Current status of Fukushima Daiichi NPS
Efforts for Decommissioning and Contaminated Water Management

Agency for Natural Resources and Energy, METI
March, 2018
Outline

1. Summary of Fukushima Daiichi NPS Accident
2. Overview and Main Progress in Decommissioning Work
3. Overview and Main progress in Contaminated Water Management
4. Improvement of working conditions
5. Revising Mid-and Long-term Roadmap
6. Communication with the public
7. Cooperation with International Communities
At the Fukushima Daiichi NPS, the safety functions were lost due to the earthquake and the tsunami.

Thus, the following severe accident could not be prevented.
### Summary of Fukushima Daiichi NPS Accident - The Damage of each Unit

<table>
<thead>
<tr>
<th>Status at the accident</th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
<th>Unit 4 (Under planned outages)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Operation</td>
<td><img src="image1" alt="Diagram of Unit 1" /></td>
<td><img src="image2" alt="Diagram of Unit 2" /></td>
<td><img src="image3" alt="Diagram of Unit 3" /></td>
<td><img src="image4" alt="Diagram of Unit 4" /></td>
</tr>
<tr>
<td>Fuels in SPF</td>
<td>392</td>
<td>615</td>
<td>566</td>
<td>1533</td>
</tr>
<tr>
<td>Core melt</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Hydrogen explosion</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
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The Current Status of each Unit

**Unit 1**
- ✓ Hydrogen explosion
- ✓ Core melt

**Unit 2**
- ➢ No hydrogen explosion
- ✓ Core melt

**Unit 3**
- ✓ Hydrogen explosion
- ✓ Core melt

**Unit 4**
- ✓ Hydrogen explosion
- ➢ No core melt

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**At the Time of the Accident**
- Installation of windbreak fences to further reduce dust scattering during rubble removal from the operating floor was completed in December 2017. And the removal of the rubble on the operating floor started from January 2018.

**Now**
- An equipment to cover the upper part of the building as well as a crane has been installed since August 2017 to start removing spent fuel from the pool in the middle of the 2018 fiscal year.

**At the Time of the Accident**
- On December 22, 2014, all (1533) fuel removal from Unit 4 SFP was completed.

**Now**
- Currently, TEPCO is proceeding with preparation work, such as removal of rubble around the reactor building and building scaffolding.
### Measures to Deal with the Aftermath of the Accident at Fukushima Daiichi Nuclear Power Station

*Measures for decommissioning*

Concerning measures for decommissioning, *progress was made in activities such as the removal of fuels from the spent fuel pools and the retrieval of fuel debris* based on the Mid-and-Long-Term Roadmap.

<table>
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</thead>
<tbody>
<tr>
<td><strong>Fuel removal</strong></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Unit 1</td>
<td></td>
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</tbody>
</table>
| Dismantling of the building covers → Removal of rubble, decontamination, etc. → Installation of covers used for removal of fuels | ![Image of the building at the time of the start of removal (FY2023)](image)
| **Unit 2**                                    |        |      |      |      |      |      |      |      |      |
| Decided which portions of the upper part of the Unit 2 building should be dismantled before the selection of removal plans [November 2015] | ![Image of the removal plans (decided in FY2017)](image) |
| Started installation of a platform for access to the operating floor [September 2016] | ![Image of the building at the time of the start of removal (around the middle of FY2018)](image) |
| **Unit 3**                                    |        |      |      |      |      |      |      |      |      |
| Removal of rubble and decontamination → Installation of shields → Installation of covers used for removal of fuels, etc. | ![Image of the building at the time of start of removal (around the middle of FY2018)](image) |
| **Fuel debris retrieval**                     |        |      |      |      |      |      |      |      |      |
| Unit 1                                        |        |      |      |      |      |      |      |      |      |
| Examination of the inside using cosmic ray muon [May 2015] | ![Image of the inside using a submersible robot](image) |
| Examination of the inside using a snake-shaped robot [April 2015] | ![Image of the inside using cosmic ray muon](image) |
| Conducted a preliminary survey in preparation for examination of the inside using robots [October 2015] | ![Image of the inside using cosmic ray muon](image) |
| **Unit 2**                                    |        |      |      |      |      |      |      |      |      |
| Examination of the inside using cosmic ray muon [July 2016] | ![Image of the inside using a submersible robot](image) |
| Examination of the inside using a snake-shaped robot [February 2017] | ![Image of the inside using a submersible robot](image) |
| **Unit 3**                                    |        |      |      |      |      |      |      |      |      |
| Implemented detailed examination of the inside based on the result of the previous examination [March 2017] | ![Image of the inside using a submersible robot](image) |
| Decided the policy for debris retrieval around the operating floor, etc. | ![Image of the inside using a submersible robot](image) |
| **Grasp of the situation in the nuclear reactor container and consideration of the method of debris retrieval** | ![Image of the inside using a submersible robot](image) |
| Engineering work, etc. | ![Image of the inside using a submersible robot](image) |
| Preparation for debris retrieval | ![Image of the inside using a submersible robot](image) |

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Concerning measures for decommissioning, progress was made in activities such as the removal of fuels from the spent fuel pools and the retrieval of fuel debris based on the Mid-and-Long-Term Roadmap.
In order to grasp the internal conditions of the PCV, from March 18\textsuperscript{th} to 22\textsuperscript{nd} 2017, a robot equipped with a dosimeter and underwater camera was remotely inserted into the PCV and an investigation was conducted. According to the analysis so far, it is estimated that fuel debris was distributed to the outside of the pedestal in the basement floor. In this investigation, the dosimeter and the underwater camera were suspended from the first floor, and information inside the PCV was gathered.
The progress of the investigation inside the Unit 2 PCV (Jan. – Feb. 2017)

- To determine the status inside the Unit 2 PCV, a camera and a robot were inserted close to the RPV by remote control from 26th January to 16th February.
- From the results of this investigation, the fallen scaffold below the RPV and the status of deposits were identified directly for the first time. In the PCV, many images were taken. Also, actual measurement of radiation and temperature were implemented. Effort toward the decommissioning of Unit 2 is progressing steadily.
- Through this investigation, there was and will be no effect by the radioactive material to the outside the PCV.

Camera investigation (26th Jan. and 30th Jan. 2017)

Robot investigation (16th Feb. 2017)

The status below RPV were identified for the first time

No massive damage of facilities below PRV

Fallen scaffold

Deposits

Interspace of scaffold

Success of the actual measurement

Radiation dose : Approx. 70 Sievert per hour*

*This radiation dose is inside of the PCV shielded by the thick steel vessel, and concrete. The radiation dose outside of the PCV is approx. 5 to 6 mSv/h. There was and will be no effect of the radioactive material outside the PCV.

Temperature : Approx. 16.5 degrees**

**It is almost the same temperature as that measured by the constantly monitoring thermometer (18.7 degrees). There is no abnormality in the cold shutdown condition.
On January 19, the inside of the Unit 2 PCV was investigated. As a result of it, recording the images were succeeded.

Through the image of the camera, the lower part of the lattice-like scaffold just below the pressure vessel was seen. It was confirmed that part of the fuel assembly dropped to the bottom of the containment vessel, and deposits considered to be fuel debris in the RPV. In addition, the dose tended to be lower inside the pedestal than outside the pedestal.

From now on, detailed analysis and evaluation of data acquired images and dose will be advanced.
In July 2017, the interior of the PCV was investigated using the underwater ROV (remotely operated underwater vehicle) to inspect the inside of the pedestal.

The investigation identified several fallen obstacles and deposits, such as seemingly solidified molten materials and grating, inside the pedestal.
"CR guide pipe" that should be at the lower part of the RPV was at the bottom of the PCV. Therefore, there is a possibility that holes of several tens of centimeters in diameter are opened at the bottom of the RPV.
TEPCO HD were published Solid Waste Storage Management Plan in Mar. 2016. Solid waste storage volume will reach about 750,000 m³ on Mar. 2029 from 350,000 m³ on Mar. 2017. Volume reducing treatment facility, incinerator and waste storage building will developing, and temporary outdoor storage areas will released in FY 2028. Large-scale waste storage building will be developing, and secondary waste from water treatment will be stored in the building.

**Present condition**
Storing status of rubble, etc.
- Rubble (flammable)
- Felled tree
- Used protective clothing

Storing status of rubble (metal, concrete etc.)
- over 1mSv/h
- 0.005 – 1 mSv/h
- under 0.005mSv/h

Contaminated soils

**Plan of waste management (~ FY2028)**

1. Incineration treatment
   - Expansion of Incinerator
   - Pretreatment of Incineration facility
2. Volume reduction treatment
   - Volume reducing treatment facility
3. Reuse and reduce is future task
   - Process method is future task

**Storage management**
- Solid waste storage building (Storage capacity is about 190000 m³)
- Temporary storage building of Contaminated soils
- Temporary storage building of used vessels of water treatment
- Large-scale storage building of used vessels of water treatment
Nuclide composition and concentration of waste are presumed to be diverse. For safe processing and disposal, it is necessary to understand characterization and plan research and development that differ from conventional.

In order to proceed with consideration of treatment and disposal, it is necessary to understand the properties (nuclide composition, radioactivity concentration) and generation amount of waste. However, analytical data are not sufficient (about 300 samples at present).

The construction of a method to understanding the characterization will be needed to proceed by combining analytical data and model-based methods, because data will be clarified after debris removal progress and plan clarification.
The purpose of setting the ninth tower of solid waste storage is to store debris generated in the decommissioning work and radioactive solid waste stored from before the accident, like the first to eighth buildings installed in the premises.

From February 2018, operation of the ninth tower of solid waste building began.

The storage capacity: approx. 61,200m³ (corresponding to 200 ℓ × 110,000 cans)

*Cf: Total amount of the first to the eighth storage capacities are corresponding to 200 ℓ × 284,500 cans*

**Unattended remote forklift**
(It is operated remotely from the seismic isolated building.)
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In the PCVs, cooling is continued by spraying water on the molten and solidified fuel. (①)
In order to prevent the stagnant water in the buildings from flowing to outside, the water level is pumped so that it stays lower than the groundwater level outside the building. This is known as water sealing.
As a result, the groundwater flows into the buildings and mixes with the stagnant water, and new contaminated water is created in the buildings. (②)
Overview of Water Management

Three Basic Principles for Water Management

1. “Isolating” groundwater from the contamination source
   Measures are taken to reduce the generation of contaminated water. (1)(2)(3)(4) of the right figure)

2. “Preventing leakage” of contaminated water
   Measures are taken for preventing leakage of contaminated water to the sea. (5)(6) of the right figure

3. ”Removing” the contamination source
   Measures are taken for removing the radioactive nuclides from the contaminated water in the tanks and in the trenches. (7)(8), etc.)
To stably cool down the fuel debris, circulated cooling water is continuously injected into primary containment vessel.

About 850,000m³
(As of January, 2018)

About 180,000m³
(As of January, 2018)

About 500~550 m³/day
(Completed on May 27, 2015)

* (A) and (B) vary depend on the measures and the precipitation.