IRID
International Research Institute
for Nuclear Decommissioning

5F, 3 Toyokaiji Building, 2-23-1 Nishi-Shimbashi, Minato-ku, Tokyo 105-0003, Japan
Phone: +81-3-6435-8601
http://www.irid.or.jp/en

IRID 2015-2016

International Research Institute
for Nuclear Decommissioning

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Our Vision

Our Purpose

To conduct experiments and research on decommissioning of nuclear power stations, and implement projects aimed to improve technological levels of member corporations and to put their technologies into practical use.

Our Basic Principle

We devote ourselves to research and development (R&D) of technology for the current most urgent challenge—decommissioning of the Fukushima Daiichi Nuclear Power Station (NPS)—from the standpoint of strengthening the foundation of nuclear decommissioning technology.

Our Principle in Action

1. We work on R&D projects effectively and efficiently while advancing integrated project management to develop and propose the best technologies and systems that are applicable early on site at the Fukushima Daiichi Nuclear Power Station (NPS) while facing a lot of extremely difficult technological challenges.

2. We build an optimal R&D structure by cooperating with relevant organizations as well as our member organizations, and gathering knowledge from Japan and abroad.

3. We actively promote efforts to develop and secure human resources who will be major players in the next generation in the fields of nuclear decommissioning and other related technology fields, including efforts to collaborate with universities and research institutions.

4. We strive to release information on our R&D activities and results to obtain the understanding of Japanese people, including those in Fukushima, and the international community to relieve their anxieties.

5. We form an international research hub (a center of excellence) through our R&D activities and contribute to acceleration of the decommissioning of the Fukushima Daiichi NPS and improvement of the technological capabilities in the international community.

Message from the President

Ever since its establishment in August 2013, the International Research Institute for Nuclear Decommissioning (IRID) has been fully committed to an urgent challenge—research and development of technologies required for the decommissioning work of the Fukushima Daiichi NPS. In August 2014, the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF) was reorganized from the Nuclear Damage Liability Facilitation Fund. Since then, the division of roles among relevant organizations engaging in the decommissioning has been clarified: The NDF formulates strategies and R&D plans for the decommissioning; The Tokyo Electric Power Company (TEPCO) implements on-site operation; and IRID conducts R&D of technology required for the decommissioning. The four key players including the government have been working closely together in the effort to decommission the Fukushima Daiichi NPS. As a result, our R&D for fuel debris retrieval, including the development of technology for investigation inside the Primary Containment Vessel (PCV) and for identification of fuel debris locations, is gradually beginning to bear fruit.

Under these circumstances, in April 2015, the NDF announced the Technical Strategic Plan 2015 for Decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company. In June of the same year, the government revised the Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4 (Mid-and-Long-Term Roadmap), clarifying milestones for fuel debris retrieval. The R&D for fuel debris retrieval is about to enter a crucial phase.

Over four years have passed since the accident at the Fukushima Daiichi NPS occurred due to the Great East Japan Earthquake. A number of residents in Fukushima Prefecture and surrounding regions are still forced to live as evacuees and many Japanese people feel anxious over the decommissioning work at the Fukushima Daiichi NPS. To enable the evacuees to return home as soon as possible and to dispel the public's anxieties, it is vital to advance the decommissioning safely and surely. IRID is determined to fulfil its responsibility to achieve steady results from R&D for the decommissioning, according to the purpose of its establishment, i.e., to gather knowledge from Japan and abroad and conduct R&D projects required for decommissioning effectively and efficiently. We sincerely appreciate your kind guidance and continued support, and encouragement of our efforts.

December, 2015

Technology Research Association,
International Research Institute for Nuclear Decommissioning

Hirofumi Kenda, President

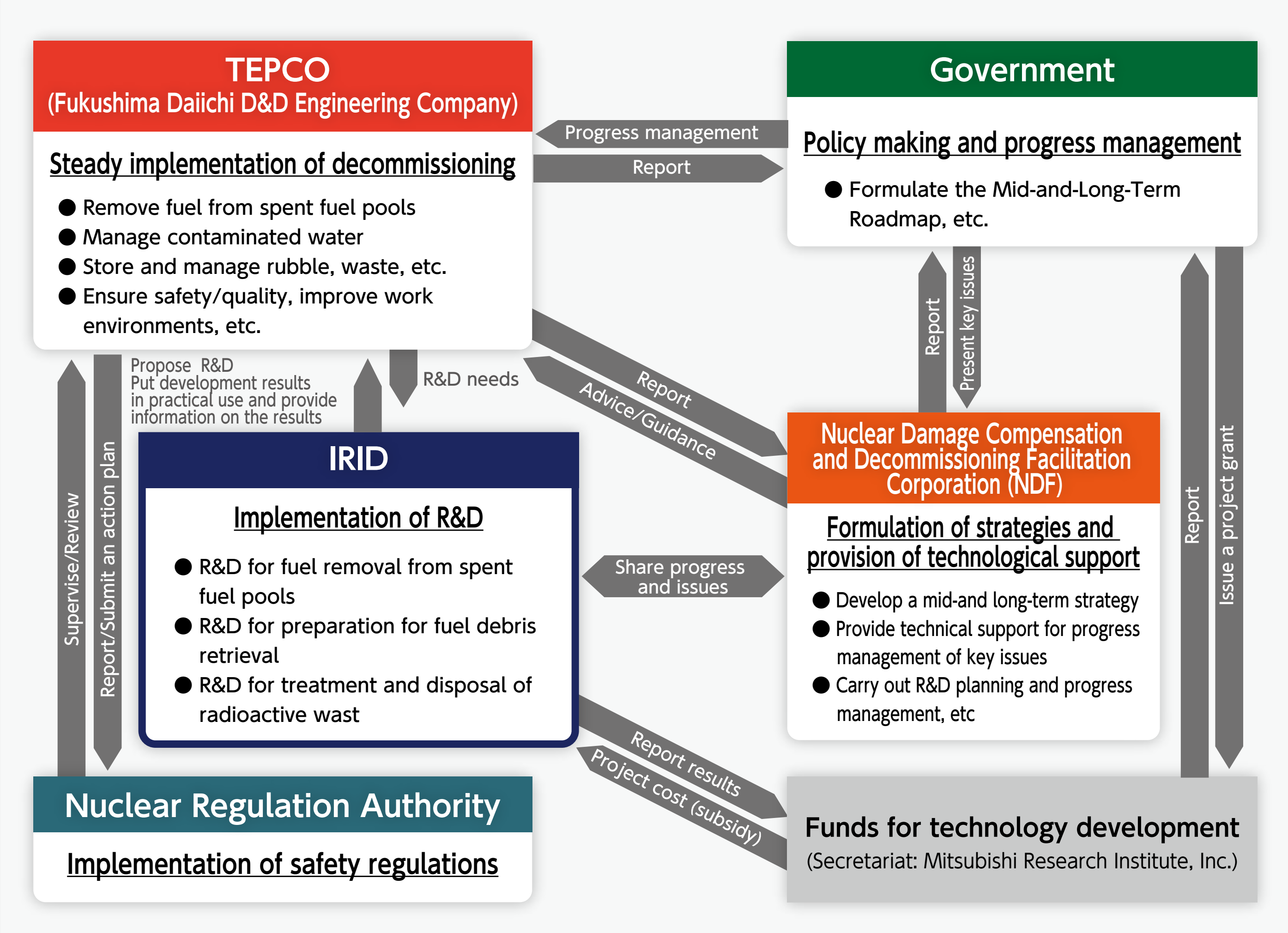
Role of IRID

IRID is a body made up of 18 organizations engaged primarily in research and development required for decommissioning of the Fukushima Daiichi NPS.
Its long-term goal is to foster, accumulate and improve decommissioning and other related technologies for the decommissioning of reactors throughout Japan. However, for the present time, we are focusing on the urgent challenge—R&D for decommissioning of the Fukushima Daiichi NPS—in accordance with the Mid-and-Long-Term Roadmap set by the government.
IRID continues to gather knowledge from Japan and abroad to conduct R&D required for decommissioning efficiently and effectively in order to advance this globally unprecedented, extremely difficult project.

According to the division of roles for decommissioning the Fukushima Daiichi NPS, the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF) formulates strategies and R&D plans for decommissioning, TEPCO's Fukushima Daiichi Decontamination and Decommissioning (D&D) Engineering Company performs the on-site operation, and IRID conducts R&D. Thus, the three parties have established a structure under which they closely cooperate with each other and work as one.
As an organization that plays a part in the structure, IRID, through its R&D, actively works on risk reduction, ensuring safety, environment preservation, etc., which are required for the decommissioning of the Fukushima Daiichi NPS, so as to help relieve anxieties of people in Fukushima Prefecture and the rest of Japan.

Role of IRID

Roles of the Organizations Involved in Decommissioning Project of the Fukushima Daiichi NPS



Decommissioning Process Specified in the Mid-and-Long-Term Roadmap

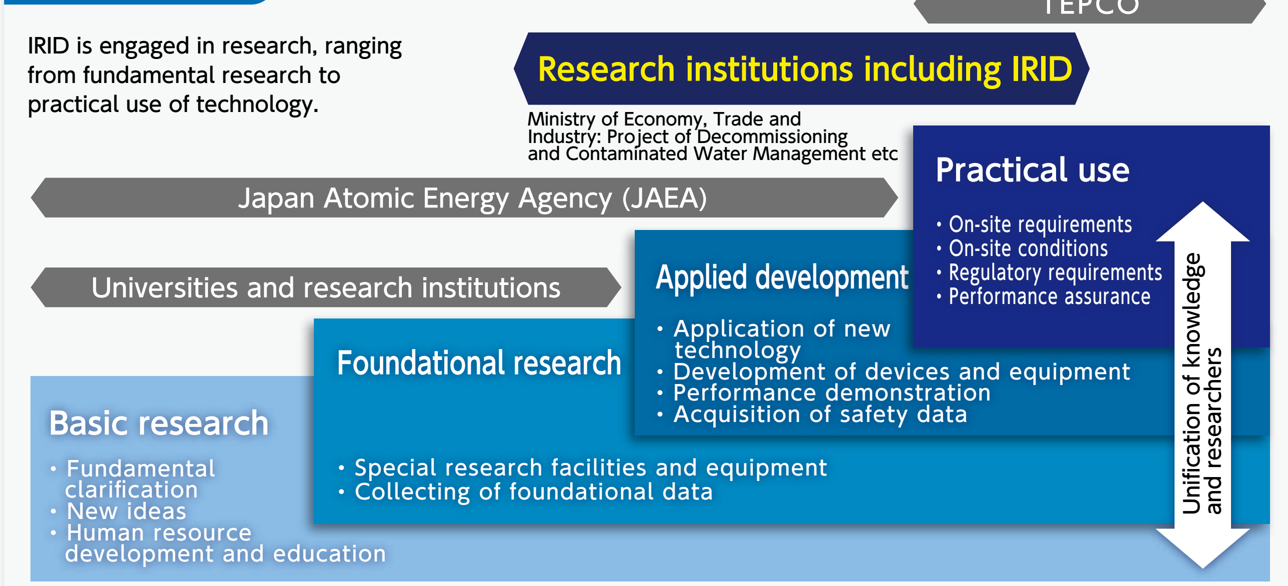
The Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4 (Mid-and-Long-Term Roadmap) has been formulated based on present knowledge and analysis of conditions that differ for each Unit of the Fukushima Daiichi NPS. It was revised a third time on June 12, 2015. The revised Mid-and-Long-Term Roadmap shows the goals and estimated target years of the decommissioning process based on an assumption that it is subject to revisions according to future on-site conditions, R&D results, etc.

The Roadmap divides the time until the completion of the decommissioning into three phases. Presently, the decommissioning process is in the second phase; we are developing R&D for preparation for fuel debris retrieval. IRID previously analogized the conditions inside the Primary Containment Vessels (PCVs) using analysis codes etc. We presently visualize the conditions of reactor cores utilizing cosmic ray muons. We also investigate inside PCVs with robots and verify previous analogy-based data by comparing with visual data. Thus, albeit gradually, we are compiling data that allows us to study various new approaches to technological difficulties faced in advancing R&D for the decommissioning, as well as developing new approaches to decommissioning methods.

Phases Defined in the Mid-and-Long-Term Roadmap and R&D Structure

Phases of the Mid-and-Long-Term Roadmap

R&D Structure



<Source> The above charts were created based on the Mid-and-Long-Term Roadmap (the third revision), as of June 12, 2015.

Scope of Business 1: R&D for Nuclear Decommissioning

R&D at IRID

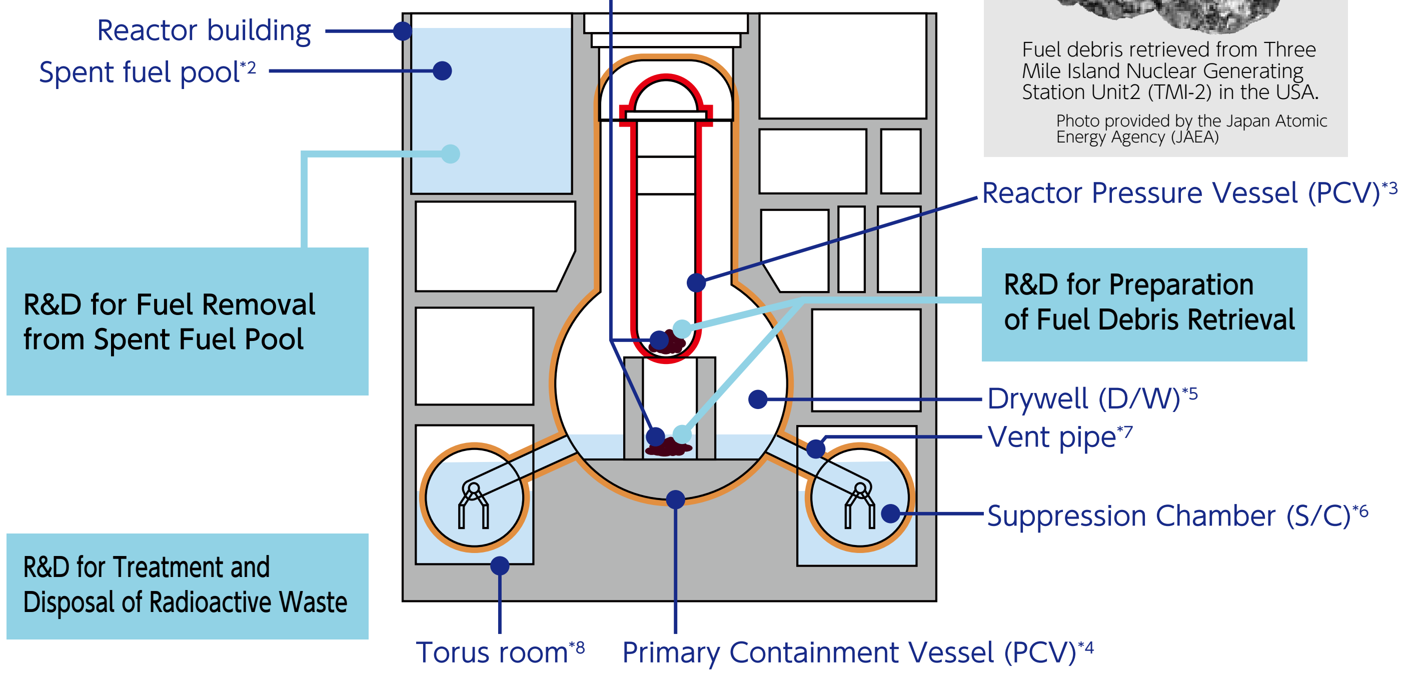
IRID is conducting research and development to advance decommissioning of the Fukushima Daiichi NPS based on the Mid-and-Long-Term Roadmap. The primary focus of our R&D activities is the upgrading of decommissioning strategies. For this purpose, we are studying whether there are any other optimal approaches, how to reduce risks, etc., while exploring how to achieve an end state (final optimal state), in tie-ups with TEPCO, relevant organizations, etc.
We have undertaken three main projects for decommissioning: R&D for Fuel Removal from Spent Fuel Pool, R&D for Preparation of Fuel Debris Retrieval, and R&D for Treatment and Disposal of Radioactive Waste.

Overview of the Reactor Building and R&D at IRID

(Reference)

Fuel debris retrieved from Three Mile Island Nuclear Generating Station Unit2 (TMI-2) in the USA.

Photo provided by the Japan Atomic Energy Agency (JAEA)



*1 Fuel debris: Lava-like fuel containing material that is produced under high temperatures through melting with control rods and structures inside the RPV, after which it cools and re-solidifies.

*2 Spent fuel pool: A water tank that stores spent fuel that is inserted in a rack under water until decay heat generated from fission products decreases. This tank is located on the top floor of the reactor building.

*3 Reactor Pressure Vessel (RPV): A cylindrical steel container that houses fuel assemblies. This container can resist high-temperature water and high-pressure steam generated by the energy released by nuclear fission inside. The RPV is housed within the PCV together with cooling equipment

*4 Primary Containment Vessel (PCV): A steel container that houses the RPV, cooling equipment, and other devices that perform important functions. This prevents radioactive substances from being released into the outside environment under abnormal plant conditions, such as when a reactor accident occurs, or in the event of a breakdown of cooling equipment. It should be noted that each of the PCVs installed in Units 1-3 at the Fukushima Daiichi NPS consists of a flask-shaped drywell, a doughnut-shaped suppression chamber and eight vent pipes connecting between the drywell and the suppression chamber.

*5 Drywell (D/W): A safety feature that is comprised of a flask-shaped container that houses equipment, including the RPV, and contains radioactive substances in case of an accident occurring

*6 Suppression chamber (S/C): A doughnut-shaped facility that stores water located in the basement of the reactor building. Condenses vapor generated in the case of reactor piping breakage and prevents excess pressure from building up. It also serves the important function of providing a water source for the Emergency Core Cooling System (ECCS) in the case of a loss-of-coolant accident.

*7 Vent pipe: Connecting piping that takes vapor generated within the D/W to the S/C in case of a reactor pipe breakage. Eight vent pipes are installed in the PCV of Units 1-3 at the Fukushima Daiichi NPS.

*8 Torus room: A room contains a torus-shaped (doughnut-shaped) S/C located in the basement of the reactor building.

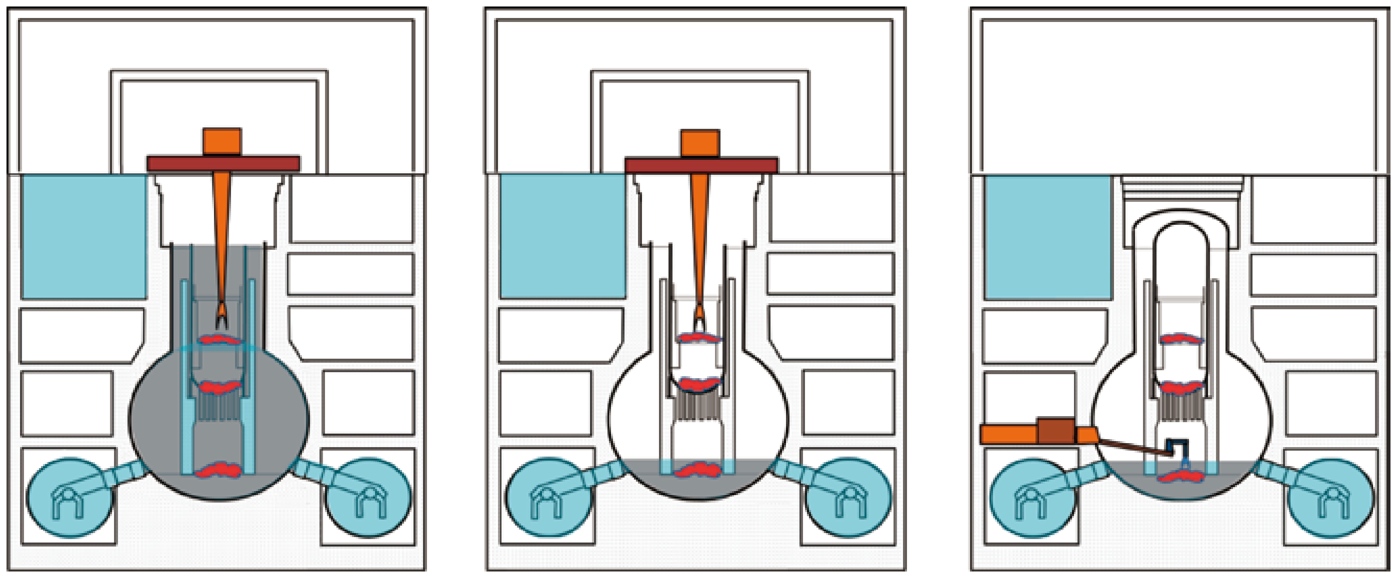
Fuel Debris

Total loss of all power sources at Units 1-3 of the Fukushima Daiichi NPS disabled the circulation pumps, preventing the flow of water into the RPVs. Without the necessary water to cool them down, the fuel inside the RPVs overheated, with temperatures thought to have risen above 2,000 degrees Celsius—a temperature high enough to melt the fuel rods themselves.
It is assumed this overheated fuel melted along with control rods and other structural components inside the RPVs. The melted material solidified again after reaching the bottom of the RPVs, and partially at the bottom of the PCVs. This solidified material is called "fuel debris."
With radiation levels inside the PCVs being tremendously high even now, workers cannot get near the structures; the shape and location of fuel debris can only be estimated using computer simulations.
The decommissioning process demands fuel debris to be retrieved from inside and stored under safe and stable conditions.

Study of Options for Methods of Fuel Debris Retrieval

Taking the Three Mile Island accident in the USA as a precedent, we have studied fuel debris retrieval methods while prioritizing the "submersion method," whereby fuel debris is fully submerged in water. This is because the method offers advantages in that water is expected to provide a shielding effect against radiation and dust scattered during the fuel debris retrieval process. This helps reduce the radiation exposure of the workers.
However, in order to submerge fuel debris under water, it is necessary to fill with water up to the upper part of the PCVs that have been affected by the severe accident at the Fukushima Daiichi NPS. There are many developmental challenges in repairing the PCVs and stopping water leakage from them. It is therefore assumed that fuel debris may not be submerged in water. Given these points, the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF) suggested, in its Technical Strategic Plan 2015 for Decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company, that there is a need to study not only the submersion method, but also the partial submersion method where fuel debris is retrieved with a part of it being exposed to the air. The NDF also showed three fuel debris retrieval methods to be focused upon as options that consider water levels in the PCVs and access directions to fuel debris (top, bottom and side), based on the viewpoints of the progress status and feasibility of technology development and risk management.

The Conceptual Diagrams of Three Representative Methods for Fuel Debris Retrieval



Submersion—Top entry method
Assuming the in-core structures above the fuel debris are removed

Partial submersion—Top entry method
Assuming that the in-core structures above the fuel debris are removed

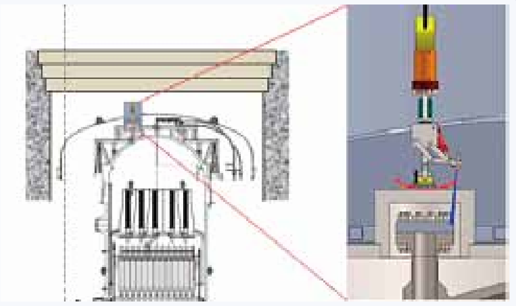
Partial submersion—Side entry method
Assuming that the equipment and other objects outside the RPV pedestal in the PCV are removed

<Source> 'Technical Strategic Plan 2015 for Decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company' developed by NDF

Overview of R&D Projects at IRID

Technology for Investigation and Analysis of the Reactor Interior

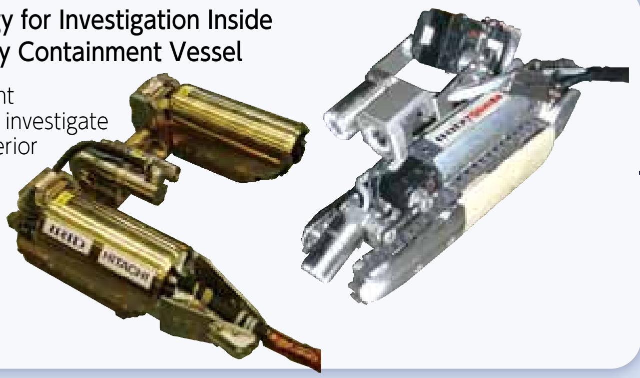
Technology for Investigation Inside the Reactor Pressure Vessel



Design of equipment to investigate from a top route created by a boring process

Technology for Investigation Inside the Primary Containment Vessel

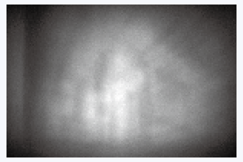
Development of robots to investigate the PCV interior



Technology for Detection of Fuel Debris

Technology for investigation of fuel debris distribution in the RPV using cosmic ray muons

Simulated image

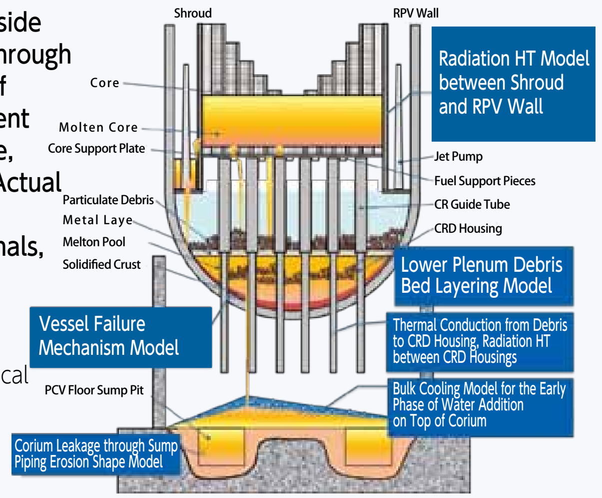


Measurement image

Technology for Investigation and Analysis (Characterization) of the Reactor Interior

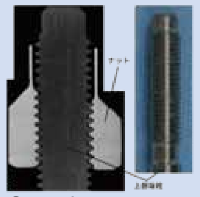
Identifying Conditions Inside the Reactor through Application of Severe Accident Analysis Code, Data on the Actual Reactor and Reactor Internals, etc.

Improvement of the physical phenomenological model

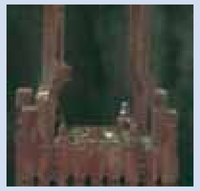


R&D for Fuel Removal from the Spent Fuel Pool

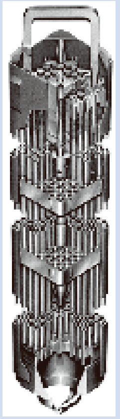
- Evaluation of long-term structural integrity of fuel assemblies (corrosion tests that assume storage environments for removed fuel assemblies and investigations of actual fuel assemblies)
- Study of methods to process damaged fuel and evaluation of impacts on damaged fuel when it is processed with the methods

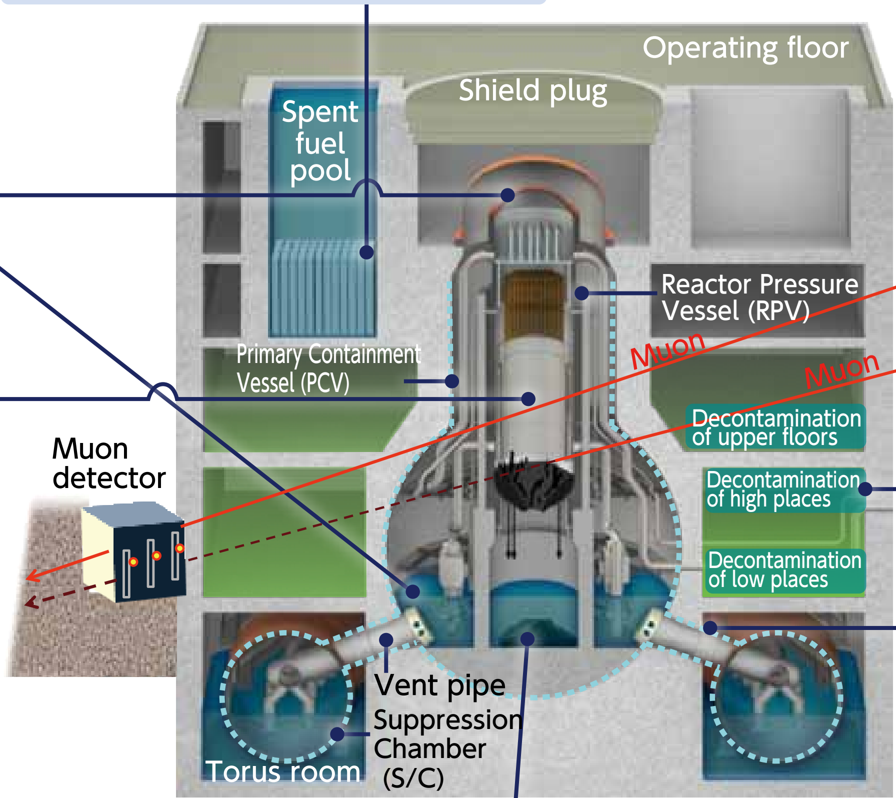


Corrosion evaluation



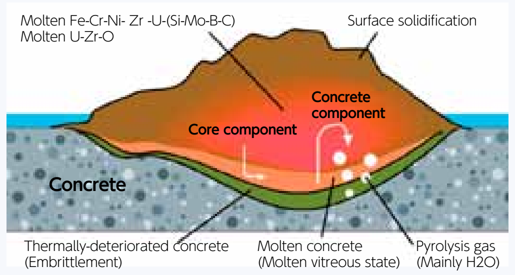
Investigation of the condition of stored fuel





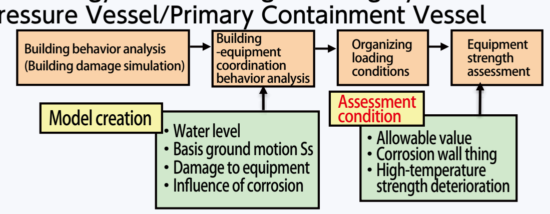
Fuel Debris Characterization

Characterization using simulated debris

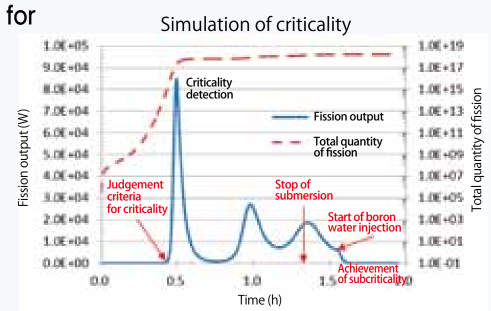


Technology for Fuel Debris Retrieval

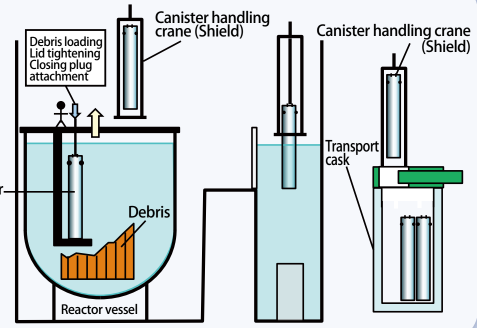
Technology for Evaluating the Integrity of the Reactor Pressure Vessel/Primary Containment Vessel



Technology for Criticality Control in Fuel Debris Retrieval



Technology for Collection, Transfer and Storage of Fuel Debris



Technology of Retrieval of Fuel Debris and Reactor Internals

Technology for Decontamination and Dose Reductionals

Technology for Remotely-operated Decontamination in the Reactor Building

High-pressure water jet decontamination (for low places)

Equipment for decontaminating upper floors (for upper floors)

Dry ice blast decontamination (for high places)

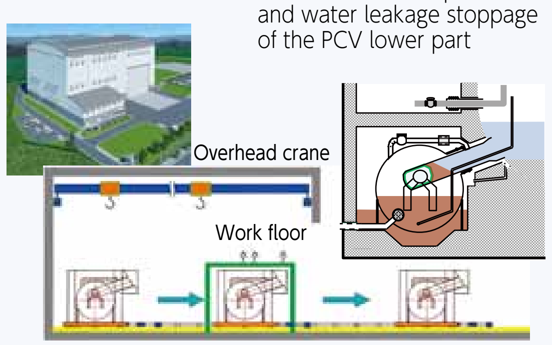
Technology for Treatment and Disposal of Solid Waste

- Characterization of accident-generated waste
- Study of long-term storage management
- Study of treatment and disposal

Technology for Repair and Water Stoppage of the Primary Containment Vessel

Full-scale Test

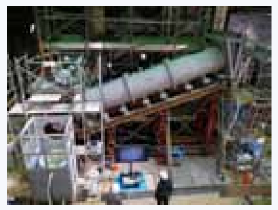
Full-scale test of repair and water leakage stoppage of the PCV lower part



Assembly   Demonstration test   Dismantling

Repair and Water Leakage Stoppage Technology for Leakage Points Inside the Primary Containment Vessel

Development of robots for investigating water leakage points



Test of water leak stoppageof the vent pipe (with a half-scale mock-up)

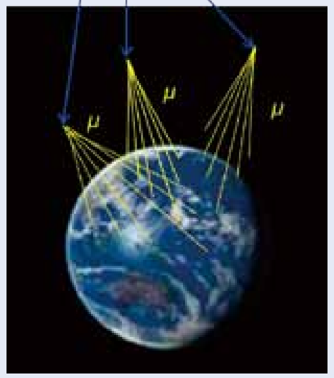
Test of reinforcement of the S/C leg part (with a full-scale mock-up)

Main R&D Topics

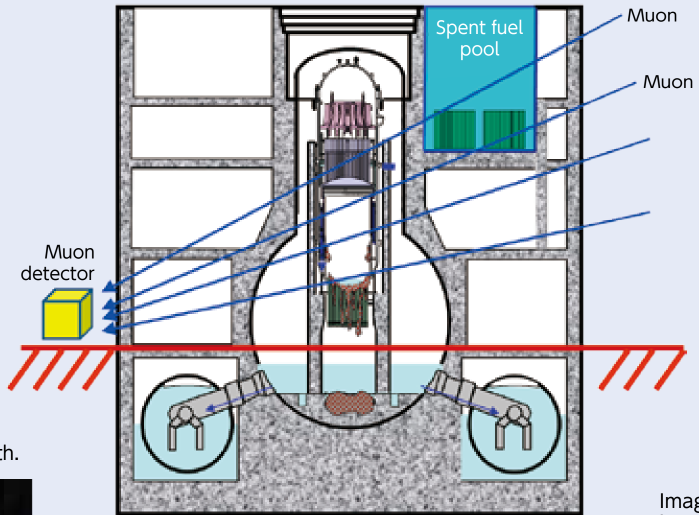
Technology for Visualizing the Reactor Interior Using Cosmic Ray Muons

Muon particles (muons) are generated by the collision of cosmic rays with the earth's atmosphere. About 170 muons per square meter rain down on the earth' s surface each second. Muons are characterized by the ability to easily penetrate substances. Some muons, however, cannot penetrate substances because they lose a part of their energy due to interaction with electrons in the process of penetrating the substances. Others are deflected from their initial direction due to interaction with nuclides. In collaboration with research institutions in Japan and abroad*, IRID developed equipment using the transmission method technology to detect the former muon phenomenon and other equipment using the scattering method technology that detects the latter muon phenomenon. In 2015, we successfully visualized the inside of the Fukushima Daiichi NPS Unit 1 using the transmission method. As a result, we obtained information credible enough to convince us that it is reasonable to think there is no fuel at the location where the reactor core in Unit 1 originally existed. * High Energy Accelerator Research Organization (KEK), Los Alamos National Laboratory (LANL), etc.

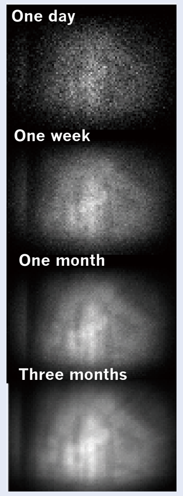
Cosmic rays



About one muon strikes an extended human hand on the earth.

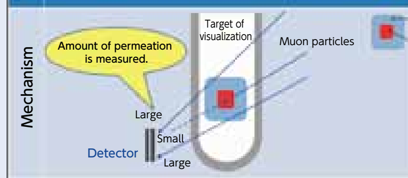
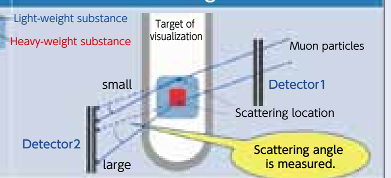


The muon detector was installed on the ground outside the reactor building of Unit 1 to measure muons.



Images depicting the reactor interior using the transmission method (Changes for each measurement period)

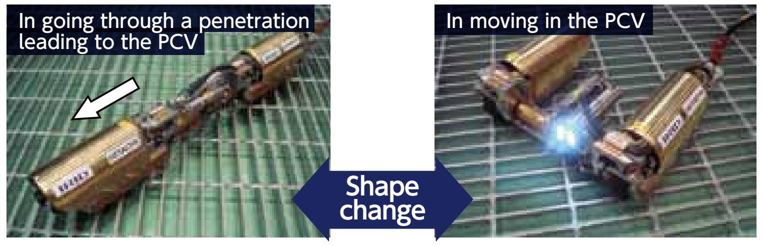
The muon detector using the transmission method that is housed in a 10-cm-thick iron shield. (It consists of three units arranged in three layers. Outside dimensions: 2.5 m x 2.0 m x 2.1 m)

	Transmission method	Scattering method
Mechanism		
Features	○ Presence of matter in incoming direction (two dimensional)	◎ Presence of matter in locations where muon particles scatter (three dimensional) Capable of identifying locations of nuclear fuel material such as uranium
	○ Spatial resolution: about 1 m	◎ Spatial resolution: about 30 cm
	◎ One small-size detector (applicable early)	○ Two large-sized detectors (They have been developed.)

Technology for Investigation Inside the Primary Containment Vessel (PCV)

■ Robot for investigating inside the PCV at Unit 1 (shape-changing robot)

We developed a robot to investigate the outside of the pedestal of the PCV at Unit 1. We also used the robot to investigate the condition inside the PCV after changing the robot's shape: The robot was converted to a rod shape with a diameter of about 10 cm when it penetrated the material. Then, the robot was converted to another shape when it moved inside the PCV to improve its moving performance. We received the 7th Robots and Society Award of the Robotics Society of Japan for this achievement.



■ Robot for investigation inside the PCV at Unit 2

We have developed a robot to investigate the interior of the pedestal of the PCV at Unit 2. After entering the pedestal, the shape of the robot was changed to raise its tail section like a scorpion to improve its field of view.

Technology for Remotely-operated Decontamination (Development of Decontamination Equipment for Upper Floors)

■ This is equipment used to remotely decontaminate upper floors (the second and third floors) of the reactor building, using three methods: high-pressure water jet; dry ice blast; and suction/blast. A lifter is used to move the equipment up or down to and from upper floors.

■ When in use, the decontamination equipment for upper floors comprises a combination of devices developed separately by Hitachi-GE Nuclear Energy, Ltd., TOSHIBA CORPORATION and Mitsubishi Heavy Industries, Ltd., respectively. Wheeled platforms are designed for common use so that a certain type of decontamination unit carried on each wheeled platform can be replaced with another type in order to effectively use the wheeled platforms and decontamination units.

A line of wheeled platforms constituting the remotely -operated decontamination equipment (in the suction and blast method)

The equipment goes up and down to a height equivalent to that of the second floor of the reactor building (a height of up to 8 m above the ground).

Repair and Water Leakage Stoppage Technology for Leakage Points Inside the PCV

■ Tested water leakage stoppage of the downcomer in S/C*

Pressure was applied to underwater anti-washout concrete in the S/C and tested the water permeability of the concrete. The test results confirmed that the amount of the water leakage was minimal and it was therefore possible to stop water leakage from the downcomer.

* Suppression chambe (pressure control room)

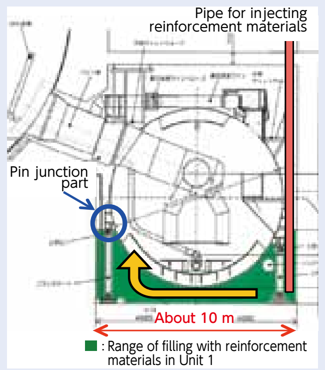
Injecting grout into a large-sized downcomer

Test on the water leak stoppage of the large-sized downcomer

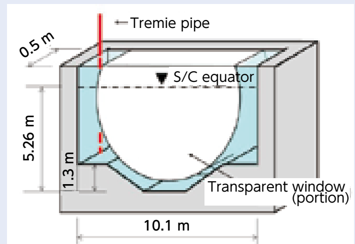
■ Tested properties of reinforcement materials that had risen after injection into a mock-up

A mock-up as large as the real S/C was prepared and injected with reinforcement materials from one side of the mock-up. This tested whether the reinforcement materials could reach and rise at the other side. The test results confirmed that the height to which the injected reinforcement materials rose on the other side was lower by about 4 cm than at the side from which the materials were injected: this difference would not cause any problem when the technology is applied at the Fukushima Daiichi site.

Picture of a full-scale mock-up



Range of filling with reinforcement materials (in Unit 1)



Outline of the full-scale mock-up (simulating Unit 2 and 3)

Information

More details about IRID R&D are available on IRID's website and in its brochures.
Please visit the IRID webpage for information and brochures.

IRID Website http://irid.or.jp/

IRID Annual Research Report 2014

Robots

Scope of Business 2: Promotion of Cooperation with Relevant International Organizations

Under an operational policy that IRID is an open organization, IRID is striving to strengthen relationships with relevant international organizations and experts to gather knowledge from Japan and abroad while conducting its activities.

International Advisors

The International Advisors group consists of three nuclear experts from around the world. This group was established to provide IRID's Board of Directors with advice from organizational, management and other perspectives. Meetings were held to deliberate on the international initiatives and management approach of IRID to provide advice to IRID on future issues and points for improvement.

The Third IRID International Advisors Meeting (December 2, 2015)*
* From the left: Prof. Brownridge, Dr. Simper, Mr. Barrett, Mr. Echavarri

■ Members

Mr. Lake Barrett (USA):
Independent Consultant (former Site Director for the Nuclear Regulatory Commission (NRC) for the Three Mile Island accident)

Professor Melanie Brownridge (See the note below.) (UK):
Head of Technology at the Nuclear Decommissioning Authority (NDA) (Head of R&D)

Mr. Luis E. Echavarri (Spain):
Former Director General of the OECD/NEA (expert with experience such as membership in the International Nuclear Safety Group (INSAG)

(Note) She is a UK member from the Third IRID International Advisors Meeting. Dr. Adrian Simper (NDA director) served as a UK member at the First and Second IRID International Advisors Meetings.

■ Schedule

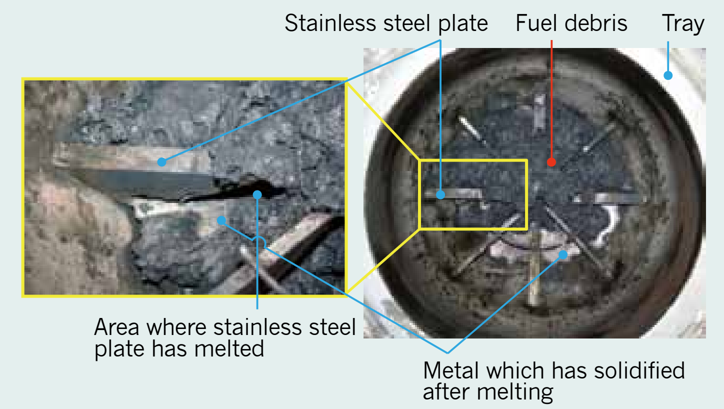
- January 9-10, 2014 The first meeting was held.
- November 17-19, 2014 The second meeting was held.
- December 2-4, 2015 The third meeting was held.

Joint Research with Overseas Research Institutions

We are collaborating with overseas research institutions to produce and analyze large-scale simulated debris using uranium.

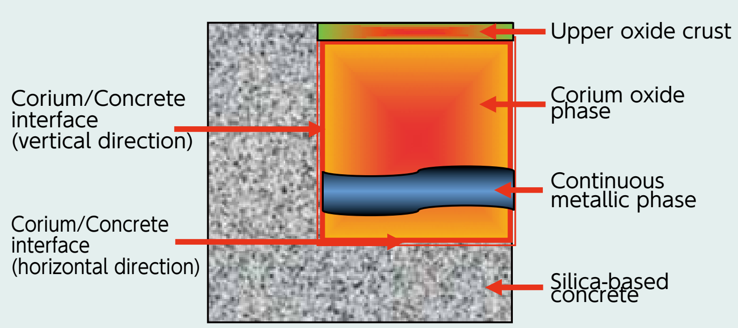
■ National Nuclear Center of the Republic of Kazakhstan (NNC)

Joint activities included producing a heterogeneous molten solidified substance by mixing and melting tens of kilograms of materials such as uranium fuel and cladding tubes and making the mixed molten material react with metal such as reactor components. The test sample of the molten solidified substance is used to study the mixed state of metal and ceramics and the properties of interface between the two.



■ French Atomic Energy and Alternative Energies Commission (CEA: Commissariat a l'Energie Atomique et aux Energies Alternatives)

With the use of products generated when the CEA tested molten core-concrete interaction (MCCI) with tens of kilograms of uranium, properties of the MCCI test products are analyzed to predict actual MCCI products.



Technological Cooperation with Overseas Nuclear Organizations

We are advancing technological cooperation with overseas nuclear organizations that have experience in decommissioning reactors and handling damaged fuels.

■ At the Paks Nuclear Power Plant in Hungary

We discussed how to handle damaged fuel and safety in storing removed fuel. We are utilizing results of these discussions for development of fuel debris canisters.

■ At the International Atomic Energy Agency (IAEA) headquarters in Vienna, Austria

We discussed ideas concerning decommissioning of the Fukushima Daiichi NPS with a team of IAEA experts consisting of engineers from many countries. We also received advice on how to gather technological information that will be of further importance.

■ At the Pacific Northwest National Laboratory and the Hanford facility in the USA.

We obtained knowledge on how to remove damaged fuel and store it safely after removal. We will continue to promote technical cooperation.

Information Release Overseas

We provideour results of our research and development at forums etc., organized by relevant international organizations.

Lecture at the 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) Workshop (October 2, 2015)

Lecture at the German-Japanese Symposium (April 21, 2015)

Scope of Business 3: Human Resource Development for R&D

Nuclear decommissioning is a long-term project that may span 30 to 40 years. It is therefore vital to get young people engaged in work involving pertinent nuclear decommissioning technologies.

R&D in Collaboration with Universities

IRID is involved in joint R&D of technologies with universities to improve the operability of remotely operated equipment.

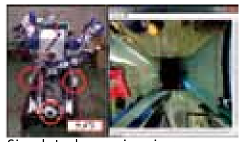
Technological challenges

- Easy-to-understand displays showing conditions around robots
- Improvement of operability of multi-joint manipulator

Enhancement of capability to grasp surrounding conditions
[Yamashita Lab, University of Tokyo]

The lab developed technologies that enable easy adjustment of image correction that enables operators to freely change types, mounting positions and orientations of cameras.


Simulated overview image captured by Super Giraffe


Simulated overview image captured by MEISTeR

Improvement of capability to grasp surrounding conditions
[Tsubouchi Laboratory, University of Tsukuba]

The laboratory developed a system capable of mapping 3D measurement data captured by cameras and laser sensors around the robot and displaying the mapping in an easy-to-understand way.

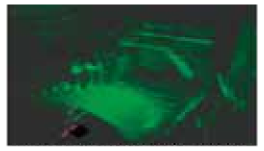
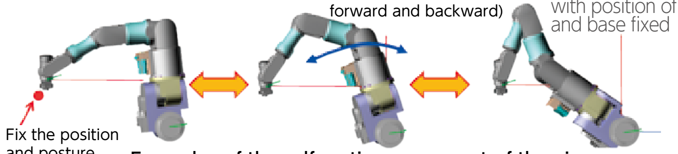

Screen displaying 3D mapping of data captured by Super Giraffe (under development)


Image of a display showing surrounding environment using sensor-captured 3D data and camera-captured images

Improvement of operability [Yokokohji Laboratory, Kobe University]

The laboratory developed a manipulation interface that allows operators to give immediate motion commands to the multi-joint manipulator to perform self-motion*, in order to improve the operability of the manipulator.



* Movement to change the manipulator's overall shape with position of hand tip and base fixed

Examples of the self-motion movement of the nine degree-of-freedom manipulator

Efforts for Human Resource Development

1. Workshop activities in cooperation with human resource development project hosted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT)

IRID participates in workshops held by universities and research institutions in cooperation with human development project 'Decommissioning Basic Research: Human resource development program', hosted by the MEXT.


Second workshop for FY 2014 in Tohoku University (January 15, 2015)

2. Information release to universities, research institutions, etc.

We are participating in joint and contract research with universities, research institutions, etc. and dispatching lecturers to speak at their sites.

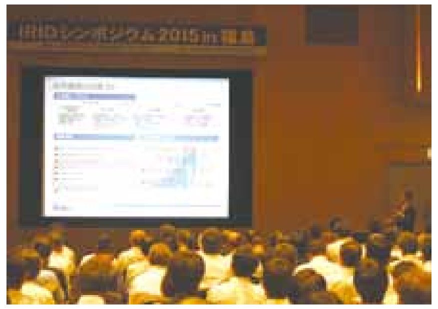

Guest lecture at the Department of Mechanical Engineering, National Institute of Technology, Oyama College (December 8, 2014)


Lecture at the 4th University-Industry Cooperation Forum at the University of Aizu (March 2, 2015)


Guest Lecture at Koriyama City Tomita Junior High School (November 25, 2015)

3. IRID Symposium

The IRID Symposium 2015 was held in Fukushima on July 23, 2015 to introduce achievements of our research and development in an easy-to-understand way; this also gave us an opportunity to explain our initiatives to municipalities, companies, school officials and the public in Fukushima Prefecture.
On the day of the symposium, panels and images were exhibited and a robot was demonstrated, which provided opportunities for about 240 participants to directly communicate with IRID staff members responsible for R&D.


Explaining the current status of R&D for the decommissioning


Exhibiting and demonstrating a shape-changing robot (prototype)


Exhibiting panels

4. Participation in various events

We have actively provided lectures and participated in meetings and events hosted by various organizations such as the scientific societies.


Lecture of Environmental Radioactivity Measures & Radioactive waste Disposal International Exhibition (RADIEX) 2015 (July 16, 2015)


Panel discussion at the 33-rd Annual Conference of the Robotics Society of Japan (September 5, 2015)


Lecture in the special session on decommissioning at the 2015 Fall Meeting of the Atomic Energy Society of Japan (Sept. 11, 2015)


Exhibition and demonstration of the shape-changing robot (prototype) at the Robot Festa Fukushima 2015 (November 3, 2015)

Information—We have an IRID glossary on our website—

The IRID Glossary consists of a Japanese-English/English-Japanese glossary named "Transl" (containing about 2,500 terms) and a nuclear-related abbreviation glossary named "Termsl" (containing about 12,000 terms).

We hope that the IRID Glossary will be used by companies and students engaged in decommissioning projects in Japan and abroad, and hope that it will facilitate decommissioning of the Fukushima Daiichi NPS as much as possible.

Website URL
http://irid.or.jp/glosy_index.html

(Note) This system operates only in Internet Explorer. It is not available in other browsers.


The search system of the IRID Glossary

Organization Profile

1. Name

Technology Research Association,
International Research Institute for Nuclear Decommissioning (IRID)

2. Location of Headquarters

5F, 3 Toyokaiji Building, 2-23-1 Nishi-Shimbashi, Minato-ku, Tokyo 105-0003, Japan
TEL: +81 3 6435 8601 (representative)

3. Date of Establishment

August 1, 2013

4. Scope of Business

- R&D for nuclear decommissioning
- Promotion of cooperation on nuclear decommissioning with relevant international and domestic organizations
- Human resource development for R&D

5. Membership (18 organizations)

National Research and Development Agencies:
- Japan Atomic Energy Agency
- National Institute of Advanced Industrial Science and Technology

Manufacturers, etc.:
- TOSHIBA CORPORATION
- Hitachi-GE Nuclear Energy, Ltd.
- Mitsubishi Heavy Industries, Ltd.
- ATOX Co., Ltd.

Electric utilities, etc.:
- Hokkaido Electric Power Co., Inc.
- Tohoku Electric Power Co., Inc.
- Tokyo Electric Power Company, Incorporated (TEPCO)
- Chubu Electric Power Co., Inc.
- Hokuriku Electric Power Company
- The Kansai Electric Power Company, Incorporated
- The Chugoku Electric Power Co.,Inc.
- Shikoku Electric Power Company, Incorporated
- Kyushu Electric Power Co., Inc.
- The Japan Atomic Power Company
- Electric Power Development Co., Ltd.
- Japan Nuclear Fuel Limited

6. Board of Directors

President: Mr. Hirofumi Kenda
Vice President: Dr. Tamio Arai
Executive Director: Mr. Kiichi Suganuma
Directors: Mr. Kiyoshi Oikawa, Mr. Hiroto Uozumi, Mr. Ei Kadokami, Mr. Kunikazu Kishimoto, Mr. Masahiro Seto, Mr. Mamoru Hatazawa, Mr. Jun Matsumoto, and Mr. Yoshinori Moriyama
Auditor: Mr. Nakatani Satoru

7. Number of Personnel

835* (excluding the number of the board of directors)

* This number includes the number of staff engaged in research conducted by IRID at IRID member organizations

(as of October 1, 2015)

<Establishment of Our Organization>

August 1, 2013: Establishment of IRID was approved by the Minister of Economy, Trade and Industry under the Act on Research and Development Partnership.

August 8, 2013: IRID held its inaugural General Meeting and Board of Directors meeting, and began operation.

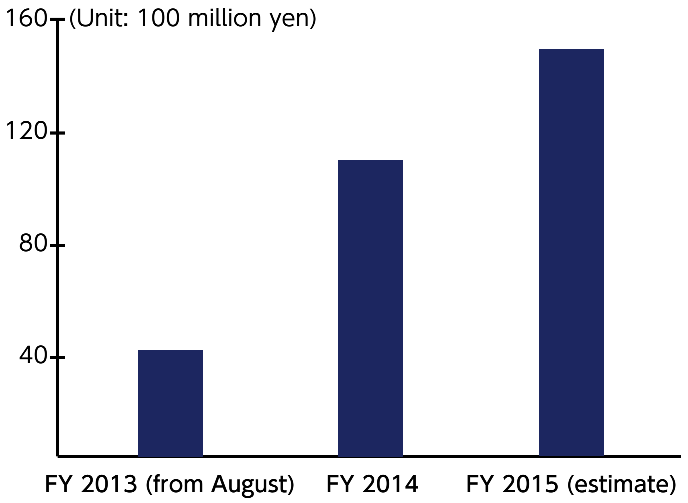
<Organizational Role>

IRID devotes its utmost efforts to the current urgent challenge—R&D for the decommissioning of the Fukushima Daiichi NPS—in cooperation with the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF) and Tokyo Electric Power Company, Incorporated (TEPCO), with a view to strengthening the foundation of future decommissioning technology and to fostering, accumulating and improving related technology.

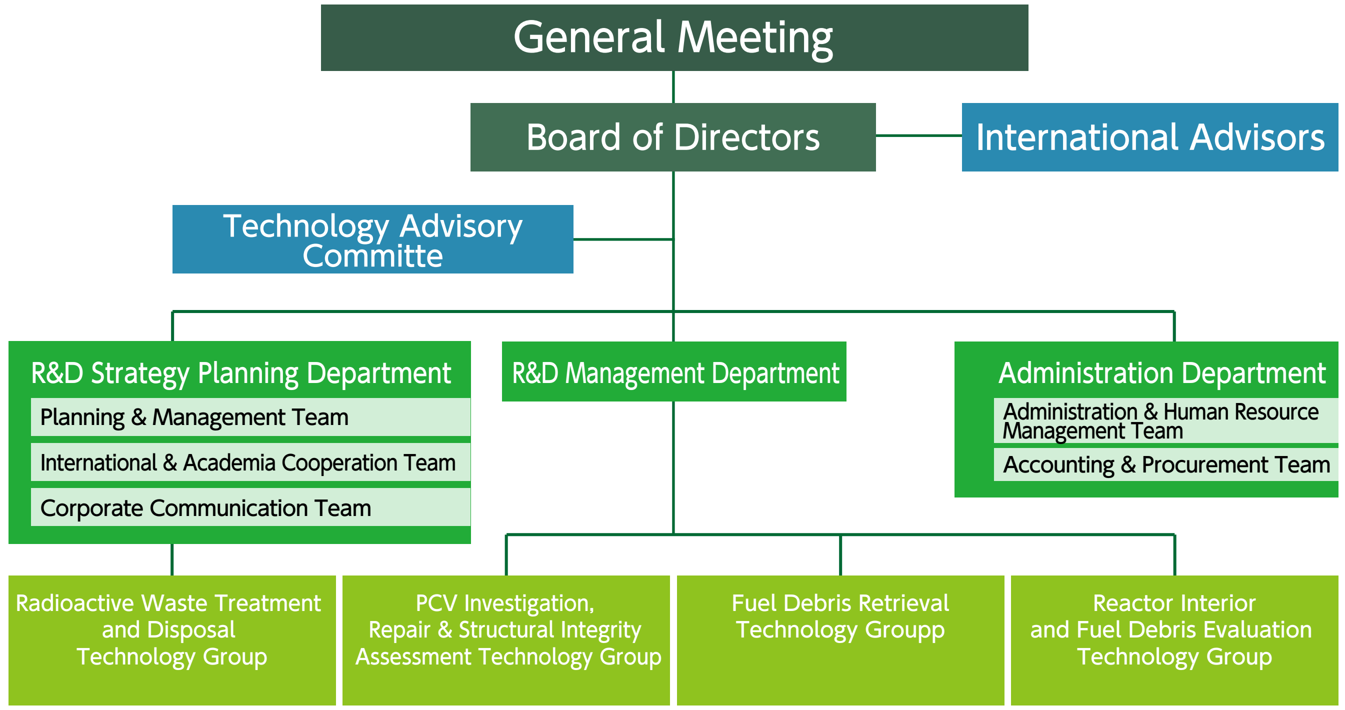
<Organizational Structure>

- IRID was inaugurated with 17 organizations, with the General Meeting as the highest decision-making body and the Board of Directors as the executive body, in compliance to the Act on Research and Development Partnership. We presently consist of 18 organizations after ATOX Co., Ltd., joined in May 2015.
- Eleven Directors and one auditor have been appointed. Some Directors are from non-IRID member organizations (universities and companies).
- To promote decommissioning, we have appointed the International Advisors and set up the Technology Advisory Committee, thereby realizing a structure to obtain the latest global expertise.
- Our organization consists of three departments: the R&D Strategy Planning Department, responsible for planning, human resource development, international cooperation and public relations; the R&D Management Department, responsible for R&D; and the Administration Department, responsible for administration. The following four Groups are dedicated to research projects: the Radioactive Waste Treatment and Disposal Technology Group; the PCV Investigation, Repair & Structural Integrity Assessment Technology Group; the Debris Retrieval Technology Group; and the Reactor Interior and Fuel Debris Evaluation Technology Group.

<Changes in Project Costs>



Organizational Structure of IRID



(as of October 1, 2015)

Technology Advisory Committee/Expert Advisors

IRID has set up the Technology Advisory Committee to obtain advice from external experts with high levels of knowledge. We have received from the Committee a wide range of opinions from broad viewpoints, including advice on technology that is extremely hard to be realized, and is based on the latest knowledge, advice on project-specific and cross-project planning, advice on human development projects, etc.
We have also received from the Expert Advisors opinions on the research plan, implementation method and result evaluation of each project, etc., and reflected the opinions in our R&D.

The fourth Technical Advisory Committee (March 24, 2015)

IRID Expert Advisors inspecting the workplace of robot development*

* 'TEMBO' equipment to remove shielding blocks and iron plates

Technical Capabilities of IRID Members

1. Japan Atomic Energy Agency (JAEA)

JAEA believes its most important project is to contribute to recovery from the accident at the Fukushima Daiichi NPS and efforts for reconstruction of Fukushima and other affected areas. JAEA has scientific and technical expertise as the sole comprehensive nuclear research and development institution in Japan.

2. National Institute of Advanced Industrial Science and Technology (AIST)

AIST conducts R&D covering seven areas: energy and environment; biotechnology; information and human engineering; materials chemistry; electronics and manufacturing; geology; and measurement standards. AIST has broad scientific knowledge and technical capabilities required for implementing IRID projects.

3. TOSHIBA CORPORATION

As a plant manufacturer, Toshiba has expertise, experience, and a proven track record in the fields of development of decontamination technology, PCV inspection and repair technology, remote operation technology, etc., related to the Project of Decommissioning and Contaminated Water Management. The company is capable of applying their development results broadly.

4. Hitachi-GE Nuclear Energy, Ltd.

The company puts in place a consistent structurer, ranging from the planning, designing and manufacturing to construction and maintenance service of nuclear power stations and further operator training. The company is capable of developing useful technology for long-and mid-term efforts towards the decommissioning of the Fukushima Daiichi NPS, etc.

5. Mitsubishi Heavy Industries, Ltd.

Mitsubishi Heavy Industries offers services ranging from basic planning to designing, and includes manufacturing, construction, maintenance and repair of pressurized-water reactor (PWR) nuclear power stations. The company has also accumulated an abundance of technologies in each of its business fields, i.e., nuclear fuels, advanced reactor plants and nuclear fuel cycles, which are very effective for project management in planning R&D. The company is capable of utilizing, applying and spreading its obtained results broadly.

6. ATOX Co., Ltd.

ATOX has expertise, experience and a proven track record in operation, inspection and repair, decontamination, and radiation control of general nuclear-related facilities. The company is highly capable of putting their expertise, experience and proven track record into practice at the site. It also possesses gamma irradiation facilities and is capable of developing useful decontamination-related technologies.

7. Tohoku Electric Power Co., Inc., Tokyo Electric Power Company, Incorporated (TEPCO), Chubu Electric Power Co., Inc., Hokuriku Electric Power Company and The Chugoku Electric Power Co.,Inc.

These companies have an abundance of expertise, experience and a proven track record in operation, maintenance, etc., of boiling water reactor (BWR) nuclear power stations, plus an abundance of technologies accumulated through joint research with other electric power companies, etc. The technologies are furthermore effective for the project management of IRID projects. The companies are capable of applying their development results broadly, based on knowledge at nuclear power stations.

8. Hokkaido Electric Power Co., Inc., The Kansai Electric Power Company, Incorporated, Shikoku Electric Power Company, Incorporated, Incorporated and Kyushu Electric Power Co., Inc.

These companies have an abundance of expertise, experience and a proven track record in operation, maintenance, etc., of pressurized-water reactor (PWR) nuclear power stations, as well as an abundance of technologies accumulated through joint research with other electric power companies, etc. The technologies are effective for management of IRID projects. The companies are capable of applying their development results broadly, based on knowledge at nuclear power stations.

9. The Japan Atomic Power Company

The Japan Atomic Power Company is engaged in demolition work at the Tokai Power Station for the decommissioning of Japan's first commercial nuclear power plant. Its mission is to act as a pioneer in demonstrating safe and rational decommissioning and promotes the establishment of remotely-operated demolition technology, material quantities and radioactive evaluations, as well as the treatment and disposal of radioactive waste, and the development of project management systems, etc. It has also accumulated useful technologies for future decommissioning.

10. Electric Power Development Co., Ltd.

The company has an abundance of expertise, experience and a proven track record in construction of boiling water reactor (BWR) nuclear power stations. It also possesses a great deal of technologies accumulated through joint research with other electric power companies etc. The technologies are effective for the management of IRID projects. The company is capable of applying their development results broadly, based on knowledge at nuclear power stations.

11. Japan Nuclear Fuel Limited

The company has business experience concerning uranium enrichment, waste burial and management, reprocessing, mixed oxide fuel production and transportation. The company also possesses an abundance of technologies accumulated through joint research with other electric power companies, etc. In particular, their extensive expertise, experience and proven track record in treatment and disposal of radioactive waste are effective for project management such as formulating what is to be implemented in IRID projects.

List of Government Subsidized R&D at IRID

The Project of Decommissioning and Contaminated Water Management in the FY2013 and the FY2014 Supplementary Budgets

Key Challenge 1: R&D for Fuel Removal from the Spent Fuel Pool
Key Challenge 2: R&D for Preparation of Fuel Debris Retrieval
Key Challenge 3: R&D for Treatment and Disposal of Radioactive Waste

(as of the end of November 2015)*1

Key Challenge	Project Name	Main Contents of the Project	Project Period	Supplementary Budget (FY)	Project Cost Amount*2 (Subsidy Rate)
1	Evaluation of Long-term Structural Integrity of Fuel Assemblies Removed from the Spent Fuel Pool	(1) Development of technology for evaluation of long-term structural integrity of fuel assemblies (2) Basic test for long-term integrity, etc.	April 1, 2015-March 31, 2017	2014	700 million JPY (100%)
2	Development of Technology for Remotely Operated Decontamination Inside Reactor Buildings	(1) Development of decontamination equipment for high places (2) Development of decontamination equipment for upper floors (3) Conceptual study of decontamination of basement floors, etc.	October 17, 2014-March 31, 2016	2013	2 billion JPY (50%)
	Development of Repair and Water Leakage Stoppage Technology for Leakage Points Inside the Primary Containment Vessel	(1) Development of technology for repair and water leakage stoppage of the Primary Containment Vessel (2) Formulation of plans up to filling the Primary Containment Vessels with water, etc.	July 23, 2014-March 31, 2016	2013	4 billion JPY (50%)
	Full-scale Test for Repair and Water Leakage Stoppage Technology for Leakage Points Inside the Primary Containment Vessel	(1) Full-scale test etc., of devices, equipment, etc., for repairing and stopping water leakage at the lower part of the Primary Containment Vessel (2) Preparation of equipment etc., required for the full-scale test (3) Study of equipment etc., required at mock-up facilities and maintenance of the equipment, etc.	July 23, 2014-March 31, 2016	2013	3.7 billion JPY (100%)
	Development of Technology for Investigation Inside the Primary Containment Vessel	(1) Plan of investigation inside the Primary Containment Vessel (2) Plan of development of investigation equipment (3) Development of investigation equipment, etc	October 15, 2014-March 31, 2016	2013	3 billion JPY (50%)
	Development of Technology for Investigation Inside the Reactor Pressure Vessel	(1) Formulation and updating of investigation and development plans (2) Element test and feasibility evaluation of technology for investigation by drilling the upper part (3) Study and feasibility evaluation of technology for sampling of fuel debris, etc.	September 9, 2015-March 31, 2016	2014	1 billion JPY (50%)
	Upgrading the Identification of Conditions Inside the Reactor through Application of Severe Accident Analysis Code, Data on the Actual Reactor and Reactor Internals, etc.	(1) Estimation of behaviors of fuel debris and fission products through accident progression analysis (2) Comprehensive analysis and evaluation of conditions inside the reactors using accident progression analysis and actual data, etc.	April 10, 2015-March 31, 2016	2014	1 billion JPY (100%)
	Development of Technology for Detection of Fuel Debris in the Reactor	(1) Implementation of small-scale demonstration test (spatial resolution: about 1 m) (2) Design, production of a detector system (spatial resolution: about 30 cm), etc.	June 20, 2014-December 31, 2015	2013	580 million JPY (50%)
	Project for Development of Fundamental Technologies for Retrieval of Fuel Debris and Internal Structures	(1) Comprehensive coordination of each element test and analysis of the element test results (2) Element test required for determining the feasibility of methods to retrieve fuel debris and internal structures, etc.	Septermber15, 2015-March 31, 2017	2014	4 billion JPY (100%)
	Project of Upgrading Approach and System for Retrieval of Fuel Debris and Internal Structures	(1) Organization of plant information toward determining a policy of retrieval of fuel debris and internal structures (2) Study of approaches, systems and equipment for retrieval of fuel debris and internal structures, etc.	Septermber15, 2015-March 31, 2017	2014	1.5 billion JPY (100%)
	Development of Technology for Collection, Transfer and Storage of Fuel Debris	(1) Formulation of plans of investigation and research for transfer and storage of damaged fuel (2) Study of storage systems of fuel debris (3) Development of safety evaluation methods (4) Development of technology for collection of fuel debris (5) Development of technology for transfer and storage of canisters, etc.	April 1, 2015-March 31, 2017	2014	800 million JPY (50%)
	Development of Technology for Evaluating Integrity of the Reactor Pressure Vessel/Primary Containment Vessel	(1) Evaluation of feasibility of the submersion method, based on the seismic integrity of the Reactor Pressure Vessels/Primary Containment Vessels (2) Simple evaluation of the earthquake-resistant strength of reactor components, based on repairs (water stoppage) of the Reactor Pressure Vessels/Primary Containment Vessels (3) Development of corrosion control measures (4) Upgrading of prediction accuracy of corrosion amount for a long term (5) Corrosion impact evaluation of the pedestal, etc.	July 25, 2014-March 31, 2016	2013	1.4 billion JPY (50%)
	Development of Technology for Criticality Control in Fuel Debris Retrieval	(1) Development of criticality evaluation methods (2) Development of methods of monitoring critical approach (3) Development of recriticality detection technology (4) Development of criticality prevention technology, etc	April 1, 2015-March 31, 2016	2014	300 million JPY (50%)
	Fuel Debris Characterization	(1) Estimation of properties of fuel debris in the reactor (2) Characterization using simulated debris (3) Development of element technology for analysis of fuel debris, etc	April 1, 2015-March 31, 2017	2014	2 billion JPY (100%)
3	R&D for Treatment and Disposal of Solid Waste	(1) Integration of R&D results (Presenting the basic policy of treatment and disposal) (2) Characterization (3) Study of treatment of radioactive waste and policy on long-term storage of radioactive waste (4) Study of disposal of radioactive waste, etc.	April 1, 2015-March 31, 2017	2014	2 billion JPY (100%)

*1 Projects listed in IRID's "Project Plan"　　*2 Project cost amounts and subsidy rates are cited from numbers written in the Application Guidelines