Outline of Decommissioning, Contaminated Water and Treated Water Management

December 21, 2023
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 with nearby metal materials etc.

<Milestones in the Mid- and Long-Term Roadmap>

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

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 * Due to the spread of COVID-19, we have revised the plan to start from the second half of fiscal 2023 to improve safety and reliability.

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

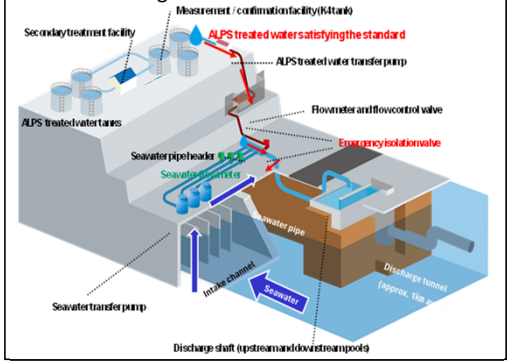
Dismantling Facilities: Scenario development & technology consideration → Design and manufacturing of devices/equipment → Dismantling

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.

Flow of discharge of ALPS treated water into the sea



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

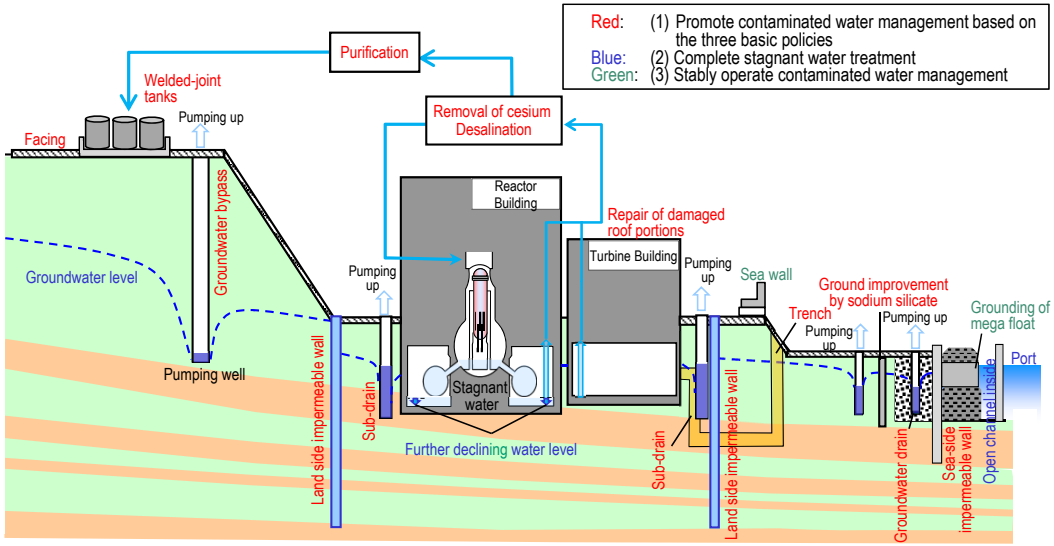
- Strontium-reduced water from other equipment is being re-treated in the Advanced Liquid Processing System (ALPS: multi-nuclide removal equipment) and stored in welded-joint tanks.
- Multi-layered contaminated water management measures, including land-side impermeable walls and sub-drains, have stabilized 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. Through these measures, the generation of contaminated water was reduced from approx. 540 m^3/day (in May 2014) to approx. 90 m^3/day (in FY2022).
- 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.
- 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.
- While assessing the dust impact, measures to reduce the stagnant water level were implemented. In March 2023, the target water level in each building was achieved. For the Units 1-3 Reactor Buildings, "reducing stagnant water in the Reactor Buildings to about half the amount at the end of 2020 during the period FY2022-2024" was achieved.
- 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 were carried out to prepare for tsunamis. As countermeasures 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 are 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.

Review of discharge of ALPS treated water into the sea

In the sea area monitoring conducted by the national government, Fukushima Prefecture and TEPCO after the discharge of ALPS treated water into the sea (third discharge), no abnormality was detected. Moreover, for the Discharge Facility, an inspection was conducted to confirm no abnormality.

To validate the oceanic dispersion simulation used to assess the radiation environmental impact, the tritium dispersion calculation and seawater monitoring data during the 1st discharge period were compared. Assessment continues for the 2nd and 3rd discharge period for validation.

For the subsequent discharge volume of ALPS treated water, transportation to Tank Group B of the Measurement/ Confirmation Facility was completed on December 11. Following the circulation and stirring operation and once compliance with the discharge requirement has been confirmed, the 4th discharge will commence from late February 2024 onward.

Unit 1 PCV internal investigation (aerial survey)

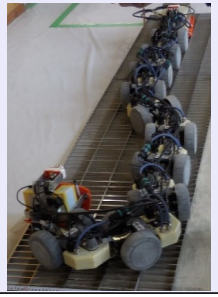
Toward fuel debris retrieval, in addition to information on the basement floor, the status of the entire PCV needs to be determined. Accordingly, an aerial survey will be conducted within this fiscal year mainly for the 1st floor area.

This survey, to be conducted within the dark and confined space inside the PCV, will use a small drone and snake-type robot.

The investigation will be conducted not only outside the pedestal but also around the bottom of the Reactor Pressure Vessel (RPV) inside the pedestal. The investigative results will be utilized to examine fuel debris retrieval methods and for future PCV and RPV internal investigations.

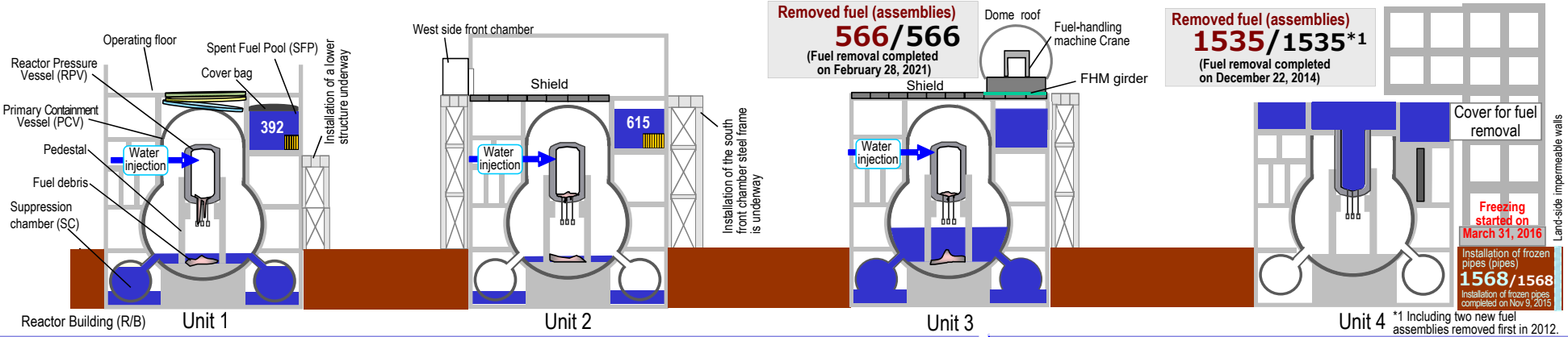
Size: approx. 19×18×5 [cm]
Weight: 185 [g] (including battery)

< Small drone >



Size: approx. 300×18×17 [cm]
Weight: approx. 25 [kg]

< Snake-type robot >



*1 Including two new fuel assemblies removed first in 2012.

Unit 2 Preparation status for trial retrieval

In the mockup facility in Naraha Town, based on the test status, efforts to resolve issues like improving work efficiency and increasing accuracy are being made so that the approx. robot arm can be used on the site. At present, tests for building access routes are underway.

On site, before removing deposits inside the X-6 penetration, from which the robot arm would be inserted into the PCV, installation of the deposit removal equipment was completed on December 14. Subsequently, installation of the spray equipment to X-53 penetration is underway.

Based on the status of deposit removal inside X-6 penetration and the test for the robot arm, which is to commence from early January, the process will be refined to ensure safe and careful trial retrieval.

< Transportation of deposit removal equipment >

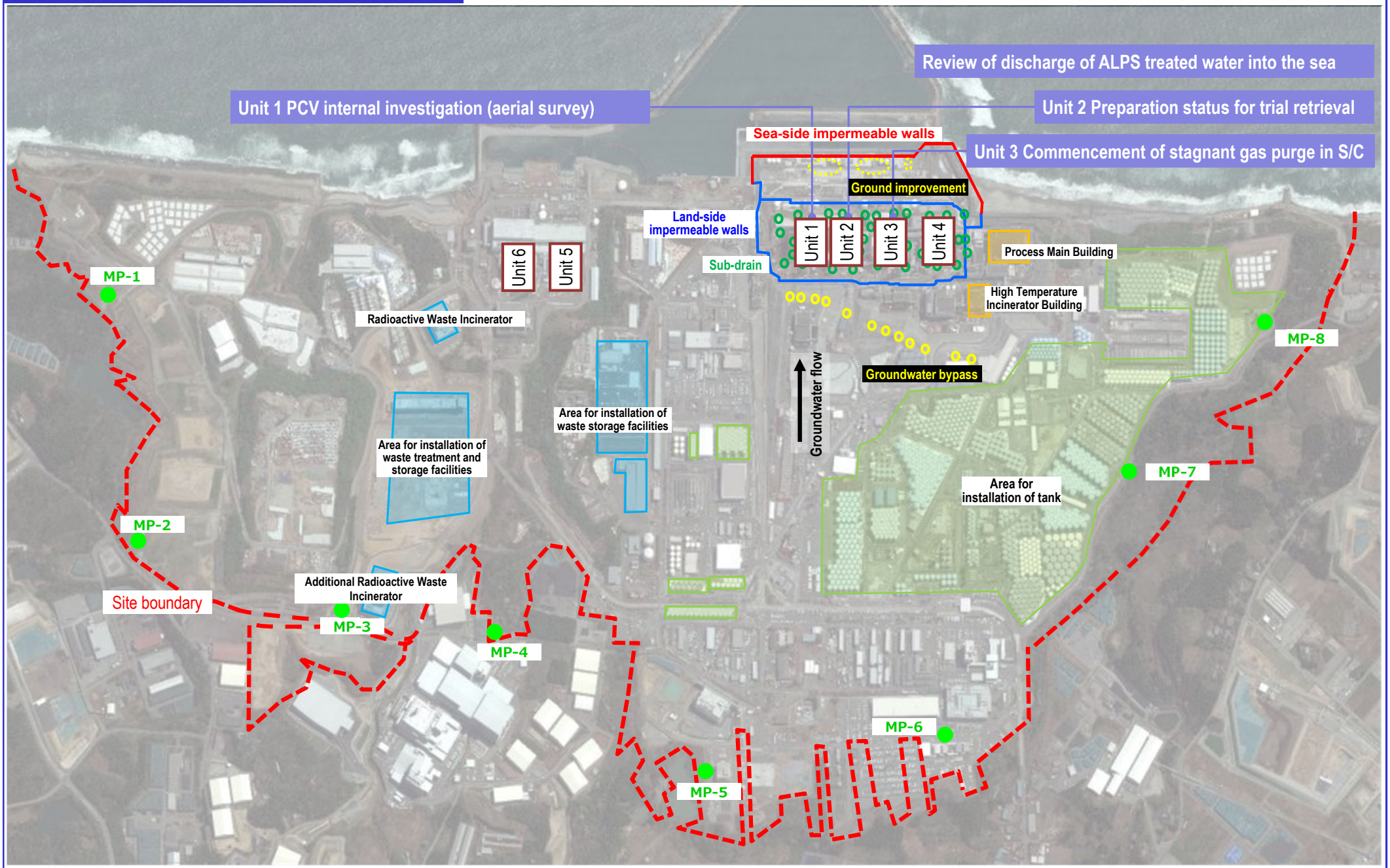
Unit 3 Commencement of stagnant gas purge in S/C

In the Unit 3 Suppression Chamber (S/C), it is assumed that in addition to stagnant gas generated at the time of the accident, hydrogen gas generated by water radiolysis remains. To reduce any risk possibly leading to hydrogen combustion, stagnant gas inside the S/C will be purged.

Before the purge, gas was sampled via gas purge equipment and analyzed. Although krypton was detected, the exposure impact assessment on the site boundaries revealed that the risk of radiation exposure to the surrounding public would be minimal.

Based on this result, to confirm the impact on parameters of the Primary Containment Vessel (PCV), a small-scale purge commenced from December 19. While monitoring PCV parameters, no significant variation was detected. Work continues with safety first.

Major initiatives – Locations on site

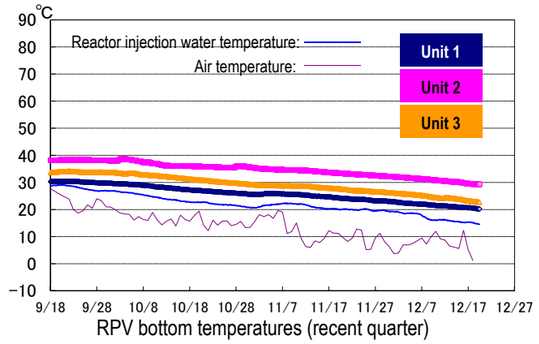


Provided by Japan Space Imaging Corp., photo taken on April 8, 2021
Product (C) [2020] DigitalGlobe, Inc., a Maxar company

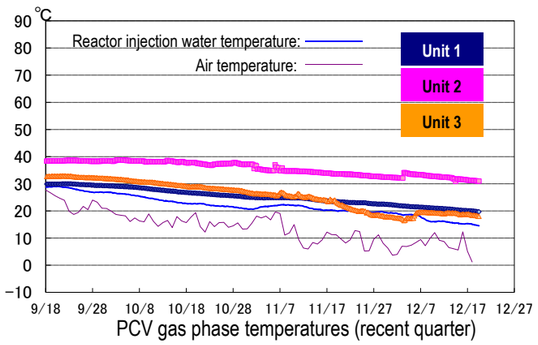
I. Confirmation of the reactor conditions

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 as shown below for recent, though it varied depending on the unit and location of the thermometer.

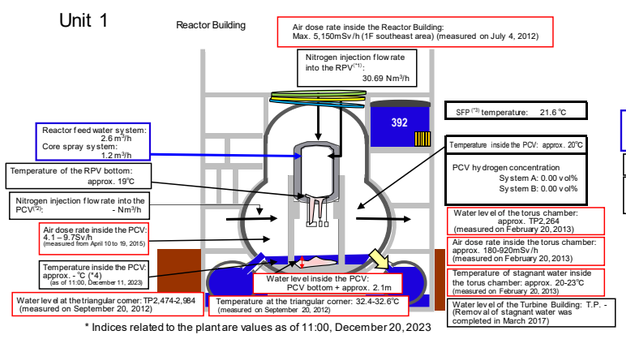


RPV bottom temperatures (recent quarter)

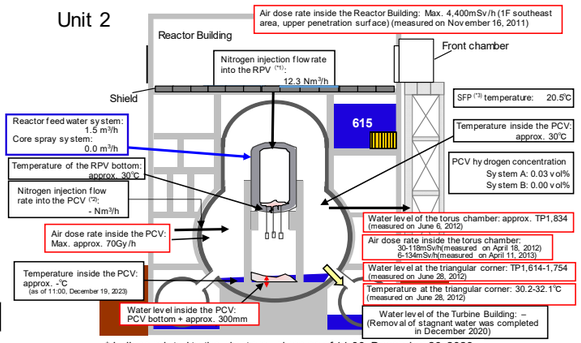


PCV gas phase temperatures (recent quarter)

*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.



* Indices related to the plant are values as of 11:00, December 20, 2023



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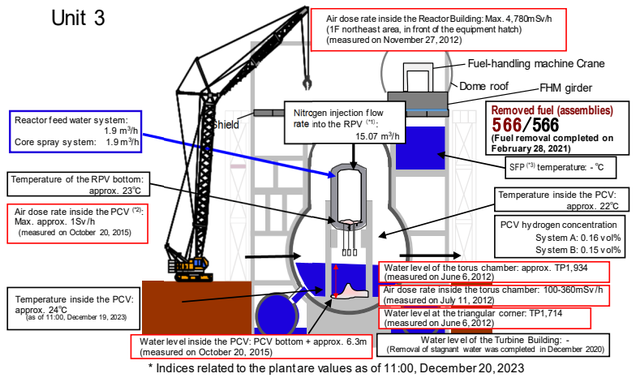


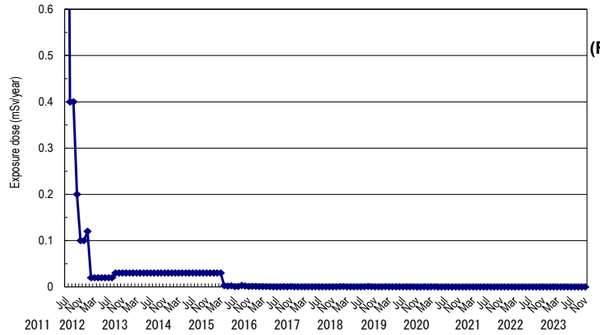
* Indices related to the plant are values as of 11:00, December 20, 2023

(*1) RPV (Reactor Pressure Vessel)
(*2) PCV (Primary Containment Vessel)
(*3) SFP (Spent Fuel Pool)
(*4) Data missing due to replacement of PCV contaminated water thermometer / water-level gauge

Release of radioactive materials from the Reactor Buildings

As of November 2023, 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. 1.8×10^{-12} Bq/cm³ and 2.0×10^{-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]: 2×10^{-5} Bq/cm³Marc
  [Cs-137]: 3×10^{-5} Bq/cm³
* Data of Monitoring Posts (MP1-MP8).
  Data of Monitoring Posts (MPs) measuring the air dose rate around the site boundary showed 0.305 –1.015 μSv/h (November 29 – December 19 2023).
  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.

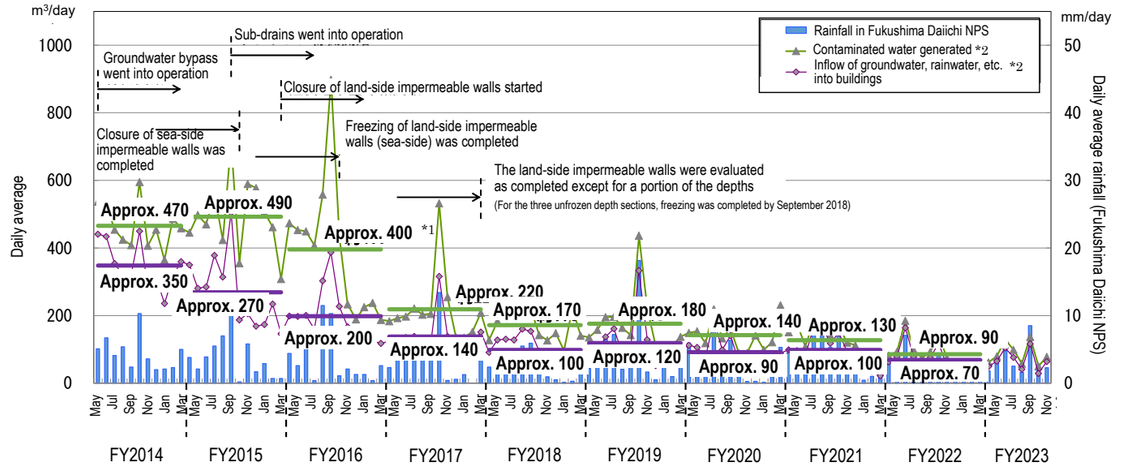
Based on the above, it was confirmed that the comprehensive cold shutdown condition had been maintained and the reactors remained in a stabilized condition.

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 and due to less rainfall than in previous normal years without concentrated heavy rain of 100 mm/day or more, the amount of contaminated water generated within FY2022 declined to approx. 90 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 December 10, 2023, 2,338 release operations had been conducted.
  The water quality of all temporary storage tanks satisfied the operational target.

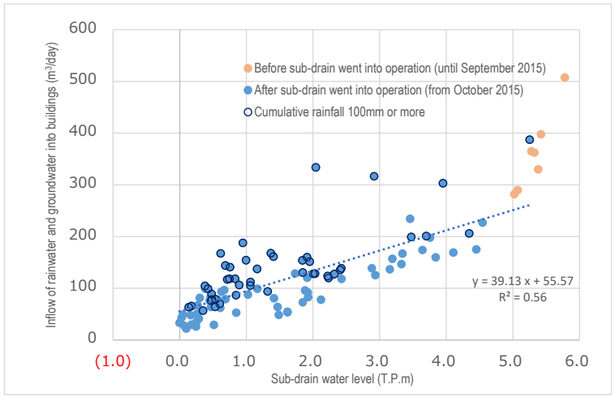


Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Units 1-4 sub-drains

➢ Implementation status of facing

- Facing is a measure that involves 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 November 2023, 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 leave the decommissioning work unaffected. As of the end of November 2023, 40% of the planned area (60,000 m^2) 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 each 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 remained at 4-5 m. The water level in the bank area has also remained low (T.P. 1.4 m) relative to 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 to the T.P. 2.5 m area.

➢ Operation of the multi-nuclide removal equipment and other water-treatment facilities

- Regarding the multi-nuclide removal equipment (existing), hot tests using radioactive water had been conducted (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 (NRA) and the entire pre-service inspection was completed. For the multi-nuclide removal equipment (additional), a pre-service inspection certificate was granted by the NRA on October 12, 2017. Regarding the multi-nuclide removal equipment (high-performance), hot tests using radioactive water had been conducted from October 18, 2014. On March 2, 2023, a pre-service inspection certificate was granted by the NRA and the entire pre-service inspection was completed.
- 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 December 14, 2023, approx. 740,000 m³ had been treated.

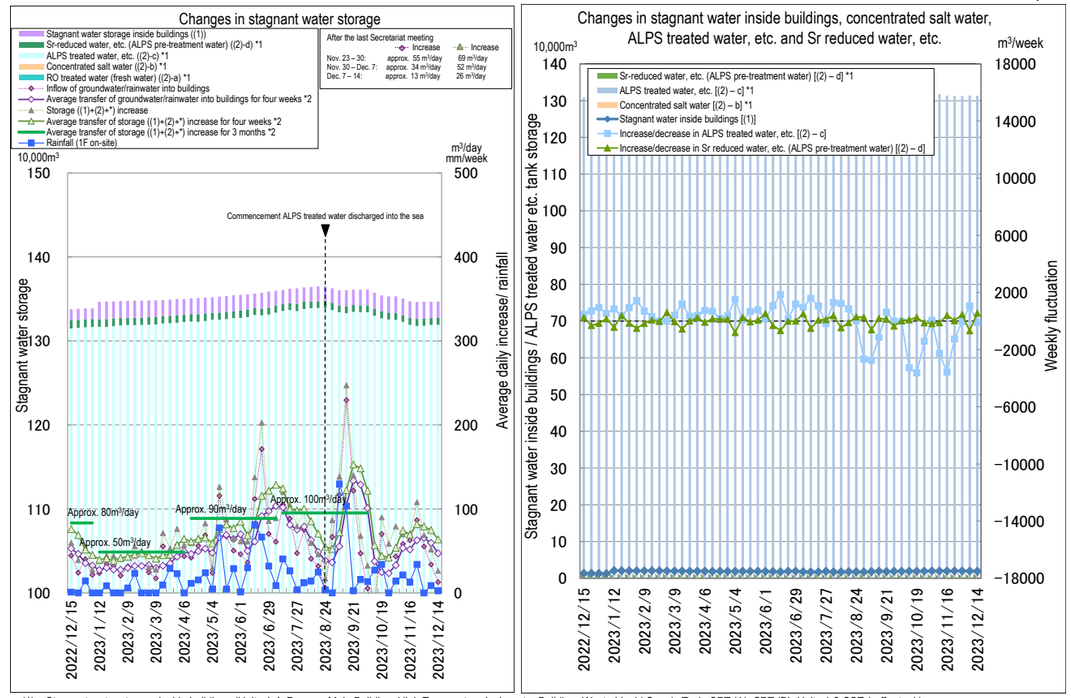
➢ Risk reduction of strontium-reduced water

- To reduce the risks of strontium-reduced water, treatment using existing, additional and high-performance multi-nuclide removal equipment is underway. Up until December 14, 2023, approx. 907,000 m³ had been treated.

➢ Storage status of contaminated water and amount of ALPS treated water, etc. stored in tanks

- The amount of ALPS treated water, etc. was approx. 1,316,154 m^3 as of December 14, 2023.
- The amount of ALPS treated water discharged into the sea was approx. 23,353 m^3 as of December 20, 2023.

As of December 14, 2023



(1): Stagnant water storage inside buildings (Units 1-4, Process Main Building, High Temperature Incinerator Building, Waste Liquid Supply Tank, SPT (A), SPT (B), Units 1-3 CST, buffer tank)
(2): Units 1-4 tank storage {[(2)-a RO treated water (fresh water)] + [(2)-b Concentrated salt water] + [(2)-c ALPS treated water, etc.] + [(2)-d Sr-reduced water, etc. (ALPS pre-treatment water)]
*: Water amount from tank bottom to water-level gauge 0% (DS)
*1: Water amount for which the water-level gauge indicates 0% or more
*2: Calculated in the method of contaminated water generated [(Inflow of groundwater/rainwater into buildings) + (other transfer) + (chemical injection into ALPS)], amount of ALPS treated water discharged was not taken into account.

Figure 3: Status of stagnant water storage

➢ Status of discharge of ALPS treated water

Measurement Object	Requirement and operation target	Measurement results	Satisfaction of requirement
[TEPCO] Tritium concentration in seawater (sea area monitoring at 10 points within 3 km from the Power Station)	・Discharge suspension level: 700 Bq/L or less ・Investigation level: 350 Bq/L or less	・700 Bq/L or less ・350 Bq/L or less	○ ○
[Ministry of the Environment] Tritium concentration in seawater (11 points off the coast of Fukushima Prefecture)	・National safety requirement: 60,000 Bq/L ・WHO drinking water guidelines: 10,000 Bq/L	・Below the lower detection limit (less than 7 - 9 Bq/L)	○ ○
[Fisheries Agency] Tritium concentration in marine products (flounder and others)	-	・Below the lower detection limit (less than 8.7 Bq/kg)	○ ○
[Fukushima Prefecture] Tritium concentration in seawater (9 points off the coast of Fukushima Prefecture)	・National safety requirement: 60,000 Bq/L ・WHO drinking water guidelines: 10,000 Bq/L	・Below the lower detection limit (less than 4.3 - 5.1 Bq/L)	○ ○

- From November 2 to 20, 2023, the third discharge of ALPS treated water into the sea in FY2023 was conducted.
- Regarding Tank Group A discharged, the concentration of the 29 types of radionuclides (excluding tritium) within the measurement and assessment scope was 0.25 in terms of the sum of the ratios to regulatory concentrations and satisfied the national government's requirement of less than 1. The concentration of tritium was 130,000 Bq/L. Regarding 39 nuclides for which no significant existence was voluntarily confirmed, the absence of any significant presence was confirmed and the water quality satisfied the requirements of national government and Fukushima prefecture. The water temperature was almost equivalent to the air temperature and after approx. 740x dilution, the

same as the seawater used for dilution (different from the warm water discharged from the power plant).
- The third amount discharged was 7,753 m^3 and the total amount of tritium was approx. 1.0 trillion Bq.
- Analysis before the discharge showed a tritium concentration in the water of the upstream seawater pipe of the discharge shaft (upstream pool) below 1,500 Bq/L as of November 1 and therefore there was no problem. (During discharge, daily checks are performed to ascertain that the calculated value and actual concentrations are at the same level and less than 1,500 Bq/L*.)

  * 1,500 Bq/L: The value stipulated by the national government, which is 1/40 of the legal requirement (60,000 Bq/L) and approx. 1/7 of WHO drinking water guidelines (10,000 Bq/L).
  Basic Policy on handling ALPS treated Water (refer to page 9)
  https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/bp_alps.pdf
- Regarding the status of sea area monitoring on handling ALPS treated water, more measurement points for seawater and fish were established near the power station and off the coast of Fukushima Prefecture and measurements of tritium and Iodine-129 of seaweed near the power station were added from April 20, 2022. As of December 20, 2023, no significant variation was detected.
- Regarding sea area monitoring conducted by TEPCO at ten points within 3 km from the power station, quick measurements taken of the tritium concentration in the seawater sampled on December 18 showed concentrations of 16 Bq/L at the nearest point (approx. 200m) from the discharge outlet and under the detection limit (less than 5.7 - 6.8 Bq/L) at other points, which was below the TEPCO operation indices of 700 Bq/L (discharge suspension level) and 350 Bq/L (investigation level).
- The quick measurement results obtained by each organization are as follows:
  Ministry of the Environment: MOE Japan is to analyze tritium concentrations on a weekly basis to compile a flash report, alongside γ ray nuclides (Cesium-137 and others), for the time being. The analytical results (obtained via quick measurements) for seawater sampled on December 5 and 8 at 11 points off the coast of Fukushima Prefecture showed tritium concentrations below the lower detection limit (less than 7 - 9 Bq/L) at all sampling points, which would have no adverse impact on human health and the environment.
  Fisheries Agency: Immediately after discharge, analysis is conducted daily as far as possible (including Saturdays and Sundays) for about one month. Quick analytical results for tritium in flounder sampled on November 30 showed tritium concentrations below the lower detection limit (approx. less than 8.7 Bq/kg) in all samples.
  Fukushima Prefecture: Quick analysis of tritium concentration is conducted monthly and as required. On December 15, tritium concentrations in seawater at nine sampling points off the coast of Fukushima Prefecture below the lower detection limit were recorded (less than 4.3 - 5.1 Bq/L) at all sampling points, which would have no adverse impact on human health and the environment.

➢ Exposure dose evaluation of the worker who suffered with the bodily contamination during work on ocean pipes of additional ALPS

- On October 25, during work to clean pipes of the additional multi-nuclide removal equipment, bodily contamination of workers occurred due to splashing of the waste cleaning liquid. Two workers (A and B) who could not be decontaminated below the controlled area exit requirement (4 Bq/cm^2), were transported to a medical institute and discharged from the institute on October 28.
- For both two workers, the effective dose and equivalent skin dose were evaluated and the results showed that in both cases, the effective dose during the work did not exceed :5 mSv and the yearly limit of equivalent skin dose, 500mSv, respectively. Moreover, no physical problems or abnormality on the contaminated skin part were detected.

➢ Progress of the rearing test of marine organisms in the Fukushima Daiichi Nuclear Power Station

- To eliminate concerns and reassure the public, a rearing test for marine organisms (flounder and abalones) in seawater with ALPS treated water added and normal seawater for comparison is underway.
- Regarding the flounder test, on September 5, 2023, in the series 4 tank (ALPS treated water diluted with seawater), one flounder died. Since September 6, no further death or abnormality was detected (as of December 14).
- For abalones, since the test started on October 25, 2022, approx. 40% had survived (38% in normal seawater and 40% in ALPS treated water diluted with seawater) (as of December 14).
- The Organically-Bonded Tritium (OBT) uptake test for flounder (tritium concentration of less than 1500 Bq/L) is considered as reaching equilibrium.
- Rearing of flounder and others in diluted ALPS treated water (less than 1,500 Bq/L) will continue.
- The OBT concentration test on flounder (less than 1,500 Bq/L) will continue. The OBT discharge test will be conducted after preparation is completed.
- The scope of rearing tests using diluted ALPS treated water from January 2024 will be as follows:
  Rearing tests of flounder using seawater of less than 1500 Bq/L and normal seawater will continue. For flounder of around 30 Bq/L and abalones and others of less than 1500 Bq/L, initially planned tests were completed. Rearing will continue and disclosure during visit will continue.
- Disclosure of marine organisms rearing tests will be amended as follows:
  Web monitoring (via YouTube) of the rearing pools by camera will continue and the rearing diary will be updated once or twice weekly from January 4, 2024 onward. The collected results of survival marine products which are currently being reared and the survival rate will be disclosed when many deaths occur after December 29, 2023.

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 remove spent fuel at Unit 1

- Before drilling for anchors on the south-side external walls of the Unit 1 Reactor Building, the surface dose was measured on November 29 and hot spots were detected.
- Due to concerns about the exposure impact on workers during installation of the Unit 1 large cover, measures to reduce dose by decontamination and shielding are being examined.
- Work will proceed with safety first to avoid any impact on the surrounding environment and workers.

➢ Main work to remove spent fuel at Unit 2

- Inside the building, decontamination to reduce the dose on the operating floor was completed and work to install shielding was also completed on December 4.
- Outside the building, on the Reactor Building south side, installation of concrete floor of the gantry was completed and work to install the front room is underway. As of December 4, installation of 43 of 45 gantry units for Unit 2 fuel removal was completed.

➢ Cause and countermeasures for bodily contamination during work to improve Unit 2 operating floor environment

- On December 11, in the front room of the gantry on the Unit 2 Reactor Building west side, contamination was detected in the nasal smear of a cooperating company worker who was decontaminating foreign materials entering prevention fences for the spent fuel pool after removal (β-ray: approx. 1,000 cpm and α-ray: 0 cpm) and there was a possibility of internal intake.
- Following decontamination of the face, the exit requirement (other than α: 4 Bq/cm^2 and α: 0.4 Bq/cm^2) was then satisfied and the worker exited the controlled area. An emergency room doctor in the access control building diagnosed no abnormality in the physical condition of the worker.
- For the worker, the committed effective dose was evaluated and the preliminary result was 0.38 mSv (record level was less than 2 mSv). The committed effective dose will be confirmed based on the bioassay result.
- The bodily contamination was considered attributable to removing the full-face mask without sufficiently loosening the band, hands/fingers or the chin part of the full-face mask where remaining contamination on the external side came into contact with the face and was therefore transmitted.
- As countermeasures, a procedure to carefully wipe the full-face mask was added to the educational material. Moreover, to prevent face contamination when taking off the full-face mask, a reminder to fully loosen the band while doing so was also reiterated to TEPCO employees and affiliated companies. In addition, in the “Full-face Mask and Others Wearing Test” conducted from this fiscal year for all workers (including TEPCO employees) who wear the full-face mask and others, education will be provided using the educational material from January 2024.

➢ Rearrangement of process related to Unit 6 spent fuel removal and work to remove fuel-containing rubble in Unit 3

- To secure space to accept 1,456 spent fuel assemblies of Unit 6 to the common pool, spent fuel assemblies stored in the common pool from FY2022 are being contained in 22 dry casks to be stored in the Temporary Cask Custody Area. As of December 13, 2023, 17 of 22 casks had been transported.
- For Unit 6 fuel removal, two of 68 transportations were completed in FY2022.
- Regarding the fuel assemblies removed from Unit 3 and stored in the common pool, rubble was included inside the fuel assemblies and calcium carbonate derived from rubble was detected in the common pool, deviating from the requirement to confirm the airtightness of dry casks (inclusion of foreign materials containing calcium carbonate as the main component on the flange face of the cask lid).
- Considering the increase in days due to measures to confirm dry cask airtightness in FY2022, the process to transport until the 16th cask by December 2023 and resume Unit 6 fuel removal from January 2024 was planned as the optimal schedule.
- At present, the work progress has improved by devising work such as preliminary cleaning of fuel assemblies by water flow as part of measures for air tightening. For this reason, securing space in the common pool by dry casks (22 units) will be prioritized. The process will be reviewed to resume Unit 6 fuel removal from May 2024 and subsequent suspension (rearrangement) due to facility inspection during Unit 6 fuel removal will be reduced to increase work efficiency.
- For fuel assemblies removed from Unit 3 stored in the common pool, as part of a fundamental solution, rubble included inside the fuel assemblies, which represents a source of calcium carbonate, will be removed.

Retrieval of fuel debris

➢ Sampling of S/C inclusive water to decrease the Unit 1 PCV water level (follow-up report on sampling results)

- To increase the seismic resistance of the Unit 1 Primary Containment Vessel (PCV), the PCV water level will be reduced. Moreover, to decrease the PCV water level, the installation of the water level gauge and water intake equipment is being examined.
- To assess the quality of inclusive water in the Suppression Chamber (S/C) and the status of the S/C bottom more accurately, sampling of S/C inclusive water (upper and middle parts inside the CUW pipe and lower end of the CUW pipe (lower part of S/C)) was conducted from the CUW pipe, a candidate in which the PCV water level gauge and water intake equipment would be installed, before installing this equipment.
- At all points, Cs-137 was 10^{-9} Bq/L and Sr-90, 10^{-7} Bq/L and total α radioactivity was below the detection limit.
- General bacterial counts were below the detection limit at the upper and middle parts inside the CUW pipe and 1.0×10^{4} CFU/mL at the lower end of the CUW. No sulfate reduction bacteria counts were detected at any points of the upper and middle parts inside the CUW pipe and the lower end of the CUW pipe. At the lower end of the CUW pipe, general bacterial counts were 10^{4} CFU/mL or less and no sulfate reduction bacteria counts were detected, therefore the risk of bacterial corrosion was considered low.

➢ Analysis status of deposits at the bottom of Unit 1 PCV (prompt report)

- In February 2023, the bottom deposit surface was sampled at four points of the outer periphery inside the Unit 1 Primary Containment Vessel (PCV) using the remotely operated underwater vehicle (ROV-E).
- The status of the deposit sampling points was determined and the deposit generation process was examined. As part of efforts to determine the status inside the RPV and PCV, deposits were transported to analytical institutions outside 1F for detailed analysis.
- This time, SEM/EDS analysis results on samples collected at the point nearest the pedestal opening (workers' access entrance) are disclosed.
- SEM/EDS analysis revealed that of the Fe and O existing across particles, iron rust was the main component and scattered particles of U and Zr, presumably derived from fuel and Si, Al and Mg, presumably derived from PCV concrete and insulates, were also identified. The outline of these observation results resembled samples collected at a point away from the pedestal opening in 2017.
- Moreover, although on a small scale, particles containing Si and U existed, which is expected to have an impact on efforts to determine the particle experience temperature. To confirm the existence state and crystal structure of U in Si-O, detailed observation using TEM/EDS/electron diffraction will be conducted.

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

- In the mockup facility in Naraha Town, based on the test status, to apply the robot arm to the site, efforts to resolve issues like improving work efficiency and increasing accuracy are being made and tests for building access routes are now underway.
- On site, before removing deposits inside X-6 penetration, from which the robot arm would be inserted into the PCV, work to install the deposit removal equipment was completed on December 14. Subsequently, installation of the spray equipment to the X-53 penetration is underway.
- Based on the deposit removal status inside the X-6 penetration and the test of the robot arm, both of which are to commence from early January, the process will be refined to ensure safe and careful trial retrieval.

➢ Analytical results of smear of Units 1/2 SGTS pipes removal (part 1) and dose investigation

- In May 2022, the inside of the Unit 2 SGTS pipe was wiped (using smear filter paper) and samples were collected and analyzed at JAEA.
- Analytical results of the γ-ray nuclide revealed that Cs-137 and -134 were detected but no other nuclides. The presence of americium 241 and other elements were confirmed in the low-energy area but were not detected. In the SEM/EDS observation, iron was the main component and no fission products other than cesium or fuel-derived components were detected.
- To confirm the impact on surrounding areas during the gamma-camera measurement and examine the radiation protection measures for future work, for the Units 1/2 SGTS pipes temporarily stored on the Unit 1 Turbine Building roof and the Unit 1 Control Building roof, the dose inside the SGTS pipes was investigated using a remotely operated robot (Spot). Based on the measurement results, high dose gas was assumed to have flown into Unit 2 pipes. For details, investigation and analysis will be conducted.
- Together with the γ-camera of the Secretariat of the Nuclear Regulation Authority, measurement was conducted to acquire knowledge on corded masks owned by TEPCO and Compton of JAEA.
- Regarding corded masks of TEPCO, the measurement time was extended from the previous one minute to five minutes. However, in the obtained image, the S/N rate was poor, a virtual image (ghosting) was generated and a radiation source existed near the center of the image. Re-examination is required and a Compton image is being analyzed at JAEA.

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 rubble and trimmed trees

- As of the end of November 2023, the total storage volume for concrete and metal rubble was approx. 394,800 m³ (+1,300 m³ compared to the end of October with an area-occupation rate of 77%). The total storage volume of trimmed trees was approx. 87,500 m³ (-4,700 m³, with an area-occupation rate of 50%). The total storage volume of used protective clothing was approx. 22,500 m³ (a slight decrease, with an area-occupation rate of 89%). The total storage volume of radioactive solid waste (incinerated ash and others) was approx. 38,200 m³ (a slight increase, with an area-occupation rate of 60%). The increase in rubble was attributable to decontamination of flanged tanks and work related to areas around Units 1-4 Reactor Buildings.

➢ Management status of secondary waste from water treatment

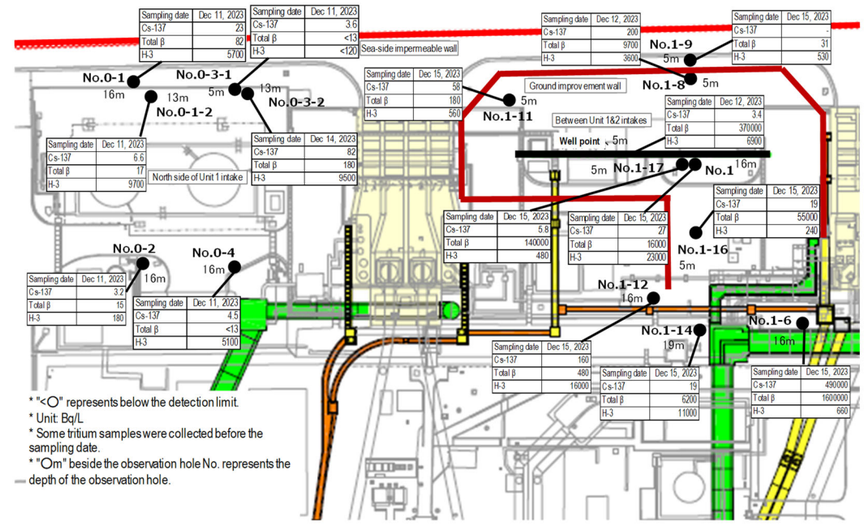
- As of November 30, 2023, the total storage volume of waste sludge was 427 m³ (area-occupation rate: 61%), while that of concentrated waste fluid was 9,472 m³ (area-occupation rate: 92%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment and others, was 5,673 (area-occupation rate: 87%).

Reduction in radiation dose and mitigation of contamination

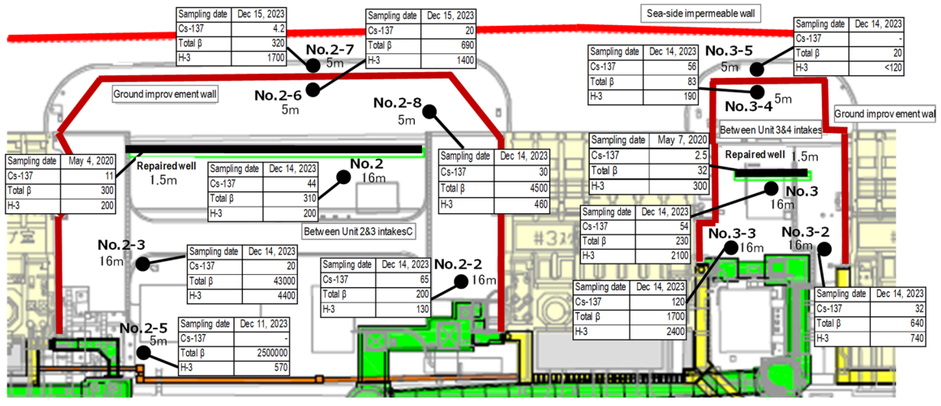
Effective dose-reduction at site boundaries and purification of port water to mitigate the impact of radiation on the external environment

➢ Status of the 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, 0-1-2, 0-3-1, 0-3-2 and 0-4. The trend continues to be carefully monitored.
- 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, 1-16 and 1-17 but has otherwise 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. 1-6, 1-9, 1-11, 1-12, 1-14, 1-16 and 1-17. The trend continues to be carefully monitored.
- 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 has been increasing or fluctuating at No. 2-5. The trend continues to be carefully monitored.
- 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 overall. The concentration of total β radioactive materials has remained constant overall but has been increasing or declining at Nos. 3-4 and 3-5. The trend continues to be carefully monitored.
- 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 as the overall area but been increasing or declining and exceeded the previous highest record at some observation holes. Investigations into the fluctuation are underway for Nos. 0-3-2, 1, 1-6, 2-5, 2-6 and 3-3.
- The concentration of radioactive materials in drainage channels has remained constant overall, despite increasing during rainfall. In Drainage Channel D, drainage of the low-dose area on the west side of the site started to pass from August 30, 2022. It has remained low, despite increasing in concentrations of cesium and total β radioactive materials during rainfall. From November 29, 2022, continuous monitors were installed and drainage around the Units 1 and 2 switch yard started to pass.
- 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 the temporary increases in Cs-137 and Sr-90 observed 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 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 has 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 was 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. During the period of discharge of ALPS treated water, the concentration of tritium increased at the sampling point near the discharge outlet, but this was considered as within the assumed range based on the results of the oceanic dispersion simulation.



<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

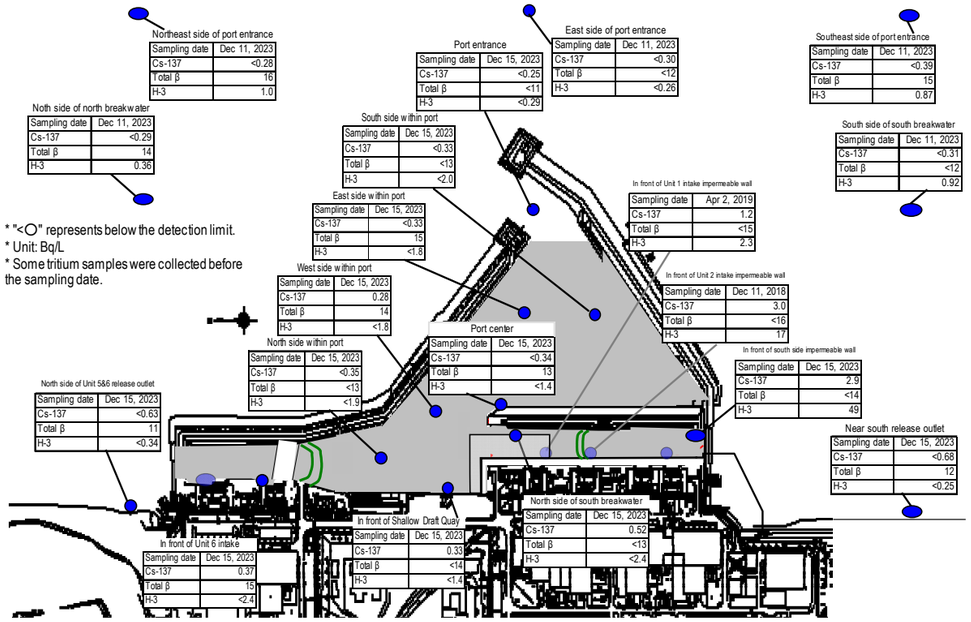


Figure 5: Seawater concentration around the port

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 August to October 2023 was approx. 9,400 (cooperating company workers and TEPCO HD employees), which exceeded the monthly average workforce (approx. 7,600). Accordingly, sufficient personnel were registered to work on site.
- It was confirmed with the prime contractors that the estimated manpower necessary for the work in January 2024 (approx. 4,300 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, at approx. 3,500 to 4,600.
- The number of workers from within Fukushima Prefecture increased slightly and the number of workers from outside remained constant. The local employment ratio (cooperating company workers and TEPCO HD employees) as of November 2023 remained constant at around 70%.
- The average exposure doses of workers were approx. 2.60, 2.51 and 2.16 mSv/person-year during FY2020, 2021 and 2022, 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 remained sufficiently within the limit and allowed them to continue engaging in radiation work.

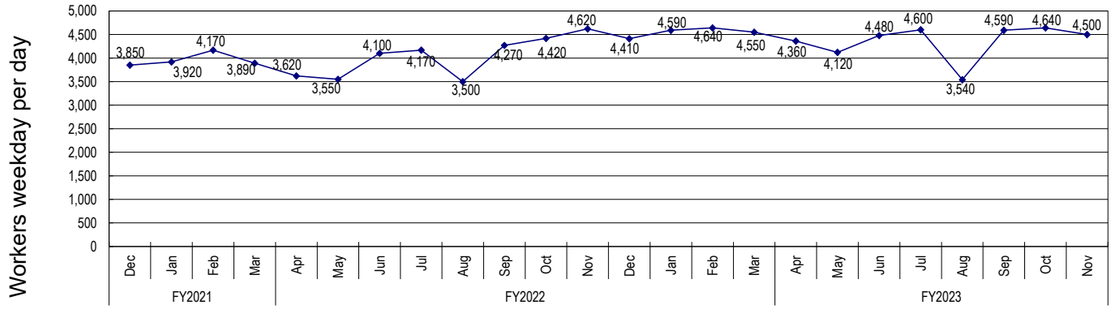


Figure 6: Changes in the average number of workers weekday per day for each month of the most recent 2 years (actual values)

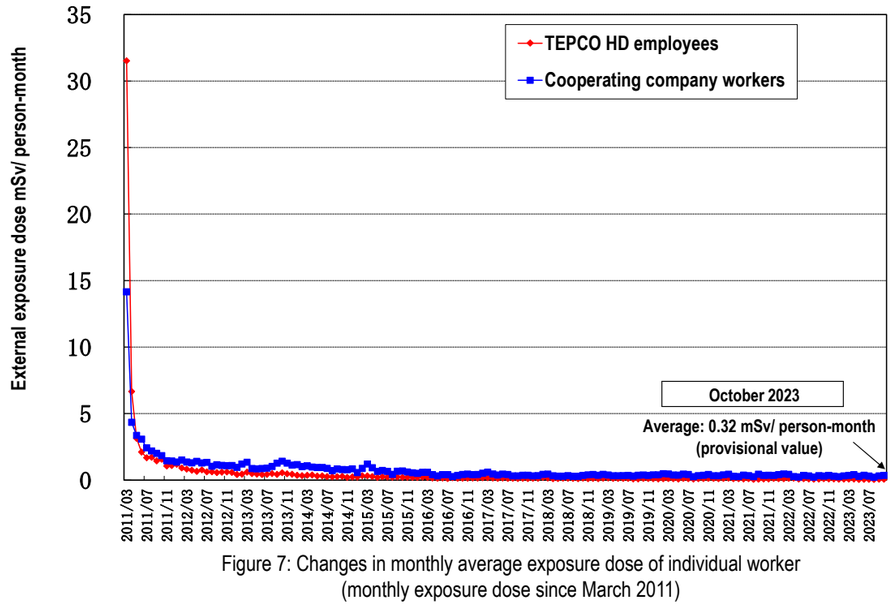


Figure 7: Changes in monthly average exposure dose of individual worker
(monthly exposure dose since March 2011)

➢ Results of the 14th questionnaire survey for workers to improve the work environment

- From July to August 2023, the 14th questionnaire survey was conducted as part of efforts to improve the work environment, to which approx. 5,000 workers responded.
- The results showed that an increased number of workers evaluated that concerns about working in the Fukushima Daiichi Nuclear Power Station had been alleviated, considered their work in the NPS rewarding and wished to continue working.
- On the other hand, some points to be improved were revealed, such as workers feeling unsafe in certain common areas within and outside the NPS. Measures for improvement will be sequentially implemented.
- TEPCO will continue to listen carefully to workers' opinions and requests, strive to improve the labor environment and create "a safe and comfortable-to-work workplace."

➢ Countermeasures for infectious diseases

- Countermeasures for various infectious diseases (influenza, norovirus, COVID-19, etc.) depend on personal decisions and basic countermeasures (visiting medical institutions when feeling unwell, ventilation, avoidance of the "Three Cs," frequent handwashing, etc.) being implemented appropriately by each worker and TEPCO proceeds with decommissioning while prioritizing safety.
- As in 2022, to prevent the spread of influenza infections and serious infections, a vaccination program of influenza has been implemented since October 2023 for TEPCO HD employees and cooperating company workers in the Fukushima Daiichi Nuclear Power Station who wish to be vaccinated.

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 December 4 - 18)"; unit (Bq/L); ND represents a value below the detection limit

Summary of TEPCO data as of December 19, 2023

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(0.33)		
Cesium-137	:	0.36		
Total β	:	15		
Toritium	:	1.5	*1	

Cesium-134	:	3.3 (H25/12/24)	→	ND(0.30)	Below 1/10
Cesium-137	:	7.3 (H25/10/11)	→	ND(0.28)	Below 1/20
Total β	:	69 (H25/8/19)	→	ND(14)	Below 1/4
Toritium	:	68 (H25/8/19)	→	ND(0.29)	Below 1/200

Cesium-134	:	3.3 (H25/10/17)	→	ND(0.35)	Below 1/9
Cesium-137	:	9 (H25/10/17)	→	ND(0.27)	Below 1/30
Total β	:	74 (H25/8/19)	→	ND(15)	Below 1/4
Toritium	:	67 (H25/8/19)	→	ND(1.9)	Below 1/30

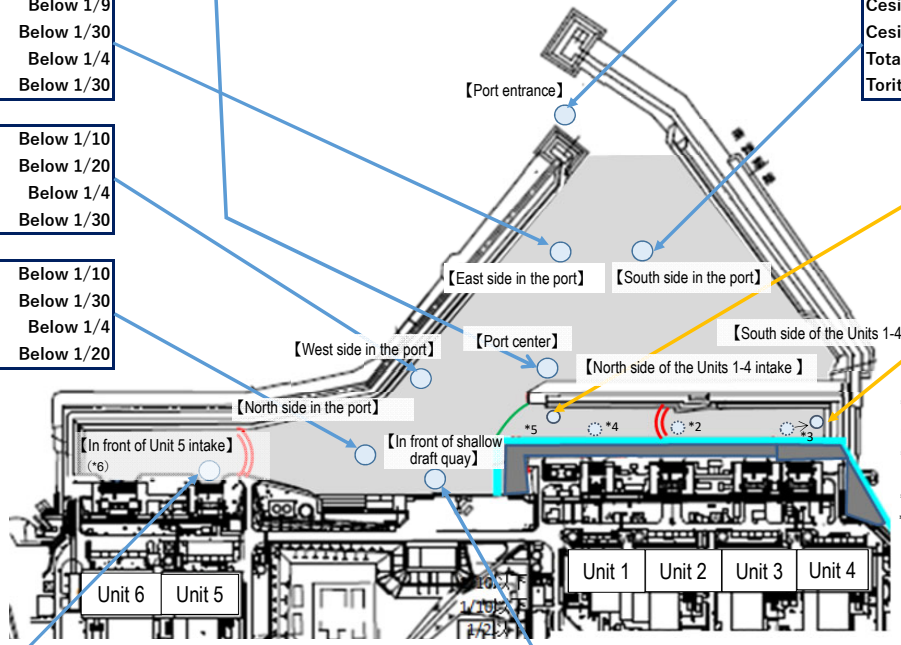
Cesium-134	:	3.5 (H25/10/17)	→	ND(0.35)	Below 1/10
Cesium-137	:	7.8 (H25/10/17)	→	ND(0.29)	Below 1/20
Total β	:	79 (H25/8/19)	→	ND(15)	Below 1/5
Toritium	:	60 (H25/8/19)	→	ND(2.1)	Below 1/20

Cesium-134	:	4.4 (H25/12/24)	→	ND(0.27)	Below 1/10
Cesium-137	:	10 (H25/12/24)	→	0.34	Below 1/20
Total β	:	60 (H25/7/4)	→	ND(15)	Below 1/4
Toritium	:	59 (H25/8/19)	→	ND(1.9)	Below 1/30

Cesium-134	:	32 (H25/10/11)	→	ND(0.30)	Below 1/100
Cesium-137	:	73 (H25/10/11)	→	0.35	Below 1/200
Total β	:	320 (H25/8/12)	→	14	Below 1/20
Toritium	:	510 (H25/9/2)	→	ND(2.4)	Below 1/200

Cesium-134	:	5 (H25/12/2)	→	ND(0.31)	Below 1/10
Cesium-137	:	8.4 (H25/12/2)	→	ND(0.26)	Below 1/30
Total β	:	69 (H25/8/19)	→	ND(15)	Below 1/4
Toritium	:	52 (H25/8/19)	→	2.2	Below 1/20

Cesium-134	:	ND(0.27)	
Cesium-137	:	3.2	
Total β	:	16	
Toritium	:	53	*1



Sea side impermeable wall
Silt fence
Silt fence for construction

Cesium-134	:	2.8 (H25/12/2)	→	ND(0.33)	Below 1/8
Cesium-137	:	5.8 (H25/12/2)	→	ND(0.35)	Below 1/10
Total β	:	46 (H25/8/19)	→	ND(12)	Below 1/3
Toritium	:	24 (H25/8/19)	→	ND(2.4)	Below 1/10

Cesium-134	:	5.3 (H25/8/5)	→	ND(0.28)	Below 1/10
Cesium-137	:	8.6 (H25/8/5)	→	ND(0.27)	Below 1/30
Total β	:	40 (H25/7/3)	→	14	Below 1/2
Toritium	:	340 (H25/6/26)	→	ND(1.4)	Below 1/200

*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. The point was further moved to the outside of the silt fence from January 20, 2023, to install the silt fence to the Drainage Channel K outlet as a measure for fish in the port. (The sampling point was moved to approx.. 3m east side)

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

*5: For the point, monitoring point was moved to the land side from May 25, 2023 along with work in the surrounding area.

*6: For the point, with the completion of work to install ALPS related facilities and others, monitoring point was moved from "In front of Unit 6 intake" to "In front of Unit 5 intake" from July 3, 2023.

	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/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 December 4 - 18)

Summary of TEPCO data as of December 19, 2023

	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(0.33)	
Cesium-137	ND (H25)	→	ND(0.26)	
Total β	ND (H25)	→	ND(15)	
Toritium	ND (H25)	→	–	

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

Cesium-134	ND (H25)	→	ND(0.33)	
Cesium-137	1.6 (H25/10/18)	→	ND(0.31)	Below 1/2
Total β	ND (H25)	→	ND(15)	
Toritium	6.4 (H25/10/18)	→	–	

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

Cesium-134	ND (H25)	→	ND(0.32)	
Cesium-137	ND (H25)	→	ND(0.34)	
Total β	ND (H25)	→	ND(15)	
Toritium	ND (H25)	→	–	

Cesium-134	ND (H25)	→	ND(0.33)	
Cesium-137	ND (H25)	→	ND(0.30)	
Total β	ND (H25)	→	ND(15)	
Toritium	4.7 (H25/8/18)	→	–	

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

Cesium-134	3.3 (H25/12/24)	→	ND(0.30)	Below 1/10
Cesium-137	7.3 (H25/10/11)	→	ND(0.28)	Below 1/20
Total β	69 (H25/8/19)	→	ND(14)	Below 1/4
Toritium	68 (H25/8/19)	→	ND(0.29)	Below 1/200

【Port entrance】

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

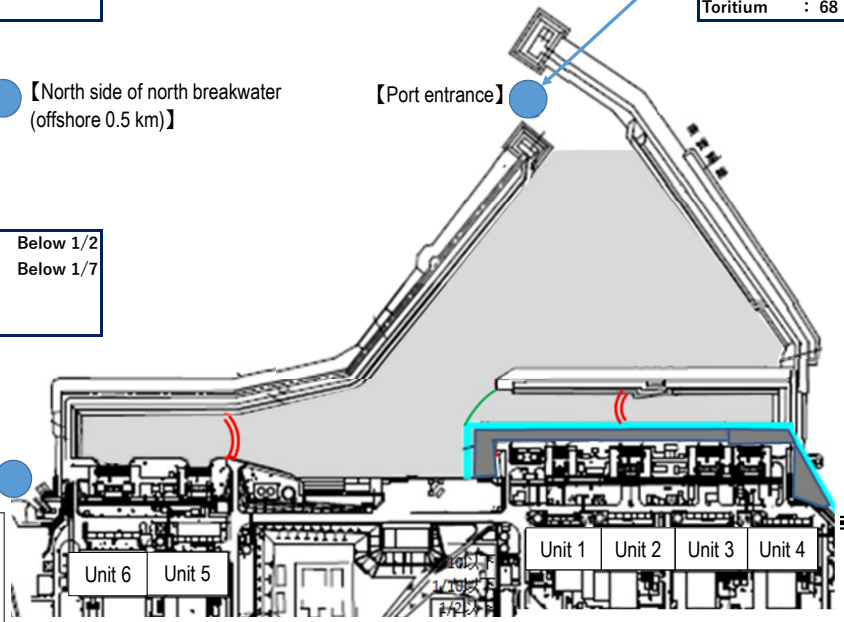
Cesium-134	ND (H25)	→	ND(0.34)	
Cesium-137	ND (H25)	→	ND(0.30)	
Total β	ND (H25)	→	ND(15)	
Toritium	ND (H25)	→	–	

Cesium-134	1.8 (H25/6/21)	→	ND(0.69)	Below 1/2
Cesium-137	4.5 (H25/3/17)	→	ND(0.63)	Below 1/7
Total β	12 (H25/12/23)	→	14	
Toritium	8.6 (H25/6/26)	→	–	

【North side of Unit 5 and 6 release outlet】

Cesium-134	ND (H25)	→	ND(0.75)	
Cesium-137	3 (H25/7/15)	→	ND(0.58)	Below 1/5
Total β	15 (H25/12/23)	→	11	
Toritium	1.9 (H25/11/25)	→	ND(0.25)	Below 1/2

【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.

*: 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.

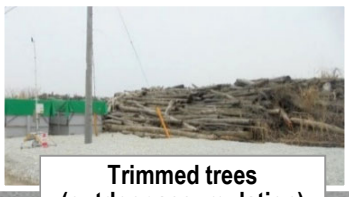
Source: TEPCO website, Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station http://www.tepco.co.jp/decommision/planaction/monitoring/index-j.html

Appendix 2

December 21, 2023

TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site Layout

- 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 (covered by sheet)

Solid waste storage facility

Covered by sheet (container storage)

Tank installation status

Temporary waste sludge storage

Spent adsorption vessel temporary storage facility

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 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 m^3/day or less (within 2020)
- Suppressing the amount of contaminated water generated to 100 m^3/day or less (within 2025)
- [Completed] Treatment of contaminated water in buildings was completed* (within 2020) *Except for Units 1-3 Reactor Buildings, Process Main Building and High Temperature Incinerator Building.
- [Completed] Contaminated water in Reactor Buildings was reduced to about a half of the level at the end of 2020 (FY2022-FY2024)

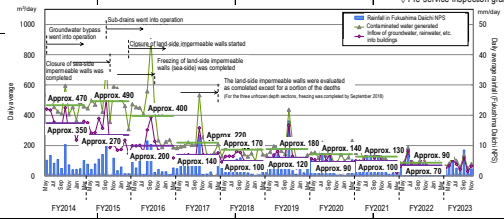
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024

Contaminated water management【Remove】

Contaminated water treatment facility
- ▽Reception start of contaminated water to Central Waste Treatment Building
- ▽Decontamination equipment (AREVA)
- ▽Evaporative concentration equipment
- ▽Cesium Adsorption Apparatus (KURION)
- ▽2nd Cesium Adsorption Apparatus (SARRY)
- Cesium Adsorption Apparatus (KURION)
- ▽Treatment of RO-condensed salt water complete
- ▽Reduction of strontium by Cesium Adsorption Apparatus (KURION) (from 2015.1.6)
- ▽Reduction of strontium by 2nd Cesium Adsorption Apparatus (SARRY) (from 2014.12.26)
- ▽Purification of strontium-reduced water in flanged tanks complete
- ▽Purification of strontium-reduced water complete
- ▽Reduction of strontium by 3rd Cesium Adsorption Apparatus (SARRY II) (from 2019.7.12)
- ▽Treatment start of strontium-reduced water (ALPS: from 2015.12.4, additional: from 2015.5.27, high-performance: from 2015.4.15)
- ▽Multi-nuclide Removal Equipment (ALPS) (System A: from 2013.3.30, System B: from 2013.6.13, System C: from 2013.9.27, hot tests conducted)
- ▽Multi-nuclide Removal Equipment (additional ALPS)
- ▽Start of full-scale operation (from 2017.10.16)
- ▽Multi-nuclide Removal Equipment (high performance ALPS) (from 2014.10.18, hot tests conducted)
- ▽Pre-service inspection granted (2023.3.2)


Landing of the second Cesium Adsorption Apparatus (SARRY)


Multi-nuclide removal equipment (ALPS)



Removal of contaminated water from seawater pipe trench
- ▽Trench Purification by mobile equipment
- ▽Completion of tunnel filling
- ▽Transfer of stagnant water complete
- ▽Completion of shaft filling
- 【Removal of contaminated water in seawater pipe trench】
- Unit 3
- ▽Completion of tunnel filling
- ▽Filling of openings II and III complete
- ▽Transfer stagnant water complete
- ▽Completion of filling parts running over drainage channel
- Unit 4
- ▽Completion of tunnel filling
- ▽Transfer of stagnant water complete
- ▽Completion of shaft filling (except for upper part of Shaft D)


Unit 2 seawater pipe trench Shaft D filling work

Contaminated water management【Redirect】

Groundwater bypass
- ▽Installation start of groundwater bypass
- **▽Operation start of groundwater bypass (drainage started from 2014.5.21)**
- **Suppressing the average amount of contaminated water generated to approx. 90 m^3/day ▽**


Pumping well

Sub-drain
- ▽Recovery of existing sub-drain pit and start of new installation
- ▽Installation start of Water-Treatment Facility special for Sub-drain & Groundwater drains
- **▽Operation start of sub-drain (drainage started from 2015.9.14)** (Treatment capacity: 1000 m^3/day)
- **▽Enhancement of treatment capacity** (2000m^3/day)


Sub-drain purification system

Land-side impermeable wall
- ▽Start of maintenance operation on north and south sides
- ▽Freezing completion
- ▽Start of maintenance operation in all sections
- In some temperature measurement tubes near the K drainage channel cross, temperature exceeded 0℃ locally ▽
- Start of maintenance operation on east side▽
- ▽Freezing start
- **▽Freezing completion (except for some parts)**
- Although no influence was detected on the impermeable function of the land-side impermeable walls but test investigation is underway for the stoppage effect


Land-side impermeable wall brine (refrigerant) circulation pipe

Facing
- ▽Completion of waterproof pavement (facing) (except for areas of 2.5 and 6.5m above sea level and around Unit 1-4)
- ▽Completion of waterproof pavement (facing) (except for around Unit 1-4)


Placement of seaside impermeable walls complete

Contaminated water management【Retain】

Bank groundwater measures
- High concentration of radioactive materials detected from observation well of bank ▽
- ▽Area 2.5m above sea level – Start of ground improvement by water glass
- ▽Completion
- ▽Start of pumping of water from contaminated areas (well point)
- ▽Installation start of seaside impermeable walls
- **▽Installation of seaside impermeable walls complete**
- ▽Operation start of groundwater drain (pumping-up started on 2015.11.5)

Storage facility
- ▽Completion of purification treatment of RO concentrated salt water
- ▽Storage in steel square tanks
- ▽Completion of replacement of steel square tanks
- ▽Removal of steel horizontal tanks complete (except for condensed waste liquid)
- ▽Water leakage (300L) from flanged tank
- ▽Water leakage (100t) from flanged tank
- ▽Storage in flanged cylindrical tanks
- ▽Completion of fence to prevent leakage expanding
- ▽Water leakage (10L) from flanged tank
- ▽Work to raise fence height complete
- **▽Purification of strontium-reduced water in flanged tanks complete**
- ▽Transfer and storage of all treated water in welded-joint tanks
- ▽Leakage of contaminated water from underground reservoir => Start of transfer to tanks
- ▽Transfer of contaminated water to tanks complete
- ▽Storage in cylindrical steel welded-joint tanks
- ▽Purification of strontium-reduced water complete
- ▽Sprinkling start of rainwater within tank fences by rainwater treatment facility (from 2014.5.21)


Construction of welded-joint tanks


Flanged and welded-joint tanks

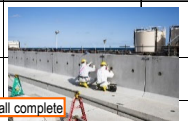
Treatment of stagnant water
- ▽Start to maintain water-level difference with sub-drain water level
- ▽Installation of stagnant water transfer equipment/transfer start
- ▽Completion of work to improve reliability of transfer line (replacement with PE pipes)
- ▽Transfer start from each building to Central Rw Building
- **▽Treatment of stagnant water in buildings complete**
- **▽Reduction of contaminated water in the Reactor Buildings to approx. half of the level at the end of 2020 achieved**
- ▽Floor exposure of Unit 1 T/B
- ▽Separation of stagnant water between Units 1 and 2
- ▽Floor exposure of Unit 1 Rw/B
- ▽Separation of stagnant water between Units 3 and 4
- ▽Floor exposure of Unit 2 T/B, Rw/B
- ▽Floor exposure of Unit 3 T/B, Rw/B
- ▽Floor exposure of Unit 4 R/B, T/B, Rw/B
- ▽Completed lowering to target water level of Unit 2 R/B
- ▽Completed lowering to target water level of Unit 1, 3 R/B

Countermeasures to tsunami

Closure of openings
- ▽Examination start of measures to close building openings
- ▽Work for common pool complete
- ▽Work for Units 1 and 2 T/B complete
- ▽Work for HTI building complete
- ▽Work for Process Main Building complete
- ▽Work for Unit 3 T/B complete
- ▽Work for Unit 1-3 R/B complete
- **▽Measures to close openings were completed**
- ▽Work for Units 1-4 RwB was completed

Seawall
- ▽Installation of outer-rise tsunami seawall complete
- ▽Construction start of Chishima Trench Tsunami Seawall
- Japan Trench tsunami seawall ▽Completion of installation ▽On-site start

Mega float
- ▽Start of marine construction
- ▽Internal filling complete (reduction of tsunami risks)
- Temporary grounding of mega float▽

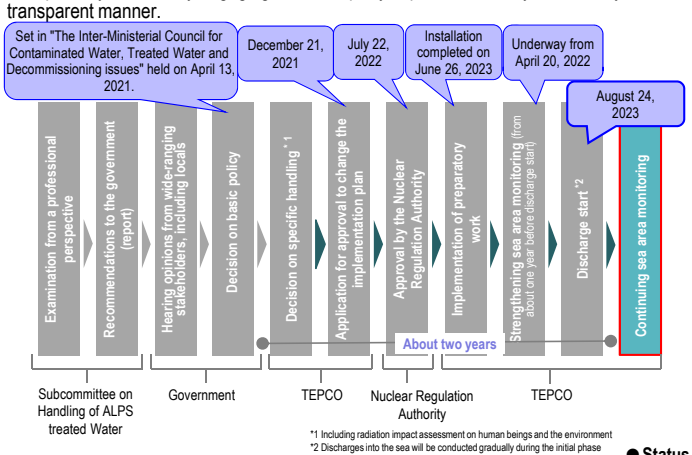

Chishima Trench Tsunami Seawall complete


Construction of Japan Trench Tsunami Seawall

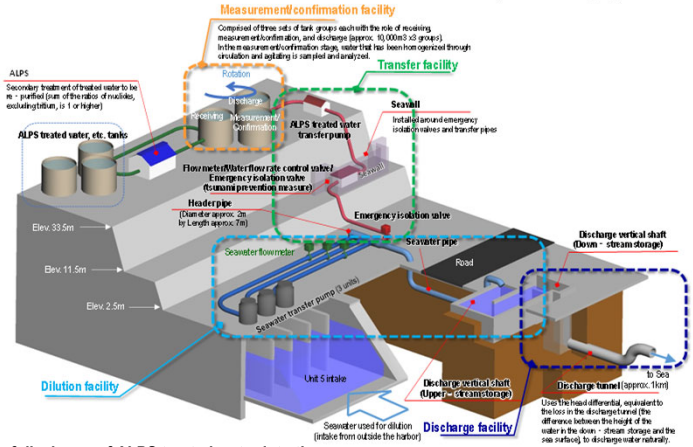
2 Handling of ALPS treated water

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.



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



Information provision and communication to foster understanding

■ Occasions to deepen the understanding are organized by communications related to decommission via various media and visit to the power station.

■ On the dedicated website “Treated Water Portal Site” (Japanese, English, Chinese and Korean) within the TEPCO website, monitoring results of radioactive materials are published timely.

Dialogue meeting

■ Visit and dialogue meeting of Fukushima Daiichi Nuclear Power Station have been held since 2019 for 13 cities, towns and villages.

■ Through various opportunities such as visit and on-site explanations, communications continue where opinions of related parties are heard, their thought is taken seriously, and TEPCO conveys its efforts, thought and countermeasures for reputational damage.

Examination concerning handling of ALPS treated water

Tritiated Water Taskforce (2013.12 – 2016.5, 15 meetings)

Tank area viewed from the Large Rest House (2015.10.29)

2016.6 Report of Tritiated Water Taskforce

Subcommittee on Handling of ALPS treated water (2016.11 – 2020.1, 17 meetings)

2018.8 Explanatory and hearing meeting, receiving opinions

2020.2 Report of Subcommittee on Handling of ALPS treated water

Opportunity for receiving opinions from parties concerned concerning handling of ALPS treated water (2020.4 – 2020.10, 7 meetings)

2021.4.13 The basic policy on the handling of ALPS treated water was set
2021.4.16 The response of TEPCO was announced

2021.12.21 The “Application Documents for Approval to Amend the Implementation Plan for Fukushima Daiichi Nuclear Power Station Specified Nuclear Facility” regarding ALPS treated water were submitted to the Nuclear Regulation Authority
2021.12.28 “The Action Plan concerning the Continuous Implementation of the Basic Policy on Handling of ALPS Treated Water” was formulated

Review meeting concerning the implementation plan on handling of ALPS treated water (from 2021.7 to 2022.4, 15 meetings)

2022.4.28, 5.13, 7.15 Application to partially revise the Application Documents for Approval to Amend the Implementation Plan was submitted
2022.7.22 Application for the Application Documents for Approval to Amend the Implementation Plan was approved
2022.8.4 Work has commenced
2022.8/30 The "Approach to Strengthening and Expansion of Measures in the Handling of ALPS Treated Water" was summarized
2022.11.14 Application for the Application Documents for Approval to Amend the Implementation Plan was submitted (amendment of organizational structure, and nuclides to be measured and assessed, and others)
2023.2.14, 20 Application for the Application Documents for Approval to Amend the Implementation Plan was submitted (amendment of organizational structure, and nuclides to be measured and assessed, and others)
2023.5.10 Approval
2023.6.26 Completion of installation
2023.7.7 Receipt of Certificate of Completion for Pre-service Inspections
2023.8.24 Commencement of discharge

2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

● Status of discharge of ALPS treated water into the sea

On August 22, 2023, as the 1st phase of the 1st discharge of ALPS treated water, a small amount of ALPS treated water (approx. 1 m3) was diluted with seawater (approx. 1,200 m3), and to confirm that ALPS treated water was diluted as assumed, diluted ALPS treated water was stored in the discharge shaft (upstream pool) and sampled.

On August 24, regarding tritium concentration of diluted ALPS treated water, it was confirmed the analytical value was within the range of uncertainty of calculated concentration and below 1,500 Bq/L. Subsequently, discharge of ALPS treated water into the sea commenced from the same day (August 24) and the 1st discharge was completed on September 11.

Discharge of ALPS treated water from Tank Group C of the measurement / confirmation facility into the sea (2nd discharge) commenced from October 5, 2023, and completed on October 23.

From November 2, 2023, discharge of ALPS treated water from Tank Group A of the measurement / confirmation facility into the sea (3rd discharge) commenced. Since the commencement of discharge, it has been confirmed that the discharge was conducted safely as planned based on the results of quick analysis conducted daily by TEPCO on tritium in seawater. The 3rd discharge was conducted safely as planned while confirming that the discharge satisfied the national government’s requirement and was completed on November 20.

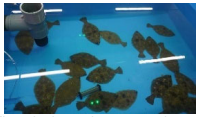
During the discharge period, no abnormality was detected by the sea area monitoring conducted by the national government, Fukushima Prefecture and TEPCO. (Discharge amount 7,753 m^3)

In the next phase, after draining water in the upstream pool to the downstream pool, inspections related to the facilities and operation will be conducted.

Tank group discharged	Tank Group B	Tank Group C	Tank Group A
Tritium concentration	140,000 Bq/L	140,000 Bq/L	130,000 Bq/L
Discharge commencement	August 24, 2023	October 5, 2023	November 2, 2023
Discharge termination	September 11, 2023	October 23, 2023	November 20, 2023
Discharge amount	7,788 m^3	7,810 m^3	7,753 m^3
Total tritium amount	1.1 trillion Bq	1.1 trillion Bq	1.0 trillion Bq

Operation by duty staff (Tank Group B, 2nd phase)

● Rearing test of marine organisms
- To alleviate concerns and lead to relief of local residents, related parties and the everyone in society, marine orgasms are being reared in tanks of seawater containing ALPS treated water and the status is compared with the original seawater controls. The progress will be shown coherently and clearly.
- Regarding behaviors of tritium and others, a lot of research has been conducted in Japan and overseas. Based on the experimental results, firstly experimental data for a half year will be collected and subsequently, the same as past experimental results, the theory “tritium in vivo is not concentrated and the concentration of tritium in vivo will not exceed the level in the growing environment” will also be reaffirmed.



Flounder in rearing preparation tank

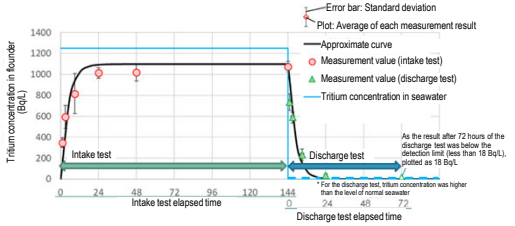
Overall view of mockup tanks

● **Measurement of tritium concentration of flounder (tritium concentration less than 1,500 Bq/L) and analysis of results**

Based on the measurement results of tritium concentration, the following was confirmed as in the past insight:

[Intake test]
- The tritium concentration did not exceed the level in the growing environment (in this test, the concentration exceeding the level in ALPS treated water diluted with seawater)
- The tritium concentration reached equilibrium in a certain period

[Discharge test]
- When flounder having reached equilibrium in the tritium concentration higher than the level of normal seawater is returned to normal seawater, the concentration decreased over time



- Daily rearing status is published in the TEPCO website and Twitter
  - TEPCO website: http://www.tepco.co.jp/decommission/information/newsrelease/breedingtest/index-j.html
  - TEPCO X (Old Twitter): https://twitter.com/TEPCOfishkeeper

● **Publication of the Comprehensive Report of the IAEA safety review**

The Comprehensive Report on the safety review concerning handling of ALPS -treated water was published by the IAEA on July 4, 2023.

In the Executive Summary of the IAEA Comprehensive Report, the IAEA concluded the following: (1) the activities by Japan associated with the discharge of ALPS treated water into the sea are consistent with relevant international safety standards,
(2) the discharge of the ALPS treated water will have a negligible radiological impact on people and the environment.

We will continue to share necessary information with the IAEA, while striving to foster further understanding of the international community about the discharge of ALPS treated water into the sea.

Sampling of ALPS treated water in the presence of the IAEA

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)

December 21, 2023
Secretariat of the Team for Countermeasures for Decommissioning, Contaminated Water and Treated Water

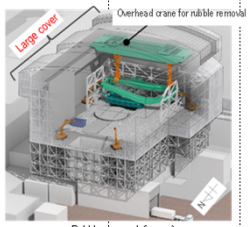
Legend: Rubble removal, etc. | Installing a fuel removal machine | Fuel removal | Storage and handling of fuel

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023～

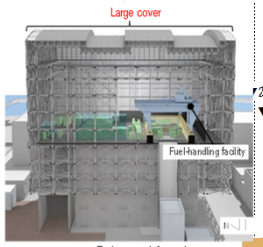
Unit 1

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

<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.



Rubble removal (image)



Fuel removal (image)

▼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
▼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
▼2021.8 Start of large cover pre-work
▼2022.4 Start of large cover installation 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.

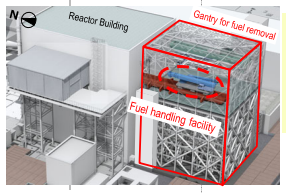

<Unit 1 northwest side 2023.2.9>

Unit 2

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.

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



▼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
▼2020.6 Investigation inside the spent fuel pool
▼2023.1 Start of steel erection
▼2023.2 Start of south-side existing facilities dismantling

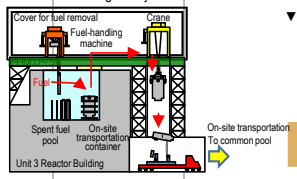

<Unit 2 Construction of gantry for fuel removal>

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.

Unit 3

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

Overview of the fuel-handling facility inside the cover



▼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
▼2021.2.28 Fuel removal completed (566 assemblies)

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.

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

Unit 4

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

▼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
▼2014.12.22 Fuel removal was completed (1533 assemblies)


<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

* 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)

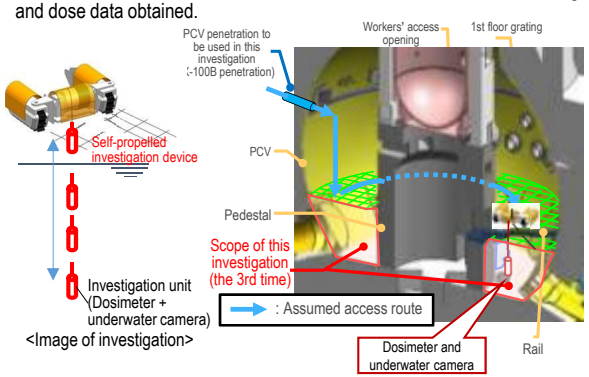
Start of fuel debris retrieval from the first unit (Unit 2). Expanding the scale in stages (within 2021 * The schedule will be extended for about 1 year due to the spread of COVID-19 infections)

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

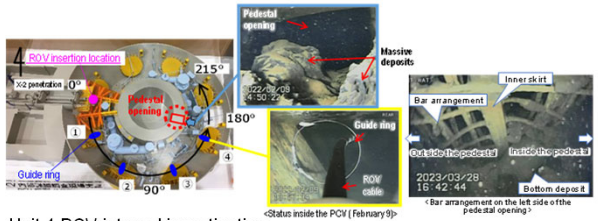
・In April 2015, a device having entered the inside of the PCV via a narrow opening (bore:φ100 mm) collected information such as images and airborne dose inside the PCV 1st floor.

・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 2022, the guide ring" was installed to facilitate the investigation. From March 28, 2023, the investigation inside the pedestal by ROV-A2 started and confirmed that a portion of the bar arrangement was exposed. Regarding the soundness of the pedestal, based on the past earthquake resistant evaluation by the International Research Institute for Nuclear Decommissioning (IRID), it was evaluated that even though a portion of the pedestal was lost, there would be no serious risk. However, as the present information is very limited, the investigation will continue to acquire as much information as possible for continued evaluation.



<Status inside the PCV (February 9)>
< Bar arrangement on the left side of the pedestal opening >

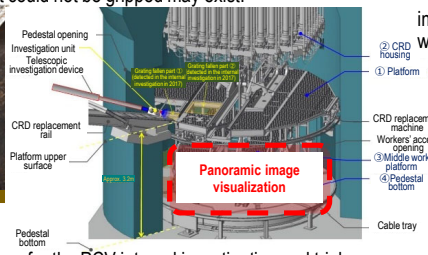
Unit 2 Investigation overview

・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.

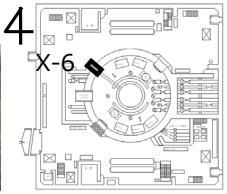

Bottom of the pedestal (after being processed in panoramic image visualization)



・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

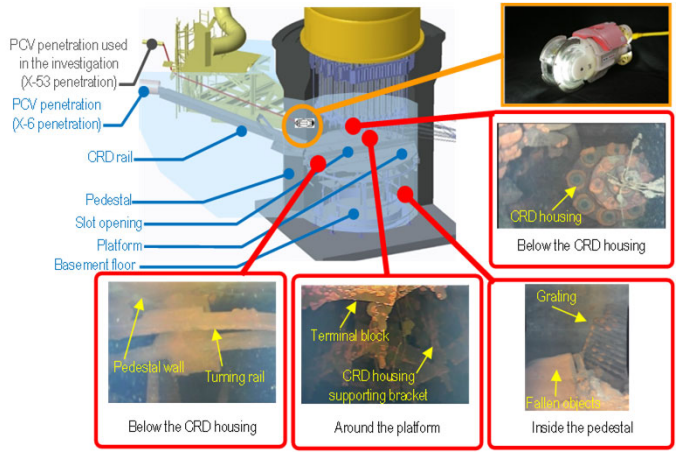
・In October 2014, the conditions of X-53 penetration, which may be under water and which is scheduled for use to investigate the inside of the PCV, was investigated via remote-controlled ultrasonic test equipment. The results showed that the penetration was not under water.

・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
	4th (From 2022.2)	Acquiring information inside PCV (inside/outside of the pedestal) - Acquiring images - Measuring deposit thickness and sampling deposit - Detecting deposit debris, 3D mapping
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

December 21, 2023
Secretariat of the Team for Countermeasures for Decommissioning, Contaminated Water and Treated Water

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 ★2023.2 Revision ★2023.11 Revision

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

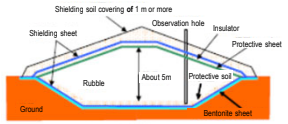
▼ 2012.9 Transfer start of rubble to the soil-covered temporary storage facility

▼ 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

Large Equipment Decontamination Facility

▼2022.5 Start of operation

▼ 2017.4 Start of pre-work
Additional Solid Waste Incinerator

2017.10 Installation work gets

▼ 2018.5 Operation start
Large Equipment Decontamination Facility

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

▼ 2020.9 Start of pre-work
Compaction Facility

Site of Volume Reduction Faciility

Present status Note

Storage of rubble and others

Present storage Approx.520,000 m³ (as of 2023.3)

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.**760,000** m³

(*2)

Approx. 300,000 m³
Approx. 70,000 m³
Approx. 60,000 m³
Approx. 140,000 m³
Approx. 180,000 m³
Approx. 7,400 tanks

Status after a decade

(*3) Approx. **290,000** m³ (*2)

Legend : Newly installed equipment and facility

Incineration

To (A) (*1)

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


Crusher example

- Radioactive Waste Incinerator
- Additional Radioactive Waste Incinerator (Completion in May 2022)

Approx. 70,000 m³ Stored and managed in Solid Waste Storage as done for rubble

Volume reduction

To (A) (*1)

Compaction Facility
(scheduled for completion in FY2022)


Concrete crusher example


Metal cutter example

Melting

Melting equipment
(under consideration)


Electric furnace example

To (B)

Approx. 50,000 m³ (*1)

Storage /management

- Solid Waste Storage (Storage capacity: approx. 250,000 m³)
- Existing Solid Waste Storage 1st-8th (existing) 9th (Operation launch in 2018.2)
- **Additional Solid Waste Storage** 10th-11th (Scheduled for completion after FY2024)

Approx. 20,000 m³
Approx. 70,000 m³
(A) (*1) Approx. 80,000 m³
(B) Approx. 60,000 m³

Based on the estimates for the amount of waste to be generated, the storage capacity (approx. 250,000 m³) will be reached in around 2031. 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 FY2025) The earthquake-resistant design is being reviewed based on the Fukushima prefecture offshore earthquake in FY2021


Work of main part

Treatment measures and others will be examined

(*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.

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.

2011 2012年 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023～

▼ 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.

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

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.

Large rest house under construction (2014.9.30)

Access Control Facility (2014.11.7)

▼ 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.

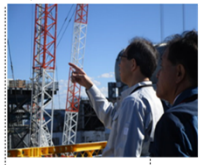
▼ In March 2015, the Fukushima revitalization meal service center opened.

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

▼ 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.

▼ 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.



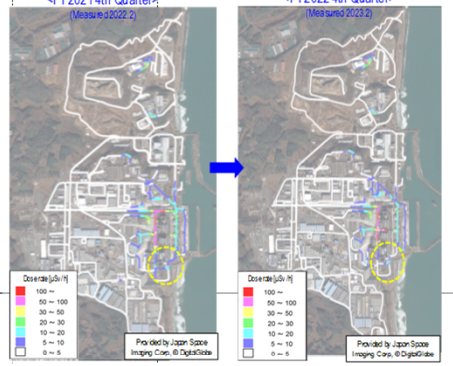
Visit by Governor of Fukushima Prefecture to the Fukushima Daiichi NPS (2018.11.1)

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

Visit by Prime Minister Kishida to the Fukushima Daiichi NPS (2023.8.21)
Observation of ALPS Treated Water Dilution/Discharge Facilities from high ground on Units 5 and 6side

<Travel survey results of major roads within the site>
It was confirmed that compared with the last fiscal year, the dose rate has been declining on roads near the southeast side of the Unit 4 Turbine Building and the west side of the Process Main Building (area circled by yellow dot line).

<FY2021 4th Quarter> (Measured 2022.2)
<FY2022 4th Quarter> (Measured 2023.2)

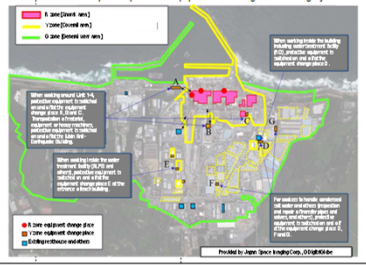


▼ In May 2013, areas excluding those around Unit 1-4, tank areas and rubble storage areas were set to full-face mask unnecessary areas.

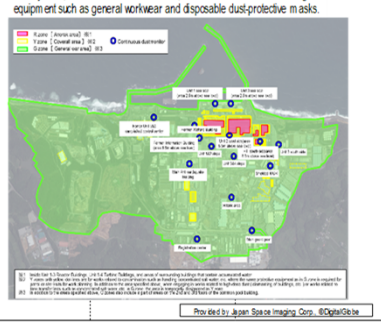
▼ In May 2015, full-face mask unnecessary area was expanded to cover about 90% of the site.

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

▼ In 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.



▼ 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).

Move in general working clothes (2016.1.7)

Facing (2017.4.13)