13 Development of Experimental Techniques/Facilities at JAEA R&D Centers

Tsuruga Head Office

We are engaged in checking the unchecked equipment and improving the safety culture and so on to remedy the overdue status of the components inspection schedule for "MONJU" and to return to a normal state as soon as possible from the present status of deviation from the Nuclear Reactor Regulation Law.

We are also working steadily toward the decommissioning of "FUGEN" and related technical development as well as selection tests to determine suitable cutting methods for the dismantling required for the decommissioning of the Tokyo Electric Power Company, Incorporated Fukushima Daiichi Nuclear Power Station (1F) as a result of the accident.

In addition, technical cooperation, such as promotion of research and development (R&D), including that on laser technology, by industry–government–academia collaboration is being advanced substantially. In particular, the industrial application of lasers to fast reactor heat exchanger tube repair technology is in progress (Topic 13-1).

The FBR Safety Technology Center was established in April 2013. The center conducts R&D toward commercial deployment of the fast breeder reactor, mainly in the area of safety studies, such as severe accident analysis and evaluation for "MONJU".

Ceremony launching the FBR Safety Technology Center (April 2, 2013)

Tokai Research and Development Center, Nuclear Science Research Institute (NSRI)

The NSRI facilities, such as research reactors (JRR-3, JRR-4, and NSRR), accelerators (e.g., Tandem), critical assemblies (e.g., STACY, FCA), and hot laboratories (e.g., WASTEF, BECKY) were also damaged during the Great East Japan Earthquake. Because the damaged lifelines were recovered quickly, hot laboratories were able to begin supporting the nuclear fuel R&D activities, and accelerators started operation for common use by researchers from JAEA, universities, and other organizations. In addition, the Fukushima Project Team, which was launched on October 1, performed R&D activity using these facilities (Chapter 1, Topics 1-12, 1-14, 1-15). In the recovery of NSRI security, a new building with an earthquake-resistant structure was completed and established as the urgent activity base in the event of atomic accidents.

Regarding the use of NSRI technology, NSRI cooperated with companies in the development of their technologies. For example, a dosimeter system that can simultaneously measure various weather conditions was produced by a manufacturer using radiation detection and electronics technologies developed at NSRI.

Japan Research Reactor-3 (JRR-3)

Nuclear Fuel Cycle Safety Engineering Research Facility (NUCEF)

Nuclear Safety Research Reactor (NSRR)

Reactor Fuel Examination Facility

Main research facilities at Nuclear Science Research Institute

Tokai Research and Development Center, Nuclear Fuel Cycle Engineering Laboratories

At the Plutonium Fuel Development Center, basic data on mixed oxide (MOX) fuels was acquired, and treatment tests of MOX fuel powder were conducted as part of a technical collaboration with Japan Nuclear Fuel Limited.

At the Tokai Reprocessing Technology Development Center, cold tests on the vitrification of high-level radioactive liquid waste and cementation of low-level radioactive liquid waste were conducted.

The Waste Management Department developed decommissioning technologies for old nuclear facilities, planned and built the Tokai Waste Treatment Facility for treating uranium and trans-uranic wastes, conducted fundamental and applied studies to increase the reliability of waste disposal technologies, and developed safety assessment methods.

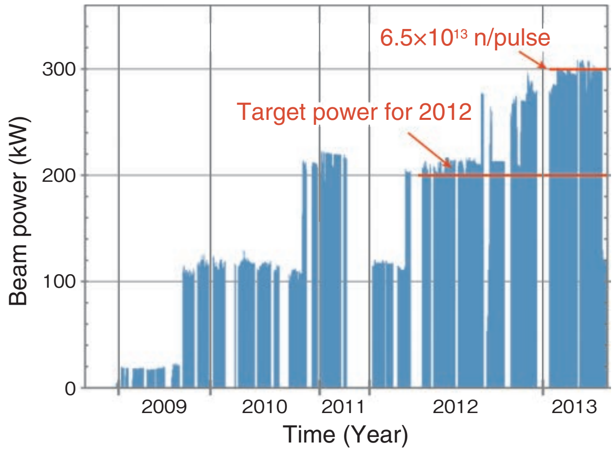
At the Radiation Protection Department, the concentrations of radioactive materials and the ambient dose rate were measured on and off site, and analytical methods for environmental samples were developed (Topic 13-2).

The Department of Fukushima Technology Development has supported the activity of the Fukushima Project Team and has conducted R&D for decommissioning of the damaged Fukushima reactors (Chapter 1, Topics 1-13, 1-20).

Sampling of seabed soil with a monitoring boat

J-PARC Center

In fiscal year 2012 (FY2012), J-PARC provided neutron beams to users for 8 run cycles (176 d). We successfully achieved steady and reliable operation at the target beam power of 200 kW, which was one of our goals for FY2012, by September, and also increased the power to 300 kW in October at the Materials and Life Science Facility (MLF). As a result of this power increase at the MLF the world's strongest neutron intensity of 6.5×10^{13} neutrons per pulse, was generated. This intense neutrons enabled many experimental outcomes, such as the development of high-performance structural materials (Topic 13-3) and the development of high-performance elliptical super-mirror (Topic 13-4). In addition, the MLF muon source produced 250×10^{6} muons per pulse, which exceeds 3×10^{4} muons at a similar facility in the UK and became world's record. A total of 526 proposals were submitted to the MLF user programs which was much more than in any year before the Great East Japan Earthquake. Other major progresses on the dominantly JAEA projects at J-PARC is as follows: (1) the new neutron instrument, the Energy Resolved Neutron Imaging System, which aims to measure elements, magnetic fields and crystalline structure in matter, is under construction at the MLF; and (2) Acceleration cavities with an annular-ring coupled structure were fabricated (Topic 13-5).



Operational history of J-PARC

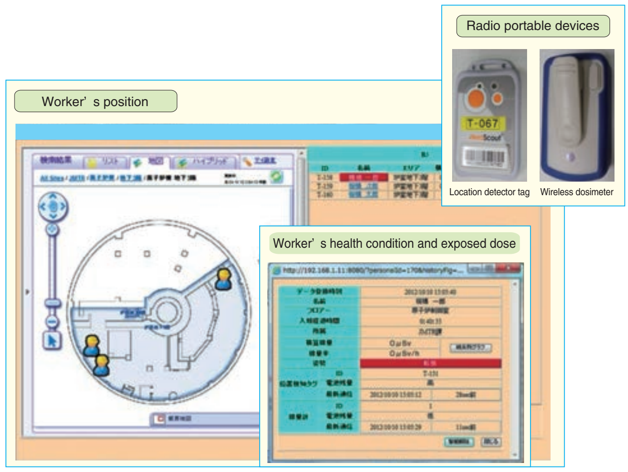
Oarai Research and Development Center

Restoration work was performed and safety measures were taken for the facilities and equipment damaged by the Great East Japan Earthquake.

In the Japan Materials Testing Reactor (JMTR), the confirmation of the integrity of the facilities after the Great East Japan Earthquake was completed, and the results were reported to the regulatory agency with the goal of re-operation. A light water reactor water environment demonstration test facility was fabricated and installed with funding from the Leading-edge Research Promotion Fund, which was provided by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan. A real-time system for monitoring radiation workers' locations, health conditions, and exposed doses using portable radio devices was developed and put into operation. To enable domestic ^{99}Mo production, a technique for fabricating a high-density pellet was developed (Topic 13-6).

In the Experimental Fast Reactor "JOYO," equipment for use in repair work was designed and fabricated. A mock-up test using those pieces of equipment was started. The compatibility of a zirconium alloy with high-temperature sodium was examined (Topic 13-7).

In the High Temperature engineering Test Reactor (HTTR), an inspection of the facilities and a comprehensive evaluation of the integrity of the equipment were conducted with the goal of resuming operation. A damage detection method for the neutron detector was established (Topic 13-8).



Development of real-time personal exposure and health condition monitoring system in the JMTR
The system can monitor workers' locations, health conditions, and exposed radiation doses in real time using wireless portable devices.

Naka Fusion Institute

The Naka Fusion Institute conducts R&D toward the practical use of fusion energy.

Currently, it is involved mainly in the procurement and development of the JA-shared apparatuses as a domestic agency of the ITER project and in the upgrade of the large tokamak device JT-60 to the satellite tokamak device JT-60SA, which will be used for research supporting and complementing ITER as Broader Approach activities in cooperation with the European Union.

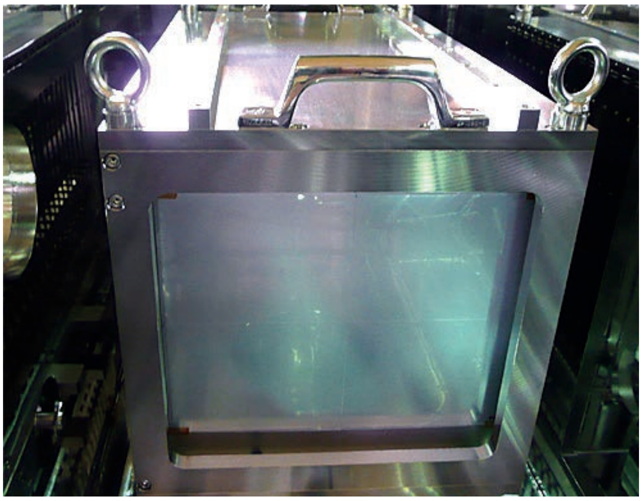
In 2012, the production of the superconducting conductor for ITER was advanced, and the production of the superconducting coil was begun. Moreover, the disassembly of the main body of JT-60 was completed; the cryostat base, which was procured from Europe, was accepted, and the assembly of JT-60SA began.

The production of JT-60SA components was proceeded, and the smallest superconducting poloidal magnetic field coil (EF4) was completed. In addition, three 40° sectors of the vacuum vessel for the actual machine were welded, and a total of six were completed.

Celebration of the delivery of the first component from the EU and the beginning JT-60SA tokamak assembly (March 25, 2013)

Takasaki Advanced Radiation Research Institute

Takasaki Ion Accelerators for Advanced Radiation Application (TIARA) consisting of four ion accelerators, an electron accelerator, and gamma irradiation facilities are made available to researchers in JAEA and other organizations for R&D activities on new functional and environmentally friendly materials, biotechnology, the radiation effects of materials, and quantum beam analysis. Practical technology development activities that are currently in progress involve microbeams, single ion hits, techniques for uniform wide-area irradiation at the cyclotron, three-dimensional in-air PIXE analysis, and a three-dimensional microfabrication technique (Topic 13-9) at the electrostatic accelerators. In 2012, a beam shape control technique was developed that transforms a complicated transverse intensity distribution into a Gaussian-like one through multiple scattering using a thin metallic foil. A 70 mm × 40 mm beam with ±10% uniformity was obtained by focusing the transformed beam with multipole magnets.

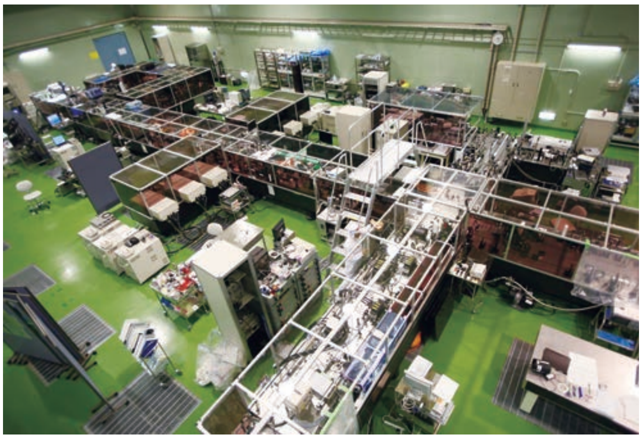


A container of 22 radiochromic dosimetry films for measuring the size and uniformity of a beam, installed in the chamber for formation and irradiation of a large-area uniform beam

Kansai Photon Science Institute

In the Kizu District, we are in the process of improving the laser facilities, e.g., improving the quality of the high-intensity lasers. Regarding high-intensity short-pulse lasers, we worked on improving the position stability of the beam and, by exchanging the mirror mount and reducing the wobbling in the position, improved the reproducibility of experimental results. In addition, in the Consortium for Photon Science and Technology, we are in the process of developing ultrawideband light sources ranging from terahertz to X-rays to quantum beams.

In the Harima District, we have been developing and improving a state-of-the-art analysis technique for the functional expression mechanism and reaction mechanism of materials using the JAEA synchrotron radiation beamlines at SPring-8. They are also applied to studies related to nanotechnology, energy, and the environment, for instance, a decontamination technique for revitalization in Fukushima. Further, under the Nanotechnology Platform Project entrusted to us by MEXT, external researchers are being supported.



JAEA Kansai Advanced Relativistic ENgineering (J-KAREN) laser system

Horonobe Underground Research Center

We are currently constructing the Horonobe Underground Research Laboratory for conducting geoscientific research and R&D on geological disposal technologies targeted at sedimentary rocks.

In FY2012, the west shaft was excavated to depths ranging from 50 m to 350 m (the east and ventilation shafts already reached 350 m in depth in the last fiscal year). In addition, the 350 m research gallery passed through the ventilation shaft to join the east shaft. About 400 m of the 700-m-long gallery have been completed.

In geoscientific research, we have continuously developed techniques for investigating the geological environment and for deep underground engineering, and studied the long-term stability of the geological environment. On the other hand, in our R&D on geological disposal, we investigated the impact of low-alkaline cement materials, including high fly-ash and silica fume content cement, to the surrounding groundwater and rock mass. In addition, the use of materials in spraying techniques was tested in situ during the construction of the 350 m research gallery.

Penetration of 350 m research gallery between the ventilation and east shafts

Tono Geoscience Center (TGC)

The TGC's task is to provide the scientific and technical foundations for developing a safe technique for the geological disposal of high-level radioactive waste. This involves research into the long-term stability of the geological environment, the development and improvement of techniques for the characterization of the deep geological environment, and a wide range of engineering techniques for deep underground applications at an underground research laboratory in crystalline rock, referred to as the Mizunami Underground Research Laboratory. Approximately 150 m of horizontal excavations (Sub Stage, Access/Research Galleries-North and South) were completed for the GL −500 m stage (meters below ground level). While planning the construction, it was necessary to obtain reliable preliminary information on the bedrock conditions in terms of the rock mass stability and hydrogeology. Therefore, site characterization borehole investigations were conducted before excavation began (Topic 13-10). Research and development activities, such as geological mapping during excavation and borehole investigations, were also conducted.

Breaking through at part of the GL –500 m Sub Stage (July 30, 2012)

Ningyo-toge Environmental Engineering Center

The Ningyo-toge Environmental Engineering Center has advanced the environmental remediation of the Ningyo-toge and Togo Uranium Mines after decades of mine-related activities, including uranium exploration and mining, were terminated. The main purposes of the remediation are to take measures to ensure the safety and protection from radiation via exposure pathways to humans in the future, and to prevent the occurrence of mining pollution.

As part of the remediation, the upstream part of the Yotsugi Mill Tailings Pond, the highestprioritized facility among all of the mine-related facilities, was remediated to FY2012. In the remediation, a multi-layered capping was constructed on the ground surface after the specifications and the entire remediation procedure were determined. Monitoring data will be accumulated to confirm the effectiveness of the remediation, and the results will be used for remediation of the downstream part of the Pond.

The Center also performed the required maintenance of related facilities and promoted technology development. In addition, a sense of security among local residents and active use of local features (Topic 13-11, "Investigation of Properties of Radon Hot Springs") have been sought as another indispensable aspect of the Center's activities.

Upstream part of the Yotsugi Mill Tailings Pond

Aomori Research and Development Center

In the Rokkasho District, R&D toward developing the fusion DEMO reactor is in progress, for example, a fusion simulation using a supercomputer that has the second-best performance in Japan, and the development of the fusion reactor structural material using various material analysis and testing devices. In addition, the injector for the prototype accelerator of the International Fusion Materials Irradiation Facility (IFMIF) was delivered, and commissioning is planned to begin this autumn.

In the Mutsu District, a research survey of reasonable and economical large assembly dismantling methodologies for the operation of a waste disposal plant for research facilities, and decommissioning of the nuclear-powered ship Mutsu (e.g., surveying the contaminant content and developing technology to analyze ultra-trace elements using accelerator mass spectrometry) are conducted continuously.

Delivery of the injector for the prototype accelerator to the IFMIF/EVEDA (Engineering Validation and Engineering Design Activities) accelerator building