Summary of Decommissioning and Contaminated Water Management

April 25, 2019

Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

Main decommissioning work and steps

Fuel removal from the Unit 4 SFP was completed on December 22, 2014 and from the Unit 3 SFP is underway from April 15, 2019. Dust density 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 (Unit 3) → Fuel removal (Unit 4) → Storage and handling

Unit 1: Fuel removal scheduled to start in FY2023
Unit 2: Fuel removal scheduled to start in FY2023
Unit 3: Fuel removal scheduled to start around mid-FY2018*
Unit 4: Fuel removal completed in 2014

* Fuel removal started from April 15, 2019.

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

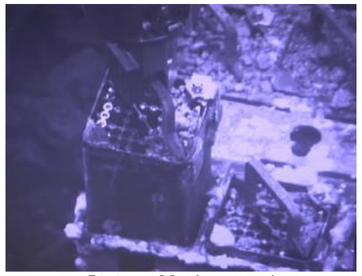
(Note 2) The method employed to retrieve fuel debris from the first unit will be confirmed in FY2019.

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

Toward fuel removal from the spent fuel pool

Toward fuel removal from the Unit 3 SFP, the rubble removal training, which was scheduled in conjunction with fuel removal training, started from March 15, 2019, and fuel removal started from April 15.

As measures to reduce the dose on the Reactor Building operating floor, decontamination and installation of shields were completed in June and December 2016, respectively. Installation of a fuel removal cover started in January 2017, and installation of all dome roofs was completed in February 2018.



Status of fuel removal (April 15, 2019)

Three principles behind contaminated water countermeasures

Countermeasures for contaminated water are implemented in accordance with the following three principles:

1 **Eliminate** contamination sources

① Multi-nuclide removal equipment, etc.
② Remove contaminated water from the trench (Note 3)

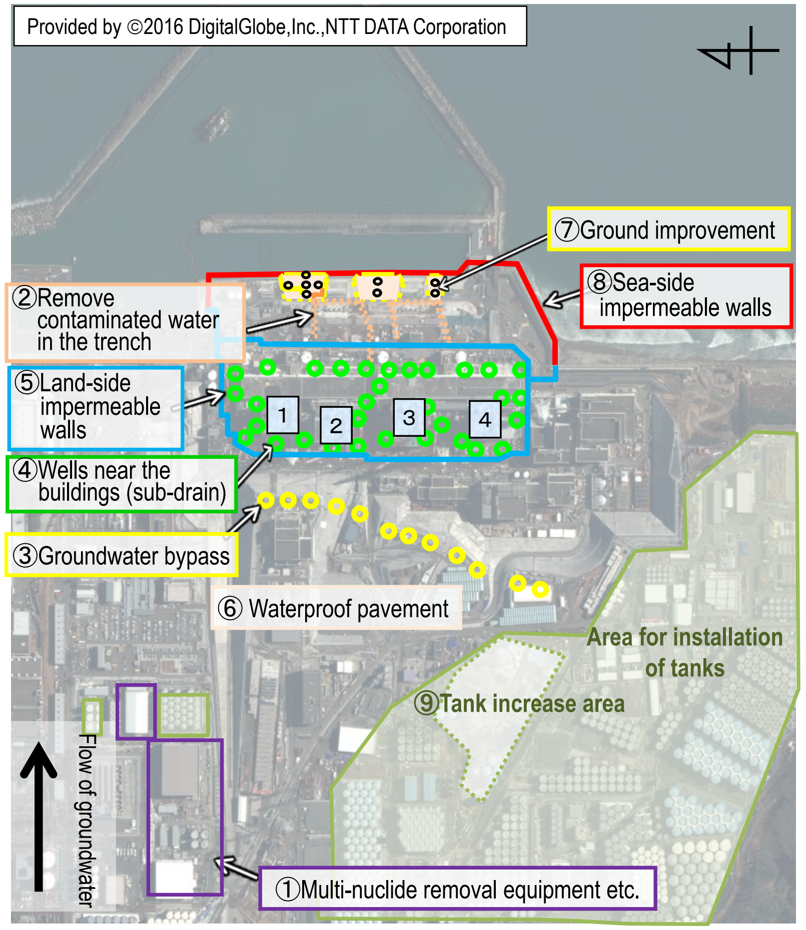
(Note 3) Underground tunnel containing pipes.

2. **Isolate** water from contamination

③ Pump up groundwater for bypass
④ Pump up groundwater near buildings
⑤ Land-side impermeable walls
⑥ Waterproof pavement

3. **Prevent leakage** of contaminated water

⑦ Enhance soil by adding sodium silicate
⑧ Sea-side impermeable walls
⑨ Increase the number of (welded-joint) tanks



Multi-nuclide removal equipment (ALPS), etc.

- This equipment removes radionuclides from the contaminated water in tanks and reduces risks.
- Treatment of contaminated water (RO concentrated salt water) was completed in May 2015 with multi-nuclide removal equipment, additional multi-nuclide removal equipment installed by TEPCO (operation commenced in September 2014) and a Japanese Government subsidy project (operation commenced in October 2014).
- Strontium-treated water from equipment other than ALPS is being re-treated in ALPS.

(High-performance multi-nuclide removal equipment)

Reducing generation of contaminated water through multi-layered measures

- Multi-layered measures are implemented to reduce inflow of rainwater and groundwater to buildings.
- Multi-layered contaminated water management measures, including land-side impermeable walls and subdrains, have kept the groundwater level low stably. The increase in contaminated water generation during rainfall is being suppressed by repairing damaged parts of building roofs, facing onsite, etc.
- Through these measures, generation of contaminated water was reduced from approx. 470 m^3/day (in FY2014) to approx. 170 m^3/day (in FY2018).
- The groundwater level around Unit 1-4 Reactor Buildings will continue to be maintained low through steady operation of land-side impermeable walls. In addition, measures to prevent rainwater inflow, including repairing damaged parts of building roofs and facing, continue to further reduce the generation of contaminated water.

Inside the land-side impermeable wall

Outside the land-side impermeable wall

Replacing flanged tanks with welded-joint tanks

- Replacement of flanged tanks with more reliable welded-joint tanks is underway.
- Strontium-treated water stored in flanged tanks was purified and transferred to welded-joint tanks. The transfer was completed in November 2018. Transfer of ALPS-treated water was completed in March 2019.

(Installed welded-joint tanks)

Progress Status and Future Challenges of the Mid-and-Long-Term Roadmap toward Decommissioning of TEPCO Holdings Fukushima Daiichi Nuclear Power Station (Outline)

Progress status

◆ The temperatures of the Reactor Pressure Vessel (RPV) and Primary Containment Vessel (PCV) of Units 1-3 have been maintained within the range of approx. 15-25°C*1 over the past month. There was no significant change in the density of radioactive materials newly released from Reactor Buildings into the air*2. It was concluded that the comprehensive cold shutdown condition had been maintained.

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

* 2 In March 2019, the radiation exposure dose due to the release of radioactive materials from the Unit 1-4 Reactor Buildings was evaluated at less than 0.00022 mSv/year at the site boundary. The annual radiation dose from natural radiation is approx. 2.1 mSv/year (average in Japan).

Start of work to create an access route for the internal investigation of the Unit 1 PCV

As part of work to create an access route for the internal investigation of the Primary Containment Vessel (PCV), scheduled for the 1st half of FY2019, drilling on the outside of X-2 penetration* started on April 8, 2019.

Throughout the work to create an access route, boundaries will be secured as was done in the previous internal investigations of the PCV.

To prevent any influence on the surrounding environment, the PCV will be depressurized as a measure to further reduce the risk of dust being released. In addition, the temperature and pressure inside the PCV and dust density in the work area, etc. will be monitored appropriately.

* X-2 penetration: A penetration with doors via which workers enter or exit the PCV.

Test to check the cooling condition of Unit 2 fuel debris

A water injection reduction test (STEP 1) was conducted, in which water injection rate into the reactor was temporarily changed to check for temperature variation closer to the actual status while taking the heat release to air into consideration (April 2-16).

When the reactor injection rate was changed from 3.0 to 1.5 m³/h, the maximum temperature increase at the Reactor Pressure Vessel (RPV) bottom was up to about 5°C*. It was confirmed that the overall temperature variation including other parameters was almost within expectations. Based on the results of this test, the second test to suspend water injection for about seven hours (STEP 2) will be conducted from mid-May 2019.

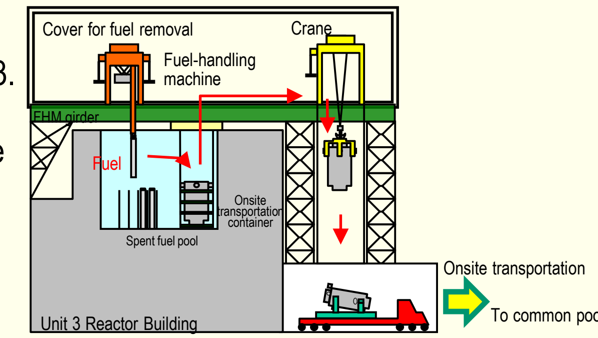
Based on the results of these two tests, using the heat balance evaluation which conveys the actual status more accurately, improvement will be made including optimizing the emergency response procedures.

* Temperature at the beginning of the test: about 20°C

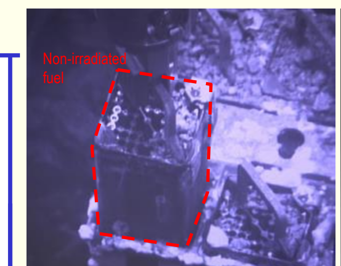
Start of fuel removal from the Unit 3 SFP

From April 15, removal of 514 spent fuel assemblies and 52 non-irradiated fuel assemblies (a total of 566 assemblies) stored in the Unit 3 spent fuel pool started. Seven non-irradiated fuel assemblies were then loaded in the transportation container and transportation to the common pool was completed on April 23.

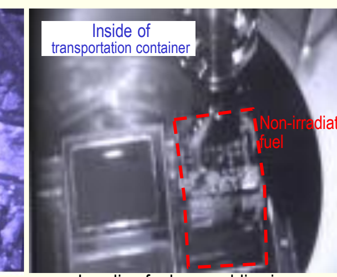
After reviewing fuel removal on this occasion, improving the procedures as required and providing more training, fuel removal (for the second time onward) will be implemented.



Overview of fuel removal work



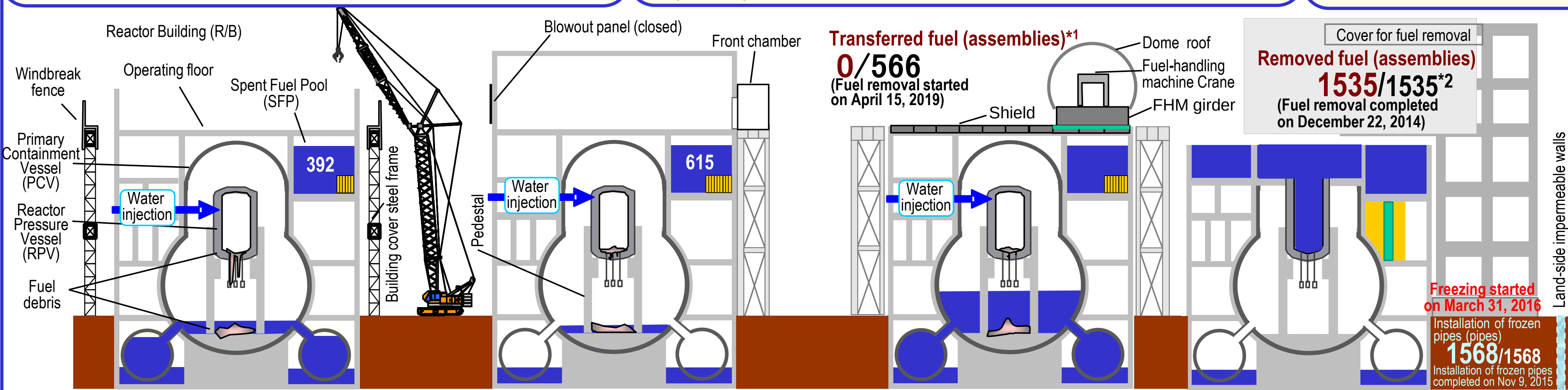
Extracting fuel assemblies



Loading fuel assemblies in transportation container


Removing rubble


After removing rubble



*1 Fuel assemblies stored in the rack of the common pool

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

Measures for hydrogen sulfide at welded-joint tanks storing strontium-treated water

In October 2018, generation of hydrogen sulfide was detected at some welded-joint tanks storing strontium-treated (Sr-treated) water.

A tank was selected and inspected inside, whereupon considerable sludge was found at the bottom. After investigating the cause, the generation of hydrogen sulfide was considered attributable to sludge mixed in Sr-treated water during desalination, which created an anaerobic environment inside the tanks and activated sulphate-reducing bacteria. For other strontium-treated water tanks, water will also be removed and sludge collected. They will be reused to store water treated at ALPS.

Completion of assembling the equipment toward dismantling the Unit 1/2 exhaust stack

The demonstration test of the dismantling equipment STEP 3 (verification of work procedures), which had been conducted since February, was completed on April 2. Before starting the dismantling work from mid-May, the dismantling equipment was transferred to the site and its assembly completed on April 25 to comprehensively check its operation.

On April 13 and 18, as an investigation prior to dismantling, the radiation dose inside and outside the stack was measured and the status inspected using a camera to confirm that no abnormality likely to interfere with the present dismantling plan.


Assembly of dismantling equipment

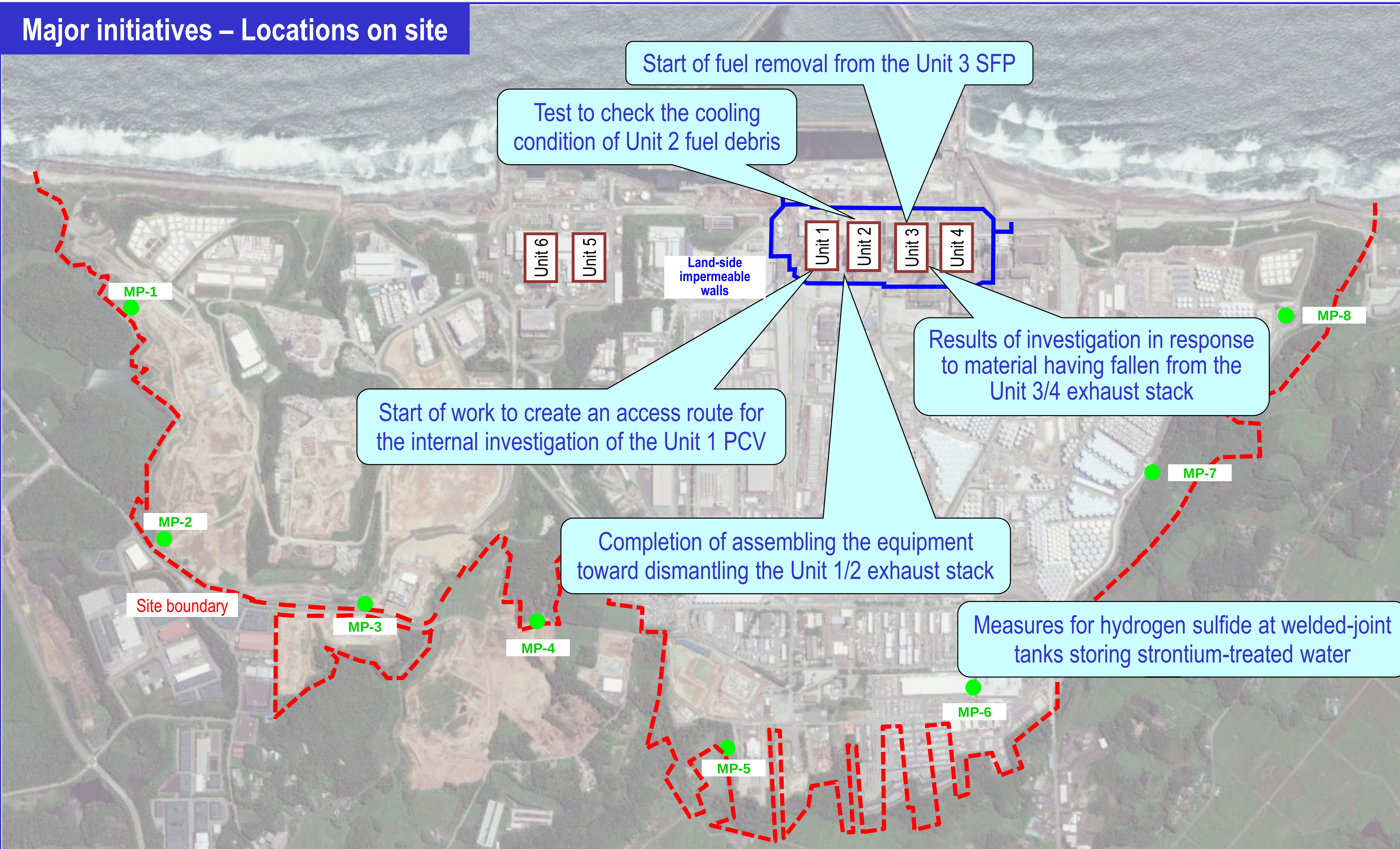
Results of investigation in response to material having fallen from the Unit 3/4 exhaust stack

In response to the detection of scaffold material having fallen from the Unit 3/4 exhaust stack in January 2019, zoning and entry restrictions were immediately implemented at four onsite exhaust stacks, including the area of the above stack and safe passages installed within March 2019.

The Unit 3/4 exhaust stack and the Turbine Building centralized exhaust stack were investigated using a drone to check their corrosion status at potentially degraded parts detected by photos taken from the ground. The investigation detected degradation in some similar scaffold materials but confirmed that they were not in a condition that may immediately lead to falling (on March 8, 19 and April 10).

A measurement also conducted showed that the radiation dose around the above exhaust stack was 0.02-0.3 mSv/h (on April 10). Based on these results, measures to reduce the risk of falling will be examined.

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 0.387 – 1.419 μSv/h (March 27 to April 23, 2019).

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.

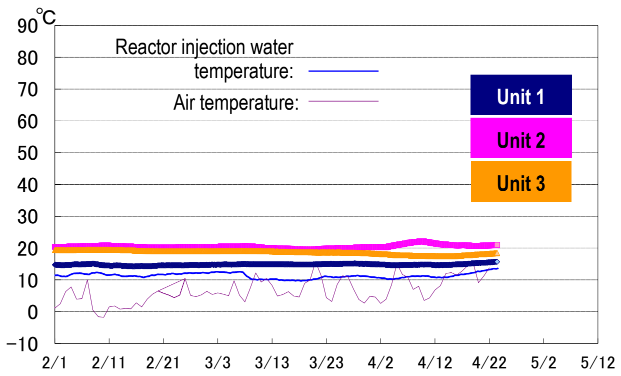
Therefore, monitoring results at these points are lower than elsewhere in the power plant site.

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.

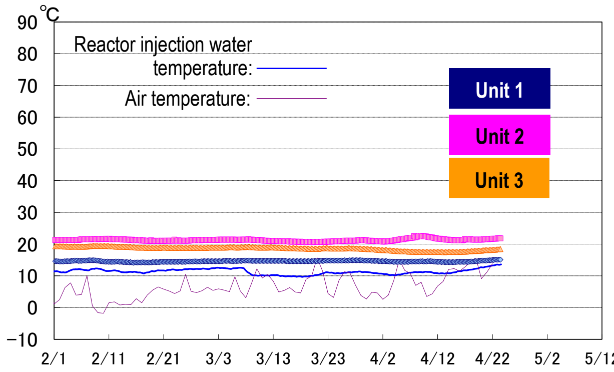
I. Confirmation of the reactor conditions

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



RPV bottom temperatures (recent quarter)



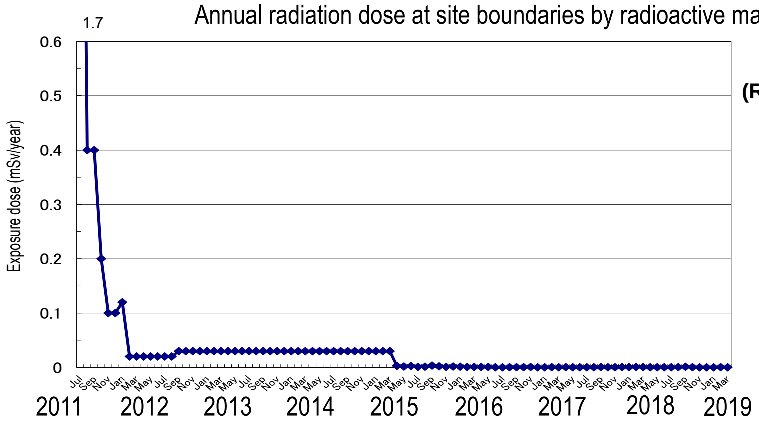
PCV gas phase temperatures (recent quarter)

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

2. Release of radioactive materials from the Reactor Buildings

As of March 2019, the density of radioactive materials newly released from Reactor Building Units 1-4 into the air and measured at the site boundary was evaluated at approx. 1.9×10^{-12} and 3.1×10^{-12} Bq/cm³ for Cs-134 and -137 respectively, while the radiation exposure dose due to the release of radioactive materials there was less than 0.00022 mSv/year.

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



(Reference)

* The density limit of radioactive materials in the air outside the surrounding monitoring area:
[Cs-134]: 2 x 10^{-5} Bq/cm³
[Cs-137]: 3 x 10^{-5} Bq/cm³

* Data of Monitoring Posts (MP1-MP8).
Data of Monitoring Posts (MPs) measuring the airborne radiation rate around the site boundary showed 0.387 – 1.491 μSv/h (March 27- April 23, 2019).
To measure the variation in the airborne radiation rate of MP2-MP8 more accurately, environmental improvement (tree trimming, removal of surface soil and shielding around the MPs) was completed.

Note: 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.

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 abnormality 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.

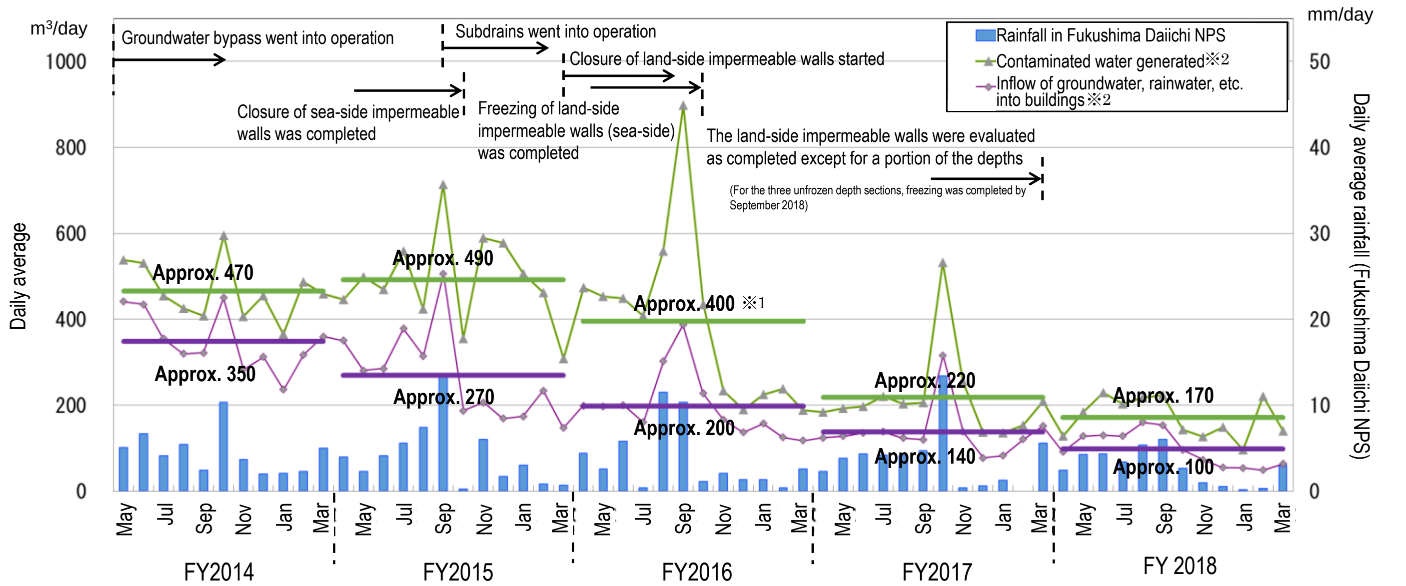
II. Progress status by each plan

1. Contaminated water management

To tackle the increase in contaminated water due to groundwater inflow, fundamental measures to prevent such inflow into the Reactor Buildings will be implemented, while improving the decontamination capability of water treatment and preparing facilities to control the contaminated water

➢ 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, reduced the groundwater inflow into buildings.
- Following the steady implementation of "isolation" measures (groundwater bypass subdrains, frozen walls, etc.), the inflow reduced from approx. 470 m³/day (the FY2014 average) when the measures were first launched to approx. 170 m³/day (the FY2018 average), though it varied depending on rainfall, etc.
- 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, etc. 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 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 April 23, 2019, 461,584 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.

➢ 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 onwards. Up until April 23, 2019, a total of 672,584 m³ had been drained after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Due to the rising water level of the groundwater drain pond after the sea-side impermeable walls had been closed, pumping started on November 5, 2015. Up until April 23, 2019, a total of approx. 199,281 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 March 14 - April 17, 2019).
- As one of the multi-layered contaminated water management measures, in addition to waterproof pavement (facing; as of the end of March 2019, approx. 94% of the planned area was completed) to prevent rainwater infiltrating the ground, etc., facilities to enhance the subdrain treatment system were installed and went into operation from April 2018, increasing the treatment capacity 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 at the peak time.
- To maintain the level of groundwater pumped up from the subdrains, work to install additional subdrain pits and recover those already in place is underway. The additional pits are scheduled to begin operation sequentially from a pit for which work was completed (12 of 14 pits went into operation). For recovered pits, work for all three pits

scheduled was completed, which went into operation from December 26, 2018 (3 of 3 pits went into operation).

- 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 into 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.

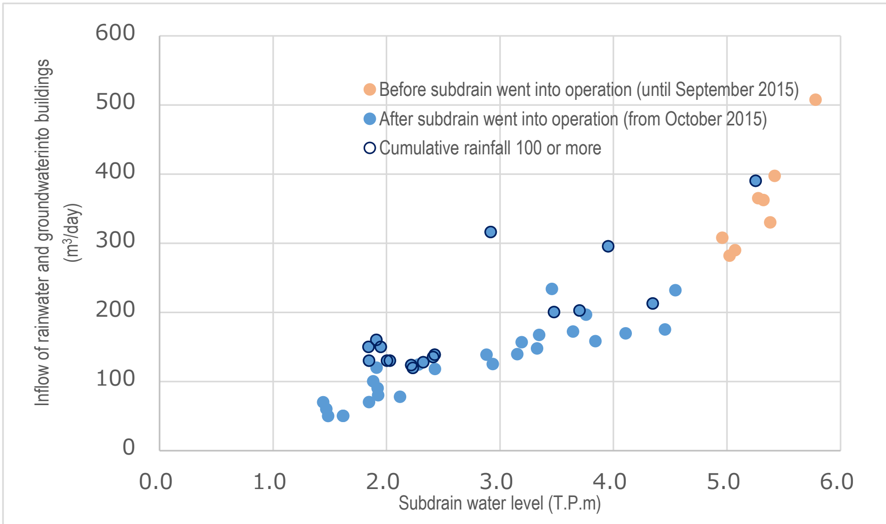


Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Unit 1-4 subdrains

➢ Construction status of the land-side impermeable walls

- 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 frozen soil of sufficient thickness was identified. The scope of the maintenance operation was expanded in March 2018.
- In March 2018, the land-side impermeable walls were considered 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 between the inside and outside increased to approx. 4-5 m. Multi-layered contaminated water management measures, including subdrains and facing, have kept the groundwater level stable. Consequently, a water-level management system to isolate the buildings from the groundwater was considered to have been established. The Committee on Countermeasures for Contaminated Water Treatment, held on March 7, 2018, clearly recognized the effect of the land-side impermeable walls in shielding the groundwater and evaluated that the land-side impermeable walls had allowed a significant reduction in the amount of contaminated water generated.

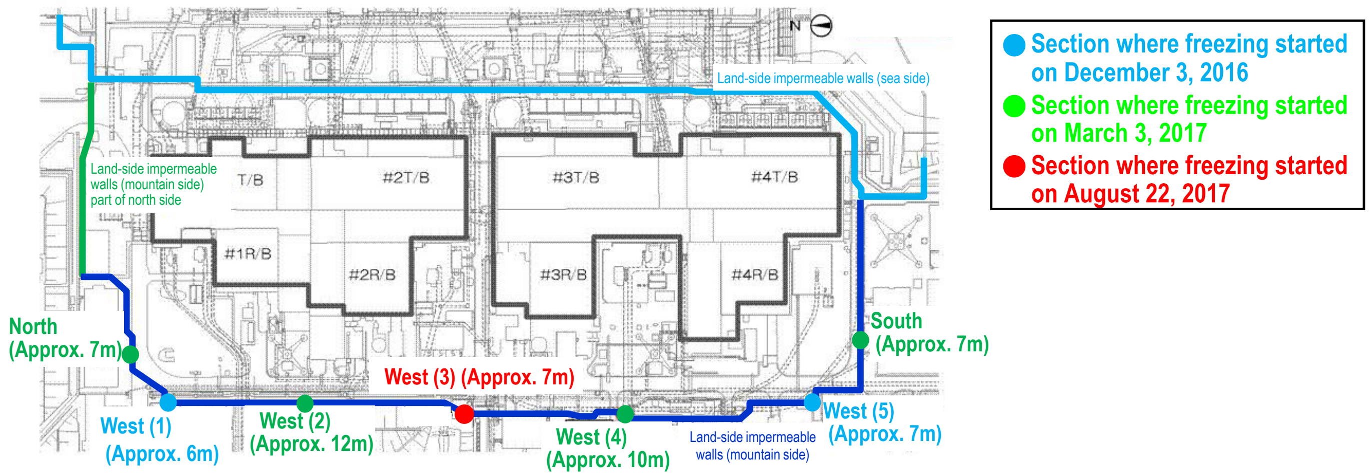


Figure 3: Closure of part of the land-side impermeable walls (on the mountain side)

➢ Operation of multi-nuclide removal equipment

- Regarding the multi-nuclide removal equipment (existing and high-performance), hot tests using radioactive water were 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 April 18, 2019, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 405,000, 542,000 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 April 18, 2019, approx. 578,000 m³ had been treated.

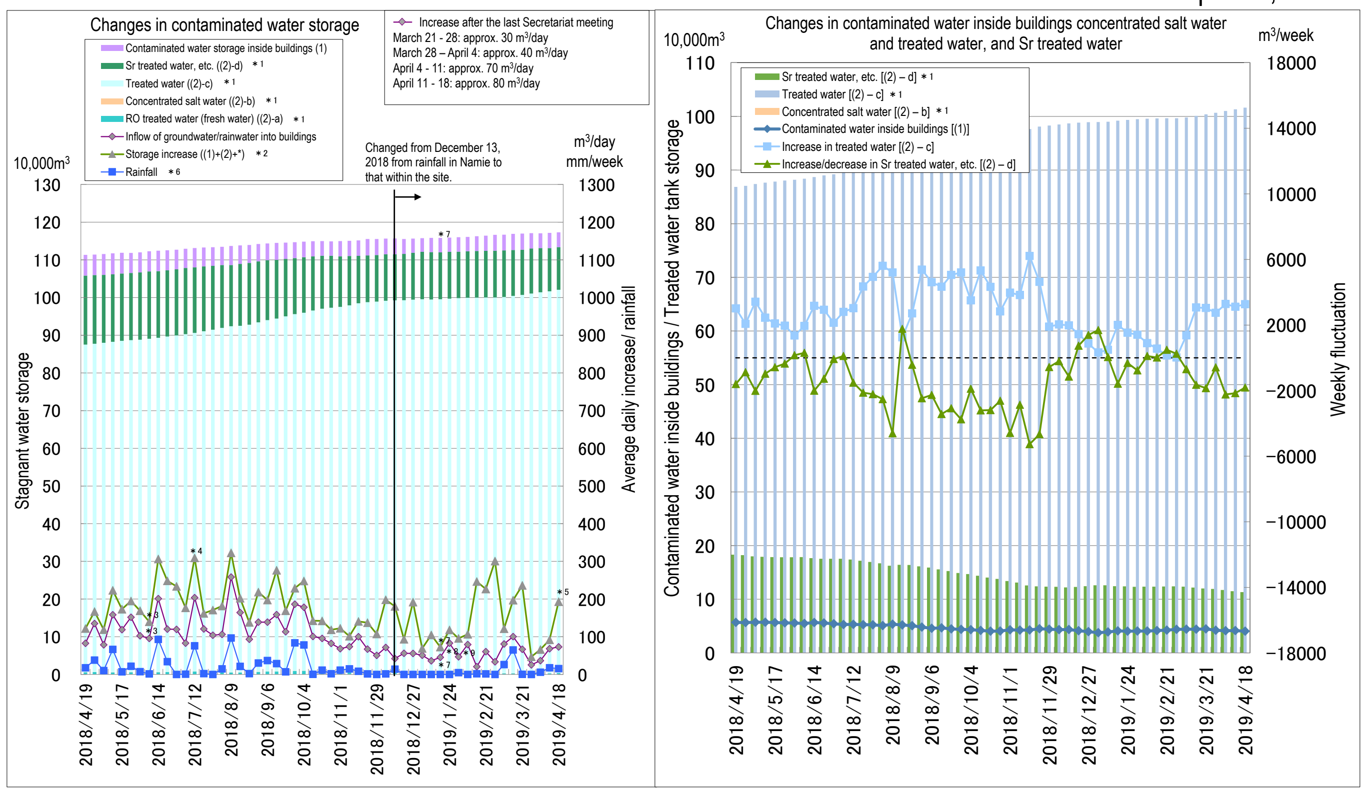
➢ Toward reducing the risk of contaminated water stored in tanks

- Treatment measures comprising the removal of strontium by cesium-adsorption apparatus (KURION) (from January 6, 2015) and the secondary cesium-adsorption apparatus (SARRY) (from December 26, 2014) have been underway. Up until April 18, 2019, approx. 514,000 m³ had been treated.

➢ Measures in the Tank Area

- Rainwater, under the release standard and having accumulated within the fenced-in area of the contaminated water tank area, was sprinkled on site after eliminating radioactive materials using rainwater-treatment equipment since May 21, 2014 (as of April 22, 2019, a total of 125,631 m³).

As of April 18, 2019



*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: Reevaluated based on the revised calculation formula for contaminated water storage volume in Unit 2-4 Turbine Building seawater system pipe trenches.
(Period of reevaluation: December 28, 2017 – June 7, 2018)
*4: Reevaluated based on the revised method to manage the transfer volume from the Unit 1 seawater pipe trench. (Period of reevaluation: May 31 – June 28, 2018)
*5: The storage amount increased due to transfer to buildings in association with the decommissioning work.
(The transferred amount comprised (①Transfer from On-site Bunker Building to Process Main Building: approx. 90 m³/day, ②Transfer from wells and groundwater drains: approx.13 m³/day, ③ALPS waste chemical: 8 m³/day, etc.)
*6: Changed from December 13, 2018 from rainfall in Namie to that within the site.
*7: Since January 17, 2019, Unit 3 C/B contaminated water has been managed in addition to contaminated water storage in buildings. For inflow of groundwater, rainwater, etc.to buildings and increase in storage have been reflected since January 24, 2019.
*8: Considered attributable to the increased inflow of groundwater, rainwater, etc. to buildings due to the decline in the level of contaminated water in buildings on January 17, 2019.
*9: Water-level gauges were replaced (February 7 – March 7, 2019)

Figure 4: Status of contaminated water storage

➢ Investigation into inflow parts to the Onsite Bunker Building and future measures

- For the Onsite Bunker Building, where an ongoing increase since mid-November 2018 was confirmed, inflow parts were investigated.
- The investigation to date detected an area where water remained on the first basement floor. On April 19, 2019, water in this area was removed and an investigation into water level variation, etc. confirmed no water level increase and water flow.
- As a procedure to identify inflow parts, closure of inflow pipes is being examined. At the first step, the effectiveness of the closure will be verified by a mockup test, while a non-destructive method to identify inflow parts will also be examined alongside.

➢ Investigative results of tanks storing strontium-treated water in which hydrogen sulfide was detected

- In October 2018, generation of hydrogen sulfide was detected at some welded-joint tanks storing strontium-treated water.
- A tank was selected and inspected inside, whereupon considerable sludge was found at the bottom. After investigating the cause, the generation of hydrogen sulfide was considered attributable to sludge mixed in strontium-treated water during desalination, which created an anaerobic environment inside the tanks and activated sulphate-reducing bacteria.
- For other strontium-treated water tanks, water will also be removed and sludge collected. They will be reused to store water treated at multi-nuclide removal equipment.

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

- The installation of windbreak fences, which will reduce dust scattering during rubble removal, started on October 31, 2017 and was completed by December 19, 2017.
- From January 22, 2018, as work to prepare for fuel removal from the spent fuel pool, rubble removal on the north side of the operating floor started. Rubble is being removed carefully by suction equipment. No significant variation was identified around the site boundaries where the density of radioactive materials was monitored and at onsite dust monitors during the above removal work. Once removed, rubble is stored in solid waste storage facilities or other storage areas depending on the dose level.
- Before formulating a plan to remove rubble around the spent fuel pool, an onsite investigation started from July 23, 2018 and was completed on August 2, 2018.
- To create an access route for preparatory work to protect the spent fuel pool, etc., work to remove four sections of X-braces (one each on the west and south sides and two on the east side, respectively) started from September 19, 2018 and all planned four sections had been removed by December 20, 2018.
- On March 6, 2019, the creation of an access route from the west working floor was completed and the floor opening was covered to prevent small rubble falling from the operating floor during the work.
- From March 18, 2019, the removal of small rubble in the east-side area around the SFP started as an initial step using pliers and suction equipment. From April 2, 2019, rubble removal in the same area started using a remote-controlled heavy machine.
- To grasp the characteristics of dust generated while removing rubble over the reactor building operating floor, the dust particle size distribution will be measured in May 2019.

➢ Main work to help spent fuel removal at Unit 2

- On November 6, 2018, before the investigation toward formulating a work plan to dismantle the Reactor Building rooftop, etc., 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 the ceiling inside the operating floor and confirm the contamination status was completed. After analyzing the investigative results, the "contamination density distribution" throughout the entire operating floor was obtained, based on which the airborne radiation dose rate inside the operating floor could be evaluated. A shielding design and measures to prevent radioactive material scattering, etc. will be examined.
- From April 8, 2019, work to move and contain the remaining objects on the operating floor (2nd round), such as materials and equipment which may hinder the work toward fuel removal, started. The 2nd round included placing remaining objects in the container and cleaning the floor to suppress dust scattering, which were not scheduled in the 1st round. The status of dust density, etc. is monitored to steadily implement the work with safety first.

➢ Main process to help fuel removal at Unit 3

- Regarding the fuel-handling machine (FHM) and crane, consecutive defects have occurred since the test operation started on March 15, 2018.
- On August 8, 2018, an alarm was issued during the pre-operation inspection of the FHM, whereupon operation was suspended. This was attributable to disconnection due to corrosion by rainwater ingress into the cable connection. Abnormalities were also detected in several control cables.
- On August 15, 2018, an alarm of the crane was issued during work to clear materials and equipment and operation was suspended.
- On September 29, 2018, to determine the risks of defects in fuel-handling facilities, the FHM was temporarily recovered and a safety inspection (operation check and facility inspection) started. For 14 defects detected in the safety inspection, measures were completed on January 27, 2019.
- On February 8, 2019, a function check after cable replacement was completed.
- On February 14, 2019, review of recovery measures in the event of defect occurrence, etc. and training for fuel removal using dummy fuel and the transport container started. During the training, seven defects were detected, although it was confirmed that these did not constitute safety problems that could lead to fuel, rubble, etc. falling
- From March 15, 2019, the rubble removal training inside the pool started.
- From April 15, 2019, removal of 514 spent fuel assemblies and 52 non-irradiated fuel assemblies (a total of 566 assemblies) stored in the spent fuel pool started. Seven non-irradiated fuel assemblies were then loaded in the transport container and transportation to the common pool was completed on April 23, 2019.
- After reviewing fuel removal on this occasion, improving the procedures as required and providing more training, fuel removal (for the second time onward) will be implemented. The dust density in the surrounding environment is being monitored and work implemented with safety first.

➢ Progress status toward dismantling the Unit 1/2 exhaust stack

- Toward dismantling of the Unit 1/2 exhaust stack, the demonstration test of the dismantling equipment STEP 3 (verification of work procedures), which had been conducted since February 2019, was completed on April 2, 2019.
- On April 13 and 18, 2019, as an investigation prior to dismantling, the radiation dose inside and outside the stack was measured and the status inspected using a camera to confirm no abnormality likely to interfere with the present dismantling plan.
- Before starting the dismantling work from mid-May 2019, the dismantling equipment was transferred to the site and its assembly completed on April 25, 2019 to comprehensively check its operation.

➢ Measures in response to material having fallen from the Unit 3/4 exhaust stack

- In response to the detection of scaffold material having fallen from the Unit 3/4 exhaust stack on January 2019, zoning and entry restrictions were immediately implemented at four onsite exhaust stacks, including the area of the above stack and safe passages installed within March 2019.
- On March 8, 19 and April 10, 2019, the Unit 3/4 exhaust stack and the Turbine Building centralized exhaust stack were investigated using a drone to check their corrosion status at potentially degraded parts detected by photos taken from the ground. The investigation detected degradation in some similar scaffold materials but confirmed that they were not in a condition that may immediately lead to falling.

- A measurement conducted on April 10, 2019 showed that the radiation dose around the above exhaust stack was 0.02-0.3 mSv/h.
- Based on these results, measures to reduce the risk of falling will be examined.

3. Retrieval of fuel debris

➢ Work to create an access route for internal investigation of the Unit 1 PCV

- As part of work to create an access route for the internal investigation of the Primary Containment Vessel (PCV), scheduled for the 1st half of FY2019, drilling on the outside of X-2 penetration, a penetration with doors through which workers enter or exit the PCV, started on April 8, 2019.
- Throughout the work to create an access route, boundaries will be secured, as was done in the previous internal investigations of the PCV. To prevent any influence on the surrounding environment, the PCV will be depressurized as a measure to further reduce the risk of dust being released. In addition, the temperature and pressure inside the PCV and dust density in the work area, etc. will be monitored appropriately.

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 March 2019, the total storage volume of concrete and metal rubble was approx. 266,800 m³ (+2,800 m³ compared to at the end of February with an area-occupation rate of 67%). The total storage volume of trimmed trees was approx. 134,100 m³ (with a slight increase, with an area-occupation rate of 76%). The total storage volume of used protective clothing was approx. 56,000 m³ (+500 m³, with an area-occupation rate of 82%). The increase in rubble was mainly attributable to tank-related construction. The increase in used protective clothing was attributable to the acceptance of used protective clothing.

➢ Management status of secondary waste from water treatment

- As of April 4, 2019, the total storage volume of waste sludge was 597 m³ (area-occupation rate: 85%), while that of concentrated waste fluid was 9,330 m³ (area-occupation rate: 91%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment, etc., was 4,332 (area-occupation rate: 68%).

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

➢ Results of the test (STEP 1) to check the cooling condition of the Unit 2 fuel debris

- During the period April 2-16, 2019, a water injection reduction test (STEP 1) was conducted, in which the water injection rate into the reactor was temporarily changed to check for temperature variation closer to the actual status while taking the heat release to air into consideration.
- When the reactor injection rate was changed from 3.0 to 1.5 m³/h, the maximum temperature increase at the RPV bottom was up to about 5℃ as compared to about 20℃ at the test start. It was confirmed that the overall temperature variation, including other parameters, was almost within expectations.
- Based on the results of this test, the second test to suspend water injection for about seven hours (STEP 2) will be conducted from mid-May 2019.
- Based on the results of these two tests, and using the heat balance evaluation which conveys the actual status more accurately, improvements will be made, including optimizing the emergency response procedures.

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

- At No. 1-6, the H-3 density has been repeatedly declining and increasing since March 2018 and currently stands at around 2,200 Bq/L.
- At No. 1-8, the H-3 density had been increasing from around 2,000 Bq/L since December 2018 and currently stands at around 3,200 Bq/L.
- At No. 1-12, the density of gross β radioactive materials had been decreasing from around 800 Bq/L since September 2018 to around 200 Bq/L. It has since been increasing and currently stands at around 2,300 Bq/L. Since August 15, 2013, pumping of groundwater continued (at the well point between the Unit 1 and 2 intakes: August 15, 2013 – October 13, 2015 and from October 24; at the repaired well: October 14 - 23, 2015).
- At No. 2-3, the density of gross β radioactive materials had been increasing from around 600 Bq/L since December 2017 and currently stands at around 8,300 Bq/L.
- At No. 2-5, the H-3 density had been increasing from around 1,200 Bq/L since December 2018 and currently stands at around 2,300 Bq/L. The density of gross β radioactive materials at the same point had been increasing from around 30,000 Bq/L since December 2018 and currently stands at around 53,000 Bq/L. Since December 18, 2013, pumping of groundwater continued (at the well point between the Unit 2 and 3 intakes: December 18, 2013 - October 13, 2015; at the repaired well: from October 14, 2015).
- In the Unit 1-4 intake open channel area, densities of radioactive materials in seawater have remained below the legal discharge limit except for the increase in Cs-137 and Sr-90 during rain. They have also been declining following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls. The density of Cs-137 has been decreasing since March 20, 2019, when the silt fence was transferred to the center of the open channel.
- In the area within the port, densities of radioactive materials in seawater have remained below the legal discharge limit, except for the increase in Cs-137 and Sr-90 during rain. They have been below the level of those in the Unit 1-4 intake open channel area and have 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 densities of radioactive materials in seawater, those of Cs-137 and Sr-90 declined and remained low following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls.

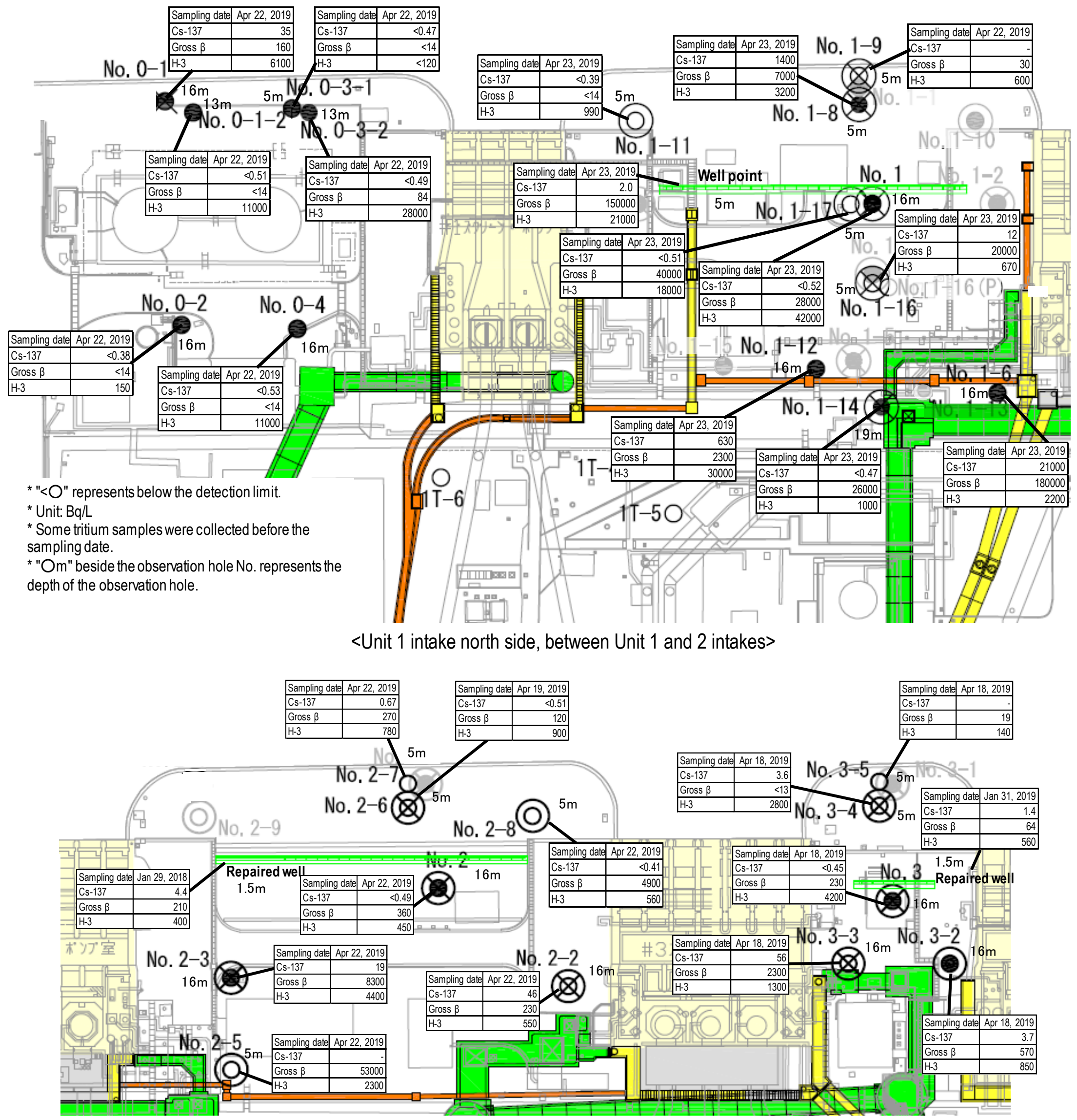


Figure 5: Groundwater density on the Turbine Building east side

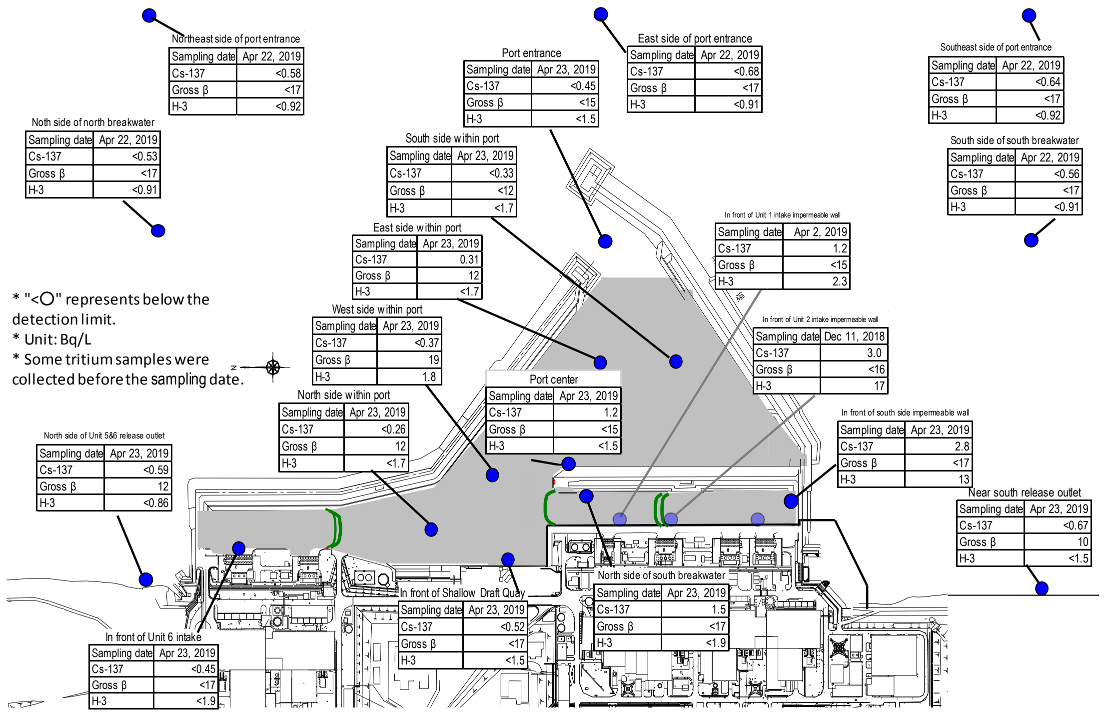


Figure 6: Seawater density around the port

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

Securing appropriate staff long-term while thoroughly implementing workers' exposure dose control. Improving the work environment and labor conditions continuously based on an understanding of workers' on-site needs

➢ 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 December 2018 to February 2019 was approx. 9,500 (TEPCO and partner company workers), which exceeded the monthly average number of actual workers (approx. 7,200). 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 May 2019 (approx. 4,210 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. 3,900 to 6,200 since FY2016 (see Figure 7).
- The number of workers decreased from both within and outside Fukushima Prefecture. The local employment ratio (TEPCO and partner company workers) as of March 2019 has remained constant at around 60%.
- The monthly average exposure dose of workers remained at approx. 0.59 mSv/month during FY2015, approx. 0.39 mSv/month during FY2016 and approx. 0.36 mSv/month during FY2017. (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.

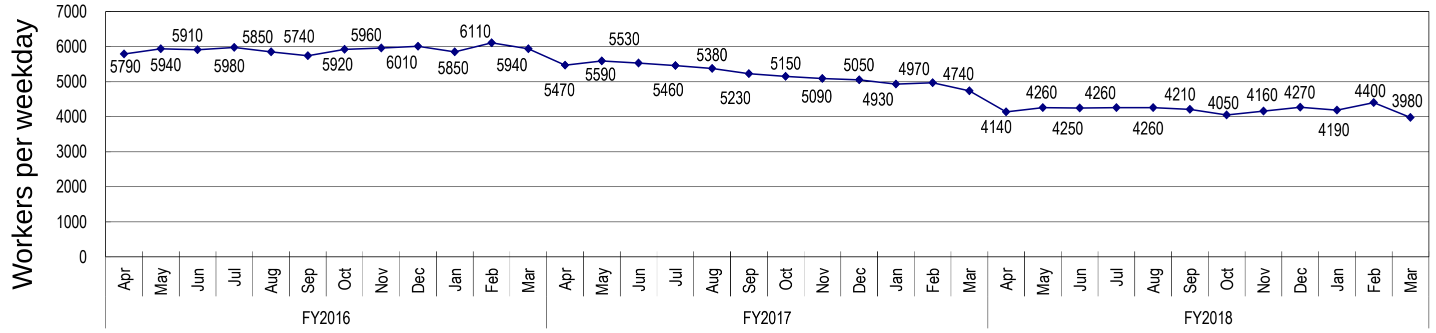


Figure 7: Changes in the average number of workers per weekday for each month since FY2016 (actual values)

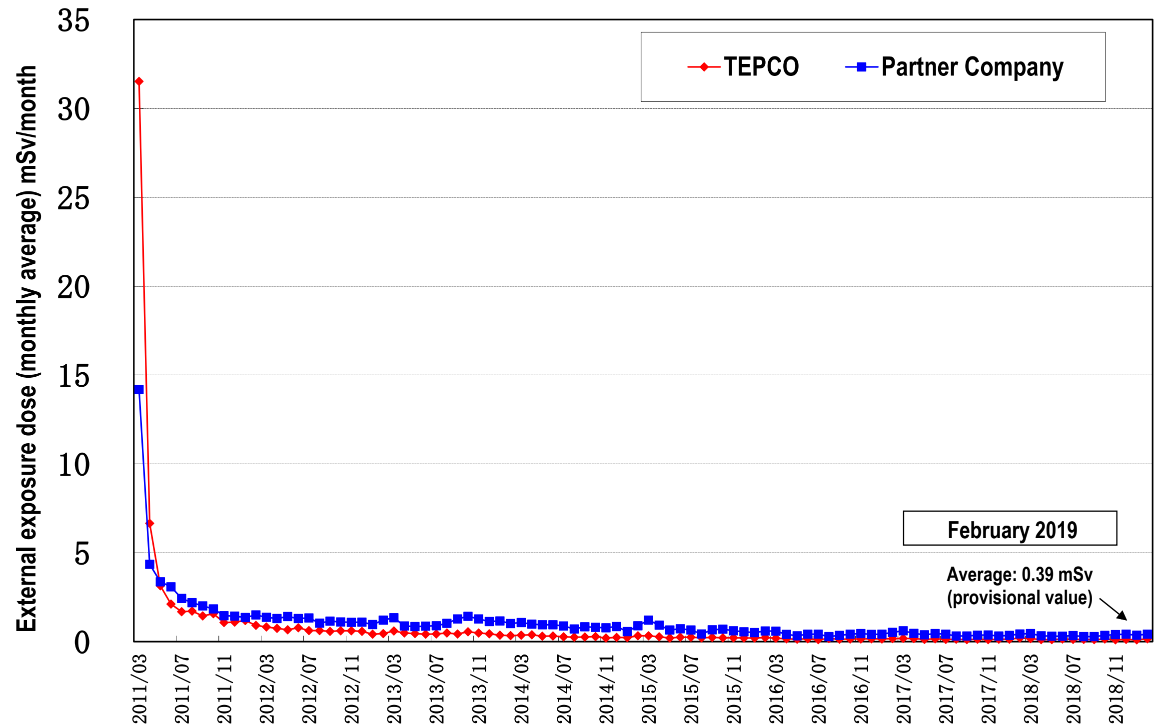


Figure 8: Changes in monthly individual worker exposure dose
(monthly average exposure dose since March 2011)

- Measures to prevent infection and expansion of influenza and norovirus
  - Since November 2018, measures for influenza and norovirus have been implemented, including free influenza vaccinations (subsidized by TEPCO HD) at the Fukushima Daiichi Nuclear Power Station (from October 24 to November 30, 2018) and medical clinics around the site (from November 1, 2018 to January 31, 2019) for partner company workers. As of January 31, 2019, a total of 6,330 workers had been vaccinated. In addition, a comprehensive range of other measures is also being implemented, including daily actions to prevent infection and expansion (measuring body temperature, health checks and monitoring infection status) and response after detecting possible infections (swift exit of potentially affected personnel and control of entry, mandatory mask-wearing in working spaces, etc.).
- Status of influenza and norovirus cases
  - Until the 16th week of 2019 (April 15-21, 2019), 310 influenza infections and 15 norovirus infections were recorded. The totals for the same period for the previous season showed 317 cases of influenza and 11 norovirus infections.
- FY2018 accident occurrence status and FY2019 safety activity plan
  - The number of work accidents in FY2018 increased to 21 from 17 in the previous fiscal year. Issues such as an increased number of accidents and two accidents involving serious injuries (incapacitating the persons concerned from work for 14 days or more) need to be analyzed and ongoing accident prevention measures must be reviewed and improved.
  - The number of heat stroke cases in FY2018 increased to eight from six the previous fiscal year. The previous fiscal year had an unusually hot summer, with six of the above eight cases having occurred during breaks or after rather than during work. Based on these factors, ongoing measures to prevent heat stroke cases, such as limiting continuous work time using the WBGT value, were considered effective.
  - In FY2019, safety activities will be implemented focused on “raising and infiltrating safety awareness,” “improving skills of safety management” and “improving safety activities such as TBM-KY risk assessment”. In addition, measures to prevent heat stroke cases at the time of drastic temperature changes, will also be enhanced to eliminate accidents causing injury or death.
- Health management of workers in the Fukushima Daiichi NPS
  - As health management measures in line with the guidelines of the Ministry of Health, Labour and Welfare (issued in August 2015), a scheme was established and operated, whereby primary contractors confirmed reexamination at medical institutions and the subsequent status of workers who are diagnosed as requiring “detailed examination and treatment” in the health checkup, with TEPCO confirming the operation status by the primary contractors.
  - The recent report on the management status of the health checkup during the third quarter (October – December) in FY2018 confirmed that the primary contractors had provided appropriate guidance and properly managed the operation under the scheme. The report on the follow-up status during the second quarter in FY2018 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. Checking of operations will continue.

8. Others

- Progress status of the work to reduce the risk of tsunamis, etc. to the mega float
  - During the period November 12, 2018 to April 24, 2019, a defense embankment was installed in the Unit 1-4 intake open channels to protect the sea-side impermeable walls before transferring the mega float.
  - Following this work, Step 1 for relocation of the mega float consisting of “transfer of the mega float,” “treatment of ballast water and internal decontamination” and “work to create a bottom-seated mound” commenced.
  - Work to reduce the risk of tsunamis by transferring the mega float and seating it on the mound will be completed in around the 1st half of FY2020. Effective use of the mega float as a bank and Shallow Draft Quay will start within FY2021.
- Certificates of gratitude offered to the work teams having rendered distinguished services in decommissioning and contaminated water management
  - Certificates of gratitude were offered to work teams, which boldly took on difficult challenges and rendered distinguished services, from the Prime Minister, the Minister of Economy, Trade and Industry and the State Minister of METI (Chief of Onsite Task Force for Nuclear Disasters).
  - The certificates of gratitude from the Prime Minister were awarded by Prime Minister Shinzo Abe on April 14 at the ceremony held during his visit to the Fukushima Daiichi NPS. The certificates of gratitude from the METI Minister and the Chief of Onsite Task Force for Nuclear Disasters were awarded by METI State Minister Yoshihiko Isozaki on April 16 at the ceremony held when he visited the site.

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 April 19-23)"; 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

Sea side impermeable wall
Silt fence

Cesium-134: 3.3 (2013/10/17) →ND(0.29) Below 1/10
Cesium-137: 9.0 (2013/10/17) → 0.31 Below 1/20
Gross β: 74 (2013/ 8/19) → 12 Below 1/6
Tritium: 67 (2013/ 8/19) →ND(1.7) Below 1/30

Cesium-134: 4.4 (2013/12/24) →ND(0.29) Below 1/10
Cesium-137: 10 (2013/12/24) →ND(0.37) Below 1/20
Gross β: 60 (2013/ 7/ 4) → 19 Below 1/3
Tritium: 59 (2013/ 8/19) → 1.8 Below 1/30

Cesium-134: 5.0 (2013/12/2) → ND(0.28) Below 1/10
Cesium-137: 8.4 (2013/12/2) → ND(0.26) Below 1/30
Gross β: 69 (2013/8/19) → 12 Below 1/5
Tritium: 52 (2013/8/19) → ND(1.7) Below 1/30

Cesium-134: 2.8 (2013/12/2) → ND(0.47) Below 1/5
Cesium-137: 5.8 (2013/12/2) → ND(0.45) Below 1/10
Gross β: 46 (2013/8/19) → ND(17) Below 1/2
Tritium: 24 (2013/8/19) → ND(1.9) Below 1/10

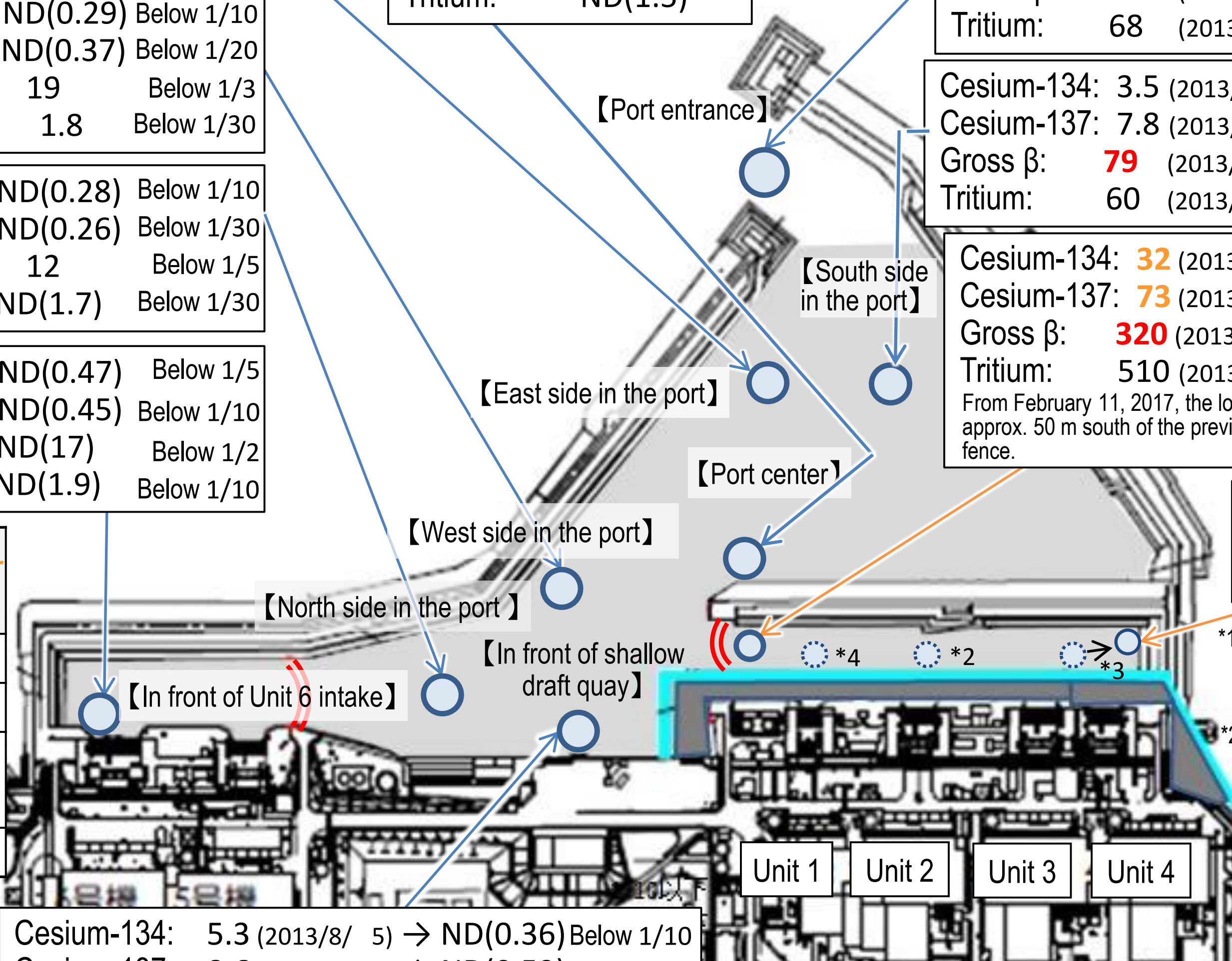
Cesium-134: ND(0.52)
Cesium-137: 1.2
Gross β: ND(15)
Tritium: ND(1.5) *

Cesium-134: 3.3 (2013/12/24) → ND(0.38) Below 1/8
Cesium-137: 7.3 (2013/10/11) → ND(0.45) Below 1/10
Gross β: 69 (2013/ 8/19) → ND(15) Below 1/4
Tritium: 68 (2013/ 8/19) → ND(1.5) Below 1/40

Cesium-134: 3.5 (2013/10/17) → ND(0.34) Below 1/10
Cesium-137: 7.8 (2013/10/17) → ND(0.33) Below 1/20
Gross β: 79 (2013/ 8/19) → ND(12) Below 1/6
Tritium: 60 (2013/ 8/19) → ND(1.7) Below 1/30

Cesium-134: 32 (2013/10/11) → ND(0.59) Below 1/50
Cesium-137: 73 (2013/10/11) → 1.5 Below 1/40
Gross β: 320 (2013/ 8/12) → ND(17) Below 1/10
Tritium: 510 (2013/ 9/ 2) → ND(1.9) Below 1/200
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 (0.39)
Cesium-137: 2.8
Gross β: ND (17)
Tritium: 13 *1



Cesium-134: 5.3 (2013/8/ 5) → ND(0.36) Below 1/10
Cesium-137: 8.6 (2013/8/ 5) → ND(0.52) Below 1/10
Gross β: 40 (2013/7/ 3) → ND(17) Below 1/2
Tritium: 340 (2013/6/26) → ND(1.5) Below 1/200

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

*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 April 24, 2019

Note: The gross 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 April 19-23)

	Legal discharge limit	WHO Guidelines for Drinking Water Quality
Cesium-134	60	10
Cesium-137	90	10
Strontium-90 (strongly correlate with Gross 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 (0.82)	
Cesium-137:	ND (2013)	→ ND (0.58)	
Gross β:	ND (2013)	→ ND (17)	
Tritium:	ND (2013)	→ ND (0.92)	

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

Cesium-134:	ND (2013)	→ ND (0.75)	
Cesium-137:	1.6 (2013/10/18)	→ ND (0.68)	Below 1/2
Gross β:	ND (2013)	→ ND (17)	
Tritium:	6.4 (2013/10/18)	→ ND (0.91)	Below 1/7

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

Cesium-134:	ND (2013)	→ ND (0.64)	
Cesium-137:	ND (2013)	→ ND (0.64)	
Gross β:	ND (2013)	→ ND (17)	
Tritium:	ND (2013)	→ ND (0.92)	

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

Cesium-134:	ND (2013)	→ ND (0.62)	
Cesium-137:	ND (2013)	→ ND (0.53)	
Gross β:	ND (2013)	→ ND (17)	
Tritium:	4.7 (2013/ 8/18)	→ ND (0.91)	Below 1/5

【Port entrance】

Cesium-134:	3.3 (2013/12/24)	→ND (0.38)	Below 1/8
Cesium-137:	7.3 (2013/10/11)	→ND (0.45)	Below 1/10
Gross β:	69 (2013/ 8/19)	→ND (15)	Below 1/4
Tritium:	68 (2013/ 8/19)	→ND (1.5)	Below 1/40

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

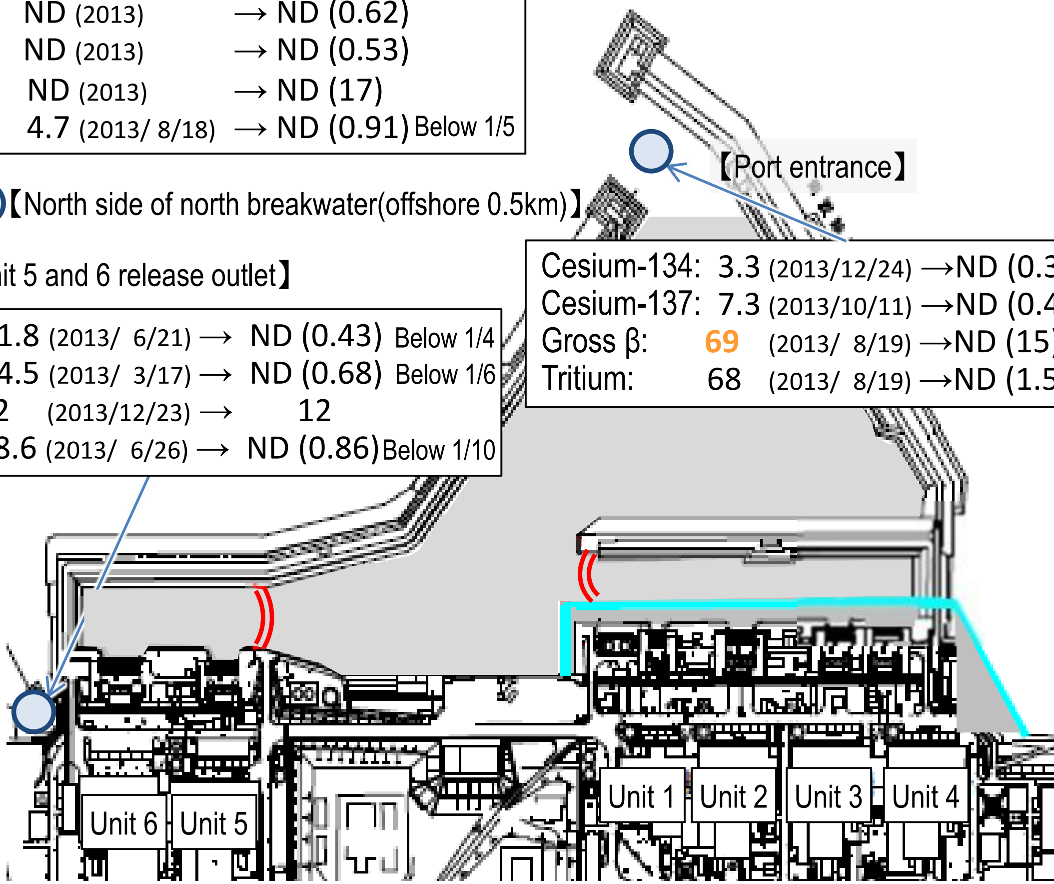
Cesium-134:	ND (2013)	→ ND (0.75)	
Cesium-137:	ND (2013)	→ ND (0.56)	
Gross β:	ND (2013)	→ ND (17)	
Tritium:	ND (2013)	→ ND (0.91)	

【North side of Unit 5 and 6 release outlet】

Cesium-134:	1.8 (2013/ 6/21)	→ ND (0.43)	Below 1/4
Cesium-137:	4.5 (2013/ 3/17)	→ ND (0.68)	Below 1/6
Gross β:	12 (2013/12/23)	→ 12	
Tritium:	8.6 (2013/ 6/26)	→ ND (0.86)	Below 1/10

【Near south release outlet】

Cesium-134:	ND (2013)	→ ND (0.77)	
Cesium-137:	3.0 (2013/ 7/15)	→ ND (0.67)	Below 1/4
Gross β:	15 (2013/12/23)	→ 10	
Tritium:	1.9 (2013/11/25)	→ ND (0.86)	Below 1/2



Note: The gross 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

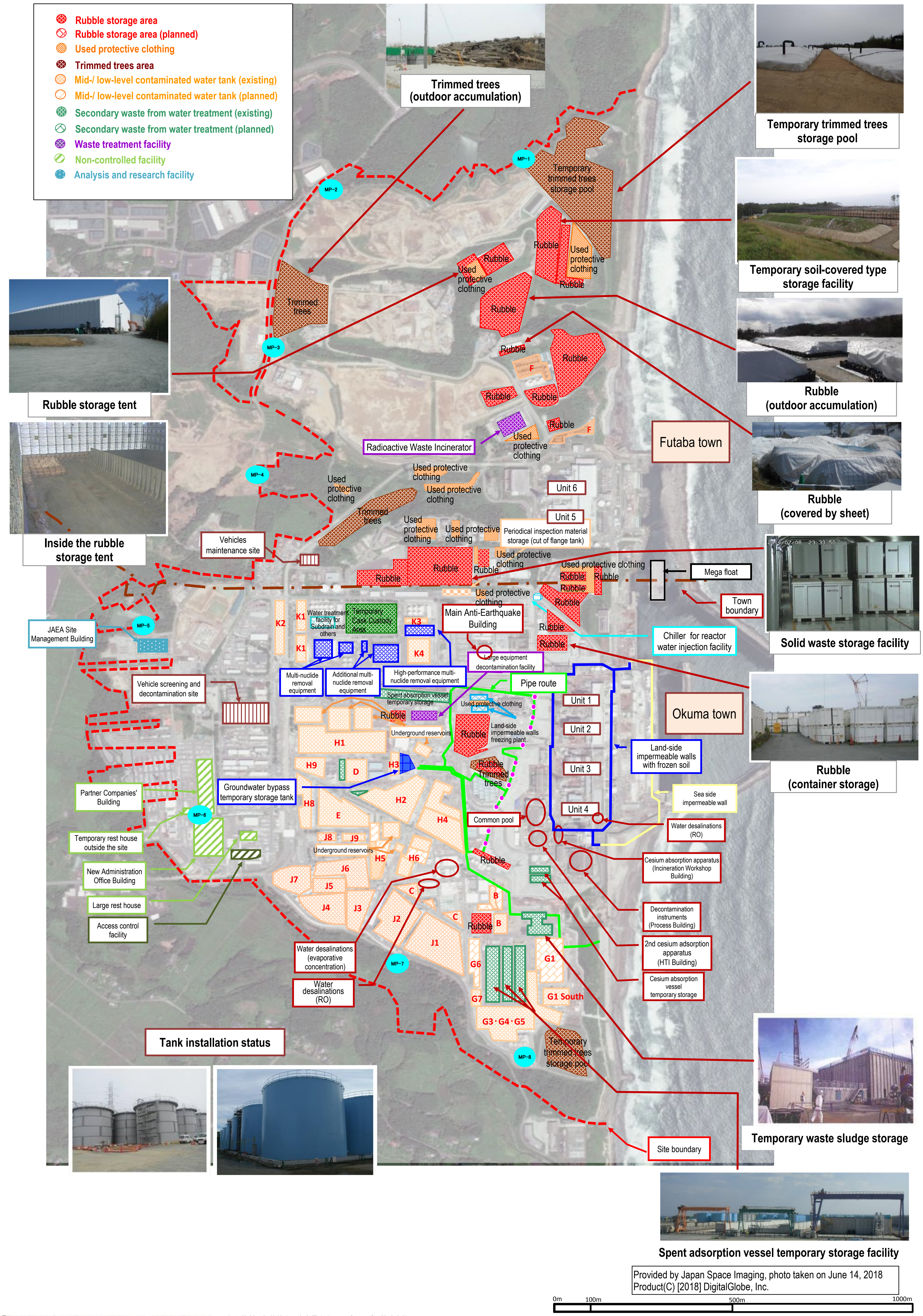
Summary of TEPCO data as of April 24, 2019

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

Appendix 2

TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site Layout

April 25, 2019



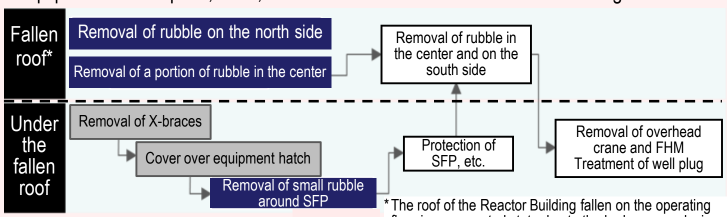
Provided by Japan Space Imaging, photo taken on June 14, 2018
Product(C) [2018] DigitalGlobe, Inc.

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

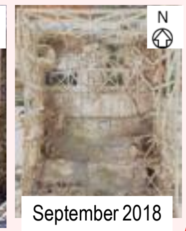
Regarding fuel removal from Unit 1 spent fuel pool, there is a plan to install a dedicated cover for fuel removal over the top floor of the Reactor Building (operating floor). On November 10, 2016, removal of all roof panels and wall panels of the building cover was completed. On May 11, 2017, removal of pillars and beams of the building cover was completed. On December 19, 2017, modification of the pillars and beams of the building cover and installation windbreak fences were completed.
From March 18, 2019, removal of small rubble in the east-side area around the SFP started as an initial step using pliers and suction equipment. From April 2, 2019, rubble removal in the same area started using remote-controlled heavy machine.



* The roof of the Reactor Building fallen on the operating floor in a connected state due to the hydrogen explosion

Steps of rubble removal

October 2015



September 2018

<Status of the operating floor>

Unit 2

To facilitate removal of fuel assemblies and retrieval of debris in the Unit 2 spent fuel pool, the scope of dismantling and modification of the existing Reactor Building rooftop was examined. From the perspective of ensuring safety during the work, controlling impacts on the outside of the power station, and removing fuel rapidly to reduce risks, we decided to dismantle the whole rooftop above the highest floor of the Reactor Building.
Examination of the following two plans continues: Plan 1 to share a container for removing fuel assemblies from the pool and retrieving fuel debris; and Plan 2 to install a dedicated cover for fuel removal from the pool.

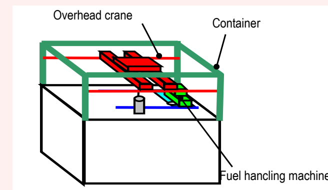


Image of Plan 1

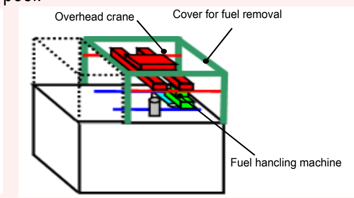
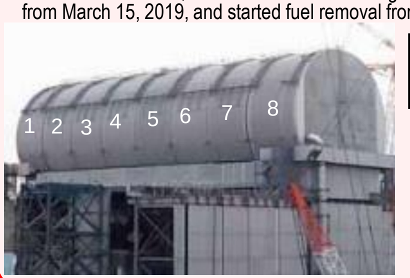


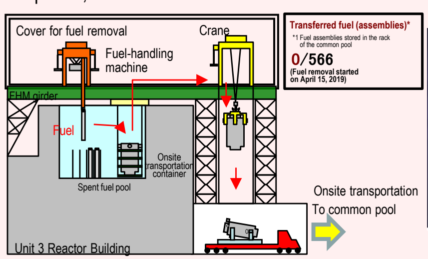
Image of Plan 2

Unit 3

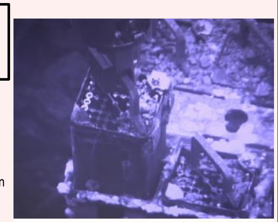
Prior to the installation of a cover for fuel removal, removal of large rubble from the spent fuel pool was completed in November 2015. To ensure safe and steady fuel removal, training of remote control was conducted at the factory using the actual fuel-handling machine which will be installed on site (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


Fuel removal status
(April 15, 2019)

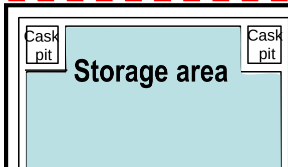
Unit 4

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.

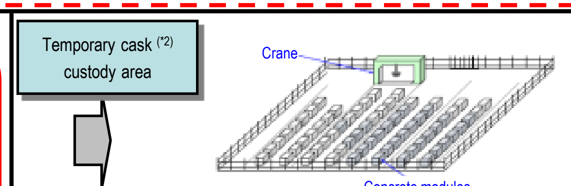
Common pool



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)

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

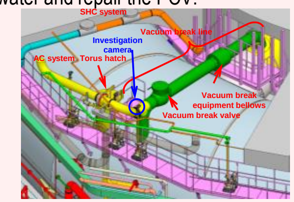
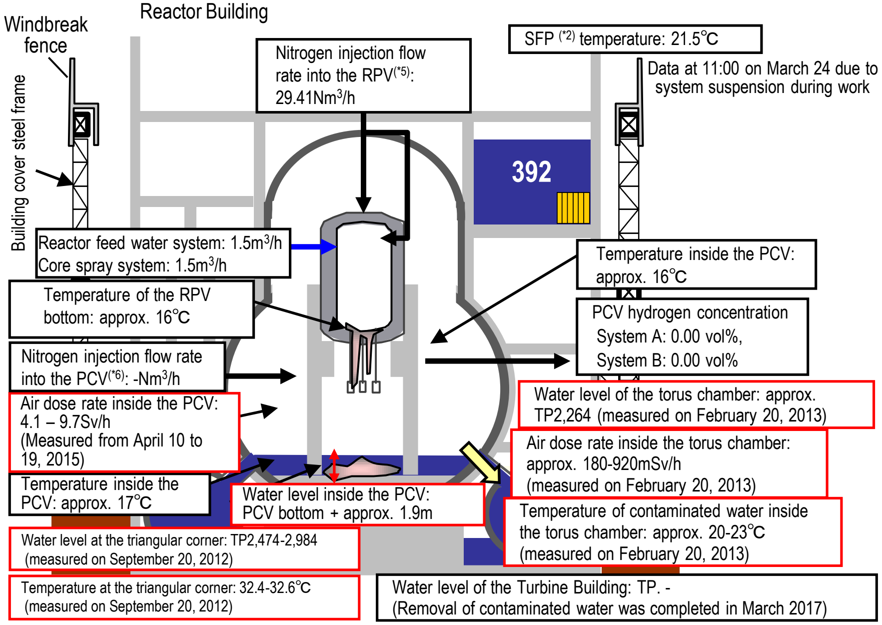


Image of the S/C upper part investigation

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, April 24, 2019

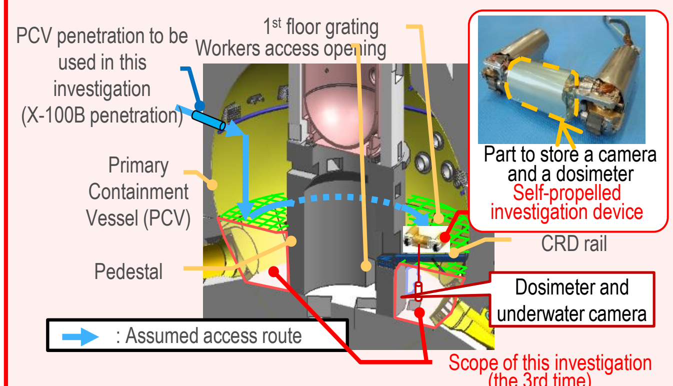
Investigations inside PCV	1st (Oct 2012)	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling contaminated water - Installing permanent monitoring instrumentation
	2nd (Apr 2015)	Confirming the status of PCV 1st floor - Acquiring images - Measuring 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>

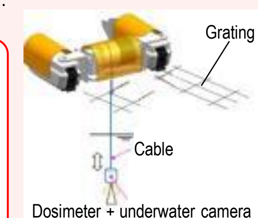


Image of hanging of dosimeter and camera

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

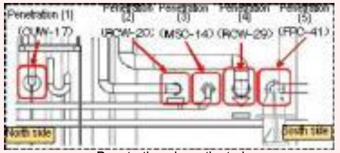
Installation of an RPV thermometer and permanent PCV supervisory instrumentation

(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.

Investigative results on torus chamber walls

- The torus chamber walls were investigated (on the north side of 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

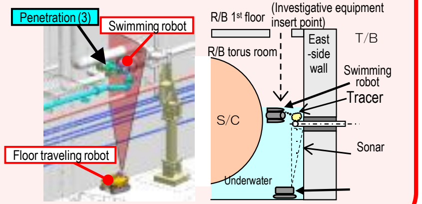
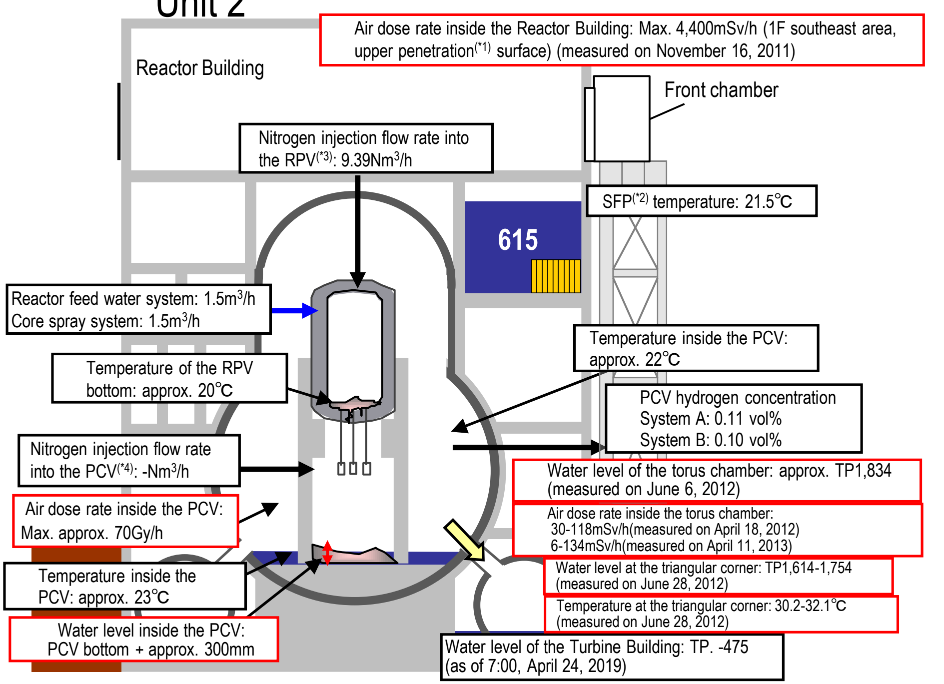


Image of the torus chamber east-side cross-sectional investigation

Unit 2



* Indices related to plant are values as of 11:00, April 24, 2019

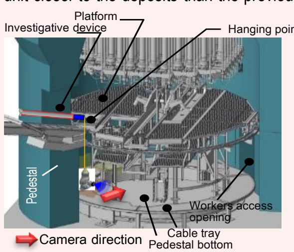
Investigations inside PCV	1st (Jan 2012)	- Acquiring images - Measuring air temperature
	2nd (Mar 2012)	- Confirming water surface - Measuring water temperature - Measuring dose rate
	3rd (Feb 2013 – Jun 2014)	- Acquiring images - Sampling contaminated water - Measuring water level - Installing permanent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

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

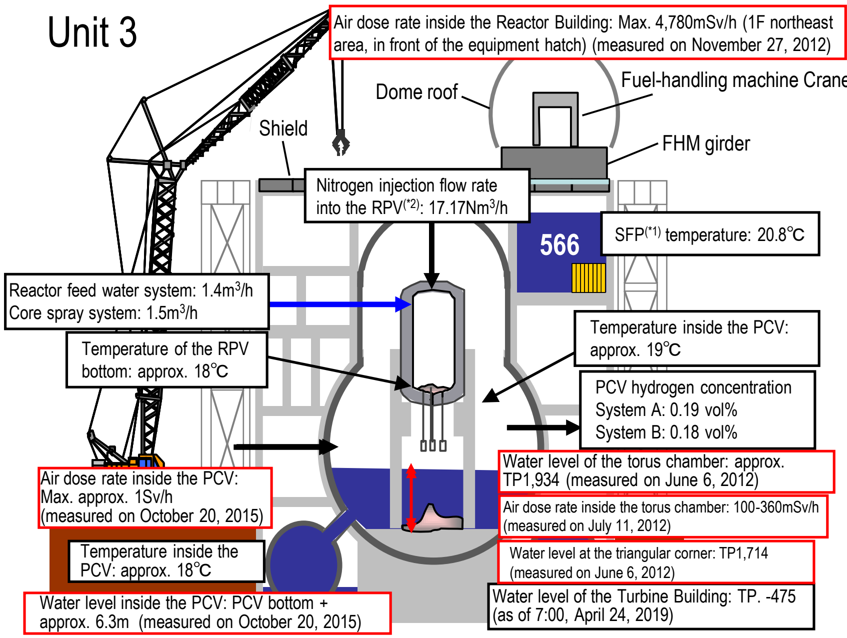
On January 18, 2014, a flow of water from around the door of the Steam Isolation Valve room in the Reactor Building Unit 3 1st floor northeast area to the nearby floor drain funnel (drain outlet) was detected. As the drain outlet connects with the underground part of the Reactor Building, there is no 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, April 24, 2019

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

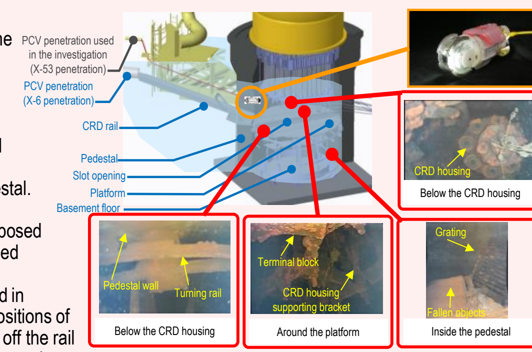
- As part of the investigation into the PCV to facilitate fuel debris retrieval, the status around the Unit 3 PCV equipment hatch was investigated using a small self-traveling investigation device on November 26, 2015.
- Given blots such as rust identified below the water level inside the PCV, there 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

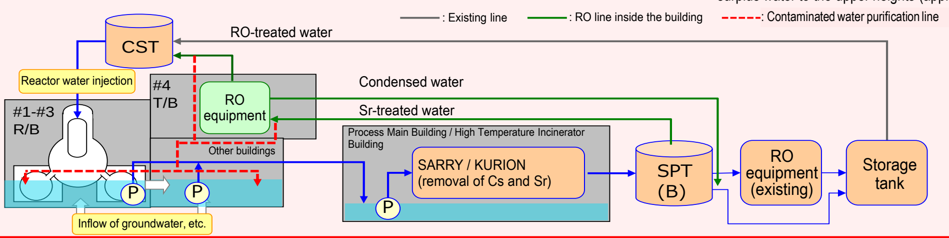
Progress toward decommissioning: Work related to circulation cooling and contaminated water treatment line

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.

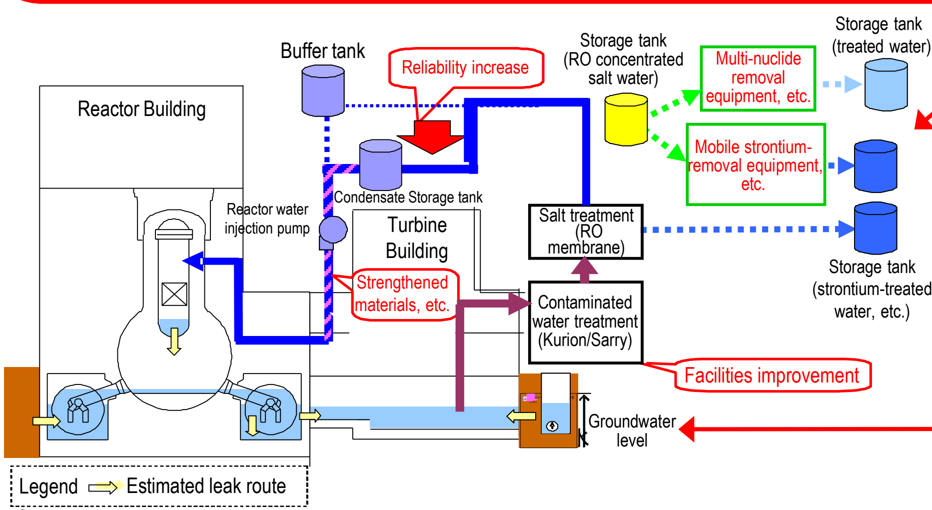

Start of dismantling in H1 east area

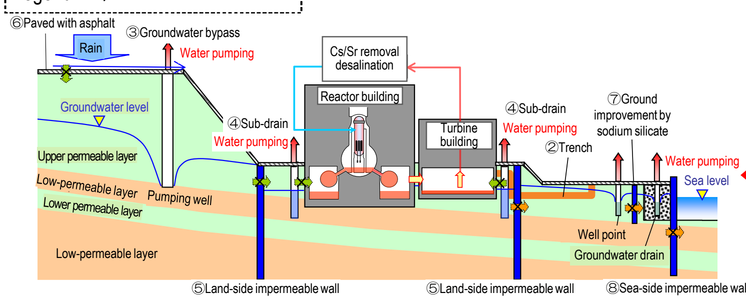

After dismantling in H1 east area

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

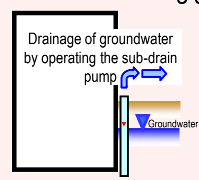
Contaminated water (RO concentrated salt water) is being treated using seven types of equipment including the multi-nuclide removal equipment (ALPS). Treatment of the RO concentrated salt water was completed on May 27, 2015, with the exception of the remaining water at the tank bottom. The remaining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

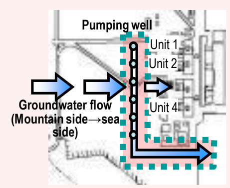
Measures to pump up groundwater flowing from the mountain side upstream of the Building to reduce the groundwater inflow (groundwater bypass) have been implemented.

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.

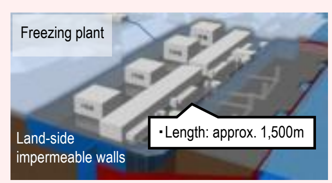


Installing land-side impermeable walls with frozen soil around Units 1-4 to prevent the inflow of groundwater into the building

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, the land-side impermeable walls were considered completed except for a portion of the depths based on a monitoring result showing that the underground temperature had declined below 0°C in almost all areas and on the mountain side, the difference between the inside and outside increased to approx. 4-5 m. The multi-layered contaminated water management measures, including subdrains and facing, have kept the groundwater level stable. Consequently, a water-level management system to isolate the buildings from groundwater was considered to have been established. The Committee on Countermeasures for Contaminated Water Treatment held on March 7 clearly recognized the effect of the land-side impermeable walls in shielding groundwater and evaluated that the land-side impermeable walls allowed for 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°C by September 2018. From February 2019, maintenance operation started at all sections.



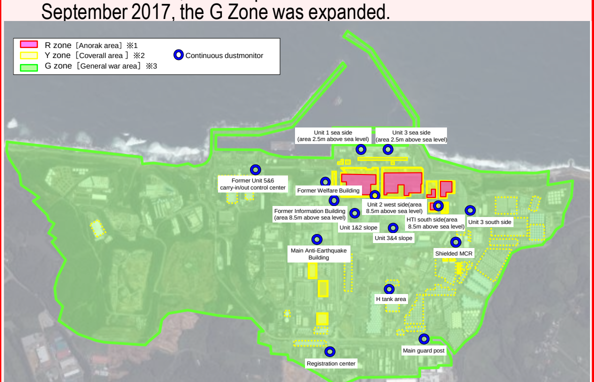
Progress toward decommissioning: Work to improve the environment within the site

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.

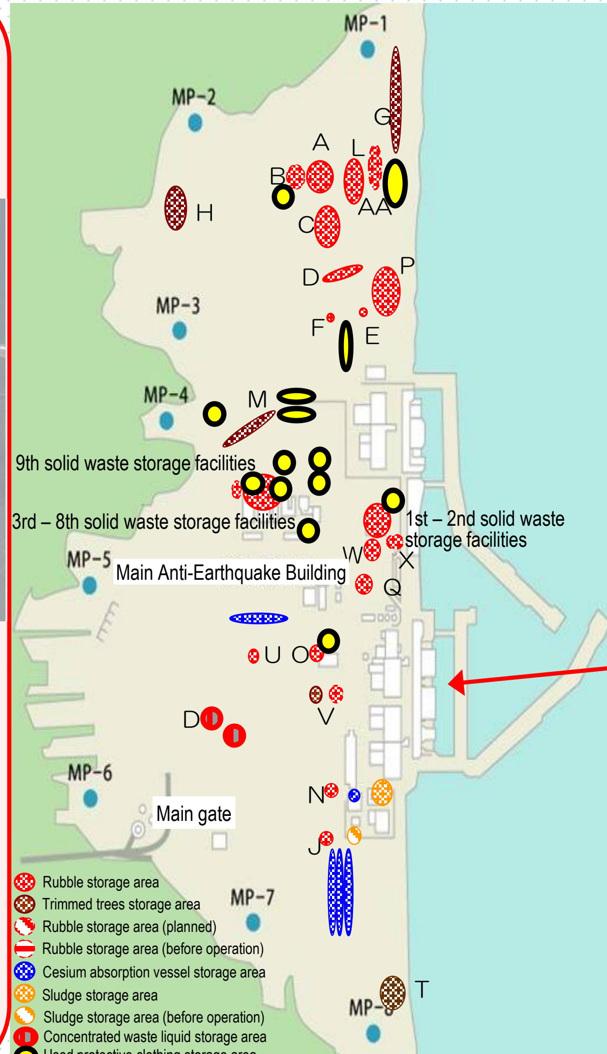
From March 2016, limited operation started. From March and September 2017, the G Zone was expanded.



※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.