Outline of Decommissioning and Contaminated Water Management

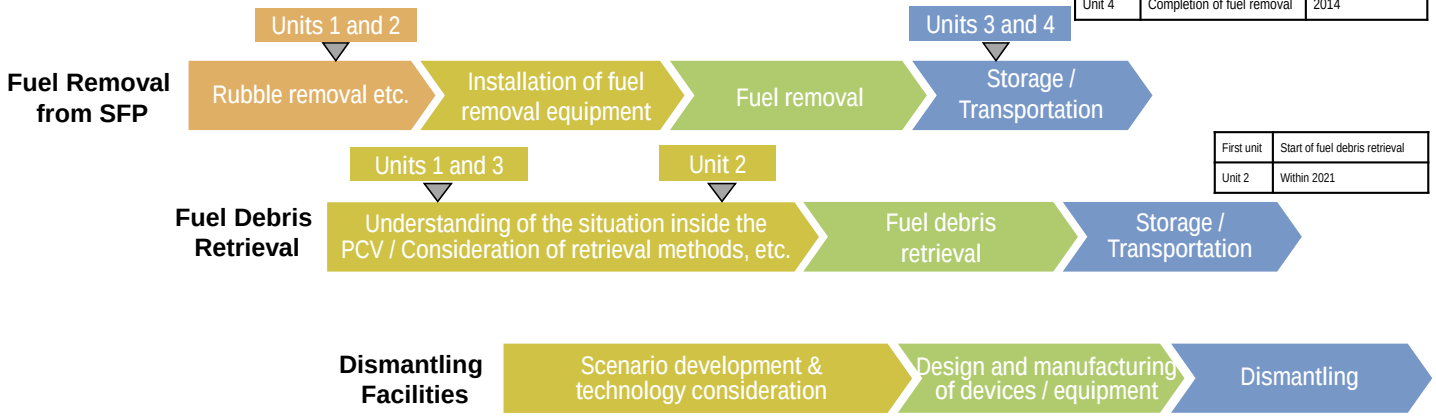
October 28, 2021
Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

Main decommissioning work and steps

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

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

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

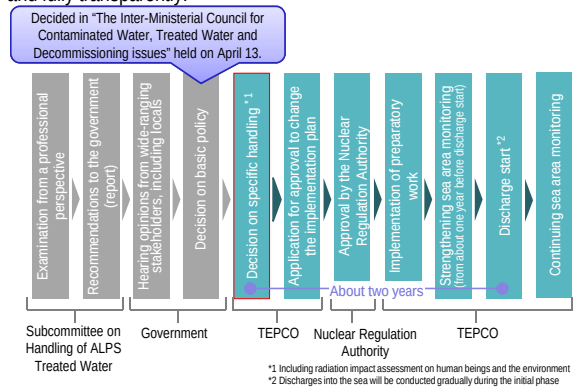


First unit	Start of fuel debris retrieval
Unit 2	Within 2021

Measures of treated water

Handling of ALPS treated water

Regarding the discharge of ALPS treated water into the sea, TEPCO must comply with regulatory and other safety standards to safeguard the public, 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 continuously and fully transparently.



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

Contaminated water management – triple-pronged efforts -

(1) Efforts to promote contaminated water management based on the three basic policies
① "Remove" the source of water contamination ② "Redirect" fresh water from contaminated areas
③ "Retain" contaminated water from leakage

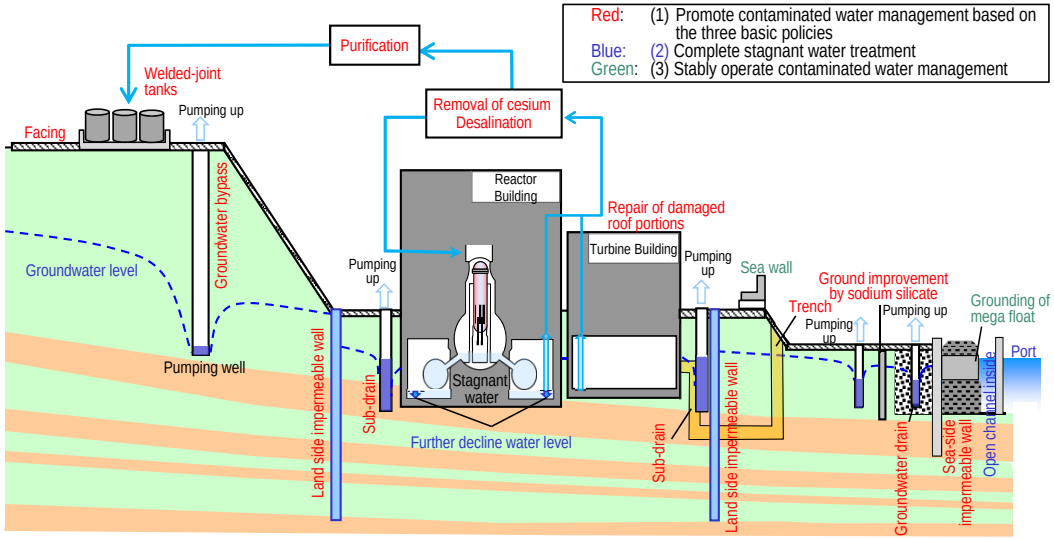
- Strontium-reduced water from other equipment is being re-treated in the multi-nuclide removal equipment (ALPS) and stored in welded-joint tanks.
- Multi-layered contaminated water management measures, including land-side impermeable walls and sub-drains, have stabilized the groundwater at a low level and the increased contaminated water generated during rainfall is being suppressed by repairing damaged portions of building roofs, facing onsite, etc. Through these measures, the generation of contaminated water was reduced from approx. 540 m^3/day (in May 2014) to approx. 180 m^3/day (in FY2019) and approx. 140 m^3/day (in 2020).
- Measures continue to further suppress the generation of contaminated water to 100 m^3/day or less within 2025.

(2) Efforts to complete stagnant water treatment

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

(3) Efforts to stably operate contaminated water management

- To prepare for tsunamis, various measures are underway. For heavy rain, sandbags are being installed to suppress direct inflow into buildings while work closing building openings and installing sea walls to enhance drainage channels and other measures are being implemented as planned.



Progress status

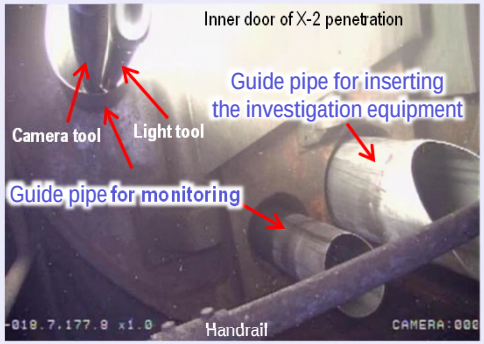
◆ The temperatures of the Reactor and the Primary Containment Vessel of Units 1-3 have been maintained stable.
There was no significant change in the concentration of radioactive materials newly released from Reactor Buildings into the air. It was concluded that the comprehensive cold shutdown condition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

Toward the Unit 1 PCV internal investigation, work to install guide pipes related to creating an access route was completed

Toward the internal investigation of the Unit 1 Primary Containment Vessel (PCV), work to install guide pipes related to creating an access route was completed on October 14.

Toward the internal investigation, work to exchange the cover sheet, install the investigation equipment and others will start from November.

Work continues carefully with safety first toward starting the PCV internal investigation within FY2021.



<Status of installed guide pipes>

The performance verification test continues for the trial retrieval equipment of Unit 2 fuel debris

The ongoing performance verification test in a domestic factory (Kobe), which started from August, continues.

Moreover, training sessions are conducted under a VR environment to operate the robot arm or using the actual dual-arm manipulator.

They will continue, alongside verification tests.

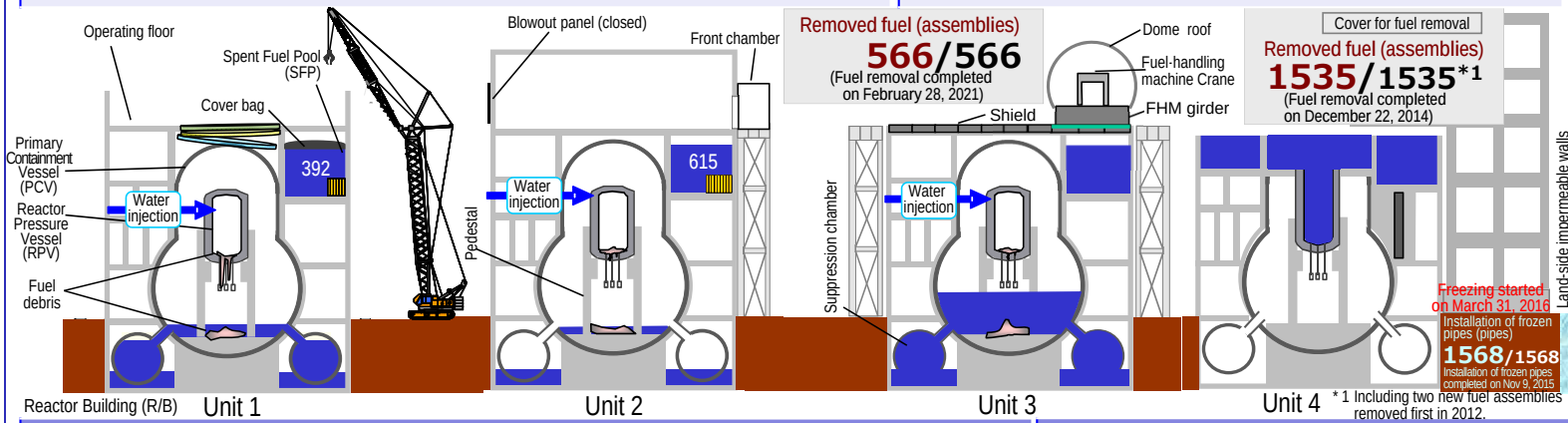

<Performance verification test of the robot arm>

Preparation proceeds toward investigation utilizing a new drilled hole of the shield plug inside the top floor of the Unit 2 Reactor Building

To determine the contamination status of the shield plug in more detail, an investigation utilizing a new drilled hole is planned. On October 7, a dose investigation was conducted above the shield plug before examining the drilled hole location.

The investigative results showed a high dose detected at the center and connection, which varied.

Based on the results of the dose investigation, work to drill 13 holes will be implemented from late November to mid-December and an investigation will be conducted utilizing the new hole from mid-December.



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

Foundation work of the volume reduction facility building was complete

Construction of a volume reduction facility to cut metals and crush concrete is underway and the foundation work was completed on October 22.

Toward completion of the construction within FY2022, safe work will proceed.

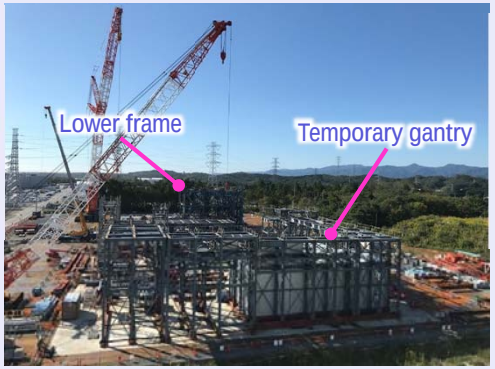

<Construction status (October 20, 2021)>

Toward installation of the Unit 1 large cover, semi-assembly of steel frames and others and investigation into external walls of the Reactor Building are underway

Toward installation of a large cover, the semi-assembly of steel frames and others is underway in a yard outside the site and that of the temporary gantry is almost completed.

Around the building, before installing an anchor in the Reactor Building and subsequently a large cover, work started from October 20 to investigate cracks on external walls of the Reactor Building and verify their strength by sampling the concrete core.

Toward installing a large cover in around FY2023, pre-work continues with safety first.



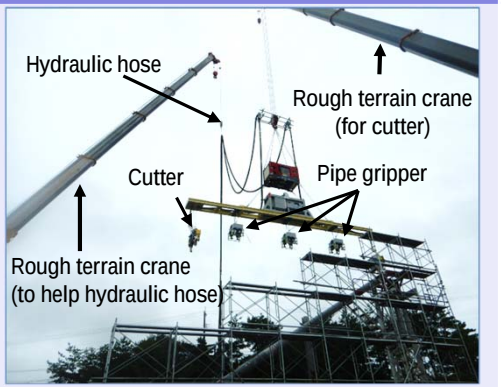
<Whole view of the yard outside the site (October 11, 2021)>

Toward removing a portion of Unit 1/2 SGTS pipes, measures to prevent scattering were completed and mockup testing is underway

To prevent radioactive dust scattering while cutting the high-dose 1/2 Standby Gas Treatment System (SGTS), work to inject urethane by remote-control equipment was completed on September 26.

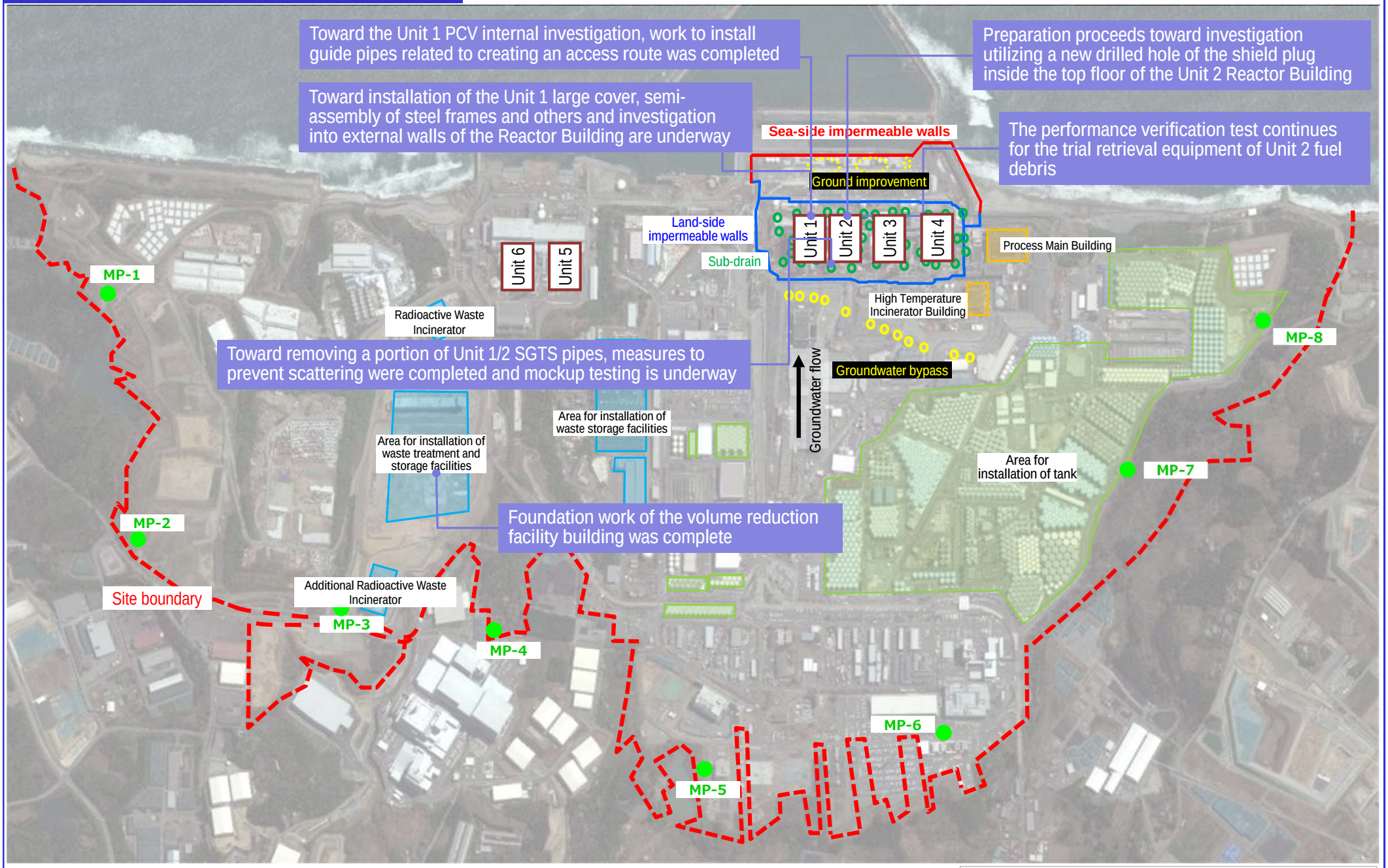
At the same time, mockup tests of pipe cutting using remote-control equipment were also repeated and insights acquired from these tests were reflected in procedures and facilities.

To proceed with the work safely and steadily, operation training using actual cranes will be repeated. With the aim of removing the pipes in mid-November, preparation proceeds.



<Mockup test for pipe cutting>

Major initiatives – Locations on site

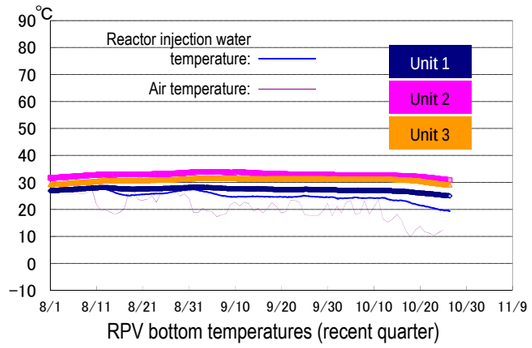


Provided by Japan Space Imaging Corp., photo taken on April 8, 2021
Product (C) [2020] DigitalGlobe, Inc., a Maxar company

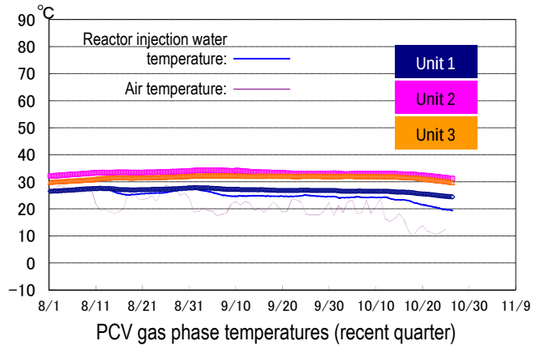
I. Confirmation of the reactor conditions

Temperatures inside the reactors

Through continuous reactor cooling by water injection, the temperatures of the Reactor Pressure Vessel (RPV) bottom and the Primary Containment Vessel (PCV) gas phase were maintained within the range of approx. 25 to 35°C for the past month, though it varied depending on the unit and location of the thermometer.

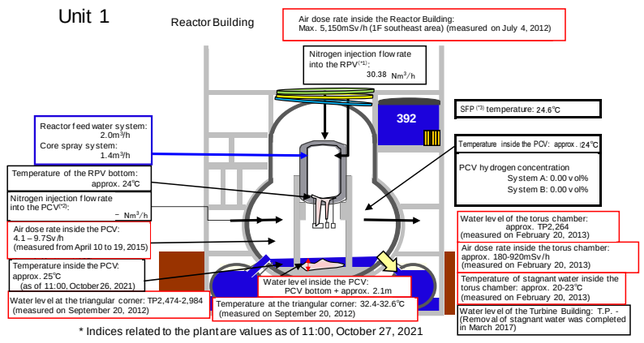


RPV bottom temperatures (recent quarter)

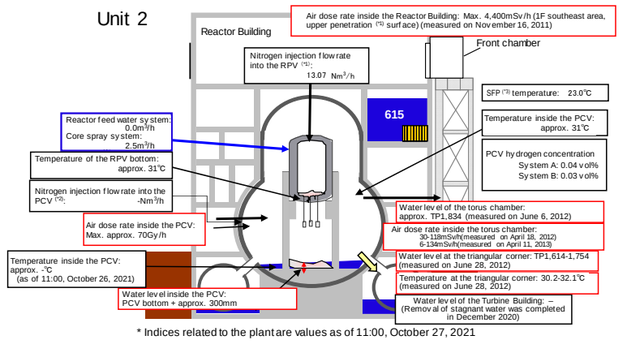


PCV gas phase temperatures (recent quarter)

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



* Indices related to the plant are values as of 11:00, October 27, 2021



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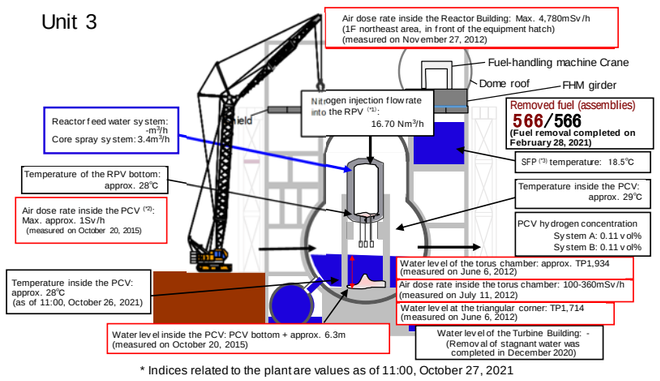


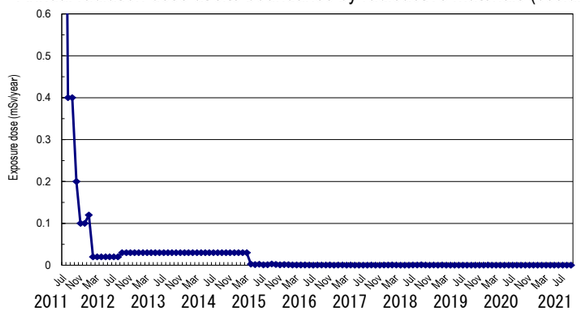
* Indices related to the plant are values as of 11:00, October 27, 2021

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

Release of radioactive materials from the Reactor Buildings

As of September 2021, the concentration of radioactive materials newly released from Reactor Building Units 1-4 into the air and measured at the site boundary was evaluated at approx. 2.6 × 10-12 Bq/cm^3 and 2.1 × 10-12 Bq/cm^3 for Cs-134 and -137 respectively, while the radiation exposure dose due to the release of radioactive materials there was less than 0.00005 mSv/year.

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



(Reference)

* The concentration limit of radioactive materials in the air outside the surrounding monitoring area:
  [Cs-134]: 2 x 10^{-5} Bq/cm^{3Marc}
  [Cs-137]: 3 x 10^{-5} Bq/cm^3
* Data of Monitoring Posts (MP1-MP8).
  Data of Monitoring Posts (MPs) measuring the air dose rate around the site boundary showed 0.341 – 1.101 μSv/h (September 29 – October 26, 2021).
  To measure the variation in the air dose rate of MP2-MP8 more accurately, work to improve the environment (trimming trees, removing surface soil, and shielding around the MPs) was completed.

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

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

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.

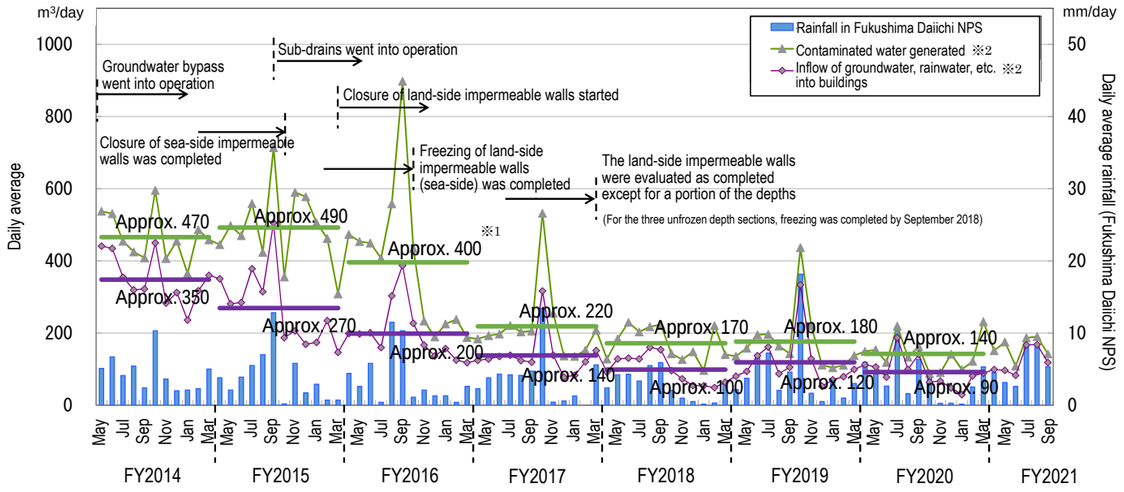
II. Progress status by each plan

Handling of ALPS treated water

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

➢ Status of contaminated water generated

- Multi-layered measures, including pumping up by sub-drains and land-side impermeable walls, which were implemented to control the continued generation of contaminated water, suppressed the groundwater inflow into buildings.
- After implementing "redirecting" measures (groundwater bypass, sub-drains, land-side impermeable walls and others) and rainwater prevention measures, including repairing the damaged portions of building roofs, the amount of contaminated water generated within FY2020 declined to approx. 140 m^3/day.
- Measures will continue to further reduce the amount of contaminated water generated.



*1 Values differ from those announced at the 20th Committee on Countermeasures for Contaminated Water Treatment (held on August 25, 2017) because the 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 October 18, 2021 and 1,689 releases were conducted.
- The water quality of all temporary storage tanks satisfied the operation target.

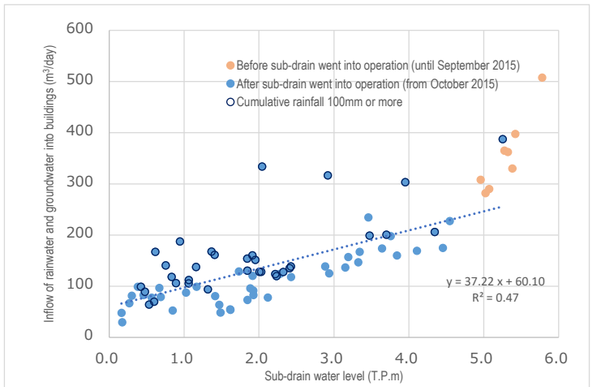


Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Units 1-4 sub-drains

➢ Implementation status of facing

- Facing is a measure involving asphalting of the onsite surface to reduce the radiation dose, prevent rainwater infiltrating the ground and decrease the amount of underground water flowing into buildings. As of the end of September 2021, 95% of the planned area (1,450,000 m^2 on site) had been completed. For the area inside the land-side impermeable walls, implementation proceeds appropriately after constructing a yard from implementable zones that leave the decommissioning work unaffected. As of the end of September 2021, 25% of the planned area (60,000 m^2) had been completed.

➢ Status of groundwater level around buildings

- The groundwater level in the area inside the land-side impermeable walls has been declining every year. On the mountain side, the difference between the inside and outside was maintained, despite varying during rainfall. The water level of the groundwater drain observation well has been maintained at approx. T.P. +1.4 m, sufficiently below the ground surface (T.P. 2.5 m).

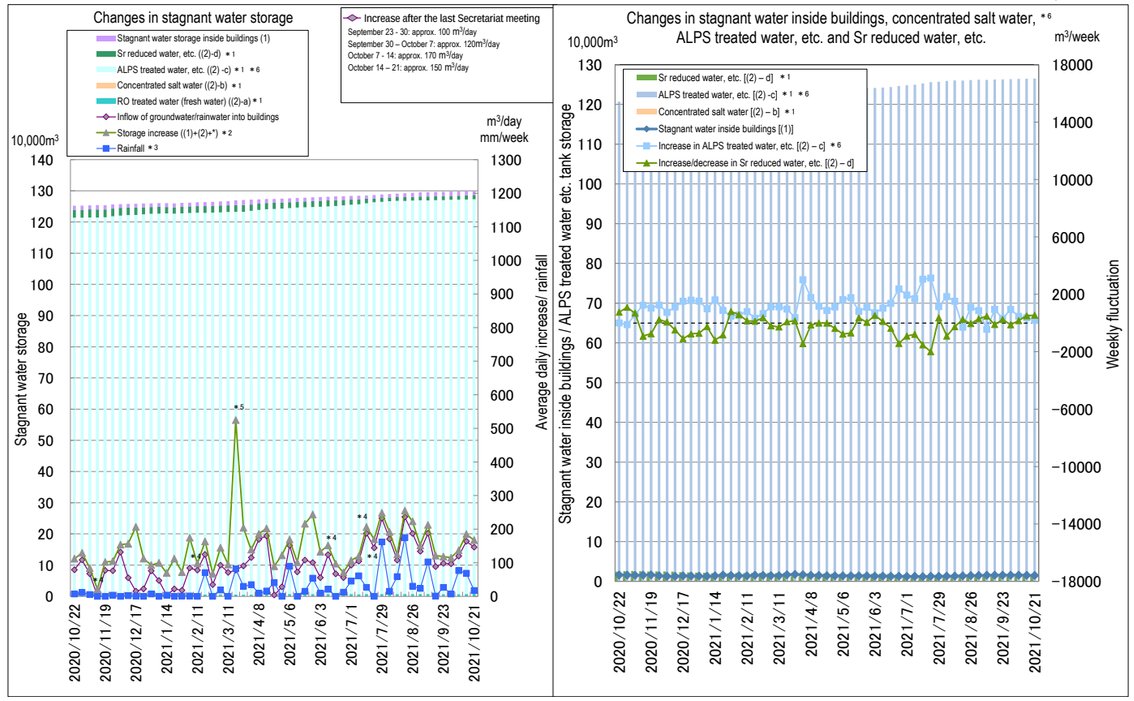
➢ Operation of multi-nuclide removal equipment

- As of October 21, 2021, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 478,000, 718,000 and 103,000 m^3, respectively (including approx. 9,500 m^3 stored in the J1(D) tank, which contained water with highly concentrated radioactive materials at the System B outlet of the existing multi-nuclide removal equipment).
- 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 October 21, 2021, approx. 657,000 m^3 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 October 21, 2021, approx. 819,000 m^3 had been treated.

As of October 21, 2021



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

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

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

*4: Considered attributable to the fluctuation inflow of groundwater, rainwater, and others to buildings due to the decline in the level of contaminated water in buildings.
(November 12-19, 2020, February 4-11, June 3-10 and July 8-22, 2021)

*5: Stored amount increased due to transfer to buildings in association with decommissioning work on March 18, 2021.
(Major breakdown of the transferred amount: (1) Contaminated water inside the tank fences (water transferred from the Shallow Draft Quay drainage channel) was transferred to the Process Main Building: approx. 390 m³/day, (2) Contaminated water inside the tank fences (water transferred from the Shallow Draft Quay drainage channel) was transferred to the High Temperature Incinerator Building: approx. 10 m³/day, (3) Transfer from the Unit 3 additional FSTR to the Unit 3 Radioactive Waste Treatment Building: approx. 10 m³/day and others)

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

Figure 3: Status of stagnant water storage

➢ Increase in temperature in the land-side impermeable wall temperature measuring tube 150-7S

- Around the crossing of the impermeable wall and the drainage channel K, the underground temperature increased from August 27, while in some sections, the underground temperature measured by temperature measuring tubes increased to 0°C or more after September 15.
- Even as of September 15, the water level inside the land-side impermeable walls was declining and as of October 26,

the water-level difference between the inside and outside remained at 6.6m, hence the overall impermeability of the land-side impermeable walls was deemed to continue.

- Drainage Channel K included a reinforced section at the crossing with the land-side impermeable wall as a measure to counter expansion. There was potential for having flown into the frozen range from potential cracks in the reinforced section (no visible damage could be detected within visible range of the water surface inside Drainage Channel K).
- The section will be dried up in the first week of November and a detailed visual investigation, repair of cracks and others will be conducted.

Fuel removal from the spent fuel pools

Work to help remove spent fuel from the pool is progressing steadily while ensuring seismic capacity and safety.

➢ Main work to help spent fuel removal at Unit 1

- From late April 2021, work to assemble a temporary gantry and others is underway in a yard outside the site toward installing a large cover.
- A work yard was prepared around the Reactor Building and work to install a large cover started from August 2021.

➢ Main work to help spent fuel removal at Unit 2

- To reduce the dose on the operating floor, a mockup of decontamination work was implemented. Preparatory work in the front room of the west-side gantry was conducted from June 22, 2021 and decontamination work has been underway since August 19.
- At present, removal of hindrances (underground objects and others) and preparatory work for ground improvement is currently underway. Ground improvement started from late October and work to install the gantry will start from the 1st half of FY2022.

Retrieval of fuel debris

➢ Progress status toward Unit 1 PCV internal investigation

- All work to install guide pipes was completed on October 14, related to creating an access route toward the internal investigation of the Unit 1 Primary Containment Vessel (PCV).
- To acquire information related to the construction plan to collect deposits toward fuel debris retrieval, a remotely operated underwater vehicle (ROV) will be inserted into the basement inside the PCV from X-2 penetration to investigate inside and outside the pedestal.

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

- The trial retrieval equipment for Unit 2 fuel debris, which had been developed in the UK, arrived in Japan on July 10.
- The ongoing performance verification test in a domestic factory (Kobe), which started from August, continues.

Plans to store, process and dispose of solid waste and decommission of reactor facilities

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

➢ Management status of the rubble and trimmed trees

- Based on the plan concerning optimization of waste, the volumes of temporary accumulation are counted from this month. As of the end of September 2021, the total storage volume for concrete and metal rubble was approx. 311,200 m^3 (+800 m^3 compared to the end of August with an area-occupation rate of 75%). The total storage volume of trimmed trees was approx. 140,800 m^3 (registering a slight increase, with an area-occupation rate of 80%). The total storage volume of used protective clothing was approx. 31,500 m^3 (-1,200 m^3, with an area-occupation rate of 60%). The increase in rubble was mainly attributable to work/ decontamination of flanged tanks and work around Unit 1-4 buildings. As of the end of September 2021, there were 17 temporary deposits with storage capacity exceeding 1,000m^3 and the total storage volume was 56,900 m^3.

➢ Management status of secondary waste from water treatment

- As of the end of September 2021, the total storage volume of waste sludge was 442 m^3 (area-occupation rate: 63%), while that of concentrated waste fluid was 9,380 m^3 (area-occupation rate: 91%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment and other vessels, was 5,216 (area-occupation rate: 82%).

➢ Measures to optimize waste management

- At present, the management varies depending on the “positioning” of the material such as construction materials and equipment, temporary accumulation and rubble. However, multiple problems have recently occurred concerning on-site material management.
- In response, to implement safety measures focused on “characteristics” of the material and manage materials properly and in the right place depending on “positioning,” the necessary operation and implementation plan will be reviewed and examined and proceed in an organized manner.
- Measures for the storage condition of rubble will be prioritized. The appropriate management condition will be verified and corrected within FY2021 and the storage of rubble will be shifted to ensuring an appropriate storage condition is maintained within FY2022.

Reactor cooling

The cold shutdown condition will be maintained by cooling the reactor by water injection and measures to complement the status monitoring continue

➢ Work to replace the switch box for the Unit 1 PCV gas control facility

- At the Unit 1 PCV gas control facility, due to erroneous operation of the emergency stop button, the exhaust fan (A) of the in-service PCV gas control facility stopped, followed by the entire system. In response, as a hardware measure to prevent erroneous operation, the switch box (emergency stop button) will be replaced.
- For the new switch box, the emergency stop button will be redesigned as a mushroom-type (red) and a door with a key will be installed to prevent erroneous operation.
- The work is scheduled for November 16, 2021 and will require a shutdown of the PCV gas control facility. It will be implemented after defining the necessary safety measures and moving outside the operation limit according to the plan.

➢ Progress status regarding reduction of water injection rate into Unit 2 and 3 reactors

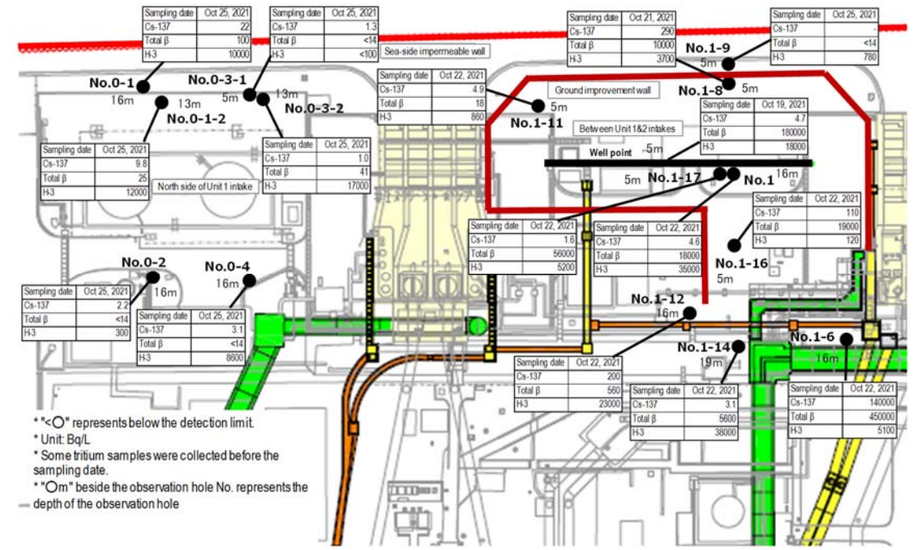
- Based on the results of tests to stop water injection and the temperature evaluation of the Reactor Pressure Vessel (RPV) and the Primary Containment Vessel (PCV), the water injection rate has room in terms of maintaining stable cooling.
- As part of work to reduce the volume of contaminated water generated in buildings by suppressing the ground water inflow, the possible amount of freshwater (source water) generated will also decline, there will be a need to reduce the water-injection rate.
- Therefore, for Units 2 and 3, which maintain stable PCV water levels, the water injection rate will be reduced in two steps, from the existing 3.0 1.7 m^3/h to the target figure of 1.7 m^3/h.
- Regarding STEP 1 (reactor water injection rate: 2.5 m^3/h) at Unit 2, as there were no problems with the core spray and water supply systems during trial operation from July 14, full-scale operation started from September 9.
- Regarding Unit 3, the reactor water injection rate was reduced to 2.5 m^3/h from August 16 and water was injected solely by the core spray system or water supply system (lasting about one month on each). As no abnormality was detected in the RPV bottom temperature, PCV temperature and dust concentration of the PCV gas control facility, full-scale operation started from October 14.
- STEP 2 (reactor water injection rate: 1.7m^3/h) will start first in Unit 3 from November 10 (for Unit 2, the process coordination is underway).

Reduction in radiation dose and mitigation of contamination

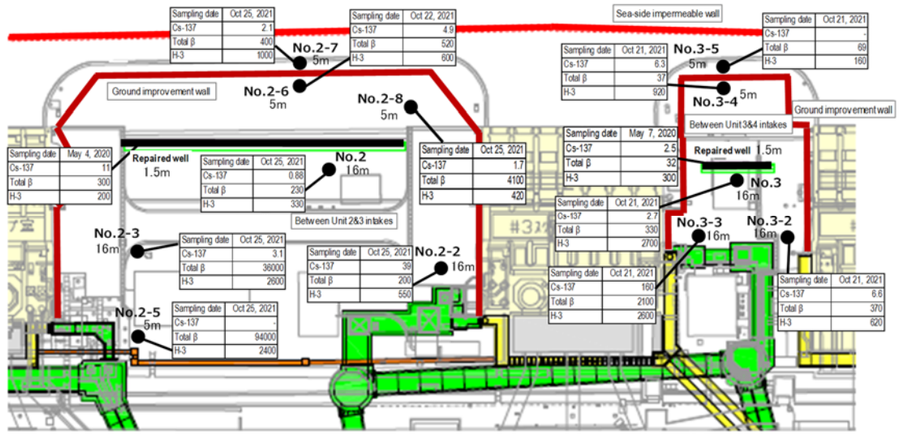
Effective dose-reduction at site boundaries and purification of port water to mitigate the impact of radiation on the external environment

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

- In the Unit 1 intake north side area, the H-3 concentration was below the legal discharge limit of 60,000 Bq/L at all observation holes and remained constant or has been declining overall. The concentration of total β radioactive materials increased temporarily from April 2020 and has been increasing or declining at No. 0-3-2 but remains constant or is declining overall.
- In the area between the Unit 1 and 2 intakes, the H-3 concentration has remained below the legal discharge limit of 60,000 Bq/L at all observation holes. It has been increasing or declining at No. 1-14 but has remained constant or been declining overall. The concentration of total β radioactive materials has remained constant or been declining at many observation holes overall.
- In the area between the Unit 2 and 3 intakes, the H-3 concentration has been below the legal discharge limit of 60,000 Bq/L at all observation holes and has remained constant or been declining overall. The concentration of total β radioactive materials has also remained constant or been declining at many observation holes overall.
- In the area between the Unit 3 and 4 intakes, the H-3 concentration has been below the legal discharge limit of 60,000 Bq/L at all observation holes and remained constant or been declining overall, although increasing and declining at No. 3-3. The concentration of total β radioactive materials has also remained constant or been declining overall.
- The concentration of radioactive materials in drainage channels has remained constant overall, despite increasing during rainfall.
- In the open channel area of seawater intake for Units 1 to 4, the concentration of radioactive materials in seawater has remained below the legal discharge limit and has been declining long term, despite temporary increases in Cs-137 and Sr-90 noted during rainfall. They have also been declining following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls. The concentration of Cs-137 has remained slightly higher in front of the south side impermeable walls and slightly lower on the north side of the east breakwater since March 20, 2019, when the silt fence was transferred to the center of the open channel due to mega float-related construction.
- In the port area, the concentration of radioactive materials in seawater has remained below the legal discharge limit and been declining long term, despite 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 outlet and near the south outlet due to the influence of weather, marine meteorology and other factors. Regarding the concentration of Sr-90, variation has been observed since last year in the area outside the port (south and north outlets). Monitoring of the tendency continues, including the potential influence of the weather, marine meteorology and others.



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



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

Figure 4: Groundwater concentration on the Turbine Building east side

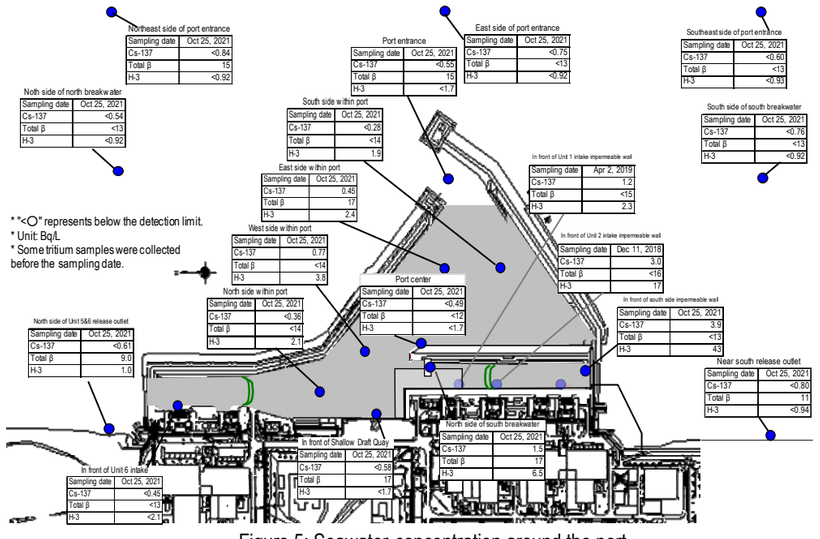


Figure 5: Seawater concentration around the port

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

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

➢ Staff management

- The monthly average total of personnel registered for at least one day per month to work on site during the past quarter from June to August 2021 was approx. 8,600 (cooperating company workers and TEPCO HD employees), which exceeded the monthly average workforce (approx. 6,400). Accordingly, sufficient personnel are registered to work on site.
- It was confirmed with the prime contractors that the estimated manpower necessary for the work in November 2021 (approx. 3,700 workers per day: cooperating company workers and TEPCO HD employees) would be secured at present. The average numbers of workers per day for each month (actual values) for the most recent 2 years were maintained, with approx. 3,000 to 4,200 (see Figure 6).
- The number of workers from both within and outside Fukushima Prefecture increased slightly. The local employment ratio (cooperating company workers and TEPCO HD employees) as of September 2021 also remained constant at around 70%.
- The average exposure doses of workers were at approx. 2.44, 2.54 and 2.60 mSv/person-year during FY2018, 2019 and 2020, respectively. (The legal exposure dose limit is 100 mSv/person and 50 mSv/person-year over five years, the TEPCO HD management target is 20 mSv/person-year).
- For most workers, the exposure dose was sufficiently within the limit and allowed them to continue engaging in radiation work.

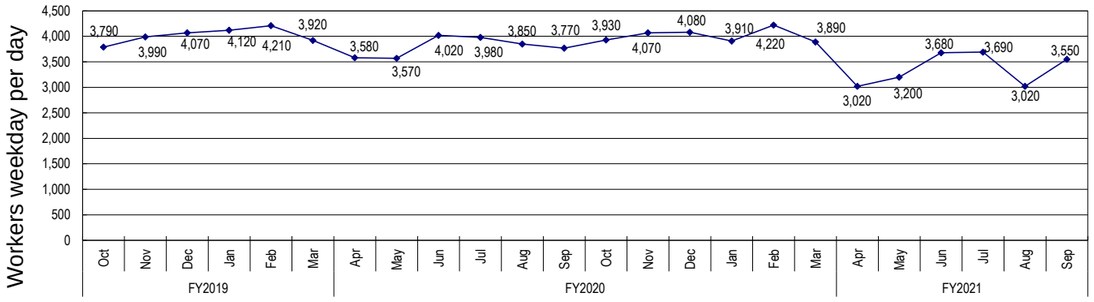


Figure 6: Changes in the average number of workers weekday per day for each month of the past 2 years (actual values)

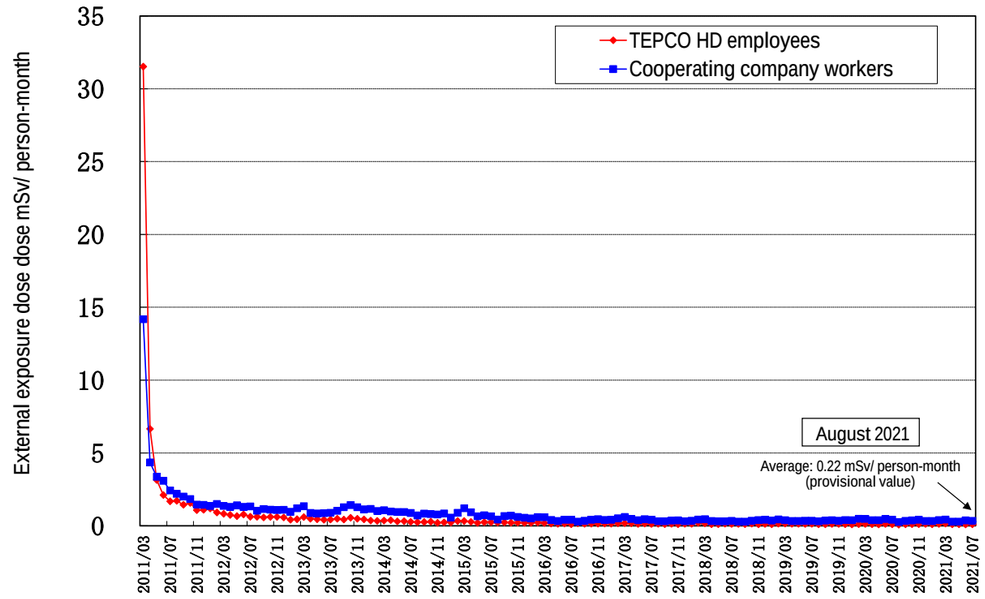


Figure 7: Changes in monthly average exposure dose of individual worker (monthly exposure dose since March 2011)

➢ Review of the ongoing countermeasures to suppress the spread of COVID-19 infections at the Fukushima Daiichi NPS

- In response to the cancellation of the state of emergency by the government and others, part of the ongoing countermeasures to suppress the spread of COVID-19 infections at the Fukushima Daiichi NPS have been reviewed since October 8. Countermeasures to prevent the infection spreading will continue to be properly implemented and decommissioning work will proceed with safety first.
- The main changes after the review have included the need to “carefully select business travel,” “ensure antigen tests are conducted for business travel before moving to other prefectures NPS located and for new entrants from other prefectures, before they enter Fukushima,” and “carefully consider group dining, taking risks into account.”
- Basic countermeasures have continued to prevent the COVID-19 infection spreading, such as requiring employees to take their temperature before coming to the office, wear masks at all times and avoid the “Three Cs” (Closed spaces, Crowded places, Close-contact settings) by using the rest house in shifts and eating silently.
- As of 15:00, October 27, 2021, 104 TEPCO HD employees and cooperating company workers (including 10 TEPCO HD employees) of the Fukushima Daiichi NPS had contracted COVID-19 and a total of no employees after September 2.
- No significant influence on decommissioning work, such as a corresponding delay to work processes due to this infection, had been identified.

➢ Health management of workers in the Fukushima Daiichi NPS

- As health management measures in line with the guidelines of the Ministry of Health, Labour and Welfare (issued in August 2015), a scheme was established and operated, whereby prime contractors confirmed reexamination at medical institutions and the subsequent status of workers who were diagnosed as requiring “detailed examination and treatment” in the health checkup, with TEPCO confirming the operation status by the prime contractors.
- The recent report on the management status of the health checkup during the first quarter (April – June) in FY2021 confirmed that the prime contractors had provided appropriate guidance and managed operations properly under the scheme. The report on the follow-up status during the fourth quarter in FY2020 and before confirmed that responses to workers, which had not been completed by the time of the previous report, were being provided on an ongoing

basis and checking of operations will continue.

- Status of heat stroke cases
  - Measures to further prevent heat stroke commenced from April 2021 to cope with the hottest season.
  - In FY2021, seven workers suffered heat stroke due to work up until October 25 (in FY2020, 11 workers up until the end of October). Continued measures will be taken to prevent heat stroke.

Others

- Status of construction of Radioactive Material Analysis and Research Facility Building 1 and establishment of analysis plan/ system
  - Radioactive Material Analysis and Research Facility Building 1 are being built for completion in June 2021.
  - As in the operation test of the air-conditioning system in January 2021, the air flow of the blower did not achieve the prescribed performance, with the cause being investigated and measures examined. Accordingly, the completion and operation start in June 2021 are delayed.
  - To respond flexible to the various analytical needs generated in association with decommissioning progress, modification and adjustment are underway for early completion as required. The plan is now being refined and completion of construction is forecast for around September 2022.

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 October 18-25)"; unit (Bq/L); ND represents a value below the detection limit

Summary of TEPCO data as of October 26, 2021

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

Cesium-134	:	ND(0.53)		
Cesium-137	:	ND(0.49)		
Total β	:	ND(12)		
Toritium	:	ND(1.7)		※1

Cesium-134	:	3.3 (H25/12/24)	→	ND(0.42)	Below 1/7
Cesium-137	:	7.3 (H25/10/11)	→	ND(0.55)	Below 1/10
Total β	:	69 (H25/8/19)	→	15	Below 1/4
Toritium	:	68 (H25/8/19)	→	ND(1.7)	Below 1/40

Cesium-134	:	3.3 (H25/10/17)	→	ND(0.38)	Below 1/8
Cesium-137	:	9 (H25/10/17)	→	0.45	Below 1/20
Total β	:	74 (H25/8/19)	→	17	Below 1/4
Toritium	:	67 (H25/8/19)	→	2.4	Below 1/20

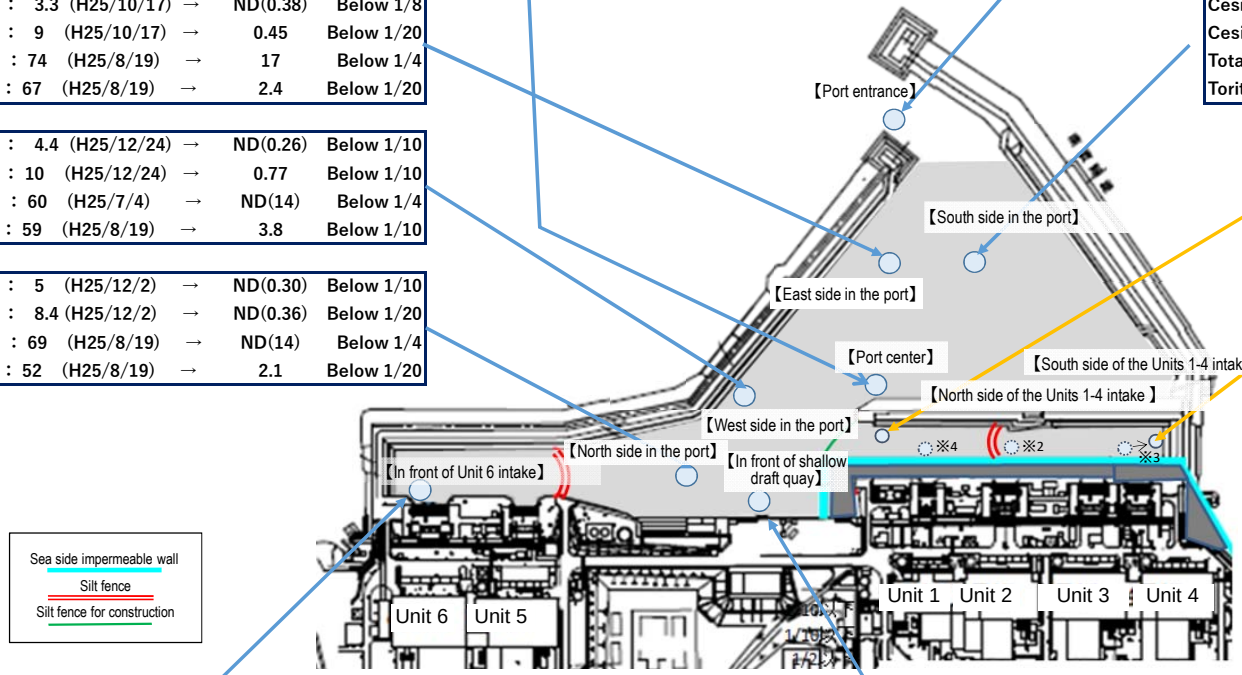
Cesium-134	:	3.5 (H25/10/17)	→	ND(0.32)	Below 1/10
Cesium-137	:	7.8 (H25/10/17)	→	ND(0.28)	Below 1/20
Total β	:	79 (H25/8/19)	→	ND(14)	Below 1/5
Toritium	:	60 (H25/8/19)	→	1.9	Below 1/30

Cesium-134	:	4.4 (H25/12/24)	→	ND(0.26)	Below 1/10
Cesium-137	:	10 (H25/12/24)	→	0.77	Below 1/10
Total β	:	60 (H25/7/4)	→	ND(14)	Below 1/4
Toritium	:	59 (H25/8/19)	→	3.8	Below 1/10

Cesium-134	:	32 (H25/10/11)	→	ND(0.60)	Below 1/50
Cesium-137	:	73 (H25/10/11)	→	1.5	Below 1/40
Total β	:	320 (H25/8/12)	→	17	Below 1/10
Toritium	:	510 (H25/9/2)	→	6.5	Below 1/70

Cesium-134	:	5 (H25/12/2)	→	ND(0.30)	Below 1/10
Cesium-137	:	8.4 (H25/12/2)	→	ND(0.36)	Below 1/20
Total β	:	69 (H25/8/19)	→	ND(14)	Below 1/4
Toritium	:	52 (H25/8/19)	→	2.1	Below 1/20

Cesium-134	:	ND(0.37)		
Cesium-137	:	3.9		
Total β	:	ND(13)		
Toritium	:	43		※1



Cesium-134	:	2.8 (H25/12/2)	→	ND(0.51)	Below 1/5
Cesium-137	:	5.8 (H25/12/2)	→	ND(0.45)	Below 1/10
Total β	:	46 (H25/8/19)	→	ND(13)	Below 1/3
Toritium	:	24 (H25/8/19)	→	ND(2.1)	Below 1/10

Cesium-134	:	5.3 (H25/8/5)	→	ND(0.32)	Below 1/10
Cesium-137	:	8.6 (H25/8/5)	→	ND(0.58)	Below 1/10
Total β	:	40 (H25/7/3)	→	17	Below 1/2
Toritium	:	340 (H25/6/26)	→	ND(1.7)	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.

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

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

Source: TEPCO website Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station http://www.tepco.co.jp/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 October 18-25)

Summary of TEPCO data as of October 26, 2021

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

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

Cesium-134	: ND	(H25)	→	ND(0.70)	
Cesium-137	: ND	(H25)	→	ND(0.84)	
Total β	: ND	(H25)	→	15	
Toritium	: ND	(H25)	→	ND(0.92)	

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

Cesium-134	: ND	(H25)	→	ND(0.66)	
Cesium-137	: 1.6	(H25/10/18)	→	ND(0.75)	Below 1/2
Total β	: ND	(H25)	→	ND(13)	
Toritium	: 6.4	(H25/10/18)	→	ND(0.92)	Below 1/6

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

Cesium-134	: ND	(H25)	→	ND(0.79)	
Cesium-137	: ND	(H25)	→	ND(0.60)	
Total β	: ND	(H25)	→	ND(13)	
Toritium	: ND	(H25)	→	ND(0.93)	

Cesium-134	: ND	(H25)	→	ND(0.73)	
Cesium-137	: ND	(H25)	→	ND(0.54)	
Total β	: ND	(H25)	→	ND(13)	
Toritium	: 4.7	(H25/8/18)	→	ND(0.92)	Below 1/5

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

Cesium-134	: 3.3	(H25/12/24)	→	ND(0.42)	Below 1/7
Cesium-137	: 7.3	(H25/10/11)	→	ND(0.55)	Below 1/10
Total β	: 69	(H25/8/19)	→	15	Below 1/4
Toritium	: 68	(H25/8/19)	→	ND(1.7)	Below 1/40

【Port entrance】

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

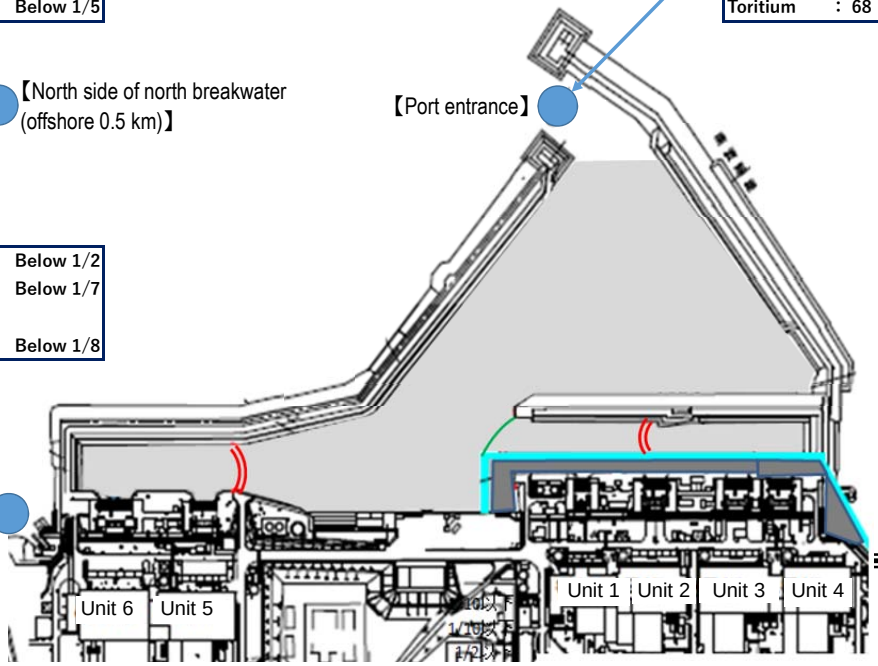
Cesium-134	: ND	(H25)	→	ND(0.68)	
Cesium-137	: ND	(H25)	→	ND(0.76)	
Total β	: ND	(H25)	→	ND(13)	
Toritium	: ND	(H25)	→	ND(0.92)	

Cesium-134	: 1.8	(H25/6/21)	→	ND(0.74)	Below 1/2
Cesium-137	: 4.5	(H25/3/17)	→	ND(0.61)	Below 1/7
Total β	: 12	(H25/12/23)	→	9.0	
Toritium	: 8.6	(H25/6/26)	→	0.99	Below 1/8

【North side of Unit 5 and 6 release outlet】

Cesium-134	: ND	(H25)	→	ND(0.67)	
Cesium-137	: 3	(H25/7/15)	→	ND(0.80)	Below 1/3
Total β	: 15	(H25/12/23)	→	11	
Toritium	: 1.9	(H25/11/25)	→	ND(0.89)	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.

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

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

TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site Layout

Appendix 2

October 28, 2021

- 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
- Waste treatment facility
- Non-controlled facility
- Analysis and research facility

Trimmed trees (outdoor accumulation)

Temporary trimmed trees storage pool

Temporary soil-covered type

Rubble (outdoor accumulation)

Rubble storage tent

Inside the rubble storage tent

Rubble (covered by sheet)

Solid waste storage facility

Rubble (container storage)

Spent adsorption vessel temporary storage facility

Temporary waste sludge storage

Tank installation status

Futaba town

Okuma town

Rubble storage tent
Inside the rubble storage tent
Additional Radioactive Waste Incinerator
Large Waste Storage
Radioactive Waste Incinerator
Trimmed trees
Trimmed trees
Vehicles maintenance site
Water treatment facility for Sub-drain
Water treatment facility for Sub-drain and others
JAEA Analytical Facility Management Building
JAEA Analytical Facility Laboratory-1
Vehicle screening and decontamination site
Partner Companies' Building
Groundwater bypass temporary storage tank
Temporary rest house outside the site
New Administration Office Building
Heliport
Large rest house
Access control facility
Underground reservoirs
Water desalinations (evaporative concentration)
Water desalinations (RO)
Site boundary
Temporary trimmed trees storage pool
Periodical Inspection Material Storage (cutting of flanged-tanks)
Temporary Cask Custody Area
Main Anti-Earthquake Building
Multi-nuclide removal equipment
Additional multi-nuclide removal equipment
High-performance multi-nuclide removal equipment
Spent absorption vessel temporary storage
Large equipment decontamination facility
Land-side impermeable walls with frozen soil
Land-side impermeable walls freezing plant
Mega float
Pipe route
Common pool
Sea side impermeable wall
Water desalinations (RO)
Cesium absorption apparatus (Incineration Workshop Building)
Decontamination instruments (Process Building)
3rd cesium adsorption apparatus (Onsite Bunker Building)
2nd cesium adsorption apparatus (HTI Building)
Cesium absorption vessel temporary storage
Unit 1
Unit 2
Unit 3
Unit 4
Unit 5
Unit 6
Town boundary
Used protective clothing
Rubble
MP-1
MP-2
MP-3
MP-4
MP-5
MP-6
MP-7
MP-8
H1
H2
H3
H4
H5
H6
H8
H9
J1
J2
J3
J4
J5
J6
J7
J8
J9
K1
K2
K3
K4
G1
G1 South
G3・G4・G5
G6
G7
B
C
D
E
F

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

0m 100m 500m 1000m

1-1 Contaminated water management

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

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

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

Reference
October 28, 2021
Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

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

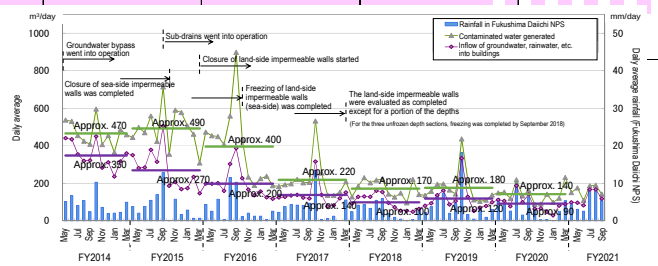
Contaminated water management【Remove】

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)
- ▽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)


Cesium Adsorption Apparatus (KURION)


Landing of 2nd Cesium Adsorption Apparatus (SURRY)


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 2
  - ▽Completion of tunnel filling
  - ▽Transfer of stagnant water complete
  - ▽Completion of shaft filling (except for upper part of
- Unit 3
  - ▽Completion of tunnel filling
  - ▽Filling of openings II and III complete
  - ▽Transfer stagnant water complete
  - ▽Completion of filling parts running ove
- Unit 4


Unit 2 seawater pipe trench Shaft D filling work

▽Suppressing the average amount of contaminated water generated to approx. 140 m3/day

Contaminated water management【Redirect】

Groundwater bypass
- ▽Installation start of groundwater bypass
- ▽Operation start of groundwater bypass (drainage started from 2014.5.21)

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 m3/day)
- ▽Enhancement of treatment capacity (2000 m3/day)

Land-side impermeable wall
- ▽Start of maintenance operation on north and south sides
- ▽Freezing completion
- ▽Start of maintenance operation in all sections
- ▽Installation start of land-side impermeable walls
- ▽Freezing start
- Start of maintenance operation ▽
- ▽Freezing completion (except for some parts)

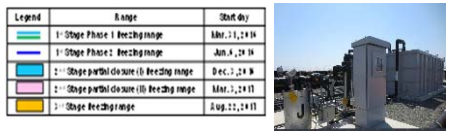
Facing
- ▽Completion of waterproof pavement (facing) (except for areas of 2.5 and 6.5m above sea level and around Unit 1-4)
- ▽Completion of waterproof pavement (facing) (except for around Unit 1-4)

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
- ▽Purification of RO-condensed salt water complete
- ▽Storage in steel square tanks
- ▽Replacement of steel square tanks complete
- ▽Removal of steel horizontal tanks complete (except for condensed waste liquid storage tank)
- ▽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)


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



Pumping well


Sub-drain purification system


Land-side impermeable wall brine (refrigerant) circulation pipe

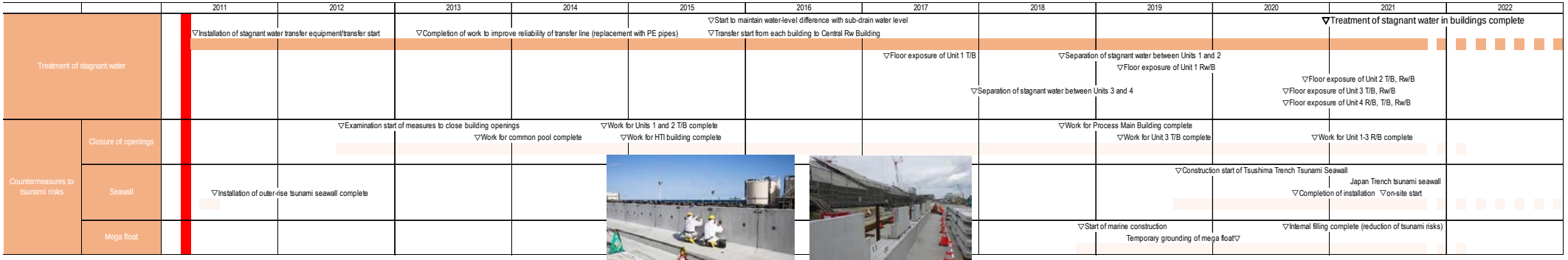

Construction of welded-joint tanks


Placement of seaside impermeable walls complete


Flanged and welded-joint tanks

1-2 Contaminated water management

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



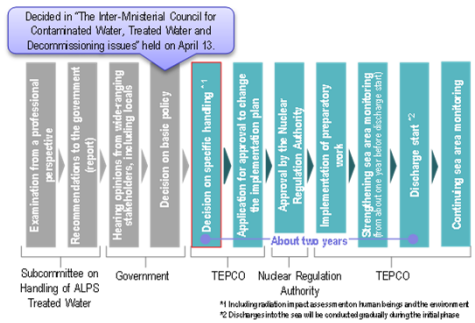
Chishima Trench Tsunami Seawall complete

Construction of Japan Trench Tsunami Seawall

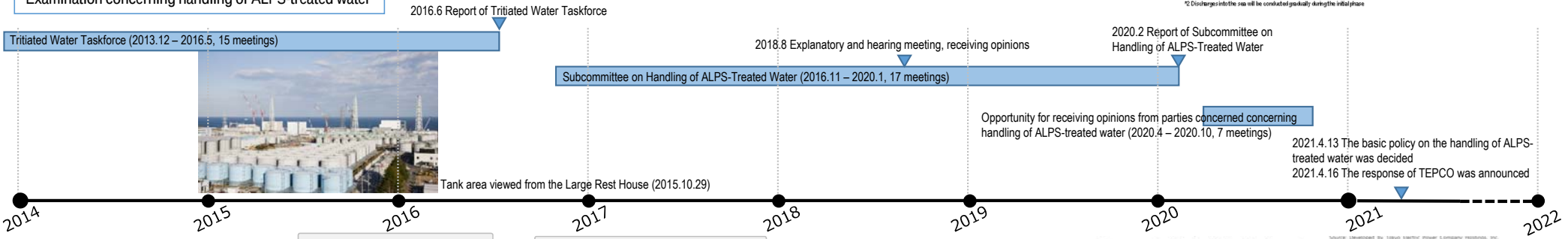
2 Handling of ALPS-treated water

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

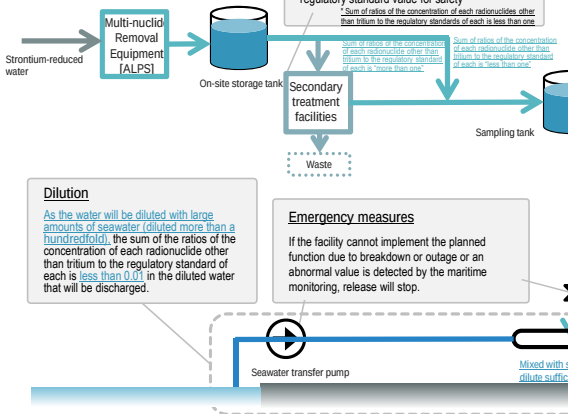
Regarding the discharge of ALPS-treated water into the sea, TEPCO must comply with regulatory and other safety-related standards to ensure the safety of the public, surrounding environment and agricultural, forestry and fishery products. To minimize adverse impacts on reputation, monitoring will be further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



Examination concerning handling of ALPS-treated water



[Conceptual diagram of facilities for releasing ALPS-treated water into the sea]



Secondary treatment
Secondary treatment will be conducted as necessary to ensure the level of radioactive materials, excluding tritium, is lower* than the regulatory standard value for safety
* Sum of ratios of the concentration of each radionuclides other than tritium to the regulatory standards of each is less than one

Site use plan
To stably discharge ALPS-treated water and construct facilities necessary for decommissioning, construction of sampling tanks and alternative tanks and dismantling of empty storage tanks and others will be examined.

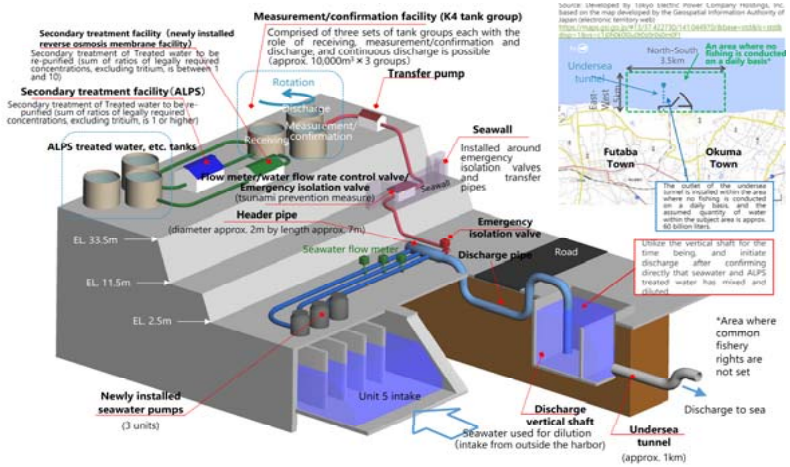
Analysis of ALPS-treated water
TEPCO will publish the concentration of tritium, 62 nuclides (nuclides subject to removal by ALPS) and carbon-14 in ALPS-treated water and the results of assessments as well as the third-party measurement and assessment results.

Concentration of tritium inside discharged water
The tritium concentration of the discharged water will be less than 1,500 Bq/L. This will be assessed based on the tritium concentration in the ALPS-treated water before discharge and the amount of water it was diluted by.

Dilution
As the water will be diluted with large amounts of seawater (diluted more than a hundredfold), the sum of the ratios of the concentration of each radionuclide other than tritium to the regulatory standard of each is less than 0.01 in the diluted water that will be discharged.

Emergency measures
If the facility cannot implement the planned function due to breakdown or outage or an abnormal value is detected by the maritime monitoring, release will stop.

Amount discharged
In the near term, discharge amounts will be within the threshold of 22 trillion Bq/year which was the target discharge management value for Fukushima Daiichi before the accident. This amount will be reviewed as needed based on decommissioning progress made.



3 Removal of fuel from spent pool

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

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

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

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

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

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


<Unit 4 Cover for fuel removal>

In the Mid- and-Long-Term Roadmap, the Phase 1 target involved starting to remove fuel from inside the spent fuel pool (SFP) of the 1st Unit within two years of completing Step 2 (by December 2013).
On November 18, 2013, fuel removal from Unit 4, namely the first Unit, got underway and Phase 2 of the roadmap started.
On November 5, 2014, within a year of commencing fuel removal work, all 1,331 spent fuel assemblies in the pool had been transferred. The transfer of the remaining non-irradiated fuel assemblies to the Unit 6 SFP was completed on December 22, 2014. (two of the non-irradiated fuel assemblies were removed in advance in July 2012 for fuel checks)
This marks the completion of fuel removal from the Unit 4 Reactor Building.


Fuel removal

Unit 4

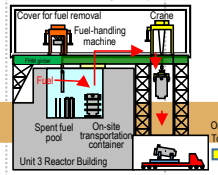
▼ 2014.12.22 Fuel removal was completed (1533 assemblies)

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

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

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

Overview of the fuel-handling facility inside the cover



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

Unit 3

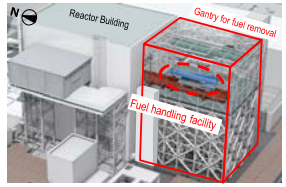
▼ 2021.2.28 Fuel removal completed (566 assemblies)

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

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


<Unit 2 Construction of gantry for fuel removal>

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



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

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

Unit 2

▼ 2020.3-6 Installation of spent fuel pool cover
▼ 2020.9-11 Measures to prevent and alleviate rubble falling
▼ 2020.11-2021.6 Dismantling of remaining cover
▼ 2017.12 Completion of building cover dismantling and windbreak fence installation
▼ 2018.1-2020.12 Rubble removal on the north side of Reactor Building
▼ 2018.9-12 Removal of X-braces
▼ 2021.8 Start of large cover pre-work

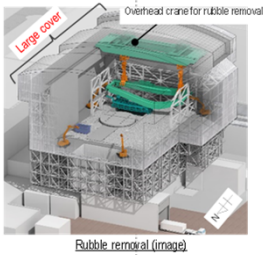
For Unit 1, a large cover will be installed over the whole building, within which rubble will be removed.

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

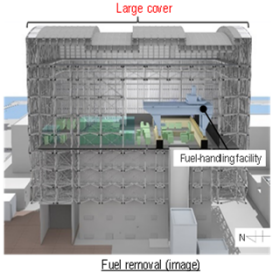
<Reference> Progress to date
Rubble removal on the north side of the operating floor started from January 2018 and has been implemented sequentially. In July and August 2019, the well plug, which was misaligned, was investigated, followed in August and September by the conditions of the overhead crane.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

Unit 1


<Unit 1 Dismantling of remaining cover>



Rubble removal (image)



Fuel removal (image)

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

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

4 Work toward fuel debris retrieval

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

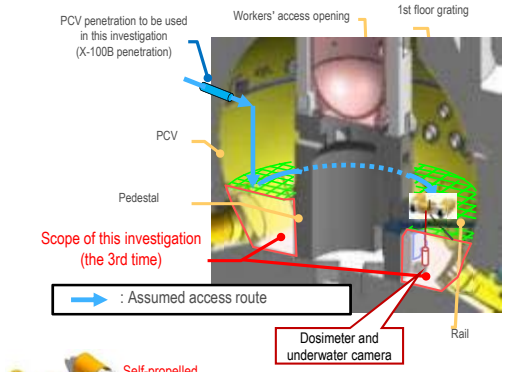
Start of fuel debris retrieval from the first unit (Unit 2). Expanding the scale in stages (within 2021 * The schedule will be extended for about 1 year due to the spread of COVID-19 infections)

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

Unit 1 Investigation overview

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

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



<Image of investigation>

<Image near the bottom>

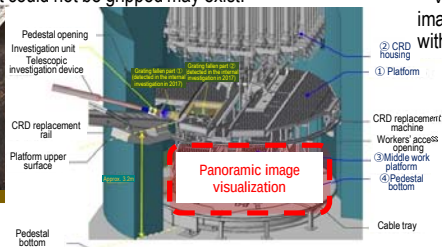
Unit 2 Investigation overview

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

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

・In February 2019, an investigation touching the deposits at the bottom of the pedestal and on the platform was conducted and confirmed that the pebble-shaped deposits, etc. could be moved and that hard rock-like deposits that could not be gripped may exist.

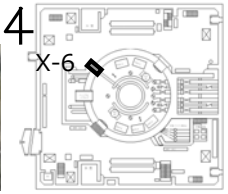
Bottom of the pedestal (after being processed in panoramic image visualization)



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

<Conditions of deposits before and after contact>

<Work in front of the penetration>



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

Unit 3 Investigation overview

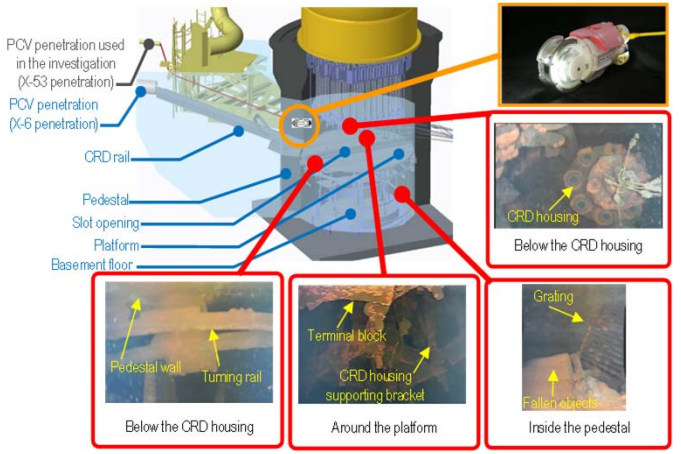
・In October 2014, the conditions of X-53 penetration, which may be under water and which is scheduled for use to investigate the inside of the PCV, was investigated via remote-controlled ultrasonic test equipment. The results showed that the penetration was not under water.

・In October 2015, to confirm the conditions inside the PCV, an investigative device was inserted into the PCV from X-53 penetration to obtain images, data on dosage and temperature and sample stagnant water. No damage to the structure and walls inside the PCV was identified and the water level was almost identical to estimated values. In addition, the dose inside the PCV was confirmed to be lower than in other Units.

・In July 2017, the inside of the PCV was investigated using the underwater ROV (remotely operated underwater vehicle) to inspect the inside of the pedestal. Analysis of the imagery obtained in the investigation identified damage to multiple structures and the supposed core internals.

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

<Conditions inside the pedestal>



Unit 1 PCV internal investigation

Investigations inside the PCV	1st (2012.10)	- Acquiring images - Measuring the air temperature and dose rate - Measuring the water level and temperature - Sampling stagnant water - Installing permanent monitoring instrumentation
	2nd (2015.4)	Confirming the status of the PCV 1st floor - Acquiring images - Measuring the air temperature and dose rate - Replacing permanent monitoring instrumentation
	3rd (2017.3)	Confirming the status of the PCV 1st basement floor - Acquiring images - Measuring the dose rate - Sampling deposit - Replacing permanent monitoring instrumentation
Leakage points from PCV	- PCV vent pipe vacuum break line bellows (identified in 2014.5) - Sand cushion drain line (identified in 2013.11)	

Evaluation of the location of fuel debris inside the reactor by measurement using muons
Confirmed that there was no large fuel in the reactor core. (2015.2-5)

Unit 2 PCV internal investigation

Investigations inside the PCV	1st (2012.1)	- Acquiring images - Measuring the air temperature
	2nd (2012.3)	- Confirming water surface - Measuring the water temperature - Measuring the dose rate
	3rd (2013.2 – 2014.6)	- Acquiring images - Sampling stagnant water - Measuring water level - Installing permanent monitoring instrumentation
	4th (2017.1-2)	- Acquiring images - Measuring the dose rate - Measuring the air temperature
	5th (2018.1)	- Acquiring images - Measuring the dose rate - Measuring the air temperature
	6th (2019.2)	- Acquiring images - Measuring the dose rate - Measuring the air temperature - Determining characteristics of a portion of deposit
Leakage points from PCV	- No leakage from the torus chamber rooftop - No leakage from any internal/external surfaces of S/C	

Evaluation of the location of fuel debris inside the reactor by measurement using muons
The existence of high-density materials, which were considered to constitute fuel debris, was confirmed at the bottom of RPV and in the lower part and outer periphery of the reactor core. It was assumed that a significant portion of fuel debris existed at the bottom of RPV. (2016.3-7)

Unit 3 PCV internal investigation

Investigations inside the PCV	1st (2015.10-12)	- Acquiring images - Measuring the air temperature and dose rate - Measuring the water level and temperature - Sampling stagnant water - Installing permanent monitoring instrumentation (2015.12)
	2nd (2017.7)	- Acquiring images - Installing permanent monitoring instrumentation (2017.8)
Leakage points from PCV	- Main steam pipe bellows (identified in 2014.5)	

Evaluation of the location of fuel debris inside the reactor by measurement using muons
The evaluation confirmed that no large lump existed in the core area where fuel had been placed and that a portion of the fuel debris potentially existed at the bottom of the RPV. (2017.5-9)

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

5 Management of solid radioactive waste

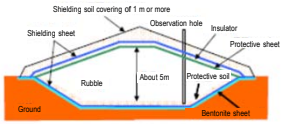
Reference
October 28, 2021
Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment
5／6

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)

★ 2016.3 Announcement of Storage Management Plan of Solid Waste (Ver. 1)
★ 2017.6 Revision ★ 2018.5 Revision ★ 2019.6 Revision ★ 2020.7 Revision ★ 2021.7 Revision

▼ 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



<Outline of soil-covered temporary storage facility>


External view of storage building
External view of the 9th Solid Waste Storage

▼ 2014.7 Start of pre-work
9th Solid Waste Storage
▼ 2018.2 Operation start


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


2021.1.18
1st Large Waste Storage
Roof construction (from the inside)

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

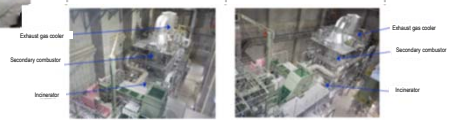
2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

▼ 2013.5 Installation work gets underway
Solid Waste Incinerator
▼ 2016.3 Operation start
▲2016.8-11 Manual stop (due to pin-hole incidence)


Whole view of Solid Waste Incinerator


Electrical room


Control room



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

▼ 2017.4 Start of pre-work
Additional Solid Waste Incinerator


External view of
Large Equipment Decontamination Facility

2017.10 Installation work gets
▼ 2018.5 Operation start
Large Equipment Decontamination Facility

▼ 2020.9 Start of pre-work
Compaction Facility

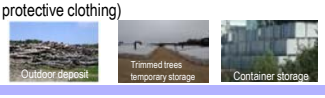

2021.3.20
Site of Volume Reduction Faciility

Present status Note

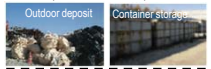
Storage of rubble and others

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

Rubble (combustible), trimmed trees, used protective clothing



Contaminated soil (0.005 - 1 mSv/h)



Rubble (metal, concrete, others)

More than 1 mSv/h

0.005-1 mSv/h

Less than 0.005mSv

Storage of water treatment secondary waste


Spent adsorption vessel temporary storage

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

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

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

Approx. 60,000 m³ → (B)

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

Approx. 220,000 m³ → Volume reduction

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

Status after a decade

Legend: Newly installed equipment and facility

Incineration

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


Crusher example

Radioactive Waste Incinerator

Additional Radioactive Waste Incinerator (scheduled for completion in FY2021)
2021.3
The installation process was reviewed
Toward an operation launch within FY2021, installation work continues


Work of main part

Volume reduction

Compaction Facility
(scheduled for completion in FY2022)


Concrete crusher example


Metal cutter example

Melting

Melting equipment


Electric furnace example

(*3) Approx. 270,000 m³ (*2)

Storage /management

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

Approx. 20,000 m³

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

Approx. 60,000 m³

(*1) (A) Approx. 60,000 m³

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

(B) Approx. 60,000 m³

Approx. 70,000 m³ (*1)

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

Reuse will be examined

Spent Adsorption Vessel Temporary Storage

To (B)

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


Work of main part

(*1) Items for which incineration, compaction, melting or reuse is difficult are stored directly in Solid Waste Storage without being treated
(*2) As values less than 10,000 m³ are rounded, they may not be consistent with the total of breakdown
(*3) In the estimate, approx. 250,000 m³ of waste will be stored in Solid Waste Storage at the end of FY2028.

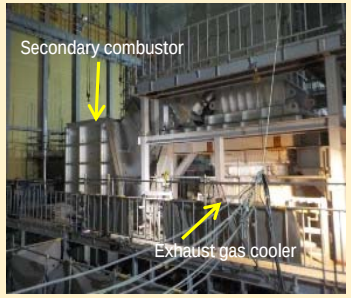
Note: Used protective clothing before incineration and BG-level concrete waste for which treatment and reuse is decided at present are not included.

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

●Efforts to eliminate temporary outdoor storage of rubble and others

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


Whole view of the Additional Solid Waste Incinerator Building



Main equipment

6 Improvement of work environment

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

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

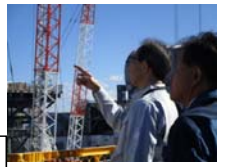
External view of Access Control Facility

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.

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

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

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



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

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

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.

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

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

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

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021

Changes in operation of controlled area

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

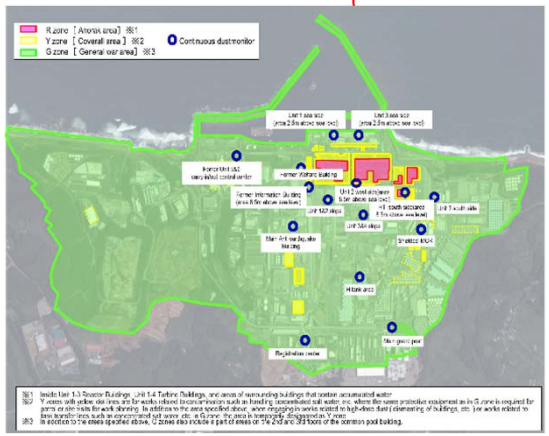
In May 2015, full-face mask unnecessary area was expanded to cover about 90% of the site.

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

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

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

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



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

<Travel survey results of major roads within the site>
The dose rate has been declining every year.

Measured in August 2016

Measured in August 2018

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