Outline of Decommissioning and Contaminated Water Management

July 30, 2020
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 started from April 15, 2019 at Unit 3. Dust concentration in the surrounding environment is being monitored and work is being implemented with safety first. 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.

Fuel Removal from SFP: Rubble removal & dose reduction (Units 1 & 2) → Installing fuel removal machine → Fuel removal (Unit 3) → Storage and handling (Unit 4)

Fuel Debris Retrieval: Ascertaining the status inside the PCV/ examining the fuel debris retrieval method, etc. (Note 2) (Unit 1-3, Unit 2) → Fuel debris retrieval → Storage and handling

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

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

Fuel removal from the spent fuel pool

Fuel removal from the spent fuel pool started from April 15, 2019 at Unit 3. With the aim of completing fuel removal by the end of FY2020, rubble and fuel are being removed.

Fuel removal
(April 15, 2019)

Removed fuel (assemblies)
266/566
(As of July 30, 2020)

Contaminated water management proceeds with the following three efforts:

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

[Three basic policies]

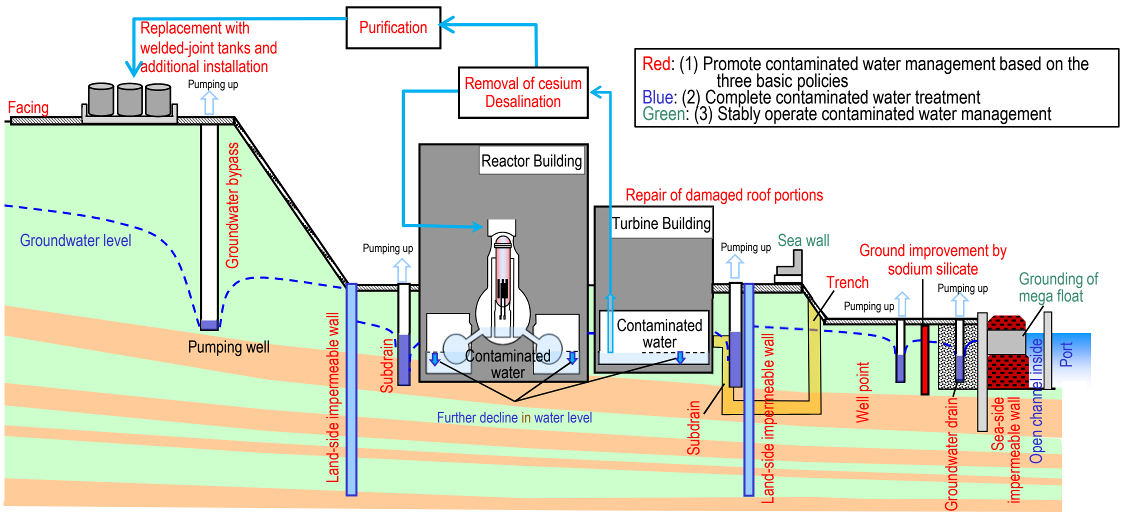
1. "Remove" the source of water contamination
2. "Redirect" fresh water from contaminated areas
3. "Retain" contaminated water from leakage

(2) Efforts to complete contaminated water treatment

4. Treatment of contaminated water in buildings
5. Measures to remove α–nuclide and reduce the concentration in contaminated water
6. Measures to alleviate the radiation dose of Zeolite sandbags in the Process Main Building and High-Temperature Incinerator Building and examine safe management methods

(3) Efforts to stably operate contaminated water management

7. Planning and implementing necessary measures to prepare for large-scale disasters such as tsunami and heavy rain
8. Periodically inspecting and updating facilities to maintain the effect of contaminated water management going forward
9. Examining additional measures as required, with efforts to gradually expand the scale of fuel debris retrieval in mind



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

- Strontium-treated 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 subdrains, have stabilized the groundwater at a low level and the increased amount of 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 FY2014) to approx. 180 m^3/day (in FY2019).
- Measures continue to further suppress the generation of contaminated water to approx. 150 m^3/day within FY2020 and 100 m^3/day or less within 2025.

(2) Efforts to complete contaminated water treatment

- Contaminated water levels in buildings declined as planned and connected parts between Units 1 and 2 and 3 and 4 were respectively separated. For α-nuclide detected as water levels declined progressively, characteristics are being determined and treatment methods examined.
- Treatment of contaminated water in buildings will be completed within 2020, excluding Unit 1-3 Reactor Buildings, Process Main Building and High-Temperature Incinerator Building. For Reactor Buildings, the amount of contaminated water there will be reduced from the level 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, measures including closing building openings, installing sea walls and transferring and grounding the mega float are being implemented. For heavy rain, sandbags are being installed to suppress direct inflow into buildings while work to enhance drainage channels and other measures are being implemented as planned.

Progress status

◆ The temperatures of the Reactor Pressure Vessel (RPV) and Primary Containment Vessel (PCV) of Units 1-3 have been maintained within the range of approx. 20-30°C*1 over the past month. There was no significant change in the concentration of radioactive materials newly released from Reactor Buildings into the air*2. It was concluded that the comprehensive cold shutdown condition had been maintained.

* 1 The values varied somewhat, depending on the unit and location of the thermometer.

* 2 In June 2020, the radiation exposure dose due to the release of radioactive materials from the Unit 1-4 Reactor Buildings was evaluated at less than 0.00005 mSv/year at the site boundary. The annual radiation dose from natural radiation is approx. 2.1 mSv/year (average in Japan).

Cutting of obstacles inside the PCV toward insertion of a robot for the Unit 1 inside investigation

As part of efforts to investigate inside the Unit 1 Primary Contamination Vessel (PCV), work to cut obstacles inside the PCV on the route for the investigation equipment started from May 26.

On July 7, a defect was detected in the supply of abrasive material, which was used to improve the cutting performance, and the work was suspended. At present, measures are being implemented. After confirming that there is no abnormality, work to cut the grating will be resumed. During the work, the dust concentration will be checked appropriately by the dust monitor to avoid any influence on the surrounding environment and work will proceed with safety first.

Transportation of containers housing the remaining objects on the Unit 2 R/B operating floor starting from August

For the operating floor of the Unit 2 Reactor Building, before installing a fuel-handling facility, there are plans to transport remaining objects that may hinder the installation. After completing the training to practice work skills for transportation, preparatory work inside the operating floor started from July 20.

Small containers housing the remaining objects will be housed in larger containers for transportation and storage and transported from the operating floor from early August to the solid waste storage facility.


Before removing remaining objects


After the removal

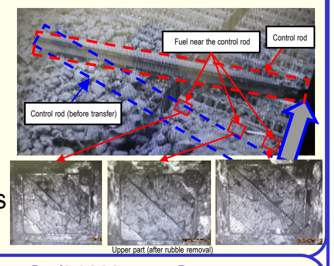

Housing small containers gathering on the operating floor of the Unit 2 R/B

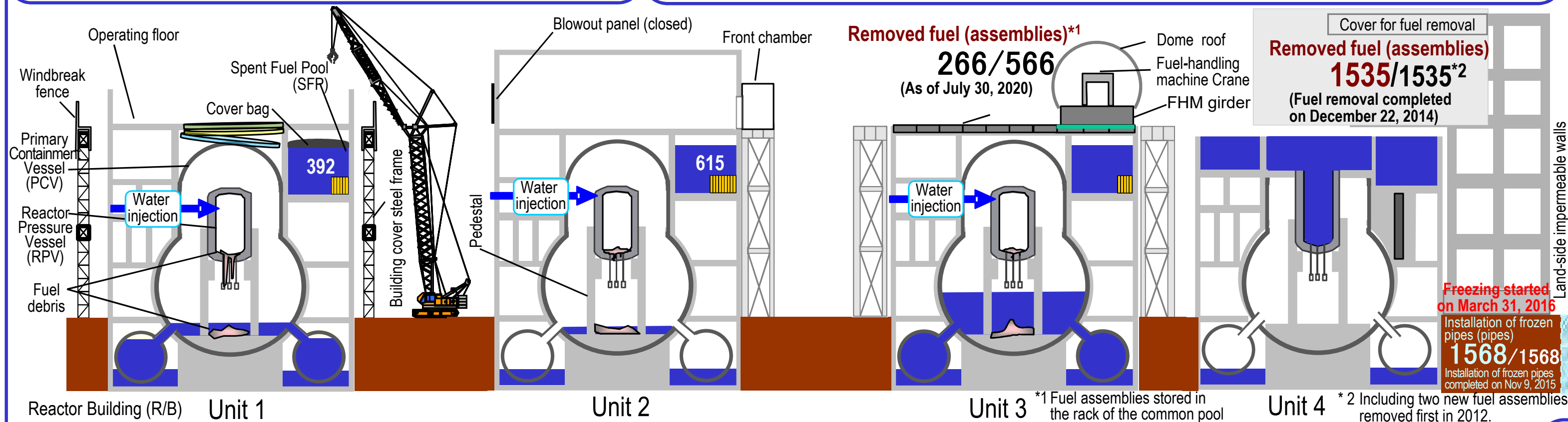

Training to put a housing larger container in a transportation container

Ongoing Unit 3 fuel removal proceeding steadily

After work was resumed on May 26, fuel removal at Unit 3 has proceeded steadily and 266 of 566 fuel assemblies have been removed.

At the same time, rubble removal has also proceeded steadily and on July 25, removal of rubble under the control rods was completed.





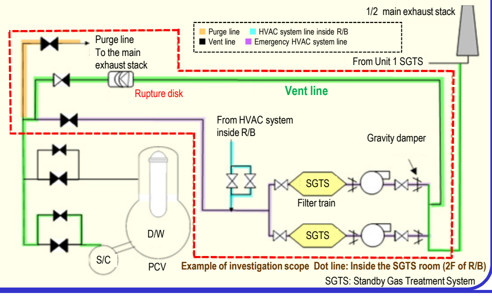
Revision of the Solid Waste Storage Management Plan

The fourth revision of the "Solid Waste Storage Management Plan," which was formulated in March 2016, was issued on July 30. Specifically, the estimated amount of solid waste to be generated in the next decade or so was updated from approx. 770,000 to 780,000 m³ and the lack of any influence on the facility installation schedule was confirmed.

Based on this plan, for rubble and other solid waste temporarily stored in the outdoor storage area, combustibles will be incinerated, metals cut and concrete broken. After minimizing the amount, solid waste will be integrated in the indoor storage as part of work toward achieving the target milestone in the Mid-and-Long-Term Roadmap "eliminating the temporary outdoor storage area within FY2028."

Plan to investigate Unit 1-4 SGTS rooms toward clarifying the accident progress

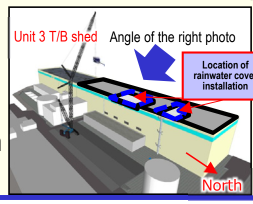
To clarify the emission behavior of radioactive materials by the PCV vent, there is a plan to investigate the inside of the Standby Gas Treatment System (SGTS) rooms of Unit 1-4, which have remained unchanged since the time of the accident occurred and do not impede the ongoing decommissioning work. Specifically, detailed information about the radiation dose and contamination, mainly of filter trains and vent lines, will be collected from around September.



Upcoming completion of measures to prevent rainwater infiltrating for the Unit 3 Turbine Building

For the Unit 3 Turbine Building, the installation of fences and other related facilities to prevent rainwater infiltration was completed, following which the installation of a rainwater cover to shield the damaged roof parts on the south side started on July 20.

After completing the installation of a rainwater cover on the north side by early August, waterproof painting on the rooftop will be completed by September. Efforts will continue toward achieving the target milestone within 2020 "suppressing contaminated water generated to about 150 m³day" as stipulated in the Mid-and-Long-Term Roadmap.



Installation of rainwater cover (July 20)

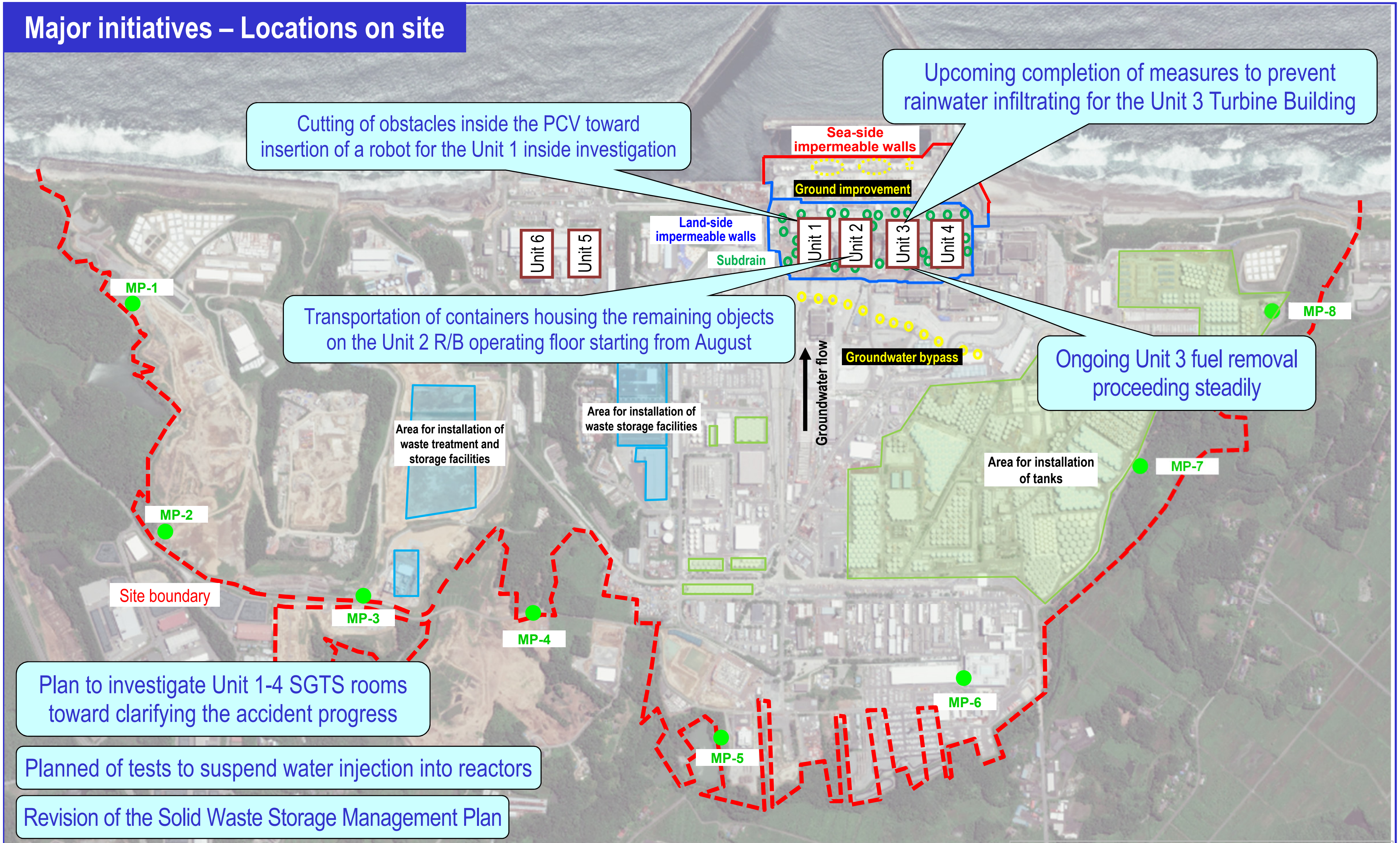
Planned of tests to suspend water injection into reactors

A test involving temporarily suspending water injection to the reactor was conducted at Units 1-3 in FY2019 and it was confirmed that the increase in temperature due to suspension of water injection was almost within the assumed range.

Based on these results, tests to suspend water injection to the reactor are planned for five, three and seven days for Unit 1, 2 and 3, respectively.

For Units 1 and 3, the range of water-level decline inside the PCV and other parameters will be checked and for Unit 2, it will be checked that the increase in the RPV bottom temperature is precisely reproduced by the temperature evaluation model to enhance insights when examining how best to inject water in future.

Major initiatives – Locations on site



* Data of Monitoring Posts (MP1-MP8.)

Data (10-minute values) of Monitoring Posts (MPs) measuring the airborne radiation rate around site boundaries showed 0.255 – 1.171 μSv/h (July 1 - 28, 2020).

We improved the measurement conditions of monitoring posts 2 to 8 to measure the air-dose rate precisely. Construction work, such as tree-clearing, surface soil removal and shield wall setting, were implemented from February 10 to April 18, 2012.

Therefore, monitoring results at these points are lower than elsewhere in the power plant site.

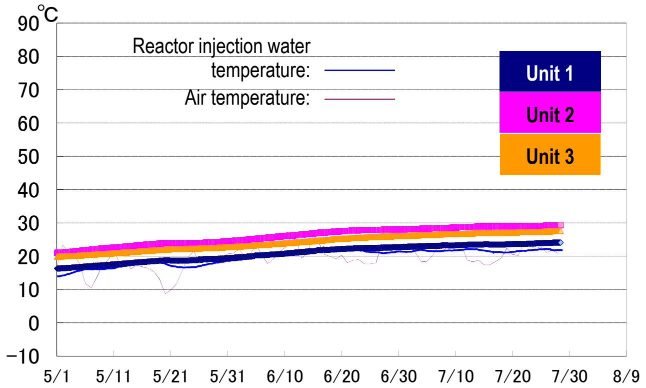
The radiation shielding panels around monitoring post No. 6, which is one of the instruments used to measure the radiation dose at the power station site boundary, were taken off from July 10-11, 2013, since further deforestation, etc. had caused the surrounding radiation dose to decline significantly.

Provided by Japan Space Imaging, photo taken on June 14, 2018
Product(C) [2018] DigitalGlobe, Inc.

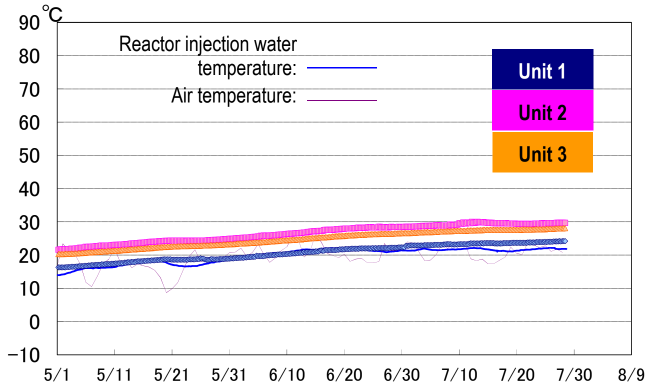
I. Confirmation of the reactor conditions

1. 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. 20 to 30°C for the past month, though it varied depending on the unit and location of the thermometer.



RPV bottom temperatures (recent quarter)



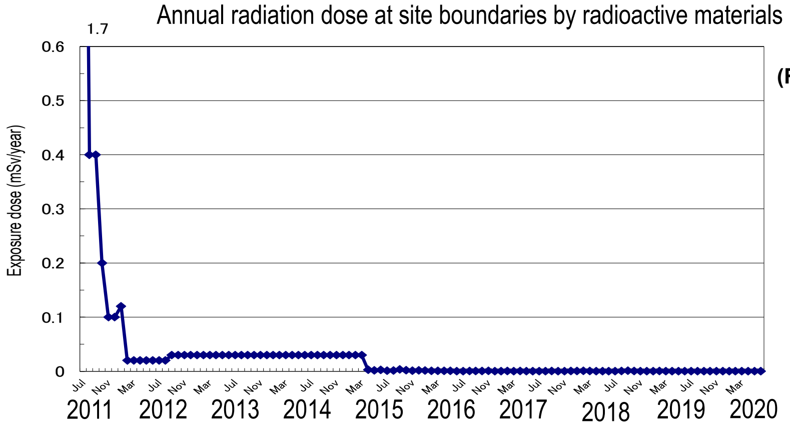
PCV gas phase temperatures (recent quarter)

* The trend graphs show part of the temperature data measured at multiple points.

2. Release of radioactive materials from the Reactor Buildings

As of June 2020, the concentration of the radioactive materials newly released from Reactor Building Units 1-4 into the air and measured at the site boundary was evaluated at approx. 2.1×10^{-12} Bq/cm³ and 2.3^{-12} Bq/cm³ for Cs-134 and Cs-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]: 2×10^{-5} Bq/cm³
[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 0.255 – 1.171 μSv/h (July 1 - 28, 2020).
To measure the variation in the air dose rate of MP2-MP8 more accurately, environmental improvement (tree trimming, removal of 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.

3. 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.

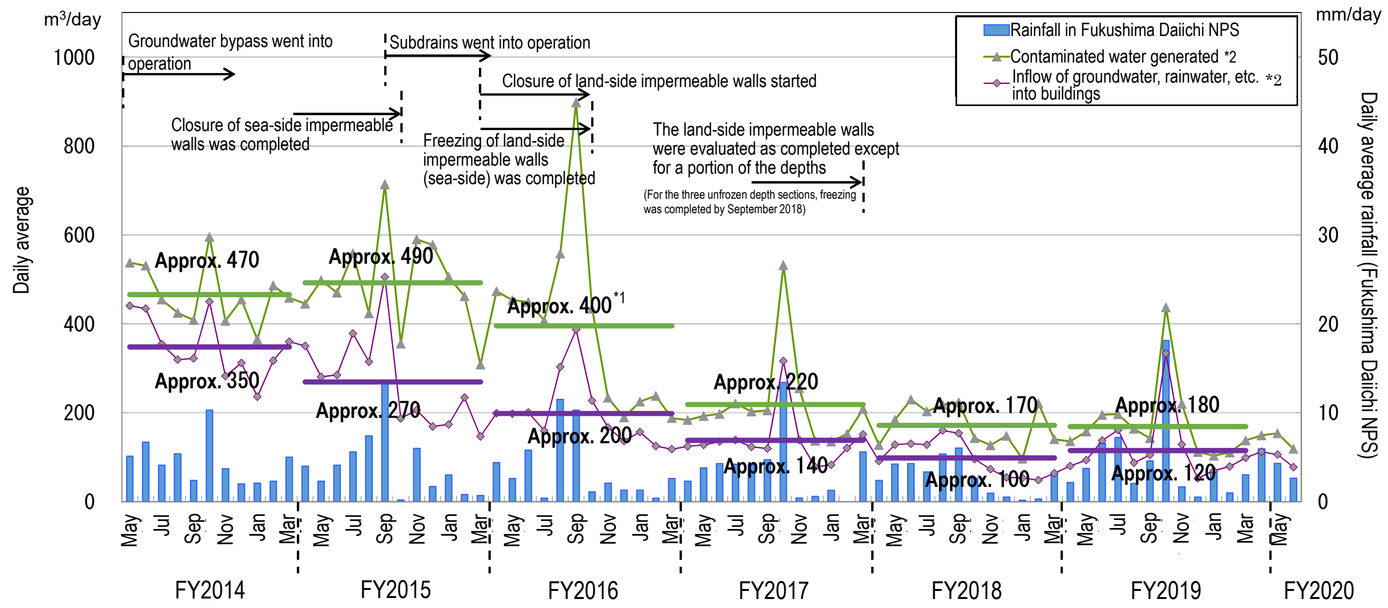
II. Progress status by each plan

1. Contaminated water management

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

➢ Status of contaminated water generated

- Multi-layered measures, including pumping up by subdrains and land-side impermeable walls, which were implemented to control the continued generation of contaminated water, suppressed the groundwater inflow into buildings.
- After "redirecting" measures (groundwater bypass, subdrains, land-side impermeable walls and others) were steadily implemented, the generation amount reduced from approx. 470 m³/day (the FY2014 average) when the measures were first launched to approx. 180 m³/day (the FY2019 average).
- Measures will continue to further reduce the volume 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, rainwater, into buildings

➢ Operation of the groundwater bypass

- From April 9, 2014, the operation of 12 groundwater bypass pumping wells commenced sequentially to pump up groundwater. The release then started from May 21, 2014, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until July 28, 2020, 571,207 m³ of groundwater had been released. The pumped-up groundwater was temporarily stored in tanks and released after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Pumps are inspected and cleaned as required based on their operational status.

➢ Operation of the Water Treatment Facility special for Subdrain & Groundwater drains

- To reduce the level of groundwater flowing into the buildings, work began to pump up groundwater from wells (subdrains) around the buildings on September 3, 2015. The pumped-up groundwater was then purified at dedicated facilities and released from September 14, 2015, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until July 28, 2020, a total of 941,081 m³ had been drained after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Due to the rising level of the groundwater drain pond after the sea-side impermeable walls had been closed, pumping started on November 5, 2015. Up until July 28, 2020, a total of approx. 244,075 m³ had been pumped up and a volume of under 10 m³/day is being transferred from the groundwater drain to the Turbine Buildings (average for the period June 24 – July 22, 2020).
- As one of the multi-layered contaminated-water management measures, in addition to a waterproof pavement that aims to prevent rainwater infiltrating, facilities to enhance the subdrain treatment system were installed and went into

operation from April 2018, increasing the treatment capacity from 900 to 1,500 m³/day and improving reliability. Operational efficiency was also improved to treat up to 2,000 m³/day for almost one week during the peak period.

- To maintain the groundwater level, work to install additional subdrain pits and recover existing ones is underway. The additional pits are scheduled to start operation sequentially, from a pit for which work is completed (12 of 14 new subdrain pits went into operation). To recover existing pits, work for all three pits scheduled was completed and all went into operation from December 26, 2018. Work to recover another pit started from November 2019 (No. 49pit).
- To eliminate the need to suspend water pumping while cleaning the subdrain transfer pipe, the pipe will be duplicated. Installation of the pipe and ancillary facilities was completed.
- Since the subdrains went into operation, the inflow to buildings tended to decline to under 150 m³/day when the subdrain water level declined below T.P. 3.0 m but increased during rainfall.

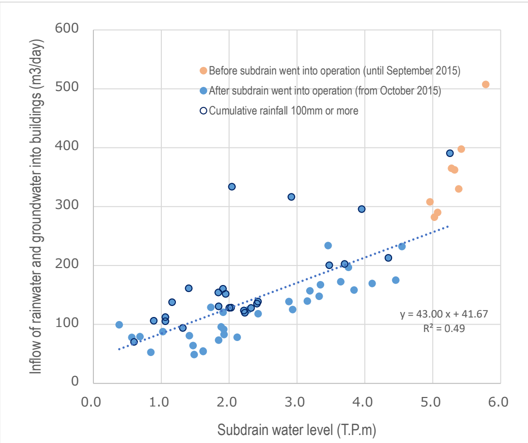


Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Units 1-4 subdrains

Implementation status of facing

- Facing is a measure that covers the ground surface onsite with asphalt to reduce the radiation dose, prevent rainwater infiltrating into the ground and decrease the amount of underground water flowing into buildings. As of the end of June 2020, 94% of the planned area (1,450,000 m² onsite) had been completed. For the area inside the land-side impermeable walls, implementation proceeds appropriately after constructing a yard from implementable zones that do not affect the decommissioning work. As of the end of June 2020, 12% of the planned area (60,000 m²) had been completed.

Construction status of the land-side impermeable walls and status of groundwater levels around the buildings

- An operation to maintain the land-side impermeable walls and prevent the frozen soil from thickening further continued from May 2017 on the north and south sides and started from November 2017 on the east side, where sufficiently thick frozen soil was identified. The scope of the maintenance operation was expanded in March 2018.
- In March 2018, construction of the land-side impermeable walls was completed, except for a portion of the depth, based on a monitoring result showing that the underground temperature had declined below 0°C in almost all areas, while on the mountain side, the difference in internal and external water levels increased to approx. 4-5 m. The 21st Committee on Countermeasures for Contaminated-Water Treatment, held on March 7, 2018, evaluated that alongside the function of subdrains and other measures, a water-level management system to stably control groundwater and redirect groundwater from the buildings had been established and allowed the amount of contaminated water generated to be reduced significantly.
- A supplementary method was implemented for the unfrozen depth and it was confirmed that the temperature of this portion had declined below 0°C by September 2018. From February 2019, a maintenance operation started throughout all sections.
- The groundwater level in the area inside the land-side impermeable walls has been declining every year. On the mountain side, the difference between the inside and outside was maintained, despite varying during rainfall. The water level of the groundwater drain observation well has been at approx. T.P.+1.5 m, sufficiently below the ground surface (T.P. 2.5 m).

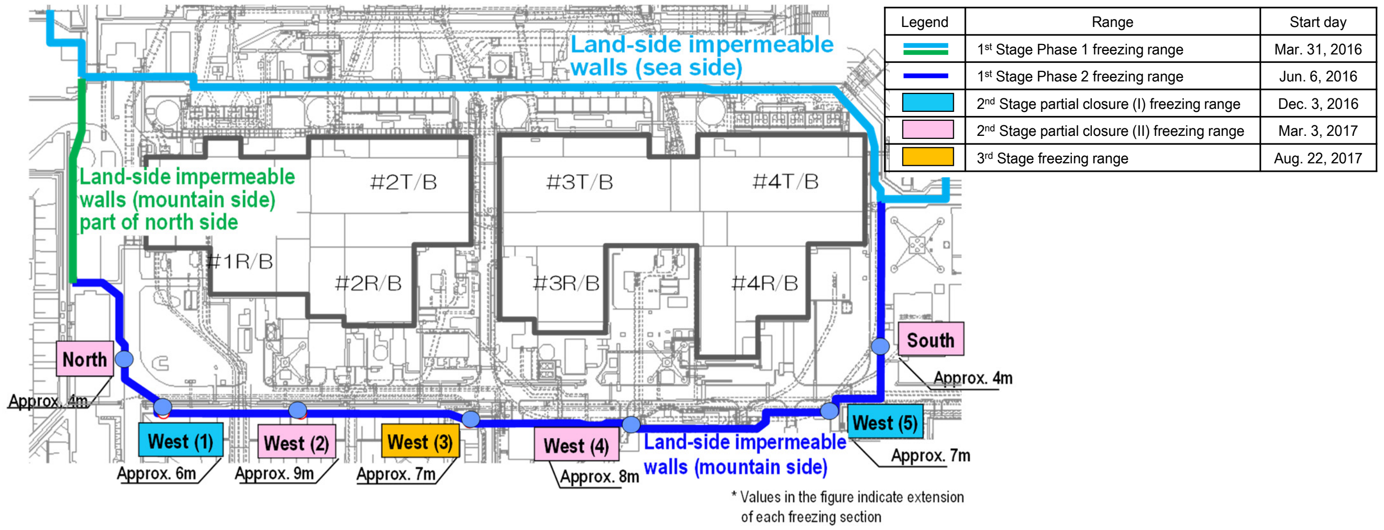


Figure 3: Closure parts of the land-side impermeable walls (on the mountain side)

Operation of multi-nuclide removal equipment

- Regarding the multi-nuclide removal equipment (existing and high-performance), hot tests using radioactive water are underway (for existing equipment, System A: from March 30, 2013, System B: from June 13, 2013, System C: from September 27, 2013; and for high-performance equipment, from October 18, 2014). The additional multi-nuclide removal equipment went into full-scale operation from October 16, 2017.
- As of July 23, 2020, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 451,000, 670,000 and 103,000 m³, respectively (including approx. 9,500 m³ stored in the J1(D) tank, which contained water with highly concentrated radioactive materials at the System B outlet of the existing multi-nuclide removal equipment).
- To reduce the risks of strontium-treated water, treatment using existing, additional, and high-performance multi-nuclide removal equipment has been underway (existing: from December 4, 2015; additional: from May 27, 2015; high-performance: from April 15, 2015). Up until July 23, 2020, approx. 746,000 m³ had been treated.

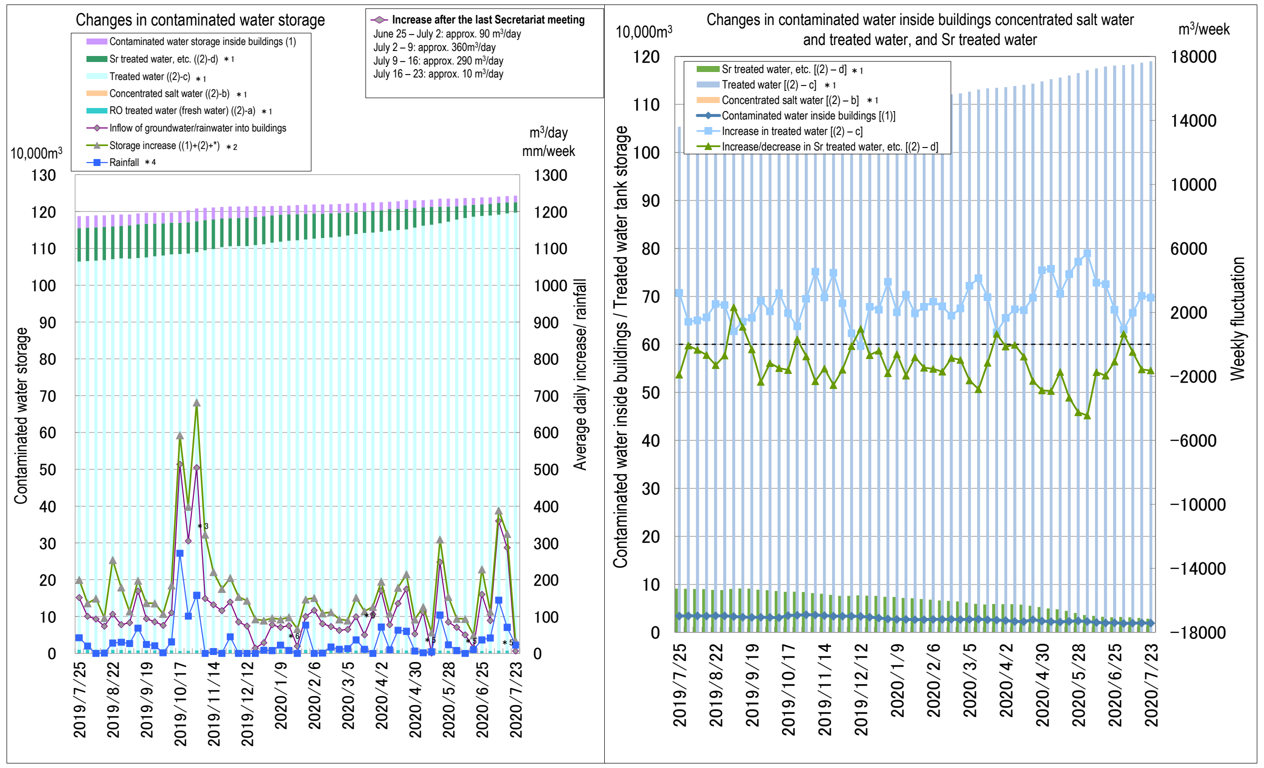
Toward reducing the risk of contaminated water stored in tanks

- Treatment measures comprising the removal of strontium by cesium-absorption apparatus (KURION) (from January 6, 2015), the secondary cesium-absorption apparatus (SARRY) (from December 26, 2014) and the third cesium-absorption apparatus (SARRY II) (from July 12, 2019) are underway. Up until July 23, 2020, approx. 598,000 m³ had been treated.

Measures in the Tank Area

- Rainwater accumulates and is collected inside the area of contaminated-water tanks. After removing radionuclides, the rainwater is sprinkled on the ground of the site, if the radioactivity level does not meet the standard for discharging into the environment since May 21, 2014 (as of July 28, 2020, a total of 159,241 m³).

As of July 23, 2020



*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: The storage amount increased due to transfer to buildings in association with the decommissioning work.
(The transferred amount comprised (① Transfer of RO concentrated water from groundwater drains to Turbine Building: approx. 80 m³/day, ② Transfer from wells and groundwater drains: approx. 50 m³/day, ③ Transfer from Unit 5/6 SPT to Process Main Building: approx. 20 m³/day, others)

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

*5: Considered attributable to the increased inflow of groundwater, rainwater, and others to buildings due to the decline in the level of contaminated water in buildings. (March 18, May 7-14, June 11-18, and July 16-23, 2020)

*6: From the period January 16-23, 2019, amid a decline in the water level in Unit 4 R/B, system water in S/C flowing into R/B contaminated water is reflected in the inflow of groundwater and rainwater in addition to the transferred amount generated in decommissioning work.

Figure 4: Status of contaminated water storage

➢ Investigation inside the Unit 1/2 exhaust stack drain sump pit

- The water level in the pit was confirmed as varying during rainfall, even after the lid was installed on the Unit 1/2 exhaust stack top on May 1. The inside of the pit was investigated to find an inflow route.
- The investigation during rainfall (max. 4mm/hour) on July 14 detected wet marks, which were considered traces of rainwater inflow, on the south side inside the pit and slight fluctuation on the water surface in the lower part.
- Measures reflecting the assumed rainwater inflow route will be implemented and their effects verified.

➢ Progress status of measures to prevent rainwater infiltrating from the roof of the Unit 3 Turbine Building

- For the Unit 3 Turbine Building, the installation of fences and other related facilities to prevent rainwater infiltration was completed, following which installation of a rainwater cover to shield the damaged roof parts on the south side started on July 20.
- After completing the installation of a rainwater cover on the north side by early August, waterproof painting on the rooftop will be completed by September.
- Efforts will continue toward achieving the target milestone within 2020 "suppressing contaminated water generated to about 150 m³/day" as stipulated in the Mid- and-Long-Term Roadmap.

➢ Policy to utilize tanks based on the analytical results of the reused-tank water

- Toward completing the treatment of Sr-treated water by ALPS in August 2020, treated water is stored in newly installed welded-joint tanks and reused Sr-treated water tanks, for which water removal was completed. Before the reuse, any water remaining at the tank bottom and sludge was removed and the tank was cleaned.
- Due to the influence of radioactive materials remaining in the reused tanks, it was assumed that the concentration of radioactive materials in tank water after receiving ALPS-treated water may exceed that of the ALPS outlet water. The concentration of radioactive materials in the tank water was analyzed for G3-H and K2-B areas, where reused tanks became full.
- Based on the analytical result showing that the sums of the ratios of the legally required concentrations exceeded 1 in both tank areas, they were subject to secondary treatment. The same handling will continue.
- The treatment of Sr-treated water by ALPS will be completed by August 2020 as planned.
- To reduce the concentration of radioactive materials in treated water stored, the method to reuse welded-joint tanks will be re-examined.

2. 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. The removal of spent fuel from the Unit 4 pool commenced on November 18, 2013 and was completed by December 22, 2014

➢ Main work to help spent fuel removal at Unit 1

- From March 18, 2019, the removal of small rubble in the east-side area around the spent fuel pool (SFP) started using pliers and suction equipment, while small rubble removal on the south side of the SFP started from July 9.
- The well plug, which was considered misaligned from the normal position due to the influence of the hydrogen explosion at the time of the accident, was investigated for the period July 17 – August 26, 2019, by taking photos with a camera, measuring the air dose rate and collecting 3D images.
- A prior investigation on September 27, 2019 confirmed the lack of any obstacle which may affect the plan to install the cover over the SFP, the absence of any heavy object such as a concrete block, as detected in Unit 3 and the fact that panel- and bar-shaped rubble pieces were scattered on the rack.
- After examining two methods: (i) installing a cover after rubble removal and (ii) initially installing a large cover over the Reactor Building and then removing rubble inside the cover, method (ii) was selected to ensure safer and more secure removal.
- During rubble removal work on the upper part of the Reactor Building, roof steel frames, small rubble and other objects may fall. To reduce the potential risk of these fallen objects affecting the soundness of fuel assemblies stored there, a cover bag was installed over the surface of the spent fuel pool. During the period June 8 to 11, the cover bag was injected onto the pool surface, extended to cover the entire pool surface area, expanded by inflating it with air and filled with air mortar. Support materials will be installed for the fuel-handling machine in October 2020 and for the overhead crane in November and rubble removal and other work will proceed steadily with safety first, toward starting fuel removal during the period FY2027 to FY2028.

➢ Main work to help spent fuel removal at Unit 2

- On November 6, 2018, before investigating with a work plan to dismantle the Reactor Building rooftop and other tasks in mind, work to move and contain the remaining objects on the operating floor (1st round) was completed.
- On February 1, 2019, an investigation to measure the radiation dose on the floor, walls and ceiling inside the operating floor and confirm the contamination status was completed. After analyzing the investigative results, the "contamination concentration distribution" throughout the entire operating floor was obtained, based on which the air dose rate inside the operating floor could be evaluated. A shielding design and measures to prevent radioactive material scattering will be examined.
- From April 8, 2019, work to move and contain the remaining objects on the operating floor (second round) started, such as materials and equipment which may hinder installation of the fuel-handling facility and other work. The second round mainly included moving the remaining small objects and placing them in the container. It also included cleaning the floor to suppress dust scattering and was completed on August 21.
- From September 10, 2019, work got underway to move and contain the remaining objects on the operating floor (third round), such as materials and equipment which may hinder the installation of the fuel-handling facility and other work.

The third round mainly included moving the remaining large objects and placing them in the container.

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

➢ Main process to help fuel removal at Unit 3

- From April 15, 2019, work got underway to remove 514 spent fuel assemblies and 52 non-irradiated fuel assemblies (566 in total) stored in the spent fuel pool. Seven non-irradiated fuel assemblies were then loaded into the transportation cask and transported to the common pool on April 23. The first fuel removal was completed on April 25.
- The periodical inspection of the fuel-handling facility, which started on July 24, 2019, was completed on September 2, 2019. Some defective rotations of the tensile truss and mast were detected during the following adjustment work toward resumption of the fuel removal. In response, parts were replaced and the operation checked to confirm no problem.
- Fuel removal work was resumed from December 23, 2019 and has proceeded as planned.
- By February 14, 2020, a visual check of all fuel handles was completed.
- The inspection of the fuel-handling machine and other equipment and additional training for added workers, which had been conducted since March 30, 2020, were completed by May 23 smoothly, whereupon fuel removal was resumed from May 26. At present, 266 of 566 fuel assemblies were removed. Removal work proceeds steadily with 25 assemblies remaining, for which rubble needs to be removed from the fuel top.
- At the same time, transfer of the control rods laying on the fuel rack was completed and rubble on the top of the fuel assemblies, which was under the control rods, was removed. Fuel removal continues and matters confirmed during rubble removal and the issue related to the handling of fuel assemblies with deformed handles will be addressed according to a plan to complete fuel removal by the end of FY2020.

➢ Termination of report at the Secretariat about measurement values of the continuous dust monitor installed on the Unit 3 operating floor and announcement of the website for disclosure

- Measurement by the continuous dust monitor installed on the operating floor of the Unit 3 Reactor Building started from October 2014 to validate the effect of anti-scattering agents, which were sprayed before and after the work and the measurement values were reported at the Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment (hereinafter referred to as the "Secretariat") since February 2015.
- After completing the decontamination on the surface of the operating floor in June 2016 and installing the shield in December 2016, less dust with radioactive materials was scattered and no anti-scattering agents were sprayed thereafter. In addition, installation of the dome roof was completed in February 2018. Accordingly, measurement values no longer need be reported from this Secretariat meeting onward.
- As of June 2020, fuel removal work has been underway inside the dome. Measurement values of said monitor installed outside the dome remained sufficiently below the high radioactivity level (1.00E-03). (The concentration of radioactive materials inside the dome was monitored on the outlet side after traversing the ventilation system filter.)
- The measurement values will continue to be disclosed on the website of TEPCO Holdings, Inc. as previously from the following URL: https://www.tepco.co.jp/hd/

3. Retrieval of fuel debris

➢ Status of obstacle cutting work related to the Unit 1 PCV inside investigation

- As part of efforts to investigate inside the Unit 1 Primary Contamination Vessel (PCV), work to cut obstacles inside the PCV on the route for the investigation equipment started from May 26, 2020.
- On July 7, when the cutter was started up, a defect was detected in the supply of abrasive material, which was used to improve the cutting performance and the work was suspended. At present, measures are being implemented. After confirming that there is no abnormality, work to cut the grating will be resumed.
- During the work, the dust concentration will be checked appropriately by the dust monitor to avoid any influence on the surrounding environment and the work will proceed with safety first.

➢ Status of water sampling from the Unit 3 suppression chamber

- To reduce the water level in the Unit 3 PCV in a phased manner, water sampling inside the suppression chamber started on July 21 to determine the water quality. To reduce exposure during the work, any dose increase around the sampling equipment was suppressed and the water was sampled on July 23. The analytical results showed a total β radioactivity concentration of 8.31×10^9 Bq/L, Cs-137 was 6.73×10^9 Bq/L and chlorine concentration of 5820 ppm.
- Work will continue taking the reduction of exposure dose into consideration and proceeding based on the results of future dose measurement and analysis.

➢ Check of the pressure-reduction function of the Unit 2 Primary Containment Vessel (PCV)

- Toward the trial retrieval and inside investigation of Unit 2 scheduled in 2021, pressure reduction is being examined to suppress external leakage from the PCV.
- Pressure in the PCV will be reduced by increasing the exhaustion volume via the existing gas-control facility filter. To reduce the PCV pressure to a level equal to air pressure, the pressure-reduction function was checked for the period July 6-10, 2020.
- It was confirmed that the pressure could be reduced to a target level equal to air pressure and there were no abnormalities in monitoring parameters while checking the pressure-reduction function.

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

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

➢ Management status of the rubble and trimmed trees

- As of the end of June 2020, the total storage volume for concrete and metal rubble was approx. 296,000 m³ (+1,000 m³ compared to at the end of May with an area-occupation rate of 72%). The total storage volume of trimmed trees was approx. 134,300 m³ (slight increase, with an area-occupation rate of 77%). The total storage volume of used protective clothing was approx. 37,800 m³ (-3,600 m³, with an area-occupation rate of 55%). The increase in rubble was mainly attributable to work related to tanks and rubble removal around the Unit 1-4 buildings, while the decrease in used protective clothing was attributable to the incinerator operation.

➢ Management status of secondary waste from water treatment

- As of July 2, 2020, the total storage volume of waste sludge was 419 m³ (area-occupation rate: 60%), while that of concentrated waste fluid was 9,380 m³ (area-occupation rate: 91%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment and other vessels, was 4,846 (area-occupation rate: 76%).

➢ Revision of the Solid Waste Storage Management Plan (FY2020 version)

- The fourth revision of the "Solid Waste Storage Management Plan," which was formulated in March 2016, was issued on July 30. Specifically, the estimated amount of solid waste to be generated over the next decade or so was updated from approx. 770,000 to 780,000 m³ and the lack of any influence on the facility installation schedule was confirmed.
- Based on this plan, for rubble and other solid waste temporarily stored in the outdoor storage area, combustibles will be incinerated, metals cut and concrete broken. After minimizing the amount, solid waste will be integrated in the indoor storage as part of work toward achieving the target milestone in the Mid- and-Long-Term Roadmap "eliminating the temporary outdoor storage area within FY2028."

5. Reactor cooling

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

➢ Tests to suspend water injection to Unit 1-3 reactors in the Fukushima Daiichi Nuclear Power Station

- A test involving temporarily suspending water injection to the reactor was conducted at Units 1-3 in FY2019 and it was confirmed that the increase in temperature due to suspension of water injection was almost within the assumed range.
- Based on these results, tests to suspend water injection to the reactor are planned for five, three and seven days for Unit 1, 2 and 3, respectively.
- For Units 1 and 3, the range of water-level decline inside the Primary Containment Vessel (PCV) and other parameters will be checked and for Unit 2, it will be checked that the increase in the Reactor Pressure Vessel (RPV) bottom temperature is precisely reproduced by the temperature evaluation model to enhance insights when examining how best to inject water in future.

➢ Operation resumption of the nitrogen gas separator (B)

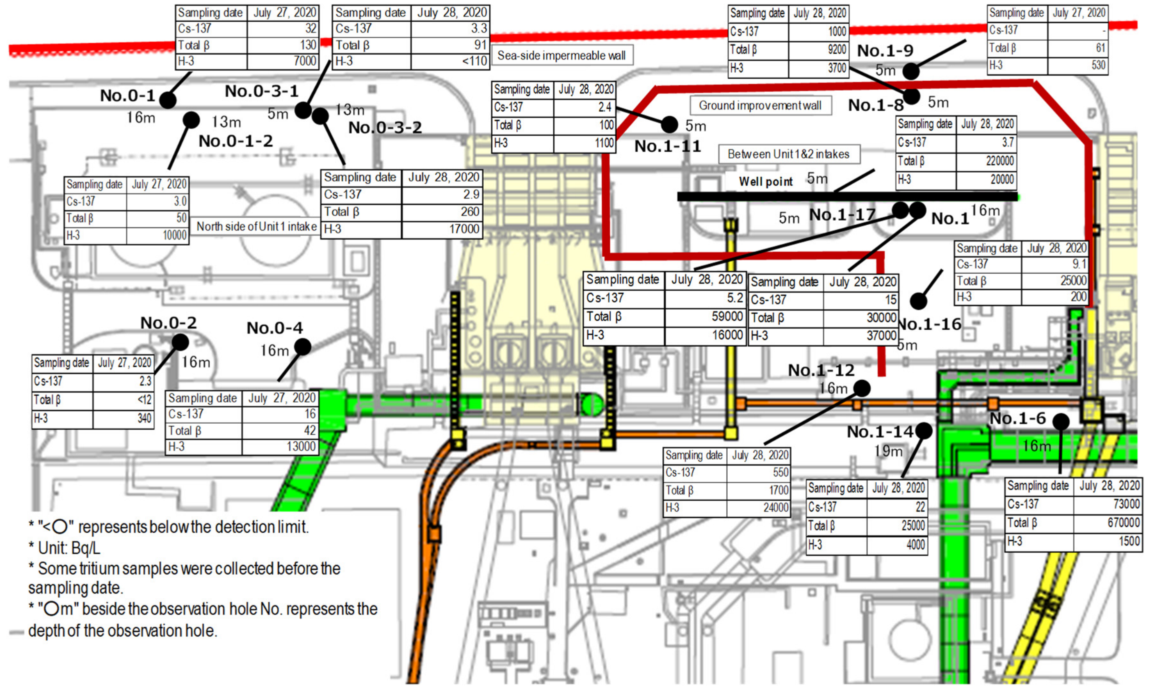
- Regarding the nitrogen gas separator (B), in response to the inability to confirm the true value of the nitrogen concentration for the period April 21-24, inspections and measures were implemented and operation was resumed on July 13.
- Based on the investigative results, the event was considered attributable to fine activated carbon flowing out from the adsorption tank into the controller, which converted and transmitted the nitrogen concentration and subsequently triggered a controller defect. Recurrence prevention measures were implemented, including moving the flowing-out (exhaust) part of the adsorption tank to the outside of the nitrogen separator and modifying the facility to immediately detect the field alarm at the central control room of the Main Anti-Earthquake Building.

6. Reduction in radiation dose and mitigation of contamination

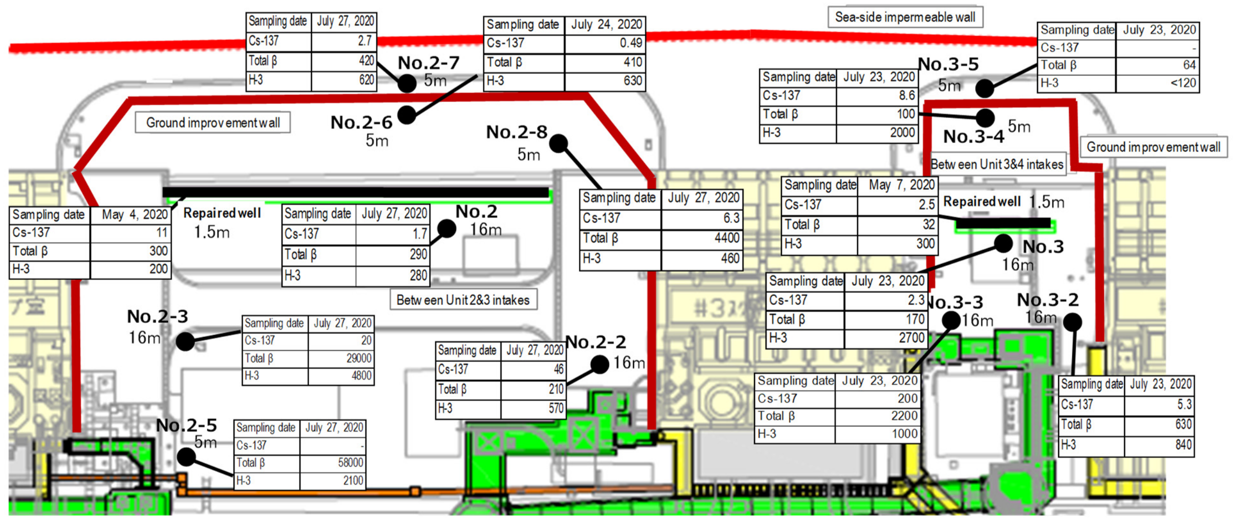
Effective dose-reduction at site boundaries and purification of port water to mitigate the impact of radiation on the external environment

➢ 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 has been below the legal discharge limit of 60,000 Bq/L at all observation holes and remained constant or been declining. The concentration of total β radioactive materials had remained constant overall but increased temporarily from April. The trend will continue to be monitored.
- In the area between Unit 1 and 2 intakes, the H-3 concentration has been below the legal discharge limit of 60,000 Bq/L at all observation holes. It increased temporarily at No. 1-14 but is currently declining and remained constant or been declining at many observation holes overall. The concentration of total β radioactive materials has remained constant at many observation holes overall, though it temporarily increased and is currently declining at No. 1-11 and peaked at No. 1-6 within the past variation range.
- In the area between Unit 2 and 3 intakes, the H-3 concentration has been below the legal discharge limit of 60,000 Bq/L at all observation holes and remained almost constant or been declining, though it has been increasing or decreasing at No. 2-3. The concentration of total β radioactive materials has been increasing at No. 2-3 located on the east side of No. 2-5 at the highest location.
- In the area between 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. The concentration of total β radioactive materials has also remained constant or been declining overall though it increased at No. 3-4 in June but was lower compared to No. 3-3.
- The concentration of radioactive materials in drainage channels has remained constant, despite increasing during rainfall.
- In the Units 1-4 open channel area of seawater intake for Units 1 to 4, the concentration of radionuclides in seawater has remained below the legal discharge limit, despite increases in Cs-137 and Sr-90 noted during rainfall. They have also been declining following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls. The concentration of Cs-137 has remained slightly higher in front of the south side impermeable walls and slightly lower on the north side of the east breakwater since March 20, 2019, when the silt fence was transferred to the center of the open channel due to mega float-related construction.
- In the port area, the concentration of radionuclides in seawater has remained below the legal discharge limit, despite observing small increases in Cs-137 and Sr-90 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.



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



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

Figure 5: Groundwater concentration on the Turbine Building east side

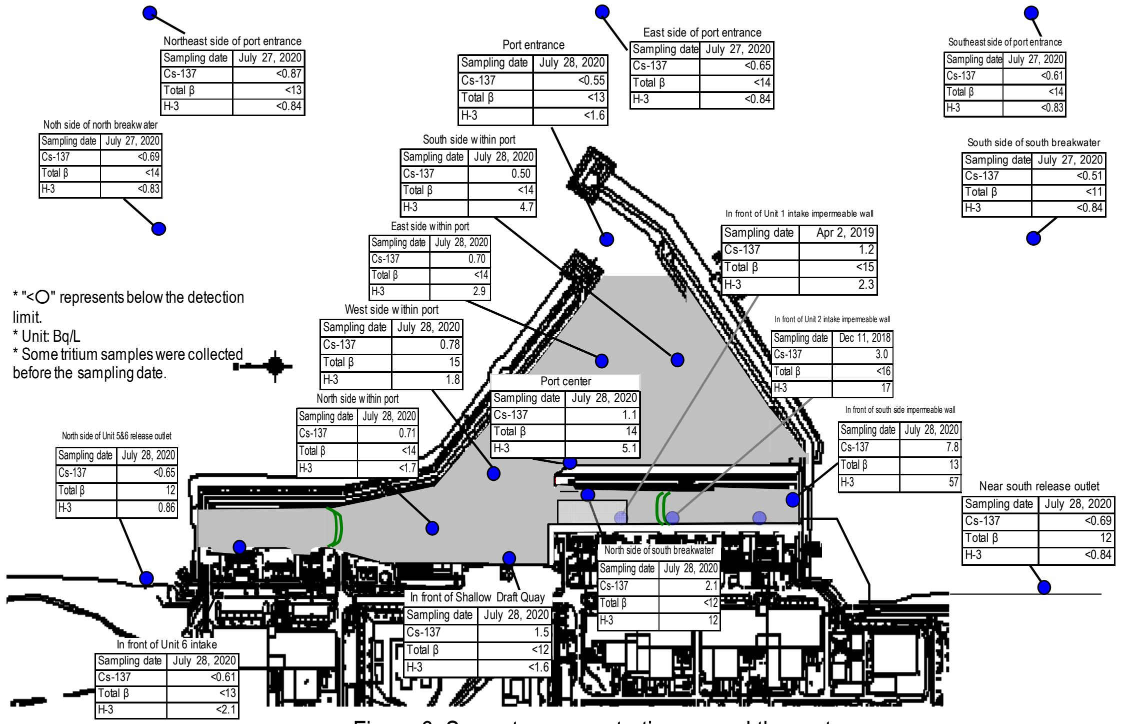


Figure 6: Seawater concentration around the port

- Survey not implemented for the rest space in the Large Equipment Maintenance Building
  - A rest space (a controlled area without any risk of contamination) was set up and provided on the second floor of the Large Equipment Maintenance Building for the entrusted tank decontamination and storage work. The work was suspended for the period July 1 - August 31, 2020 and the rest space was used to facilitate inspection work of large decontamination equipment in the same building during that period.
  - When using the rest space, the “surface contamination density” and the “radioactive material concentration in air” must be measured daily to confirm that the space is not contaminated. However, the surface contamination density on July 1 and the radioactive material concentration in air on July 1, 3 and 6 were not measured.
  - The two parameters have been measured since July 7 and it was confirmed that the maintenance level of the controlled area where there is no risk of contamination was satisfied.
  - A cause analysis will follow to implement measures appropriately.

7. 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 March to May 2020 was approx. 9,000 (TEPCO and partner company workers), which exceeded the monthly average number of actual workers (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 August 2020 (approx. 3,900 per day: TEPCO and partner company workers) would be secured at present. The average numbers of workers per day per month (actual values) were maintained, with approx. 3,400 to 4,400 since FY2018 (see Figure 7).
  - The number of workers from both within and from outside Fukushima Prefecture increased. The local employment ratio (TEPCO and partner company workers) as of June 2020 also remained constant at around 65%.
  - The monthly average exposure doses of workers remained at approx. 0.22, 0.20 and 0.21* mSv/month during FY2017, FY2018 and FY2019, respectively. * Provisional value for FY2019 (Reference: Annual average exposure dose 20 mSv/year ≒ 1.7 mSv/month)
  - For most workers, the exposure dose was sufficiently within the limit and allowed them to continue engaging in radiation work.

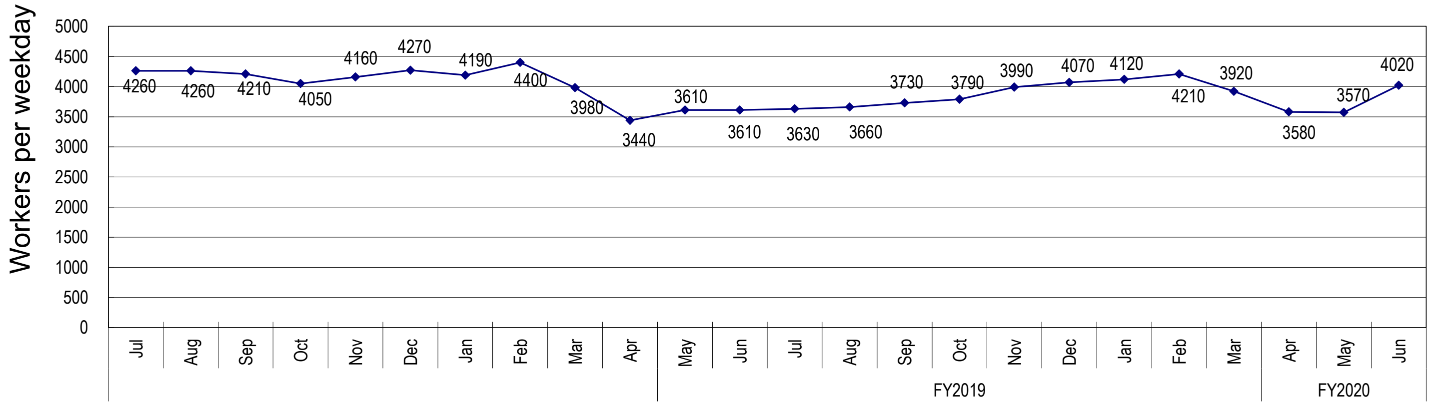


Figure 7: Changes in the average number of workers per weekday for each month since FY2018 (actual values)

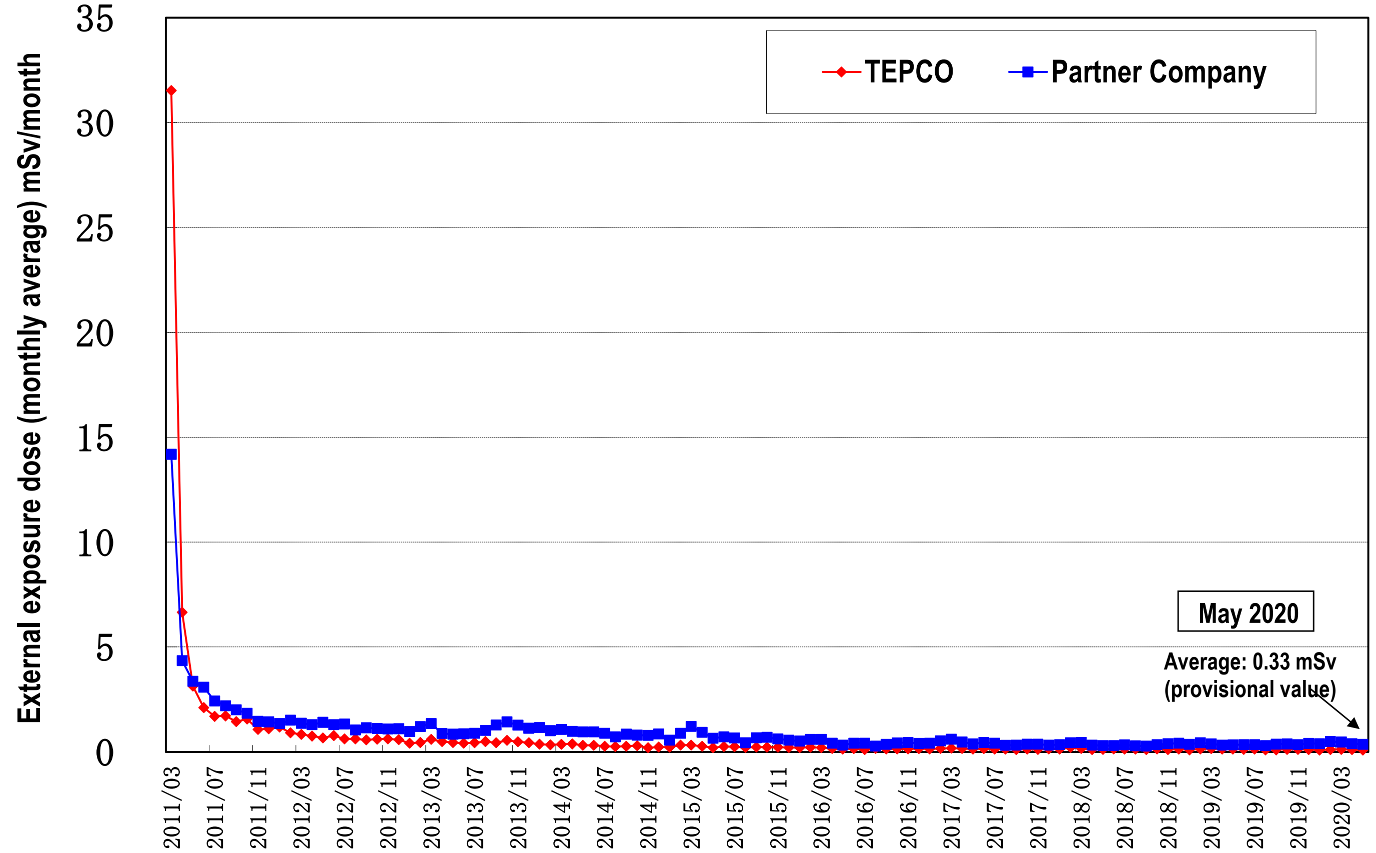


Figure 8: Changes in monthly individual worker exposure dose
(monthly average exposure dose since March 2011)

- Health management of workers in the Fukushima Daiichi Nuclear Power Station
  - 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 fourth quarter (January – March) in FY2019 confirmed that the prime contractors had provided appropriate guidance and managed operation properly under the scheme. The report on the follow-up status before the third quarter in FY2019 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 would continue.

➢ Status of heat stroke cases

- In FY2020, measures to further prevent heat stroke commenced from April to cope with the hottest season.
- In FY2020, two workers suffered heat stroke due to work up until July 27 (in FY2019, four workers up until the end of July). Continued measures will be taken to prevent heat stroke.

➢ COVID-19 infectious disease prevention countermeasures at the Fukushima Daiichi NPS

- At the Fukushima Daiichi Nuclear Power Station (NPS), countermeasures continue to be implemented according to the local infection status to prevent the COVID-19 infection spreading, such as requiring employees to take their temperature prior to coming to the office, wear masks at all times and avoid the "Three Cs" (Closed spaces, Crowded places, Close-contact settings) by shift-use of the rest house, etc.
- As of July 28, 2020, no TEPCO HD employees or cooperative firm laborers of the Fukushima Daiichi NPS had contracted COVID-19 and no significant influence on decommissioning work, such as a delay to the work processes, was identified.

8. Others

➢ Plan to investigate Unit 1-4 SGTS rooms

- To clarify the emission behavior of radioactive materials by the PCV vent, there is a plan to investigate the inside of the Standby Gas Treatment System (SGTS) rooms, which have remained unchanged since the time of the accident occurred and do not impede the ongoing decommissioning work.
- Specifically, detailed information about the radiation dose and contamination, mainly of filter trains and vent lines, will be collected from around September.

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 July 20-27)"; unit (Bq/L); ND represents a value below the detection limit

Source: TEPCO website Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station http://www.tepco.co.jp/nu/fukushima-np/f1/smp/index-j.html

Cesium-134:	3.3 (2013/10/17) →	ND(0.22)	Below 1/10
Cesium-137:	9.0 (2013/10/17) →	0.44	Below 1/20
Total β:	74 (2013/ 8/19) →	15	Below 1/4
Tritium:	67 (2013/ 8/19) →	2.9	Below 1/20

Cesium-134:	4.4 (2013/12/24) →	ND(0.29)	Below 1/10
Cesium-137:	10 (2013/12/24) →	0.90	Below 1/10
Total β:	60 (2013/ 7/ 4) →	ND(13)	Below 1/4
Tritium:	59 (2013/ 8/19) →	1.8	Below 1/30

Cesium-134:	5.0 (2013/12/2) →	ND(0.32)	Below 1/10
Cesium-137:	8.4 (2013/12/2) →	0.56	Below 1/10
Total β:	69 (2013/8/19) →	15	Below 1/4
Tritium:	52 (2013/8/19) →	ND(1.7)	Below 1/30

Cesium-134:	2.8 (2013/12/2) →	ND(0.43)	Below 1/6
Cesium-137:	5.8 (2013/12/2) →	ND(0.58)	Below 1/10
Total β:	46 (2013/8/19) →	ND(11)	Below 1/4
Tritium:	24 (2013/8/19) →	ND(2.1)	Below 1/10

Cesium-134:	ND(0.48)
Cesium-137:	ND(0.64)
Total β:	ND(13)
Tritium:	5.1 *1

Cesium-134:	3.3 (2013/12/24) →	ND(0.44)	Below 1/7
Cesium-137:	7.3 (2013/10/11) →	ND(0.55)	Below 1/10
Total β:	69 (2013/ 8/19) →	ND(13)	Below 1/5
Tritium:	68 (2013/ 8/19) →	ND(1.6)	Below 1/40

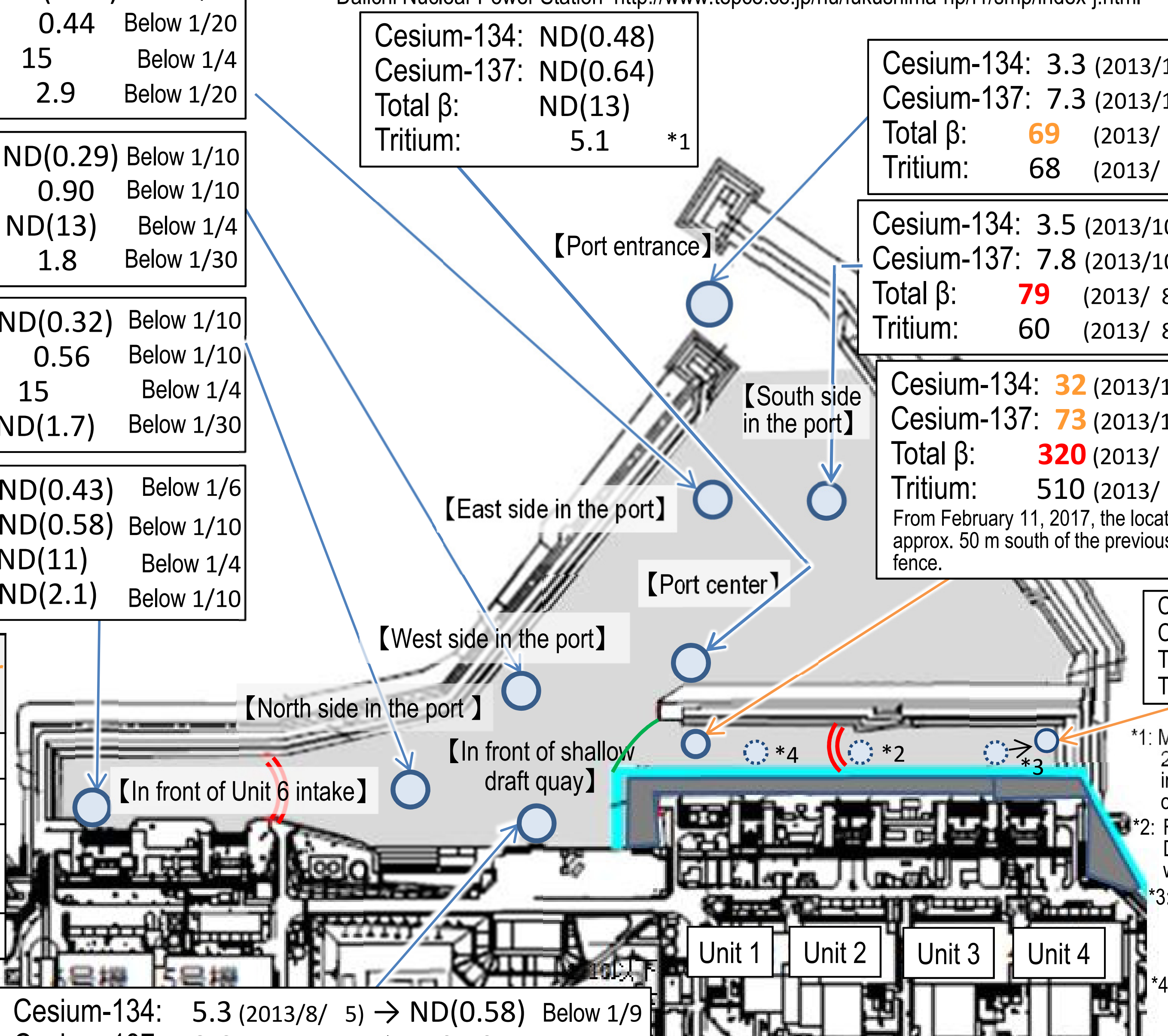
Cesium-134:	3.5 (2013/10/17) →	ND(0.27)	Below 1/10
Cesium-137:	7.8 (2013/10/17) →	ND(0.34)	Below 1/20
Total β:	79 (2013/ 8/19) →	15	Below 1/5
Tritium:	60 (2013/ 8/19) →	4.0	Below 1/10

Cesium-134:	32 (2013/10/11) →	ND(0.47)	Below 1/60
Cesium-137:	73 (2013/10/11) →	1.7	Below 1/40
Total β:	320 (2013/ 8/12) →	15	Below 1/20
Tritium:	510 (2013/ 9/ 2) →	12	Below 1/40

From February 11, 2017, the location of the sampling point was shifted approx. 50 m south of the previous point due to the location shift of the silt fence.

Cesium-134:	ND(0.85)
Cesium-137:	5.1
Total β:	12
Tritium:	57 *1

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



Cesium-134:	5.3 (2013/8/ 5) →	ND(0.58)	Below 1/9
Cesium-137:	8.6 (2013/8/ 5) →	0.52	Below 1/10
Total β:	40 (2013/7/ 3) →	ND(11)	Below 1/3
Tritium:	340 (2013/6/26) →	ND(1.6)	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.

Summary of TEPCO data as of July 28, 2020

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.

Status of seawater monitoring around outside of the port
(comparison between the highest values in 2013 and the latest values)

(The latest values sampled during July 20-27)

	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

Unit (Bq/L); ND represents a value below the detection limit; values in ( ) represent the detection limit; ND (2013) represents ND throughout 2013

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

Cesium-134: ND (2013) → ND (0.95)
Cesium-137: ND (2013) → ND (0.87)
Total β: ND (2013) → ND (13)
Tritium: ND (2013) → ND (0.84)

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

Cesium-134: ND (2013) → ND (0.45)
Cesium-137: 1.6 (2013/10/18) → ND (0.65) Below 1/2
Total β: ND (2013) → ND (14)
Tritium: 6.4 (2013/10/18) → ND (0.84) Below 1/7

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

Cesium-134: ND (2013) → ND (0.52)
Cesium-137: ND (2013) → ND (0.61)
Total β: ND (2013) → ND (14)
Tritium: ND (2013) → ND (0.83)

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

Cesium-134: ND (2013) → ND (0.77)
Cesium-137: ND (2013) → ND (0.69)
Total β: ND (2013) → ND (14)
Tritium: 4.7 (2013/ 8/18) → ND (0.83) Below 1/5

【Port entrance】

Cesium-134: 3.3 (2013/12/24) →ND (0.44) Below 1/7
Cesium-137: 7.3 (2013/10/11) →ND (0.55) Below 1/10
Total β: 69 (2013/ 8/19) →ND (13) Below 1/5
Tritium: 68 (2013/ 8/19) →ND (1.6) Below 1/40

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

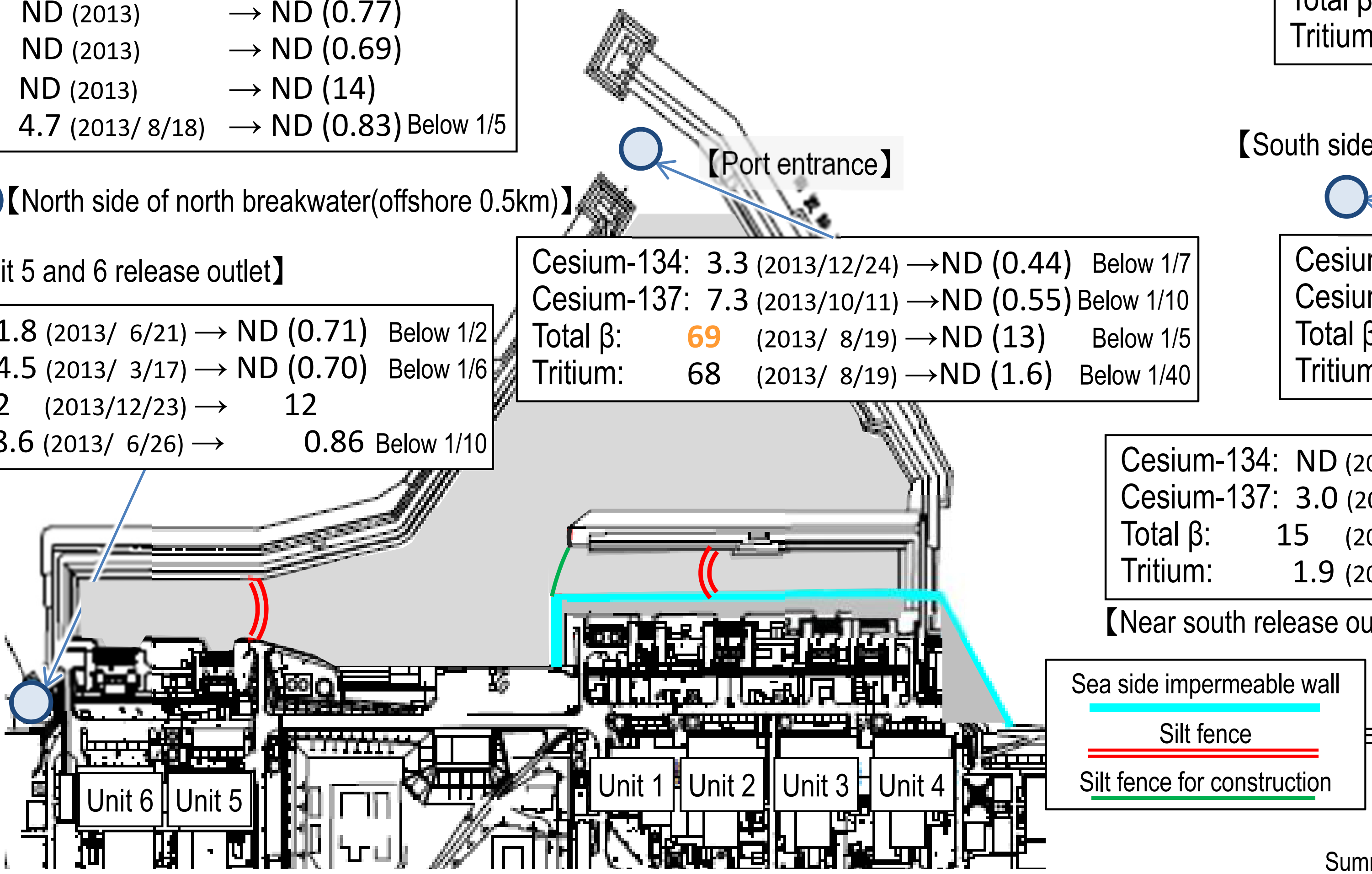
Cesium-134: ND (2013) → ND (0.64)
Cesium-137: ND (2013) → ND (0.51)
Total β: ND (2013) → ND (11)
Tritium: ND (2013) → ND (0.84)

【North side of Unit 5 and 6 release outlet】

Cesium-134: 1.8 (2013/ 6/21) → ND (0.71) Below 1/2
Cesium-137: 4.5 (2013/ 3/17) → ND (0.70) Below 1/6
Total β: 12 (2013/12/23) → 12
Tritium: 8.6 (2013/ 6/26) → 0.86 Below 1/10

【Near south release outlet】

Cesium-134: ND (2013) → ND (0.80)
Cesium-137: 3.0 (2013/ 7/15) → ND (0.64) Below 1/4
Total β: 15 (2013/12/23) → 14
Tritium: 1.9 (2013/11/25) → ND (0.84) Below 1/2



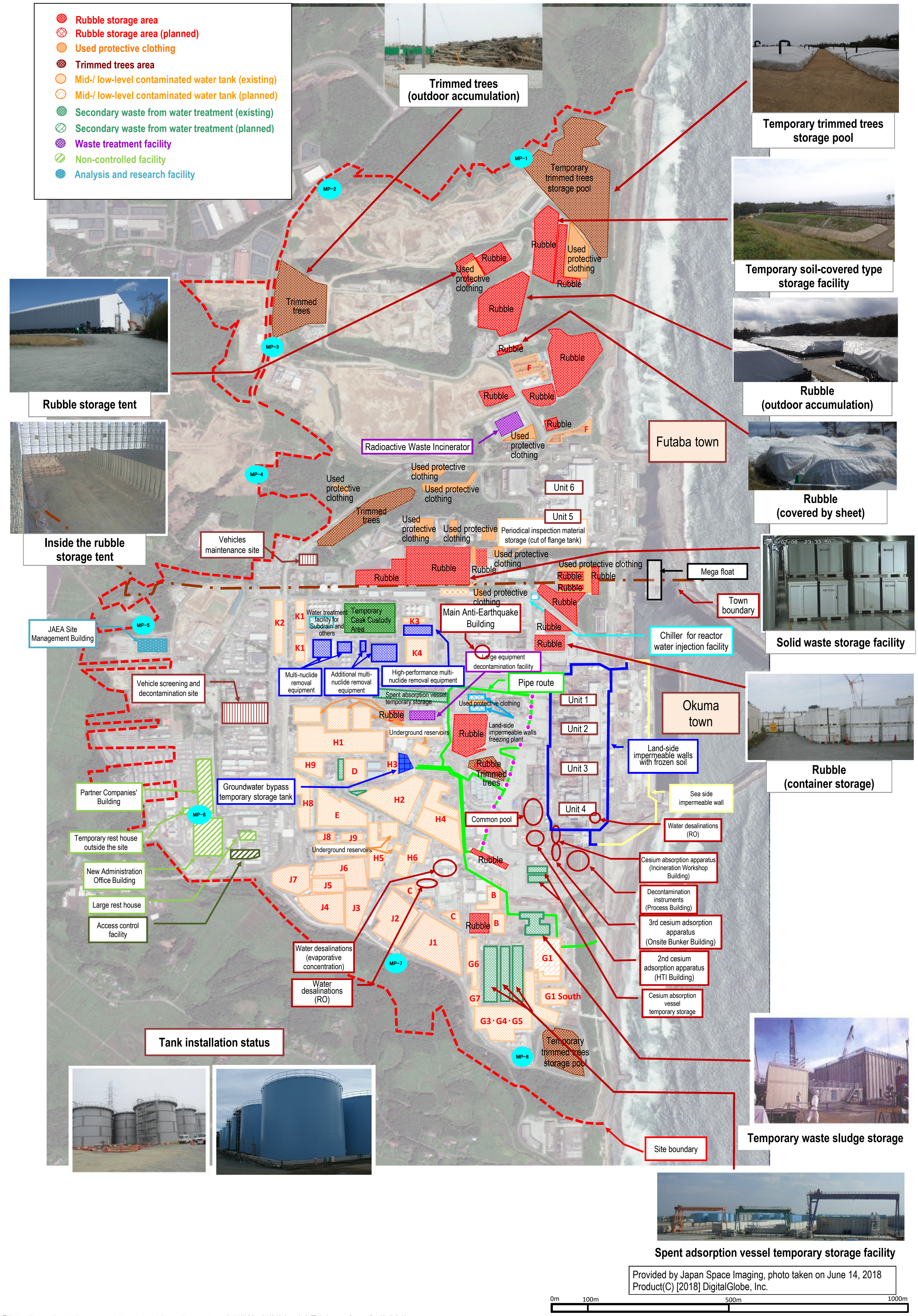
Note: The Total β measurement values include natural potassium 40 (approx. 12 Bq/L). They also include the contribution of yttrium 90, which radioactively balance strontium 90.

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

Summary of TEPCO data as of July 28, 2020

Source: TEPCO website, Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station, http://www.tepco.co.jp/nu/fukushima-np/f1/smp/index-j.html

TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site Layout



Reference

July 30, 2020
Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

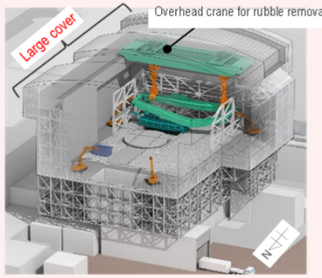
Progress toward decommissioning: Fuel removal from the spent fuel pool (SFP)

Immediate target	Commence fuel removal from the Unit 1-3 Spent Fuel Pools

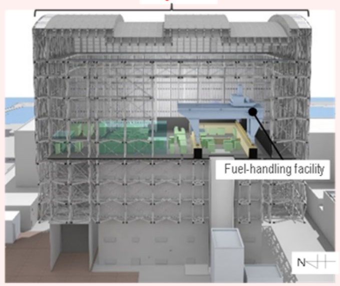
Unit 1

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

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



Rubble removal (image)

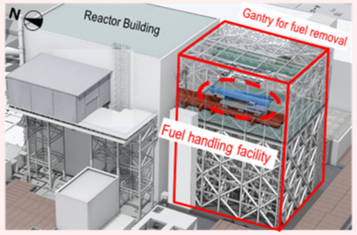


Fuel removal (image)

Unit 2

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

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

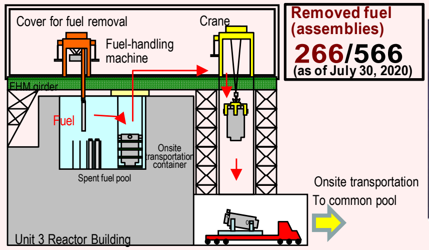


Overview of fuel removal (bird's-eye view)

Unit 3

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

Installation of dome roof (February 21, 2019)



Overview of the fuel-handling facility inside the cover

Removed fuel (assemblies)
266/566
(as of July 30, 2020)


Fuel removal status
(April 15, 2019)

Unit 4

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

On November 5, 2014, within a year of commencing work to fuel removal, all 1,331 spent fuel assemblies in the pool had been transferred. The transfer of the remaining non-irradiated fuel assemblies to the Unit 6 SFP was completed on December 22, 2014. (2 of the non-irradiated fuel assemblies were removed in advance in July 2012 for fuel checks)
This marks the completion of fuel removal from the Unit 4 Reactor Building.
Based on this experience, fuel assemblies will be removed from Unit 1-3 pools.


Fuel removal status

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

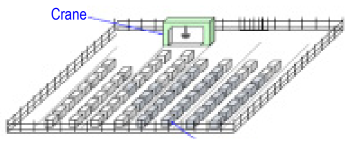
Common pool

Cask pit | Storage area | Cask pit

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

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

Temporary cask (*2) custody area



Spent fuel is accepted from the common pool

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

<Glossary>
(*1) Operating floor: During regular inspection, the roof over the reactor is opened while on the operating floor, fuel inside the core is replaced and the core internals are inspected.
(*2) Cask: Transportation container for samples and equipment, including radioactive materials.

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

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

Investigation into TIP Room of the Unit 1 Reactor Building

- To improve the environment for future investigations inside the PCV, etc., an investigation was conducted from September 24 to October 2, 2015 at the TIP Room(*1). (Due to high dose around the entrance in to the TIP Room, the investigation of dose rate and contamination distribution was conducted through a hole drilled from the walkway of the Turbine Building, where the dose was low)
- The investigative results identified high dose at X-31 to 33 penetrations(*2) (instrumentation penetration) and low dose at other parts.
- As it was confirmed that work inside the TIP room would be available, the next step will include identification of obstacles which will interfere the work inside the TIP Room and formulation of a plan for dose reduction.

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

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

Leak point

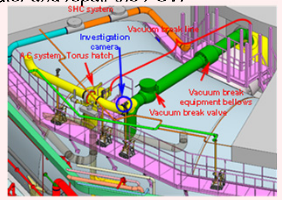
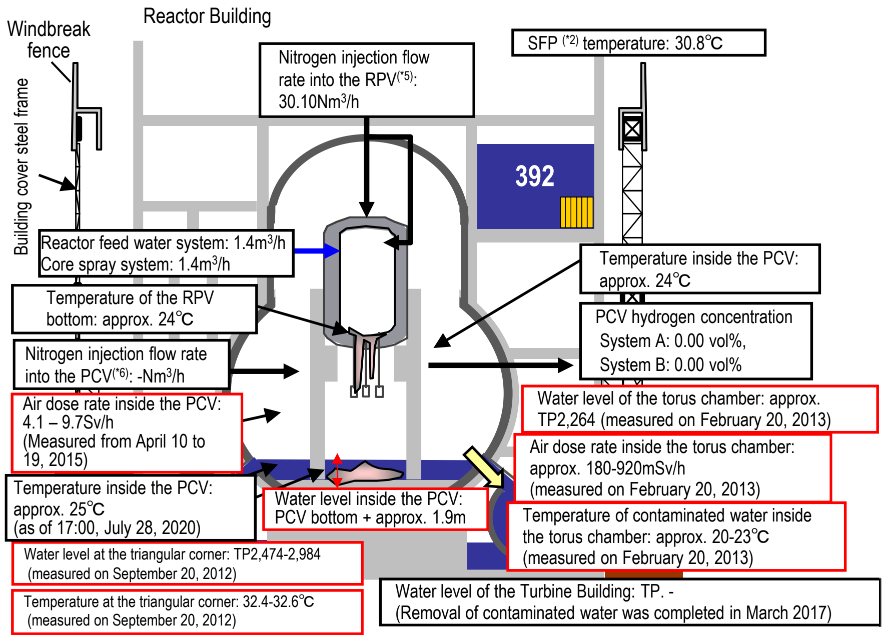


Image of the S/C upper part investigation

Unit 1

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



* Indices related to the plant are values as of 11:00, July 29, 2020

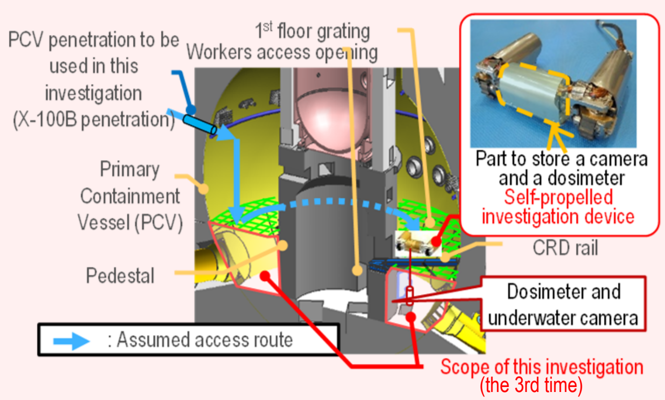
Investigations inside PCV	1st (Oct 2012)	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling contaminated water - Installing permanent monitoring instrumentation
	2nd (Apr 2015)	Confirming the status of PCV 1st floor - Acquiring images - Measuring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

Status of investigation inside the PCV

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

[Investigative outline]

- In April 2015, a device, which entered the inside of the PCV through a narrow access opening (bore: ϕ 100 mm), collected information such as images and airborne dose inside the PCV 1st floor.
- In March 2017, the investigation using a self-propelled investigation device, conducted to inspect the spreading of debris to the basement floor outside the pedestal, took images of the PCV bottom status for the first time. The status inside the PCV will continue to be examined based on the collected image and dose data.



<Image of investigation inside the PCV>

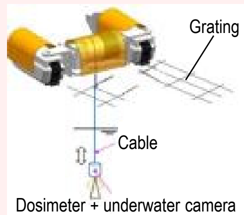


Image of hanging of dosimeter and camera

Image near the bottom

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

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

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

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

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

Installation of an RPV thermometer and permanent PCV supervisory instrumentation

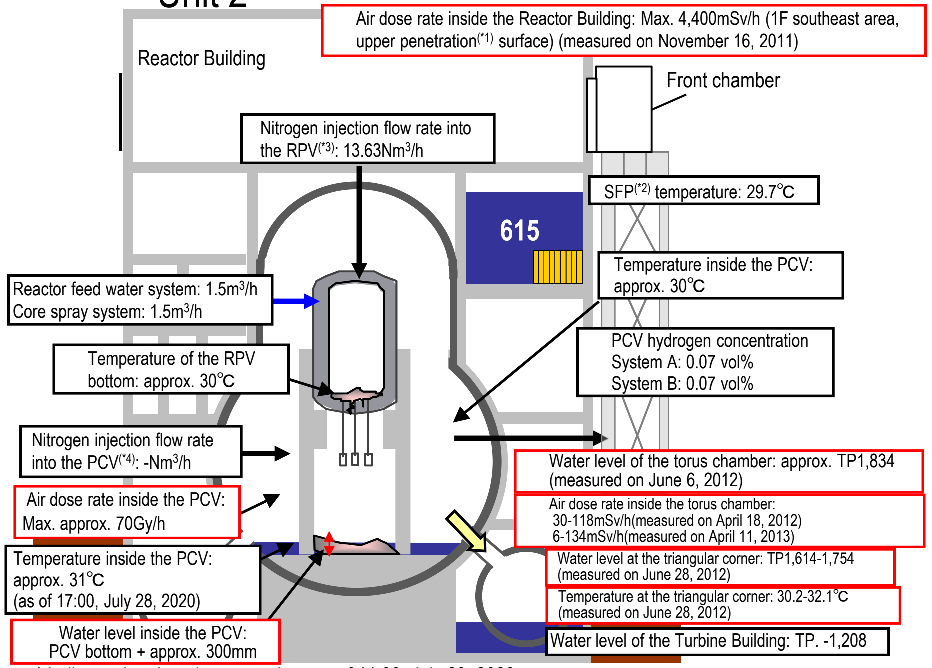
(1) Replacement of the RPV thermometer

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

(2) Reinstallation of the PCV thermometer and water-level gauge

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

Unit 2

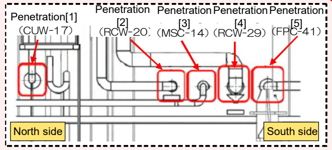


* Indices related to plant are values as of 11:00, July 29, 2020

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

Investigative results on torus chamber walls

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



Penetrations investigated

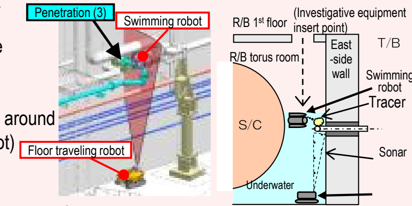


Image of the torus chamber east-side cross-sectional investigation

Status of investigation inside the PCV

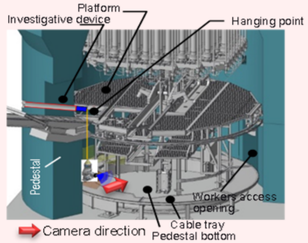
Prior to fuel debris retrieval, an investigation inside the PCV will be conducted to inspect the status there including the location of fuel debris.

[Investigative outline]

- Investigative devices such as a robot will be injected from Unit 2 X-6 penetration(*1) and access the inside of the pedestal using the CRD rail.

[Progress status]

- On January 26 and 30, 2017, a camera was inserted from the PCV penetration to inspect the status of the CRD replacement rail on which the robot will travel. On February 9, deposit on the access route of the self-propelled investigative device was removed and on February 16, the inside of the PCV was investigated using the device.
- The results of this series of investigations confirmed fallen and deformed gratings and a quantity of deposit inside the pedestal.
- On January 19, 2018, the status below the platform inside the pedestal was investigated using an investigative device with a hanging mechanism. From the analytical results of images obtained in the investigation, deposits probably including fuel debris were found at the bottom of the pedestal. In addition, multiple parts higher than the surrounding deposits were also detected. We presumed that there were multiple routes of fuel debris falling. Obtained data were processed in panoramic image visualization to acquire clearer images.
- On February 13, 2019, an investigation touching the deposits at the bottom of the pedestal and on the platform was conducted and confirmed that the pebble-shaped deposits, etc. could be moved and that hard rock-like deposits that could not be gripped may exist.
- In addition, images, etc. would help determine the contour and size of the deposits could be collected by moving the investigative unit closer to the deposits than the previous investigation.



Investigative status (image)

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

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

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

<Glossary> (*1) Penetration: Through-hole of the PCV (*2) SFP (Spent Fuel Pool) (*3) RPV (Reactor Pressure Vessel) (*4) PCV (Primary Containment Vessel) (*5) Tracer: Material used to trace the fluid flow. Clay particles

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

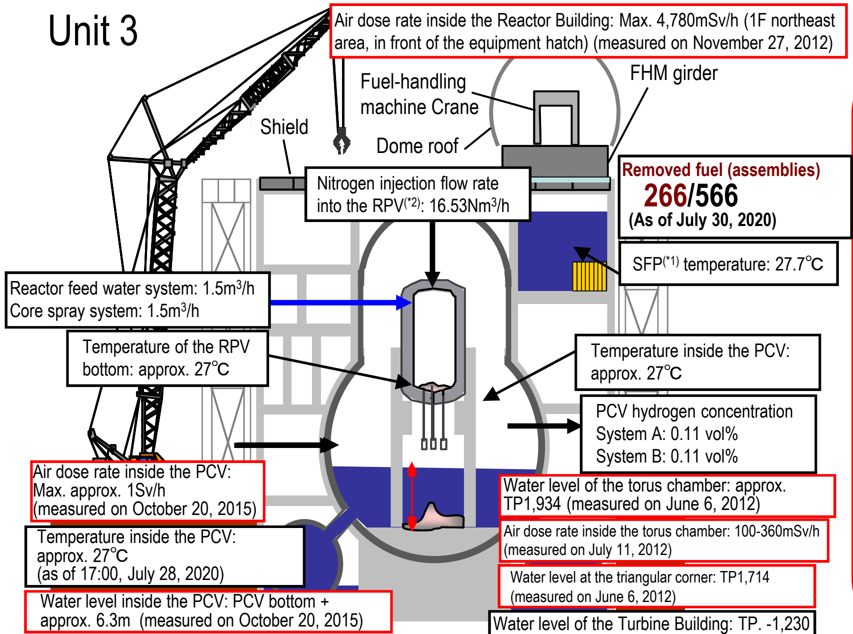
Immediate target	Identify the plant status and commence R&D and decontamination toward fuel debris retrieval

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

On January 18, 2014, a flow of water from around the door of the Steam Isolation Valve room in the Reactor Building Unit 3 1st floor northeast area to the nearby floor drain funnel (drain outlet) was detected. As the drain outlet connects with the underground part of the Reactor Building, there is no possibility of outflow from the building.
From April 23, 2014, image data has been acquired by camera and the radiation dose measured via pipes for measurement instrumentation, which connect the air-conditioning room on the Reactor Building 2nd floor with the Main Steam Isolation Valve Room on the 1st floor. On May 15, 2014, water flow from the expansion joint of one Main Steam Line was detected.
This is the first leak from PCV detected in the Unit 3. Based on the images collected in this investigation, the leak volume will be estimated and the need for additional investigations will be examined. The investigative results will also be utilized to examine water stoppage and PCV repair methods.

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

Unit 3

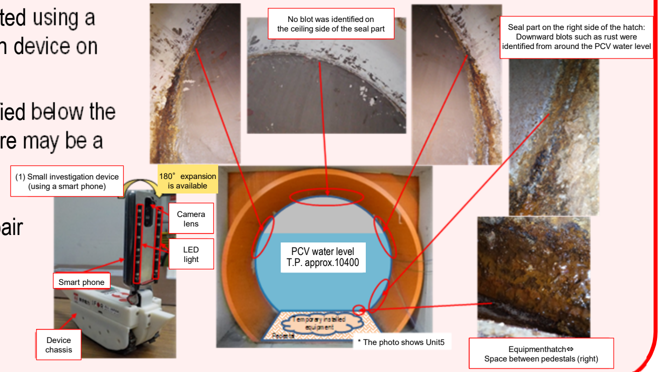


* Indices related to plant are values as of 11:00, July 29, 2020

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

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

- As part of the investigation into the PCV to facilitate fuel debris retrieval, the status around the Unit 3 PCV equipment hatch was investigated using a small self-traveling investigation device on November 26, 2015.
- Given blots such as rust identified below the water level inside the PCV, there may be a leakage from the seal to the extent of bleeding.
  Methods to investigate and repair the parts, including other PCV penetrations with a similar structure, will be considered.

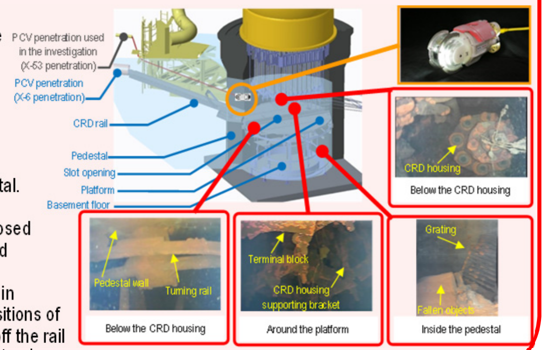


Investigation inside the PCV

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

[Investigative outline]

- The status of X-53 penetration(*4), which may be under the water and which is scheduled for use to investigate the inside of the PCV, was investigated using remote-controlled ultrasonic test equipment. The results showed that the penetration was not under the water (October 22-24, 2014).
- For the purpose of confirming the status inside the PCV, an investigation device was inserted into the PCV from X-53 penetration on October 20 and 22, 2015 to obtain images, data of dose and temperature and sample contaminated water. No damage was identified on the structure and walls inside the PCV and the water level was almost identical with the estimated value. In addition, the dose inside the PCV was confirmed to be lower than in other Units.
- In July 2017, the inside of the PCV was investigated using the underwater ROV (remotely operated underwater vehicle) to inspect the inside of the pedestal.
- Analysis of image data obtained in the investigation identified damage to multiple structures and the supposed core internals. Consideration about fuel removal based on the obtained information will continue.
- Videos obtained in the investigation were reproduced in 3D. Based on the reproduced images, the relative positions of the structures, such as the rotating platform slipping off the rail with a portion buried in deposits, were visually understood.



Status inside the pedestal

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

Period	Evaluation results
May – Sep 2017	The evaluation confirmed that no large lump existed in the core area where fuel had been placed and that part of the fuel debris potentially existed at the bottom of the RPV.

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

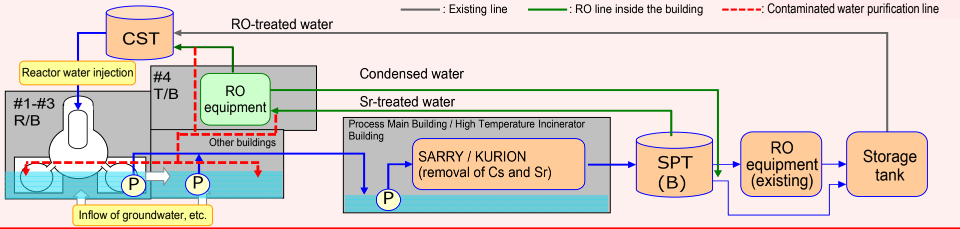
Progress toward decommissioning: Work related to circulation cooling and contaminated water treatment line

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

Work to improve the reliability of the circulation water injection cooling system and pipes to transfer contaminated water.

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

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



Progress status of dismantling of flange tanks

- To facilitate replacement of flanged tanks, dismantling of flanged tanks started in H1 east/H2 areas in May 2015. Dismantling of all flanged tanks was completed in H1 east area (12 tanks) in October 2015, in H2 area (28 tanks) in March 2016, in H4 area (56 tanks) in May 2017, in H3 B area (31 tanks) in September 2017, in H5 and H5 north areas (31 tanks) in June 2018, in G6 area (38 tanks) in July 2018, H6 and H6 north areas (24 tanks) in September 2018 and G4 south area (17 tanks) in March 2019.

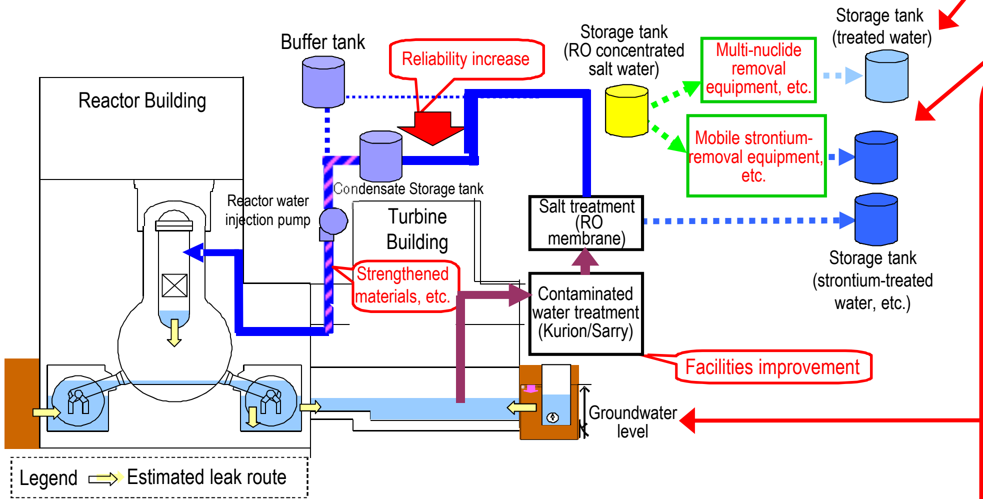

Start of dismantling in H1 east area

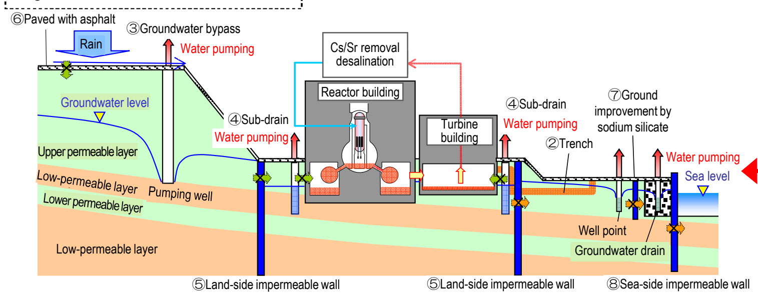

After dismantling in H1 east area

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

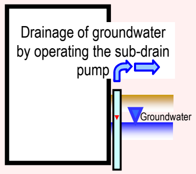
Contaminated water (RO concentrated salt water) is being treated using seven types of equipment including the multi-nuclide removal equipment (ALPS). Treatment of the RO concentrated salt water was completed on May 27, 2015, with the exception of the remaining water at the tank bottom. The remaining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

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





Preventing groundwater from flowing into the Reactor Buildings

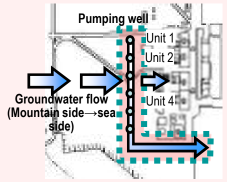


Reducing groundwater inflow by pumping sub-drain water

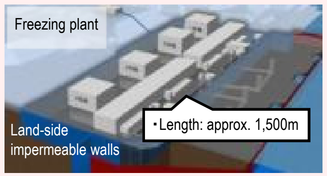
To reduce groundwater flowing into the buildings, pumping-up of groundwater from wells (subdrains) around the buildings started on September 3, 2015. Pumped-up groundwater was purified at dedicated facilities and released after TEPCO and a third-party organization confirmed that its quality met operational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

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

Measures to pump up groundwater flowing from the mountain side upstream of the Building to reduce the groundwater inflow (groundwater bypass) have been implemented.
The pumped up groundwater is temporarily stored in tanks and released after TEPCO and a third-party organization have confirmed that its quality meets operational targets.
Through periodical monitoring, pumping of wells and tanks is operated appropriately.
At the observation holes installed at a height equivalent to the buildings, the trend showing a decline in groundwater levels is checked.
The analytical results on groundwater inflow into the buildings based on existing data showed a declining trend.



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



To prevent the inflow of groundwater into the buildings, installation of impermeable walls on the land side is planned. Freezing started on the sea side and at a part of the mountain side from March 2016 and at 95% of the mountain side from June 2016. Freezing of the remaining unfrozen sections advanced with a phased approach and freezing of all sections started in August 2017.

In March 2018, construction of the land-side impermeable walls was completed, except for a portion of the depth, based on a monitoring result showing that the underground temperature had declined below 0℃ in almost all areas, while on the mountain side, the difference between the inside and outside increased to approx. 4-5 m. The 21st Committee on Countermeasures for Contaminated Water Treatment, held on March 7, 2018, evaluated that together with the function of sub-drains, etc., a water-level management system to stably control groundwater and isolate the buildings from it had been established and had allowed a significant reduction in the amount of contaminated water generated.

For the unfrozen depth, a supplementary method was implemented and it was confirmed that temperature of the part declined below 0℃ by September 2018. From February 2019, maintenance operation started at all sections.

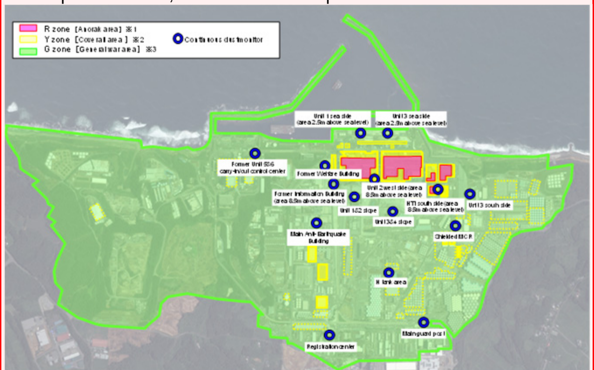
Progress toward decommissioning: Work to improve the environment within the site

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

Optimization of radioactive protective equipment

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

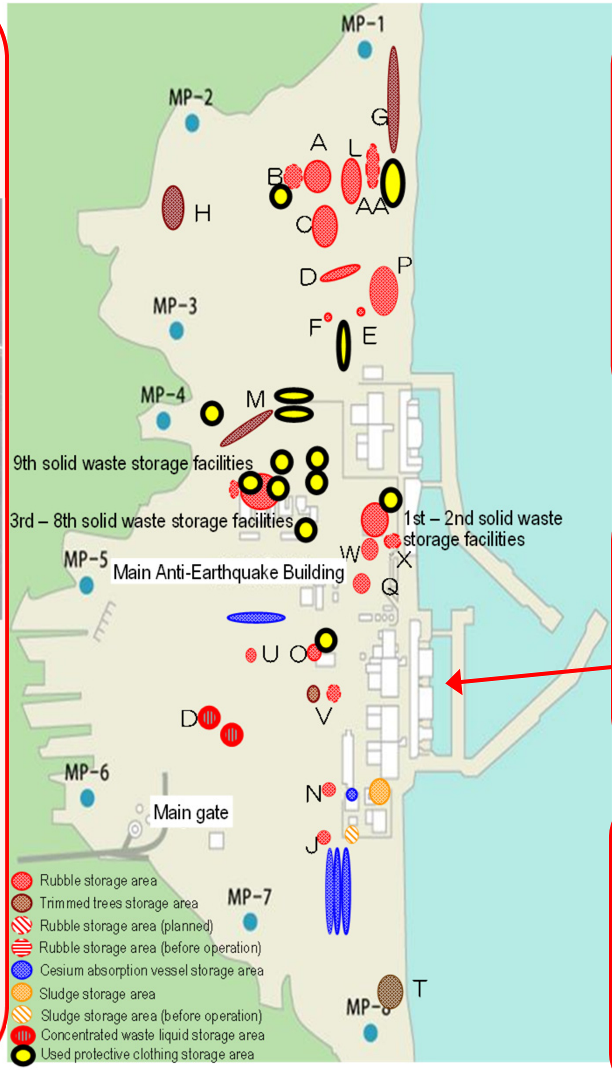
From March 2016, limited operation started. From March and September 2017, the G Zone was expanded.



※1 Inside Unit 1-3 Reactor Buildings, Unit 1-4 Turbine Buildings, and areas of surrounding buildings that contain accumulated water.
※2 Y zones with yellow dot-lines are for works related to contamination such as handling concentrated salt water, etc., where the same protective equipment as in G zone is required for patrol or site visits for work planning. In addition to the area specified above, when engaging in works related to high-dose dust (dismantling of buildings, etc.) or works related to tank transfer lines such as concentrated salt water, etc. In G zone, the area is temporarily designated as Y zone.
※3 In addition to the areas specified above, G zones also include a part of areas on the 2nd and 3rd floors of the common pool building.

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

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



Installation of dose-rate monitors

To help workers in the Fukushima Daiichi Nuclear Power Station precisely understand the conditions of their workplaces, a total of 86 dose-rate monitors were installed by January 4, 2016.

These monitors allow workers to confirm real time on-site dose rates at their workplaces.

Workers are also able to check concentrated data through large-scale displays installed in the Main Anti-Earthquake Building and the access control facility.

Installation of Dose-rate monitor

Installation of sea-side impermeable walls

To prevent the outflow of contaminated water into the sea, sea-side impermeable walls have been installed.

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

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

Status of the large rest house

A large rest house for workers was established and its operation commenced on May 31, 2015.

Spaces in the large rest house are also installed for office work and collective worker safety checks as well as taking rest.

On March 1, 2016 a convenience store opened in the large rest house. On April 11, operation of the shower room started. Efforts will continue to improve convenience of workers.