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

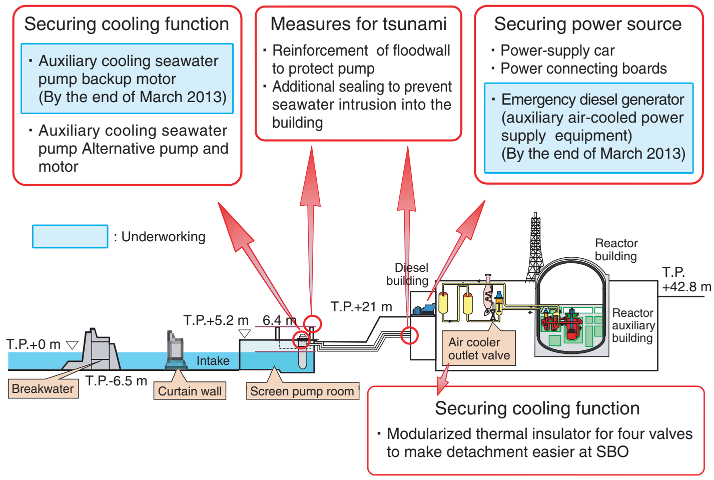
## Tsuruga Head Office

Following the accident at the Tokyo Electric Power Company, Incorporated Fukushima Daiichi Nuclear Power Station (1F) on March 11, 2011, emergency safety measures have been implemented at both the "MONJU" and "FUGEN" Power Stations.

At "MONJU", there have been no confirmed effects on the reactor vessel or the core internals after the replacement of the in-vessel transfer machine (IVTM) and its function check for the recovery work of the IVTM falling accident that occurred in August 2010. The suspended 40% power confirmation test, which is the second stage of the three-stage system start-up tests, awaits the government policy decision giving the green light to restart, while taking utmost care to maintain the quality level of the facilities and equipment.

At "FUGEN", the decommissioning and its related technical development have been steadily conducted. The implementation of decontamination facilities has been launched on a trial basis, in particular, to treat low-level radioactive waste as general waste (Topic 13-1).

Also, the technical collaboration among industry, government, and academia, including research and development projects in the field of laser development and laser applications, has been actively promoted.




"MONJU" Safety Measures

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

The NSRI facilities, such as research reactors (JRR-3, JRR-4, and NSRR), accelerators (Tandem etc.), critical assemblies (STACY, FCA, etc.), and hot laboratories (WASTEF, BECKY, etc.) also suffered damage during the Great East Japan Earthquake. Because of the quick recovery of the damaged lifelines, research activities at NSRI were able to begin supporting the restoration from the accident at 1F from an early stage.

To continue the development of technology, the ring-type dosimeter, which has advantages of long-term stability and repeatability in the readout process (Topic 13-2), was developed. In addition, a handy-type dosimeter was produced by manufacturers, employing electronics technologies that were developed at NSRI. Investigations of the practical (rational) and efficient disposal of radioactive waste have been carried out, and the results were applied to the system to classify the very-low-dose concrete generated from JRR-3 modification construction work as industrial waste (Topic 13-3).

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 (NSRI)

## Tokai Research and Development Center, Nuclear Fuel Cycle Engineering Laboratories

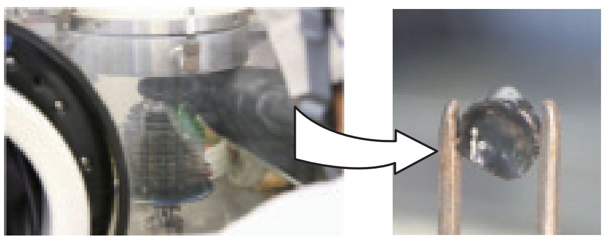
At the Plutonium Fuel Development Center, physical properties of MOX fuels were studied, and the test for the preparation of standard plutonium materials was executed as a part of technological cooperation with the Japan Nuclear Fuel Limited (JNFL).

At the Reprocessing Technology Development Center, we carried out seismic reinforcement of the Tokai Reprocessing Plant and technological cooperation with the JNFL for the operation of the Rokkasho Reprocessing Plant. In addition, safety measures were executed to prevent against the loss of the cooling functions.

We also performed various other R&D activities, such as basic studies to maintain FBR cycle technologies (Topic 13-4) and tests to enhance the reliability of geological disposal technologies. In addition, we developed a basic design for the construction of an incineration facility for radioactive waste treatment.

Furthermore, as a part of the activities for the decommissioning of the damaged Fukushima reactors, the mimetic molten debris were fabricated by mixing zircaloy and uranium oxide, and these were then investigated.

Plutonium Fuel Development Facility



The mimetic molten debris (right hand) fabricated by the apparatus for measuring melting points (left hand)

Mimetic molten debris fabricated at the Plutonium Fuel Development Facility

## J-PARC Center

The extensive damage to facilities and infrastructure caused by the Great East Japan Earthquake on the 11th of March 2011 led to the shutting down of the J-PARC. However, because of the tremendous effort of the competent J-PARC staff, the Linac accelerator was restarted on the 9th of December, 2011, and the neutron beam production was verified at the Materials and Life Science Experimental Facility (MLF) on the 22nd of December. After performing various commissioning operations, user programs in both the MLF and neutrino experimental facilities resumed on the 24th of January, 2012. The supplies of proton beam intensities to those facilities were recovered to their pre-earthquake values of 210 kW and 180 kW, respectively. Since January 2012, the number of J-PARC users also quickly recovered to more than 2500 persons per month, which was the same as the number before the earthquake. Many exciting results were reported from all experimental facilities, including the neutron structure analysis of a single protein crystal and a technical development for visualizing the magnetic field in matter taking place at the MLF.

Staff members celebrating the resumption of proton beam delivery to the Materials and Life Science Experimental Facility (December 22, 2011)

## Oarai Research and Development Center

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

Immersion tests of materials in sodium chloride solution and cesium decontamination trial tests, etc. were carried out as part of the R&D into the decommissioning of 1F.

In the Japan Materials Testing Reactor (JMTR), facilities were inspected aiming at re-operation, and various irradiation facilities and equipment and a simulator for the irradiation test reactors were fabricated by the "Leading-edge Research Promotion Fund," which was provided by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan.

In the Experimental Fast Reactor "JOYO," there was progress in the design of pieces of equipment used in the repair work. The dummy for a mock-up test using these equipment was also fabricated.

In the High Temperature Engineering Test Reactor (HTTR), facilities were inspected with the aim of resuming operation. The verification runs were conducted in the cold state, and a comprehensive evaluation of the integrity of the equipment was also carried out.

The construction of the Advanced Technology Experiment Sodium (Na) Facility (AtheNa) to carry out sodium tests, etc., in the FaCT project was also completed.


Training using a simulator for irradiation test reactors

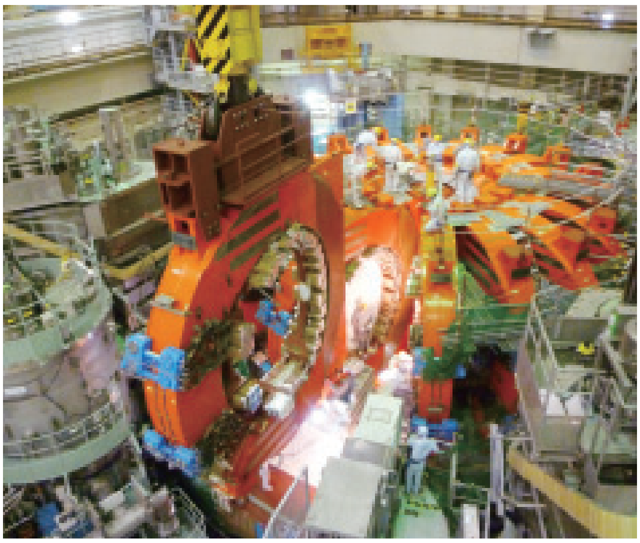
## Naka Fusion Institute

The Naka Fusion Institute conducts research and development toward the practical use of fusion energy.

Currently, it is mainly involved 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 the research supporting and complementing ITER as the "Broader Approach activities" in cooperation with the European Union.

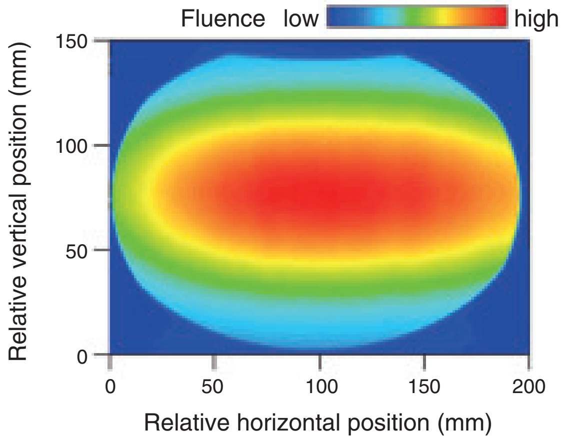
In 2011, the Japan Atomic Energy Agency (JAEA) brought forward the planned production of the superconducting conductor of the ITER. In the disassembling operation of JT-60, the disassembly and removal of TF coils as the major components of JT-60 was continued, and the removal of all 18 coils was completed by the end of the fiscal year.

The component production of JT-60SA was carried out. Three 40-degree sectors of the vacuum vessel for the actual machine were delivered and completed with the continuation of the production of the superconducting conductor for the magnetic field coil of the actual machine.


Disassembly operation of TF coils in JT-60 (December 2011)

### Takasaki Advanced Radiation Research Institute

Takasaki Ion Accelerators for Advanced Radiation Application (TIARA), which consists of four ion accelerators, the electron accelerator, and the gamma irradiation facilities, are made available to researchers in the JAEA and other organizations for R&D activities regarding 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, and three-dimensional in-air PIXE analysis, and three-dimensional microbeam writing technology with proton beams of different energies at the electrostatic accelerators. In 2011, a technique used to measure the transverse intensity distribution of a uniform wide-area beam by a radiochromic dosimetry film was developed for 520 MeV Ar and 490 MeV Xe.

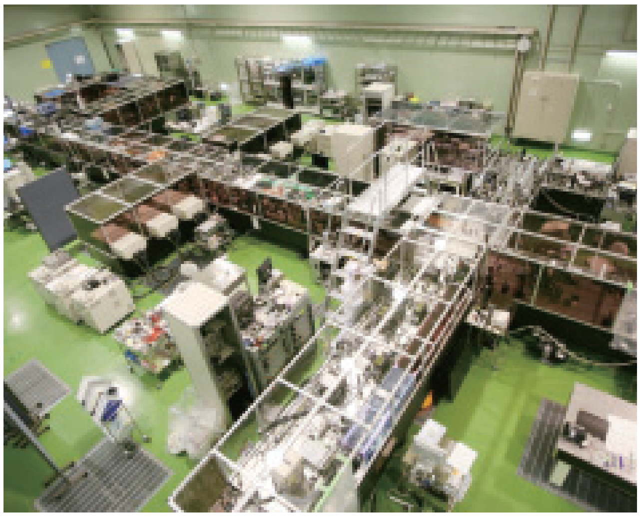



Two-dimensional Gaussian-like intensity distribution of a 520 MeV Ar beam measured with a radiochromic film

### Kansai Photon Science Institute

In the Kizu District, we are in the process of improving laser facilities, e.g., the improvement in the quality of high-intensity lasers. With regards to high-intensity short-pulse lasers, we successfully reduced the pulse width and improved the laser wavefront. We achieved an intensity two times that obtained previously ($10^{21}$ W/cm$^2$). Also, in the Consortium for Photon Science and Technology, we are in the process of developing ultra wideband light sources ranging from terahertz-x-rays to quantum beams, as a management agency.

In the Harima District, we have been developing and improving a state-of-the-art analysis technique for the functional expression mechanism and the reaction mechanism of materials using JAEA synchrotron radiation beamlines at SPring-8. They are also applied to studies related to nanotechnology, energy, and the environment and are used for external applications. In the JAEA soft X-ray beamline, we successfully developed an ultrahigh-precision, element-selective measurement technique for the magnetization of nanoscale thin films.



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

### Horonobe Underground Research Center

We are currently constructing an underground research laboratory for carrying out investigations involving “Geoscientific research” and “Research and development of geological disposal technologies,” focusing on sedimentary rocks.

In the fiscal year 2011, both the east and ventilation shafts were excavated from depths ranging from 250 m to 350 m in depth, and the west shaft was excavated from the ground level (GL) down to a depth of 50 m. The construction of the 250 m drift has been completed, and the construction of the 350 m drift has begun.

In geoscientific research, we have continuously carried out the development of techniques for the investigation of the geological environment, for the long-term monitoring of the geological environment, and for the development of engineering techniques for use in the deep underground environment and studies regarding the long-term stability of the geological environment.

In our R&D into geological disposal technologies, we investigated the degree of influence of low-alkaline cement materials, including HFSC (Highly Fly-ash containing Silica-fume Cement) in the surrounding groundwater and rock mass. Also, the use of the materials in spraying techniques was tested in situ during the construction of the 250 m Gallery.

Spraying test of low-alkaline cement in the 250 m Gallery off the west shaft

## Tono Geoscience Center (TGC)

The TGC's task is to provide scientific and technical foundations for the development of a safe technique for the geological disposal of high-level radioactive waste. This involves research into the long-term stability of the geological environment and 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 (MIU). The Main Shaft was excavated from 481.3 m to 500.4 m below GL, and the Ventilation Shaft was excavated from 497.7 m to 500.2 m below GL (meters below ground level). Then, approximately 5-m-long horizontal tunnels were excavated at the GL -500 m stage (Topic 13-12). Research and development activities, such as geological mapping during excavation and borehole investigations, were also carried out.

View of the intersection of the Main Shaft and the horizontal tunnel at the GL -500 m stage

## Ningyo-toge Environmental Engineering Center

We are currently developing an engineering approach for the decommissioning of a uranium refinement and conversion plant (URCP) facility and a uranium enrichment plant facility in the Ningyo-toge Environmental Engineering Center. The URCP facility decommissioning project is the first trial for any commercial-scale nuclear fuel facility in Japan. We began the decommissioning project of the URCP facility in FY 2008 and have since completed the dismantling of the main (large size) equipment. In the process, we carried out the application tests by using the commercially available decontamination reagent for economic purposes and convenience. Also, we obtained successful results for metal surface decontamination, and it has satisfied the standard value*.

From now on, the application to the decontamination of large-size equipment will be considered, including 1F.

*the standard value which carried out from a radiation control area: $\alpha$-ray 0.4 Bq/cm$^2$, $\beta$ $\gamma$-ray 4.0 Bq/ cm$^2$

This photograph shows the state of decontamination of a tank obtained using a commercially available decontamination reagent. The commercially available decontamination reagent, which became a film, is peeled off in the figure.

## Aomori Research and Development Center

In the Rokkasho district, the use of radioisotopes in the DEMO R&D building was permitted by the relevant authorities as one of three research facilities of the Broader Approach Activities in the Field of Fusion Energy Research. The supercomputer (made by Bull, France) was installed in the Fusion Computational Simulation Centre (CSC), and the supercomputer had been in service to the users from April 2012.

In the Mutsu district, we continuously carried out a research survey for a reasonable/economical large-assembly-dismantling methodology for the operation of a waste disposal plant for research facilities, the decommissioning of the nuclear-powered ship Mutsu (such as a survey of the contaminant contained), and the development of a technology for the analysis of ultra-trace elements using accelerator mass spectrometry.

Exterior of the supercomputer at the CSC