# Relationship between the subsidized projects of Decommissioning and Contaminated Water Management program and connection to preliminary engineering

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## 1. Introduction

To safely and steadily carry out the decommissioning of the Fukushima Daiichi NPP, it is important to gather together wisdom in Japan and overseas, and conduct research and development. For this reason, the Ministry of Economy, Trade and Industry has implemented a Subsidy Program of "Decommissioning and Contaminated Water Management" to support research and development with high technical difficulty since FY2013. In fiscal 2017, 16 subsidized projects were implemented by subsidized operating entities. The contents of research and development in these projects were diverse. To apply the results obtained in the subsidy projects to the decommissioning of Fukushima Daiichi NPP, mutual coordination among subsidized projects are essential.

## 2. Relationship between the subsidized projects of Decommissioning and Contaminated Water Management program and connection to preliminary engineering

The whole diagram of the project for Decommissioning and Contaminated Water Management implemented in FY2017 is shown below. The Decommissioning and Contaminated Water Management projects are roughly divided into “Internal Investigation”, “Debris Retrieval (development of method)”, “Debris Retrieval (development of fundamental technologies), “Improvement of Work Environment” at fuel debris retrieval, and “Processing of solid waste”. The figure shows the status of collaboration of results obtained in each project.

**Application in actual equipment · Preliminary engineering**

(implemented by TEPCO Holdings, out of scope of Decommissioning and · Contaminated Water Management project)

### “Internal Investigation”

**○Development of Technologies for In-depth Investigation of PCV Inside**

Grasp the situation inside the PCV with high accuracy, increase the scale of access and survey equipment, and upgrade the survey technology to finalize the method of fuel debris retrieval.

**○Development of Investigation Technology of Inside of PCV**

Formulate investigation plan and develop plan, develop essential technologies, develop equipment to access the interior of the PCV from a small opening, on-site demonstration, construct a larger access route, to determine the fuel debris retrieval policy and to finalize the method.

**○Development of Investigation Technology of Inside of RPV**

Develop remote investigation equipment and system for accurately grasping the situation inside and outside the pedestal inside the RPV, to determine the fuel debris retrieval policy.

**○Development of Technologies for Grasping and Analyzing Properties of Fuel Debris (Estimation of Aging Properties of Fuel Debris)**

Acquire knowledge on the fine particles in the shape of fuel debris, their migration into water, and predict the long-term aging behavior of fuel debris.

**○Development of Technologies for Grasping and Analyzing Properties of Fuel Debris**

Update fuel debris characteristics list, characterization such as behavior during dehydration using simulated debris, develop analysis technology, consideration of transportation method to facility for analysis, etc.

**○Upgrading Level of Grasping State inside Reactor**

Based on the results obtained by FY 2016, estimate the conditions inside RPV and PCV will be promoted through analysis and evaluations which should mitigate the uncertainty in the estimations of conditions inside RPV and PCV.

✓ Estimated information and data such as distribution, amount, and composition of fuel debris

✓ Results of examination of retrieving and collecting fuel debris

✓ Results of development technologies for safely processing and disposing solid waste generated by accident.
✓ Investigation results of the waste stream

**Milestones in the Mid-and-Long-Term Roadmap**
Technical prospects regarding policies for treatment and disposal and its safety (around 2021)

✓ Fuel debris characteristics list

**Milestones in the Mid-and-Long-Term Roadmap**
(1) Finalization of fuel debris retrieval methods for the initial Unit (FY 2019)
(2) Start of fuel debris retrieval at the initial Unit (within 2021)

### “Debris Retrieval (Development Method)”

**○Advancement of Retrieval Method and System of Fuel Debris and Internal Structures**

Conduct technology development necessary for solving problems to ensure safety of retrieval method and system; comparative evaluation from the viewpoint of exposure and maintainability, to complete the conceptual study of retrieval method and system.

**○Development of Criticality Control Technologies of Fuel Debris**

Prevention of criticality for each fuel debris retrieval procedure and criticality control method that does not affect radiation exposure and the environment even if it occurs should be formulated, to determine the fuel debris retrieval policy.

✓ Analysis and investigation needs

✓ Information and data on estimated fuel debris distribution, amount, and composition etc.
✓ List of Fuel debris characteristics

✓ Information and data such as the required hardness of fuel debris related to the development of the retrieval equipment
✓ Results of applicability from the survey improving the performance sensor

✓ Data based on element tests for feasibility of retrieval method

✓ Criticality control methods
✓ Safety requirement
✓ Functional requirement

### “Debris Retrieval (Development of Fundamental Technology) ”

**○Development of Fundamental Technologies for Retrieval of Fuel Debris and Internal Structures**

Perform element tests according to the policy of fuel debris retrieval and development of full-scale for actual machine to contribute on the selection of the method of retrieval of fuel debris and internal structures.

**○Development of Fundamental Technologies for Retrieval of Fuel Debris and Internal Structures(Development of Small Neutron Detectors)**

Develop a small size detector that can measure weak neutrons under high gamma ray dose, to identify the fuel debris distribution inside the PCV.

✓ Analysis and investigation needs
✓ Technology to access inside and outside the pedestal and detect neutrons derived from the fuel debris

### “Processing of Solid Waste”

**○Research and Development of Processing and Disposal of Solid Waste**

After characterization of the solid waste, investigate and examine to present the study of treatment concept and safety evaluation method, and develop necessary technology to reduce the risk of storage and management of solid waste.

✓ Results for the confirmation of the applicability of repair / water stoppage technology in actual equipment
✓ Developed System on the technology for collection, transfer and storage

✓ Study results of retrieving and collecting fuel debris
✓ Criticality control information on water stoppage point and method

✓ Knowledge of sorting waste

✓ Safety requirement, specification and system related to transfer and storage of fuel debris canister and study of fuel debris storage form

✓ Safety scenario
✓ Safety requirement, specification and system related to transfer and storage of fuel debris canister and study results of fuel debris storage form

✓ Safety scenario
✓ Results of applying sampling of fuel debris for sensor performance improvement
✓ Physical properties data for design of sampling system and retrieval equipment
✓ Safety requirement, specification and system related to transfer and storage of fuel debris canister and study results of fuel debris storage form

✓ Study results of retrieving and collecting fuel debris

### “Debris Retrieval (Improvement of Work Environment)”

**○Development and Management of Evaluation Method of Seismic Performance/Impact of RPV and PCV**

Identify the impact on critical devices inside the RPV / PCV at the occurrence of a large-scale earthquake and s to consider measures to prevent or reduce the effects to confirm the effectiveness of a safety scenario based on such measures.

**○Development of Repair Technology for Leakage Sections in PCV**

Establish the containment function within the PCV, develop repair technology for the leakage section and confirm actual application, from the standpoints of radioactive material release/dispersion prevention, and cooling maintenance, to determine the fuel debris retrieval policy and to finalize the fuel debris retrieval method.

**○Full-scale Test of Repair Technology for Leakage Sections in PCV**

Perform a full-scale test of the technology developed in "Development of repair technology for leakage section in containment vessel" and confirm its viability.

**○Development of Sampling Technologies for Retrieving Fuel Debris and Internal Structures**

Based on the research results of FY2008 and the latest knowledge of Fukushima Daiichi, review the sampling plan and further study the technical issues related to the sampling system and equipment.

**○Development of Technologies for Containing, Transportation and Storage of Fuel Debris**

Canister storage specifications mainly from the safety design set by FY 2018 will be evaluated and improve from the standpoint of removal method and transfer of fuel debris and new canister storage specifications will be set.

✓ Information and data on estimated fuel debris distribution, amount, composition, and behavior during drying of fuel debris
✓ List of Fuel debris characteristics

✓ Safety requirement, specification and system related to transfer and storage of fuel debris canister, study results of fuel debris storage form

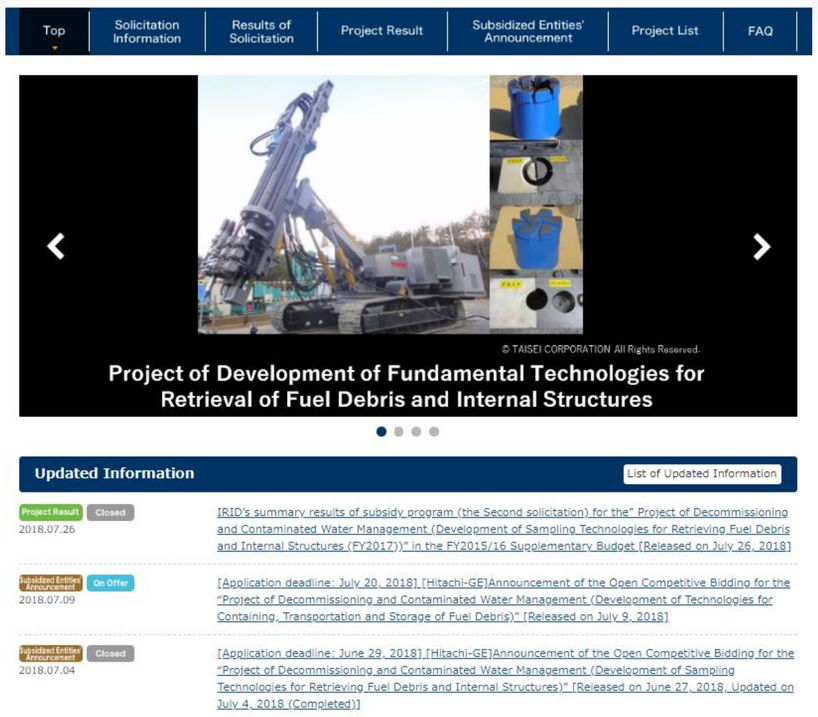
"Subsidy for Decommissioning and Contaminated Water Management project cost" Subsidized project by Ministry of Economy, Trade and Industry
The Management Office for the Project of Decommissioning and Contaminated Water Management (Mitsubishi Research Institute, Inc.)

* This figure does not exhaustively show the cooperation among each project, but items which seemed to be important are extracted and summarized by MRI in the light of the project objective.
* Cooperation between subsidized projects included in each R&D of "Internal Investigation", "Debris Retrieval (Development Method)", "Debris Retrieval (Development of Fundamental Technology)" and "Debris Retrieval (Improvement of Work Environment)" is appropriately implemented.

【Reference】
[1] Ministry of Economy, Trade and Industry, Agency for Natural Resources and Energy, Progress of R & D Project and Direction of Next Plan, Decommissioning and Contaminated Water Management Team Meeting / Project Management Office Meeting (51st)
[2] Decommissioning and Contaminated Water Management Ministerial Conference “Mid-and-Long-Term Roadmap towards the Decommissioning of Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company Holdings, Incorporated” , August 26th, 2017
[3] International Research Institute for Nuclear Decommissioning, Annual Research Report 2017
[4] International Research Institute for Nuclear Decommissioning Website, R&D results (http://irid.or.jp/research/20170000/)
[5] Management Office for the Project of Decommissioning and Contaminated Water Management Website (http://dccc-program.jp/, http://en.dccc-program.jp/)

## 4. Website

**Japanese : http://dccc-program.jp/**
**English : http://en.dccc-program.jp/**

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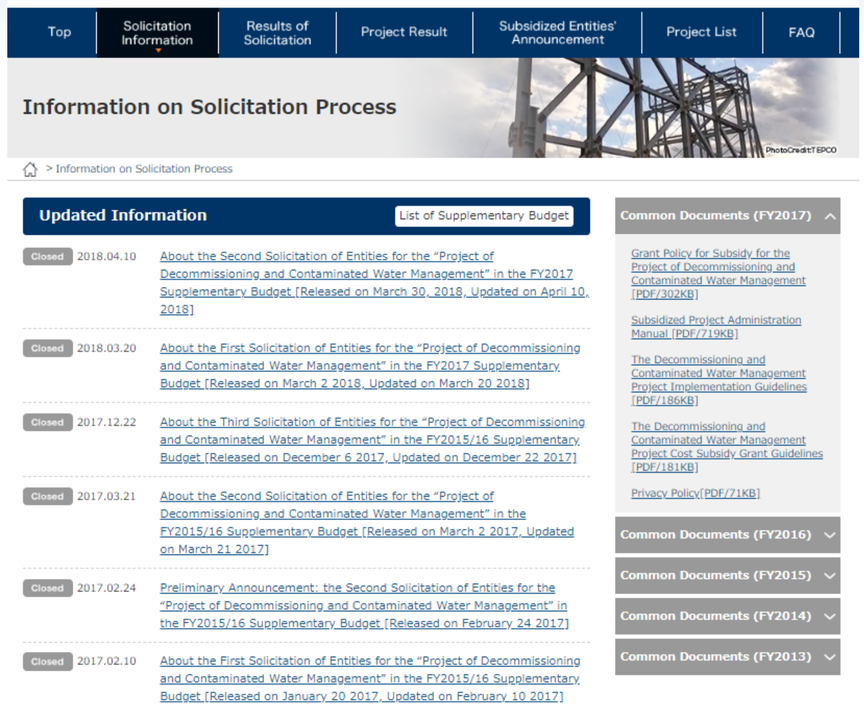


Information on Solicitation Process

## 5. Project List

### Internal Investigation

| Subject Area | Subsidized Project Name | Implementation Period | | | | |
|---|---|---|---|---|---|---|
| | | FY2014 | FY2015 | FY2016 | FY2017 | FY2018 |
| R&D for Nuclear Decommissioning "Internal Investigation" | | | | | | |
| | Assessing Conditions Inside Reactor through application of Severe Accident Analysis Code | Closed | | | | |
| | Advancement of Grasping Conditions inside Reactor by Accident Progression Analysis and Actual Data, etc. | | Closed | | | |
| | Upgrading Level of Grasping State inside Reactor | | | Closed | | |
| | Development of Techologies for the Detection of Fuel Debris inside Reactors | Closed | | | | |
| | Development of Technologies for Characterization and Processing of Fuel Debris | Closed | | | | |
| | Properties Analysis of Actual Debris | Closed | | | | |
| | Grasping Properties of Fuel Debris | | Closed | | | |
| | Development of Technologies for Grasping and Analyzing Properties of Fuel Debris | | | | In Process | |
| | Development of Technologies for Grasping and Analyzing Properties of Fuel Debris (Estimation of Aging Properties of Fuel Debris) | | | | In Process | |
| | Development of Investigation Technology of Inside of RPV | Closed | Closed | Closed | | In Process |
| | Development of Investigation Technology of Inside of PCV | Closed | | Closed | | |
| | Development of Technologies for In-depth Investigation of PCV Inside | | | | In Process | |
| | Development of Technologies for In-depth Investigation of PCV Inside (On-site demonstration of Technologies for In-depth Investigation through X-6 penetration) | | | | | In Process |
| | Development of Technologies for In-depth Investigation of PCV Inside (On-site demonstration of Technologies for In-depth Investigation considering measures of deposits) | | | | | In Process |

### Improvement of Work Environment

| Subject Area | Subsidized Project Name | Implementation Period | | | | |
|---|---|---|---|---|---|---|
| | | FY2014 | FY2015 | FY2016 | FY2017 | FY2018 |
| R&D for Nuclear Decommissioning "Internal Investigation" | | | | | | |
| R&D for Nuclear Decommissioning "Development of Retrieval Method" | | | | | | |
| R&D for Nuclear Decommissioning "Improvement of Work Environment" | | | | | | |
| | Development of Technologies for Integrity Evaluation of RPV and PCV | Closed | | | | |
| | Development of Corrosion Inhibition Technology for RPV and PCV | | | Closed | | |
| | Development and Management of Evaluation Method of Seismic Performance/Impact of RPV and PCV | | | Closed | | |
| | Development of Criticality Control Technologies of Fuel Debris | Closed | Closed | Closed | | |
| | Development of Technologies for Containing, Transportation and Storage of Fuel Debris | Closed | Closed | | In Process | |
| | Development of Technologies for Non-destructive Detection of Radioactive Material Deposited in S/C, etc. | Closed | | | | |
| | Development of Remote Decontamination Technology in the Reactor Building | Closed | | | | |
| | Development of Technologies for Repair and Water Stoppage of Leakage Sections in PCV | Closed | | | | |
| | Development of Repair Technology for Leakage Sections in PCV | | | Closed | | |
| | Full-scale Test for Repairing Leaks from PCV and Water Stoppage of PCV | Closed | | | | |
| | Full-scale Test of Repair Technology for Leakage Sections in PCV | | | Closed | | |
| | Development of closed circulation systems for water inside PCV | | | | | In Process |
| | Development of Sampling Technologies for Retrieving Fuel Debris and Internal Structures | | | | In Process | |

### Debris Retrieval

| Subject Area | Subsidized Project Name | Implementation Period | | | | |
|---|---|---|---|---|---|---|
| | | FY2014 | FY2015 | FY2016 | FY2017 | FY2018 |
| R&D for Nuclear Decommissioning "Internal Investigation" | | | | | | |
| R&D for Nuclear Decommissioning "Development of Retrieval Method" | | | | | | |
| | Development of Technologies for Retrieval of Fuel Debris and Internal Structures | Closed | | | | |
| | Conceptual Study of Innovative Approach for Fuel Debris Retrieval and Feasibility Study of Essential Technologies | Closed | | | | |
| | Project of Upgrading Approach and System for Retrieval of Fuel Debris and Internal Structures | | Closed | | | |
| | Advancement of Retrieval Method and System of Fuel Debris and Internal Structures | | | | In Process | |
| | Advancement of Retrieval Method and System of Fuel Debris and Internal Structures (Development of technology for criticality control in fuel debris retrieval) | | | | | In Process |
| | Project of Development of Fundamental Technologies for Retrieval of Fuel Debris and Internal Structures | | Closed | | | |
| | Project of Development of Fundamental Technologies for Retrieval of Fuel Debris and Internal Structures (Development of Small Neutron Detectors) | | | | In Process | |
| | Advancement of Fundamental Technologies for Retrieval of Fuel Debris and Internal Structures | | | | In Process | |

### Processing of Solid Waste

| Subject Area | Subsidized Project Name | Implementation Period | | | | |
|---|---|---|---|---|---|---|
| | | FY2014 | FY2015 | FY2016 | FY2017 | FY2018 |
| R&D for Nuclear Decommissioning "Internal Investigation" | | | | | | |
| R&D for Nuclear Decommissioning "Development of Retrieval Method" | | | | | | |
| R&D for Nuclear Decommissioning "Improvement of Work Environment" | | | | | | |
| R&D for Nuclear Decommissioning "Processing of Solid Waste, etc." | | | | | | |
| | Development of Technologies for Processing and Disposal of Accident Waste | Closed | | | | |
| | Research and Development of Processing and Disposal of Solid Waste | | Closed | | In Process | |
| | Research and Development of Processing and Disposal of Solid Waste (Research and development on preceding processing methods and analytical methods) | | | | | In Process |