Outline of Decommissioning and Contaminated Water Management

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

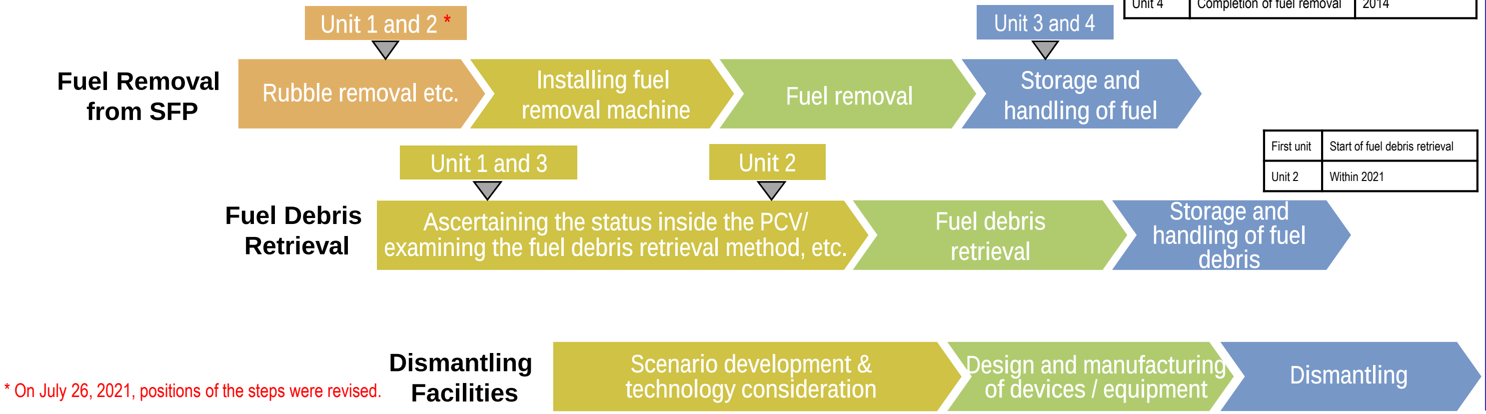
Main decommissioning work and steps

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 (Note 1) retrieval from Units 1-3.

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

Units 1-6	Completion of fuel removal	Within 2031
Unit 1	Start of fuel removal	FY2027 - FY2028
Unit 2	Start of fuel removal	FY2024 - FY2026
Unit 3	Completion of fuel removal	Within FY2020
Unit 4	Completion of fuel removal	2014

First unit	Start of fuel debris retrieval
Unit 2	Within 2021

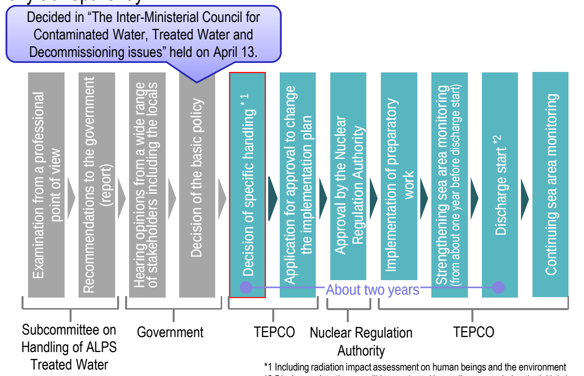


* On July 26, 2021, positions of the steps were revised.

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.



*1 Including radiation impact assessment on human beings and the environment
*2 Discharges into the sea will be conducted in small amounts during the initial phase

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

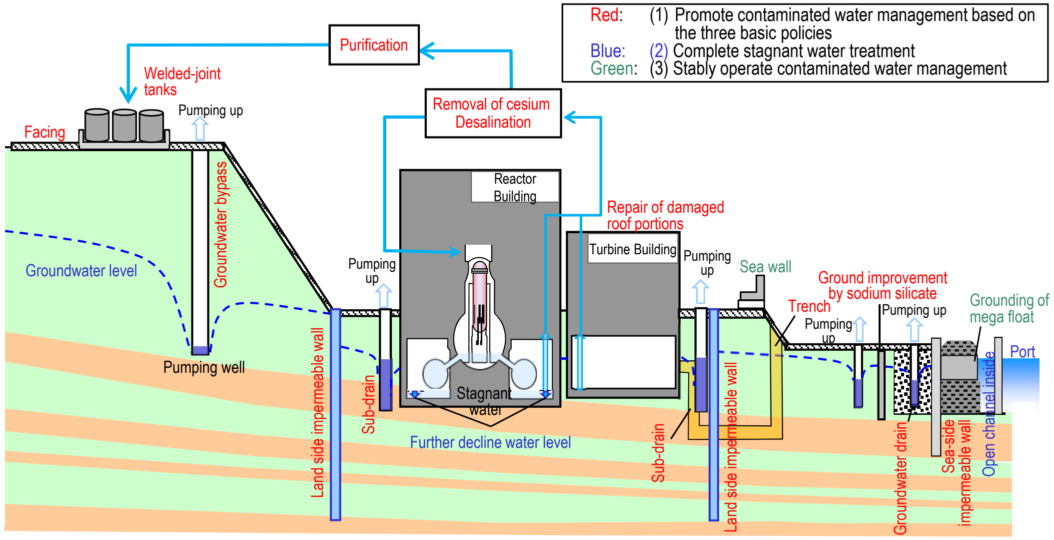
- Strontium-reduced water from other equipment is being re-treated in the multi-nuclide removal equipment (ALPS) and stored in welded-joint tanks.
- Multi-layered contaminated water management measures, including land-side impermeable walls and sub-drains, have stabilized the groundwater at a low level 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 m^3/day (in May 2014) to approx. 180 m^3/day (in FY2019) and approx. 140 m^3/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.



Progress status

◆ 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°C*1 over the past month.
There was no significant change in the concentration of radioactive materials newly released from Reactor Buildings into the air*2. It was concluded that the comprehensive cold shutdown condition had been maintained.

* 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).

Design concerning the facilities necessary to measure and evaluate radioactivity concentration before discharging ALPS treated water being examined

Regarding the discharge of ALPS treated water into the sea, its radioactivity concentration will be measured before dilution and discharge. It will be confirmed, including by a third party, that the sum of ratios of legally required concentrations of 62 nuclides (which must be removed by ALPS) and C-14 is less than 1.

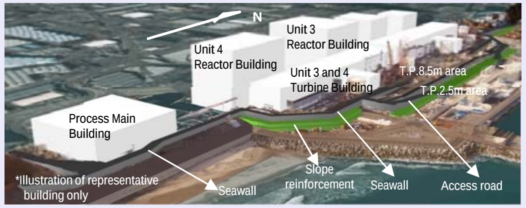
It will take some time to measure and evaluate the radioactivity concentration before discharge for some nuclides. To ensure smooth measurement, the three roles of tank areas (receiving, measuring and evaluating, and discharging) will be operated in rotation.

Furthermore, new technological trends related to tritium separation will be continuously monitored. From May 27, investigation and proposals related to such technologies started to be accepted through a new scheme, including a third-party organization.

Toward installing the Japan Trench Tsunami Seawall, construction will start from mid-June 2021

To prepare for an imminent emergency of the Japan Trench tsunami, which was announced by the Cabinet Office in April 2020, construction to install the "Japan Trench Tsunami Seawall" will start from around mid-June 2021.

Toward early reduction of the tsunami risk, work will proceed with safety first to complete the construction by the second half of FY2023.



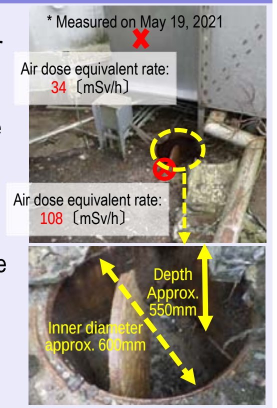
Investigation on a manhole from which rainwater was considered to flow into the Unit 1/2 exhaust stack drain sump pit

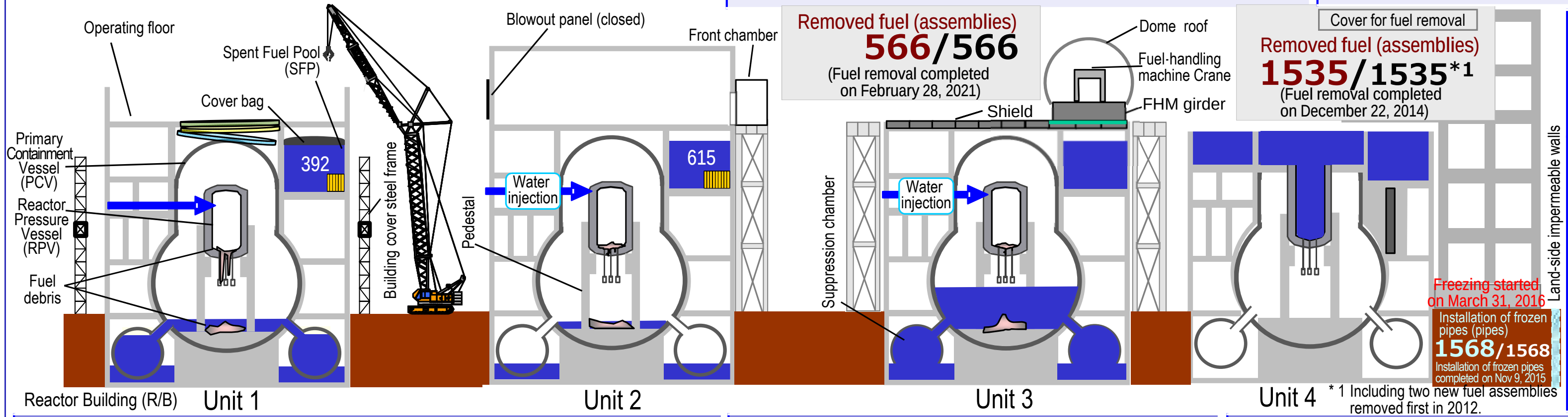
Despite measures to prevent rainfall inflow into the drain sump pit of the Unit 1/2 exhaust stack, the water level inside the pit increased during rainfall under certain circumstances.

As part of an investigation to locate the portion of the rain water inflow, water was sprinkled on the ground surface around the pit for the period April – May and it was determined that the water level increased when water was sprinkled on the southeast side of the pit.

An onsite inspection, which was implemented despite the high doses involved, detected a manhole from which rainwater was considered to inflow.

Measures to prevent rainwater inflow will be implemented for that portion.





An investigation implemented for obstacles inside the Unit 1 PCV, in which information of obstacle location is acquired prior to the internal investigation

During the period April 23-29, 2021, an investigation was implemented for obstacles inside the Primary Containment Vessel (PCV) and information on obstacle location such as instrument piping and conduit was acquired.

Based on this location information, the route to insert the equipment for the PCV internal investigation was confirmed.

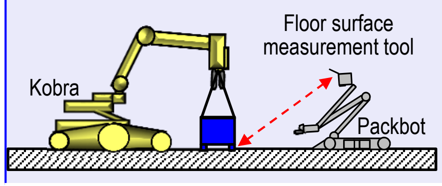
Preparation is underway to resume obstacle cutting work. Work continues with safety first.

Investigation on the Unit 2 operating floor implemented with the Secretariat of the Nuclear Regulation Authority

On April 14 and 15, an investigation was implemented on the floor surface and the ceiling surface of the Unit 2 operation floor.

It was evaluated that a higher air dose rate (max. approx. 117 mSv/h) on the shield plug than elsewhere was attributable to the effect of cesium accumulated in a space and the lower part of the shield plug.

To achieve a target dose of 1 mSv/h or less for the operating floor, decontamination and shielding will be implemented.



Investigation inside the Unit 2 reactor well (flash report)

On May 20, the inside of the reactor well under the Unit 2 shield plug, where a high dose was detected, was investigated using a camera and dosemeter. Samples were also taken from pipes connecting to the inside of the well or others on April 23.

The maximum dose equipment rate at the measured point was 530 mSv/h.

To utilize the result in future decommissioning work, investigations inside the reactor well will continue.

<Condition under the shield plug>

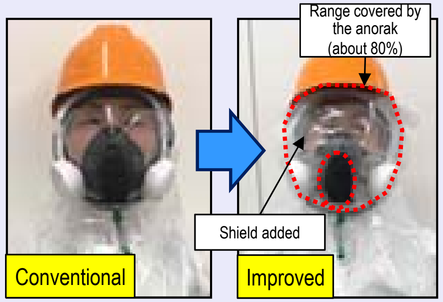
An anorak for a full-face mask introduced as part of countermeasures to prevent intake

During work in buildings with a high level of contamination or others, each worker wears a full-face mask and radiation protection equipment (anorak) covering the whole body.

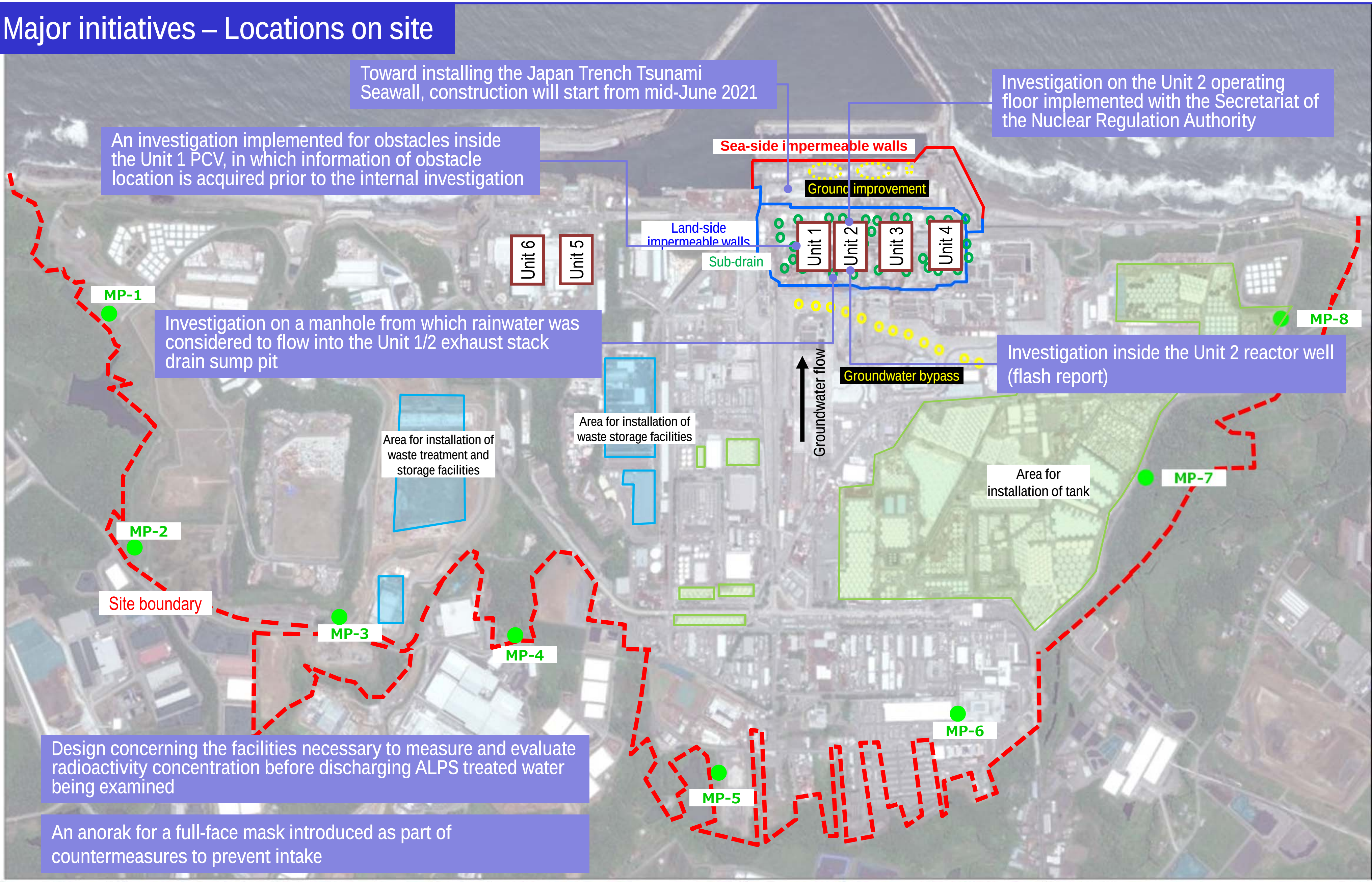
Some events involved contamination attached on the surface of the full-face mask spreading to the face. As a part of countermeasures, an anorak capable of covering about 80% of the head and full-face mask is introduced.

The anorak has other features to alleviate feelings of discomfort while being worn: to secure visibility, a shield is added on the face part; and the part covering the filter of the full-face mask can be squeezed with rubber and cut to prevent breezing.

Work to improve equipment and other factors will continue for better work environment.



Major initiatives – Locations on site



* Data of Monitoring Posts (MP1-MP8.)

Data (10-minute values) of Monitoring Posts (MPs) 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.

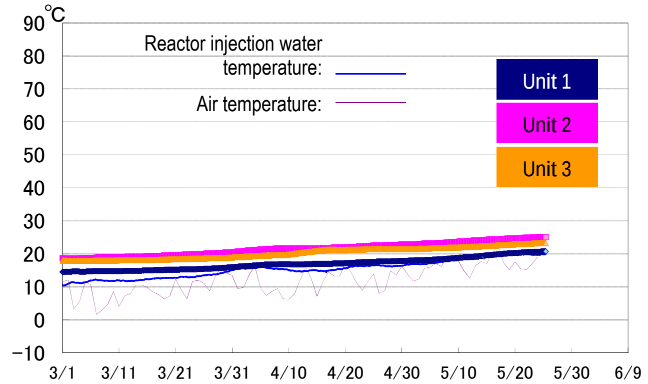
The radiation shielding panels around monitoring post No. 6, which is one of the instruments used to measure the radiation dose at the power station site boundary, were taken off from July 10 - 11, 2013, since further deforestation, etc. had caused the surrounding radiation dose to decline significantly.

Provided by Japan Space Imaging Corp., photo taken on May 24, 2020
Product (C) [2020] DigitalGlobe, Inc., a Maxar company

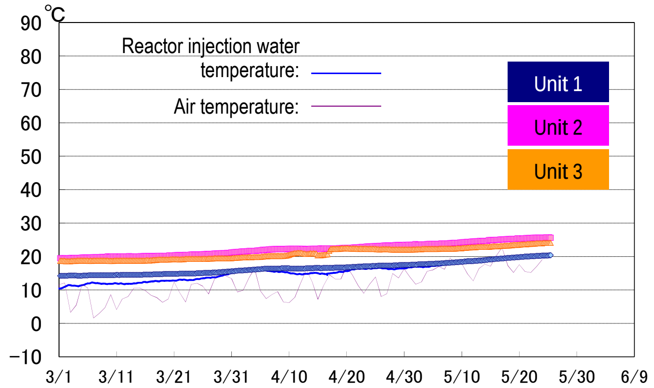
I. Confirmation of the reactor conditions

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.



RPV bottom temperatures (recent quarter)



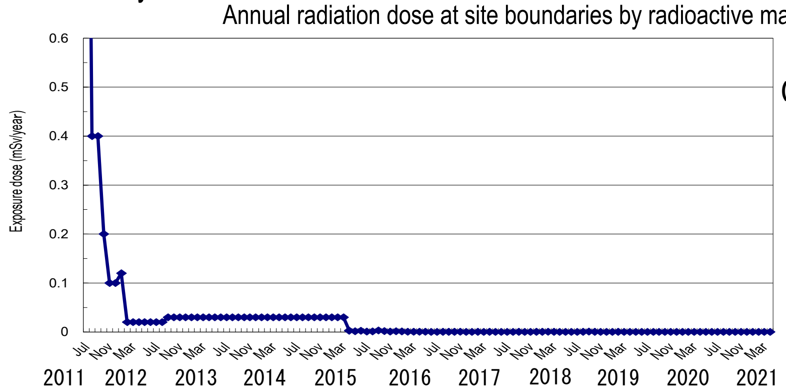
PCV gas phase temperatures (recent quarter)

*1 The trend graphs show part of the temperature data measured at multiple points.
*2 A part of data could not be measured due to maintenance and inspection of the facility and other work.

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. 2.0×10^{-12} Bq/cm^3 and 1.8×10^{-12} Bq/cm^3 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



(Reference)

- * The concentration limit of radioactive materials in the air outside the surrounding monitoring area:
  [Cs-134]: 2 x 10^{-5} Bq/cm^3
  [Cs-137]: 3 x 10^{-5} Bq/cm^3
- * Data of Monitoring Posts (MP1-MP8).
  Data of Monitoring Posts (MPs) measuring the air dose rate around the site boundary showed 0.351 – 1.197 μSv/h (April 26 – May 25, 2021).
  To measure the variation in the air dose rate of MP2-MP8 more accurately, work to improve the environment (trimming trees, removing surface soil, and shielding around the MPs) was completed.

Note 1: Different formulas and coefficients were used to evaluate the radiation dose in the facility operation plan and monthly report. The evaluation methods were integrated in September 2012. As the fuel removal from the spent fuel pool (SFP) commenced for Unit 4, the radiation exposure dose from Unit 4 was added to the items subject to evaluation since November 2013. The evaluation has been changed to a method considering the values of continuous dust monitors since FY2015, with data to be evaluated monthly and announced the following month.

Note 2: Radiation dose was calculated using the evaluation values of release amount from Units 1-4 and Units 5 and 6. The radiation dose of Unit 5 and 6 was evaluated based on expected release amount during operation until September 2019 but the evaluation method was reviewed and changed to calculate based on the actual measurement results of Units 5 and 6 from October.

actual measurement results of Units 5 and 6 from October.

Other indices

There was no significant change in indices, including the pressure in the PCV and the PCV radioactivity density (Xe-135) for monitoring criticality, nor was any anomaly in the cold shutdown condition or criticality sign detected.

Based on the above, it was confirmed that the comprehensive cold shutdown condition had been maintained and the reactors remained in a stabilized condition.

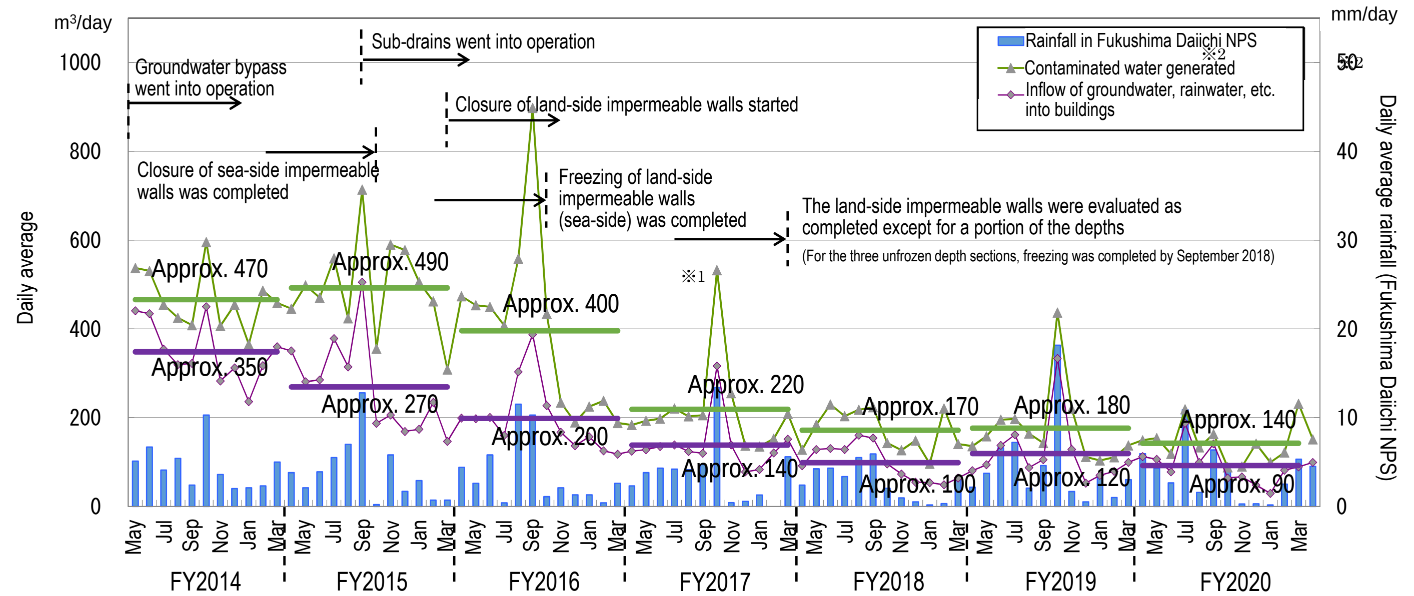
II. Progress status by each plan

Contaminated water management

Based on the three basic policies: "remove" the source of water contamination, "redirect" fresh water from contaminated areas and "retain" contaminated water from leakage, multi-layered contaminated water management measures have been implemented to stably control groundwater

➢ 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.



*1 Values differ from those announced at the 20th Committee on Countermeasures for Contaminated Water Treatment (held on August 25, 2017) because the calculation method of the contaminated water volume generated was reviewed on March 1, 2018. Details of the review are described in the materials for the 50th and 51st meetings of the Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment.

*2: The monthly daily average is derived from the daily average from the previous Thursday to the last Wednesday, which is calculated based on the data measured at 7:00 on every Thursday.

Figure 1: Changes in contaminated water generated and inflow of groundwater and rainwater into buildings

➢ 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 had 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 m^3/day and improving reliability. Operational efficiency was also improved to treat up to 2,000 m^3/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 m^3/day when the sub-drain water level declined below T.P. 3.0 m but increased during rainfall.

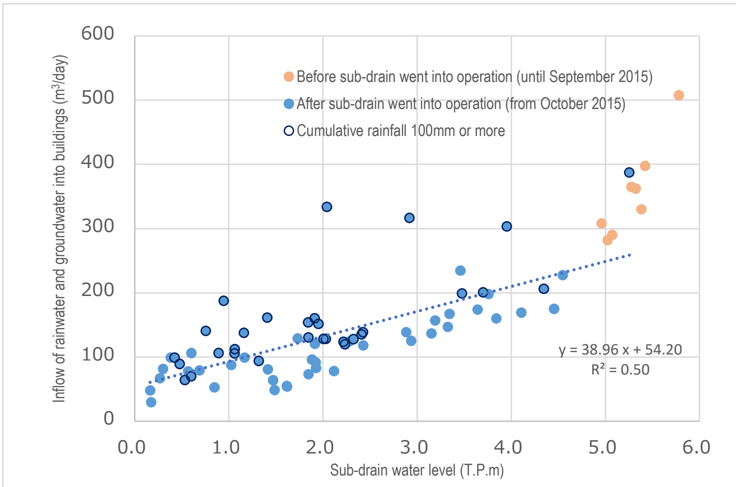


Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Units 1-4 sub-drains

➢ 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 m^2 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 m^2) 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).

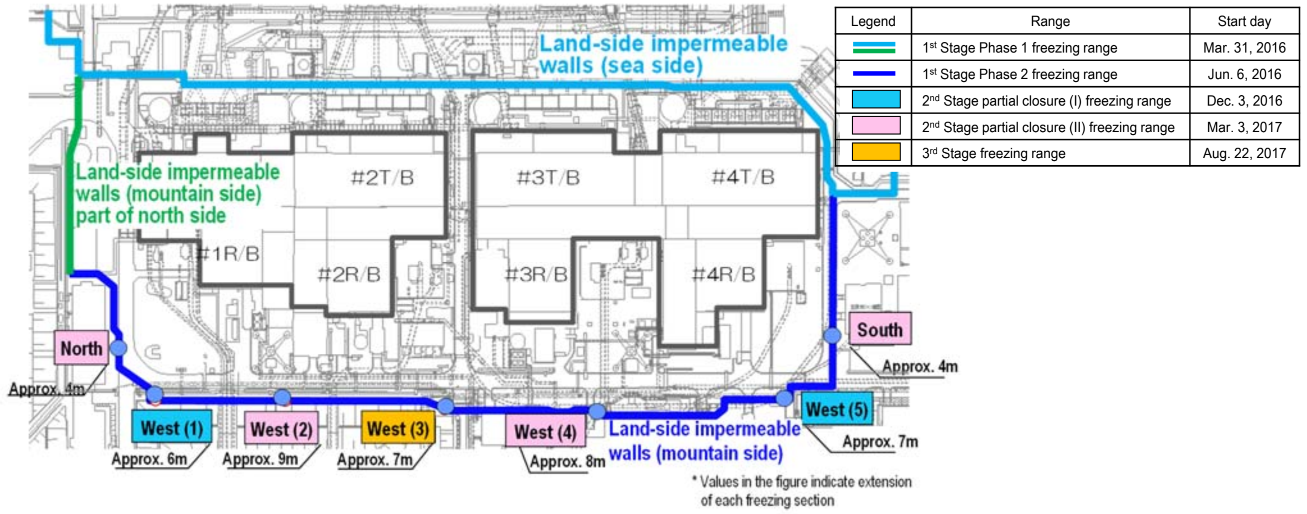


Figure 3: Closure parts of the land-side impermeable walls (on the mountain side)

➢ 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 m^3, respectively (including approx. 9,500 m^3 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 m^3 had been treated.

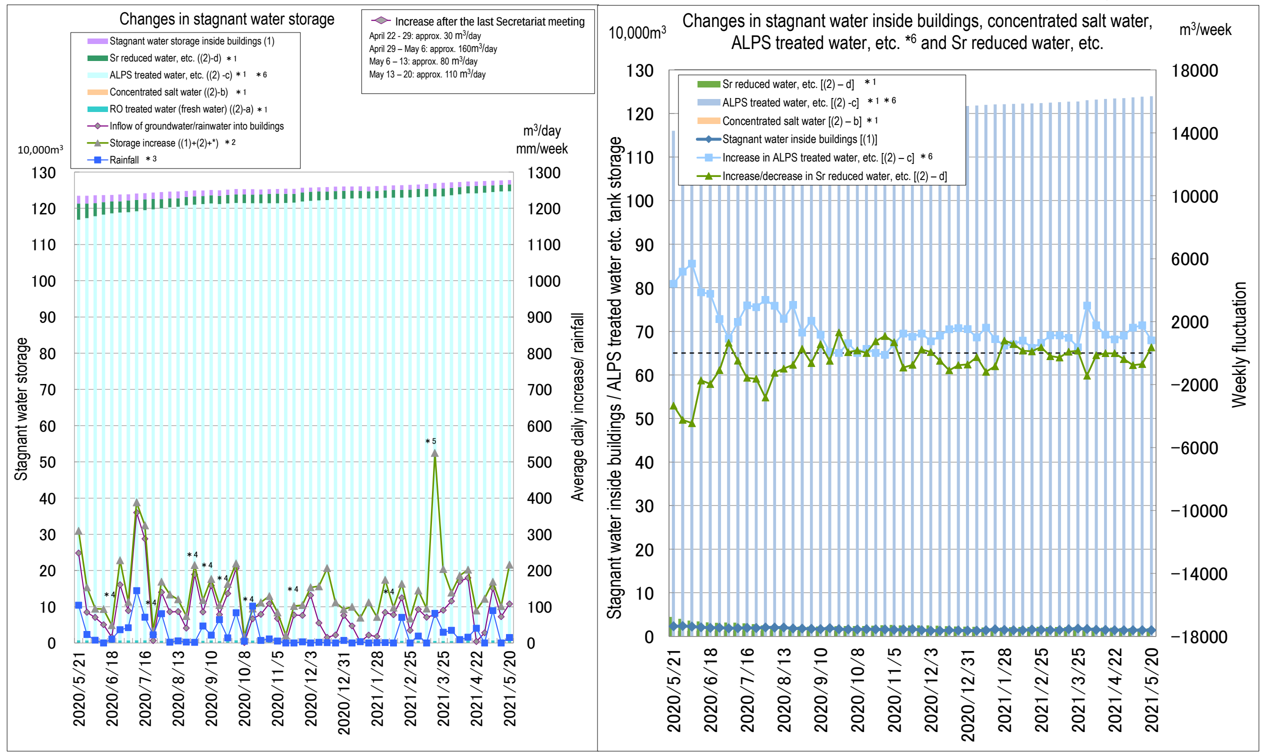
➢ Toward reducing the risk of contaminated water stored in tanks

- 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 m^3 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 m^3).

As of May 20, 2021



*1: Water amount for which the water-level gauge indicates 0% or more

*2: To detect storage increases more accurately, the calculation method was reviewed as follows from February 9, 2017: (The revised method was applied from March 1, 2018)
[(Inflow of groundwater/rainwater into buildings) + (other transfer) + (chemical injection into ALPS)]

*3: Changed from December 13, 2018 from rainfall in Namie to that within the site.

*4: Considered attributable to fluctuation inflow of groundwater, rainwater, and others to buildings due to the decline in the level of stagnant water in buildings.
(May 7-14, June 11-18, July 16-23, August 20-27, September 3-10 and 17-24, October 1-8, November 12-19, 2020 and February 4-11,2021)

*5: Stored amount increased due to transfer to buildings in association with decommissioning work on March 18, 2021.
(Major breakdown of the transferred amount: (1) Stagnant water inside the tank fences (water transferred from the Shallow Draft Quay drainage channel) was transferred to the Process Main Building: approx. 390 m^3/day, (2) Stagnant water inside the tank fences (water transferred from the Shallow Draft Quay drainage channel) was transferred to the High Temperature Incinerator Building: approx. 10 m^3/day, (3) Transfer from the Unit 3 additional FSTR to the Unit 3 Radioactive Waste Treatment Building: approx. 10 m^3/day and others)

*6: The notation of treated water by the multi-nuclide removal equipment and others was reviewed in accordance with the definition change of ALPS treated water by the Government (April 27, 2021)

Figure 4: Status of stagnant water storage

Fuel removal from the spent fuel pools

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

Promoting efforts to reduce and store waste generated appropriately and R&D to facilitate adequate and safe storage, processing and disposal of radioactive waste

➢ 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 m^3 (+100 m^3 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 m^3 (+200 m^3, with an area-occupation rate of 77%). The total storage volume of used protective clothing was approx. 32,800 m^3 (+600 m^3, 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 m^3 (area-occupation rate: 61%), while that of concentrated waste fluid was 9,368 m^3 (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

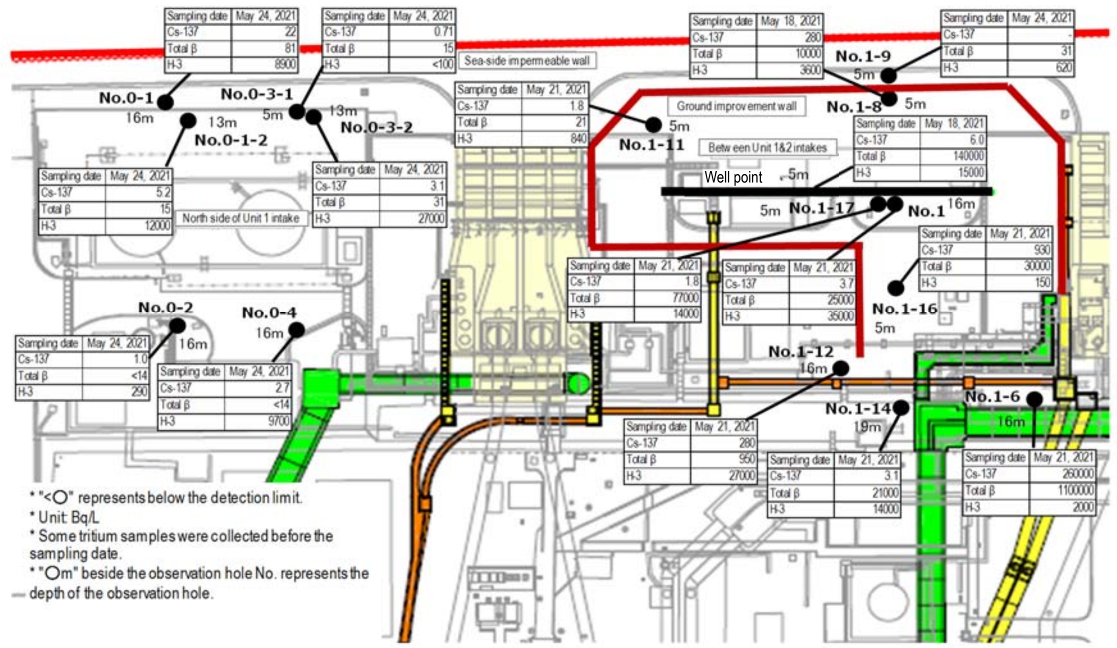
➢ Status of groundwater and seawater on the east side of Turbine Building Units 1-4

- 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 constant or is declining overall.

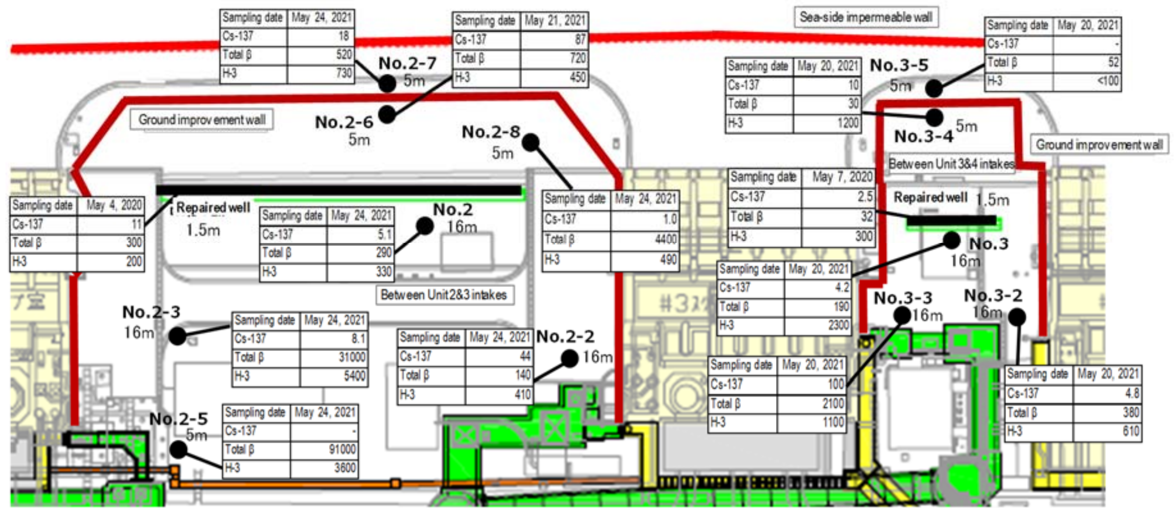
- In the area between the Unit 1 and 2 intakes, the H-3 concentration has remained below the legal discharge limit of 60,000 Bq/L at all observation holes. It has been increasing or declining at No. 1-14 but has remained constant or been declining at many observation holes overall. The concentration of total-β radioactive materials has remained constant or been declining at many observation holes overall.
- In the area between the Unit 2 and 3 intakes, the H-3 concentration has been below the legal discharge limit of 60,000 Bq/L at all observation holes and remained almost constant or been declining. The concentration of total-β radioactive materials has remained almost constant or been declining overall.
- In the area between the Unit 3 and 4 intakes, the H-3 concentration has been below the legal discharge limit of 60,000 Bq/L at all observation holes and remained constant or been declining though increasing and declining at No. 3-3. The concentration of total-β radioactive materials has also remained constant or been declining overall.
- The concentration of radioactive materials in drainage channels has remained constant, despite increasing during rainfall.
- In the open channel area of seawater intake for Units 1 to 4, the concentration of radionuclides in seawater has remained below the legal discharge limit, despite increases in Cs-137 and Sr-90 noted during rainfall. They have also been declining following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls. The concentration of Cs-137 has remained slightly higher in front of the south side impermeable walls and slightly lower on the north side of the east breakwater since March 20, 2019, when the silt fence was transferred to the center of the open channel due to mega float-related construction.
- In the port area, the concentration of radionuclides in seawater has remained below the legal discharge limit, despite increases in Cs-137 and Sr-90 observed during rainfall. They have remained below the level of those in the Units 1-4 intake open channel area and been declining following the completed installation and connection of steel pipe sheet piles for the sea-side impermeable walls.
- In the area outside the port, regarding the concentration of radioactive materials in seawater, those of Cs-137 and Sr-90 declined and remained low after steel pipe sheet piles for the sea-side impermeable walls were installed and connected.

➢ Leakage of radioactive materials from a rubble storage container stored in the temporary storage area W (on the north side of the training building) for rubble and others

- On March 2, 2021 a high alarm was issued by the PSF (Plastic Scintillation Fiber) monitor installed at the Shallow Draft Quay drainage channel. A cause investigation for this event pinpointed a deposit with a dose-equivalent rate of 70μm in the temporary storage area W which is located in upstream of the drainage channel and the deposit was collected on March 24.
- An inspection inside rubble storage containers, which were transferred from the temporary storage area W to the solid waste storage facility, detected moisture-containing adsorbent in plastic bags and stagnant water at the bottom of a rubble storage container (one unit), a portion of which had corroded significantly.
- Having analyzed the deposit and stagnant water at the bottom, it was considered that stagnant water in that rubble storage container had leaked from the bottom and formed a deposit on the ground surface.
- There was no significant increase in the total-β radioactivity concentration of the Shallow Draft Quay drainage channel after the deposit was removed and the ground surface was covered. Accordingly, the high alarm issued by the PSF monitor on March 2 was considered attributable to stagnant water at the bottom inside a rubble storage container with a significantly corroded portion, leaking in the temporary storage area W, flowing out from the temporary storage area alongside rainwater during rainfall and subsequently reaching the drainage channel.
- 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.



<Unit 1 intake north side, between Unit 1 and 2 intakes>



<Between Unit 2 and 3 intakes, between Unit 3 and 4 intakes>

Figure 5: Groundwater concentration on the Turbine Building east side

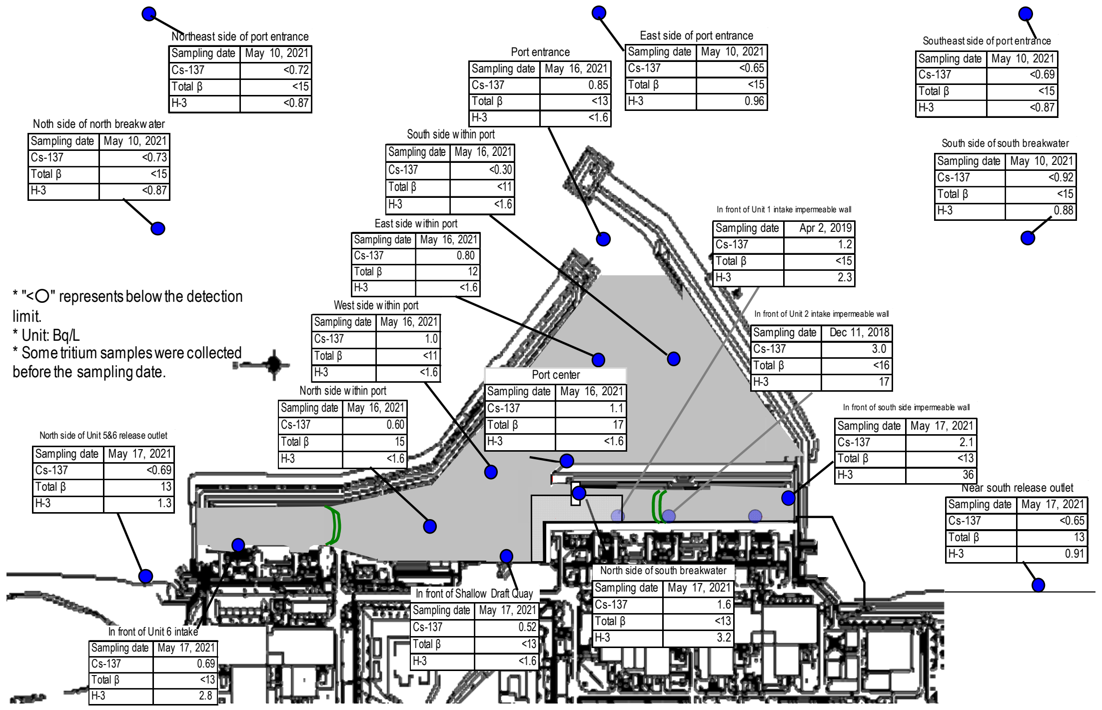


Figure 6: Seawater concentration around the port

Outlook of the number of staff required and efforts to improve the labor environment and conditions

Adequate number of staff will be secured in the long-term, while firmly implementing radiation control of workers. The work environment and labor conditions will be continuously improved by responding to the needs on the site.

➢ Staff management

- The monthly average total of personnel registered for at least one day per month to work on site during the past quarter from January to March 2021 was approx. 8,900 (cooperating company workers and TEPCO HD employees), which exceeded the monthly average number of actual workers (approx. 6,800). Accordingly, sufficient personnel are registered to work on site.
- It was confirmed with the prime contractors that the estimated manpower necessary for the work in June 2021 (approx. 3,400 weekday per day: cooperating company workers and TEPCO HD employees) would be secured at present. The average numbers of workers per day for each month (actual values) of recent 2 years period were maintained, with approx. 3,000 to 4,200 (see Figure 7).
- The number of workers from within Fukushima Prefecture remained constant while the number of those 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 value for FY2020
- For most workers, the exposure dose was sufficiently within the limit and allowed them to continue engaging in radiation work.

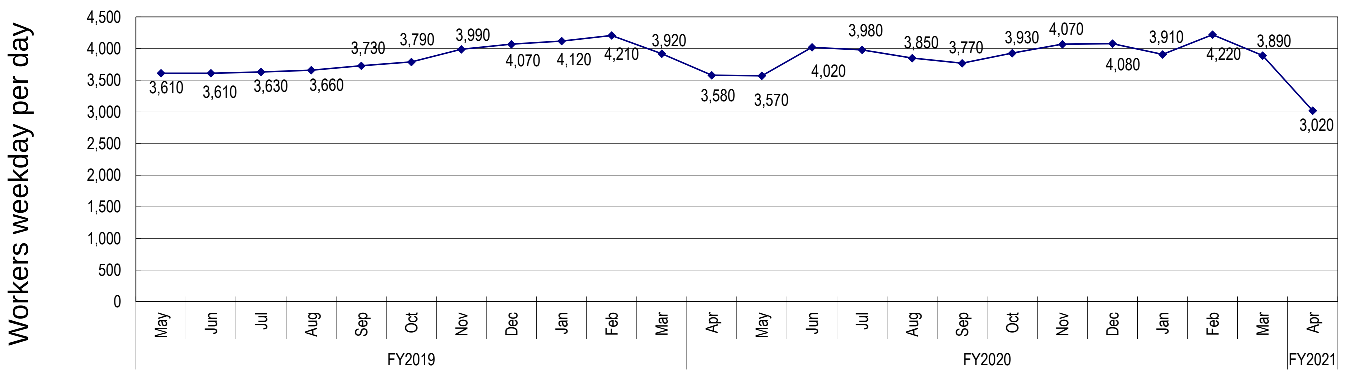


Figure 7: Changes in the average number of workers weekday per day for each month of recent 2 years (actual values)

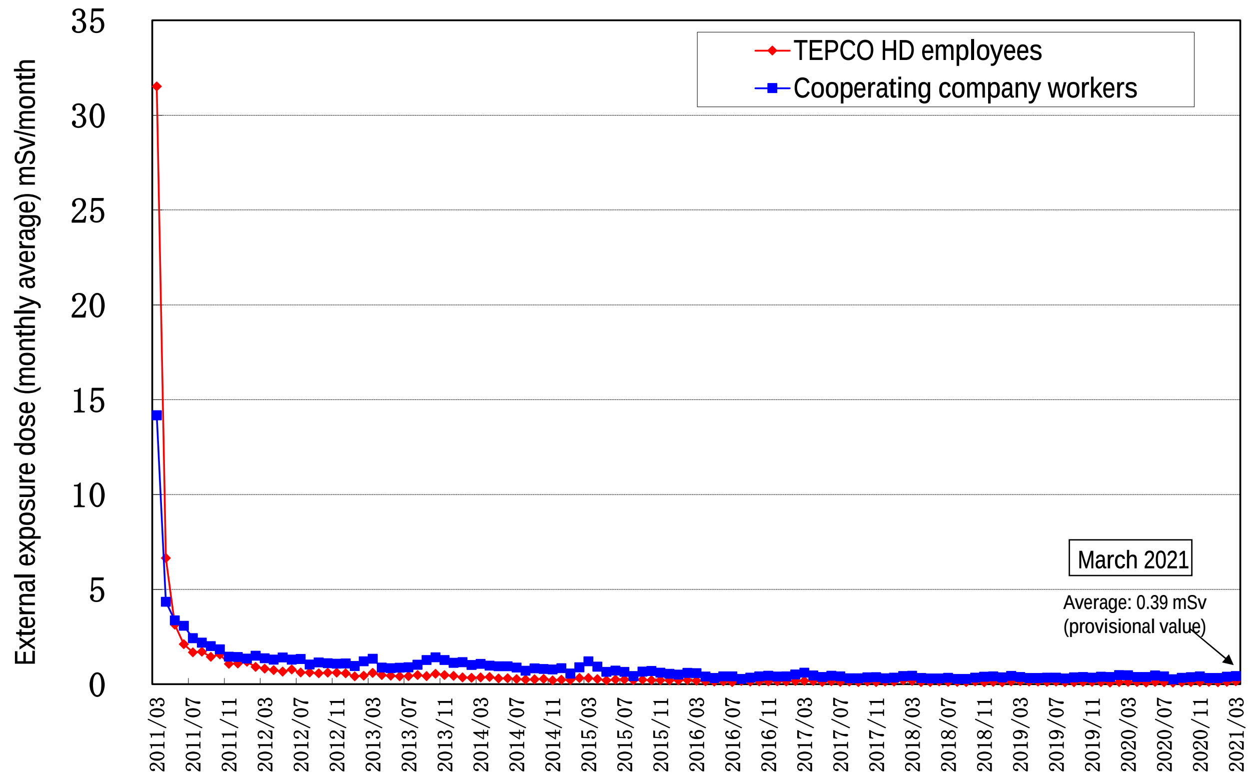


Figure 8: Changes in monthly individual worker exposure dose
(monthly average exposure dose since March 2011)

➢ 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 β 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	ND(0.44)
Cesium-137	0.84
Total β	ND(12)
Toritium	1.9

※1

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 :	69	(H25/8/19)	→	14	Below 1/4
Toritium :	68	(H25/8/19)	→	ND(1.6)	Below 1/40

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 β :	74	(H25/8/19)	→	ND(13)	Below 1/5
Toritium :	67	(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 β :	79	(H25/8/19)	→	14	Below 1/5
Toritium :	60	(H25/8/19)	→	ND(1.8)	Below 1/30

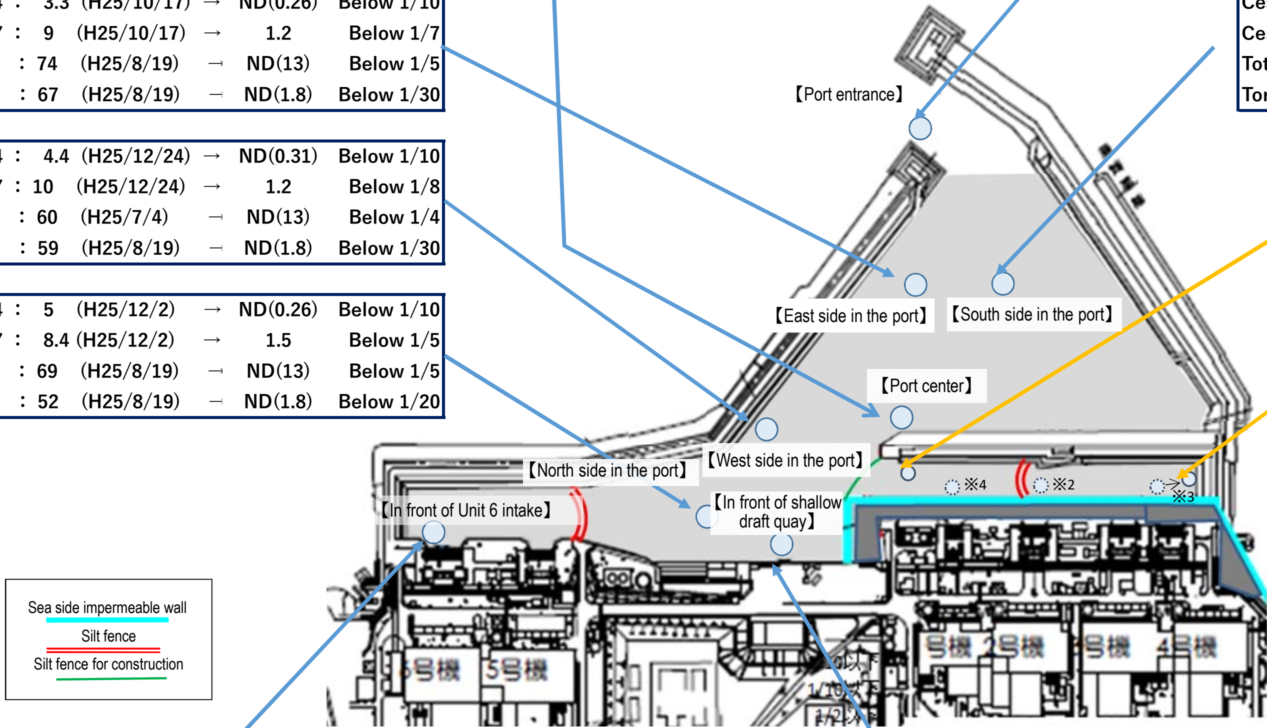
Cesium-134 :	4.4	(H25/12/24)	→	ND(0.31)	Below 1/10
Cesium-137 :	10	(H25/12/24)	→	1.2	Below 1/8
Total β :	60	(H25/7/4)	→	ND(13)	Below 1/4
Toritium :	59	(H25/8/19)	→	ND(1.8)	Below 1/30

Cesium-134 :	32	(H25/10/11)	→	ND(0.60)	Below 1/50
Cesium-137 :	73	(H25/10/11)	→	2.6	Below 1/20
Total β :	320	(H25/8/12)	→	ND(12)	Below 1/20
Toritium :	510	(H25/9/2)	→	4.1	Below 1/100

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 β :	69	(H25/8/19)	→	ND(13)	Below 1/5
Toritium :	52	(H25/8/19)	→	ND(1.8)	Below 1/20

Cesium-134	ND(0.70)
Cesium-137	16
Total β	24
Toritium	29

※1



※1: Monitoring commenced in or after March 2014. Monitoring inside the sea-side impermeable walls was finished because of the landfill.

※2: For the point, monitoring was finished from December 12, 2018 due to preparatory work for transfer of mega float.

※3: For the point, monitoring point was moved from February 6, 2019 due to preparatory work for transfer of mega float

※4: For the point, monitoring was finished from April 3, 2019 due to preparatory work for transfer of mega float.

	Legal discharge limit	WHO Guidelines for Drinking Water Quality
Cesium-134	60	10
Cesium-137	90	10
Strontium-90 (strongly correlate with Total β)	30	10
Tritium	60,000	10,000

Cesium-134 :	2.8	(H25/12/2)	→	ND(0.59)	Below 1/4
Cesium-137 :	5.8	(H25/12/2)	→	0.62	Below 1/9
Total β :	46	(H25/8/19)	→	15	Below 1/3
Toritium :	24	(H25/8/19)	→	2.7	Below 1/8

Cesium-134 :	5.3	(H25/8/5)	→	ND(0.45)	Below 1/10
Cesium-137 :	8.6	(H25/8/5)	→	0.56	Below 1/10
Total β :	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/decommision/planaction/monitoring/index-j.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	WHO Guidelines for Drinking Water Quality
Cesium-134	60	10
Cesium-137	90	10
Strontium-90 (strongly correlate with Total β)	30	10
Tritium	60,000	10,000

【Northeast 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	
Toritium :	ND	(H25)	→	ND(0.92)	

【East side of port entrance (offshore 1 km)】

Cesium-134 :	ND	(H25)	→	ND(0.76)	
Cesium-137 :	1.6	(H25/10/18)	→	ND(0.78)	Below 1/2
Total β :	ND	(H25)	→	14	
Toritium :	6.4	(H25/10/18)	→	ND(0.92)	Below 1/6

【Southeast side of port entrance (offshore 1 km)】

Cesium-134 :	ND	(H25)	→	ND(0.41)	
Cesium-137 :	ND	(H25)	→	ND(0.72)	
Total β :	ND	(H25)	→	14	
Toritium :	ND	(H25)	→	ND(0.92)	

【North side of north breakwater (offshore 0.5 km)】

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

【Port entrance】

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 :	69	(H25/8/19)	→	14	Below 1/4
Toritium :	68	(H25/8/19)	→	ND(1.6)	Below 1/40

【South side of south breakwater (offshore 0.5 km)】

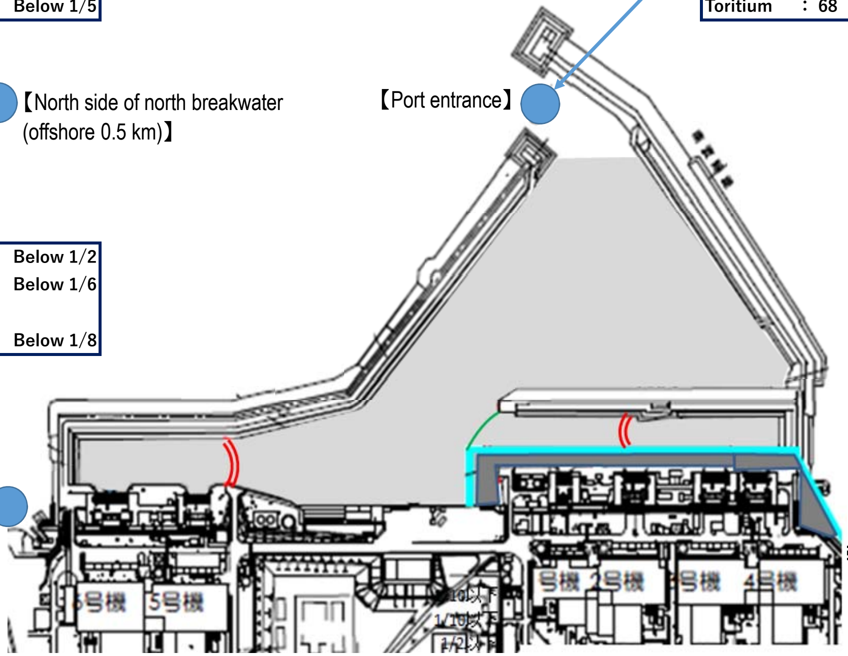
Cesium-134 :	ND	(H25)	→	ND(0.69)	
Cesium-137 :	ND	(H25)	→	ND(0.70)	
Total β :	ND	(H25)	→	15	
Toritium :	ND	(H25)	→	ND(0.91)	

【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	
Toritium :	8.6	(H25/6/26)	→	ND(0.98)	Below 1/8

【Near south release outlet】

Cesium-134 :	ND	(H25)	→	ND(0.88)	
Cesium-137 :	3	(H25/7/15)	→	ND(0.68)	Below 1/4
Total β :	15	(H25/12/23)	→	11	
Toritium :	1.9	(H25/11/25)	→	ND(0.98)	



Sea side impermeable wall

Silt fence

Silt fence for construction

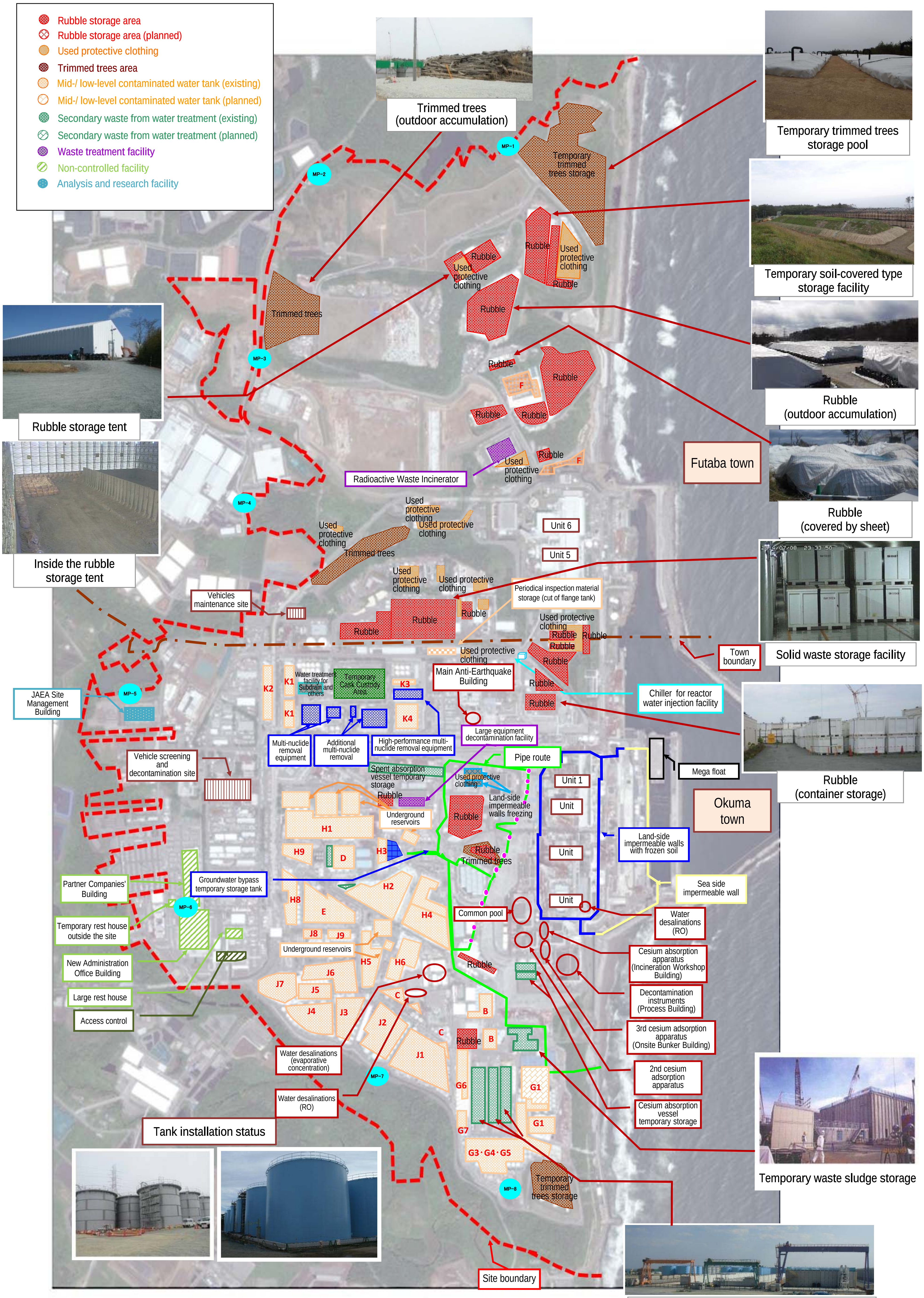
Note: The Total β measurement values include natural potassium 40 (approx. 12 Bq/L). They also include the contribution of yttrium 90, which radioactively balance strontium 90.

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

May 27, 2021

TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site Layout



Provided by Japan Space Imaging Corporation, photo taken on May 24, 2020
Product(C) [2020] DigitalGlobe, Inc., a Maxar company

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

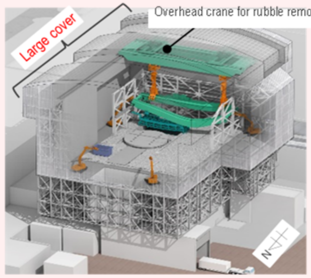
Progress toward decommissioning: Fuel removal from the spent fuel pool (SFP)

Immediate target	Commence fuel removal from the Unit 1-2 Spent Fuel Pools

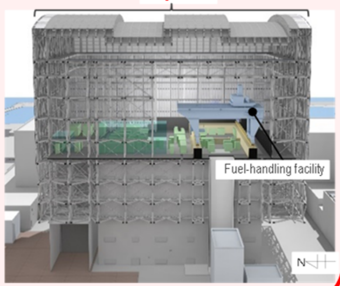
Unit 1

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.



Rubble removal (image)

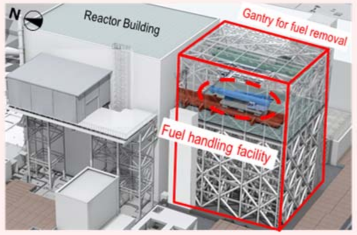


Fuel removal (image)

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.

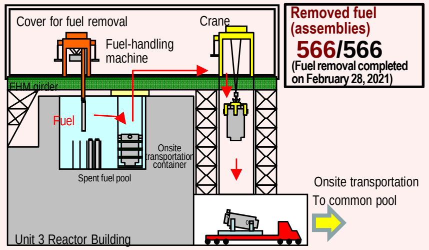


Overview of fuel removal (bird's-eye view)

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.

Installation of dome roof (February 21, 2019)



Overview of the fuel-handling facility inside the cover


Fuel removal (566th assembly)
(February 26, 2021)

Unit 4

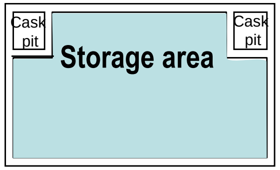
In the Mid- and-Long-Term Roadmap, the target of Phase 1 involved commencing fuel removal from inside the spent fuel pool (SFP) of the 1st Unit within two years of completion of Step 2 (by December 2013). On November 18, 2013, fuel removal from Unit 4, or the 1st Unit, commenced and Phase 2 of the roadmap 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.
Based on this experience, fuel assemblies will be removed from other Unit pools.


Fuel removal status

* A part of the photo is corrected because it includes sensitive information related to physical protection.

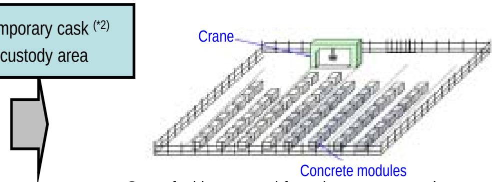
Common pool



An open space will be maintained in the common pool (Transfer to the temporary cask custody area)

Progress to date
- The common pool has been restored to a condition allowing it to re-accommodate fuel to be handled (November 2012)
- Loading of spent fuel stored in the common pool to dry casks commenced (June 2013)
- Fuel removal from the Unit 4 spent fuel pool began to be received (November 2013 - November 2014)
- Fuel removal from the Unit 3 spent fuel pool began to be received (April 2019 – February 2021)

Temporary cask (*2) custody area



Spent fuel is accepted from the common pool

Operation commenced on April 12, 2013; from the cask-storage building, transfer of 9 existing dry casks completed (May 21, 2013); fuel stored in the common pool sequentially transferred.

<Glossary>
(*1) 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.
(*2) Cask: Transportation container for samples and equipment, including radioactive materials.

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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

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(*1). (Due to high dose around the entrance in 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(*2) (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.

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.

Leak point

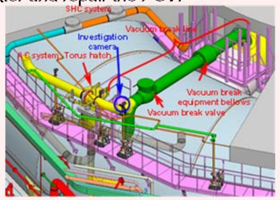
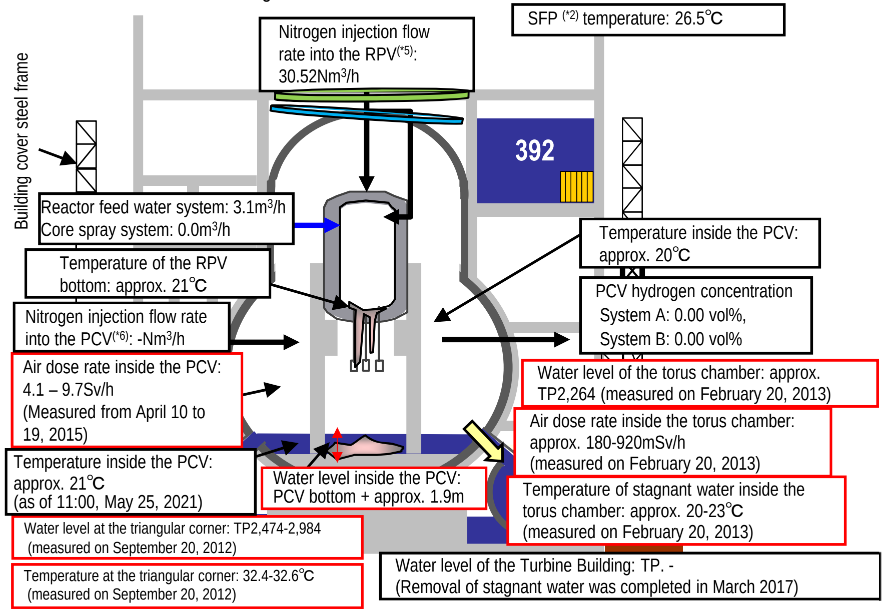


Image of the S/C upper part investigation

Unit 1

Air dose rate inside the Reactor Building:
Max. 5,150mSv/h (1F southeast area) (measured on July 4, 2012)



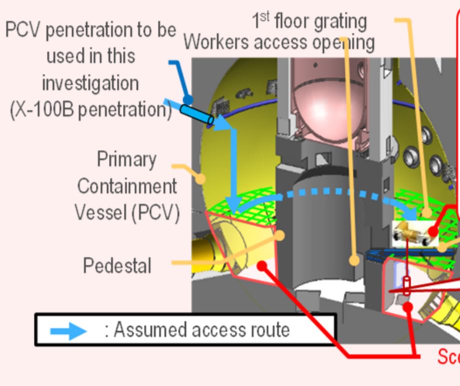
* Indices related to the plant are values as of 11:00, May 26, 2021

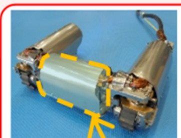
Investigations inside PCV	1st (Oct 2012)	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling stagnant water - Installing permanent monitoring instrumentation
	2nd (Apr 2015)	Confirming the status of PCV 1st floor - Acquiring images - Measuring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

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: ϕ 100 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.





<Image of investigation inside the PCV>

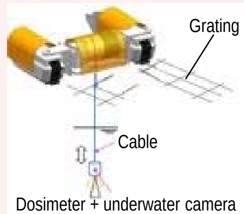


Image of hanging of dosimeter and camera

Image near the bottom

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

Period	Evaluation results
Feb - May 2015	Confirmed that there was no large fuel in the reactor core.

<Glossary>
(*1) TIP (Traversing In-core Probe)
(*2) Penetration: Through-hole of the PCV
(*3) S/C (Suppression Chamber): Suppression pool, used as the water source for the emergent core cooling system.
(*4) SFP (Spent Fuel Pool):
(*5) RPV (Reactor Pressure Vessel)
(*6) PCV (Primary Containment Vessel)

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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

Installation of an RPV thermometer and permanent PCV supervisory instrumentation

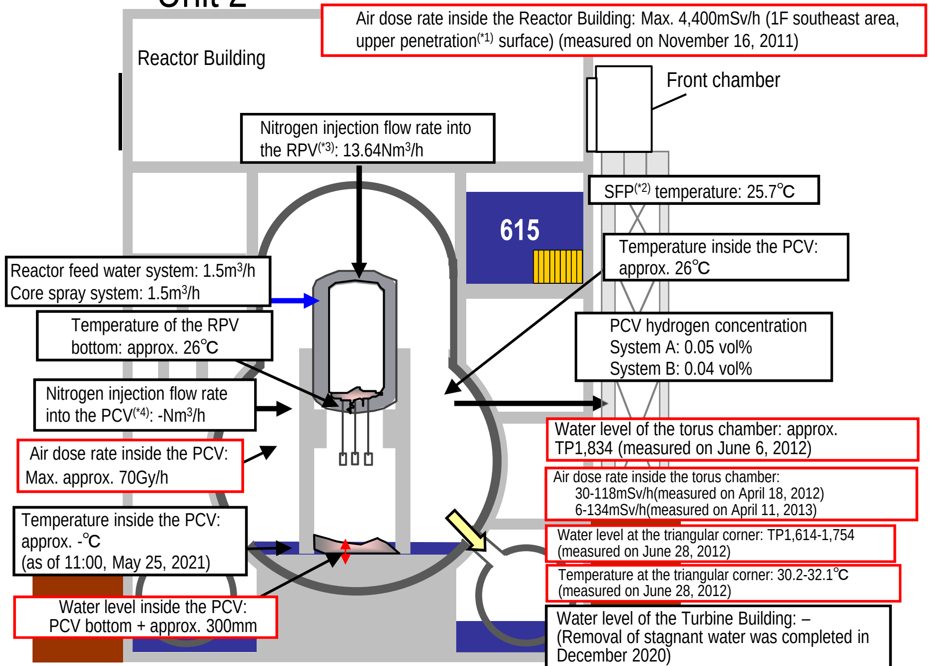
(1) Replacement of the RPV thermometer

- 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-stripping 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.

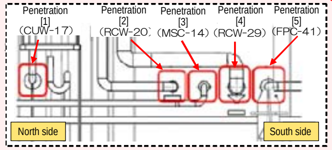
Unit 2



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

Investigations inside PCV	1st (Jan 2012)	- Acquiring images - Measuring air temperature
	2nd (Mar 2012)	- Confirming water surface - Measuring water temperature - Measuring dose rate
	3rd (Feb 2013 – Jun 2014)	- Acquiring images - Sampling stagnant water - Measuring water level - Installing permanent monitoring instrumentation
	4th (Jan – Feb 2017)	- Acquiring images - Measuring dose rate - Measuring air temperature
	5th (Jan 2018)	- Acquiring images - Measuring dose rate - Measuring air temperature
	6th (Feb 2019)	- Acquiring images - Measuring dose rate - Measuring air temperature - Grasping characteristics of a portion of deposit
Leakage points from PCV	- No leakage from torus chamber rooftop	- No leakage from all inside/outside surfaces of S/C

Investigative results on torus chamber walls



Penetrations investigated

- July 2014, the torus chamber walls were investigated (on the north 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)

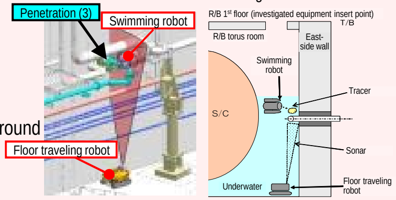


Image of the torus chamber east-side cross-sectional investigation

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.

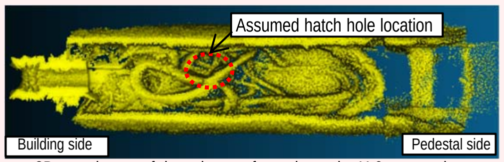
[Investigative outline]

- Investigative devices such as a robot will be injected from Unit 2 X-6 penetration(*1) 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 unit closer to the deposits than the previous investigation.
- 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 inserted into the penetration. By the contact, it was confirmed that deposits inside the penetration did not deformed and unstuck.
- 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.

<Condition of deposits before and after contact>



<3D scan image of deposit seen from above the X-6 penetration>

<Work in front of the penetration>

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

Period	Evaluation results
Mar – Jul 2016	Confirmed the existence of high-density materials, which was considered as fuel debris, at the bottom of RPV, and in the lower part and the outer periphery of the reactor core. It was assumed that a large part of fuel debris existed at the bottom of RPV.

<Glossary> (*1) Penetration: Through-hole of the PCV (*2) SFP (Spent Fuel Pool) (*3) RPV (Reactor Pressure Vessel) (*4) PCV (Primary Containment Vessel) (*5) Tracer: Material 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

Water flow was detected from the Main Steam Isolation Valve* room

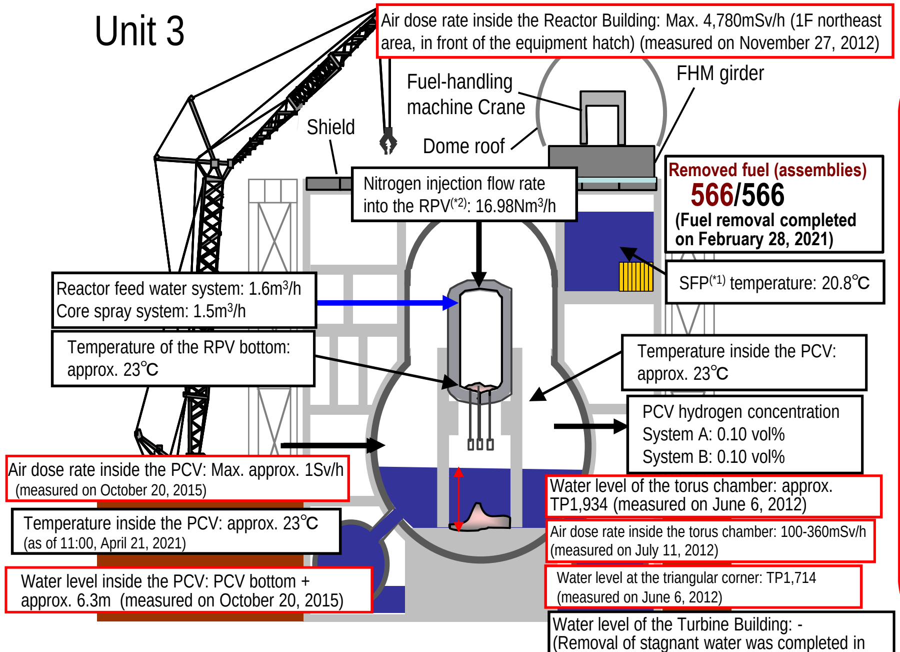
On January 18, 2014, a flow of water from around the door of the Steam Isolation Valve room in the Reactor Building Unit 3 1st floor northeast area to the nearby floor drain funnel (drain outlet) was detected. As the drain outlet connects with the underground part of the Reactor Building, there is no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

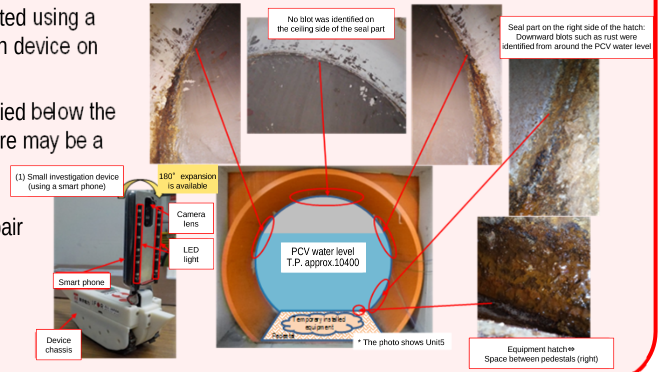


* Indices related to plant are values as of 11:00, May 26, 2021

Investigations inside PCV	1st (Oct – Dec 2015)	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling stagnant water - Installing permanent monitoring instrumentation (December 2015)
	2nd (Jul 2017)	- Acquiring images - Installing permanent monitoring instrumentation (August 2017)
Leakage points from PCV		- Main steam pipe bellows (identified in May 2014)

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.

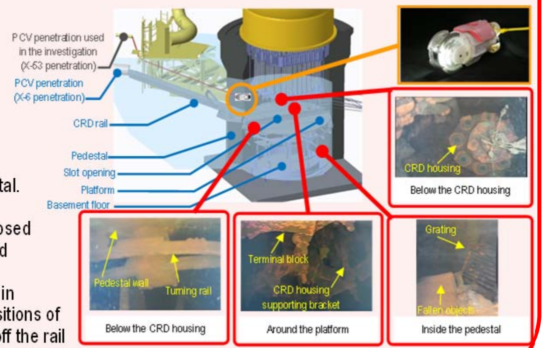


Investigation inside the PCV

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(*4), 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.



Status inside the pedestal

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

Period	Evaluation results
May – Sep 2017	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.

<Glossary>
(*1) SFP (Spent Fuel Pool) (*2) RPV (Reactor Pressure Vessel) (*3) PCV (Primary Containment Vessel) (*4) Penetration: Through-hole of the PCV

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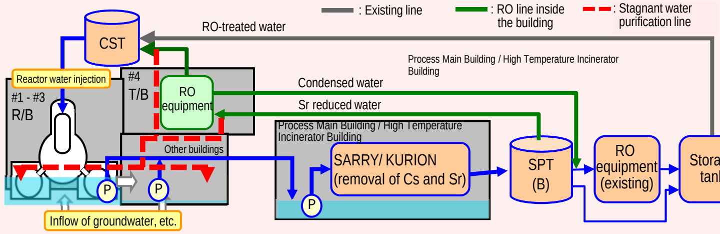
Progress toward decommissioning: Work related to circulation cooling and stagnant water treatment line

Immediate target	Stably continue reactor cooling and stagnant water treatment, and improve reliability

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 reactor water injection 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 reactors. 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 stared 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 equipment to the Unit 1 Reactor Building and the Unit 2-4 Turbine Buildings.
- The risks of stagnant water inside the buildings will continue to be reduced in addition to reduction of its storage.

* The entire length of contaminated water transfer pipes is approx. 2.1km, including the transfer line of surplus water to the upper heights (approx. 1.3km).



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 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 H4 area (56 tanks) in May 2017, in H3 B area (31 tanks) in September 2017, in H5 and H5 north areas (31 tanks) in June 2018, in G6 area (38 tanks) in July 2018, H6 and H6 north areas (24 tanks) in September 2018 and G4 south area (17 tanks) in March 2019.

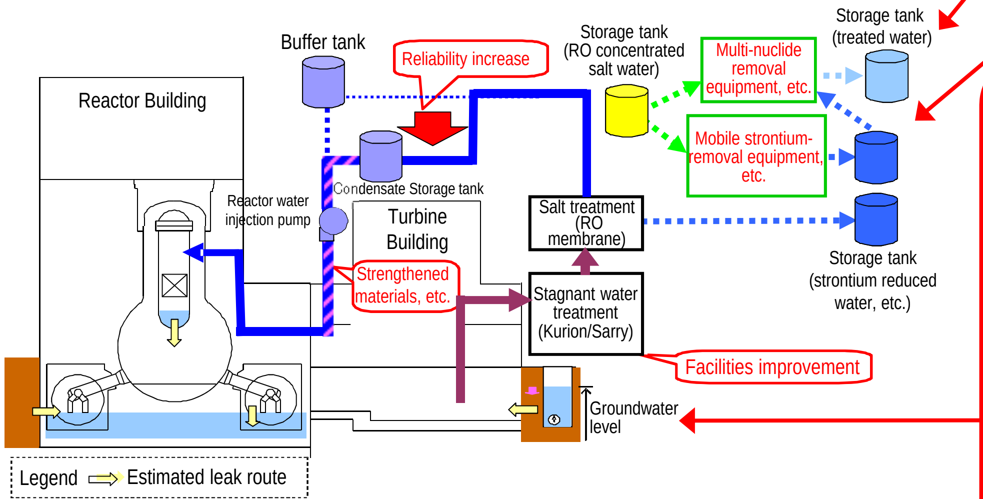

Start of dismantling in H1 east area

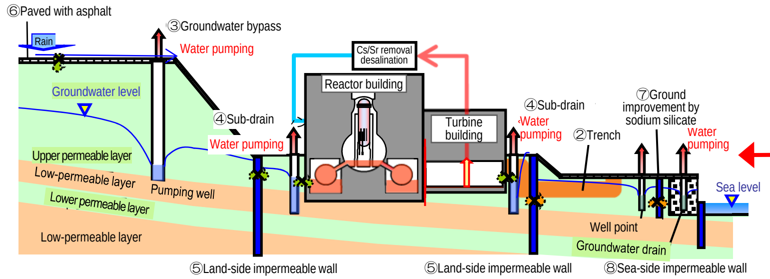

After dismantling in H1 east area

Completion of purification of contaminated water (RO concentrated salt water)

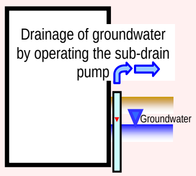
Contaminated water (RO concentrated salt water) is being treated using seven types of equipment including the multi-nuclide removal equipment (ALPS). Treatment of the RO concentrated salt water was completed on May 27, 2015, with the exception of the remaining water at the tank bottom. The remaining water will be treated sequentially toward dismantling the tanks.

The strontium reduced water from other facilities than the multi-nuclide removal equipment will be re-purified in the multi-nuclide removal equipment to further reduce risks.





Preventing groundwater from flowing into the Reactor Buildings

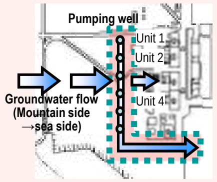


Reducing groundwater inflow by pumping sub-drain water

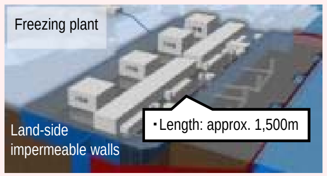
To reduce groundwater flowing into the buildings, pumping-up of groundwater from wells (sub-drains) around the buildings started on September 3, 2015. Pumped-up groundwater was purified at dedicated facilities and released after TEPCO and a third-party organization confirmed that its quality met operational targets.

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 have 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 95% of the mountain side from June 2016. 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℃ 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℃ by September 2018. From February 2019, maintenance operation started at all sections.

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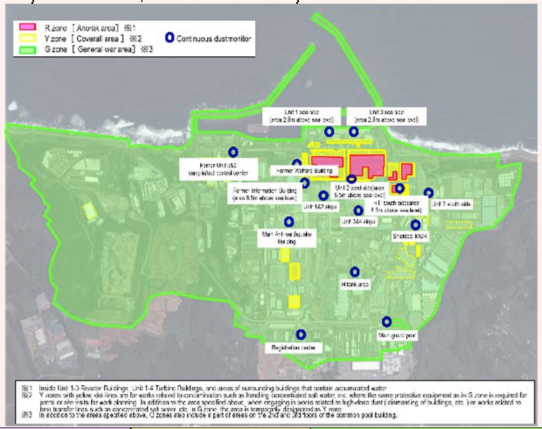
Progress toward decommissioning: Work to improve the environment within the site

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

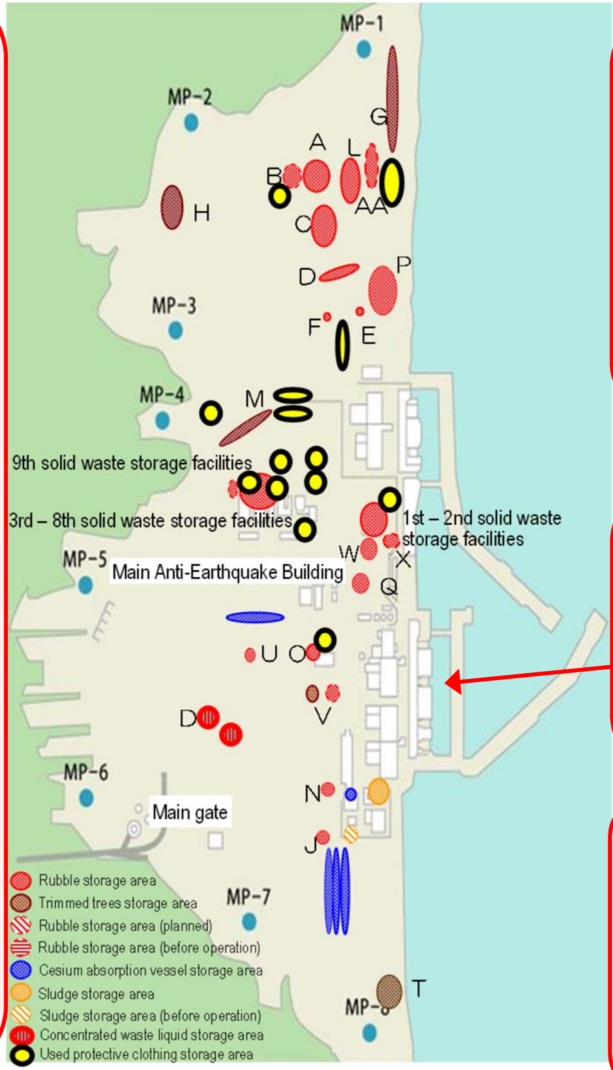
Based on the progress of measures to reduce environmental dosage on site, the site is categorized into two zones: highly contaminated area around Unit 1-4 buildings, etc. and other areas to optimize protective equipment according to each category aiming at improving safety and productivity by reducing load during work.

From March 2016, limited operation started. From March and September 2017, the G Zone was expanded.



R zone (Anorak area)	Y zone (Coverall area)	G zone (General wear)
Full-face mask 	Full-face or half-face masks *1 *2  	Disposable disposable mask 
Anorak on coverall Or double coveralls 	Coverall 	General*3  Dedicated on-site wear 

*1 For works in buildings including water-treatment facilities [multi-nuclide removal equipment, etc.] (excluding site visits), wear a full-face mask.
*2 For works in tank areas containing concentrated salt water or Sr-treated water (excluding works not handling concentrated salt water, etc., patrol, on-site investigation for work planning, and site visits) and works related to tank transfer lines, wear a full-face mask.
*3 Specified light works (patrol, monitoring, delivery of goods brought from outside, etc.)



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 Dose-rate monitor

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.

Installation of steel pipe sheet piles for sea-side impermeable wall

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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