Outline of Decommissioning, Contaminated Water and Treated Water Management

August 25, 2022
Secretariat of the Team for Countermeasures for Decommissioning, Contaminated Water and Treated Water

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

Fuel Removal from SFP: Units 1 and 2 — Rubble removal etc. → Installation of fuel removal equipment → Fuel removal; Units 3 and 4 — Storage / Transportation

First unit	Start of fuel debris retrieval
Unit 2	Within 2021 *Expected to be delayed by approximately 1 year

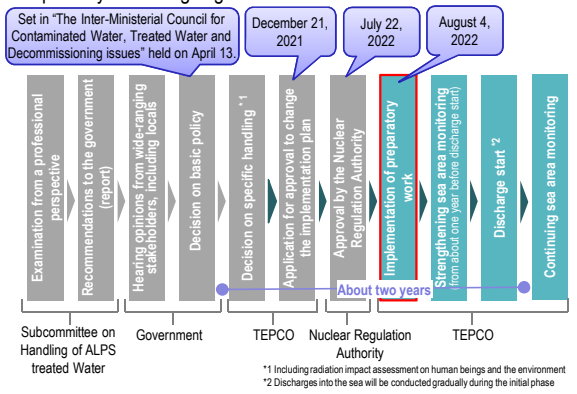
Fuel Debris Retrieval: Units 1 and 3 / Unit 2 — Understanding the situation inside the PCV / Consideration of retrieval methods, etc. → Fuel debris retrieval → Storage / Transportation

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

Measures for 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, the 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 having safety checked by the IAEA. Moreover, accurate information will be disseminated with full transparency on an ongoing basis.



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

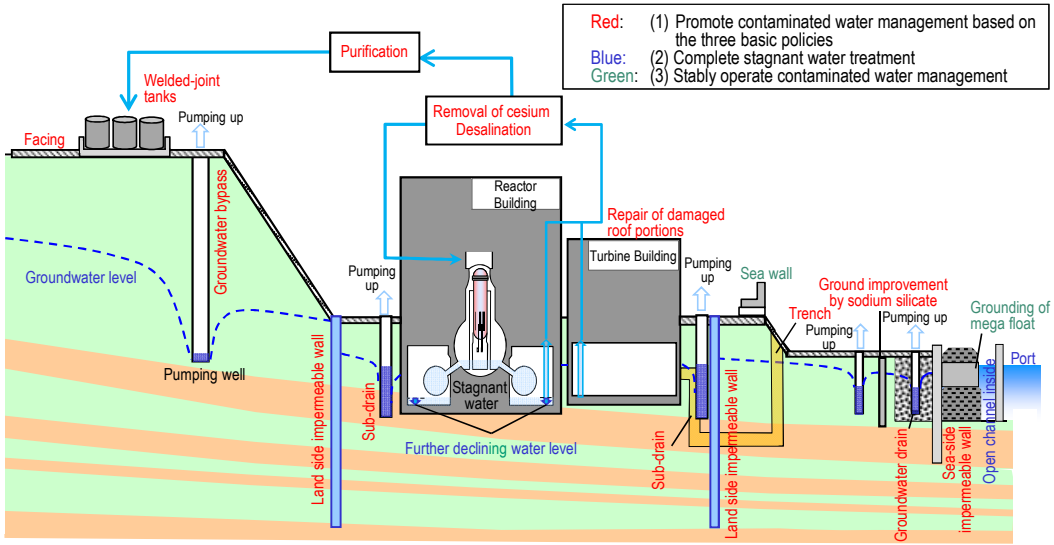
- Strontium-reduced water from other equipment is being re-treated in the Advanced Liquid Processing System (ALPS: multi-nuclide removal equipment) and stored in welded-joint tanks.
- Multi-layered contaminated water management measures, including land-side impermeable walls and sub-drains, have stabilized 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. 130 m^3/day (in FY2021).
- Measures continue to further suppress the generation of contaminated water to 100 m^3/day or less within 2025.

(2) Efforts to complete stagnant water treatment

- To reduce 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 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

- Various measures are underway to prepare for tsunamis. For heavy rain, sandbags are being installed to suppress direct inflow into buildings while work to close openings in buildings and install sea walls to enhance drainage channels and other measures is being implemented as planned.



Progress status

◆ The temperatures of the Reactor and the Primary Containment Vessel of Units 1-3 have been maintained stable.
There was no significant change in the concentration of radioactive materials newly released from Reactor Buildings into the air. It was concluded that the comprehensive cold shutdown condition had been maintained.

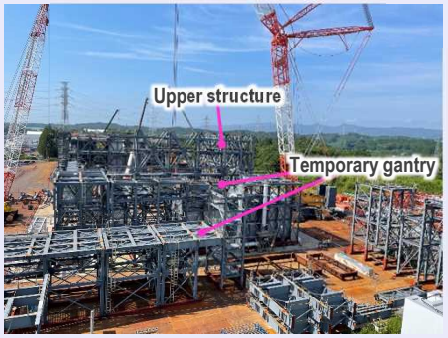
Progress of work inside and outside the site toward installing the Unit 1 large cover

Outside the site, the ground assembly of steel frames and others has been underway as part of efforts to install a large cover, which was completed for the temporary gantry and lower structure and approx. 40% for the upper structure.

Within the site, anchors and base plates are being installed to support the large cover. A temporary gantry is also being installed from the part where anchors and base plates were installed.

As preparation to mitigate any dust scattering during work, as well as sprinkling water using crane, equipment to spray water over the Reactor Building operating floor was installed on the rooftop of the Unit 1 Turbine Building as part of enhanced measures.

After installing a large cover over the Reactor Building in around FY2023, the rubble inside the cover will be removed.



<Work outside the site (August 8, 2022)>

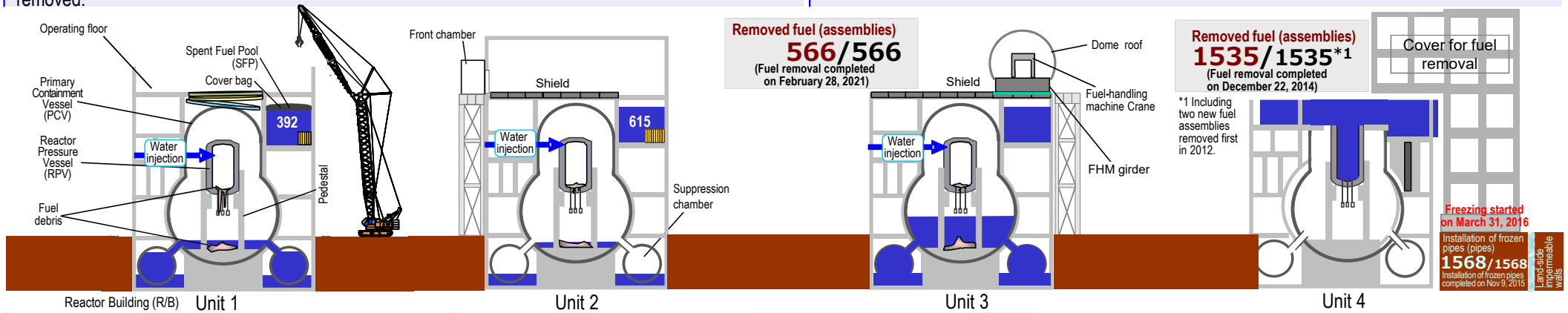
Progress of work around the Unit 1/2 Radioactive Waste Treatment Building

To reduce the risk of delaying the process to remove the pipes of the Unit 1/2 Standby Gas Treatment System (SGTS) and install the Unit 1 cover, the process of work around the Unit 1/2 Radioactive Waste Treatment Building (Rw/B) is being reconfigured.

Rubble removal work around the Unit 1/2 Rw/B resumed from August 23, as the construction of the course for the rubble-removing heavy machine was completed in the range for preceding work.

Work to date to remove the SGTS pipes was reviewed and measures to improve reliability by modifying the cutter and others are being examined.


<Rubble removal work>



Unit 2 Trial retrieval of fuel debris

Regarding the robot arm, by conducting mockup tests in Naraha to simulate the actual site, improvements such as modifying the control program are underway to reduce the risk of contact while removing fuel debris.

Moreover, work to install the isolation room started toward opening the X-6 penetration hatch. Damage in the rubber box detected during the work will be addressed.

On this occasion, when the response status based on the test, measures in the site and others were organized, to increase safety and reliability of the trial retrieval (internal investigation and sampling of debris), the process was reviewed to that which added a preparation period for about one or one and a half year and would start the trial retrieval work from around late FY2023.

Commencement of work on ALPS treated water dilution/discharge facility and related facilities

Work on ALPS treated water dilution/discharge facility and related facilities commenced on August 4.

Preparation is underway, including laying pipes for the measurement / confirmation facility and the transfer facility around K4 area tanks, building the discharge tunnel by shield machine and installing a partitioning weir in the Unit 5 and 6 intake open channel.

Work will continue with safety prioritized.

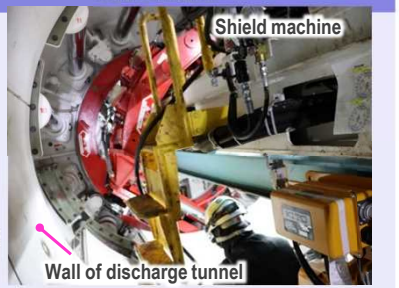


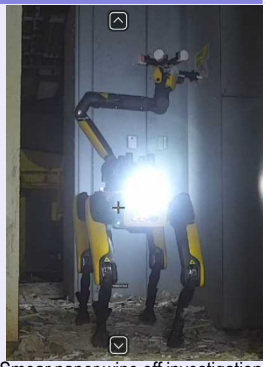
Photo taken from inside the shield machine looking from the rear toward the front
<Shield machine excavation work>

Unit 2 Investigation in the control room of the fuel-handling machine

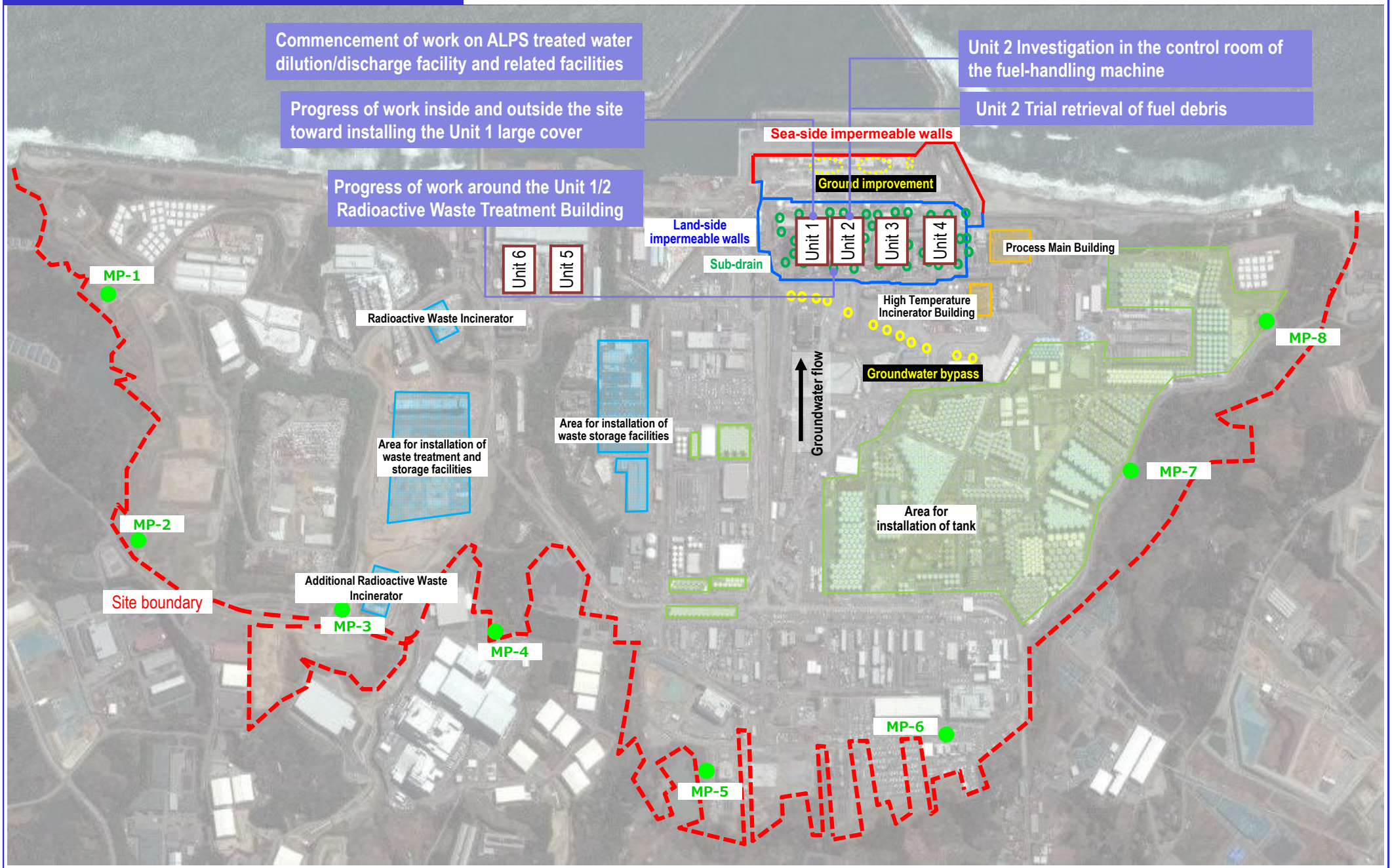
To acquire information to help clarify the accident progress, an investigation, including measuring the dose distribution and the smear paper wipe off, was conducted for the control room of the Unit 2 fuel-handling machine (FHM control room) using the remotely operated robot (SPOT).

On the second floor of the FHM control room, certain places were deemed difficult to investigate by SPOT due to damage detected on the floor surface. For these places, additional investigation is scheduled during work to dismantle the FHM control room, which started from August 22.

Smear samples will be analyzed in the internal laboratory and the external analysis institute.


<Smear paper wipe off investigation by the investigation robot (SPOT)>

Major initiatives – Locations on site

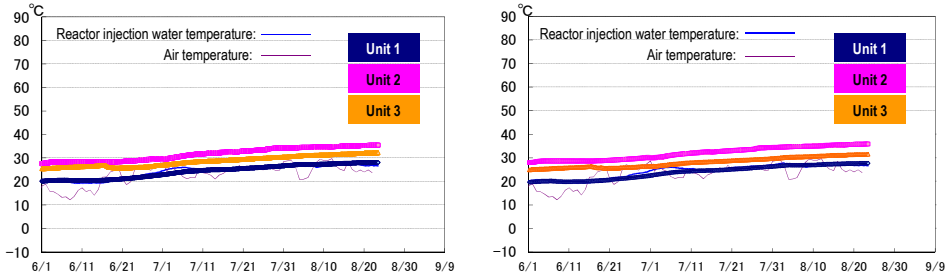


Provided by Japan Space Imaging Corp., photo taken on April 8, 2021
Product (C) [2020] DigitalGlobe, Inc., a Maxar company

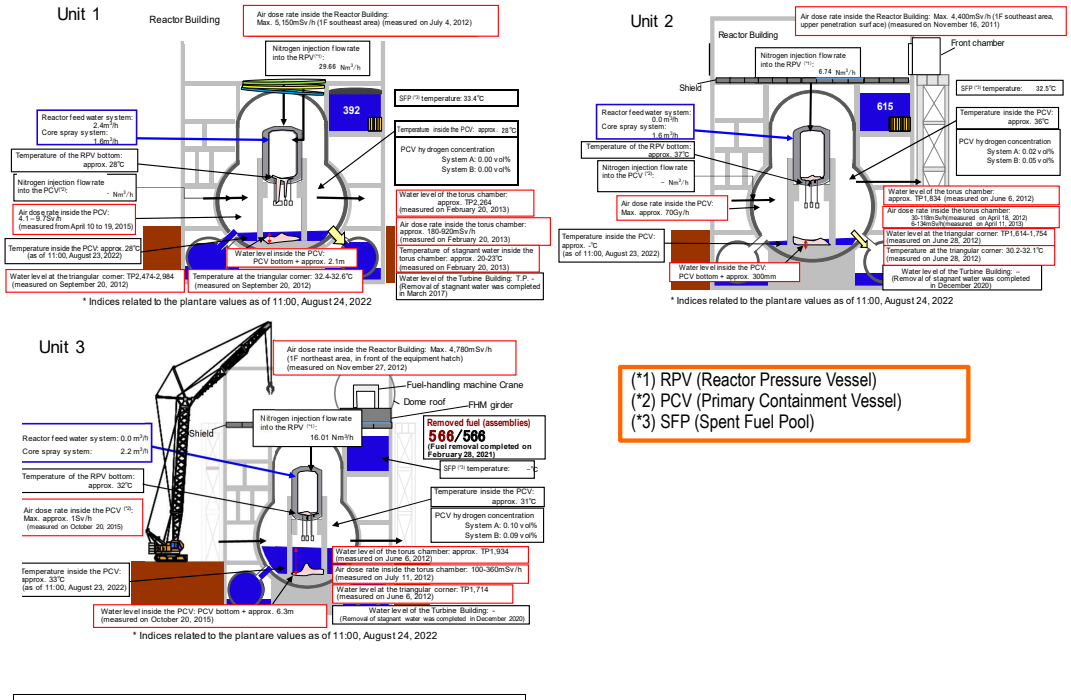
I. Confirmation of the reactor conditions

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. 25 to 40°C for the past month, though it varied depending on the unit and location of the thermometer.



*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.

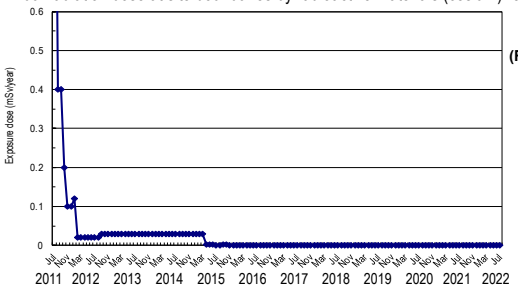


(*1) RPV (Reactor Pressure Vessel)
(*2) PCV (Primary Containment Vessel)
(*3) SFP (Spent Fuel Pool)

Release of radioactive materials from the Reactor Buildings

As of July 2022, 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. 2.1×10^{-12} Bq/cm³ and 1.8×10^{-12} Bq/cm³ 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/cm³Marc
[Cs-137]: 3 x 10^{-5} Bq/cm³
* Data of Monitoring Posts (MP1-MP8).
Data of Monitoring Posts (MPs) measuring the air dose rate around the site boundary showed 0.330 – 1.042 μSv/h (July 27 – August 23, 2022).
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.

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.

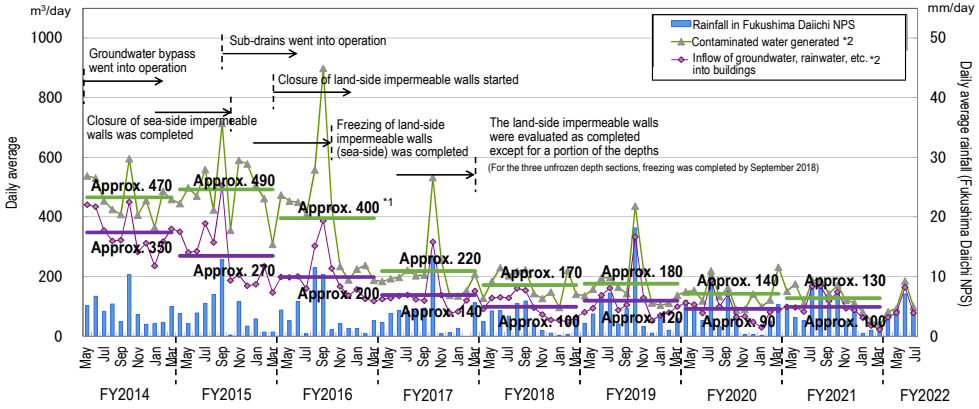
Based on the above, it was confirmed that the comprehensive cold shutdown condition had been maintained and the reactors remained in a stabilized condition.

II. Progress status by each plan

Measures for contaminated water and treated water

➢ 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 portions of building roofs, the amount of contaminated water generated within FY2021 declined to approx. 130 m³/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 method of calculating 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 Water-Treatment Facility special for Sub-drain & Groundwater drains

- At the Water-Treatment Facility Special for Sub-drain & Groundwater drains, release started from September 14, 2015 and up until August 16, 2022, 1,944 release operations had been conducted.
  The water quality of all temporary storage tanks satisfied the operation target.

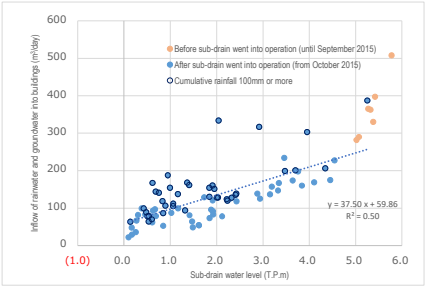


Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Units 1-4 sub-drains

➢ Implementation status of facing

- Facing is a measure involving asphalting the on-site surface to reduce the radiation dose, prevent rainwater infiltrating the ground and reduce the amount of underground water flowing into buildings. As of the end of July 2022, 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 leave the decommissioning work unaffected. As of the end of July 2022, 30% of the planned area (60,000 m²) had been completed.

➢ Status of the groundwater level around buildings

- The groundwater level in the area inside the land-side impermeable walls has been declining every year due to the land-side impermeable walls and the decline in the set water level of the sub-drains. On the mountain side, the average difference between the inside and outside has been 4-5 m. The water level in the bank area has remained low (T.P. 1.4 m) compared with the ground surface (T.P. 2.5 m).
- As the set water level of the sub-drains declined slightly (T.P. -0.55 ⇒ -0.65 m) and others in FY2021, the groundwater level on the sea side of the Unit 1-4 buildings remained low (except during heavy rainfall) compared with the T.P. 2.5 m area.

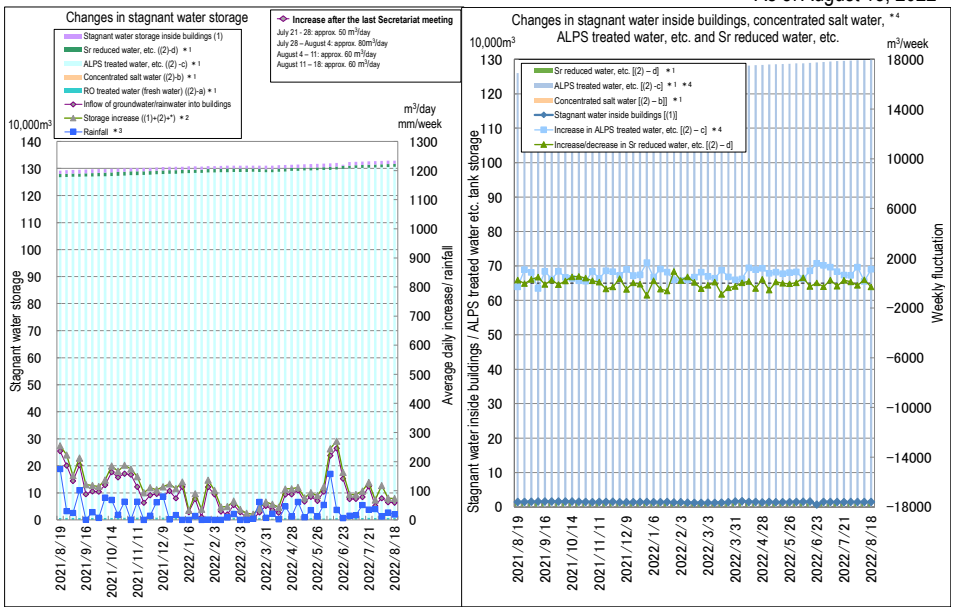
➢ Operation of the multi-nuclide removal equipment

- Regarding the multi-nuclide removal equipment (existing), hot tests using radioactive water are ongoing (System A: from March 30, 2013, System B: from June 13, 2013, System C: from September 27, 2013). On March 23, 2022, a pre-service inspection certificate was granted by the Nuclear Regulation Authority and the entire pre-service inspection was completed. The (additional) multi-nuclide removal equipment went into full-scale operation from October 16, 2017. Regarding the (high-performance) multi-nuclide removal equipment, hot tests using radioactive water have been underway (from October 18, 2014).
- As of August 18, 2022, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 488,000, 741,000 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).
- Treatment measures comprising the removal of strontium by cesium-adsorption apparatus (KURION), the secondary cesium-adsorption apparatus (SARRY) and the third cesium-adsorption apparatus (SARRY II) continued. Up until August 18, 2022, approx. 685,000 m³ had been treated.

➢ Risk reduction of strontium-reduced water

- To reduce the risks of strontium-reduced water, treatment using existing, additional and high-performance multi-nuclide removal equipment is underway. Up until August 18, 2022, approx. 850,000 m³ had been treated.

As of August 18, 2022



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

Figure 3: Status of stagnant water storage

➢ Status of the sea area monitoring related to the handling of ALPS treated water

- The concentration of tritium in seawater within 2km of the port has remained constant for the past year and also remained low at new measurement points within the fluctuation range of seawater in Japan*. The concentration of Cesium-137 increased temporarily, which was considered due to rainfall as in the past fluctuation in seawater around the Fukushima Daiichi Nuclear Power Station. However, it remained constant relative to the measurement value for the past year and at new measurement points and also remained low within the fluctuation range of seawater in Japan*. For tritium, monitoring has been conducted with a lower detection limit since April 18.
- Both concentrations of tritium and Cesium-137 in seawater within 20km of the coast had remained constant for the past year and low within the fluctuation range of seawater in Japan*.
- The concentration of tritium in seawater further than 20km from the coast remained low, including at new measurement points, within the fluctuation range of seawater in Japan*. The concentration of Cesium-137 remained constant for the past year within the fluctuation range of seawater in Japan*.

* : The range of the minimum – maximum values detected during April 2018 – March 2020 in the database below

In Japan (including off the coast of Fukushima Prefecture)
Tritium concentration: 0.043 - 20 Bq/L
Cesium-137 concentration: 0.0010 - 0.38 Bq/L
Off the coast of Fukushima Prefecture
Tritium concentration: 0.043 - 0.89 Bq/L
Cesium-137 concentration: 0.0013 - 0.38 Bq/L

Source: Environmental Radioactivity and Radiation in Japan, Environmental Radiation Database
https://www.kankyo-hoshano.go.jp/data/database/

- For the status of fish and seaweed, although no samples were collected in April, measured data is being verified for samples collected in May.

➢ Collection status of resin leaking from the Reactor Water Clean-up System spent resin tank room in the Unit 3 Filter Sludge Tank Room (FSTR) building

- On September 1, 2020, leakage of waste liquid and spent resin was detected from pipes connected with the Reactor Water Clean-up System spent resin storage tanks on the basement floor of the Unit 3 FSTR building.
- Spent resin having leaked started to be collected from June 2021 and was then transferred to the waste sludge storage tank (B) of the FSTR building.
- Given the reduced resin collection volume due to the incline inside the tanks, work had been temporarily suspended since March 2022 to review the collection method. After the review, the collection was resumed from August 2022.
- As the collection inside the tanks was completed and spent resin was collected to a level lower than the connection of the leakage pipes, the risk of spent fuel leaking outside the tanks was eliminated. Residual spent fuel outside the tanks will be collected by around the end of November and work will be completed within 2022, including clean up and others.

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

- From late April 2021, work to assemble a temporary gantry and others has been underway in a yard outside the site as part of efforts to install a large cover. The ground assembly was completed for the temporary gantry and lower structure and approx. 40%, for the upper structure.
- A work yard was prepared around the Reactor Building and work to install a large cover started from August 2021.
- From April 13, 2022, drilling to install an anchor in the Reactor Building started. A temporary gantry was also installed from the part where anchors and base plates were installed.
- As preparation to mitigate any dust scattering during work, as well as sprinkling water using cranes, equipment to spray water over the Reactor Building operating floor was installed on the rooftop of the Unit 1 Turbine Building as part of enhanced the measures.

➢ Main work to help spent fuel removal at Unit 2

- Decontamination to suppress dust scattering on the top floor of the Reactor Building was completed in December 2021 and contamination reduction was confirmed based on smear sampling results. Work to install shielding started from February within a range including above the reactor well, where the dose was observed to peak and will be completed at the end of May.
- From October 28, 2021, ground improvement work started before installing the gantry for fuel removal and was completed on April 19, 2022. Work to install the gantry foundation will then proceed.
- Outside the site, work to prepare a yard for ground assembly of steel frames was completed on March 18. Before the ground assembly, preparation will proceed.

Retrieval of fuel debris

➢ Progress status toward Unit 1 PCV internal investigation

- To acquire information related to the construction plan to collect deposits and others toward fuel debris retrieval, a remotely operated underwater vehicle (ROV) will be inserted from X-2 penetration into the basement within the PCV to investigate inside and outside the pedestal.
- During June 7-11, the thickness of deposits was measured using the remotely operated submersible ROV-C robot.

➢ Progress status toward Unit 2 PCV internal investigation and trial retrieval

- The trial retrieval equipment for the Unit 2 fuel debris, which had been developed in the UK, arrived in Japan on July 10, 2021.
- The ongoing performance verification test in a domestic factory (Kobe), which started from August 2021, finished on January 21, 2022.
- The equipment was transported from January 28, 2022 and the robot arm arrived on January 31 and the enclosure, on February 4, at the Naraha Center for Remote Control Technology Development of the Japan Atomic Energy Agency (JAEA) (hereinafter referred to as the “Naraha mockup facility”).
- From February 14, 2022, the performance verification test and operational training started at the Naraha mockup facility.

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 July 2022, the total storage volume for concrete and metal rubble was approx. 329,900 m^3 (+3,200 m^3 compared to the end of June with an area-occupation rate of 88%). The total storage volume of trimmed trees was approx. 129,300 m^3 (+100 m^3, with an area-occupation rate of 74%). The total storage volume of used protective clothing was approx. 30,400 m^3 (-700 m^3, with an area-occupation rate of 58%). The increase in rubble was attributable to work around Units 1-4 buildings, construction related to the port, decontamination of flanged tanks and others. As of the end of July 2022, there were ten temporary deposits with storage capacity exceeding 1,000m^3, storage 47,900m^3.

➢ Management status of secondary waste from water treatment

- As of August 4, 2022, the total storage volume of waste sludge was 442 m^3 (area-occupation rate: 63%), while that of concentrated waste fluid was 9,380 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 5,402 (area-occupation rate: 85%).

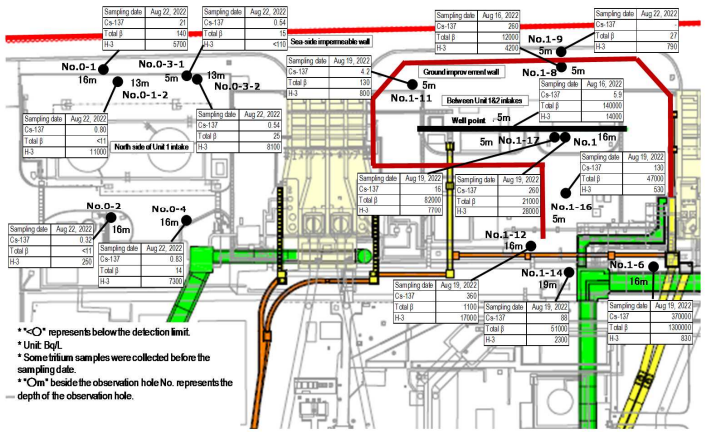
➢ Status of the additional Radioactive Waste Incinerator

- On May 23, the operation of the additional Radioactive Waste Incinerator resumed.
- On June 10, water was detected inside the fly removal system, the incineration operation was suspended for inspection. No external leakage of radioactive materials was identified.
- Equipment to supply water to the system was investigated and no abnormality was detected in any portion. This was assumed to be attributable to frequent starting and stopping of the burner, subsequently resulting in over-supply of the exhaust gas spray following the temperature change.
- Before resuming operation, the temperature control value will be changed and the properties of the ash will be verified.
- On June 18, during a patrol, cracking and others were detected in the seal plate over the joint of the secondary burner and stoker and in the welded part of the rotary kiln joint cylinder.
- As when the cracks were detected, the incineration operation was suspended and negative pressure was maintained by a blower in the area within the affected system, no radioactive material was deemed to have leaked outside.
- After observing the crack surface, the cracking was deemed attributable to ductile fracture by excessive stress, caused by the impact of the Fukushima Offshore Earthquake on March 16. Moreover, cracking of the welded parts due to insufficient strength was also detected.
- Based on occurrence of the above issues, similar facility parts were investigated and new issues, such as loose bolts and cracks in furnace refractory materials, were detected. Parts of these issues are being repaired and other treatment, implemented with restoration targeted for around September.

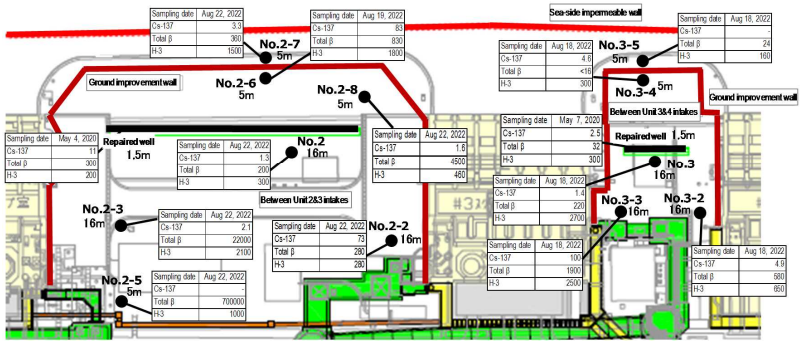
Effective dose-reduction at site boundaries and purification of port water to mitigate the impact of radiation on the external environment

➢ 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 has remained constant overall but increased temporarily from April 2020 and is even increasing or declining at many observation holes at present, including Nos. 0-1-2, 0-3-1, 0-3-2 and 0-4. The trend continues to be monitored carefully.
- 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 Nos. 1-14 and 1-17 but has otherwise remained constant or been declining overall. The concentration of total β radioactive materials has remained constant overall but been increasing or declining at many observation holes, including Nos. 1-6, 1-9, 1-11, 1-12, 1-14, 1-16 and 1-17. The trend continues to be monitored carefully.
- 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. It has been increasing and declining at Nos. 2-3, 2-5, 2-6 and 2-7 but has remained constant overall. The concentration of total β radioactive materials has remained constant overall but been increasing or declining at Nos. 2-3, 2-5 and 2-6. The trend continues to be monitored carefully.
- 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. It has remained constant or been declining overall. The concentration of total β radioactive materials has remained constant overall but has been increasing or declining at many observation holes, including Nos. 3-4 and 3-5. The trend continues to be monitored carefully.
- In the groundwater on the east side of the Turbine Buildings, as with the total β radioactive materials, the concentration of cesium has also remained constant but been increasing or declining and exceeded the previous highest record at some observation holes. Investigations into fluctuation are underway for Nos. 0-3-2, 1, 1-6, 2-6 and 3-3.
- The concentration of radioactive materials in drainage channels has remained constant overall, despite increasing during rainfall.
- In the open channel area of seawater intake for Units 1 to 4, the concentration of radioactive materials in seawater has remained below the legal discharge limit and been declining long term, despite temporary 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 radioactive materials in seawater has remained below the legal discharge limit and been declining long term, despite temporary 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. Regarding the concentration of Cs-137, a temporary increase was sometimes observed on the north side of the Unit 5 and 6 outlets and near the south outlet due to the influence of weather, marine meteorology and other factors. Regarding the concentration of Sr-90, variation has been observed in FY2021 in the area outside the port (north and south outlets). Monitoring of the tendency continues, including the potential influence of the weather, marine meteorology and others.



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



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

Figure 4: Groundwater concentration on the Turbine Building east side

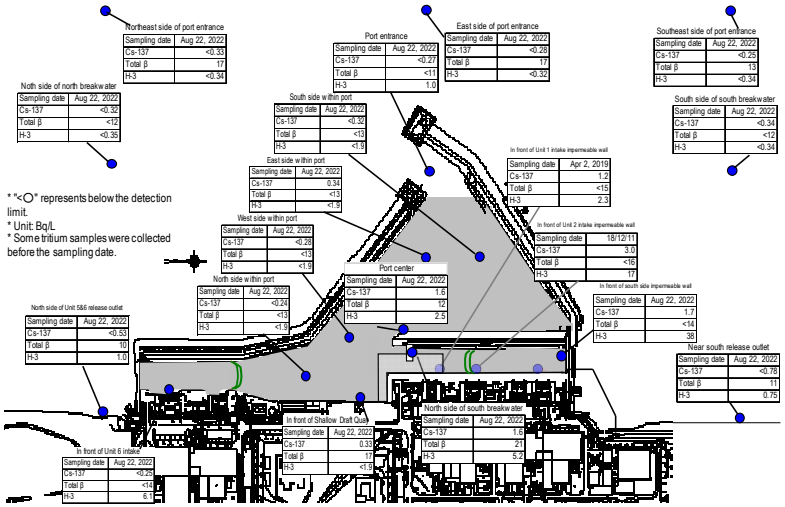


Figure 5: Seawater concentration around the port

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 April to June 2022 was approx. 9,100 (cooperating company workers and TEPCO HD employees), which exceeded the monthly average workforce (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 September 2022 (approx. 4,000 workers 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) for the most recent 2 years were maintained, with approx. 3,000 to 4,200.
- The number of workers from within Fukushima Prefecture remained constant and those outside, decreased slightly. The local employment ratio (cooperating company workers and TEPCO HD employees) as of July 2022 remained constant at around 70%.
- The average exposure doses of workers were approx. 2.54 and 2.60 and 2.51 mSv/person-year during FY2019, 2020 and 2021, respectively. (The legal exposure dose limits are 100 mSv/person and 50 mSv/person-year over five years, the TEPCO HD management target is 20 mSv/person-year).
- For most workers, the exposure dose was sufficiently within the limit and allowed them to continue engaging in radiation work.

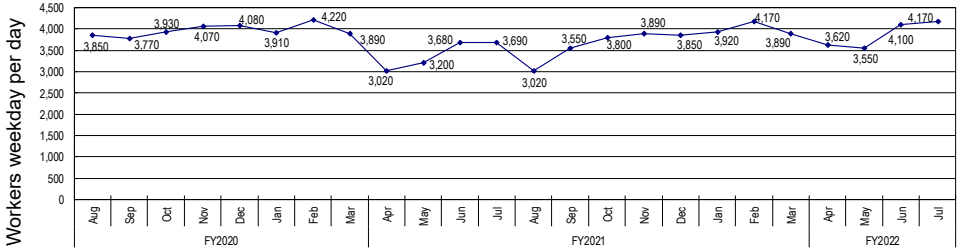


Figure 6: Changes in the average number of workers weekday per day for each month of the past 2 years (actual values)

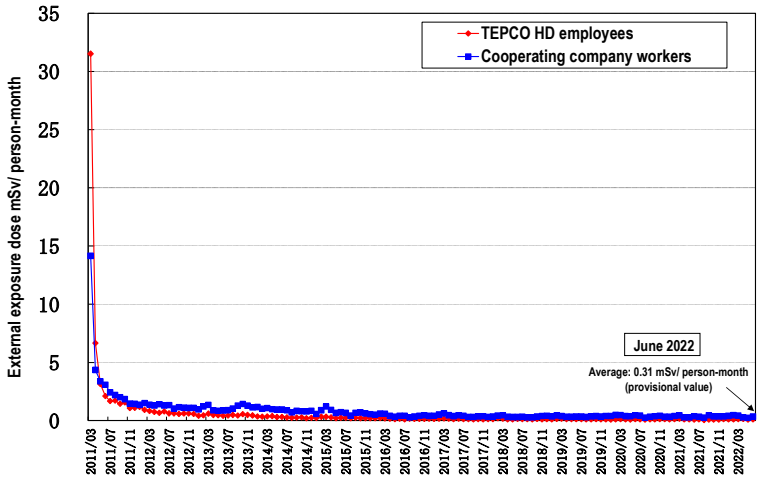


Figure 7: Changes in monthly average exposure dose of individual worker
(monthly exposure dose since March 2011)

➢ Countermeasures to suppress the spread of COVID-19 infections

- Since mid-July, “not to bring” the virus into the nuclear power station, the following additional measures were noted for TEPCO HD and cooperating companies:
  - Employees must check their own physical condition and that of their family members. Those at risk of infection, such as those having moved outside Fukushima Prefecture and their family members having moved from outside, are required to early detect infections by voluntarily undergoing an antigen test.
  - When commuting, an ongoing occupancy rate of 50% continues to be recommended. Attention is drawn to the need to avoid smoking on board, wear masks, ensure ventilation, refrain from conversation and others.
- From the beginning of August, infections have been increasing than ever, mainly among cooperating company employees. Based on this status, the following countermeasures are implemented to suppress the infection spreading:
  - Cooperating companies which recorded many infections were visited to inspect the status of the infection suppressing countermeasures, such as ventilation within the office and instruct strict implementation of these countermeasures (particularly when commuting and taking a break).
  - Common areas within the site are simultaneously disinfected. Before coming to the company after the Obon holiday, employees must strictly check their own physical condition and voluntarily undergo an antigen test.
- The ongoing basic countermeasures to prevent infection spreading, such as requiring employees to take their temperature before coming to the office, wear masks at all times, avoid the “Three Cs” by using the rest house in shifts, eat silently and carefully select business travel, will continue to be properly implemented to proceed with decommissioning work, prioritizing safety above all.
- As of August 24, 2022, 829 workers (including 114 TEPCO HD employees, 711 cooperating company workers, three business partner company employees and one temporary worker) of the Fukushima Daiichi Nuclear Power Station had contracted COVID-19, an increase of 422 workers (including 49 TEPCO HD employees, 372 cooperating company workers and one business partner company employee) from those in the previous published material (as of July 27).
- No significant influence on decommissioning work, such as a corresponding delay to work processes due to this infection, had been identified.

➢ Status of heat stroke cases

- In FY2022, measures to further prevent heat stroke commenced from April to cope with the hottest season.
- FY2022, seven workers suffered heat stroke due to work up until August 22 (in FY2021, seven workers up until the end of August). Continued measures will be taken to prevent heat stroke.

Others

➢ Progress status of the Mid-and-Long-Term Plan of accident investigation in the Fukushima Daiichi Nuclear Power Station

- As part of efforts to investigate and analyze the accident in the Fukushima Daiichi Nuclear Power Station (hereinafter referred to as 1F), many matters were clarified in the “Internal Accident Report” and “Examination of Unsolved Issues” and others and including instructions provided by internal and external accident investigation committees and others, reflected in the safety measures appropriately. To ensure no recurrence and acquire information to help clarify the whole picture (an in-depth study of the accident progress) and make power reactors even safer, many insights need to be drawn by acquiring on-site information (confirming the actual accident situation) and utilizing and subsequently reflecting these insights in safety measures.
- At the same time, steady decommissioning in 1F is also important. New useful insights for accident investigation and analysis may be acquired in the course of on-site work. However, inadequate data sampling may modify on-site conditions and result in valuable information being lost. The results of the accident investigation and analysis need to be appropriately organized and shared to proceed with on-site work.
- Therefore, to help implement future investigations of the accident in 1F according to plan and substantially by TEPCO HD, the Mid-and-Long-Term Plan of the 1F accident investigations was formulated in November 2021 and is being revised based on the latest work progress and status.

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 August 8 - 22)"; unit (Bq/L); ND represents a value below the detection limit

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.

Summary of TEPCO data as of August 23, 2022

Cesium-134	:	ND(0.35)		
Cesium-137	:	1.6		
Total β	:	12		
Toritium	:	4.3		※1

Cesium-134	:	3.3	(H25/12/24) →	ND(0.31)	Below 1/10
Cesium-137	:	7.3	(H25/10/11) →	ND(0.27)	Below 1/20
Total β	:	69	(H25/8/19) →	ND(11)	Below 1/6
Toritium	:	68	(H25/8/19) →	1.0	Below 1/60

Cesium-134	:	3.3	(H25/10/17) →	ND(0.27)	Below 1/10
Cesium-137	:	9	(H25/10/17) →	0.34	Below 1/20
Total β	:	74	(H25/8/19) →	ND(13)	Below 1/5
Toritium	:	67	(H25/8/19) →	ND(2.2)	Below 1/30

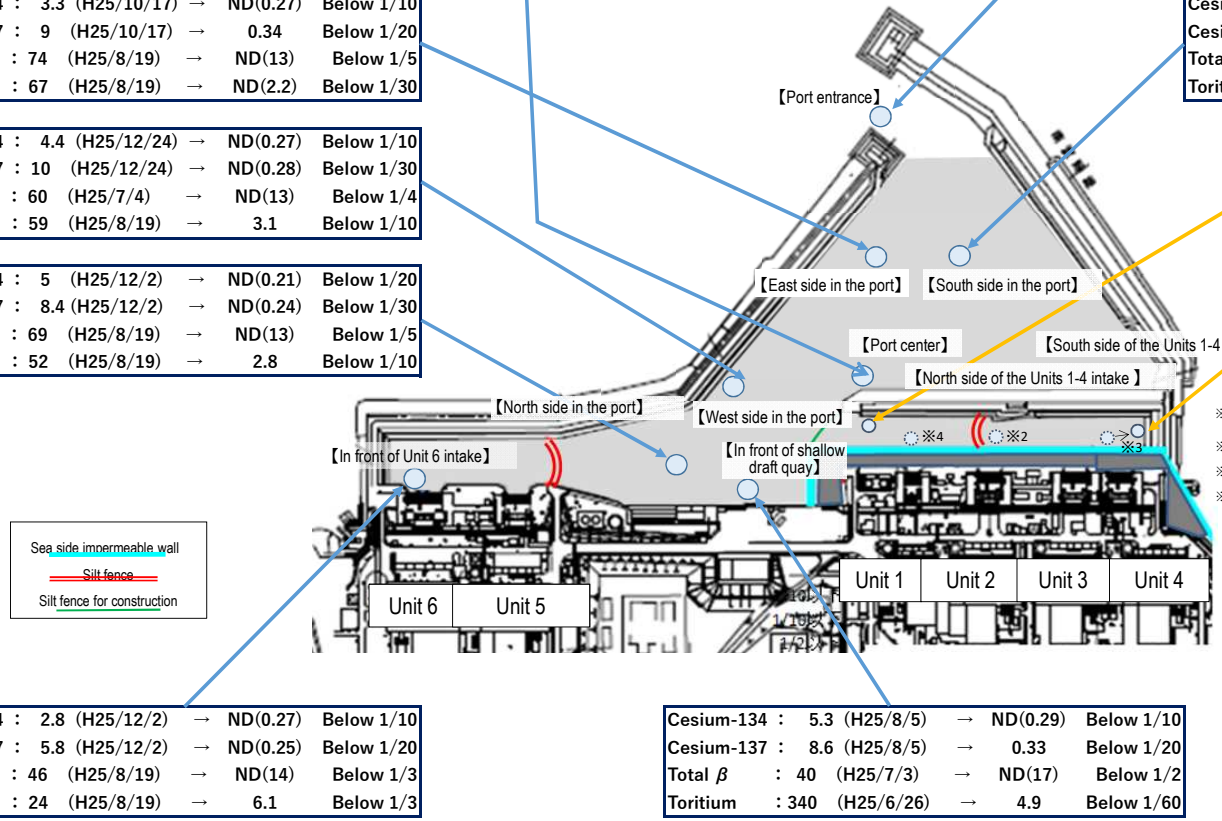
Cesium-134	:	3.5	(H25/10/17) →	ND(0.32)	Below 1/10
Cesium-137	:	7.8	(H25/10/17) →	ND(0.32)	Below 1/20
Total β	:	79	(H25/8/19) →	ND(13)	Below 1/6
Toritium	:	60	(H25/8/19) →	ND(2.1)	Below 1/20

Cesium-134	:	4.4	(H25/12/24) →	ND(0.27)	Below 1/10
Cesium-137	:	10	(H25/12/24) →	ND(0.28)	Below 1/30
Total β	:	60	(H25/7/4) →	ND(13)	Below 1/4
Toritium	:	59	(H25/8/19) →	3.1	Below 1/10

Cesium-134	:	32	(H25/10/11) →	ND(0.29)	Below 1/100
Cesium-137	:	73	(H25/10/11) →	1.6	Below 1/40
Total β	:	320	(H25/8/12) →	21	Below 1/10
Toritium	:	510	(H25/9/2) →	5.2	Below 1/90

Cesium-134	:	5	(H25/12/2) →	ND(0.21)	Below 1/20
Cesium-137	:	8.4	(H25/12/2) →	ND(0.24)	Below 1/30
Total β	:	69	(H25/8/19) →	ND(13)	Below 1/5
Toritium	:	52	(H25/8/19) →	2.8	Below 1/10

Cesium-134	:	ND(0.25)
Cesium-137	:	1.7
Total β	:	ND(14)
Toritium	:	50 ※1



Cesium-134	:	2.8	(H25/12/2) →	ND(0.27)	Below 1/10
Cesium-137	:	5.8	(H25/12/2) →	ND(0.25)	Below 1/20
Total β	:	46	(H25/8/19) →	ND(14)	Below 1/3
Toritium	:	24	(H25/8/19) →	6.1	Below 1/3

Cesium-134	:	5.3	(H25/8/5) →	ND(0.29)	Below 1/10
Cesium-137	:	8.6	(H25/8/5) →	0.33	Below 1/20
Total β	:	40	(H25/7/3) →	ND(17)	Below 1/2
Toritium	:	340	(H25/6/26) →	4.9	Below 1/60

※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

Source: TEPCO website Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station http://www.tepco.co.jp/decommission/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 August 8 - 22)

Summary of TEPCO data as of August 23, 2022

	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(0.34)	
Cesium-137	: ND	(H25)	→	ND(0.33)	
Total β	: ND	(H25)	→	17	
Toritium	: ND	(H25)	→	_	

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

Cesium-134	: ND	(H25)	→	ND(0.30)	
Cesium-137	: 1.6	(H25/10/18)	→	ND(0.28)	Below 1/2
Total β	: ND	(H25)	→	17	
Toritium	: 6.4	(H25/10/18)	→	_	

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

Cesium-134	: ND	(H25)	→	ND(0.30)	
Cesium-137	: ND	(H25)	→	ND(0.25)	
Total β	: ND	(H25)	→	13	
Toritium	: ND	(H25)	→	_	

Cesium-134	: ND	(H25)	→	ND(0.29)	
Cesium-137	: ND	(H25)	→	ND(0.32)	
Total β	: ND	(H25)	→	ND(12)	
Toritium	: 4.7	(H25/8/18)	→	_	

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

Cesium-134	: 3.3	(H25/12/24)	→	ND(0.31)	Below 1/10
Cesium-137	: 7.3	(H25/10/11)	→	ND(0.27)	Below 1/20
Total β	: 69	(H25/8/19)	→	ND(11)	Below 1/6
Toritium	: 68	(H25/8/19)	→	1.0	Below 1/60

【Port entrance】

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

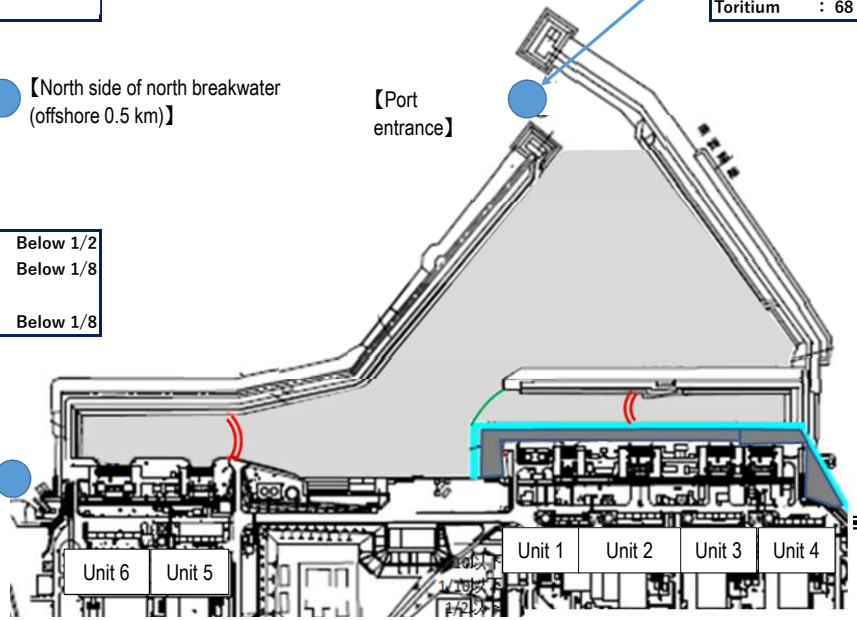
Cesium-134	: 1.8	(H25/6/21)	→	ND(0.63)	Below 1/2
Cesium-137	: 4.5	(H25/3/17)	→	ND(0.53)	Below 1/8
Total β	: 12	(H25/12/23)	→	10	
Toritium	: 8.6	(H25/6/26)	→	1.0	Below 1/8

Cesium-134	: ND	(H25)	→	ND(0.34)	
Cesium-137	: ND	(H25)	→	ND(0.34)	
Total β	: ND	(H25)	→	ND(12)	
Toritium	: ND	(H25)	→	_	

Cesium-134	: ND	(H25)	→	ND(0.73)	
Cesium-137	: 3	(H25/7/15)	→	ND(0.78)	Below 1/3
Total β	: 15	(H25/12/23)	→	11	
Toritium	: 1.9	(H25/11/25)	→	ND(0.33)	Below 1/2

【North side of Unit 5 and 6 release outlet】

【Near south release outlet】



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/decommission/planaction/monitoring/index-j.html

TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site Layout

Appendix 2

August 25, 2022

- Rubble storage area
- Rubble storage area (planned)
- Used protective clothing
- Trimmed trees area
- Mid-/ low-level contaminated water tank (existing)
- Mid-/ low-level contaminated water tank (planned)
- Secondary waste from water treatment (existing)
- Secondary waste from water treatment (planned)
- Waste treatment facility
- Non-controlled facility
- Analysis and research facility

Trimmed trees (outdoor accumulation)

Temporary trimmed trees storage pool

Temporary soil-covered type

Rubble (outdoor accumulation)

Rubble storage tent

Inside the rubble storage tent

Rubble (covered by sheet)

Solid waste storage facility

Rubble (container storage)

Tank installation status

Spent adsorption vessel temporary storage facility

Temporary waste sludge storage

MP-1 Temporary trimmed trees storage pool
MP-2
MP-3 Trimmed trees
MP-4 Trimmed trees
MP-5 JAEA Analytical Facility Management Building
MP-6 Temporary rest house outside the site
MP-7 Water desalinations (evaporative concentration)
MP-8 Temporary trimmed trees storage pool

Rubble storage tent
Additional Radioactive Waste Incinerator
Large Waste Storage
Radioactive Waste Incinerator
Futaba town
Unit 6
Unit 5
Unit 1
Unit 2
Unit 3
Unit 4
Town boundary
Vehicles maintenance site
Water treatment facility for Sub-drain
Water treatment facility for Sub-drain and others
Periodical Inspection Material Storage (cutting of flanged-tanks)
Temporary Cask Custody Area
Main Anti-Earthquake Building
JAEA Analytical Facility Management Building
JAEA Analytical Facility Laboratory-1
Vehicle screening and decontamination site
Multi-nuclide removal equipment
Additional multi-nuclide removal equipment
High-performance multi-nuclide removal equipment
Spent absorption vessel temporary storage
Large equipment decontamination facility
Land-side impermeable walls with frozen soil
Land-side impermeable walls freezing plant
Mega float
Okuma town
Pipe route
Underground reservoirs
Partner Companies' Building
Groundwater bypass temporary storage tank
Temporary rest house outside the site
New Administration Office Building
Heliport
Large rest house
Access control facility
Common pool
Sea side impermeable wall
Water desalinations (RO)
Cesium absorption apparatus (Incineration Workshop Building)
Decontamination instruments (Process Building)
3rd cesium adsorption apparatus (Onsite Bunker Building)
2nd cesium adsorption apparatus
Cesium absorption vessel temporary storage
Water desalinations (evaporative concentration)
Water desalinations (RO)
Site boundary

Rubble
Used protective clothing
Trimmed trees

K1 K2 K3 K4
H1 H2 H3 H4 H5 H6 H8 H9
J1 J2 J3 J4 J5 J6 J7 J8 J9
B C D E F
G1 G1 South G3・G4・G5 G6 G7

Provided by Japan Space Imaging Corporation, photo taken on April 8, 2021
Product(C) [2020] DigitalGlobe, Inc., a Maxar company

0m 100m 500m 1000m

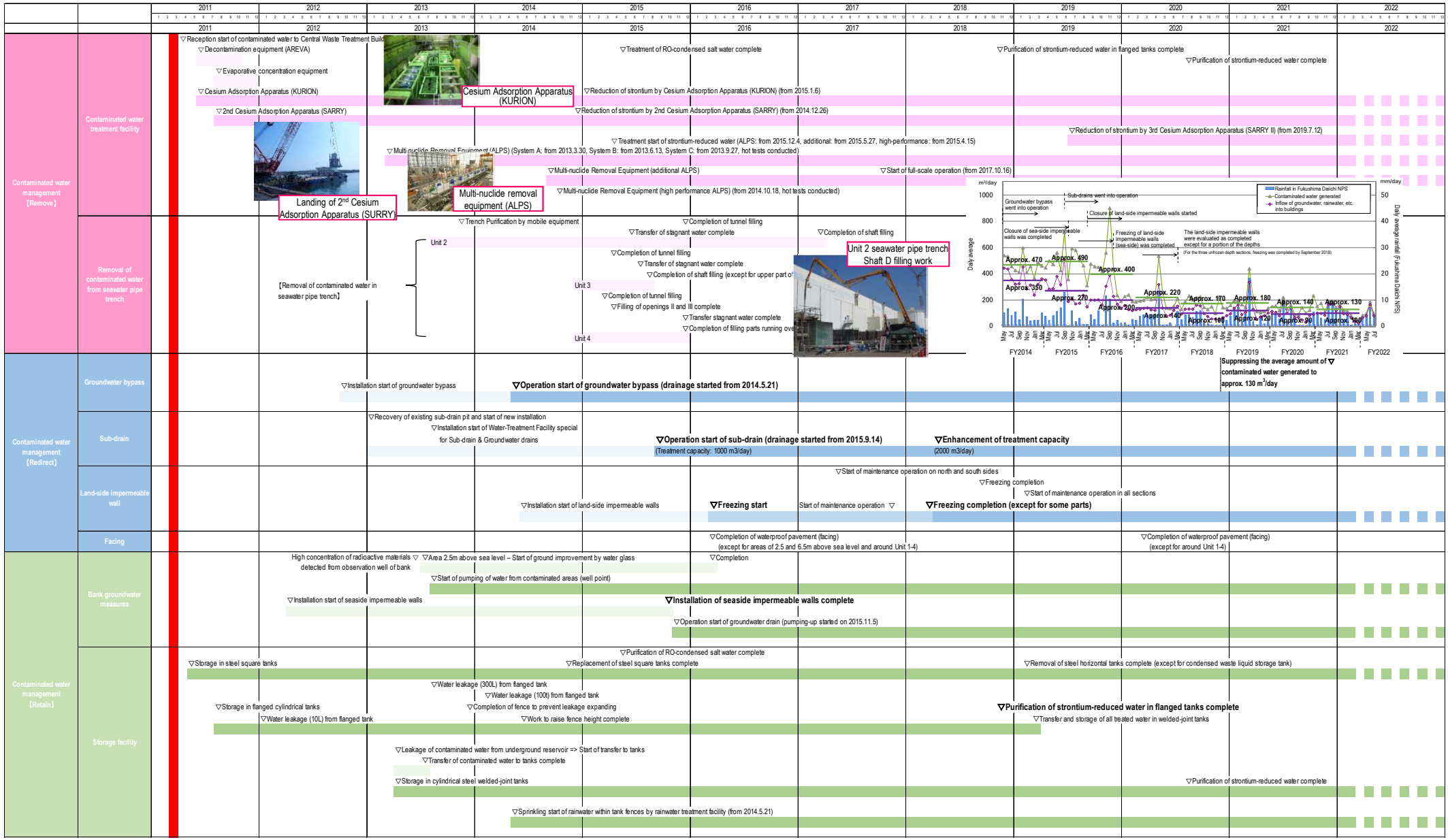
1-1 Contaminated water management

- Efforts to promote contaminated water management based on three basic policies:
  ① “Remove” the source of water contamination ② “Redirect” fresh water from contaminated areas
  ③ “Retain” contaminated water from leakage

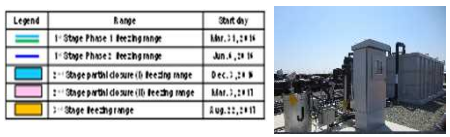
Milestones of the Mid- and-Long-Term Roadmap (major target processes)

- [Completed] Suppressing the amount of contaminated water generated to 150 m³/day or less (within 2020)
- Suppressing the amount of contaminated water generated to 100 m³/day or less (within 2025)

Reference
August 25, 2022
Secretariat of the Team for Countermeasures for Decommissioning, Contaminated Water and Treated Water




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



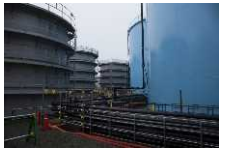
Pumping well


Sub-drain purification system


Land-side impermeable wall brine (refrigerant) circulation pipe

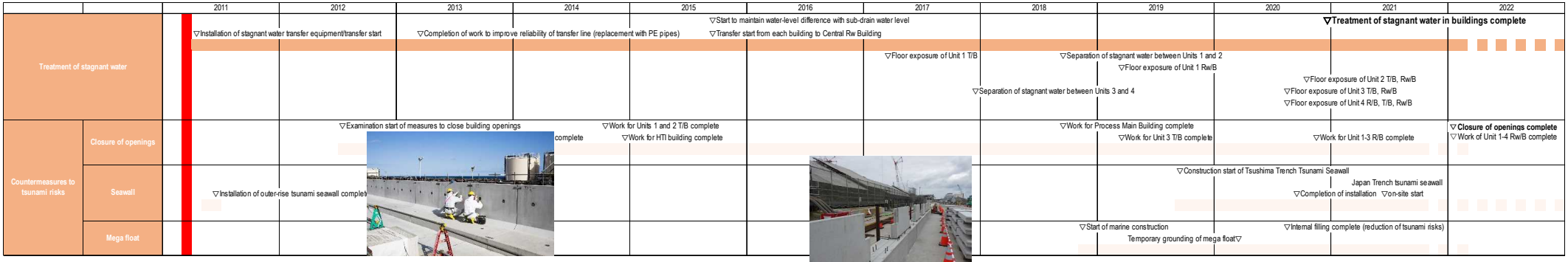

Construction of welded-joint tanks


Placement of seaside impermeable walls complete


Flanged and welded-joint tanks

1-2 Contaminated water management

Milestones of the Mid- and-Long-Term Roadmap (major target processes)
- [Completed] Treatment of contaminated water in buildings* (within 2020)
  * Except for Unit 1-3 Reactor Buildings, Process Main Building and High-Temperature Incinerator Building
- Reducing contaminated water in Reactor Buildings to about half the amount at the end of 2020 (FY2022-2024)



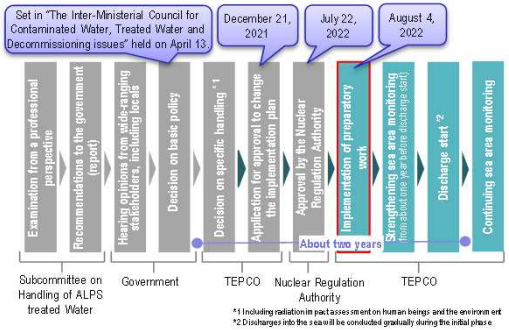
Chishima Trench Tsunami Seawall complete

Construction of Japan Trench Tsunami Seawall

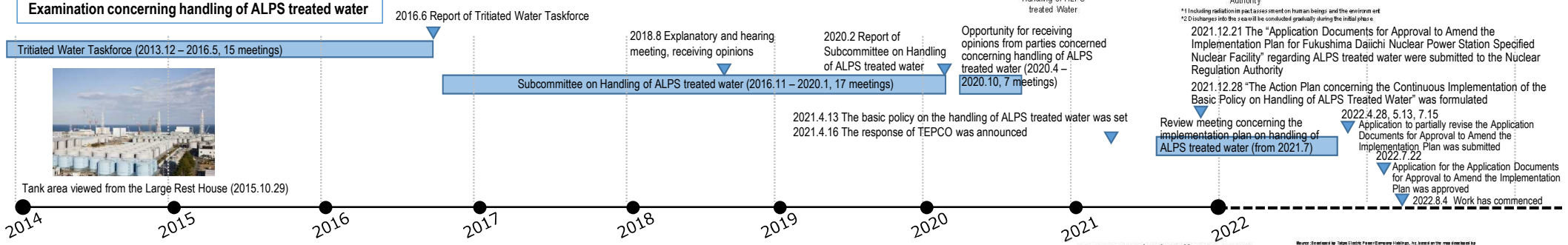
2 Handling of ALPS treated water

In “The Inter-Ministerial Council for Contaminated Water, Treated water and Decommissioning” held on April 13, the basic policy on how to handle ALPS treated water was set. Based on this, the response of TEPCO was announced on April 16.

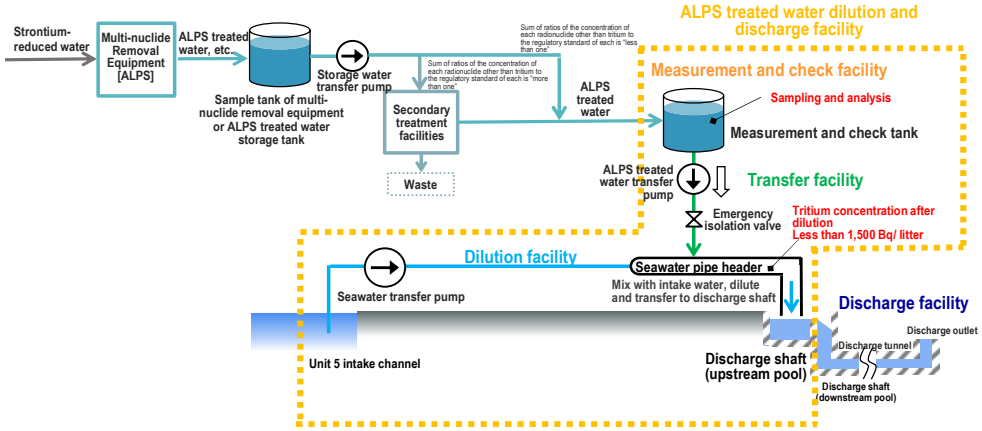
Regarding the discharge of ALPS treated water into the sea, TEPCO must comply with regulatory and other safety-related standards to ensure the safety of the public, surrounding environment and agricultural, forestry and fishery products. To minimize adverse impacts on reputation, monitoring will be further enhanced, objectivity and transparency ensured by engaging with third-party experts and safety checked by the IAEA. Moreover, accurate information will be disseminated continuously and in a highly transparent manner.

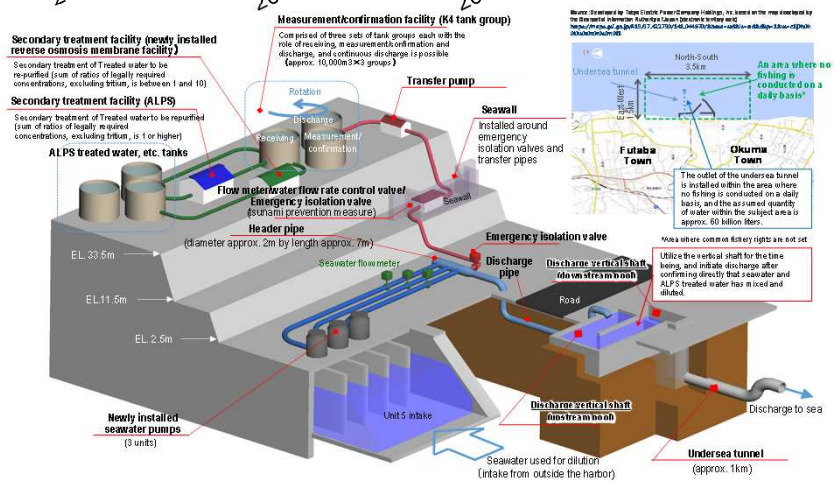


Examination concerning handling of ALPS treated water



【Overview of ALPS treated water dilution and discharge facility】





3 Removal of fuel from spent pool

Milestones of the Mid- and-Long-Term Roadmap (major target processes)

- Completion of Unit 1-6 fuel removal (within 2031)
- Completion of installation of Unit 1 large cover (around FY2023), start of Unit 1 fuel removal (FY2027-2028)
- Start of Unit 2 fuel removal (FY2024-2026)

Legend: Rubble removal, etc. | Installing a fuel removal machine | Fuel removal | Storage and handling of fuel

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

▼ 2011.11- 2012.7 Removal of rubble on the Reactor Building top floor
▼ 2012.4-2013.3 Ground improvement and foundation work
▼ 2013.4-2013.7 Installation of external walls and roof panels
▼ 2013.6-2013.10 Installation of overhead crane and fuel-handling machine
▼ 2013.8-2013.10 Removal of rubble inside the reactor well and pool
▼ 2013.11.18 Start of fuel removal

All fuel assemblies from Unit 4 had been removed by December 2014.


<Unit 4 Cover for fuel removal>

In the Mid- and-Long-Term Roadmap, the Phase 1 target involved starting to remove fuel from inside the spent fuel pool (SFP) of the 1st Unit within two years of completing Step 2 (by December 2013).
On November 18, 2013, fuel removal from Unit 4, namely the first Unit, got underway and Phase 2 of the roadmap started.
On November 5, 2014, within a year of commencing fuel removal work, 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 on December 22, 2014. (two 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.


Fuel removal

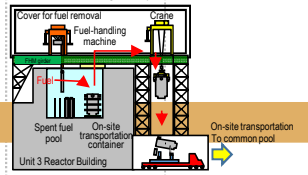
Unit 4 ▼ 2014.12.22 Fuel removal was completed (1533 assemblies)

All fuel assemblies from Unit 3 had been removed by February 2021.

Before installing a cover for fuel removal, the process of removing large rubble from the spent fuel pool was completed in November 2015. To ensure safe and steady fuel removal, training via remote control was conducted at the factory using the actual fuel-handling machine to be installed on site (February – December 2015). Installation of the fuel removal cover was completed on February 23, 2018.
With fuel removal in mind, rubble retrieval training inside the pool, which was scheduled in conjunction with fuel removal training, started from March 15, 2019 and fuel removal started from April 15, 2019. Fuel removal was completed on February 28, 2021.

▼ 2013.10 Completion of removal of large rubble on the Reactor Building top floor
▼ 2015.8 Completion of removal of the fuel-handling machine B within the spent fuel pool
▼ 2016.12 Completion of shielding on the Reactor Building top floor
▼ 2017.1 Installation start of a cover for fuel removal
▼ 2019.4.15 Start of fuel removal

Overview of the fuel-handling facility inside the cover



<Unit 3 Cover for fuel removal (dome roof) 2019.2.21>

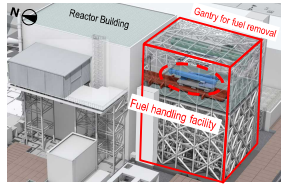
Unit 3 ▼ 2021.2.28 Fuel removal completed (566 assemblies)

For Unit 2, with the removal of spent fuel in mind, a “gantry for fuel removal” (gantry and front room) will be constructed on the south side of the building.

▼ 2015.3-2016.11 Yard construction
▼ 2016.9-2017.4 West-side gantry installation work
▼ 2017.5 Opening a hole in the west-side external wall
▼ 2018.8-2020.12 Moving and containment of remaining objects
▼ 2020.6 Investigation inside the spent fuel pool
▼ 2021.10-2022.4 Ground improvement work


<Unit 2 Construction of gantry for fuel removal>

Unit 2
Overview of fuel removal (bird's-eye view)



As part of efforts to remove fuel from the Unit 2 spent fuel pool and 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 initiate fuel removal from FY2024 to FY2026.

<Reference> Progress to date
Previously, scope 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 was examined.

Unit 2 ▼ 2020.3-6 Installation of spent fuel pool cover
▼ 2020.9-11 Measures to prevent and alleviate rubble falling
▼ 2020.11-2021.6 Dismantling of remaining cover

For Unit 1, a large cover will be installed over the whole building, within which rubble will be removed.

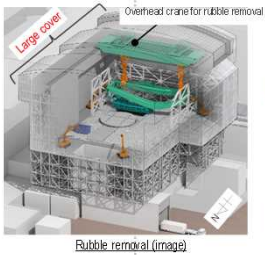
▼ 2017.12 Completion of building cover dismantling and windbreak fence installation
▼ 2018.1-2020.12 Rubble removal on the north side of Reactor Building
▼ 2018.9-12 Removal of X-braces
▼ 2021.8 Start of large cover pre-work

As part of efforts to remove fuel from the Unit 1 spent fuel pool, investigations are underway to ascertain the conditions of the fallen roof on the south side and the contamination of the well plug. Based on the results, “the method initially installing a large cover over the Reactor Building, then removing rubble within the cover” was selected to ensure safer and more secure removal. Work to install a large cover started from August 2021. Work to complete the installation of a large cover by around FY2023 is ongoing, with fuel removal scheduled to run from FY2027 to FY2028.

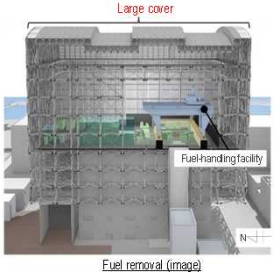
<Reference> Progress to date
Rubble removal on the north side of the operating floor started from January 2018 and has been implemented sequentially. In July and August 2019, the well plug, which was misaligned, was investigated, followed in August and September by the conditions of the overhead crane. 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, initially installing a large cover over the Reactor Building, then removing rubble inside the cover.

Unit 1


<Unit 1 Dismantling of remaining cover>



Rubble removal (image)



Fuel removal (image)

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

* Part of the photo is corrected because it includes machine information related to nuclear material protection.

4 Work toward fuel debris retrieval

Milestones of the Mid- and-Long-Term Roadmap (major target processes)

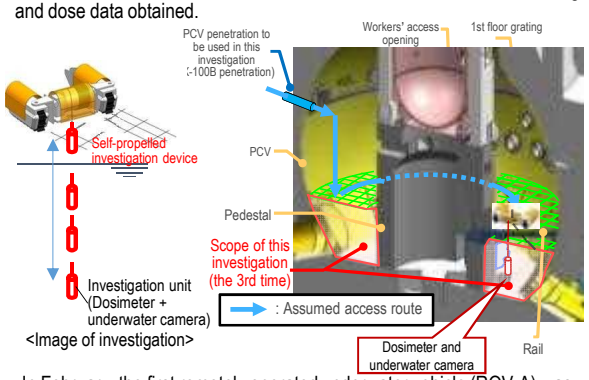
Start of fuel debris retrieval from the first unit (Unit 2). Expanding the scale in stages (within 2021 * The schedule will be extended for about 1 year due to the spread of COVID-19 infections)

Before removing fuel debris, investigations inside the Primary Containment Vessel (PCV) are conducted to inspect the conditions there, including locations of fuel debris.

Unit 1 Investigation overview

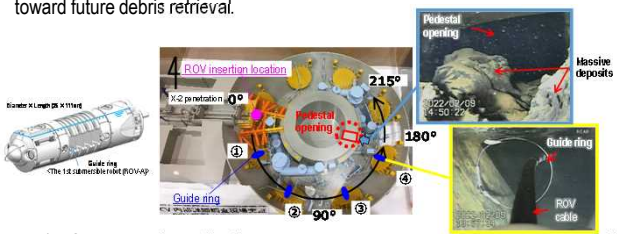
・In April 2015, a device having entered the inside of the PCV via a narrow opening (bore:φ100 mm) collected information such as images and airborne dose inside the PCV 1st floor.

・In March 2017, an investigation using a self-propelled investigation device was conducted to inspect the spreading of debris to the basement floor outside the pedestal, with images taken of the PCV bottom status for the first time. The conditions inside the PCV will continue to be examined, based on the imagery and dose data obtained.



<Image of investigation>

In February, the first remotely operated underwater vehicle (ROV-A) was inserted to install "guide rings" which will facilitate the investigation. As installation of guide rings has been completed, then a detailed investigation will be implemented.
In this investigation, distribution of deposits outside the pedestal and their characteristics or others will also be investigated. The results of these investigations will be utilized in the examination of method and procedures toward future debris retrieval.



<Status inside the PCV (February 9)>

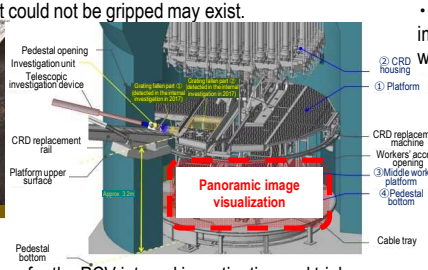
Unit 2 Investigation overview

・In January 2017, a camera was inserted from the PCV penetration to inspect the conditions of the rail on which the robot traveled. The results of a series of investigations confirmed some gratings had fallen and deformed as well as a quantity of deposit inside the pedestal.

・In January 2018, the conditions below the platform inside the pedestal were investigated. Based on the analytical results of images obtained in the investigation, deposits, probably including fuel debris, were found at the bottom of the pedestal. Moreover, multiple parts exceeding the surrounding deposits were also detected. We presumed that there were multiple instances of fuel debris falling.

・In February 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.

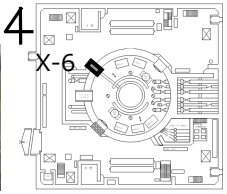

Bottom of the pedestal (after being processed in panoramic image visualization)



・In October 2020, as part of work to prepare for the PCV internal investigation and trial retrieval, a contact investigation to study deposits inside the penetration (X-6 penetration) was conducted, which involved inserting a guide pipe incorporating an investigative unit into the penetration. This confirmed that deposits inside the penetration had not deformed and come unstuck. The investigative information obtained will be utilized in the mockup test of the equipment to remove deposits inside the X-6 penetration.

<Conditions of deposits before and after contact>


<Work in front of the penetration>



<Unit 2 Reactor Building 1st floor Location of the penetration>

Unit 3 Investigation overview

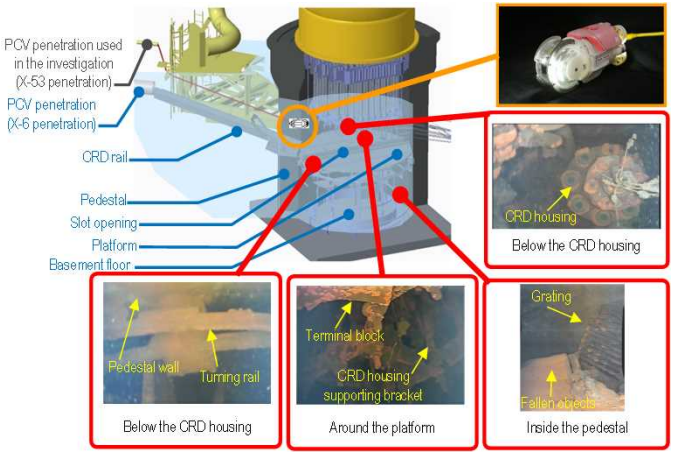
・In October 2014, the conditions of X-53 penetration, which may be under water and which is scheduled for use to investigate the inside of the PCV, was investigated via remote-controlled ultrasonic test equipment. The results showed that the penetration was not under water.

・In October 2015, to confirm the conditions inside the PCV, an investigative device was inserted into the PCV from X-53 penetration to obtain images, data on dosage and temperature and sample stagnant water. No damage to the structure and walls inside the PCV was identified and the water level was almost identical to estimated values. 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 the imagery obtained in the investigation identified damage to multiple structures and the supposed core internals.

・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.

<Conditions inside the pedestal>



Unit 1 PCV internal investigation

Investigations inside the PCV	1st (2012.10)	- Acquiring images - Measuring the air temperature and dose rate - Measuring the water level and temperature - Sampling stagnant water - Installing permanent monitoring instrumentation
	2nd (2015.4)	Confirming the status of the PCV 1st floor - Acquiring images - Measuring the air temperature and dose rate - Replacing permanent monitoring instrumentation
	3rd (2017.3)	Confirming the status of the PCV 1st basement floor - Acquiring images - Measuring the dose rate - Sampling deposit - Replacing permanent monitoring instrumentation
Leakage points from PCV	- PCV vent pipe vacuum break line bellows (identified in 2014.5) - Sand cushion drain line (identified in 2013.11)	
Evaluation of the location of fuel debris inside the reactor by measurement using muons Confirmed that there was no large fuel in the reactor core. (2015.2-5)		

Unit 2 PCV internal investigation

Investigations inside the PCV	1st (2012.1)	- Acquiring images - Measuring the air temperature
	2nd (2012.3)	- Confirming water surface - Measuring the water temperature - Measuring the dose rate
	3rd (2013.2 – 2014.6)	- Acquiring images - Sampling stagnant water - Measuring water level - Installing permanent monitoring instrumentation
	4th (2017.1-2)	- Acquiring images - Measuring the dose rate - Measuring the air temperature
	5th (2018.1)	- Acquiring images - Measuring the dose rate - Measuring the air temperature
	6th (2019.2)	- Acquiring images - Measuring the dose rate - Measuring the air temperature - Determining characteristics of a portion of deposit
Leakage points from PCV	- No leakage from the torus chamber rooftop - No leakage from any internal/external surfaces of S/C	
Evaluation of the location of fuel debris inside the reactor by measurement using muons The existence of high-density materials, which were considered to constitute fuel debris, was confirmed at the bottom of RPV and in the lower part and outer periphery of the reactor core. It was assumed that a significant portion of fuel debris existed at the bottom of RPV. (2016.3-7)		

Unit 3 PCV internal investigation

Investigations inside the PCV	1st (2015.10-12)	- Acquiring images - Measuring the air temperature and dose rate - Measuring the water level and temperature - Sampling stagnant water - Installing permanent monitoring instrumentation (2015.12)
	2nd (2017.7)	- Acquiring images - Installing permanent monitoring instrumentation (2017.8)
Leakage points from PCV	- Main steam pipe bellows (identified in 2014.5)	
Evaluation of the location of fuel debris inside the reactor by measurement using muons The evaluation confirmed that no large lump existed in the core area where fuel had been placed and that a portion of the fuel debris potentially existed at the bottom of the RPV. (2017.5-9)		

Images are provided by the International Research Institute for Nuclear Decommissioning (IRID)

5 Management of solid radioactive waste

Milestones of the Mid- and-Long-Term Roadmap (major target processes)
Eliminating temporary outdoor storage of rubble and others * Except for secondary waste of water treatment and materials for reuse or recycling (within FY2028)

★ 2017.6 Revision ★ 2018.6 Revision ★ 2019.6 Revision ★ 2020.7 Revision ★ 2021.7 Revision

★ 2016.3 Announcement of Storage Management Plan of Solid Waste (Ver. 1)

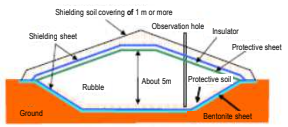
▼ 2012.9 Transfer start of rubble to the soil-covered temporary storage facility

▼ 2015.6 Transfer start of rubble to the soil-covered temporary storage facility (Tank 3)

▼ 2013.1 Start of volume reduction of trimmed trees and storage in temporary storage tank A

▼ 2019.6 Start of building construction
1st Large Waste Storage

1st Large Waste Storage Roof construction (from the inside)



<Outline of soil-covered temporary storage facility>

External view of the 9th Solid Waste Storage

▼ 2014.7 Start of pre-work
9th Solid Waste Storage


Whole view of the soil-covered temporary storage facility Tank 3

▼ 2018.2 Operation start

2021.3 High alert issued from the Shallow Draft Quay drainage channel PS monitor▼
(leakage from temporary storage Area W)

▼ 2021.7 Leakage of radioactive materials from a notch tank stored in temporary storage Area P

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

▼ 2013.5 Installation work gets underway
Solid Waste Incinerator

▼ 2016.3 Operation start

▲2016.8-11 Manual stop (due to pin-hole incidence)


Whole view of Solid Waste Incinerator


Electrical room


Control room

Whole view of Solid Waste Incinerator (Left: System A; right: System B)

2017.10 Installation work gets

▼ 2017.4 Start of pre-work
Additional Solid Waste Incinerator

▼2022.5 Start of operation

▼ 2018.5 Operation start
Large Equipment Decontamination Facility

▼ 2020.9 Start of pre-work
Compaction Facility

Site of Volume Reduction Facility

Present status Note

Storage of rubble and others

Present storage Approx.480,000 m³ (as of 2021.3)

Rubble (combustible), trimmed trees, used protective clothing

Contaminated soil (0.005 - 1 mSv/h)

Rubble (metal, concrete, others)

More than 1 mSv/h

0.005-1 mSv/h

Less than 0.005mSv

Storage of water treatment secondary waste

Estimate for the next decade (or so) Approx.**790,000** m³ (*2)

Approx. 290,000 m³ — To (A) (*1) → Incineration

Approx. 60,000 m³ → Stored and managed in Solid Waste Storage as done for rubble

Approx. 60,000 m³ → Additional Radioactive Waste Incinerator (A) / (B)

Approx. 170,000 m³ → To (A) (*1) → Volume reduction

Approx. 220,000 m³ → To (A) (*1) → Volume reduction

Approx. 6,500 tanks → Treatment measures and others will be examined

Status after a decade

Legend: Newly installed equipment and facility

Incineration

Incinerator Pre-treatment Facility (scheduled for completion in FY2025)


Crusher example

- Radioactive Waste Incinerator
- Additional Radioactive Waste Incinerator

Volume reduction

Compaction Facility (scheduled for completion in FY2022)


Concrete crusher example


Metal cutter example

Melting

Melting equipment


Electric furnace example

To (B)

Approx. 270,000 m³ (*3) (*2)

Storage /management

Solid Waste Storage (Storage capacity: approx. 260,000 m³)

Approx. 20,000 m³

Existing Solid Waste Storage
1st-8th (existing)
9th (Operation launch in 2018.2)

Approx. 60,000 m³

Additional Solid Waste Storage
10th-11th
(Scheduled for completion after FY2022)

Approx. 60,000 m³ (*1)

Approx. 60,000 m³

Approx. 70,000 m³ (*1)

Based on the estimates for the amount of waste to be generated, the storage capacity (approx. 260,000 m³) will be reached in around 2032. Scope to install an additional solid waste facility and others will be examined

Reuse will be examined

Spent Adsorption Vessel Temporary Storage

Large Waste Storage (scheduled for completion in FY2022)
Toward an operation launch within FY2022, installation work is underway


Work of main part

(*1) Items for which incineration, compaction, melting or reuse is difficult are stored directly in Solid Waste Storage without being treated
(*2) As values less than 10,000 m³ are rounded, they may not be consistent with the total of breakdown
(*3) In the estimate, approx. 240,000 m³ of waste will be stored in Solid Waste Storage at the end of FY2028.

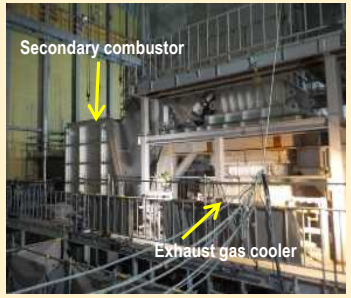
Note: Used protective clothing before incineration and BG-level concrete waste for which treatment and reuse is decided at present are not included.

- The exposure dose at the site boundaries will be reduced by aggregation to indoor storage and eliminating outdoor storage.
- The exposure dosage in exhaust gas from incinerators and at site boundaries is measured and announced on the website and others.

●Efforts to eliminate temporary outdoor storage of rubble and others

To incinerate trimmed trees and combustible rubble (woods, packing materials, paper and others), work to install the Additional Solid Waste Facility is underway.


Whole view of the Additional Solid Waste Incinerator Building



Main equipment

6 Improvement of work environment

While ensuring reliable exposure dose management for workers, sufficient personnel are secured. Moreover, while getting a handle on on-site needs, the work environment and labor conditions are continuously improved.

Regarding the site-wide reduction in the radiation dose and prevention of contamination spreading, the radiation dose on site was reduced by removal of rubble, topsoil and facing. Moreover, the operation was improved to use environmentally-improved areas as a Green Zone, within which workers are allowed to wear general work clothes and disposable dust-protective masks which are less of a physical burden.

To help workers in the Fukushima Daiichi NPS precisely understand the conditions of their workplaces, a total of 86 dose-rate monitors were installed by January 2015. These monitors allow workers to confirm on-site dose rates at their workplaces in real time.

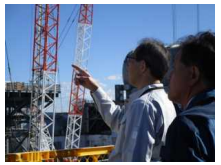
In February 2017, operation started at the Partner Companies' Building next to the New Administration Office Building.

External view of Access Control Facility

In June 2013, operation of the Access Control Facility started near the main gate of the Fukushima Daiichi NPS, to which duties conducted at J-village were shifted, including contamination examination, decontamination, switching protective equipment on and off and distribution/collection of dosimeters.

A large rest house for workers was established and its operation commenced in May 2015. Spaces in the large rest house are also installed for office work and collective worker safety checks as well as taking rest.
In March 2016, a convenience store opened in the large rest house. In April, the shower room went into operation.

In May 2017, a heliport for emergency transport was installed inside the Fukushima Daiichi NPS and went into operation.
Compared to the previous operation (at Koriyama Coast, Futaba Town or Fukushima Daini NPS, relaying to a doctor helicopter), a faster response is available for seriously ill patients requiring treatment at external medical institutions.



Visit by Governor of Fukushima Prefecture to the Fukushima Daiichi NPS (2018.11.1)

Visit by Prime Minister Kishida to the Fukushima Daiichi NPS (2021.10.17)

From March 12, 2011, in response to the increased airborne concentration of radioactive materials, instructions were issued to wear full-face masks throughout the Fukushima Daiichi NPS site, excluding the Main Anti-Earthquake Building and the rest house.

In March 2015, the Fukushima revitalization meal service center opened.

From November 2018, from the west-side high-ground area, where Unit 1-4 can be viewed, visitors can see the site in their normal clothes without having to change.

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

Changes in operation of controlled area

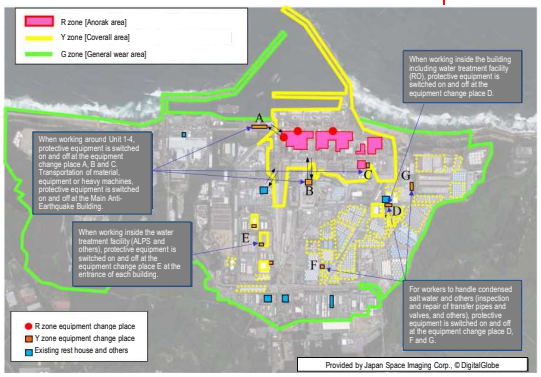
From May 2013, full-face mask unnecessary area was expanded sequentially.

In May 2015, full-face mask unnecessary area was expanded to cover about 90% of the site.

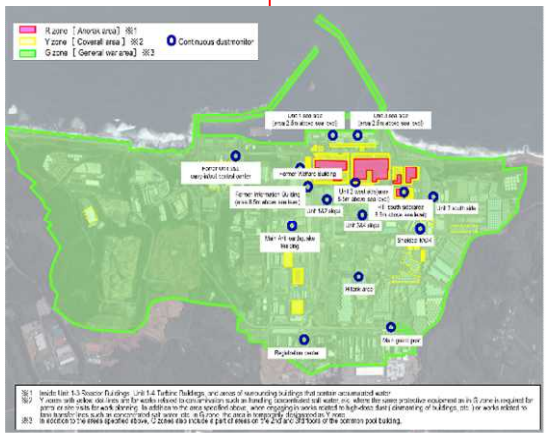
In March 2017, the G-zone area was expanded (to cover 95% of the whole site).

In August 2021, operation started while eliminating the need for the DS2 mask during light work in G-zone outside the protection area around Unit 1-4 (except for inside Units 5 and 6).

In May 2013, areas excluding those around Unit 1-4, tank areas and rubble storage areas were set to full-face mask unnecessary areas.



In March 2016, based on the progress of measures to reduce the environmental dosage on site, the site was categorized into two zones: Highly contaminated area around Unit 1-4 buildings, etc. and other areas where limited operation started to optimize protective equipment according to each category.



In May 2018, within about 96% of the site, workers are allowed to wear light equipment such as general workwear and disposable dust-protective masks.

<Travel survey results of major roads within the site>
The dose rate has been declining every year.
In particular, in the area on the east side of the Turbine Building shown a black dotted line, the dose rate declined by facing related to installation of the seawall as the countermeasure to the Japan Trench tsunami.

FY2020 4th Quarter (measured in 2021.3)

FY2021 4th Quarter (measured in 2022.2)

Provided by Japan Space Imaging Corp., © DigitalGlobe