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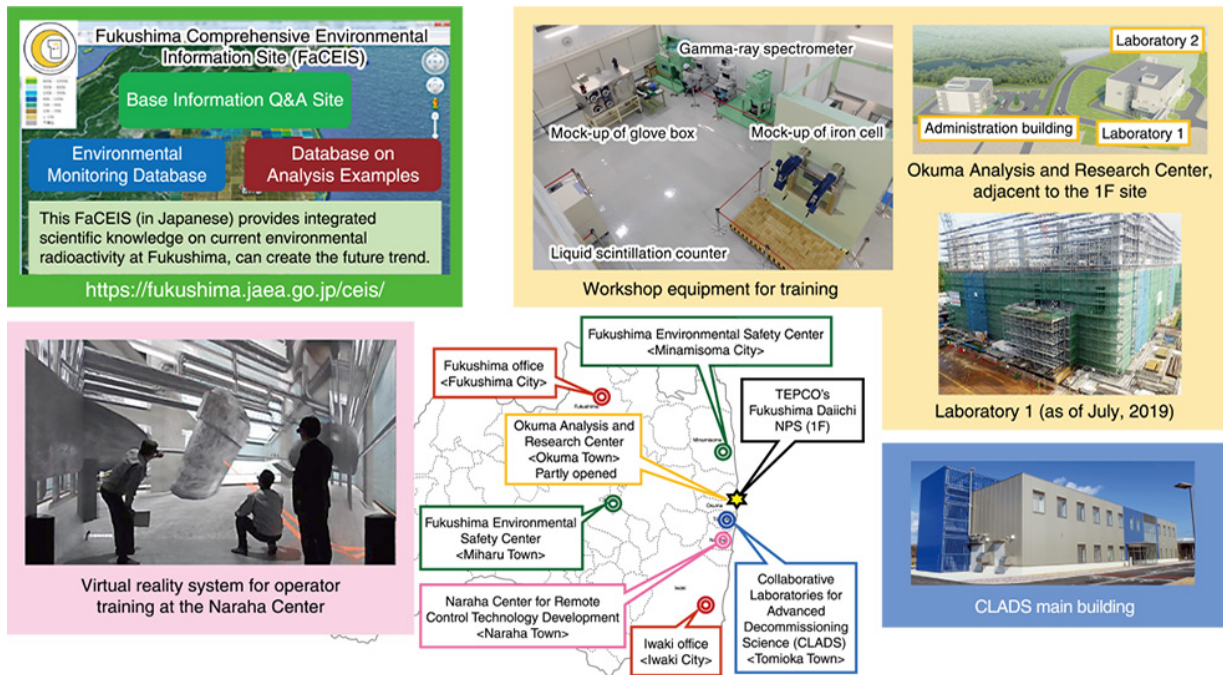

Fig.1-1 Sector of Fukushima research and development: fields and activities

As a comprehensive R&D institute in the field of nuclear energy, JAEA has been supporting the post-accident environmental restoration and decommissioning of the TEPCO's Fukushima Daiichi NPS (1F) (Fig.1-1).

The Collaborative Laboratories for Advanced Decommissioning Science (CLADS) is a research hub for R&D on decommissioning. JAEA has been studying to clarify the debris distribution inside reactors toward a retrieval of nuclear fuel debris (Topic 1-1). In order to understand the debris characteristics, JAEA has evaluated their mechanical characteristics by computer simulation (Topic 1-2) and investigated experimentally the behavior of boron that causes the debris to harden (Topic 1-3).

To ensure radiation protection during debris retrieval, JAEA has been developing the nuclear criticality evaluation method for debris (Topic 1-4) as well as an alpha-ray monitor that is available inside 1F buildings where temperature and humidity have not been controlled yet (Topic 1-5). JAEA also is studying the storage, treatment, disposal and reuse of liquid or solid types of radioactive wastes generated from decommissioning work (Topics 1-6–1-9). Additionally, a dedicated lab in collaboration with universities and industries was established in FY2019 to develop human resources and concentrate expertise toward future 1F decommissioning (Fig.1-1, bottom right).

The Naraha Center for Remote Control Technology Development was also established as a facility for the development and demonstration of remote control devices contributing to 1F decommissioning work. Here, virtual reality systems prepared for operator training (Fig.1-1, bottom left) and robot simulators for decommissioning work (Topic 1-10) are under development. The facilities are available for external researchers. For example, the International Research Institute for Nuclear Decommissioning (IRID) has performed a development of technology for Water Circulation Systems in Primary Containment Vessel (Full-scale Test) using this center.

The Okuma Analysis and Research Center is designed to analyze and characterize radioactive wastes and nuclear fuel debris for the development of long-term waste management. Laboratory 1, which will deal with low-to-medium-level radioactive waste

including rubble and secondary waste, is under construction. Laboratory 2, in the design phase, will deal with high-level radioactive material such as fuel debris. To ensure analysis work in the future, JAEA is training for analyzing work at workshop in Administration Building and so on (Fig.1-1, top right).

These centers will contribute to the decommissioning of 1F and are regarded as decommissioning-related facilities that will play a part in the Fukushima Innovation Coast Framework.

The Fukushima Environmental Safety Center has performed R&D for the environmental restoration. For the long-term assessment of transport of radioactive cesium in the environment, its discharge of radioactive cesium in the dissolved form from the overland to rivers was investigated through long-term concentration monitoring in river water (Topic 1-11) and computer simulations (Topic 1-12). The center has developed a technique to evaluate the vertical distribution of radioactive cesium in pond subsoil based on the gamma-ray spectra (Topic 1-13). JAEA discovered a phenomenon in which radionuclides drastically sink to the deep ocean due to the serpentine current (Topic 1-14). JAEA has promoted the technological development of environmental radiation monitoring and mapping to establish rapid evaluation methods for the distribution of radionuclides. JAEA has succeeded in the definition of radiation exposure dose evaluation for residence at the zone designated for reconstruction and recovery by developing the invers analysis method for airborne radiation monitoring (Topic 1-15). JAEA has also showed the effective dose estimation at the zone designated for reconstruction and recovery using new approaches for the evaluation of the effective dose (Topic 1-16), and developed an evaluation system to create detailed 3D models of residential areas to improve the precision of calculations of air dose rate distributions (Topic 1-17).

The R&D results are published on an information website (Fig.1-1, top left), contributing to building residents' sense of security and studying the measures for municipalities.

Furthermore, JAEA is contributing to Fukushima's revitalization through R&D activities with development of human resources by building networks with regional industries, research institutes, and educational institutes.