国立研究開発法人

日本原子力研究開発機構

Japan Atomic Energy Agency

Mission

私たちが果たすべき使命

原子力の未来を切り拓き、
人類社会の福祉に貢献する。

Break new ground for the future of nuclear energy, and contribute to welfare of human society

私たちは、安全確保を大前提として、我が国のエネルギーの安定確保及び地球環境問題の解決並びに新しい科学技術や産業の創出を目指した原子力の研究開発を総合的、計画的かつ効率的に行うとともに、成果の普及等を行うことにより、人類社会の福祉及び国民生活の水準向上に貢献を果たします。

On the basic premise of ensuring safety, we will conduct R&D in the field of nuclear energy in a systematic, comprehensive and efficient manner, aiming to secure stable energy supplies, solve global environmental issues and create new science, technology and industry, widely disseminating our R&D achievement, and thus contribute to the improvement of welfare of human society and rise in the national living standards.

Message from the President

President of the Japan Atomic Energy Agency
KODAMA Toshio

I would like to express my sincere appreciation for your continued understanding and support for research and development (R&D) activities that the Japan Atomic Energy Agency (JAEA) undertakes.

JAEA is Japan's sole comprehensive R&D institution on nuclear energy, and its mission is to contribute to the welfare and prosperity of human society through nuclear science and technology. Every day, JAEA strives for fulfilling the mission with a keen sense of responsibility.

In October 2019, JAEA set forth a future vision entitled "JAEA 2050 +" which outlines its future profile, namely the goals to be set and the actions to be taken toward these goals in order to continue its social contribution into the future amid the rapidly changing nuclear energy environment in the era of Reiwa.

The future vision vows to fully utilize the broad potential of nuclear energy with the aim of realizing a "New Era Nuclear Science and Technology" that can contribute to resolving global climate change, securing energy supply, and achieving the ideal future society (Society 5.0).

The "New Era Nuclear Science and Technology" is renewed efforts for actively promoting fusion of the nuclear energy field with other fields to create new social innovations.
Accordingly, JAEA will endeavor to build an organization that contributes to society and secure and develop a wide variety of human resources through internal coordination and external collaboration. In addition, to realize international cooperations and contributions, JAEA will strategically promote R&D on nuclear energy with global visions in mind.

Specific initiatives include steady progress of R&D for restoring Fukushima, improving nuclear safety, decommissioning of nuclear facilities, realizing fast reactors and advanced reactors, and management of radioactive waste in a safe manner. Alongside that, JAEA will conduct basic and fundamental research on nuclear energy, and strive to resume operation of research reactors and to promote its utilization.

To maximize R&D achievement, based on the needs of the government and business sectors, all JAEA employees will work as one with high aspirations to fulfill their duties, while placing ensuring safety above all else.

I appreciate your continued understanding and cooperation.

October 2020

Future Vision “JAEA 2050 +”

https://www.jaea.go.jp/JAEA2050/ [in Japanese]

In order to continue our social contribution into the future, JAEA formulated the Future Vision “JAEA 2050 +” in line with the policy goals of the Japanese government.

Goals toward 2050

- We will seek to contribute to the creation of a better future and innovation, efficiently utilizing the potential of nuclear energy.

1. With expertise gained through Nuclear Science and Technology, we will contribute to finding solutions for global warming issues.
2. Utilizing energy systems, including systems featuring nuclear fuel cycles of improved safety, we will contribute to ensuring stable energy supply.
3. Through Nuclear Science and Technology, we will contribute to realizing the future society (Society 5.0).

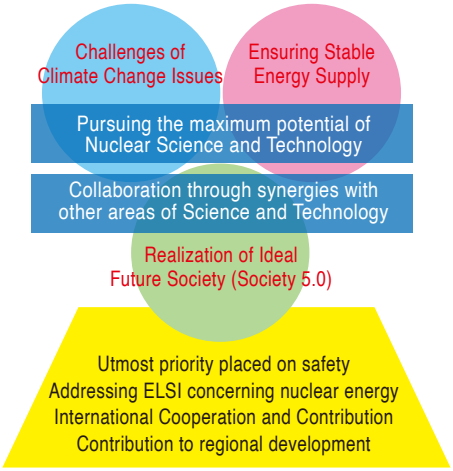
- We will strive to realize “New Era Nuclear Science and Technology” that reaffirms the value of nuclear safety in light of the lessons learned from TEPCO’s Fukushima Daiichi Nuclear Power Station accident.

“New Era Nuclear Science and Technology”: renewed efforts to contribute to future society by ensuring an interactive dialogue with society and the following:

- ▶ Development of a Nuclear Science and Technology system that addresses “S+3E,” including further enhancement of safety, and delivers the solutions to social challenges
- ▶ Creation of innovations through synergies with other areas of science and technology

- We will strive to take full advantage of Nuclear Science and Technology to tackle challenges including ELSI relevant to nuclear energy and present solutions for realizing “New Era Nuclear Science and Technology.”

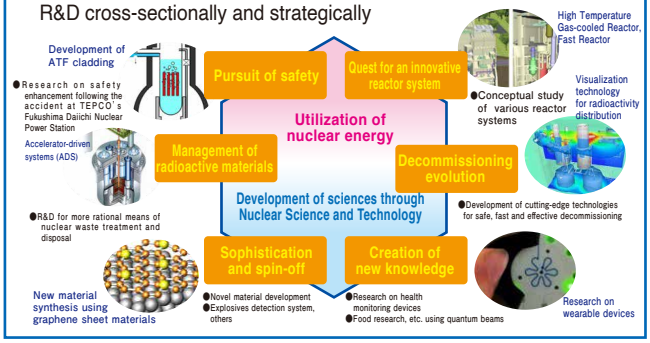
Overall Image of the Future Vision of JAEA



Actions toward 2050

R&D for Making “New Era Nuclear Science and Technology” a Reality

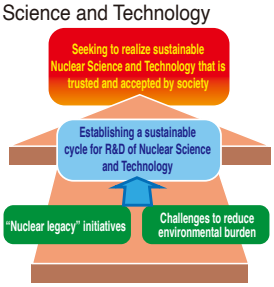
Establishing six research themes and promoting multidimensional R&D cross-sectionally and strategically



Efforts/Challenges for Sustainable Utilization of Nuclear Science and Technology

- Steadily tackling fuel cycle back-end issues through “Management of radioactive materials” and “Decommissioning evolution” to develop an R&D cycle for Nuclear Science and Technology

- “Nuclear legacy” initiatives tied to current and future use of new industrial fields
- Challenges to reduce environmental burden



International Cooperation / International Contribution and Regional Development

- Actively participate in R&D cooperation with advanced nuclear energy countries, contribute to international organizations and emerging nuclear energy countries, and disseminate and conduct outreach concerning R&D results
- Contribute to strengthening the nuclear non-proliferation and nuclear security regime
- Contribute to regional development as a community member

- Further foster trust of community members
- Contribute to the daily lives of regional members
- Develop partnership with the community
- Contribute to nurturing of future scientists and engineers

Redefining the Organizational Concept and Securing/Training Human Resources

- Reorganize JAEA to coordinate and collaborate with other sectors beyond the nuclear community and contribute to future society
- Secure and train human resources from a wide range of fields

The Vision for Human Resources Sought by JAEA

- Personnel with the ability to implement successful global activities in society
- Personnel with the ability to create new outputs and values
- Personnel with the ability to play active roles in a wide range of fields
- Personnel with the ability to work with other people and ensure the safety of facilities
- Personnel with the ability to deepen mutual understanding with society through dialogue

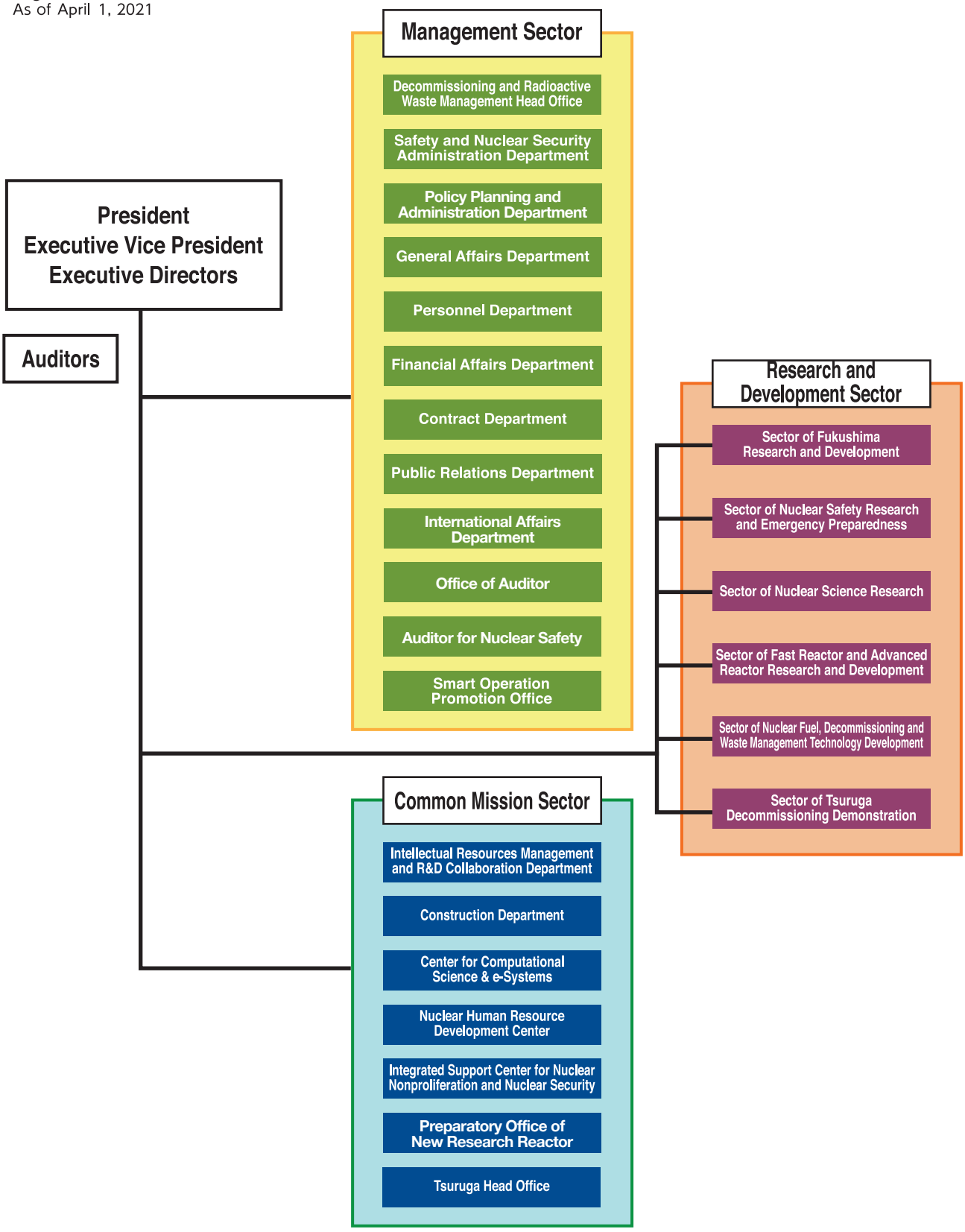
2020.10

JAEA Profile

https://www.jaea.go.jp/english/about/organization.pdf

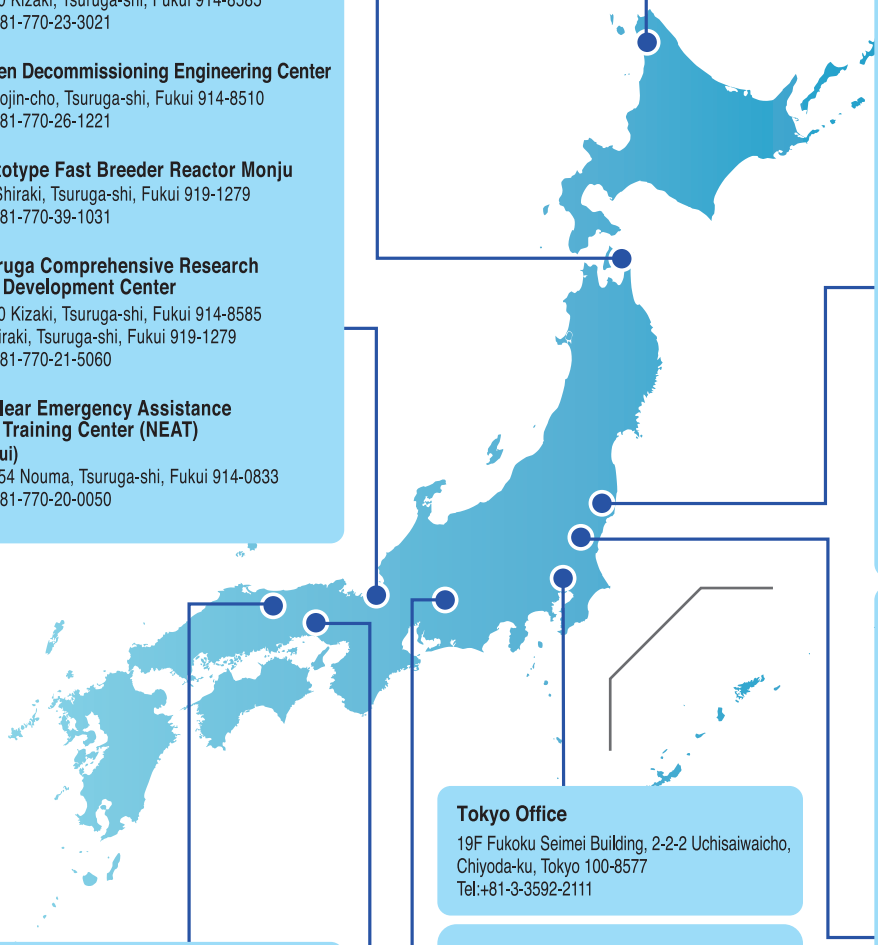
The Japan Atomic Energy Agency (JAEA) is Japan's sole comprehensive R&D institute in the field of nuclear energy stipulated by the Atomic Energy Basic Act. JAEA works on resolving the unprecedented issues facing the accident at the TEPCO's Fukushima Daiichi Nuclear Power Station, research on the improvement of nuclear safety, basic and fundamental research in the nuclear field, and R&D on the nuclear fuel cycle and on radioactive waste treatment and disposal technology.

Organization chart
As of April 1, 2021



R&D Institutes and Centers

https://www.jaea.go.jp/english/about/locationmap.html



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(Ohminato)
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Prototype Fast Breeder Reactor Monju
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Tsuruga Comprehensive Research and Development Center
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1 Shiraki, Tsuruga-shi, Fukui 919-1279
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Nuclear Fuel Cycle Engineering Laboratories(NCL)
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  Mizunami-shi, Gifu 509-6132
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- Toki Research Institute of Isotope Geology and Geochronology
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2021.4

JAEA Sector of Fukushima Research and Development

https://fukushima.jaea.go.jp/en/

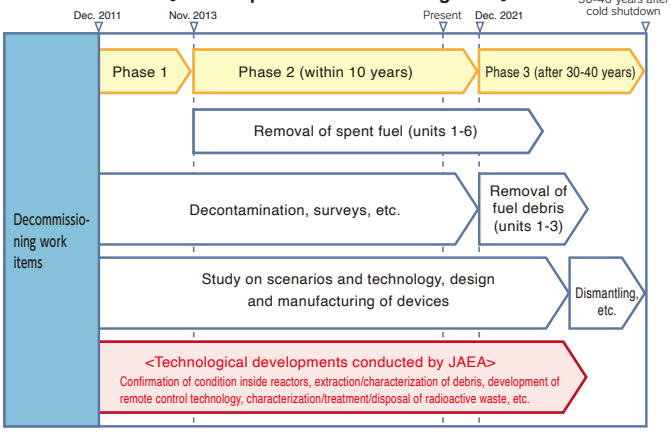
Commitment to R&D for the decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station (1F) and revitalization of Fukushima.

Center: Fukushima | Tokai | Oarai

R&D for decommissioning of 1F

JAEA steadily carries out R&D in accordance with the Mid-and-Long-Term roadmap towards the decommissioning of 1F, the strategy planned by the Nuclear Damage Compensation and Decommissioning Facilitation Corporation "NDF" and on-site requirements from medium-to long-term perspectives. In addition, JAEA focuses on developing research infrastructures and securing and fostering human resources.
Moreover, JAEA will provide on-site plants with the technical information and contribute to achieving highly safe and efficient early decommissioning while enhancing the safety of nuclear energy.

【Roadmap of Decommissioning of 1F】



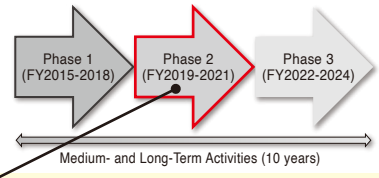
Created based on Important Stories on Decommissioning issued in March 2019 by the Ministry of Economy, Trade and Industry, on which the revised 5th Mid-and-Long-Term roadmap was reflected

R&D for environmental restoration

In collaboration with Fukushima Prefecture and National Institute for Environmental Studies (NIES), JAEA promotes R&D in accordance with Medium-term and Long-term Action Policies of the Centre for Environmental Creation (CEC), in order to implement the policy of Basic Guidelines for the Reconstruction and Revitalization of Fukushima.
JAEA carries out R&D and survey for restoration of environment contaminated by radioactive materials. JAEA conducts environmental dynamics study in the larger fields such as forests, and rivers, and develops a system to visualize and predict radiation dose rate. Moreover, JAEA will actively offer technical expertise.

【Medium-term and Long-term Action Policies of the Centre for Environmental Creation】

The applicable period is 10 years from FY2015 to FY2024. Since the business of the Fukushima Prefectural CEC is unprecedented, its activity policy is to be split into three phases.



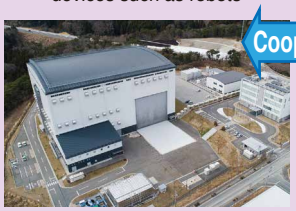
Activities in Phase 2 (FY2019-2021)
Promote investigation and research through three-party cooperation, focusing on environmental dynamics and creation
- Research related to long-term environmental dynamics and environmental impact assessment of radioactive materials
- Development and advancement of radioactive material analysis techniques
- Investigation and research on storage, volume reduction, reuse and disposal of removed soil and contaminated waste, etc.

For Phase 3 and beyond (from FY2022 onward), an activity policy is to be established after evaluating the outcome of Phase 2 activities carried out by the three parties.

Research and development organizations

Naraha Center for Remote Control Technology Development

Development/demonstration tests of remote control equipment and devices such as robots



Naraha Town, Fukushima (near 1F)

Cooperation

Collaborative Laboratories for Advanced Decommissioning Science (CLADS)

Acting as international research hub and symbol of the shared international interest for Decommissioning R&D

International Collaborative Research Building

Tomioka Town, Fukushima (near 1F)

Sharing results

R&D on environmental dynamics, radiation monitoring, etc.

Miharu Town, Fukushima

Minamisoma City, Fukushima

＊Located inside the Fukushima Prefectural Centre for Environment Creation

Cooperation

Okuma Analysis and Research Center

Characterization of radioactive waste and fuel debris (Administrative Building is in operation)

Okuma Town, Fukushima (next to the 1F site)

Cooperation

【TEPCO, IRID*, NDF】【Domestic and oversea universities, research institutes, etc.】【Fukushima Prefecture, Ministry of the Environment】
【JAEA's facilities for handling nuclear fuel/radioactive materials and irradiation facilities at Tokai and Oarai in Ibaraki Prefecture are also utilized.】

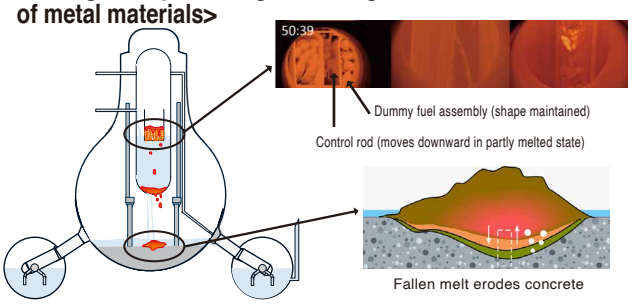
＊ International Research Institute for Nuclear Decommissioning

JAEA contributes to the decommissioning of TEPCO's 1F and environmental restoration of Fukushima.

R&D toward decommissioning, etc.

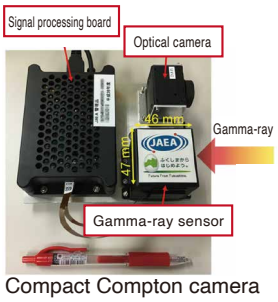
Collaborative Laboratories for Advanced Decommissioning Science (CLADS)

<Heating tests pertaining to melting and relocation behavior of metal materials>



<Development of radioactive material visualization technology>

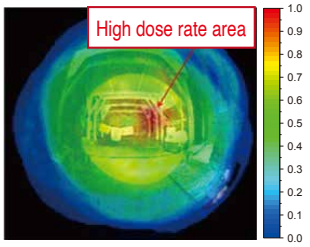
JAEA works on the development of technology to visualize radioactive materials, in order to contribute to reducing exposure dose for workers in "difficult to return zones" and 1F site and to formulation of decontamination plans.



Compact Compton camera

A compact Compton camera JAEA developed was installed on a mobile robot, which helped in ascertaining the high dose rate area inside a reactor building.


Mobile robot



R&D toward environmental restoration

Collaborative Laboratories for Advanced Decommissioning Science (CLADS)

<Dissemination of R&D achievements and development of analysis tools>

CLADS publishes the findings of the environmental dynamics study in an easy-to-understand manner based on scientifically evidence on the Web.

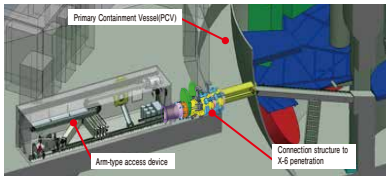
Fukushima Comprehensive Environment Information Site (FaCE!S)
- Fukushima's Environment Now and in the Future -
https://fukushima.jaea.go.jp/ceis/ [in Japanese]

Development of R&D infrastructures

Naraha Center for Remote Control Technology Development

The facilities here are available for performing demonstration tests and operation training of remote-control equipment and devices (e.g., robots) necessary for decommissioning work. In the Full-scale Test Area, IRID plans to conduct a full-scale mock-up test for detailed investigation inside the primary containment vessel (PCV) for safe implementation of trial removal of fuel debris (see figures below).
The facilities are not only for decommissioning-related work, but also for developing various robots and their demonstration tests. JAEA is also working on its own technology development aiming at the improvement of the test equipment.

Courtesy of IRID

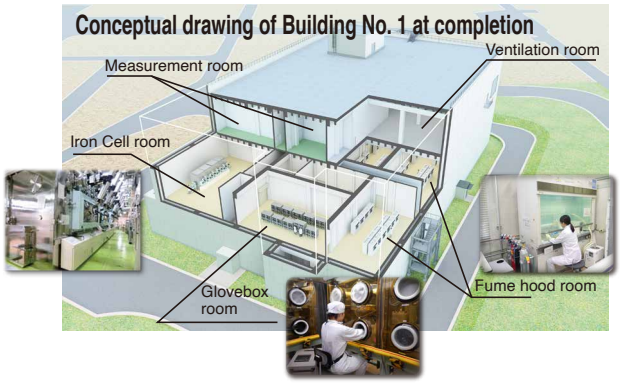


Mock-up test facility for detailed investigation inside PCV (conceptual diagram)


Mock-up test facility for detailed investigation inside PCV(full-scale test facility)

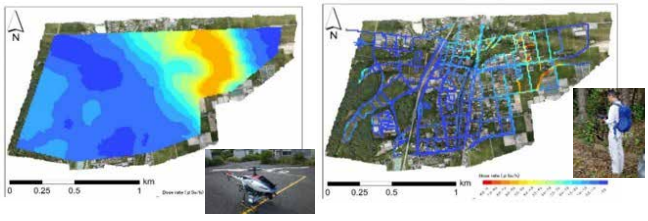
Okuma Analysis and Research Center

The Radioactive Material Analysis and Research Facility is now under development, where analysis and research will be performed for characterizing radioactive waste and fuel debris generated by the 1F accident. The Administrative Building that has living areas and meeting rooms is in operation, while Laboratory-1 that will be used for analysis of radioactive materials with surface dose rate up to 1 Sv/h such as rubble, incinerated ash, and secondary waste from water treatment, etc. is under construction. Construction of Laboratory-2 that is to be used for analysis of fuel debris will be started in the future.



<Establishment of monitoring and exposure evaluation techniques>

JAEA contributes to policy decision by national and local governments (e.g., establishment of specified reconstruction and revitalization base) through dose rate monitoring, dust monitoring, exposure dose prediction, etc.


Example of dose rate monitoring

Sector of Nuclear Safety Research and Emergency Preparedness

https://www.jaea.go.jp/04/nsrc_neat/index_e.html

This sector contributes to improvement of regulations on nuclear safety and emergency preparedness and response through various risk studies and elucidation of events that threaten the nuclear safety.

Center: Tokai (NSRI) Hitachinaka

Initiatives for continuous improvement of nuclear safety utilizing risk information

JAEA conducts cross-disciplinary implementation of various studies for improving safety in nuclear facilities. Outcome of research is disseminated toward improved safety and realization of effective prevention of nuclear emergency, utilizing risk information obtained from safety research and analysis of accident, fault, and international information collected.

Safety research for contribution to nuclear safety regulations

Based on the lessons learned from the Fukushima Daiichi Nuclear Power Station accident, JAEA conducts research to enhance the graded approach concept through continuous improvement toward the highest standards of safety.
JAEA also conducts research according mainly to the needs of the Nuclear Regulation Authority while maintaining neutrality and transparency, to establish regulation in risk-informed regulatory scheme, and advanced studies in long-term technical aspects.

Research focused on response to beyond design basis severe accidents

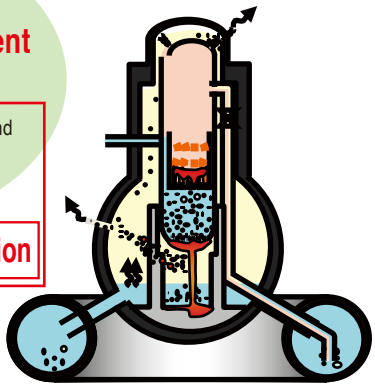
Severe Accident Prevention
Response to design basis events
Prevention of core melting under beyond design basis conditions

Severe Accident Evaluation
Advancement of methodologies for risk evaluation of nuclear facilities

Environmental/ Radiation Assessment
Protection of environment and people in nuclear accidents

Enhancement of research on external events
Large-scale natural events (e.g., earthquake, tornado), aircraft crash, etc.

Prioritization



Research fields and research facilities/devices

Fuel Safety

Nuclear Safety Research Reactor NSRR

Reactor Fuel Examination Facility RFEF

Safety of light water reactor facilities

Thermal-hydraulic Safety

Containment Integral Measurement Apparatus CIGMA

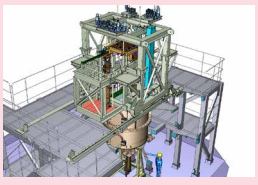
Large Scale Test Facility (Thermal-hydraulic integral effects test facility for PWR) LSTF

Fuel Cycle Safety

Apparatus for Evaluating Clogging Effect of HEPA Filter on Confinement Capability Under Fire Accident ACUA

Safety of nuclear fuel cycle facilities

Criticality Safety



Static Experiment Critical Facility STACY
＊Under conversion

Safeguards

Clean Laboratory for Environmental Analysis and Research CLEAR

Waste Safety

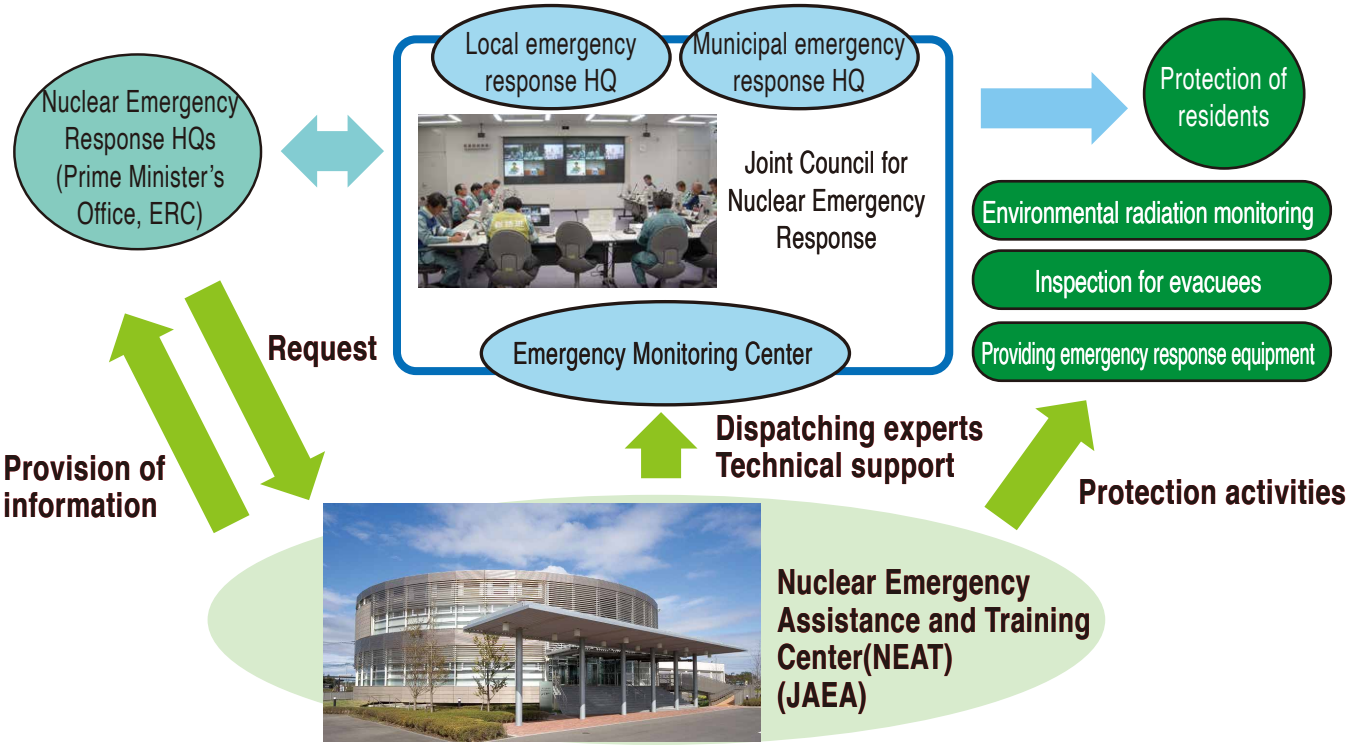
Back-end Fuel Cycle Key Elements Research Facility BECKY

Nuclear Emergency Assistance and Training

JAEA supports activities on nuclear emergency preparedness and response with human resources, information and technology.

Activities in Emergencies

JAEA provides technical support for national and local governments' nuclear emergency response activities as one of the designated public institutions based on law.
The Nuclear Emergency Assistance and Training Center (NEAT) is the base of technical support for response to nuclear emergencies.




HQ function for emergency support


Dispatching of experts for monitoring

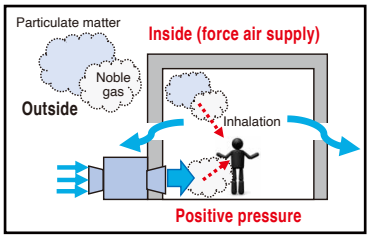

Local dispatching of special vehicles

Activities in Normal Times

JAEA supports nuclear emergency drills of national and local governments and personnel training related to nuclear emergency response. JAEA also conducts investigation and research to give support in strengthening the nuclear emergency response system, and provides assistance for nuclear emergencies and enhancing emergency preparedness systems outside Japan.


Dispatching of personnel for training of inspection for evacuees


Various trainings for police, firefighters, and response HQ personnel



Analysis of exposure dose reduction effect of sheltering facilities

Sector of Nuclear Science Research

https://snsr.jaea.go.jp/en/index.html

JAEA devotes itself to produce scientific knowledge and technologies supported by the basic nuclear science, and to foster human resources having abilities to produce them.

Center: Tokai (NSRI) Harima

Promoting basic nuclear science and engineering research and advanced nuclear science research

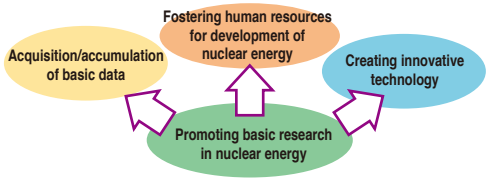
JAEA leads safe use of nuclear energy and radiation, and creates new science and technology, and industries.

In the basic nuclear science and engineering research, JAEA is devoting itself to research activities related to nuclear reactor, improvement of its fuel and material performances, radionuclide behaviors and radiation properties in order to reinforce the technology platform in nuclear science. In addition, considering the public needs, JAEA contributes to solving issues in the nuclear energy utilization such as reduction in volume and toxicity of high-level radioactive waste and safety improvements of nuclear reactors, by using the developed technologies.

In the advanced nuclear energy science research, JAEA is promoting world-leading, advanced research in actinides science and nuclear materials science, playing a key role as a core institution around the world. JAEA aims to acquire new knowledge beyond existing frameworks by discovering new principles and phenomena, and creating new materials. Furthermore, by making full use of JAEA's infrastructure facilities, JAEA is commited to the development of researchers and engineers with sophisticated problem-solving capabilities at our R&D sites.

Basic nuclear science and engineering

JAEA is devoting basic R&D for creating innovative technologies of the nuclear energy utilization, with fostering nuclear scientists and engineers who support a base of the nuclear energy.



- Nuclear data and reactor engineering
- Nuclear fuel and material science
- Nuclear chemistry
- Environmental and radiation science
- Key technologies for the light water reactor
- Partitioning and transmutation technologies

Advanced nuclear energy science research

Implementing world-leading research in advanced actinides science and advanced nuclear materials science, which is having a strong impact for its groundbreaking science and technology in leading the development of nuclear energy science.

Advanced actinides science

- Condensed system science, heavy element science, etc. → nuclear transmutation, MA nuclear data, etc.

Advanced nuclear materials science

- Energy conversion materials science →thermoelectric/multifunctional materials, etc.

Research for improving safety performance in nuclear energy utilization

JAEA is promoting JAEA fundamental R&D for improving the safety of light water reactors, and developing technologies for safer decommissioning.

JAEA is improving the safety and reliability of light water reactors, and contribute to technical basis for both the promotion and regulation. For these purposes JAEA is conducting basic research, such as development of codes and maintenance of database for reduction of accident risk, mitigation of accidents, and safer and steady decommissioning.

Basic nuclear science and engineering

- Nuclear engineering
- Thermal hydraulic engineering
- Fuels/ materials engineering
- Nuclear chemistry

Safer and steady decommissioning

- Development of techniques for evaluating nuclide composition and radioactivity for decommissioning
- Development of technologies for analyzing long-term integrity of decommissioned facilities
- Development of radionuclide distribution measurement and quantitative analysis techniques

Reduction of accident risk

- Development of technologies relevant to the feasibility of candidate cladding materials for accident-resistant fuels
- Development of models for predicting the aging of nuclear facilities
- Advancement of analysis technology of core thermal hydraulics

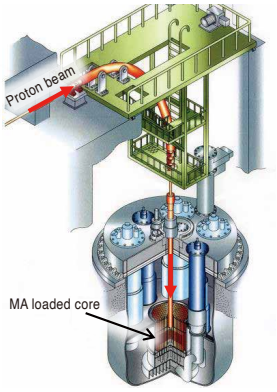
Mitigation of accident

- Advancement of analysis techniques of core-melt progression in a severe accident
- Development of technology for analyzing radioactive material behavior

R&D of nuclear transmutation using an accelerator aiming at volume reduction and mitigation of degree of harmfulness of high-level waste

Developing systems for transmutation of minor actinides contained in spent fuel using an accelerator.

Highly radiotoxic, long-lived minor actinides (MAs) are contained in high-level radioactive waste (HLW) generated by reprocessing of spent fuel from nuclear power plants. Conversion of these MAs into low-toxicity, short-lived nuclides or stable nuclides that do not emit radiation (this technique referred to as 'nuclear transmutation') will contribute to volume reduction and mitigation of degree of harmfulness of HLW and then will reduce the difficulty in the disposal of HLW.
JAEA is developing technology to separate MAs efficiently from HLW and to transmute the separated MAs efficiently and safely by using an accelerator-driven system (ADS).

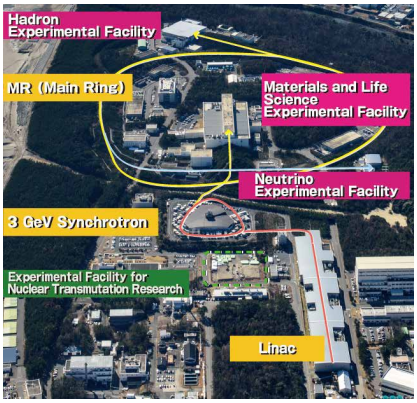


Example of ADS design

Promoting cutting-edge research by J-PARC

Supporting the development of science, technology and academia and promotion of industry as a global center of neutron science research.

The Japan Proton Accelerator Research Complex (J-PARC) is a multi-purpose research facility jointly operated by JAEA and the High Energy Accelerator Research Organization. By utilizing a variety of secondary particles, such as neutrons, muons and neutrinos, which are generated by the world-class proton accelerator, J-PARC is creating results for cutting-edge research from basic science to industrial applications together with users of the system. At the Materials and Life Science Experimental Facility, research utilizing the world's strongest pulsed neutrons is carried out, including academic studies related to various materials and studies related to development of industries (e.g., development of batteries).

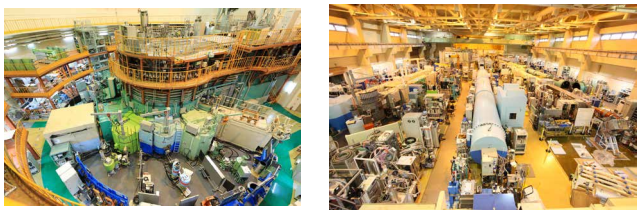


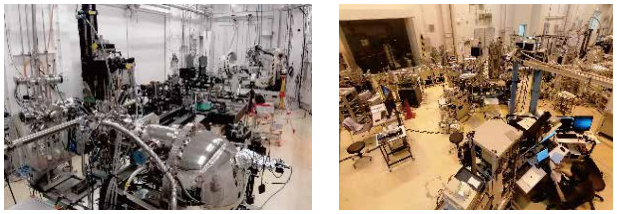
J-PARC (Tokai-mura, Ibaraki)

Neutron and synchrotron radiation applied research and development

By full use of JAEA owned neutron and synchrotron radiation applied advanced structural and functional analysis tools, we promote materials sciences research which contributes to nuclear science and utilization of nuclear energy.

JAEA develops and upgrades neutron and synchrotron radiation applied advanced analysis tools and create innovative results and seeds in a wide range of science and technology and academic fields. Moreover, JAEA provides new findings obtained by the advanced analysis tools for nuclear science and engineering research and advanced nuclear research, and then accelerates the promotion of the research in these areas.


Research reactor JRR-3 reactor room (left) and beam hall (right)


Synchrotron radiation facility SPring-8 BL22XU (left) and BL23SU (right)

Sector of Fast Reactor and Advanced Reactor Research and Development

https://www.jaea.go.jp/04/fbr/top.html [in Japanese]

We are conducting research and development for realization of advanced reactor and fuel cycle system to enable stable energy supply with enhanced safety for the future.

Center: Oarai Tsuruga

Role of Sector of Fast Reactor and Advanced Reactor Research and Development

The "Sector of Fast Reactor and Advanced Reactor Research and Development" conducts research and development (R&D) on advanced reactors such as fast reactor and high-temperature gas-cooled reactor and R&D on fuel cycle technology toward the improvement of energy sustainability, safety, reliability, economy, etc. for the future.

In addition, the sector conducts following R&Ds to promote decommissioning and waste management.

- ○R&D for decommissioning of Fukushima Daiichi nuclear power station
- ○Planning and technical development for decommissioning of the Japan Materials Testing Reactor (JMTR)
- ○Technical development on radioactive waste management and decommissioning
- ○Technical development on laser application study

JMTR

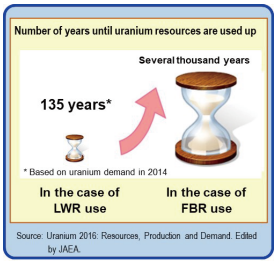
OWTF

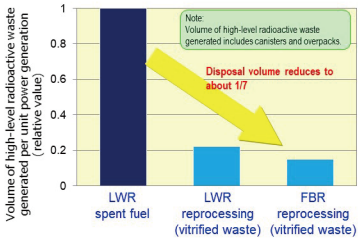
Sumadeco*
(*Fukui Smart Decommissioning Technology Demonstration Base)

Significance of R&D of fast reactor cycle system

Fast reactors enable efficient use of plutonium recovered from spent fuel generated at commercial nuclear power plants (light water reactors). In a medium- to long-term, fast reactors are considered to greatly contribute to effective use of resources and energy independence of Japan by efficient conversion of non-fissile uranium (accounts for 99.3% of uranium) into plutonium fuel.

Long-lived minor actinides (MA) are contained in spent fuel generated by nuclear power generation. It is possible to reduce the volume and environmental burden of high-level radioactive waste to be disposed of by separating MA from spent fuel and converting them to substances burnable in fast reactors or directly burning them.





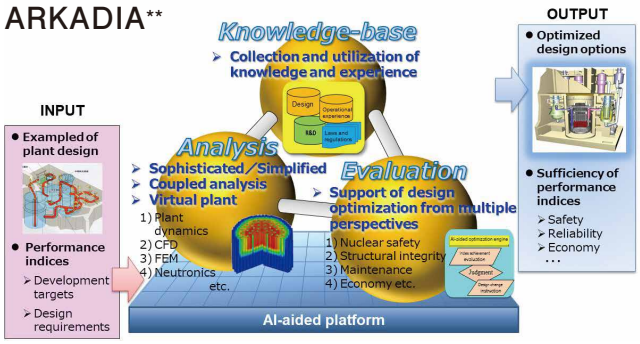
Reduction of volume of high-level radioactive waste generated

Development of technology base toward commercialization of fast reactor cycle

JAEA is promoting the following activities primarily using domestic resources, but also utilizing international cooperation, toward maintain and development of R&D technology base that can contribute to nuclear innovations and is applicable to various nuclear reactor concepts.

- Development of Advanced Reactor Knowledge- and AI-aided Design Integration Approach through the whole plant lifecycle(ARKADIA), as an innovative R&D technology base for realizing evolutional development process including reduction of development cost through shortened design work periods and alternating traditional experiments
- Establishment of innovative safety/structure standard systems utilizing risk information, in order to realize optimization of design margins and formulation of rational maintenance plans
- Studies on elemental technologies pertaining to, for example, small modular reactors (SMRs) and enhanced safety, as innovative technologies with consideration to easiness of plant construction projects and improvement of social acceptance
- R&D on fuel cycle technology focusing on MA recycling and priority tasks such as Pu management, while maintaining consistency with light water reactor cycle

For the experimental fast reactor JOYO, JAEA is aiming to resume its operation as early as possible through steady promotion of measures to comply with new regulatory standards. Once operation is resumed, JOYO will be utilized to contribute to the development of innovative technologies as a multi-functional fast neutron irradiation facility.



**)Advanced Reactor Knowledge- and AI-aided Design Integration Approach through the whole plant lifecycle

Experimental Fast Reactor JOYO (Oarai Research and Development Institute)

2020.10

R&D on High-Temperature Gas-cooled Reactor (HTGR) and heat utilization technology

Through the development of HTGR and hydrogen production technologies, JAEA will contribute to practical application of highly-safe HTGR, a trump card for global warming prevention.

Inherent safety characteristics of HTGR, which stems from consisting key elements: coated fuel particles with excellent heat resistance and radioactive material confinement properties, a highly heat-resistant and large heat capacity graphite moderator, and chemically inert helium gas coolant, make it possible to practically eliminate severe accidents which are postulated in LWRs. HTGR is a next-generation nuclear energy system that is expected to contribute to reducing environmental burdens through a wider spectrum of heat utilization.

HTTR (High-Temperature Engineering Test Reactor)

R&D on HTGR system

Characteristics of HTGR

- Various heat utilizations: able to supply high-temperature heat exceeding 900°C, which enables a wide variety of heat utilizations such as hydrogen production, power generation, sea water desalination, etc.
- Superior safety: HTGRs do not cause core meltdown due to their inherent safety

Helium coolant

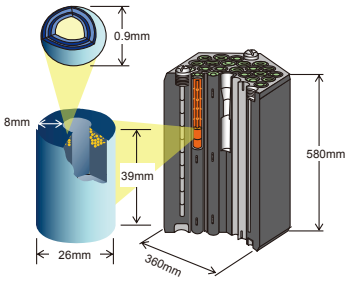
Stable at high temperature (no temperature limit)

Graphite core structure

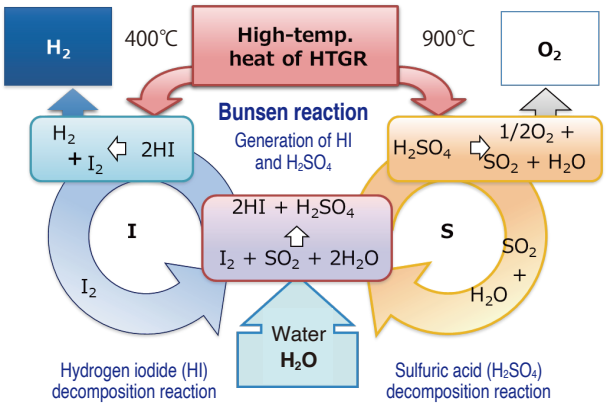
Temperature limit 2500°C

TRISO fuel coating

Retain radioactive material at 1600°C



Characteristics of thermochemical water splitting hydrogen production process, Iodine Sulfur (IS) process



- Thermal decomposition of water at approx. 900°C*1 using iodine (I) and sulfur (S)
- High theoretical thermal efficiency of 73%*2 through high-temperature endothermic reaction and low-temperature exothermic reaction
- Continuous hydrogen production (30 L, 150 hours) using practical industrial materials achieved for the first case in the world (January 2019)

*1: IS process can be applied if waste heat (heat source) of about 900°C is available.
*2: Maximum thermal efficiency of practical system is approx. 60% due to limitations on heat recovery, etc.

Safety (S)

- No meltdown due to inherent safety

Improvement of Economic Efficiency (E)

- Energy utilization efficiency close to 80% (efficient energy use by cogeneration with hydrogen production and power generation, etc.), power generation efficiency of approximately 50%

Adaptability to Environment (E)

- Reduction of spent fuel quantity to 1/4 of LWRs
- Substantial reduction of CO_2 emissions by supplying hydrogen to steelworks and fuel cells

Stable Energy supply (E)

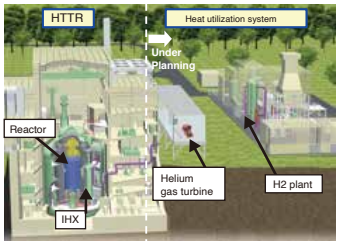
- Stable supply of CO_2-free hydrogen by thermochemical water splitting hydrogen production process, IS process, using (semi-domestic) nuclear energy

HTGR hydrogen production system enables fulfilling the requirements of S+3E in Japan's Strategic Energy Plan

R&D on Heat utilization technology

Development of heat utilization technology utilizing heat from HTGR

- Plans of the development of heat utilization technologies such as hydrogen production technology and helium gas turbine power generation technology using high temperature heat supplied from HTTR
- Considerations currently being given to safety standards of HTGR pertaining to coupling with heat utilization systems



HTTR GT/H_2 test layout (under plannning)

Major bilateral collaboration

Poland — National Centre for Nuclear Research (NCBJ)

- "Memorandum of Cooperation in the Field of HTGR Technologies" (May 2017)
- "Implementing Arrangement for Cooperation in Research and Development in the Field of HTGR Technologies" (September 2019)

United Kingdom — Nuclear fuel company Urenco

- Cooperation in power/heat cogeneration (commercial) HTGR U-Battery project

USA — US Department of Energy, Idaho National Laboratory

- Development and verification of advanced simulation codes, joint study on HTTR heat utilization test plan, development of helium gas turbine technology, etc.

Sector of Nuclear Fuel, Decommissioning and Waste Management Technology Development

https://www.jaea.go.jp/04/backend/ [in Japanese]

This sector works on the technological development of decommissioning and radioactive waste management.

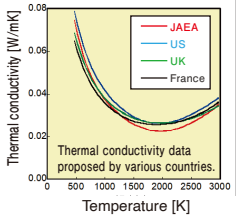
Center: Tokai (NCL) | Horonobe | Tono | Ningyo-toge | Aomori

Technological development related to nuclear fuel cycle

Nuclear Fuel Cycle Engineering Laboratories (NCL) engages in various technological developments toward realization of nuclear fuel cycle.

[Technological Development for MOX Fuel]

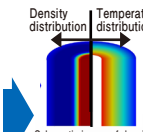
In the Plutonium Fuel Development Center (PFDC), thermo-chemical properties of MOX fuel have been measured and evaluated to apply improving the MOX fuel production technology and simulation accuracy of fuel behavior under irradiation. The measurement results, internationally acknowledged as highly reliable data, contribute to the establishment of property database in international institutions as well as international standardization of the property data of nuclear materials.



Thermo-chemical properties measured at PFDC are adopted for six out of seven types of physical property data recommended by international institutions.
- Thermal Conductivity
- Melting Temperature
- Thermal Expansion
- Oxygen Potential
- Lattice Parameter
- Mechanical Properties

The data are used in fuel behavior simulation, fuel design and etc. at international laboratories.

Thermo-chemical property measurement and establishment of database



Schematic image of density and temperature distributions in a fuel pellet under irradiation calculated by simulation program

Example of fuel behavior simulation

[Development of the co-processing process]

The Nuclear Backend Technology Center conducts the development of the co-processing process, which can recover plutonium with uranium, for improving nuclear proliferation resistance in the future reprocessing plant. This process would improve decontamination performance as well as achieve significant simplification of the process and reduction in the amount of liquid waste.

Centrifugal contactor for co-recovery test

[Establishment of new radioactive waste treatment technologies]

The Nuclear Backend Technology Center promotes the STRAD Project for development of new radioactive liquid waste treatment technologies through collaborations with universities and other organizations. The Center also promotes R&D on solidification technology using alkali-activated materials (AAM), which are expected to form glass-like structures at room temperature and to immobilize radioactive elements.

Current representative studies in STRAD* Project

*: Systematic Treatments of RAdioactive wastes for Decommissioning

R&D on geological disposal technologies of high-level radioactive waste

Steadily promoting fundamental R&D required for achieving disposal and enhancing reliability of long-term safety of geological disposal technologies.

[Underground Research Laboratory Project]

The Horonobe Underground Research Center in Hokkaido continues to work on the three important research issues, (1) Demonstration of EBS in geological environment, (2) Demonstration of disposal concept, and (3) Validation of buffer capacity of the sedimentary rock to tectonism. Meanwhile, since the Mizunami Underground Research Laboratory in Gifu Prefecture achieved its initial objectives of establishing the technology to safely excavate and maintain deep underground space, and technology to investigate and evaluate the deep geological environment, its R&D activities were completed and backfilling of the underground facilities has been started in FY2019.

A gallery at the Horonobe Underground Research Center (sedimentary rock)

[Study on long-term stability of the geological environment]

The Toki Geochronology Research Laboratory (TGR) in Gifu Prefecture conducts the development of investigation technologies and evaluation techniques for identifying characteristics of seismic and fault activities, volcanic and geothermal activities, uplift and erosion, climate and sea-level changes, and their impact on the geological environment, as well as the development of dating technologies using advanced equipment.

Accelerator mass spectrometry dating system at TGR (JAEA-AMS-TONO-5MV)

[Study on design and safety assessment of geological disposal systems]

Research facilities at Nuclear Fuel Cycle Engineering Laboratories (NCL) in Tokai Village, Ibaraki Prefecture are developing technologies necessary for design and safety assessment of geological disposal systems. This is being achieved by the acquisition of experimental data on the behavior of engineered barrier systems and migration properties of radionuclides, and utilization of results obtained from underground research laboratories.

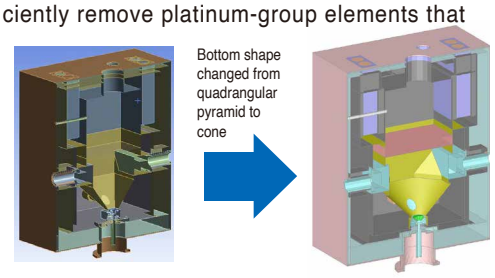
Laboratory experiments using radionuclides at QUALITY (Quantitative Assessment Radionuclide Migration Experimental Facility) in NCL

Reprocessing technology development and decommissioning

JAEA will proceed with the decommissioning of Japan's first reprocessing plant while prioritizing safety, and contribute to the establishment of systematized decommissioning technology.

[High-level liquid waste vitrification technology]

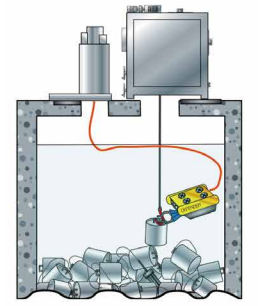
JAEA steadily progresses vitrification of high-level liquid waste, and works on technological development pertaining to advancement of vitrification technology. In order to efficiently remove platinum-group elements that hinder stable operation, the melter is planned to be upgraded to a new type melter in which the bottom shape is changed from the current quadrangular pyramid to a cone.



Current melter　　New melter

[High-level solid waste removal technology]

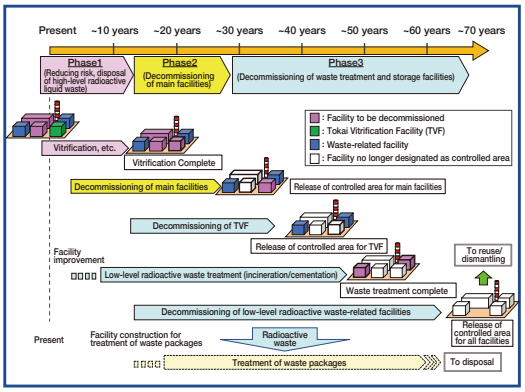
The chopped pieces of cladding tube of spent fuel are placed in hull canisters and stored underwater (in a pool). To take heavy, high dose rate and disorganized hull canisters out of water through remote control, JAEA is working on the development of devices such as underwater robots while utilizing overseas knowledge and findings.



The image of hull canister removal device

[Decommissioning of Tokai Reprocessing Plant]

The Tokai Reprocessing Plant (TRP) has shifted to the decommissioning stage. Decommissioning of TRP is essential and extremely important in establishing a nuclear fuel cycle, and is a long-term large-scale project that spans multiple generations. JAEA will tackle diverse challenges in the decommissioning by mustering domestic and overseas wisdom to develop technologies pertaining to decontamination and dismantling of facilities and equipment, remote control, disposal of radioactive waste, and measurement and analysis, and thereby contribute to the establishment of systematized decommissioning technology.



Outline of decommissioning schedule

Decommissioning of related nuclear facilities and R&D

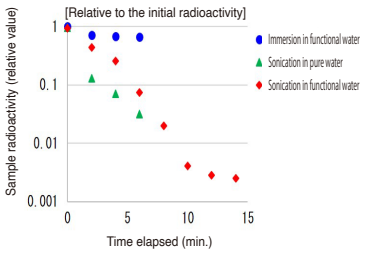
JAEA is committed to the safe and rational decommissioning of nuclear facilities, and dissemination of the outcome of technological development inside and outside Japan.

In order to reduce the volume of waste as much as possible, the Ningyo-toge Environmental Engineering Center carries out the development of technologies for uranium decontamination using functional water*1 and for measuring the amount of uranium in waste subject to clearance*2 that is generated by dismantling.

*1 Functional water is water with specific function, referring to electrolyzed water here. It has been confirmed that 99.9% of uranium was removed using functional water.

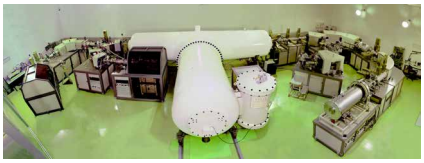
*2 Clearance is a framework for reusing or disposing of low-radioactivity waste with little detrimental effects on human health as nonradioactive waste after obtaining approval and confirmation by the national regulation.

The Aomori Research and Development Center promotes the decommissioning of nuclear facilities on nuclear powered ship Mutsu, assay of trace elements (iodine, carbon) in environmental samples using an accelerator mass spectrometer, and the development of relevant analysis technologies.

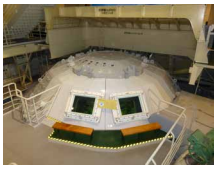


Result of decontamination test using carbon steel

Complex shape-supporting clearance level testing apparatus



Accelerator mass spectrometer



Exhibition of reactor dismantled from nuclear ship (Mutsu Science Museum)

Sector of Tsuruga Decommissioning Demonstration

https://www.jaea.go.jp/04/haishisochi/ [in Japanese]

JAEA will safely and steadily implement the decommissioning of "Fugen" and "Monju" while gaining the understanding of the public including local communities.

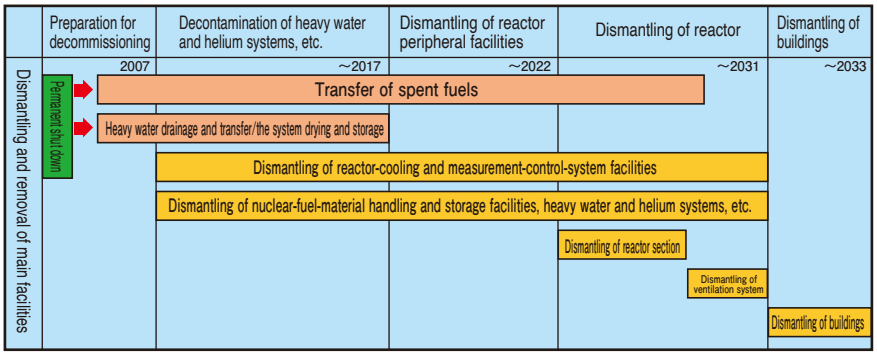
Center: Tsuruga

Toward the Completion of the Decommissioning of Fugen

Prototype Advanced Thermal Reactor "Fugen" was permanently shut down in March 2003 after operating for about 25 years. The decommissioning plan for Fugen was approved in February 2008 and the decommissioning has been progressing steadily.

The Basic schedule of Fugen decommissioning

The decommissioning is scheduled in four phases toward the completion in FY 2033



[Decontamination of heavy water and helium systems, etc.]
Heavy water transfer and tritium removal (completed)
Dismantling and removal of condensers, etc. (completed)

[Dismantling of reactor peripheral facilities]
Dismantling and removal of reactor peripheral facilities such as a part of reactor cooling system facilities and heavy water and helium systems (in progress)

[Dismantling of reactor]
Dismantling and removal of reactor

[Dismantling of buildings]
Dismantling of reactor facility buildings

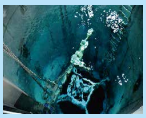
Technological development for the decommissioning of Fugen

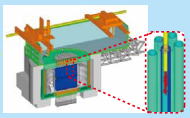
JAEA has promoted the development of specific technologies necessary for the decommissioning of Fugen as well as the improvement and the advancement of existing technologies.

Reactor dismantling technology

- Technological development related to reactor dismantling process
- Development of specific remote dismantling devices
- Study on dismantling procedure using mock-up facility
- Safety assessment on reactor dismantling and waste processing
- Technological development for collecting samples from reactor-structural material


Core-structural-material sampling device


Underwater-remote-dismantling mock-up test


Schematic illustration of reactor section dismantling

Efficient dismantlement of double-tubed structure

Decontamination technology

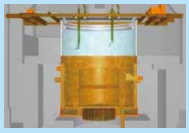
- Optimization of decontamination technology
- Study on downsizing the secondary waste


Automatic decontamination apparatus

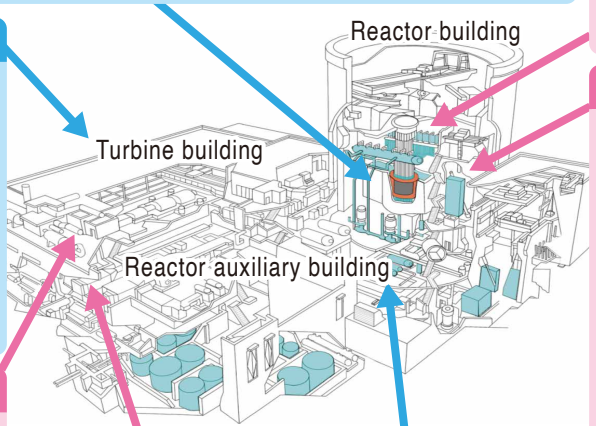

Manual decontamination apparatus

Dismantling plan evaluation technology


- Planning and evaluation of work safety using VR, MR, etc.

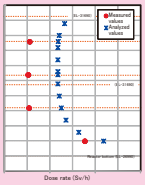

- Establishment of work procedure and plan, using 3D-CAD and the plan-evaluation system "PRODIA"

Reflecting actual data on evaluation technology



Survey technology for site-contamination status

- Evaluation of contamination status through analysis
- Improvement of evaluation accuracy by collecting samples from structural material and reflecting analysis results
- Evaluation of volume of waste, etc. based on evaluation results
- Data reflection to decontamination methods and dismantling plans



NaI measurement (non-destructive)

Gamma-ray measurement


Measurement objects (example)

Dismantling technology for non-specific equipment

- Demonstration of dismantling techniques using existing technologies
- Accumulation and evaluation of actual dismantling data


Utilization of thermal cutting (gas cutting) [Turbine system piping cutting]


Utilization of mechanical cutting (wire saw) [Through-holing work to the building]

Measurement and reuse technology

- Demonstration of technologies developed domestically or oversea
- Establishment of rational measurement technologies
- Demonstration of reuse process


Clearance measurement work

Legend
- Development of specific technology
- Improvement and advancement of existing technologies

Heavy water and tritium-related technology

- Safe and rational draining of heavy water
- Demonstration of tritium measurement, removal and decontamination technologies and techniques

ふげん&もんじゅ 心をひとつに廃止措置

Toward the Completion of the Decommissioning of Monju

For the Prototype Fast Breeder Reactor "Monju", JAEA will safely and steadily implement the first decommissioning of a sodium-cooled reactor in Japan in accordance with the Basic Plan approved in March 2018.

The Basic Schedule of Monju decommissioning

The overall decommissioning process for approx. 30 years will be implemented in four phases.

Phase	Phase 1 (Fuel unloading)	Phase 2 (Preparation for dismantling)	Phase 3 (Dismantling I)	Phase 4 (Dismantling II)
FY	2018 ～ 2022	2023	～	2047
Main Activities	Fuel unloading activities	Preparations for dismantling sodium-cooling equipment	Dismantling and removal of sodium-cooling equipment	Dismantling and removal of buildings
	Assessment of the radiation distribution			
		Dismantling and removal of power generation facilities such as water/steam systems		

[Phase 1] Fuel unloading
Transferring fuel assemblies out of the reactor vessel and ex-vessel fuel storage tank to the spent fuel pool

[Phase 2] Preparation for dismantling
Preparations for dismantling sodium-cooling equipment, dismantling and removing power-generating facilities

[Phase 3] Dismantling I
Dismantling and removal of sodium-cooling equipment and power-generating facilities

[Phase 4] Dismantling II
Dismantling and removal of buildings

Schedule for Fuel unloading Process

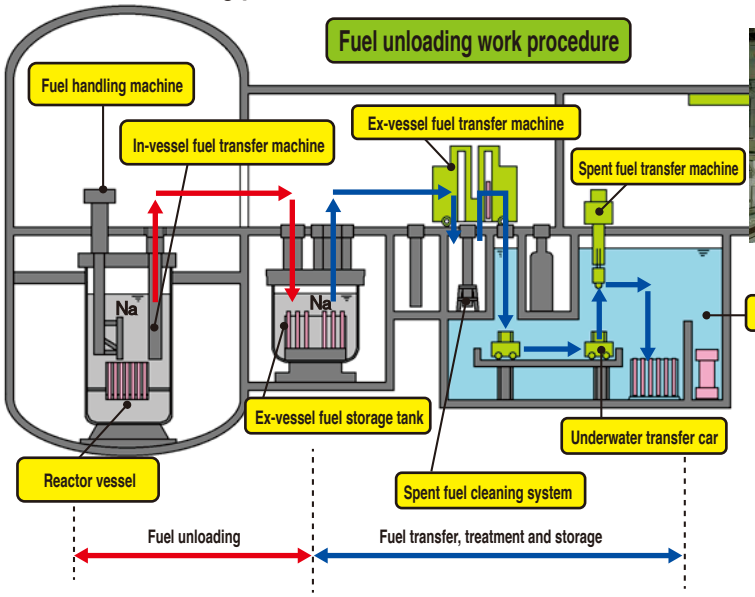
Fuel unloading has been implemented with top priority, planned to be completed in FY 2022.

＊As of July 2020

	FY	2018	2019	2020	2021	2022
Fuel unloading activities	Fuel assembly (FA) transfer, treatment and storage (530 FAs) Ex-vessel fuel storage tank → Fuel pool	86 FAs (Completed)	174 FAs (Completed)	146 FAs		124 FAs (Completed)
	Fuel unloading (370 FAs) Reactor vessel → Ex-vessel fuel storage tank		100 FAs (Completed)	146 FAs		124 FAs
	Facility inspection					

Outline of Fuel unloading Process

In the fuel unloading process, fuel assemblies are unloaded from the reactor vessel and transferred to the fuel pool.




Ex-vessel fuel transfer machine


Operators working on fuel unloading

Spent fuel pool

Fuel unloading
Unloading fuel assemblies from the reactor vessel and transferring them to the ex-vessel fuel storage tank

Fuel transfer, treatment and storage
Removing FAs from EVST, cleaning adhered sodium at the cleaning system and transferring them to the spent fuel pool for storage

Efforts for Sustainable Utilization of Nuclear Science and Technology

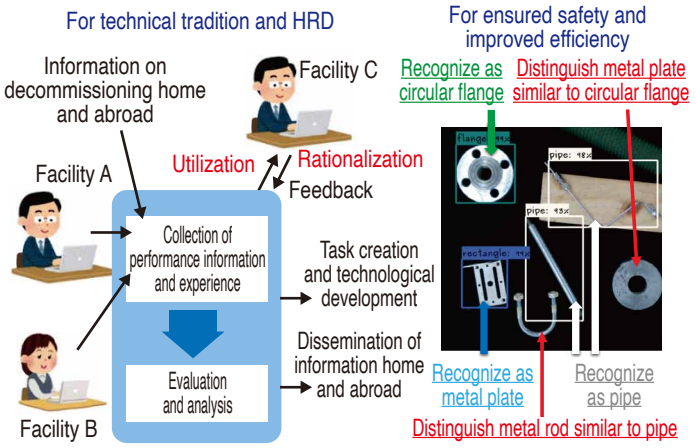
https://www.jaea.go.jp/04/be [in Japanese]

JAEA will steadily implement measures to address back-end issues to realize sustainable Nuclear Science and Technology that is trusted and accepted by society.

Planning and promotion of comprehensive management of back-end issues

JAEA formulates and promotes comprehensive plans for the decommissioning of nuclear facilities and radioactive waste management.

JAEA has various facilities which had supported R&D on nuclear science and technology and completed their missions. To continue utilization of Nuclear Science and Technology with social trust, it is important to carry out decommissioning of such facilities and processing and disposal of associated radioactive waste in a safe, efficient and rational manner. To that end, JAEA formulates and implements comprehensive plans for the decommissioning of nuclear facilities and management of radioactive waste.
In addition, as new R&D initiatives for supporting these efforts, JAEA is working on the introduction of knowledge management systems and the development of an AI-based waste segregation system.



Facilities to be decommissioned (examples)


JMTR


JMTR Hot Laboratory


Fugen


Monju


Tokai Reprocessing Plant

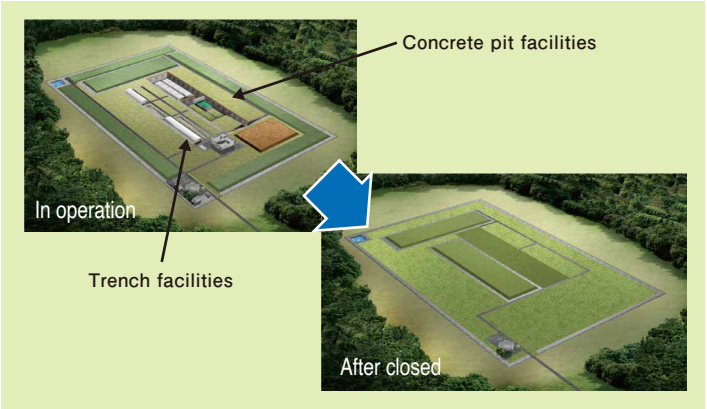

Plutonium Fuel Fabrication Facility

JAEA will safely and efficiently decommission various kinds of facilities (e.g., reserch reactors, fast reactors, reprocessing facilities, MOX fuel fabrication facilities, hot laboratory) while taking as much time as required, even up to 70 years.

Promotion of Disposal Project of Low-level Radioactive Waste Generated from Research, Industrial and Medical Facilities

JAEA will steadily promote the disposal project of low-level radioactive waste generated from research, industrial and medical facilities, as the main implementing organization of the project.

Nuclear Science and Technology are used in a wide variety of fields including R&D, educational, industrial, and medical activities, making contributions not only to the development of science, technology and academia but also to the enhancement of the quality of our daily life.
To ensure the sustainable long-term use of nuclear energy, it is essential to implement disposal project of low-level radioactive waste generated from research, industrial and medical facilities using safety and reliable measures under a responsible framework.
JAEA promotes siting process for disposal facilities, and as preliminary studies in preparation for basic designing of disposal facilities, studies on the structure of concrete pit and trench disposal facilities, and developing waste acceptance criteria.



Conceptual image of disposal site

Activities for Maintaining and Advancing R&D

Streamlining the Facilities + Safety Improvement + Management of Back-End Issues
Steadily working on the initiatives above, JAEA will maintain and advance its R&D.

Back-end Roadmap + Medium/Long-Term Management Plan of JAEA Facilities

- JAEA has led R&D in the field of nuclear energy as Japan's sole comprehensive nuclear R&D institute.
- The majority of JAEA's nuclear facilities were constructed in the era of Showa, requiring measures to address aging and earthquake resistance .
- Proper back-end measures such as decommissioning of nuclear facilities and treatment and disposal of radioactive waste has become an urgent task for maintaining and advancing JAEA's R&D functions.

- Considering that the decommissioning of Tokai Reprocessing Plant takes approximately 70 years, JAEA has formulated the Back-end Roadmap as the long-term prospect and policy for back-end measures.
- As a specific plan, JAEA formulated the Medium-/Long-Term Management Plan of JAEA Facilities. This comprehensive plan focuses on three objectives: (1) selection and consolidation of facilities, (2) measures to maintain the safety of facilities, and (3) management of back-end issues.
- To steadily promote the back-end measures, JAEA has established the Decommissioning and Radioactive Waste Management Head Office as the headquarters for integrally managing the decommissioning and treatment and disposal of radioactive waste.

Back-end Roadmap (policy for 70 years)

The 1st period (-2028, about 10 years)

Implement back-end measures while giving priority to ensuring safety of facilities.
Specified in the Medium/Long-Term Management Plan of JAEA Facilities.

The 2nd period (2029-2049, for about 20 years)

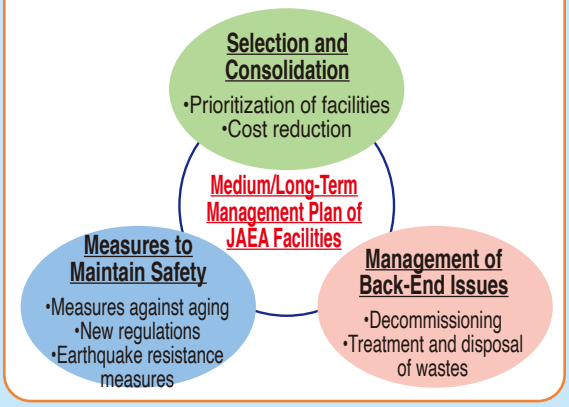
Transition toward full-scale decommissioning through the implementation of the disposal of radioactive waste and the establishment of waste processing facilities.

The 3rd period (2050-, for about 40 years)

Implement full-scale back-end measures toward completion.

Medium/Long-Term Management Plan of JAEA Facilities (specific plan for the next 10 years): revised every year

Trinity Plan of all JAEA's facilities



Selection and Consolidation of Facilities

【Policy of Selection and Consolidation】
- As a nation, the facilities essential for maintaining the minimum R&D functions should be continued to use as much as possible, considering below:
  - Consolidation of testing functions as much as possible
  - Decommissioning of facilities that are difficult to continue to use from the viewpoint of safety measure cost, etc.

Selection of JAEA's facilities
- Facilities continued to be used 46 facilities
- Facilities to be decommissioned 43 facilities

Facilities to be decommissioned are to be systematically decommissioned in order.

Measures to Maintain Safety

- Measures against aging
- New regulations
- Earthquake resistance measures
- Risk reduction measures for Tokai Reprocessing Plant

Specification for each facility

Management of Back-End Issues

- Decommissioning plan (including consolidation of nuclear fuel materials)
- Establishment plan for waste processing facilities, etc.
- Plan for production of waste packages

Specification for each facility

2020.10

Safety Assurance and Risk Management

https://www.jaea.go.jp/about_JAEA/ [in Japanese]

JAEA works on R&D while placing the utmost priority on thorough safety assurance and risk management.

Safety Initiatives

As a national R&D institute that handles radioactive materials, in its Basic Policy, JAEA specifies safety assurance as the utmost priority for its management and operations. In addition, based on the Basic Safety Management Policies, JAEA continuously seeks to fostering and sustaining a safety culture and fostering a nuclear security culture to ensure the safety of its facilities and operations and proper control of its nuclear materials.

Each JAEA site undertakes various security activities in accordance with the Quality Policy on Nuclear Safety and the Basic Policy on Safety and Health Management. Each site also seeks continuous operational improvement by repeating the plan-do-check-act (PDCA) process.

JAEA manages and evaluates these activities through management reviews, nuclear safety audits, etc. and promotes autonomous and continuous improvement for further enhancement of safety.

(Examples of safety activities at JAEA)

Ensuring radiation safety

JAEA strives for ensuring radiation safety by conducting measurement of environmental radiation for monitoring the radiation safety of surrounding environment, measurement of concentration of radioactive materials contained in soil, vegetables, seafood, etc., monitoring of radiation dose at work sites and concentration of radioactive materials in the air, and measurement and management of exposure dose of workers.

Monitoring vehicle

Measurement of radiation dose at work site

Improvement of Crisis Management Capability

JAEA is working to improve the crisis management capability of its individual employees by implementing regular education and training in order to implement rapid reporting and emergency response at the time of an accident or incident.

In addition, JAEA implements various safety measures at each of its facilities as countermeasures against a nuclear facility disaster accompanying a major earthquake.

Power supply vehicle connection drills

Outdoor contamination-control drills

Risk management initiatives

JAEA implements risk management activities including promotion of compliance toward reduction and elimination of operational risks as an organization that shall be trusted by local residents and citizens.

In its risk management activities, JAEA endeavors to reduce risks by identifying, analyzing, and assessing operational risks and taking measures based on the assessment results.

In addition, JAEA holds compliance seminars (e.g., training for employees newly promoted to the managerial level, interdepartmental training) and publishes compliance guidebooks to raise awareness on compliance in its employees.

For details, please see Status of Risk Management in the Annual Report Japan Atomic Energy Agency 2020 (Business Report FY2019).

https://www.jaea.go.jp/english/publication/annual_report/2020.pdf#page=11

Compliance seminar (Fukushima Head Office)

Nuclear Non-proliferation and Nuclear Security

https://www.jaea.go.jp/04/iscn/index_en.html

Further strengthening nuclear nonproliferation and nuclear security

Towards a world without nuclear weapons and nuclear terrorism, the Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN) conducts technological developments, policy research, supports human capacity building in the field of nuclear non-proliferation and nuclear security and supports the CTBT International Verification Regime.

Technological developments

JAEA is setting targets for development themes focusing on domestic and international challenges and needs in the field of nuclear non-proliferation and nuclear security, and is carrying out technology development that is expected to be utilized by international organizations such as the IAEA and globally, in cooperation with research institutes in Japan, the US and Europe. JAEA is developing various fundamental technologies which will contribute to enhance safeguards and proliferation resistance on future nuclear fuel cycle facilities, and establishing technologies contributing to strengthen nuclear security, such as detection and measurement of nuclear materials, and nuclear forensics, etc.

Policy research

JAEA is conducting policy research based on the technical knowledge and in light of international trends on nuclear nonproliferation and nuclear security. JAEA is collecting and compiling relevant information and data, and disseminating information, through the ISCN newsletters featuring topics related to nuclear non-proliferation, nuclear security, and international and domestic trends, etc.

Supporting human capacity building

JAEA is committed to support human capacity building in Asian countries by developing training curriculums, conducting training, seminars, and workshops, improving nuclear fuel cycle related facilities and teaching the importance of ensuring nuclear non-proliferation and nuclear security.

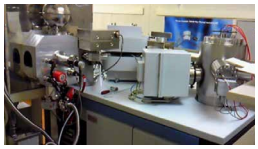
Contribution to the CTBT International Verification Regime

JAEA is contributing to the international nuclear non-proliferation effort by operating international monitoring system facilities for radionuclides and a national data center for analyzing and evaluating monitoring data established based on the Protocol to the Comprehensive Nuclear-Test-Ban Treaty (CTBT), and developing associated verification technologies for nuclear tests besides.

Understanding promotion activities

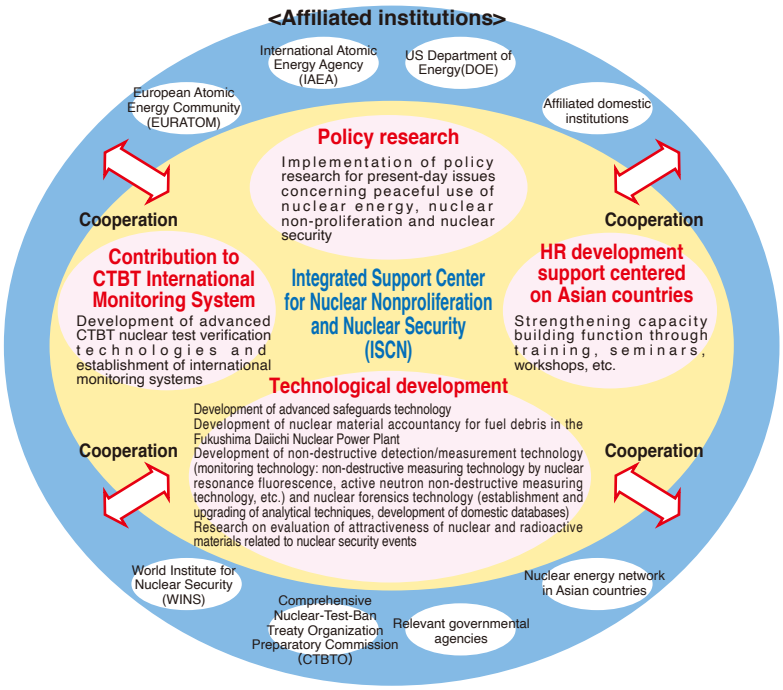
JAEA promotes understanding on nuclear nonproliferation/security and introduces Japan's and JAEA's efforts on nuclear nonproliferation by reporting and sharing R&D results at academic conferences, holding international forums, and disseminating information (ISCN New Letter, trends in nuclear nonproliferation, Nuclear Nonproliferation Pocket Book) through the JAEA website.

International monitoring system facility Noble gas monitoring apparatus

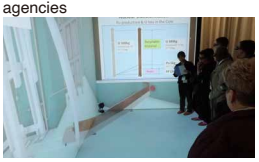


Thermal ionization mass spectrometer, TIMS for use in nuclear forensics

Efforts to promote understanding through International Forum (once a year)



On-site practical facility training by invited specialists from relevant domestic and international agencies



Safeguards training in virtual facilities using Virtual Reality system

Delayed gamma-ray analysis instrument, tested at the JRC Ispra (Italy)

Securing Public Trust

https://www.jaea.go.jp/index.html [in Japanese]

JAEA works to promote mutual understanding with the public through dissemination of the results of its R&D to diverse stakeholders, public consultations, public relations, and dialog activities.

Interaction with diverse stakeholders

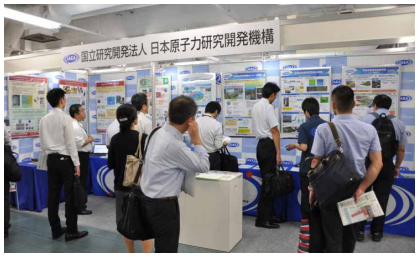
JAEA actively disseminates information to diverse stakeholders by staying in tune with society's needs through public hearings, public relations, and dialog activities.

By actively providing and disclosing information relating to JAEA's R&D findings, accidents, incidents, etc., JAEA ensures transparency of its operations. In addition, by taking into consideration the viewpoints of returning these R&D findings to society and communicating risks with society, through deferential public consultations, PR, and dialog, JAEA is able to deepen mutual understanding with the public and local communities, which will lead to securing trust.
Furthermore, by paying heed to diverse stakeholder and public view points, JAEA reflects advice from third-parties in order to contribute to these activities more effectively.

Public hearings, public relations, dialog activities, etc.

JAEA effectively conducts understanding promotion activities such as opening its facilities to the public, holding facility tours and briefing session, and having a booth at external exhibitions. Also, JAEA actively provides support to science education by holding science cafés and experiment classes as outreach activities, interactive communication activities utilizing its potential as a R&D institution.

JAEA briefing session

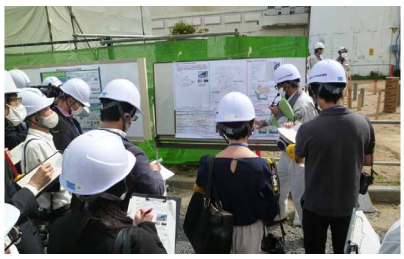


Public consultation, PR, and dialog activities at an exhibition

Science Café

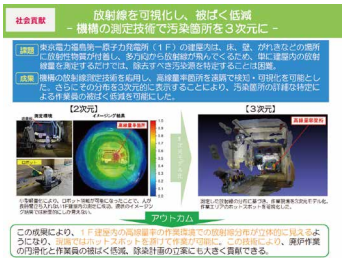
Dissemination of information to the public via media

Through press releases, JAEA endeavors to accurately and swiftly notify the public of its business activities in an easy-to-understand manner. JAEA also holds press reporter study meetings for the purpose of providing news media with knowledge and information on advanced science and fostering better understanding on JAEA's business.
In addition, as one of its efforts to disseminate its R&D results in an easy-to-understand manner, JAEA has opened a page on the JAEA website containing a simplified abstract version of press releases.



Briefing at on-site press gathering

Press reporter study meeting



Easy-to-understand research achievement

Internet-based Dissemination of R&D Results and Collection/ Dissemination of Nuclear-related Information

Internet-based dissemination of results

Transmitting information via the Internet for widespread dissemination of results.

Official social media accounts list:

https://www.jaea.go.jp/sns/ [in Japanese]

Actively releasing the latest information and R&D findings via SNS.

Information on events

https://www.jaea.go.jp/news/event/ [in Japanese]

Providing information on various events and facility tours held at JAEA centers.

Newsletter:

https://www.jaea.go.jp/english/publication/#other

Introducing R&D findings by 'GENKI' in an easy-to-understand manner

Brochure:

https://www.jaea.go.jp/english/about/#pamphlet

Brochure introducing activities performed by each department and R&D findings.

JAEA Channel:

https://www.jaea.go.jp/atomic_portal/jaea_channel/

Visually introducing R&D findings with 'Project JAEA,' easy-to-understand videos.

Introduction of JAEA's R&D achievements in an easy-to-understand manner

https://www.jaea.go.jp/study_results/representative/ [in Japanese]

Introducing JAEA's R&D achievements in an easy-to-understand manner, especially on the latest R&D projects.

Dissemination of R&D results and transmission of information

As a library specialized in nuclear energy in Japan, the JAEA library collects and provides a broad spectrum of information about nuclear science and technology, such as books, journals and technical reports for the purpose of providing support in R&D activities in Japan.

In addition, JAEA is actively committed to the dissemination of R&D information through its activities as the national center for the IAEA INIS (International Nuclear Information System), and by collecting and providing information related to the accident at TEPCO's Fukushima Daiichi Nuclear Power Station through its Fukushima Nuclear Accident Archive (FNAA).

JAEA Library

Data

Photographs

Collect

Disseminate

Fukushima Nuclear Accident Archive (FNAA)

For further information contact: Intellectual Resources Management and R&D Collaboration Department, JAEA, tenkai-ir@jaea.go.jp

Promoting Use of Research Facilities and Collaboration with Industry, Academia and Government

https://www.jaea.go.jp/business_base/ [in Japanese]

JAEA operates facilities utilization systems for external utilization of JAEA's state-of-the-art large research facilities.

Promoting external utilization of research facilities

Through external utilization of facilities, JAEA makes broad contributions from basic studies for the advancement of science to creation of innovations in materials and medical care fields.

JAEA's research facilities and equipment, which are defined as public assets, are available to external users inside and outside Japan for their R&D, industrial applications, etc. under the facilities utilization systems.

Especially, in the field of neutron utilization, JAEA operates two neutron facilities, the research reactor JRR-3 and Materials and Life Science Experimental Facility of J-PARC, on the same site. For JRR-3, JAEA is working to promote its utilization under JAEA's facilities utilization systems, and for J-PARC, in compliance with the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities.
By utilizing the world's highest performance neutron beam, it is expected to promote cutting-edge academic studies and the creation of new technologies such as the development of functional materials and new pharmaceuticals that support society.

Facilities available under JAEA's facilities utilization systems

Tandetron accelerator mass spectrometer (Mutsu, Aomori)

Mock-up test facility (Naraha, Fukushima)

Tandem accelerator (Tokai, Ibaraki)

Smart Decommissioning Technology Demonstration Base (Tsuruga, Fukui)

SPring-8 (Sayo, Hyogo)

In addition to these, Facility of radiation standard, Reactor Fuel Examination Facility (Tokai, Ibaraki), Joyo, Hot Laboratory facilities (Oarai, Ibaraki), and Pelletron accelerator for radioactive age determination (Toki, Gifu) are available.

Reactor and accelerator Two neutron facilities in operation (Tokai, Ibaraki)

Research reactor JRR-3

J-PARC
Materials and life science experimental facility

JAEA contributes to the creation of innovations by extensively returning R&D results to the public and society.

Promoting collaboration with industry, academia and government

JAEA is strategically working on the establishment of ideal R&D infrastructure including enhanced industry-academia-government collaboration, to maximize the effects of its R&D results and to contribute to the society, as well as to lead them to creation of innovations. Specifically, JAEA promotes collaboration with industry, academia and government such as joint research, technology transfer and technical co-operation for adding and creating new values.
JAEA also holds the JAEA Technology Salon for introducing its advanced technologies and discussing interests in their practical application and the possibility of commercialization, in a bid to drive R&D through the interdisciplinary research and to promote the utilization of R&D results.
In addition, JAEA R&D results, i.e. technical reports, journal articles and intellectual properties are accumulated in a database and provided through the JAEA website.

JAEA Technology Salon

JST New Technology Presentation Meetings

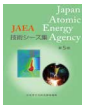
Ibaraki Technology Exhibition

【Utilization of intellectual properties】

JAEA aims to encourage, promote and create innovations such as the development of new products using JAEA's patents, etc., by implementing practical joint research in the industry.

【JAEA Technology Seeds】

JAEA publishes and disseminates information on its intellectual properties such as patents in easy-to-understand descriptions.



Productization examples

Heat stroke monitoring and warning device

Deodorant Japanese paper

International Cooperation and Nuclear Human Resources Development

https://www.jaea.go.jp/business_base/ [in Japanese]

Promoting effective and efficient R&D through close cooperation with overseas research institutes and international organizations.

Global cooperation and contribution

Based on the Strategy for the International Cooperation, JAEA promotes international cooperation and makes a wide variety of international contributions.

JAEA is actively promoting cooperation with overseas research institutes and international organizations for advancing R&D by incorporating wisdom from other countries. In addition, JAEA is proactively promoting the dispatch of specialists overseas, presentations at international meetings, and international use of JAEA's research facilities in order to contribute to the development of global nuclear science and technology through JAEA's technological know-how and experience.

Contribution to the emerging nuclear energy countries

Promoting activities for nuclear human resources development and technological support for emerging nuclear energy countries mainly in Asia

Multilateral cooperation

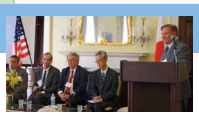
Promoting cooperation in multilateral cooperative framework for advanced reactor R&D (Generation IV International Forum), etc.

International use of research facilities

Promoting international use of J-PARC and research reactors

Bilateral cooperation

Cooperation with the USA on advanced reactor and nuclear non-proliferation technology, and cooperation with France on fast reactor, decommissioning technology, etc.



Symposium on US-Japan Nuclear Energy Research Cooperation (Washington D.C.)

Workshop on Nuclear Innovation co-organized by JAEA-CEA (Paris)

Contribution to international organizations

Dispatch of specialists to the International Atomic Energy Agency (IAEA) and Organization for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA), etc.

IAEA (Vienna)

Exhibition at IAEA General Conference (Showcasing of JAEA's activities)

JAEA is committed to the nuclear human resource development for Japan and foreign countries to meet the social needs.

Development of nuclear human resources

JAEA provides domestic and international training courses on various fields of nuclear energy and also cooperates with universities for student education.

Domestically, JAEA holds training courses of different levels, from basic to national qualification levels, and provides educational support for universities. JAEA also conducts broad and diverse HRD activities in collaboration with relevant institutions in Japan.
Internationally, JAEA hosts training courses inviting engineers and researchers from Asian countries to Japan for developing instructors who will contribute to HRD in their countries.
Through the above activities, JAEA promotes the development of human resources in Japan and Asian countries who assume important roles in the field of nuclear energy.

Domestic Training Course

- Technical Training Courses for
  - -Nuclear Engineers
  - -RI & Radiation Engineers
  - -National exam/qualification acquisition
- On-demand Training Courses

Radiation dose measurement exercise in Basic Radiation Course

Japan Nuclear Human Resources Development Network

- Collaborative framework among industries, academia and the government for effective and efficient human resource development in the nuclear field
- Operation of the network as a joint secretariat
- Implementation of training courses including Japan-IAEA Nuclear Energy Management School
- Collaboration with the IAEA

Japan-IAEA Nuclear Energy Management School 2019

International Training Course

- Instructor Training Courses and Follow-up Training Courses for 9 Asian countries
  - Reactor Engineering
  - Environmental Radioactivity Monitoring
  - Nuclear/Radiological Emergency Preparedness
- Nuclear Technology Seminars for 11 Asian countries

Radiation dose measurement exercise in Instructor Training Course

Cooperation with universities

- Partnership agreements (19 graduate schools, 2 university faculties, 2 technical colleges)
- Nuclear Professional School of The University of Tokyo
- University collaboration network (Japan Nuclear Education Network, JNEN) activities
- Programs for accepting university students

Summer interns operating a drone

2020.10

Advanced Computer Science and Simulation Technology

https://ccse.jaea.go.jp/index_eng.html

We are conducting R&D on the utilization of supercomputers to enlarge scientific knowledge and technology promoting the use of nuclear energy.

R&D on Advanced Computational Technique

In nuclear energy R&D, there are demands to elucidate the mechanisms of phenomena which are hard to observe in experiments and to predict their progression over time. Computer simulation is an effective way to obtain scientific knowledge relating with such phenomena. In particular, to find solutions to scientific problems arisen from the accident at TEPCO's Fukushima Daiichi Nuclear Power Station, and to spark new innovation in nuclear energy, simulations of complex phenomena governed by various factors (multi-scale/multi-physics problems) are required.

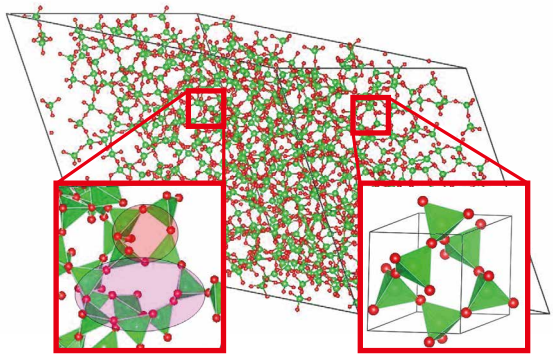
JAEA promotes the development of:

- cutting-edge multi-scale simulation modeling technology utilizing AI (machine learning),
- high-speed computing technique using supercomputers, and
- large-scale data real-time visualization technology

to solve multi-scale/multi-physics problems in nuclear energy R&D fields.

We release software developed through these research initiatives publicly, so that they can be used widely in not only academia but also industry.

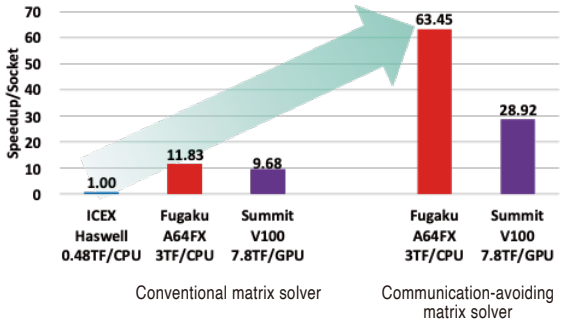
Multiscale-simulation modeling technology utilizing AI



Loops made of 4 or 7 tetrahedra　　Loop made of 6 tetrahedra

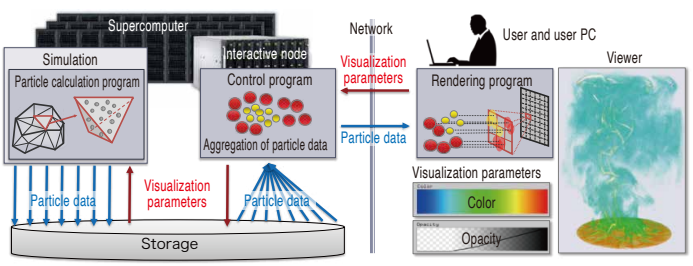
Analysis of complex SiO2 glass structure through molecular dynamics calculations utilizing results of AI-aided learning (machine learning)

High performance computing technique using supercomputers

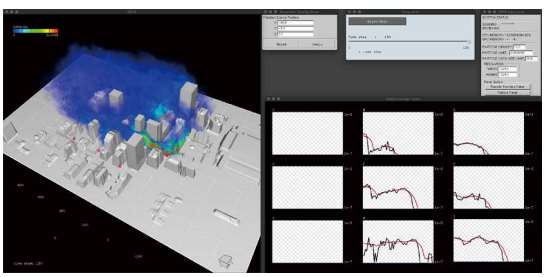


High performance computing technique such as communication-avoiding algorithms that can fully utilize the performance of exascale computers including Fugaku and Summit

Real-time visualization technology for extreme scale data



Open source in-situ visualization system PBVR



Example of real-time in-situ visualization in plume dispersion analysis

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