Outline of Decommissioning and Contaminated Water Management

Main decommissioning work and steps

Fuel removal from the spent fuel pool was completed in December 2014 at Unit 4 and on February 28, 2021 at Unit 3. Work continues sequentially toward the start of fuel removal from Units 1 and 2 and debris removal from Units 1-3.

(Note 1) Fuel assemblies having melted through in the accident.

Fuel Removal from SFP

Rubble removal etc. Installing fuel removal machine Fuel removal Storage and handling of fuel

Fuel Debris Retrieval

Ascertaining the status inside the PCV/ examining the fuel debris retrieval method, etc.

Dismantling Facilities

Scenario development & technology consideration Design and manufacturing of devices / equipment Dismantling

Measures of treated water

Handling of ALPS treated water

Regarding the discharge of ALPS treated water into the sea, TEPCO must comply with regulatory and other safety standards to safeguard the public, surrounding environment and agricultural, forestry and fishery products. To minimize adverse impacts on reputation, monitoring will be further enhanced and objectivity and transparency ensured by engaging with third-party experts and safety will be checked by the IAEA.

Moreover, accurate information will be disseminated continuously and fully transparently.

Contaminated water management – triple-pronged efforts -

(1) Efforts to promote contaminated water management based on the three basic policies

1) "Remove" the source of water contamination 2) "Redirect" fresh water from contaminated areas 3) "Retain" contaminated water from leakage

- Strontium-reduced water from other equipment is being re-treated in the multi-nuclide removal equipment (ALPS) and stored in welded-joint tanks.
- Multi-layered contaminated water management measures, including land-side impermeable walls and sub-drains, have stabilized the groundwater at a low level and the increased contaminated water generated during rainfall is being suppressed by repairing damaged portions of building roofs, facing onsite, etc. Through these measures, the generation of contaminated water was reduced from approx. 540 m³/day (in May 2014) to approx. 180 m³/day (in FY2019) and approx. 140 m³/day (in 2020).
- Measures continue to further suppress the generation of contaminated water to 100 m³/day or less within 2025.

(2) Efforts to complete stagnant water treatment

- To lower the stagnant water levels in buildings as planned, work to install additional stagnant water transfer equipment is underway. At present, the floor surface exposure condition can be maintained except for the Unit 1-3 Reactor Buildings, Process Main Building and the High Temperature Incinerator Building.
- In 2020, treatment of stagnant water in buildings was completed, except for the Unit 1-3 Reactor Buildings, Process Main Building and High-Temperature Incinerator Building. For Reactor Buildings, the amount of stagnant water there will be reduced to about half of the amount at the end of 2020 during the period FY2022-2024.
- For Zeolite sandbags on the basement floors of the Process Main Building and High-Temperature Incinerator Building, measures to reduce the radiation dose are being examined with stabilization in mind.

(3) Efforts to stably operate contaminated water management

- To prepare for tsunamis, various measures are underway. For heavy rain, sandbags are being installed to suppress direct inflow into buildings while work closing building openings and installing sea walls to enhance drainage channels and other measures are being implemented as planned.
The temperatures of the Reactor Pressure Vessel (RPV) and Primary Containment Vessel (PCV) of Units 1-3 have been maintained within the range of approx. 15-25°C1 over the past month. There was no significant change in the concentration of radioactive materials newly released from Reactor Buildings into the air2. It was concluded that the comprehensive cold shutdown condition had been maintained.

The annual radiation dose from natural radiation is approx. 2.1 mSv/year (average in Japan).

1 The values varied somewhat, depending on the unit and location of the thermometer.
2 In March 2021, the radiation exposure dose due to the release of radioactive materials from the Unit 1-4 Reactor Buildings was evaluated at less than 0.00004 mSv/year at the site boundary. The annual radiation dose from natural radiation is approx. 2.1 mSv/year (average in Japan).
Data of Monitoring Posts (MP1-MP8) measuring the airborne radiation rate around site boundaries showed 0.351 – 1.197 μSv/h (April 26 – May 25, 2021). We improved the measurement conditions of monitoring posts 2 to 8 to measure the air-dose rate precisely. Construction work, such as tree-clearing, surface soil removal and shield wall setting, were implemented from February 10 to April 18, 2012. Therefore, monitoring results at these points are lower than elsewhere in the power plant site.

The radiation shielding panels around monitoring post No. 6, which is one of the instruments used to measure the radiation dose at the power station site boundary, were taken off from July 10 - 11, 2013, since further deforestation, etc., had caused the surrounding radiation dose to decline significantly.

An anorak for a full-face mask introduced as part of countermeasures to prevent intake

A radiation shielding panel around monitoring post No. 6, which is one of the instruments used to measure the radiation dose at the power station site boundary, was taken off from July 10 - 11, 2013, since further deforestation, etc., had caused the surrounding radiation dose to decline significantly.
I. Confirmation of the reactor conditions

Temperatures inside the reactors

Through continuous reactor cooling by water injection, the temperatures of the Reactor Pressure Vessel (RPV) bottom and the Primary Containment Vessel (PCV) gas phase were maintained within the range of approx. 15 to 25°C for the past month, though it varied depending on the unit and location of the thermometer.

Release of radioactive materials from the Reactor Buildings

As of April 2021, the concentration of radioactive materials newly released from Reactor Building Units 1-4 into the air and measured at the site boundary was evaluated at approx. 2.0 x 10^-12 Bq/cm^2 and 1.8 x 10^-12 Bq/cm^2 for Cs-134 and -137 respectively, while the radiation exposure dose due to the release of radioactive materials there was less than 0.00004 mSv/year.

Annual radiation dose at site boundaries by radioactive materials (cesium) released from Reactor Building Units 1-4

Status of contaminated water generated

- Multi-layered measures, including pumping up by sub-drains and land-side impermeable walls, which were implemented to control the continued generation of contaminated water, suppressed the groundwater inflow into buildings.
- After implementing "redirecting" measures (groundwater bypass, sub-drains, land-side impermeable walls and others) and rainwater prevention measures, including repairing damaged parts of building roofs, the amount of contaminated water generated within 2020 declined to approx. 140 m^3/day.
- Measures will continue to further reduce the amount of contaminated water generated.

Operation of the groundwater bypass

- From April 9, 2014, the operation of 12 groundwater bypass pumping wells commenced sequentially to pump up groundwater. The release then started from May 21, 2014, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until May 25, 2021, 640,000 m^3 of groundwater had been released. The pumped-up groundwater was temporarily stored in tanks and released after TEPCO and a third-party organization confirmed that its quality met operational targets.
- Pumps are inspected and cleaned as required based on their operational status.

Operation of the Water-Treatment Facility special for Sub-drain & Groundwater drains

- To reduce the level of groundwater flowing into the buildings, work began to pump up groundwater from wells (sub-drains) around the buildings on September 3, 2015. The pumped-up groundwater was then purified at dedicated facilities and released from September 14, 2015, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until May 25, 2021, a total of 1,085,000 m^3 had been drained after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Due to the level of the groundwater drain pond rising after the sea-side impermeable walls had been closed, pumping started on November 5, 2015. Up until May 25, 2021, a total of approx. 263,000 m^3 had been pumped up and a volume of under 10 m^3/day is being transferred from the groundwater drain to the Turbine Buildings (average for the period April 22 – May 19, 2021).
- As one of the multi-layered contaminated-water management measures, in addition to a waterproof pavement that
aims to prevent rainwater infiltrating, facilities to enhance the sub-drain treatment system were installed and went into operation from April 2018, increasing the treatment capacity from 900 to 1,500 m³/day and improving reliability. Operational efficiency was also improved to treat up to 2,000 m³/day for almost a week during the peak period.

- To maintain the groundwater level, work to install additional sub-drain pits and recover existing pits is underway. The additional pits are scheduled to start operation sequentially, from pits for which work is completed (12 of 14 new sub-drain pits went into operation). To recover existing pits, work for all three pits scheduled was completed, all of which went into operation from December 26, 2018. Work to recover another pit (No. 49) started from November 2019 and it went into operation from October 9, 2020.

- To eliminate the need to suspend water pumping while cleaning the sub-drain transfer pipe, the pipe will be duplicated. Installation of the pipe and ancillary facilities was completed.

- Since the sub-drains went into operation, the inflow to buildings tended to decline to under 150 m³/day when the sub-drain water level declined below T.P. 3.0 m but increased during rainfall.

![Correlation between inflow such as groundwater and rainwater into buildings and the water level of Units 1-4 sub-drains](image)

**Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Units 1-4 sub-drains**

- **Implementation status of facing**
  - Facing is a measure involving asphalting of the on-site surface to reduce the radiation dose, prevent rainwater infiltrating the ground and decrease the amount of underground water flowing into buildings. As of the end of April 2021, 95% of the planned area (1,450,000 m² on site) had been completed. For the area inside the land-side impermeable walls, implementation proceeds appropriately after constructing a yard from implementable zones that do not affect the decommissioning work. As of the end of April 2021, 25% of the planned area (60,000 m²) had been completed.

- **Construction status of the land-side impermeable walls and status of groundwater levels around the buildings**
  - An operation to maintain the land-side impermeable walls and prevent the frozen soil from thickening further continued from May 2017 on the north and south sides and started from November 2017 on the east side, where sufficiently thick frozen soil was identified. The scope of the maintenance operation was expanded in March 2018.
  - In March 2018, construction of the land-side impermeable walls was completed, except for a portion of the depth, based on a monitoring result showing that the underground temperature had declined below 0°C in almost all areas, while on the mountain side, the difference in internal and external water levels increased to approx. 4.5 m. The 21st Committee on Countermeasures for Contaminated-Water Treatment, held on March 7, 2018, evaluated that alongside the function of sub-drains and other measures, a water-level management system to stably control groundwater and redirect groundwater from the buildings had been established and allowed the amount of contaminated water generated to be reduced significantly.
  - A supplementary method was implemented for the unfrozen depth and it was confirmed that the temperature of this portion had declined below 0°C by September 2018. From February 2019, a maintenance operation started throughout all sections.
  - The groundwater level in the area inside the land-side impermeable walls has been declining every year. On the mountain side, the difference between the inside and outside was maintained, despite varying during rainfall. The water level of the groundwater drain observation well has been maintained at approx. T.P. +1.5 m, sufficiently below the ground surface (T.P. 2.5 m).

![Operation of multi-nuclide removal equipment](image)

**Figure 3: Closure parts of the land-side impermeable walls (on the mountain side)**

- **Operation of multi-nuclide removal equipment**
  - Regarding the multi-nuclide removal equipment (existing and high-performance), hot tests using radioactive water are underway (for existing equipment, System A: from March 30, 2013, System B: from June 13, 2013, System C: from September 27, 2013; and for high-performance equipment, from October 18, 2014). The additional multi-nuclide removal equipment went into full-scale operation from October 16, 2017.
  - As of May 20, 2021, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 468,000, 703,000 and 103,000 m³, respectively (including approx. 9,500 m³ stored in the J1(D) tank, which contained water with highly concentrated radioactive materials at the System B outlet of the existing multi-nuclide removal equipment).
  - To reduce the risks of strontium-reduced water, treatment using existing, additional and high-performance multi-nuclide removal equipment has been underway (existing: from December 4, 2015; additional: from May 27, 2015; high-performance: from April 15, 2015). Up until May 20, 2021, approx. 795,000 m³ had been treated.

- **Toward reducing the risk of contaminated water stored in tanks**
  - Treatment measures comprising the removal of strontium by cesium-adsorption apparatus (KURION) (from January 6, 2015), the secondary cesium-adsorption apparatus (SARRY) (from December 26, 2014) and the third cesium-adsorption apparatus (SARRY II) (from July 12, 2019) are underway. Up until May 20, 2021, approx. 637,000 m³ had been treated.

- **Measures in the Tank Area**
  - Rainwater accumulates and is collected inside the area of contaminated-water tanks. After removing radionuclides, the rainwater is sprinkled over the site grounds, if the radioactivity level does not meet the standard for discharging into the environment since May 21, 2014 (as of May 24, 2021, a total of 179,000 m³).
Work to help remove spent fuel from the pool is progressing steadily while ensuring seismic capacity and safety.

- **Main work to help spent fuel removal at Unit 1**
  - After examining two methods: (i) installing a cover after rubble removal and (ii) initially installing a large cover over the Reactor Building and then removing rubble inside the cover, method (ii) was selected to ensure safer and more secure removal.
  - Before removing the fallen roof and other objects on the south side, to minimize the risk of the overhead crane/fuel-handling machine shifting its position, becoming imbalanced and subsequently falling, installation of materials to support the fuel-handling machine from below was planned.
  - Among the measures to prevent and alleviate rubble falling, work to install supports for the Unit 1 fuel-handling machine started from October 6, 2020 and was completed by October 23.
  - To install the support for the overhead crane, preparation started from October 2020 and the work was completed on November 24.
  - From December 19, 2020, before installing a large cover over the Unit 1 Reactor Building, dismantling of the interfering building cover (remaining part) started. The dismantling will be completed in June 2021 and work to install a large cover will start from the first half of FY2021.
  - Rubble removal and other work will proceed steadily with safety first, toward starting fuel removal during the period FY2027 to FY2028.

- **Main work to help spent fuel removal at Unit 2**
  - After completing the training to practice work skills for transportation, preparatory work inside the operating floor started from July 20, 2020. Containers housing the remaining objects during the previous work were transported to the solid waste storage facility from August 26, which was completed by December 11.
  - For fuel removal methods, based on the investigative results inside the operating floor from November 2018 to February 2019, a method to access from a small opening installed on the south side of the building was selected with aspects such as dust management and lower work exposure in mind (the method previously examined had involved fully dismantling the upper part of the building).

**Completion of fuel removal at Unit 3**
- On October 11, 2013, removal of large rubble on the top floor of the Reactor Building was completed.
- On November 21, 2015, removal of large rubble inside the spent fuel pool using a crawler crane was completed.
- On June 10, 2016, decontamination on the top floor of the Reactor Building was completed. On December 2, installation of shielding on the top floor of the Reactor Building was completed.
- On January 17, 2017, installation of a cover for fuel removal started. On November 12, a fuel-handling machine was installed inside the cover.
- On February 23, 2018, installation of a cover for fuel removal was completed.
- On April 15, 2019, fuel removal started.
- On February 28, 2021, fuel removal was completed.

**Retrieval of fuel debris**
- **Progress status of preparation for the investigation inside the Unit 2 PCV and trial retrieval**
  - Regarding the robot arm, which is being developed in the UK, operation tests and confirmation of combination with the enclosure are underway.
  - After this process, the equipment will be transported to Japan and undergo performance verification tests and others.
  - The transportation time will be carefully examined by taking the infection status of COVID-19 into consideration.
  - At the same time, onsite preparation work such as installation of the spray tool will be implemented, taking the development status and the progress of work preparation into consideration.

**Plans to store, process and dispose of solid waste and decommission of reactor facilities**
- **Management status of the rubble and trimmed trees**
  - As of the end of April 2021, the total storage volume for concrete and metal rubble was approx. 311,000 m³ (+100 m³ compared to at the end of March with an area-occupation rate of 77%). The total storage volume of trimmed trees was approx. 134,700 m³ (+200 m³, with an area-occupation rate of 77%). The total storage volume of used protective clothing was approx. 32,800 m³ (+600 m³, with an area-occupation rate of 48%). The increase in rubble was mainly attributable to work around the Unit 1-4 buildings, while the increase in used protective clothing was attributable to the suspension of incinerator operation.
  - **Management status of secondary waste from water treatment**
  - As of May 6, 2021, the total storage volume of waste sludge was 425 m³ (area-occupation rate: 61%), while that of concentrated waste fluid was 9,968 m³ (area-occupation rate: 91%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment and other vessels, was 5,118 (area-occupation rate: 80%).

**Reduction in radiation dose and mitigation of contamination**
- **Effective dose-reduction at site boundaries and purification of port water to mitigate the impact of radiation on the external environment**
  - **Status of groundwater and seawater on the east side of Turbine Building Units 1-4**
    - In the Unit 1 intake north side area, the H-3 concentration was below the legal discharge limit of 60,000 Bq/l at all observation holes and remained constant or has been declining overall. The concentration of total-β radioactive materials increased temporarily from April 2020. It has been increasing or declining at No. 0-3-2 but currently remains...
Based on these factors, the Regulation Concerning Security of Reactor Facilities and Protection of Specific Nuclear Fuel Materials of TEPCO Fukushima Daiichi Nuclear Power Station, Article 18 No. 10 “When nuclear fuel materials and others leak out of the controlled area” was deemed applicable to this event.

In terms of evaluating released radioactivity, the average drainage concentration during the past quarter (January 1 – March 31, 2021) was evaluated using PSF monitoring values, sampling measurement values and the flow rate in the drainage channel. As Sr-90 of 25 Bq/L was below the legal discharge limit of 30 Bq/L during normal operation and the radioactivity concentration in seawater inside the port was within the normal range of variation, there was not considered to be any impact on the environment.

- The conservatively estimated radioactivity released into the port during the same period was 1.6 billion Bq in Sr-90 (estimated total-β radioactivity released from the Shallow Draft Quay drainage channel during 1st quarter of 2020 (Jan 1-Mar 31, 2020) was 2.3 billion Bq including cesium fallout).

- As countermeasures, (1) contamination was removed from the leak part, (2) radioactivity monitoring was enhanced in the Shallow Draft Quay drainage channel and (3) inspection to detect any leakage of radioactivity materials from rubble storage containers was reinforced.
For 2021, the number of workers from within Fukushima Prefecture remained constant while the number of workers from outside decreased. The local employment ratio (cooperating company workers and TEPCO HD employees) as of April 2021 also remained constant at around 65%.

The monthly average exposure doses of workers remained at approx. 0.20, 0.21 and 0.22 mSv/month during FY2018, 2019 and 2020, respectively. *Provisional values for FY2020*

For most workers, the exposure dose was sufficiently within the limit and allowed them to continue engaging in radiation work.

Status of influenza and norovirus cases (conclusion of infection and expansion-preventive measures)

- As there have been no further cases of influenza and norovirus infections since December 2020, measures to prevent infection and expansion were concluded at the end of April 2021. During this season (2020-2021), there were one influenza infection and one norovirus infections, while the totals for the entire previous season (2019-2020) showed 170 influenza infections and ten norovirus infections, respectively.

Note: The above data is based on reports from TEPCO HD and cooperating companies, which include diagnoses at medical clinics outside the site. The subjects of this report were cooperating company workers and TEPCO HD employees in Fukushima Daiichi and Daini Nuclear Power Stations.

*The number declined by 169 for influenza cases and nine for norovirus cases compared to the previous season.

*The number of influenza cases was unprecedentedly low, even nationwide, which is considered attributable to the continued effectiveness of countermeasures to prevent COVID-19 infection. The number of norovirus cases also remained low and no outbreak was confirmed, nor any case of food poisoning. These results demonstrate the effectiveness of measures to prevent infection and expansion.

Countermeasures to prevent COVID-19 infections continue. As their basic measure items are common, there have been no further cases of influenza and norovirus infections since December 2020. However, countermeasures will continue if any infection at the workplace emerges.

Status of heat stroke cases

- In FY2021, measures to further prevent heat stroke commenced from April to cope with the hottest season.
- In FY2021, one worker suffered heat stroke due to work up until May 24 (in FY2020, one worker up until the end of May). Continued measures will be taken to prevent heat stroke.
Status of seawater monitoring within the port (comparison between the highest values in 2013 and the latest values)

“The highest value” → “the latest value (sampled during May 19-24)”; unit (Bq/L); ND represents a value below the detection limit.

Summary of TEPCO data as of May 25, 2021

Note: The Total $\beta$ measurement values include natural potassium 40 (approx. 12 Bq/L). They also include the contribution of yttrium 90, which radioactively balance strontium 90.

Cesium-134 : 3.3 (H25/10/17) → ND(0.26) Below 1/10
Cesium-137 : 9 (H25/10/17) → 1.2 Below 1/7
Total $\beta$ : 60 (H25/7/14) → ND(13) Below 1/5
Toritium : 59 (H25/8/19) → ND(1.8) Below 1/30

Cesium-134 : 3.5 (H25/10/17) → ND(0.27) Below 1/10
Cesium-137 : 7.8 (H25/10/17) → 1.0 Below 1/7
Total $\beta$ : 79 (H25/8/19) → 14 Below 1/5
Toritium : 60 (H25/8/19) → ND(1.8) Below 1/30

Cesium-134 : 4.4 (H25/12/24) → ND(0.31) Below 1/10
Cesium-137 : 10 (H25/12/24) → 1.2 Below 1/8
Total $\beta$ : 60 (H25/7/4) → ND(13) Below 1/5
Toritium : 59 (H25/8/19) → ND(1.8) Below 1/30

Cesium-134 : 5 (H25/12/2) → ND(0.26) Below 1/10
Cesium-137 : 8.4 (H25/12/2) → 1.5 Below 1/5
Total $\beta$ : 69 (H25/8/19) → ND(13) Below 1/5
Toritium : 52 (H25/8/19) → ND(1.8) Below 1/20

Cesium-134 : 5.3 (H25/8/5) → ND(0.45) Below 1/10
Cesium-137 : 6.8 (H25/8/5) → 0.56 Below 1/10
Total $\beta$ : 40 (H25/7/3) → 20 Below 1/2
Toritium : 340 (H25/6/26) → ND(1.6) Below 1/200

Source: TEPCO website Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station http://www.tepco.co.jp/decommission/plannaction/monitoring/index-3.html
### Status of seawater monitoring around outside of the port
(comparison between the highest values in 2013 and the latest values)

Unit (Bq/L); ND represents a value below the detection limit; values in ( ) represent the detection limit; ND (2013) represents ND throughout 2013 (The latest values sampled during May 19-24)

Summary of TEPCO data as of May 25, 2021

#### Legal discharge limit

<table>
<thead>
<tr>
<th>Nuclide</th>
<th>Legal discharge limit</th>
</tr>
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<tr>
<td>Cesium-134</td>
<td>60</td>
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<tr>
<td>Cesium-137</td>
<td>90</td>
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<tr>
<td>Strontium-90</td>
<td>30</td>
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<tr>
<td>Tritium</td>
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</tbody>
</table>

#### WHO Guidelines for Drinking Water Quality

| Cesium-134 | 60 |
| Cesium-137 | 90 |
| Strontium-90 | 30 |

| Cesium-134 | 60 |
| Cesium-137 | 90 |
| Strontium-90 | 30 |

#### Status of seawater monitoring around outside of the port
(Southeast side of port entrance (offshore 1 km))

- Cesium-134: ND (H25) → ND(0.81)
- Cesium-137: ND (H25) → ND(0.65)
- Total β: ND (H25) → 17
- Torotium: ND (H25) → ND(0.92)

#### Status of seawater monitoring around outside of the port
(Northeast side of port entrance (offshore 1 km))

- Cesium-134: ND (H25) → ND(0.76)
- Cesium-137: ND (H25) → ND(0.52)
- Total β: ND (H25) → 12
- Torotium: 4.7 (H25/8/18) → ND(0.92) Below 1/5

#### Status of seawater monitoring around outside of the port
(North side of north breakwater (offshore 0.5 km))

- Cesium-134: 1.8 (H25/6/21) → ND(0.61) Below 1/2
- Cesium-137: 4.5 (H25/3/17) → ND(0.74) Below 1/6
- Total β: 12 (H25/12/23) → 8.5
- Torotium: 8.6 (H25/6/26) → ND(0.98) Below 1/8

#### Status of seawater monitoring around outside of the port
(North side of Unit 5 and 6 release outlet)

- Cesium-134: 1.8 (H25/6/21) → ND(0.61) Below 1/2
- Cesium-137: 4.5 (H25/3/17) → ND(0.74) Below 1/6
- Total β: 12 (H25/12/23) → 8.5
- Torotium: 8.6 (H25/6/26) → ND(0.98) Below 1/8

#### Status of seawater monitoring around outside of the port
(Port entrance)

- Cesium-134: ND (H25) → ND(0.76)
- Cesium-137: ND (H25) → ND(0.52)
- Total β: ND (H25) → 14
- Torotium: 6.4 (H25/10/18) → ND(0.92) Below 1/6

#### Status of seawater monitoring around outside of the port
(South side of south breakwater (offshore 0.5 km))

- Cesium-134: 3.3 (H25/12/24) → ND(0.35) Below 1/9
- Cesium-137: 7.3 (H25/10/11) → ND(0.47) Below 1/10
- Total β: 68 (H25/8/19) → 14 Below 1/4
- Torotium: 68 (H25/8/19) → ND(1.6) Below 1/40

#### Status of seawater monitoring around outside of the port
(Near south release outlet)

- Cesium-134: ND (H25) → ND(0.69)
- Cesium-137: ND (H25) → ND(0.70)
- Total β: ND (H25) → 15
- Torotium: ND (H25) → ND(0.91)

#### Status of seawater monitoring around outside of the port
(South side of south breakwater (offshore 0.5 km))

- Cesium-134: 3 (H25/7/15) → ND(0.68) Below 1/4
- Total β: 15 (H25/12/23) → 11
- Torotium: 1.9 (H25/11/25) → ND(0.98)

Note: Because safety of the sampling points was unassured due to the influence of Typhoon No. 10 in 2016, samples were taken from approx. 330 m south of the Unit 1-4 release outlet. Samples were also taken from a point approx. 280m south from the same release outlet from January 27, 2017 and approx. 320m from March 23, 2018.

Source: TEPCO website, Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station http://www.tepco.co.jp/decommision/planaction/monitoring/index-j.html

#### Note

- The Total β measurement values include natural potassium 40 (approx. 12 Bq/L).
- They also include the contribution of yttrium 90, which radioactively balance strontium 90.
Progress toward decommissioning: Fuel removal from the spent fuel pool (SFP)

Unit 1
Toward fuel removal from the Unit 1 spent fuel pool, investigations have been implemented to ascertain the conditions of the fallen roof on the south side and the contamination of the well plug. Based on the results of these investigations, "the method to initially install a large cover over the Reactor Building and then remove rubble inside the cover" was selected to ensure a safer and more secure removal. Work to install a large cover will start from the first half of FY2021. Work continues to complete installation of a large cover by around FY2023 and start fuel removal from FY2027 to FY2028.

<Reference> Progress to date
Rubble removal on the north side of the operating floor started from January 2018 and has been implemented sequentially. In July and August 2019, the well plug, which was misaligned from its normal position, was investigated and in August and September, the conditions of the overhead crane were checked. Based on the results of these investigations, as the removal requires more careful work taking dust scattering into consideration, two methods were examined: installing a cover after rubble removal and initially installing a large cover over the Reactor Building and then removing rubble inside the cover.

<Reference> Operation: During regular inspection, the roof over the reactor is opened while on the operating floor, fuel inside the core is replaced and the core internals are inspected.

Unit 2
Toward fuel removal from the Unit 2 spent fuel pool, based on findings from internal operating floor investigations from November 2018 to February 2019, instead of fully dismantling the upper part of the building, the decision was made to install a small opening on the south side and use a boom crane. Examination continues to start fuel removal from FY2024 to FY2026.

<Reference> Progress to date
Previously, potential to recover the existing overhead crane and the fuel handling machine was examined. However, the high radiation dose inside the operating floor meant the decision was taken to dismantle the upper part of the building in November 2015. Findings from internal investigations of the operating floor from November 2018 to February 2019 underlined the potential to conduct limited work there and the means of accessing from the south side had been examined.

Unit 3
Prior to the installation of a cover for fuel removal, removal of large rubble from the spent fuel pool was completed in November 2015. To ensure safe and steady fuel removal, training of remote control was conducted at the factory using the actual fuel handling machine which will be installed on site (February – December 2015). Measures to reduce dose on the Reactor Building top floor (decontamination, shields) were completed in December 2016. Installation of a cover for fuel removal and a fuel-handling machine is underway from January 2017. Installation of the fuel removal cover was completed on February 23, 2018. Toward fuel removal, the rubble retrieval training inside the pool, which was scheduled in conjunction with fuel removal training, started from March 15, 2019, and started fuel removal from April 15, 2019. Fuel removal was completed on February 28, 2021.

Unit 4
In the Mid- and Long-Term Roadmap, the target of Phase 1 involving commencing fuel removal from inside the spent fuel pool (SFP) of the 1st Unit within two years of completion of Step 2 (by December 2013). On November 18, 2013, fuel removal from Unit 4, or the 1st Unit, commenced and Phase 2 of the roadmap started.

On November 5, 2014, within a year of commencing work to fuel removal, all 1,331 spent fuel assemblies in the pool had been transferred. The transfer of the remaining non-irradiated fuel assemblies to the Unit 6 SFP was completed in December 22, 2014. (2 of the non-irradiated fuel assemblies were removed in advance in July 2012 for fuel checks)
This marks the completion of fuel removal from the Unit 4 Reactor Building.

<Reference> Operating floor: During regular inspection, the roof over the reactor is opened while on the operating floor, fuel inside the core is replaced and the core internals are inspected.

"Cask": Transportation container for samples

(*2) Cask: Transportation container for samples

**Reference**
- May 27, 2021
- Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

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Progress toward decommissioning: Works to identify the plant status and toward fuel debris retrieval

Investigation into TIP Room of the Unit 1 Reactor Building

- To improve the environment for future investigations inside the PCV, etc., an investigation was conducted from September 24 to October 2, 2015 at the TIP Room. (Due to high dose around the entrance to the TIP Room, the investigation of dose rate and contamination distribution was conducted through a hole drilled from the walkway of the Turbine Building, where the dose was low)
- The investigative results identified high dose at X-31 to 33 penetrations (instrumentation penetration) and low dose at other parts.
- As it was confirmed that work inside the TIP room would be available, the next step will include identification of obstacles which will interfere the work inside the TIP Room and formulation of a plan for dose reduction.

Unit 1

Investigation in the leak point detected in the upper part of the Unit 1 Suppression Chamber (S/C(3))

Investigation in the leak point detected in the upper part of Unit 1 S/C from May 27, 2014 from one expansion joint cover among the lines installed there. As no leakage was identified from other parts, specific methods will be examined to halt the flow of water and repair the PCV.

Status of investigation inside the PCV

Prior to fuel debris retrieval, an investigation inside the PCV will be conducted to inspect the status there including the location of fuel debris.

[Investigative outline]
- In April 2015, a device, which entered the inside of the PCV through a narrow access opening (bore: φ100 mm), collected information such as images and airborne dose inside the PCV 1st floor.
- In March 2017, the investigation using a self-propelled investigation device, conducted to inspect the spreading of debris to the basement floor outside the pedestal, took images of the PCV bottom status for the first time. The status inside the PCV will continue to be examined based on the collected image and dose data.

Capturing the location of fuel debris inside the reactor by measurement using muons

Investigations inside PCV

<table>
<thead>
<tr>
<th>Period</th>
<th>Evaluation results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb - May 2015</td>
<td>Confirmed that there was no large fuel in the reactor core.</td>
</tr>
</tbody>
</table>

<Image of investigation inside the PCV>

<Image of hanging of dosimeter and camera>

<Image of image near the bottom>

*Indices related to the plant are values as of 11:00, May 26, 2021*

**Investigations inside PCV**
- 1st (Oct 2012): Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling stagnant water - Installing permanent monitoring instrumentation
- 2nd (Apr 2015): Confirming the status of PCV 1st floor
- 3rd (Mar 2017): Confirming the status of PCV 1st basement floor
- Leakage points from PCV:
  - PCV vent pipe vacuum break line bellows (identified in May 2014)
  - Sand cushion drain line (identified in November 2013)

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Progress toward decommissioning: Works to identify the plant status and toward fuel debris retrieval

May 27, 2021
Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

Installation of an RPV thermometer and permanent PCV supervisory instrumentation

(1) Replacement of the RPV thermometer
- As the thermometer installed at the Unit 2 RPV bottom after the earthquake had broken in February 2014, it was excluded from the monitoring thermometers.
- In April 2014, removal of the broken thermometer failed and was suspended. Rust-striping chemicals were injected and the broken thermometer was removed in January 2015. A new thermometer was reinstalled in March. The thermometer has been used as a part of permanent supervisory instrumentation since April.

(2) Reinstallation of the PCV thermometer and water-level gauge
- Some of the permanent supervisory instrumentation for PCV could not be installed in the planned locations due to interference with existing grating (August 2013). The instrumentation was removed in May 2014 and new instruments were reinstalled in June 2014. The trend of added instrumentation will be monitored for approx. one month to evaluate its validity.
- The measurement during the installation confirmed that the water level inside the PCV was approx. 300mm from the bottom.

Investigative results on torus chamber walls

- July 2014, the torus chamber walls were investigated (on the north and the east-side walls) using equipment specially developed for that purpose (a swimming robot and a floor traveling robot).
- At the east-side wall pipe penetrations (five points), "the status" and "existence of flow" were checked.
- A demonstration using the above two types of underwater wall investigative equipment showed how the equipment could check the status of penetration.
- Regarding Penetrations [1-5], the results of checking the sprayed tracer [5] by camera showed no flow around the penetrations. (investigation by the swimming robot)
- Regarding Penetration 3, a sonar check showed no flow around the penetrations. (investigation by the floor traveling robot)

Status of investigation inside the PCV

Prior to fuel debris retrieval, an investigation inside the PCV will be conducted to inspect the status there including the location of fuel debris. [Investigative outline]

- Investigative devices such as a robot will be injected from Unit 2 X-6 penetration[5] and access the inside of the pedestal using the CRD rail.

[Progress status]
- On January 26 and 30, 2017, a camera was inserted from the PCV penetration to inspect the status of the CRD replacement rail on which the robot will travel. On February 9, deposit on the access route of the self-propelled investigative device was removed and on February 16, the inside of the PCV was investigated using the device.
- The results of this series of investigations confirmed fallen and deformed gratings and a quantity of deposit inside the pedestal.
- On January 19, 2018, the status below the platform inside the pedestal was investigated using an investigative device with a hanging mechanism. From the analytical results of images obtained in the investigation, deposits probably including fuel debris were found at the bottom of the pedestal. In addition, multiple parts higher than the surrounding deposits were also detected. We presumed that there were multiple routes of fuel debris falling. Obtained data were processed in panoramic image visualization to acquire clearer images.
- On February 13, 2019, an investigation touching the deposits at the bottom of the pedestal and on the platform was conducted and confirmed that the pebble-shaped deposits, etc. could be moved and that hard rock-like deposits that could not be gripped may exist.
- In addition, images, etc. would help determine the contour and size of the deposits could be collected by moving the investigative device from the bottom of the pedestal and on the platform.
- On October 28, 2020, as a preparatory stage of the PCV internal investigation and the trial retrieval, a contact investigation into deposits inside the penetration (X-6 penetration) was conducted. In this investigation, a guide pipe incorporating an investigative unit was inserted into the penetration. By the contact, it was confirmed that deposits inside the penetration did not deform and stuck.
- On October 30, 2020, a 3D scan investigation was conducted, measuring deposits by the 3D scan sensor mounted on the top of the investigative unit. Information obtained in the investigation will be utilized in the mockup test of the equipment to remove deposits inside the X-6 penetration.

Capturing the location of fuel debris inside the reactor by measurement using muons

- Confirming the existence of high-density materials, which was considered as fuel debris, at the bottom of RPV, and in the outer part of the RPV bottom. It was assumed that a large part of fuel debris existed at the bottom of RPV.

Investigations inside PCV

<table>
<thead>
<tr>
<th>Period</th>
<th>Evaluation results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar.– Jul. 2016</td>
<td>Confirmed the existence of high-density materials, which was considered as fuel debris, at the bottom of RPV, and in the outer part of the RPV bottom. It was assumed that a large part of fuel debris existed at the bottom of RPV.</td>
</tr>
</tbody>
</table>

[1] Penetration: Through-hole of the CRD
[2] SFP (Secondary Feed Pipe)
[3] RPV (Reactor Pressure Vessel)
[4] Track: Tracer used to trace the fluid flow. Clay particles

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Progress toward decommissioning: Works to identify the plant status and toward fuel debris retrieval

**Immediate target**
Identify the plant status and commence R&D and decontamination toward fuel debris retrieval

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Water flow was detected from the Main Steam Isolation Valve* room
On January 18, 2014, a flow of water from around the door of the Steam Isolation Valve room in the Reactor Building Unit 3 1st floor northeast area to the nearby floor drain funnel (drain outlet) was detected. As the drain outlet connects with the undergarment part of the Reactor Building, there is no possibility of outflow from the building.

From April 23, 2014, image data has been acquired by camera and the radiation dose measured via pipes for measurement instrumentation, which connect the air-conditioning room on the Reactor Building 2nd floor with the Main Steam Isolation Valve Room on the 1st floor. On May 15, 2014, water flow from the expansion joint of one Main Steam Line was detected. This is the first leak from PCV detected in the Unit 3. Based on the images collected in this investigation, the leak volume will be estimated and the need for additional investigations will be examined. The investigative results will also be utilized to examine water stoppage and PCV repair methods.

* Main Steam Isolation Valve: A valve to shut off the steam generated from the Reactor in an emergency

### Unit 3

**Investigations inside PCV**

<table>
<thead>
<tr>
<th>Period</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd (Jul 2017)</td>
<td>- Acquiring images - Installing permanent monitoring instrumentation (August 2017)</td>
</tr>
</tbody>
</table>

**Leakage points from PCV**

- Main steam pipe bellows (identified in May 2014)

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**Investigative results into the Unit 3 PCV equipment hatch using a small investigation device**

- As part of the investigation into the PCV to facilitate fuel debris retrieval, the status around the Unit 3 PCV equipment hatch was investigated using a small self-traveling investigation device on November 26, 2015.

- Given blots such as rust identified below the water level inside the PCV, there may be a leakage from the seal to the extent of bleeding.

Methods to investigate and repair the parts, including other PCV penetrations with a similar structure, will be considered.

**Investigation inside the PCV**

Prior to fuel debris retrieval, the inside of the Primary Containment Vessel (PCV) was investigated to identify the status there including the location of the fuel debris.

**Investigative outline**

- The status of X-53 penetration*(*1), which may be under the water and which is scheduled for use to investigate the inside of the PCV, was investigated using remote-controlled ultrasonic test equipment. The results showed that the penetration was not under the water (October 22-24, 2014).

- For the purpose of confirming the status inside the PCV, an investigation device was inserted into the PCV from X-53 penetration on October 20 and 22, 2015 to obtain images, data of dose and temperature and sample stagnant water. No damage was identified on the structure and walls inside the PCV and the water level was almost identical with the estimated value. In addition, the dose inside the PCV was confirmed to be lower than in other Units.

- In July 2017, the inside of the PCV was investigated using the underwater ROV (remotely operated underwater vehicle) to inspect the inside of the pedestal.

- Analysis of image data obtained in the investigation identified damage to multiple structures and the supposed core internals. Consideration about fuel removal based on the obtained information will continue.

- Videos obtained in the investigation were reproduced in 3D. Based on the reproduced images, the relative positions of the structures, such as the rotating platform slipping off the rail with a portion buried in deposits, were visually understood.

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**Capturing the location of fuel debris inside the reactor by measurement using muons**

<table>
<thead>
<tr>
<th>Period</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>May – Sep 2017</td>
<td>The evaluation confirmed that no large lump existed in the core area where fuel had been placed and that part of the fuel debris potentially existed at the bottom of the RPV.</td>
</tr>
</tbody>
</table>

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**Glossary**

* SFP (Spent Fuel Pool)  
* RPV (Reactor Pressure Vessel)  
* PCV (Primary Containment Vessel)  
* Penetration: Through-hold of the PCV
Work to improve the reliability of the circulation water injection cooling system and pipes to transfer stagnant water.

- Operation of the reactor water injection system using Unit 3 Condensate Storage Tank (CST) as a water source commenced (from July 5, 2013). Compared to the previous systems, the reliability of the equipment, pumping system was enhanced, e.g. by increasing the amount of water-source storage and enhancing durability.
- To reduce the risk of contaminated water leakage, the circulation loop was shortened by installing a reverse osmosis (RO) device in the Unit 4 Turbine Building within the circulation loop, comprising the transfer of contaminated water, water treatment and injection into the reactor. Operation of the installed RO device started from October 7 and 24-hour operation started from October 20. Installation of the new RO device inside the building shortened the circulation loop from approx. 3 to 0.8 km.
- To accelerate efforts to reduce the radiation density in stagnant water inside the buildings, circulating purification of stagnant water inside the buildings started on the Unit 3 and 4 side on February 22 and on the Unit 1 and 2 side on April 11.
- For circulating purification, a new pipe (stagnant water purification line) divided from the water treatment equipment outlet line was installed to transfer water purified at the water treatment plant to the Unit 1 Reactor Building and the Unit 2 Turbine Buildings.
- The risks of stagnant water inside the buildings will continue to be reduced in addition to reduction of its storage.

Progress status of dismantling of flange tanks

- To facilitate replacement of flanged tanks, dismantling of flanged tanks started in H1 east-H2 areas in May of 2015. Dismantling of all flanged tanks was completed in H1 east area (12 tanks) in October 2015, in H2 area (28 tanks) in March 2016, in H3 area (66 tanks) in May 2017, in H3 B area (31 tanks) in September 2017, in H5 and H5 north area (38 tanks) in June 2018, in H6 and H6 north area (24 tanks) in September 2018 and Q4 south area (17 tanks) in March 2019.

Preventing groundwater from flowing into the Reactor Buildings

Reducing groundwater inflow by pumping sub-drain water

To reduce the inflow of groundwater flowing from the mountain side upstream of the Building to the groundwater inflow (groundwater bypass) has been implemented.

Via a groundwater bypass, reduce the groundwater level around the Building and groundwater inflow into the Building

Measures to pump up groundwater flowing from the mountain side upstream of the Building to reduce the groundwater inflow (groundwater bypass) have been implemented.

The pumped up groundwater is temporarily stored in tanks and released after TEPCO and a third-party organization confirmed that its quality meets operational targets. Through periodical monitoring, pumping of wells and tanks is operated appropriately.

At the observation holes installed at a height equivalent to the buildings, the trend showing a decline in groundwater levels is checked. The analytical results on groundwater inflow into the buildings based on existing data showed a declining trend.

Installing land-side impermeable walls with frozen soil around Units 1-4 to prevent the inflow of groundwater into the building

To prevent the inflow of groundwater into the buildings, installation of impermeable walls on the land side is planned. Freezing started on the sea side and at a part of the mountain side from March 2016 and at 90% of the mountain side from June 2018.

Freezing of the remaining unfrozen sections advanced with a phased approach and freezing of all sections started in August 2017.

In March 2018, construction of the land-side impermeable walls was completed, except for a portion of the depth, based on a monitoring result showing that the underground temperature had declined below 0°C in almost all areas, while on the mountain side, the difference between the inside and outside increased to approx. 4.5 m. The 21st Committee on Countermeasures for Contaminated Water Treatment, held on March 7, 2018, evaluated that together with the function of sub-drains, etc., a water-level management system to stably control groundwater and isolate the buildings from it had been established and had allowed a significant reduction in the amount of contaminated water generated.

For the unfrozen depth, a supplementary method was implemented and it was confirmed that temperature of the part declined below 0°C by September 2018. From February 2019, maintenance operation started at all sections.
Progress toward decommissioning: Work to improve the environment within the site

**Immediate targets**

- Reduce the effect of additional release from the entire power station and radiation from radioactive waste (secondary water treatment waste, rubble, etc.) generated after the accident, to limit the effective radiation dose to below 1mSv/year at the site boundaries.
- Prevent contamination expansion in sea, decontamination within the site

Optimization of radioactive protective equipment
Based on the progress of measures to reduce environmental dosage on site, the site is categorized into two zones: highly contaminated area around Unit 1-4 buildings, etc. and other areas to optimize protective equipment according to each category aiming at improving safety and productivity by reducing load during work. From March 2016, limited operation started. From March and September 2017, the G Zone was expanded.

Installation of dose-rate monitors
To help workers in the Fukushima Daiichi Nuclear Power Station precisely understand the conditions of their workplaces, a total of 86 dose-rate monitors were installed by January 4, 2016. These monitors allow workers to confirm real time on-site dose rates at their workplaces. Workers are also able to check concentrated data through large-scale displays installed in the Main Anti-Earthquake Building and the access control facility.

Installation of sea-side impermeable walls
To prevent the outflow of contaminated water into the sea, sea-side impermeable walls have been installed. Following the completed installation of steel pipe sheet piles on September 22, 2015, connection of these piles was conducted and connection of sea-side impermeable walls was completed on October 26, 2015. Through these works, closure of sea-side impermeable walls was finished and the contaminated water countermeasures have been greatly advanced.

Status of the large rest house
A large rest house for workers was established and its operation commenced on May 31, 2015. Spaces in the large rest house are also installed for office work and collective worker safety checks as well as taking rest. On March 1, 2016 a convenience store opened in the large rest house. On April 11, operation of the shower room started. Efforts will continue to improve convenience of workers.

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