Nuclear Technology Research Laboratory

Brief Overview

The Nuclear Technology Research Laboratory aims at positively contributing to the solving/alleviation of energy and global environmental problems by means of developing nuclear technologies, including technologies to deal with aging light water reactors and techniques to assess the biological impacts of low dosage radiation so that the use of nuclear energy is accepted by society in an affirmative manner.

Achievements by Research Theme

Fuel engineering and reactor physics

[Objectives]

To clarify the FP gas release behaviour of high burn-up MOX fuel, neutronic property changes accomplished with plutonium inventory increment and the embrittlement and failure mechanisms of fuel claddings, and consequently to support the effective fuel utilisation up to higher burn-up levels for utilities.

[Principal Results]

- Based on the comparison between the calculated and measured values of nuclide compositions in commercial spent fuels, the technologies to improve the calculation accuracy are proposed especially for radiation source nuclides that are important for shielding evaluation (Cm-244, Sr-90, et al.).
- The basic data are acquired to clarify the cladding failure mechanisms at high burn-up, in case of the abnormal power transient events by the ramp tests in a test reactor using commercial spent fuels and by the non-destructive examinations of the fuels at a hot cell laboratory.

Technical basis for nuclear reactor system safety

[Objectives]

To develop the technological basis to evaluate the safety of current and future nuclear power system for the purpose of assessing safety improvement measures for light water reactors and fast reactors

[Principal Results]

- Innovative safety systems, such as passive safety systems, and an analytical code for system approval which takes the available safety systems into consideration were studied to clarify the technical issues regarding the introduction of next generation light water reactors in Japan.
- The plant system dynamic analytical code (CERES code) developed by the CRIEPI for fast reactor application was compared with the SAS/SASSYS-1 code (U.S.) verified with the experimental data obtained from an experimental fast reactor of EBR-II(U.S.). The results confirmed the appropriateness of the computation model used by the CERES code.

Risk information technology

[Objectives]

To improve operation and maintenance of light water reactors based on risk-relevant information for optimization of maintenance planning

[Principal Results]

- The reasonable rule has been established for selection of prior distribution in hierarchical Bayesian modelling for inference of binomial parameters (e.g. probability of failures on demands).
- The computational modules have been developed for estimation of component aging mechanisms and optimization of inspection and replacement intervals. These modules were implemented to the maintenance planning program METIS.

Construction and assessment of technical concept of 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]

- The conjoint analysis technique often used for economic analysis was applied to the assessment of energy technologies. A positive prospect was developed for the feasibility of the relative comparison of evaluation factors with different characteristics, such as environmental impacts and safety, by means of expressing the differences between experts and non-experts in terms of awareness as the differences in the utility curves.
- With a small laser nuclear fusion reactor with solid metal walls, the required performance of the final optical system to withstand radiation was clarified based on the computation results of the neutron irradiation amount on the structure.

Application of basic technology in nuclear

[Objectives]

To apply high performance and highly reliable technologies, which have been developed for nuclear power systems, to other industrial fields

[Principle Results]

- The surface modification technology of titanium, Fresh Green developed by CRIEPI was extended to that of zirconium and hafnium for the nuclear industry. The Fresh Green technology applied to zirconium and hafnium exhibits corrosion resistance, hydrogen-absorption resistance, and anti-wear property.
- New highly-functional grain-boundary-controlled powders were produced with the ultra-rapid cooling and atomizing technology, CANOPUS developed by CRIEPI.
- Using the test results on the heat transfer flow characteristics and thermoelectric module performance, it was proved that the thermoelectric conversion module developed by the CRIEPI is applicable to cryogenic heat sources (heat transfer tubes for LNG vaporizers, etc.)

Fig.1 Example of Comparative Analysis Results of Transient Events of Small Fast Reactor