradiation technology was developed for efficient simulation of irradiation defects which are formed with the high burn-up claddings of light water reactors by neutron irradiation. Moreover, the conditions for the formation of irradiation defects were clarified through their observation using a transmission electron microscope.



- Burn-up: 33 MW d/kgU
- Irradiation temperature: 770℃
- The characteristics at the time of manufacture are retained and the rim tissues are not yet formed.

- Burn-up: 53 MW d/kgU
- Irradiation temperature: 880℃
- Partial miniaturisation of crystal grains at the grain surface boundary, etc. indicated by a white frame

- Burn-up: 79 MWd/kgU
- Irradiation temperature: 1,000℃
- Rim tissues are formed as a result of the accumulation of minute air bubbles (dark points) and the miniaturisation of crystal grains.

Fig.7 Observation Results of Rim Tissues of Gadolinia-Added (5 wt%) Fuel by a Scanning Electron Microscope (SEM) (from a paper presented to the Autumn Conference of the Atomic Energy Society of Japan in 2006, H12, p. 389 (2006))