2 Research on Nuclear Safety and Emergency Preparedness

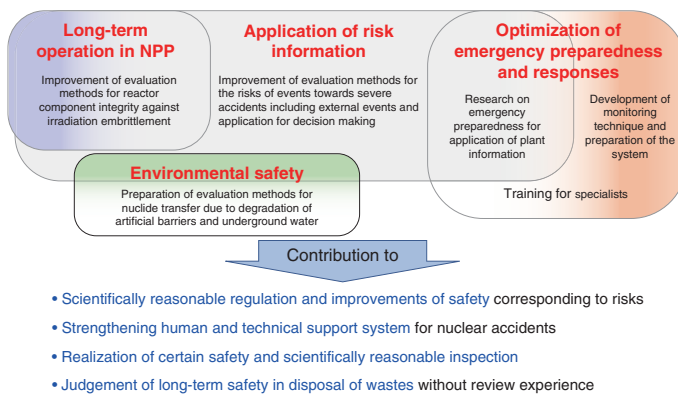## Implementing Continuous Improvements in Safety and Emergency Preparedness

Long-term operation in NPP
Improvement of evaluation methods for reactor component integrity against irradiation embrittlement

Application of risk information
Improvement of evaluation methods for the risks of events towards severe accidents including external events and application for decision making

Optimization of emergency preparedness and responses
Research on emergency preparedness for application of plant information

Development of monitoring technique and preparation of the system

Training for specialists

Environmental safety
Preparation of evaluation methods for nuclide transfer due to degradation of artificial barriers and underground water

Contribution to

- Scientifically reasonable regulation and improvements of safety corresponding to risks
- Strengthening human and technical support system for nuclear accidents
- Realization of certain safety and scientifically reasonable inspection
- Judgement of long-term safety in disposal of wastes without review experience

Fig.2-1 Activities at the Sector of Nuclear Safety Research and Emergency Preparedness
In accordance with the lessons learned from the accident at 1F and the trend in utilization of nuclear energy, we have prioritized pillars of research activities on application of risk information, optimization of emergency preparedness and responses, long-term operation in nuclear power plant (NPP), and environmental safety.

Simulated fuel bundle including heaters

Heating element 3.7 m
Sixteen electric heaters are used to represent the heating length and power of the reactor core in commercial nuclear power plants

HIDRA   4 × 4 Bundle test part

Fig.2-2 High-pressure thermal-hydraulic loop (HIDRA)
Experiments performed using HIDRA help clarify reactor core cooling performance under severe thermal and hydraulic conditions beyond the design basis.

Fig.2-3 Nuclear Safety Research Reactor (NSRR)
The NSRR allows experiments simulating a rapid power increase during a reactivity-initiated accident and under high-temperature conditions beyond the design basis to be safely performed.

The Sector of Nuclear Safety Research and Emergency Preparedness has performed safety research in accordance with the lessons learned from the accident at the TEPCO's Fukushima Daiichi NPS (1F), as well as response to emergency situations as a designated public institution assigned in the Disaster Countermeasures Basic Act and training for personnel engaging nuclear emergency preparedness and responses in normal times. As shown in Fig.2-1, pillars of research activities have been prioritized, specifically, evaluation of the risks toward severe accidents beyond the design basis, nuclear emergency preparedness for appropriate and rapid response to nuclear accidents, research for long-term operation in nuclear power plants on neutron irradiation embrittlement of reactor pressure vessels using materials harvested from commercial reactors, and environmental safety research on disposal of nuclear wastes from 1F and intermediate depth disposal. Through these activities, we have provided technical support for nuclear regulatory administration and have contributed to strengthening of nuclear emergency preparedness and responses in related administrative agencies and local public bodies.

The safety research in Japan Atomic Energy Agency (JAEA) is featured by large-scale facilities where various accident conditions can be simulated. For example, the high-pressure thermal-hydraulic loop shown in Fig.2-2 has been constructed and used to develop sophisticated techniques to evaluate core heat transfer. The Nuclear Safety Research Reactor, shown in Fig.2-3, has been used to investigate the fuel failure limit and the effect of fuel failure on the nuclear reactor during a reactivity-initiated accident, which is a design-basis event. In addition, studies on ultra-trace analysis of nuclear materials for nuclear
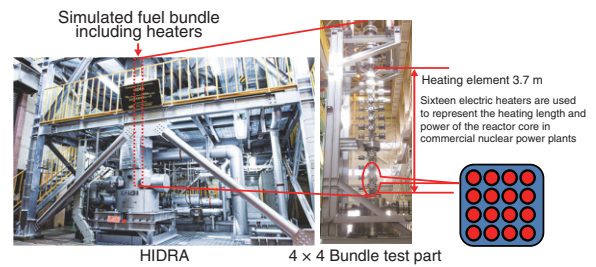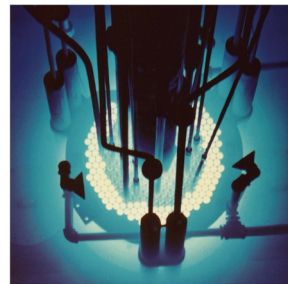
safeguards have also been performed. Furthermore, JAEA has acted as the operating agent in the OECD/NEA project on the analysis of information from the accident at 1F.

In the field of emergency preparedness and responses, the effectiveness of sheltering as a protective action has been evaluated to improve protection strategy. Moreover, techniques to integrate data obtained by different monitoring methods and investigate radioactivity distributions in coastal regions around 1F are under development. Background radioactivity monitoring of domestic nuclear power plants is continuously carried out in preparation for nuclear emergencies.

This chapter presents the results of the following recent research activities: evaluation of the risks toward core damage due to loss of safety function after internal flooding from ruptured pipes in a nuclear facility (Topic 2-1); experimental and numerical research on the flow in a containment vessel during a severe accident using a large-scale experimental facility (Topic 2-2); prediction of fuel debris form for the assessment of debris coolability in a severe accident (Topic 2-3); assessment of the sheltering effectiveness in Japanese houses in nuclear accidents (Topic 2-4); evaluation of failure probability of aged piping system in nuclear facilities against seismic ground motion (Topic 2-5); and, evaluation of exposure dose during treatment of asbestos waste arising from decommissioning of nuclear power plants (Topic 2-6).

The other topic related to 1F-accident, improvement of detection accuracy when unmanned helicopters measure the contamination status of radioactive materials released by the 1F-accident (Topic 1-15) was also detailed in Chapter 1.