Summary of Decommissioning and Contaminated Water Management

November 30, 2017

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

Main decommissioning works and steps

All fuel has been removed from Unit 4 SFP and preparatory work to remove fuel from Unit 1-3 SFP and fuel debris (Note 1) retrieval is ongoing.

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

Fuel Removal from SFP

Units 1 & 2 → Rubble removal & dose reduction → Unit 3 → Installing a Fuel-Handling Machine → 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 Debris Retrieval

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

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

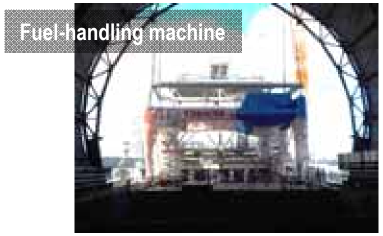
Dismantling Facilities

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

Toward fuel removal from spent fuel pool

Toward fuel removal from Unit 3 SFP, works to install the cover are underway.

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



Installation of the fuel-handling machine on the girder (November 12, 2017)

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 bypassing

④ Pump up groundwater near buildings

⑤ Land-side impermeable walls

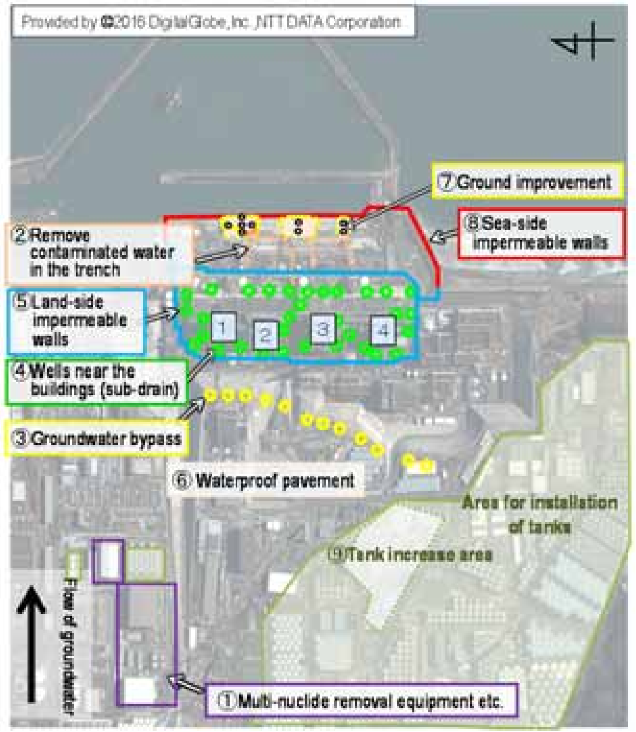
⑥ Waterproof pavement

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



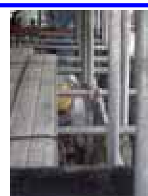
Multi-nuclide removal equipment (ALPS), etc.

- 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 via multi-nuclide removal equipment, additional multi-nuclide removal equipment installed by TEPCO (operation commenced in September 2014) and a subsidy project of the Japanese Government (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)

Land-side impermeable walls

- Land-side impermeable walls surround the buildings and reduce groundwater inflow into the same.
- Freezing started on the sea side and part of the mountain side from March 2016 and on 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.
- On the sea side, the underground temperature declined below 0°C throughout the scope requiring freezing, except for the unfrozen parts under the seawater pipe trenches and the areas above groundwater level in October 2016.



(Opening/closure of frozen pipes)

Sea-side impermeable walls

- Impermeable walls are being installed on the sea side of Units 1-4, to prevent contaminated groundwater from flowing into the sea.
- The installation of steel pipe sheet piles was completed in September 2015 and they were connected in October 2015. These works completed the closure of the sea-side impermeable walls.

(Sea-side impermeable wall)

Progress Status and Future Challenges of the Mid- and Long-Term Roadmap toward Decommissioning of TEPCO Holdings' Fukushima Daiichi Nuclear Power Station Units 1-4 (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. 20-35°C*1 over the past month. There was no significant change in the density of radioactive materials newly released from Reactor Buildings in the air*2. It was evaluated that the comprehensive cold shutdown condition had been maintained.

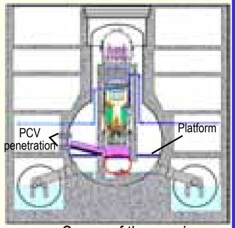
* 1 The values varied somewhat, depending on the unit and location of the thermometer.

* 2 In October 2017, the radiation exposure dose due to the release of radioactive materials from the Unit 1-4 Reactor Buildings was evaluated as less than 0.00025 mSv/year at the site boundary.
The annual radiation dose from natural radiation is approx. 2.1 mSv/year (average in Japan).

Investigation inside the Unit 2 PCV

The inside of the Unit 2 Primary Containment Vessel (PCV) will be investigated from January 2018. The previous investigation (January – February 2017) identified the part of the platform, etc. had been lost.
In this investigation, the telescopic type investigative device used in the previous investigation was upgraded to inspect the status under the platform where fuel debris potentially existed.

The investigation will proceed carefully not to affect the surrounding environment.



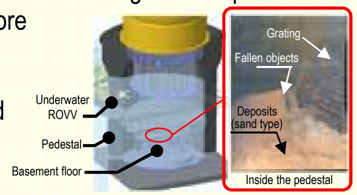
: Scope of the previous investigation
: Scope of this investigation

Cross-sectional view of R/B (image)

Results of investigation inside the Unit 3 PCV (analytical results of image data)

In July 2017, the inside of the pedestal*1 where fuel debris potentially existed was investigated using a remotely operated underwater vehicle (underwater ROV). Analysis of image data obtained in the investigation identified damage to multiple structures and the supposed core internals.

Consideration of fuel debris retrieval based on the obtained information will continue.



*1: The base supporting the RPV

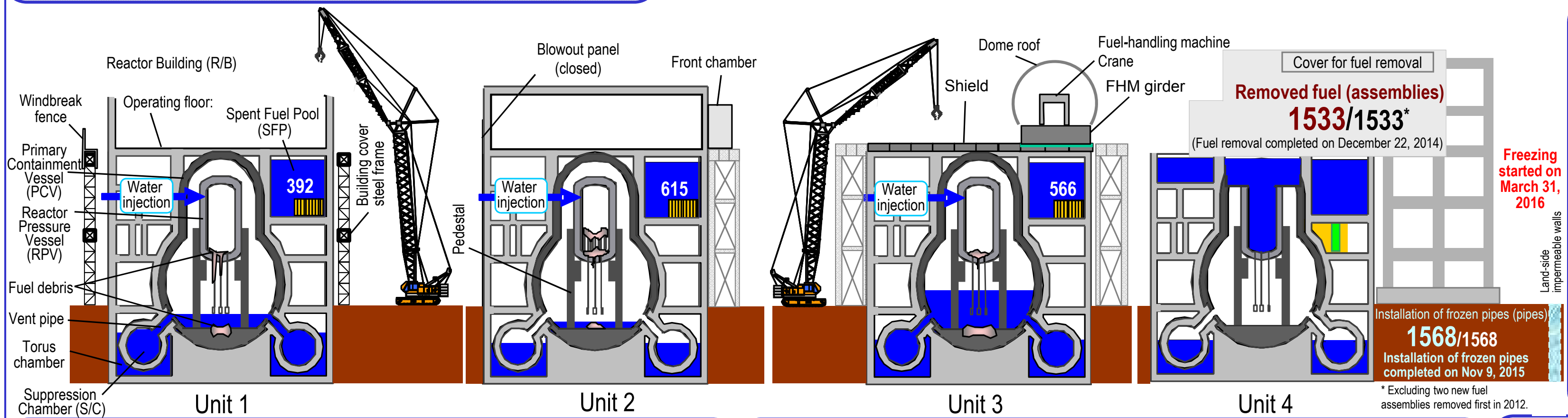
Image analysis results

Status of the land-side impermeable walls

In the land-side impermeable walls, a maintenance operation to control the frozen soil from getting any thicker continues from May 22 on the north and south sides and started from November 13 on the east side.

Due to a total of over 350 mm of rainfall brought by Typhoon No. 21 and 22, the amount of generated contaminated water temporarily increased. However, multi-layered contaminated water management, including enhancing the subdrains and the land-side impermeable walls, meant the rate of contaminated water generated to the accumulated rainfall declined compared to that of the previous year's typhoons.

Monitoring of the underground temperature, water levels and pumped-up groundwater volume will continue to confirm the effect of the land-side impermeable walls.



Completion of water removal from the Unit 2 condenser

Stagnant water in the building at the time of the accident and stored in condensers is being removed. For Unit 2, a remotely controlled water removal equipment was installed and water removal was completed by November 17. By this removal, the amount of radioactive materials in accumulated water inside Unit 1-4 and other buildings was reduced by approx. 10% compared to that of FY2014.

Water in the Unit 3 condenser will be removed in December.

Installation start of Unit 1 windbreak fences

Toward fuel removal of Unit 1, the installation of windbreak fences*2 started on October 31. Though dust scattering has been suppressed by the effect of agents, windbreak fences will be installed within December as an additional measure to reduce the dust-scattering risk during rubble removal.

After installing windbreak fences, rubble removal will start once preparation is completed.

Installation status (November 27, 2017)

*2: Fences which mitigation the wind blowing into the space around the operating floor.

Installation completion of the Unit 3 fuel-handling machine and crane on the girder

As preparatory work for fuel removal from Unit 3, a cover for fuel removal is being installed. Installation of the fifth Dome Roof (of eight) was completed by November 4. The fuel-handling machine*3 and crane*4 were installed on the girder by November 12 and 20 respectively.

The sixth Dome Roof will be installed in December.

*3: Equipment used when handling fuel assemblies in the pool.

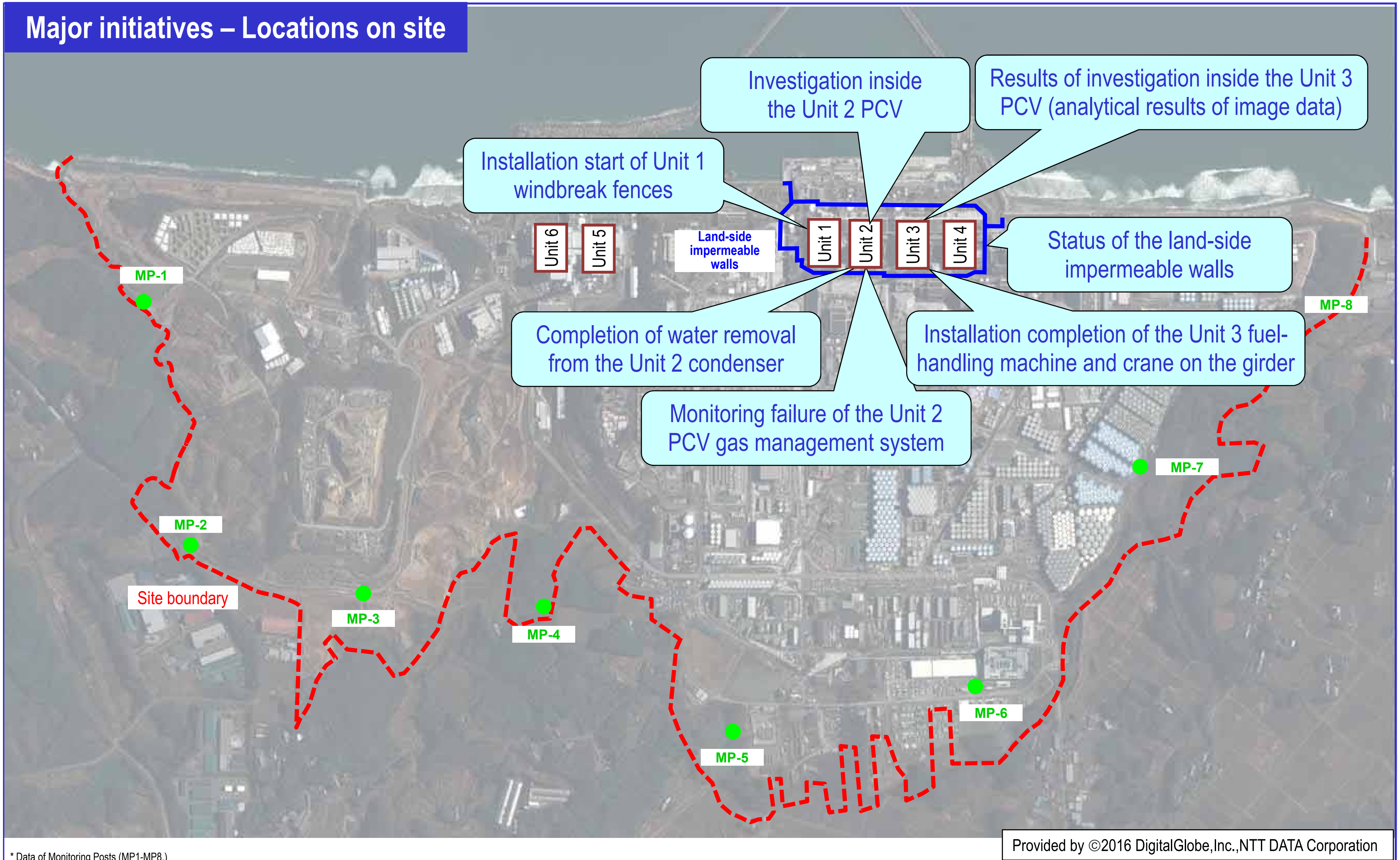
*4: Equipment to transfer transportation containers inside the cover.

Installation of the fuel-handling machine (November 12, 2017)

Monitoring failure of the Unit 2 PCV gas management system

On November 20, in the Unit 2 Primary Containment Vessel (PCV) gas management system, monitoring of air inside the PCV temporarily failed because when one monitoring system was suspended for work, the valve of the other system was closed. As no abnormality was identified in other parameters such as monitoring posts during the monitoring failure, a subcritical state was deemed to have been maintained.

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 show 0.481 – 1.801 μSv/h (October 25 – November 28, 2017).

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

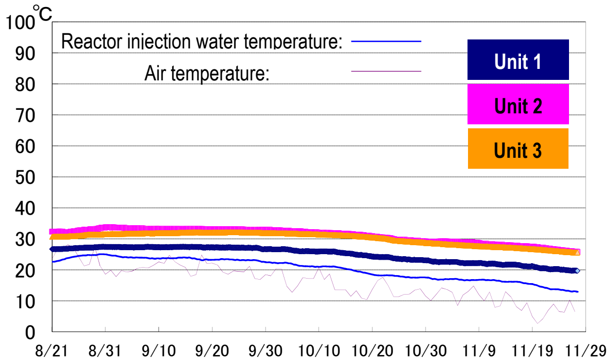
Therefore monitoring results at these points are lower than elsewhere in the power plant site.

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. has caused the surrounding radiation dose to decline significantly.

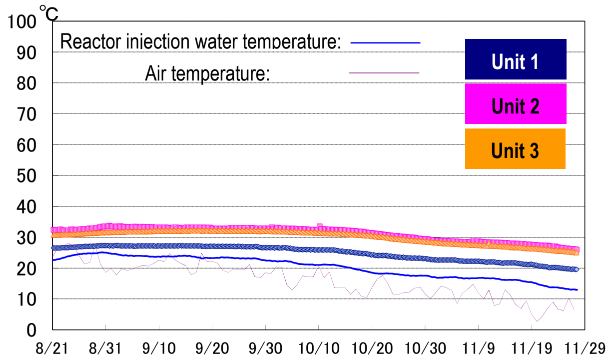
I. Confirmation of the reactor conditions

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. 20 to 35°C for the past month, though it varied depending on the unit and location of the thermometer.



RPV bottom temperatures (recent quarter)



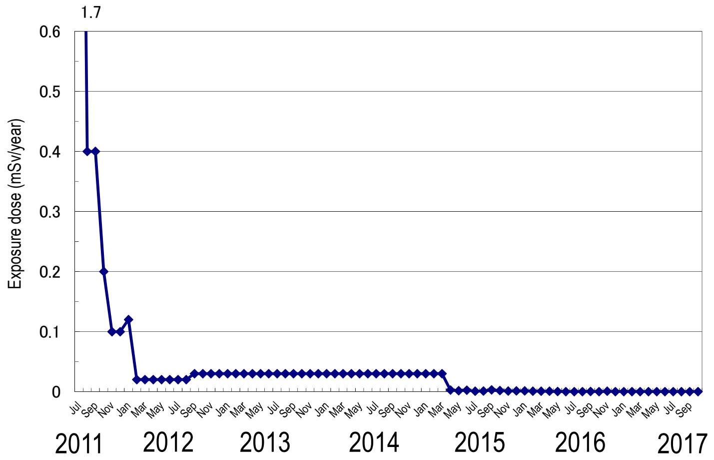
PCV gas phase temperatures (recent quarter)

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

2. Release of radioactive materials from the Reactor Buildings

As of October 2017, the density of radioactive materials newly released from Reactor Building Units 1-4 in the air and measured at the site boundary was evaluated at approx. 2.0×10^{-12} Bq/cm^3 for Cs-134 and 8.5×10^{-12} Bq/cm^3 for Cs-137, while the radiation exposure dose due to the release of radioactive materials there was less than 0.00025 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 0.481 – 1.801 μSv/h (October 25 - November 28, 2017)
  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 countermeasures

To tackle the increase in accumulated 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

➢ 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 November 27, 2017, 331,310 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 November 27, 2017, a total of 460,076 m³ had been drained after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Due to the level of the groundwater drain pond rising after the sea-side impermeable walls had been closed, pumping started on November 5, 2015. Up until November 28, 2017, a total of approx. 164,000 m³ had been pumped up and a volume of approx. 110 m³/day is being transferred from the groundwater drain to the Turbine Buildings (average for the period October 19 – November 22, 2017).
- To counter the incorrect setting identified on September 28 in the water-level gauges for the new subdrains (six sections) installed around the Unit 1-4 buildings, all LCO events related to the subdrains were comprehensively reviewed, while the appropriateness of design documents, field management system and business processes were checked for the following monitoring items (1)-(3) specified to prevent accumulated water in the buildings leaking outside:
  (1) Accumulated water level in the buildings, (2) water-level difference between accumulated water in the buildings and the subdrains near the buildings and (3) radiation density
  The investigative results identified no severe error that was categorized as a deviation from LCO, while detecting a significant difference between the current water-level gauge reference point and the measurement record as well as incorrect entry in some pits. The setting values were promptly corrected (October 27). As well as swift actions, including unifying the elevation standards, continued improvement efforts will be implemented for process management, such as establishing rules to ensure information is communicated reliably.
- As an enhancement measure, the treatment facility for subdrains and groundwater drains is being upgraded. Additional water collection tanks and temporary water storage tanks were installed and the installation of fences, pipes and ancillary facilities is also underway. The treatment capacity is being enhanced incrementally to accommodate the increasing volume of pumped-up groundwater during the high rainfall season (before measures: approx. 800 m³/day, from August 22: approx. 900 m³/day, after temporary storage tanks put into operation: approx. 1,200 m³/day and after water collection tanks put into operation: approx. 1,500m³/day).
- To maintain the level of groundwater pumped up from subdrains, work to install additional subdrain pits and recover existing subdrain pits is underway. They will go into operation sequentially from a pit for which work is completed (the number of pits which went into operation: 7 of 15 additional pits, 0 of 4 recovered pits).
- To eliminate the suspension of water pumping while cleaning the subdrain transfer pipe, the pipe will be duplicated. Installation of the pipe and ancillary facility is underway.
- Since the subdrains went into operation, the inflow into buildings tended to decline to less than 150 m³/day when the subdrain water level declined below T.P. 3.0 m, while the inflow increased during rainfall.

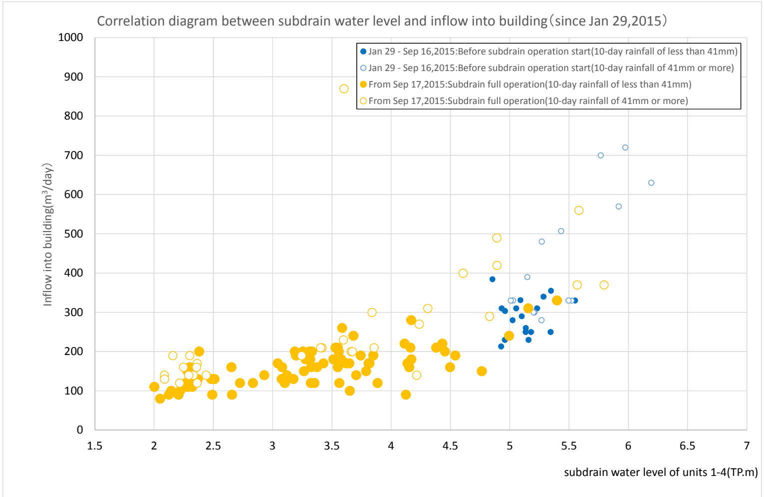


Figure 1: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Unit 1-4 subdrains

Construction status of the land-side impermeable walls

- For West (3) of the land-side impermeable walls (on the mountain side), a supplementary method was implemented (July 31 – September 15). Freezing started from August 22 and the underground temperature has been declining steadily. The difference between the inside and outside of the land-side impermeable walls near the same section increased.
- In the land-side impermeable walls, a maintenance operation to stop the frozen soil from getting any thicker continues from May 22 on the north and south sides and started from November 13 on the east side where a sufficient thickness of frozen soil was identified.
- The underground temperature, water levels and pumped-up groundwater volume will continue to be monitored to confirm the effect of the land-side impermeable walls.

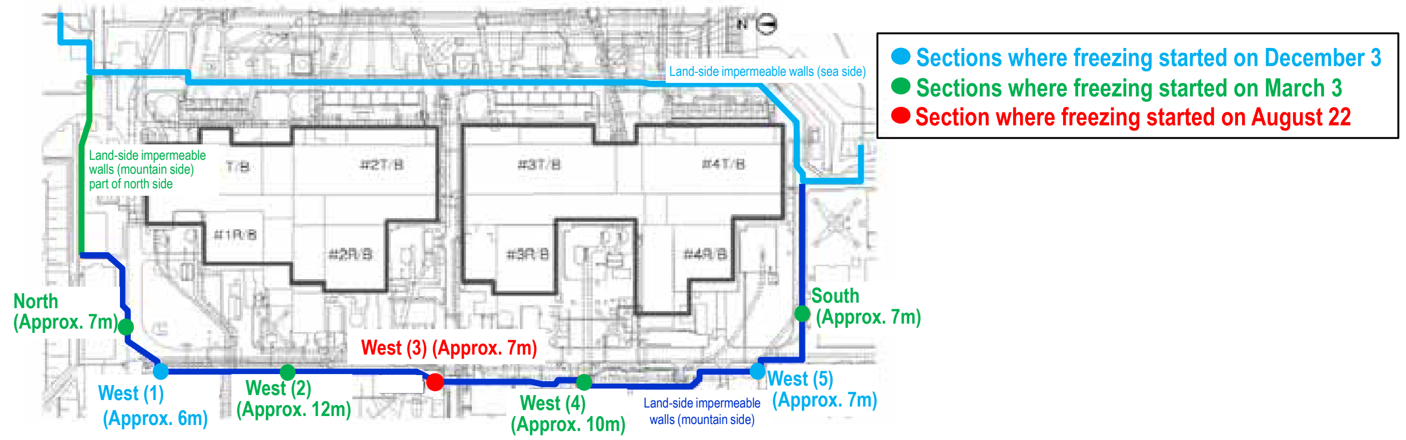


Figure 2: Closure of part of the land-side impermeable walls (on the mountain side)

Operation of multi-nuclide removal equipment

- Regarding the multi-nuclide removal equipment (existing, additional 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.

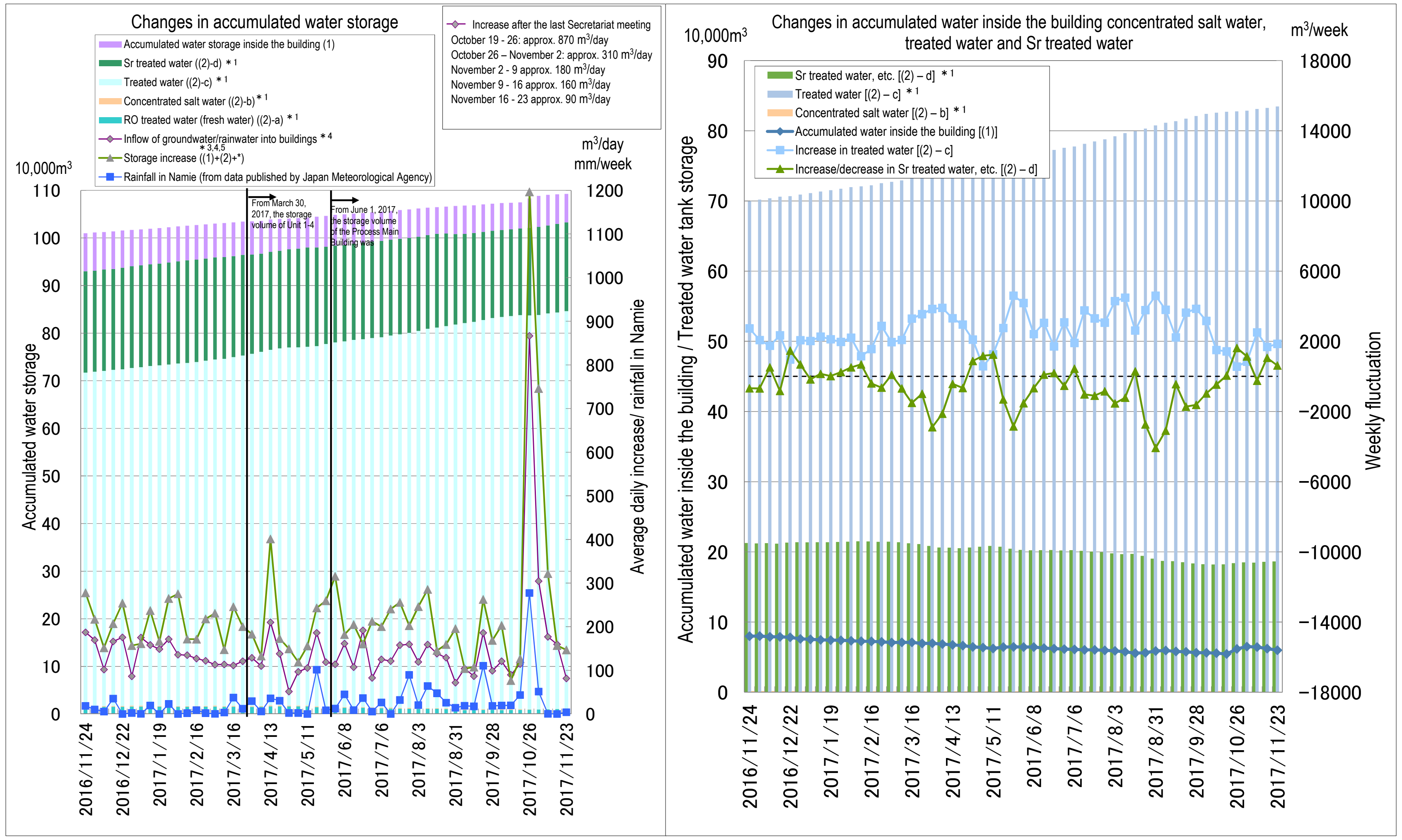


Figure 3: Status of accumulated water storage

As of November 23, 2017

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

*2: On January 19, 2017, the water volume was reviewed by reevaluating the remaining volume of concentrated salt water and the data was corrected.

*3: Including the effect of variation in water volume stored in tanks with the change in temperature.

*4: The increase is considered attributable to the uncertain cross-sectional area (evaluated value) for the water level needed to calculate the water volume stored in the Centralized Radiation Waste Treatment Facility.

Since the calculation of June 1, 2017, the cross-sectional area (evaluated value) has been reviewed.

*5: Including rainwater volume which could not be treated in the rainwater treatment facilities, transferred to Sr-treated water tanks (May 25 – June 1, 2017: 700m³/week).

*6: Corrected based on the result of an investigation conducted on July 5, 2017 revealing that the water volume in the uninvestigated areas in Unit 1 T/B was less than assumed.

- As of November 23, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 370,000, 394,000 and 103,000 m³ respectively (including approx. 9,500 m³ stored in the J1(D) tank, which contained water with a high density of radioactive materials at the System B outlet of 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 November 23, 410,000 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) and the secondary cesium-absorption apparatus (SARRY) (from December 26, 2014) have been underway. Up until November 23, approx. 415,000 m³ had been treated.

➢ Measures in Tank Areas

- Rainwater, under the release standard and having accumulated within the fences in the contaminated water tank area, was sprinkled on site after eliminating radioactive materials using rainwater-treatment equipment since May 21, 2014 (as of November 27, 2017, a total of 95,947 m³).

➢ Removal of stored water in the Unit 2 and 3 condensers

- High-dose contaminated water has been stored in Unit 1-3 condensers. To advance accumulated water treatment in buildings, the quantity of the accumulated water within must be lowered from an early stage to reduce the quantity of radioactive materials in accumulated water in buildings.
- For Unit 1, water removal was completed by August 2017.
- For Units 2 and 3, water having accumulated above the hot well roof in the condenser was removed (Unit 2: April 3-13, 2017, Unit 3: June 1-6, 2017). Water having accumulated below the hot well roof in the condenser was also removed by November 17 for Unit 2 and will be removed in December for Unit 3.

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 on December 22, 2014

➢ Main work to help remove spent fuel at Unit 1

- The removal of pillars and beams of the building cover started from March 31, 2017 and was completed on May 11. Work to install windbreak fences, which will reduce dust scattering during rubble removal, is underway. Recovery of modified pillars and beams of the building cover started on August 29 and was completed by October 26 and the installation of windbreak fences started on October 31. After this installation, rubble removal will start once preparation is completed.

➢ Main work to help remove spent fuel at Unit 2

- To help remove the spent fuel from the pool of the Unit 2 Reactor Building, preparatory work to form an opening, which would allow access to the operating floor, was completed in the external wall on the west side of the building.
- As preparatory work to remove the roof protection layer (roof block, gravel, etc.), shield frames, etc. are being installed from October 2. Removal of the roof protection layer of the Reactor Building started from October and coping, etc. is being removed from November.

➢ Main work to help remove spent fuel at Unit 3

- Installation of the dome roof, comprising a total of eight units, started on July 22. Installation of Dome Roofs 1-5 (Dome Roof 1: August 29, Dome Roof 2: September 15, Dome Roof 3: October 17, Dome Roof 4: October 28, Dome Roof 5: November 4) and the fuel-handling machine (November 12) and crane (November 20) on the girder was completed.

3. Retrieval of fuel debris

➢ Investigation inside the Unit 2 PCV

- The inside of the Unit 2 PCV will be investigated from January 2018.
- The previous investigation (January – February 2017) identified that part of the platform, etc. had been lost. In this investigation, the telescopic type investigative device used in the previous investigation was upgraded to inspect the status under the platform where fuel debris potentially existed.

➢ Investigation inside the Unit 3 PCV (analytical results of image data)

- In July 2017, the inside of the pedestal where fuel debris potentially existed was investigated using a remotely operated underwater vehicle (underwater ROV).
- Analysis of image data obtained in the investigation identified damage to multiple structures and the supposed core internals.

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 October 2017, the total storage volume of concrete and metal rubble was approx. 218,800 m³ (+2,600 m³ compared to at the end of September, with an area-occupation rate of 67%). The total storage volume of trimmed trees was approx. 133,700 m³ (- m³, with an area-occupation rate of 72%). The total storage volume of used protective clothing was approx. 63,500 m³ (+700 m³, with an area-occupation rate of 89%). The increase in rubble was mainly attributable to vehicle dismantling and construction related to rubble removal around Unit 1-4 buildings. The increase in used protective clothing was mainly attributable to acceptance of used clothing.

➢ Management status of secondary waste from water treatment

- As of November 2, 2017, the total storage volume of waste sludge was 597 m³ (area-occupation rate: 85%) and that of concentrated waste fluid was 9,364 m³ (area-occupation rate: 88%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment, etc., was 3,819 (area-occupation rate: 60%).

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

➢ Modification of Unit 2 and 3 feed water system line

- For the feed water (FDW) system line of the Unit 2 and 3 reactor water injection equipment, the connection pipe with the existing pipe in the Turbine Building will be modified and supports installed to improve the reliability of the connection (the line of Unit 1 was modified in July 2013). During the modification, water will be injected to the reactor solely from the core spray (CS) system.
- As the CS system had no past record of solo injection at the current water injection rate of 3m³/h, a water injection test solely from the CS system was conducted prior to the modification (solely from the CS system: Unit 2 October 31 – November 7; Unit 3 November 14-21). The results confirmed no significant variation in the monitoring parameters (RPV bottom temperatures, PCV temperatures and indicated values of the PCV gas management system) and no abnormality in the reactor cooling condition of both Units 2 and 3.
- After the test, the effect of recovery to the original water injection by the FDW and CS systems on the reactor cooling condition was inspected and the results identified no abnormality.

➢ Deviation from LCO attributable to a monitoring failure of the Unit 2 PCV gas management system

- At 8:10 on November 20, 2017, in System B of the Unit 2 Primary Containment Vessel gas management system (hereinafter referred to as the “PCV gas management system”), the flow rate on the radiation monitor side declined and the function to monitor the radiation density inside the PCV failed.

- On that day, System A of the PCV gas management system was also suspended for the construction to duplicate the control panel. As the radiation density of short-half-life radionuclide could not be monitored by the Unit 2 PCV gas management system, the case was judged as a deviation from the limiting condition for operation (LCO) and a deviation was declared.
- As the field investigation identified the outlet valve of the rare gas radiation monitor "fully closed," the valve was "fully opened." After confirming no abnormality in the field condition, including the flow rate and radiation monitor, recovery from the deviation from the LCO was declared at 10:53.

➢ Failure of the Unit 3 SFP circulating cooling facility primary system pump (B)

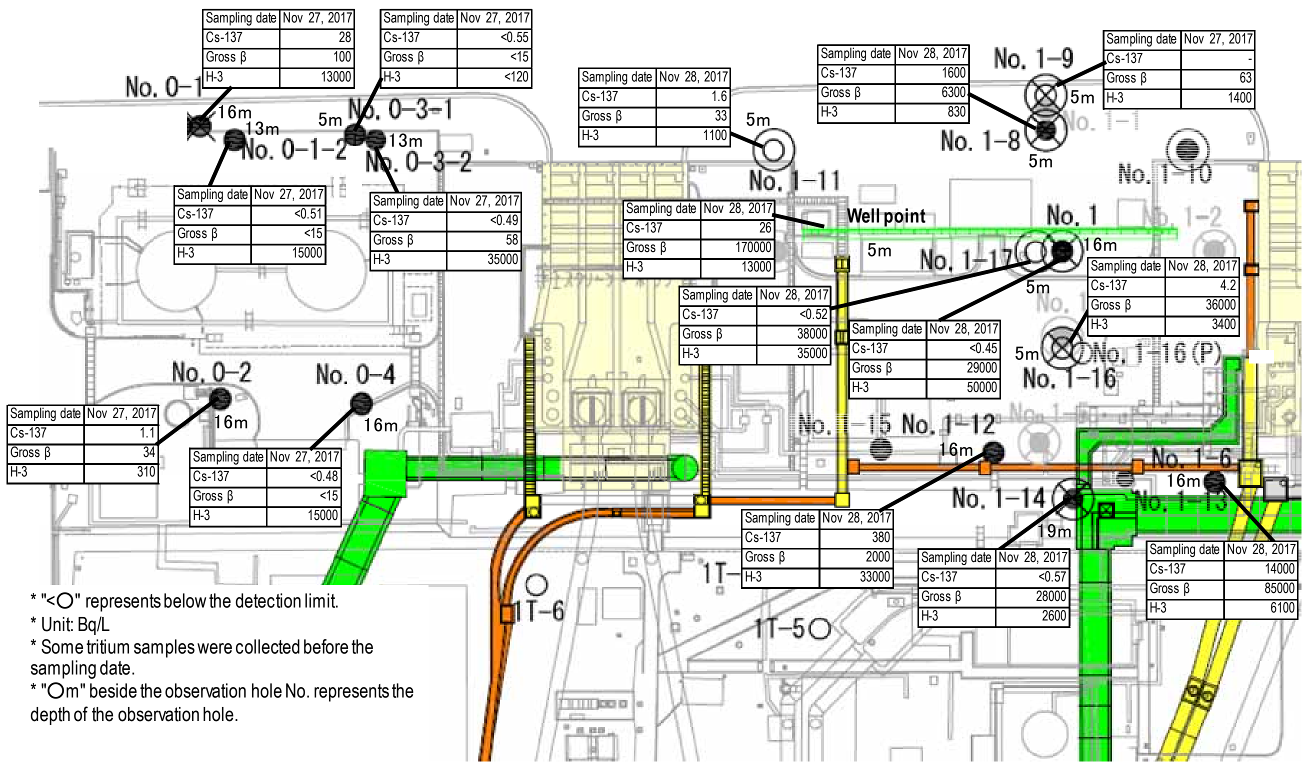
- Around 9:41 on November 27, the primary system pump (B) of the Unit 3 spent fuel pool (SFP) circulating cooling facility failed due to the "close" signal of the system inlet isolation valve and cooling of the SFP was suspended.
- Based on the investigative results, the failure was considered attributable to a worker contacting the "close" position detection switch of the valve while painting near the same.
- After no abnormality in the pump and the valve has been confirmed, the system was restarted at 11:34 and cooling resumed. As an emergency measure, prominent labels were attached to that and similar valves and permanent measures are currently being considered.

6. Reduction in radiation dose and mitigation of contamination

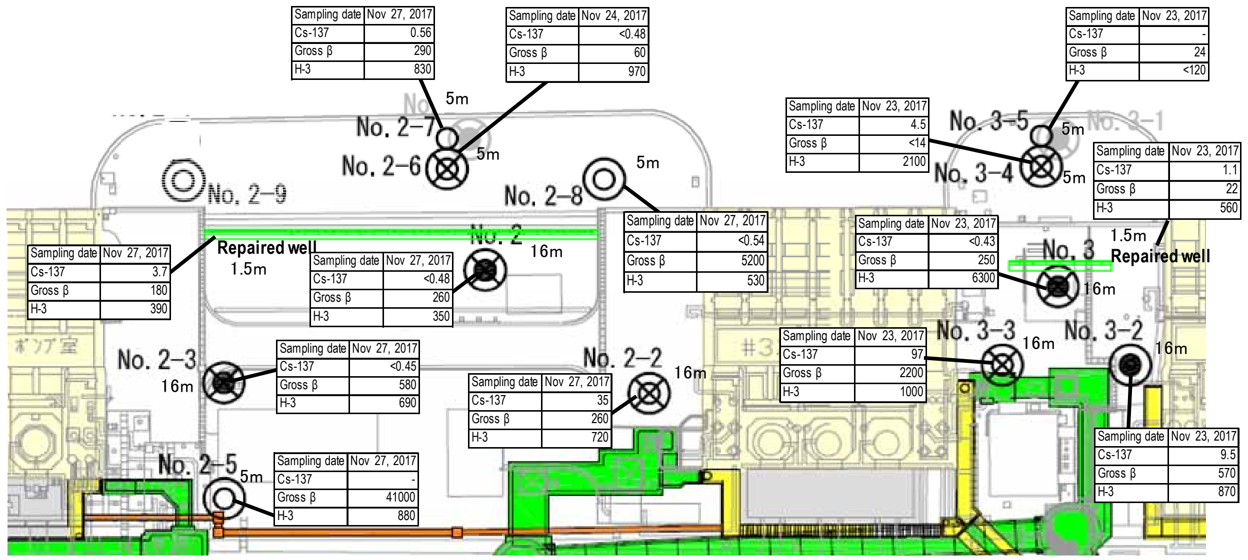
Effective dose-reduction at site boundaries and purification of port water to mitigate the impact of radiation on the external environment

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

- Regarding radioactive materials in the groundwater near the bank on the north side of the Unit 1 intake, despite the tritium density at groundwater in Observation Hole No. 0-1 gradually increasing since October 2016, it currently remains constant at around 13,000 Bq/L.
- Regarding the groundwater near the bank between the Unit 1 and 2 intakes, though the density of gross β radioactive materials at groundwater Observation Hole No. 1 had remained constant at around 18,000 Bq/L, it has been increasing since June 2017 and currently stands at around 30,000 Bq/L. Though the density of gross β radioactive materials at groundwater Observation Hole No. 1-6 had been increasing since March 2017, it has been declining since June 2017 and currently stands at around 90,000 Bq/L. Though the tritium density at groundwater Observation Hole No. 1-9 had remained constant at around 700 Bq/L, it has been increasing since October 2017 and currently stands at around 1,500 Bq/L. Though the density of gross β radioactive materials at the same groundwater Observation Hole had remained constant at around 20 Bq/L, it had been increasing to 140 Bq/L since October 2017and then declined, currently standing at around 70 Bq/L. Though the density of gross β radioactive materials at the groundwater Observation Hole No. 1-12 had remained constant at around 20 Bq/L, it had been increasing to 4,000 Bq/L since May 2017 and then declined, having been increasing from around 700 Bq/L since November 2017 and currently standing at around 2,000 Bq/L. Though the tritium density at groundwater Observation Hole No. 1-16 had been increasing from around 2,000 Bq/L since October 2017 to 5,000 Bq/L, then declining, it currently stands at around 4,000 Bq/L. The tritium density at groundwater Observation Hole No. 1-17 had been increasing from 1,000 Bq/L since February 2017 and currently stands at around 40,000 Bq/L. Though the density of gross β radioactive materials at the same groundwater Observation Hole increased from 200,000 to 600,000 Bq/L in May 2017 and then declined, it currently stands at around 40,000 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).
- Regarding radioactive materials in the groundwater near the bank between the Unit 2 and 3 intakes, the tritium density at groundwater Observation Hole No. 2-2 has been increasing from around 300 Bq/L since May 2017 and currently stands at around 700 Bq/L. Though the tritium density at groundwater Observation Hole No. 2-3 had been increasing from around 600 Bq/L since March 2017 and then declining, it currently stands at around 800 Bq/L. Though the density of gross β radioactive materials at the same groundwater Observation Hole had been increasing from 600 since June 2017, it had been declining since November 2017 and currently stands at around 500 Bq/L. Though the tritium density at groundwater Observation Hole No. 2-5 had remained constant at around 500 Bq/L, it has been increasing to 2,000 Bq/L since November 2016, then declining and currently stands at around 700 Bq/L. Though the density of gross β radioactive materials at the same groundwater Observation Hole had been increasing from around 10,000 to 80,000 Bq/L since November 2016 and then declining, it had been increasing since November 2017 and currently stands at around 40,000 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).
- Regarding radioactive materials in the groundwater near the bank between the Unit 3 and 4 intakes, though the tritium density at groundwater Observation Hole No. 3 had remained constant at around 4,000 Bq/L, it currently stands at around 8,000 Bq/L. The tritium density at groundwater Observation Hole No. 3-2 has been declining from around 3,000 Bq/L since October 2016 and currently stands at around 800 Bq/L. The density of gross β radioactive materials at the same groundwater Observation Hole has been declining from around 3,500 Bq/L since October 2016 and currently stands at around 600 Bq/L. Though the tritium density at groundwater Observation Hole No. 3-3 has been declining from around 1,200 Bq/L since July 2017 to around 500 Bq/L, it had been increasing since October 2017 and currently stands at around 1,000 Bq/L. Though the density of gross β radioactive materials at the same groundwater Observation Hole had been declining since September 2016, it had been increasing from 1,500 Bq/L since October 2017 and currently stands at around 2,500 Bq/L. At groundwater Observation Hole No. 3-4, though the tritium density had been declining from 4,000 Bq/L since March 2017 to 1,000 Bq/L, it had been increasing since October 2017 and currently stands at around 2,000 Bq/L. Since April 1, 2015, pumping of groundwater continued (at the well point between the Unit 3 and 4 intakes: April 1 – September 16, 2015; at the repaired well: from September 17, 2015).
- Regarding the radioactive materials in seawater in the Unit 1-4 intake area, densities have remained low except for the increase in cesium 137 and strontium 90 during heavy rain. They have been declining following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls. The density of cesium 137 has been increasing since January 25, 2017, when a new silt fence was installed to accommodate the relocation.
- Regarding the radioactive materials in seawater in the area within the port, densities have remained low except for the increase in cesium 137 and strontium 90 during heavy rain. They have been declining following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls.
- Regarding the radioactive materials in seawater in the area outside the port, densities of cesium 137 and strontium 90 have been declining and remained low following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls.



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



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

Figure 4: Groundwater density on the Turbine Building east side

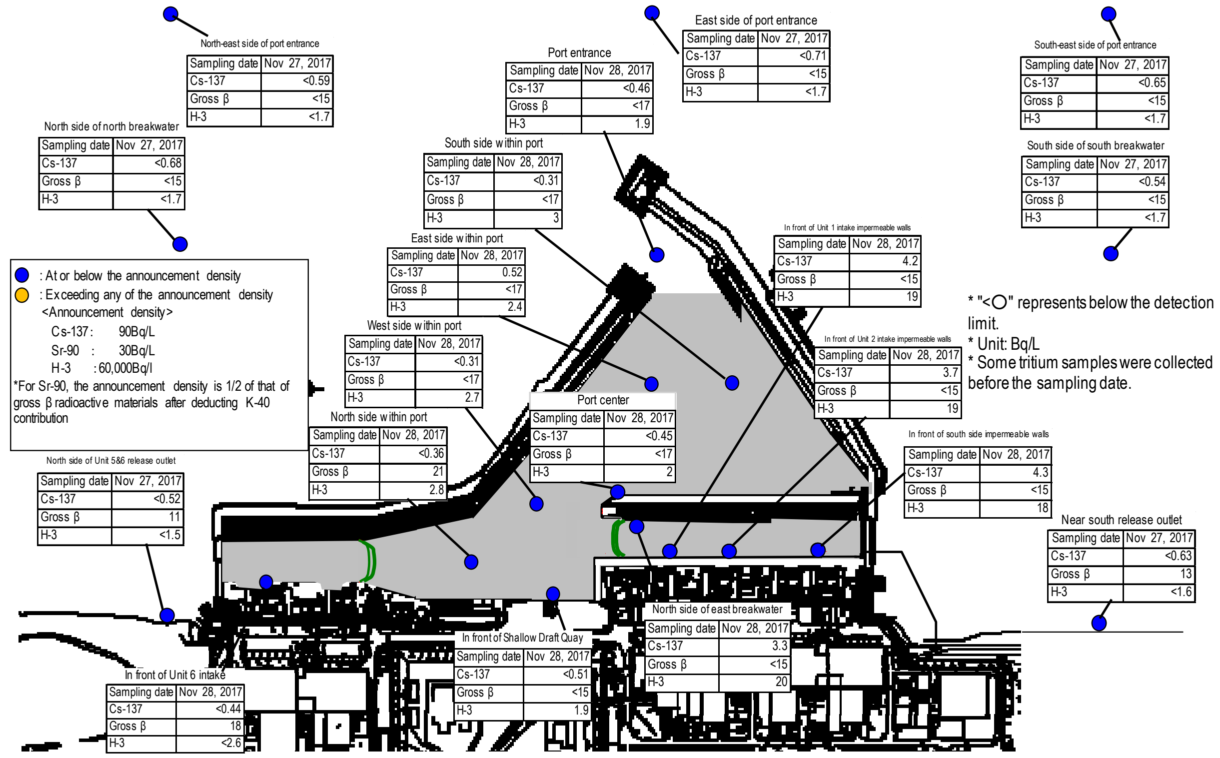


Figure 5: Seawater density around the port

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 people registered for at least one day per month to work on site during the past quarter from July to September 2017 was approx. 11,600 (TEPCO and partner company workers), which exceeded the monthly average number of actual workers (approx. 8,900). Accordingly, sufficient people are registered to work on site.
- It was confirmed with the prime contractors that the estimated manpower necessary for the work in December 2017 (approx. 5,290 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. 5,100 to 7,000 since FY2015 (see Figure 6). Some works for which contractual procedures have yet to be completed were excluded from the estimate for November 2017.
- The number of workers from outside Fukushima Prefecture has decreased. The local employment ratio (TEPCO and partner company workers) as of October has remained at around 60%.
- The monthly average exposure dose of workers remained at approx. 0.81 mSv/month during FY2014, approx. 0.59 mSv/month during FY2015 and approx. 0.39 mSv/month during FY2016. (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.

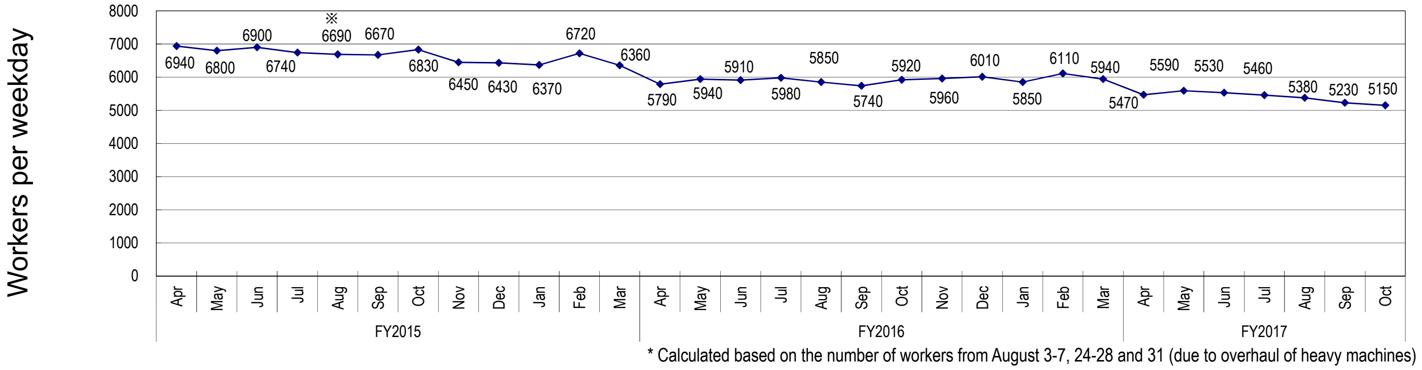


Figure 6: Changes in the average number of workers per weekday for each month since FY2015 (actual values)

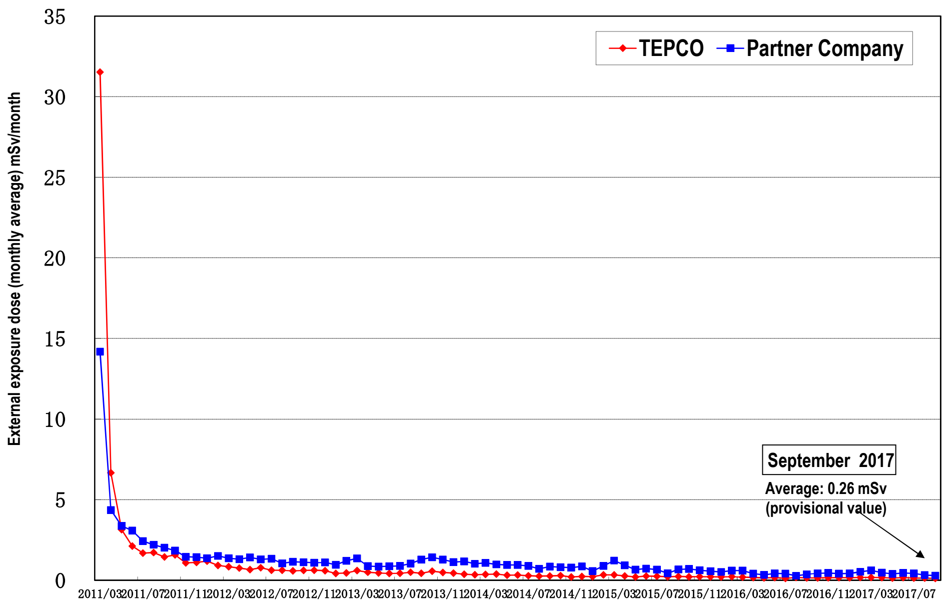


Figure 7: Changes in monthly individual worker exposure dose
(monthly average exposure dose since March 2011)

➢ Measures to prevent infection and expansion of influenza and norovirus

- Since November, measures for influenza and norovirus have been implemented, including free influenza vaccinations (subsidized by TEPCO HD) in the Fukushima Daiichi Nuclear Power Station (from October 25 to November 24) and medical clinics around the site (from November 1 to January 31, 2018) for partner company workers. As of November 24, a total of 5,334 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 possible patients and control of entry, mandatory wearing of masks in working spaces, etc.).

➢ Status of influenza and norovirus cases

- Until the 47th week of 2017 (November 20-26, 2017), one influenza infection and two norovirus infections were recorded. The totals for the same period for the previous season showed five cases of influenza and no norovirus infections.

8. Others

➢ Malfunction of the Unit 6 D/G 6A governor

- On October 30, when the Unit 6 emergency diesel generator A (hereinafter referred to as "D/G 6A") was activated for a periodical test, the governor failed to increase the rate (rotational speed) and D/G 6A was excluded from the list of standby functions. As a test operation on November 14 after replacing the governor motor confirmed no abnormality in the operation condition, D/G 6A recovered to the standby status.
- The failure of the governor motor was considered attributable to a short circuit resulting from crimp-type terminals of lead wires contacting each other in the terminal block. As a countermeasure, specific procedures to place lead wires to the terminal block were defined.

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 November 20-28)"; 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(0.28) Below 1/10
Cesium-137: 9.0 (2013/10/17) → 0.52 Below 1/10
Gross β: 74 (2013/ 8/19) → ND(17) Below 1/4
Tritium: 67 (2013/ 8/19) → 2.4 Below 1/20

Cesium-134: 4.4 (2013/12/24) → ND(0.22) Below 1/20
Cesium-137: 10 (2013/12/24) → ND(0.31) Below 1/30
Gross β: 60 (2013/ 7/ 4) → ND(17) Below 1/3
Tritium: 59 (2013/ 8/19) → 2.7 Below 1/20

Cesium-134: 5.0 (2013/12/2) → ND(0.29) Below 1/10
Cesium-137: 8.4 (2013/12/2) → ND(0.36) Below 1/20
Gross β: 69 (2013/8/19) → 21 Below 1/3
Tritium: 52 (2013/8/19) → 2.8 Below 1/10

Cesium-134: 2.8 (2013/12/2) → ND(0.56) Below 1/5
Cesium-137: 5.8 (2013/12/2) → ND(0.44) Below 1/10
Gross β: 46 (2013/8/19) → 18 Below 1/2
Tritium: 24 (2013/8/19) → ND(2.6) Below 1/9

Cesium-134: ND(0.55)
Cesium-137: ND(0.45)
Gross β: ND(17)
Tritium: 2.0 *

Cesium-134: 3.3 (2013/12/24) → ND(0.50) Below 1/6
Cesium-137: 7.3 (2013/10/11) → ND(0.46) Below 1/10
Gross β: 69 (2013/ 8/19) → ND(17) Below 1/4
Tritium: 68 (2013/ 8/19) → 1.9 Below 1/30

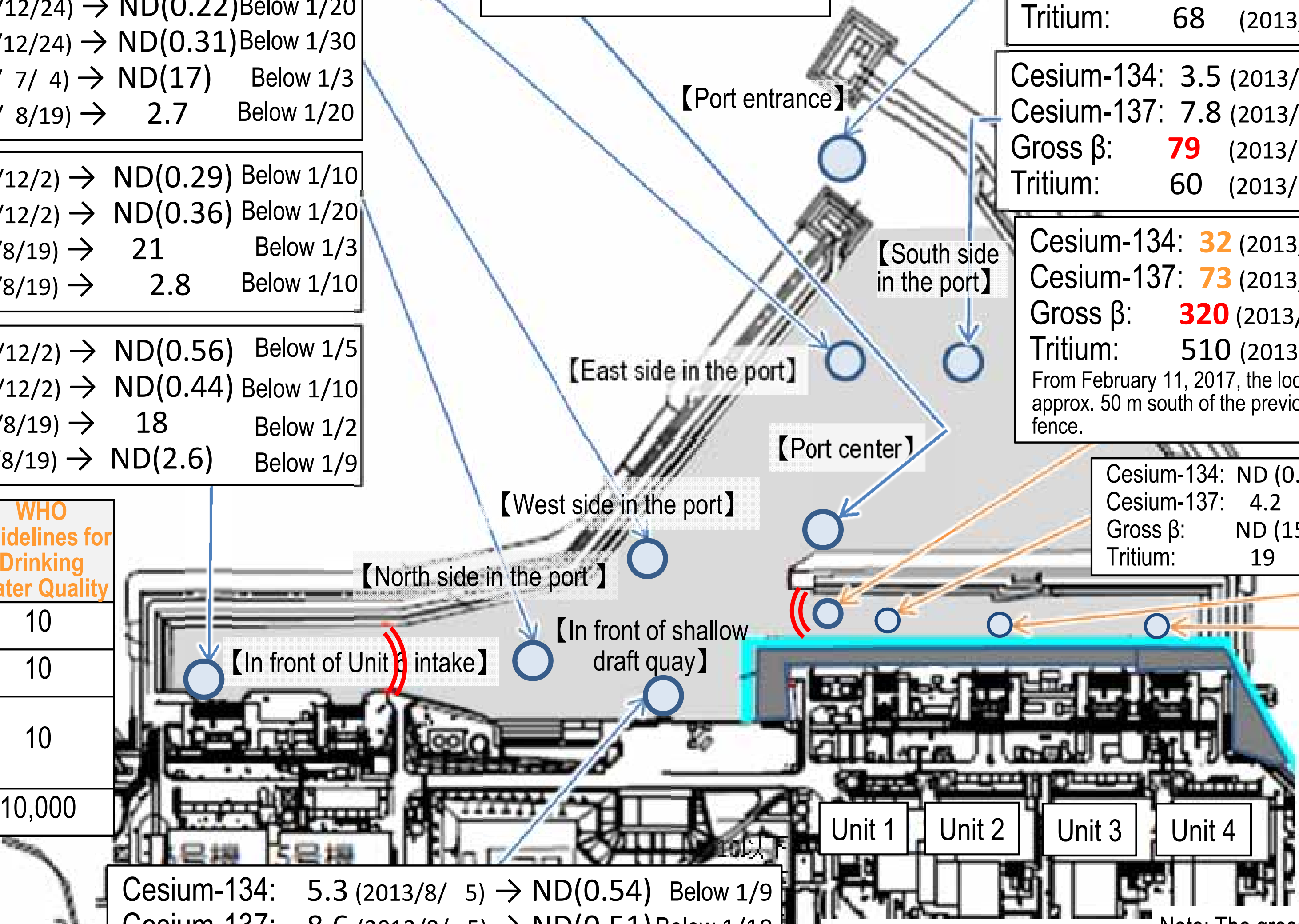
Cesium-134: 3.5 (2013/10/17) → ND(0.27) Below 1/10
Cesium-137: 7.8 (2013/10/17) → ND(0.31) Below 1/20
Gross β: 79 (2013/ 8/19) → ND(17) Below 1/4
Tritium: 60 (2013/ 8/19) → 3.0 Below 1/20

Cesium-134: 32 (2013/10/11) → 0.66 Below 1/40
Cesium-137: 73 (2013/10/11) → 3.3 Below 1/20
Gross β: 320 (2013/ 8/12) → ND(15) Below 1/20
Tritium: 510 (2013/ 9/ 2) → 20 Below 1/20
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 (0.49)
Cesium-137: 4.2
Gross β: ND (15)
Tritium: 19 *

Cesium-134: ND (0.95)
Cesium-137: 3.7
Gross β: ND (15)
Tritium: 19 *

Cesium-134: ND (0.61)
Cesium-137: 4.3
Gross β: ND (15)
Tritium: 18 *



	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

Cesium-134: 5.3 (2013/8/ 5) → ND(0.54) Below 1/9
Cesium-137: 8.6 (2013/8/ 5) → ND(0.51) Below 1/10
Gross β: 40 (2013/7/ 3) → ND(15) Below 1/2
Tritium: 340 (2013/6/26) → 1.9 Below 1/100

* Monitoring commenced in or after March 2014.
Monitoring inside the sea-side impermeable walls was finished because of the landfill.

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.

Summary of TEPCO data as of November 29, 2017

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 November 20-28)

	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 (0.71)
Cesium-137: ND (2013) → ND (0.59)
Gross β: ND (2013) → ND (15)
Tritium: ND (2013) → ND (1.7)

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

Cesium-134: ND (2013) → ND (0.82)
Cesium-137: 1.6 (2013/10/18) → ND (0.71) Below 1/2
Gross β: ND (2013) → ND (15)
Tritium: 6.4 (2013/10/18) → ND (1.7) Below 1/3

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

Cesium-134: ND (2013) → ND (0.73)
Cesium-137: ND (2013) → ND (0.65)
Gross β: ND (2013) → ND (15)
Tritium: ND (2013) → ND (1.7)

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

Cesium-134: ND (2013) → ND (0.71)
Cesium-137: ND (2013) → ND (0.68)
Gross β: ND (2013) → ND (15)
Tritium: 4.7 (2013/ 8/18) → ND (1.7) Below 1/2

【Port entrance】

Cesium-134: 3.3 (2013/12/24) →ND (0.50) Below 1/6
Cesium-137: 7.3 (2013/10/11) →ND (0.46) Below 1/10
Gross β: 69 (2013/ 8/19) →ND (17) Below 1/4
Tritium: 68 (2013/ 8/19) → 1.9 Below 1/30

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

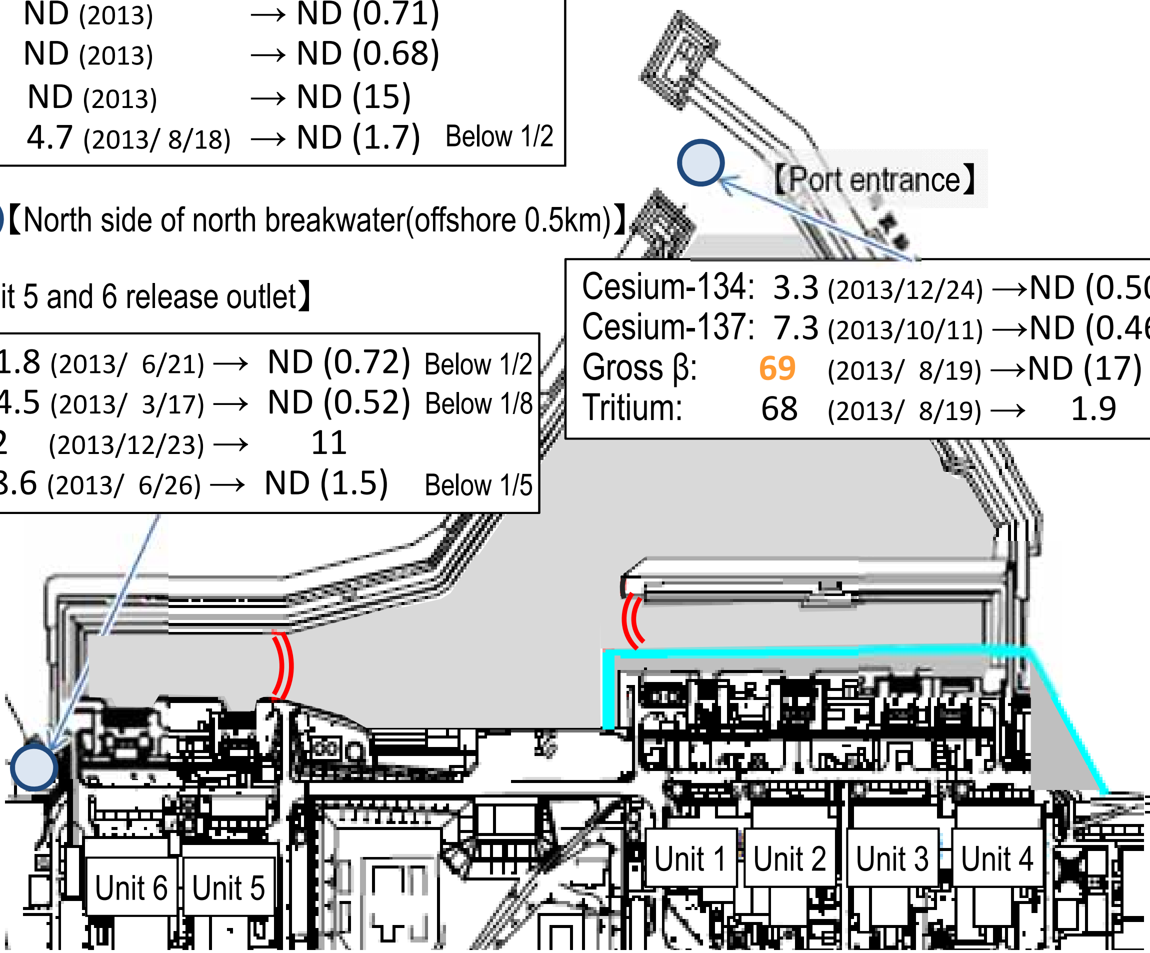
Cesium-134: ND (2013) → ND (0.59)
Cesium-137: ND (2013) → ND (0.54)
Gross β: ND (2013) → ND (15)
Tritium: ND (2013) → ND (1.7)

【North side of Unit 5 and 6 release outlet】

Cesium-134: 1.8 (2013/ 6/21) → ND (0.72) Below 1/2
Cesium-137: 4.5 (2013/ 3/17) → ND (0.52) Below 1/8
Gross β: 12 (2013/12/23) → 11
Tritium: 8.6 (2013/ 6/26) → ND (1.5) Below 1/5

【Near south release outlet】

Cesium-134: ND (2013) → ND (0.71)
Cesium-137: 3.0 (2013/ 7/15) → ND (0.63) Below 1/4
Gross β: 15 (2013/12/23) → 13
Tritium: 1.9 (2013/11/25) → ND (1.6)



Sea side impermeable wall

Silt fence

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.

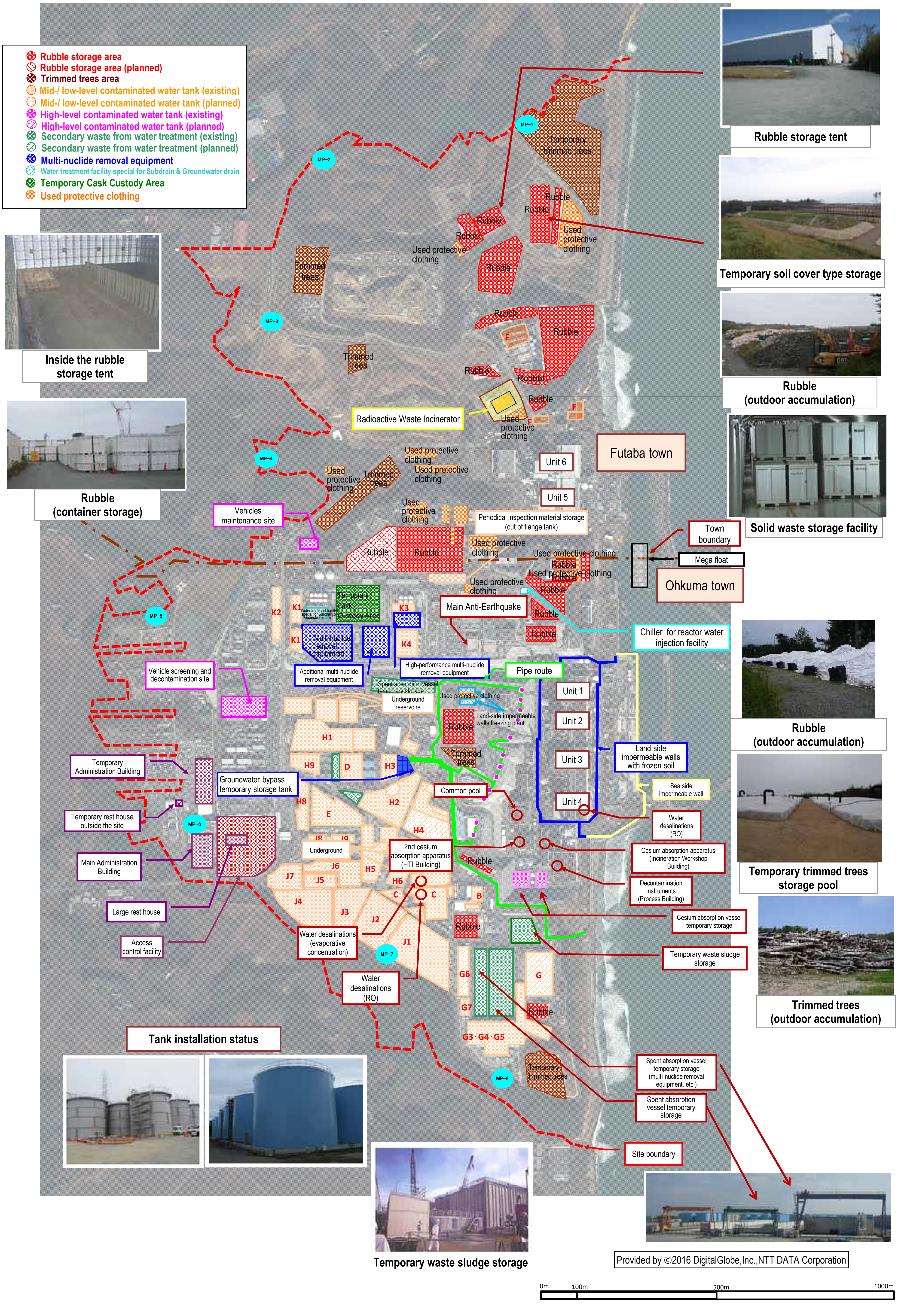
Note: Because safety of the sampling points was unassured due to the influence of Typhoon No. 10 in 2016, samples were taken from approx. 330 m south of the Unit 1-4 release outlet. From January 27, 2017, the location of the sampling point was also shifted approx. 280 m south of the Unit 1-4 release outlet.

Summary of TEPCO data as of November 29, 2017

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
November 30, 2017

TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site



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).

All roof panels and wall panels of the building cover were dismantled by November 10, 2016.

Removal of pillars and beams of the building was completed on May 11. Modification of the pillars and beams (including windbreak fence) will follow.

Prior to formulating a work plan for rubble removal, additional investigation into rubble status on the operating floor is underway.

Thorough monitoring of radioactive materials will continue.

<Dismantling of wall panels>

Flow of building cover dismantling

Unit 2

To facilitate removal of fuel assemblies and 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 fuel debris; and Plan 2 to install a dedicated cover for fuel removal from the pool.

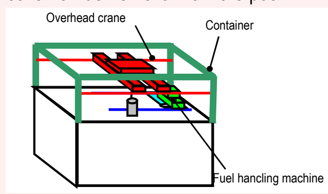


Image of Plan 1

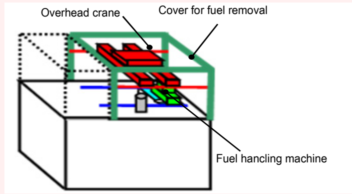


Image of Plan 2

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 dome roof (November 12)

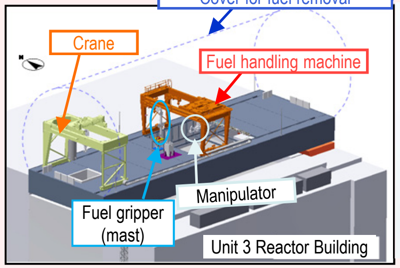


Image of entire fuel handling facility inside the cover

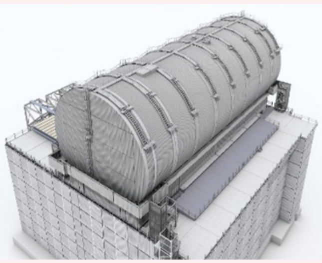


Image of the cover for fuel removal

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 remove the fuel, 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)

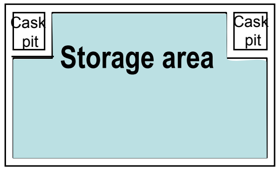
This marks the completion of fuel removal from the Unit 4 Reactor Building.

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

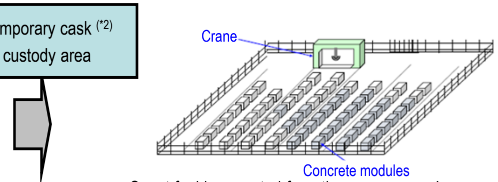


An open space will be maintained in the common pool (Transfer to the temporary cask custody area)

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 removed 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 removal

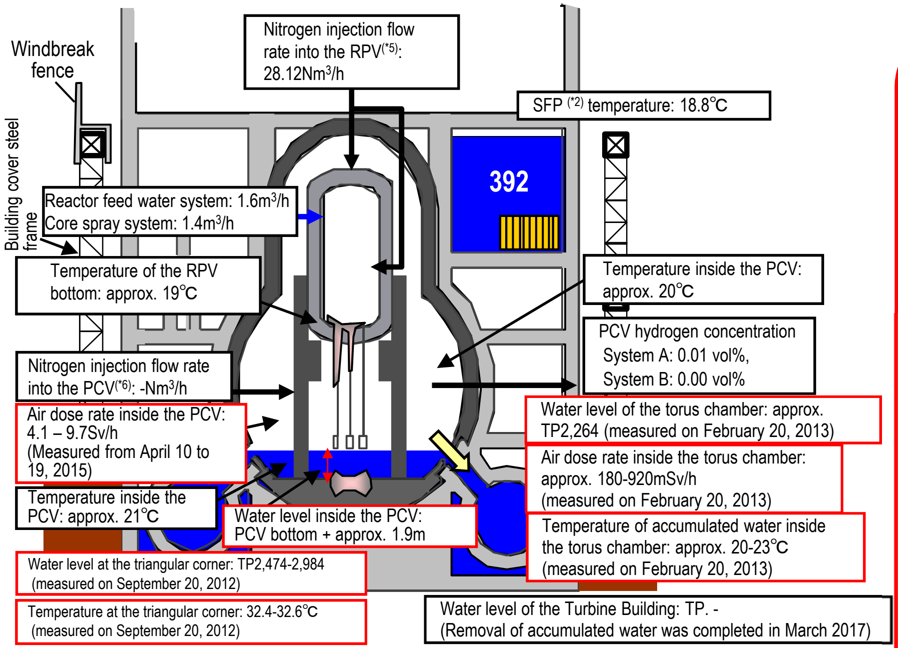
Immediate target	Identify the plant status and commence R&D and decontamination toward fuel debris retrieval

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.

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, November 29, 2017

Investigations inside PCV	1st (Oct 2012)	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling accumulated 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)

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

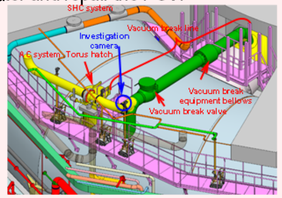


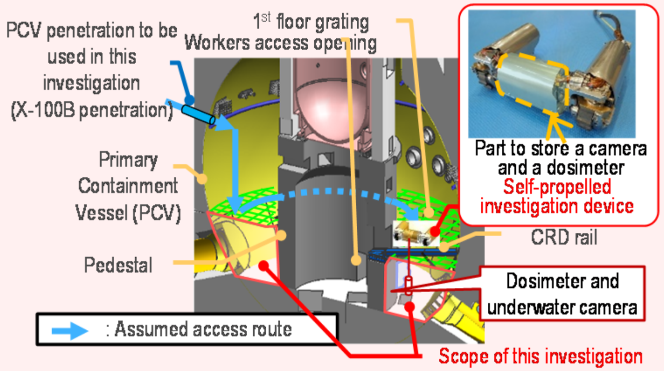
Image of the S/C upper part investigation

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>

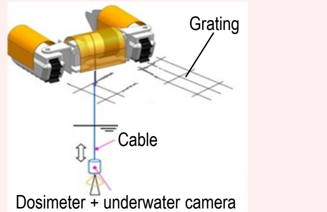


Image of hanging of dosimeter and camera

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 removal

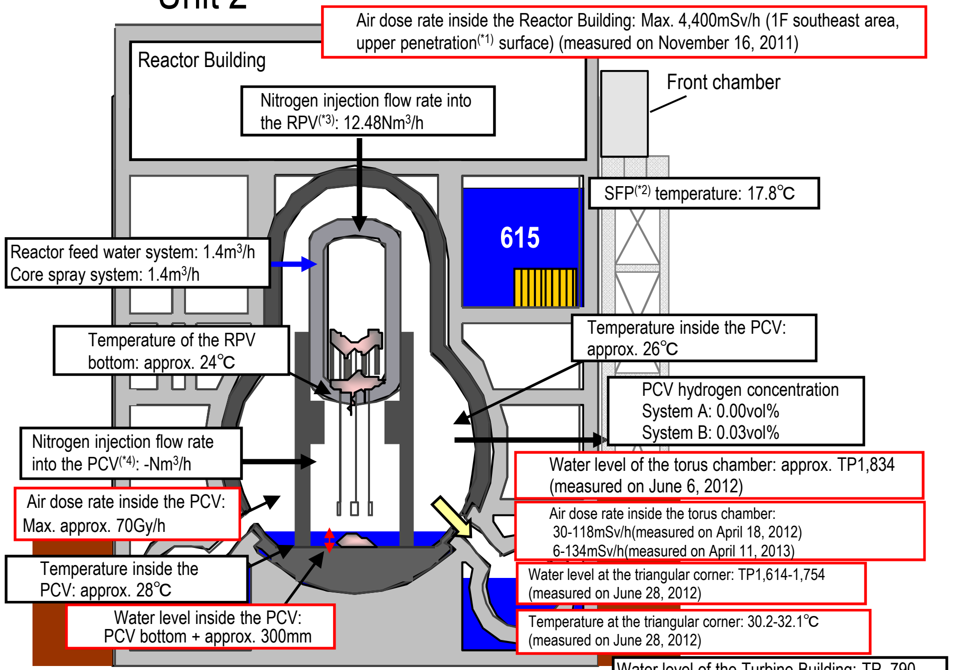
Immediate target	Identify the plant status and commence R&D and decontamination toward fuel debris retrieval

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.
- On April 2014, removal of the broken thermometer failed and was suspended. Rust-stripping chemicals were injected and the broken thermometer was removed on January 2015. A new thermometer was reinstalled on 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 on May 2014 and new instruments were reinstalled on 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

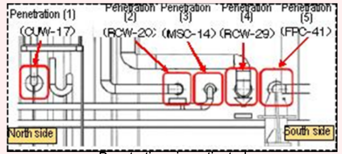


* Indices related to plant are values as of 11:00, November 29, 2017

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 accumulated 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

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

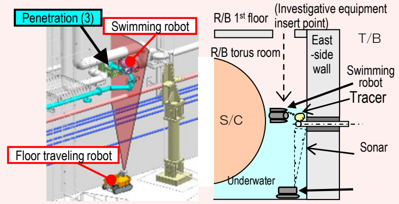


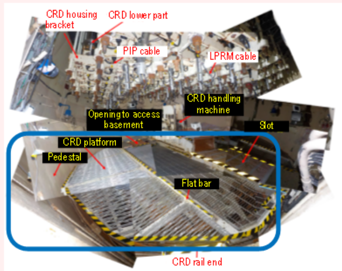
Image of the torus chamber east-side cross-sectional investigation

Status of investigation inside the PCV

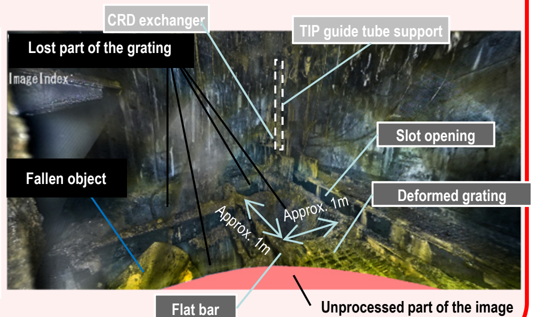
Prior to fuel debris retrieval, an investigation inside the PCV will be conducted to inspect the status there including the location of fuel debris.

[Investigative outline]
- A robot, injected from Unit 2 X-6 penetration(*1), will 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. From January 2018, the status under the platform where fuel debris potentially existed will be investigated by the upgraded telescopic type investigative device which was used in the previous investigation (January – February 2017).



(Reference) Inside the Unit 5 pedestal



Scope of investigation inside the PCV

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 removal

November 30, 2017
Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

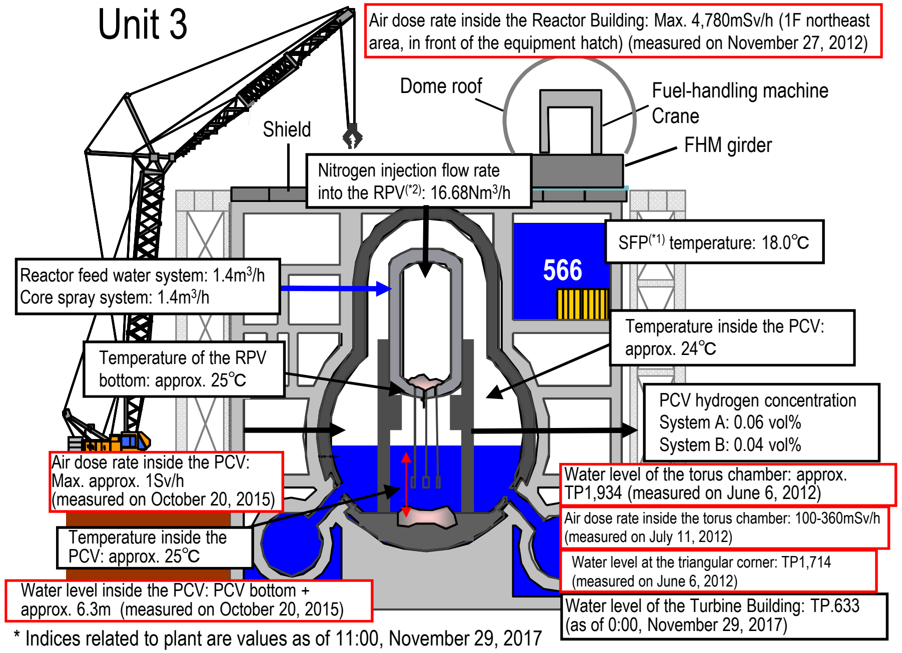
Immediate target	Identify the plant status and commence R&D and decontamination toward fuel debris retrieval

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

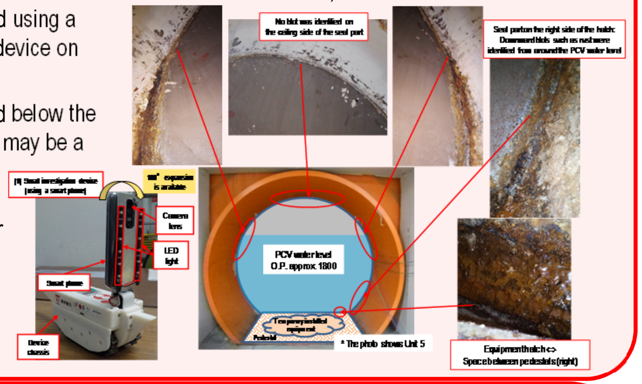


* Indices related to plant are values as of 11:00, November 29, 2017

Investigations inside PCV	1st (Oct – Dec 2015)	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling accumulated 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.

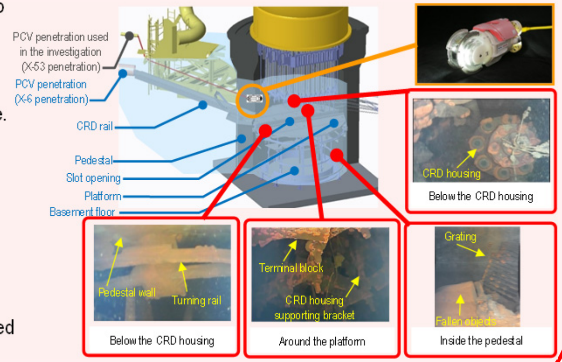


Investigation inside the PCV

Prior to removing fuel debris, 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 accumulated 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 debris removal based on the obtained information will continue.



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.

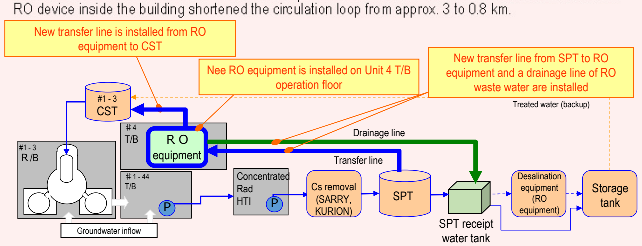
<Glossary>
(*1) SFP (Spent Fuel Pool) (*2) RPV (Reactor Pressure Vessel) (*3) PCV (Primary Containment Vessel) (*4) Penetration: Through-hole of the PCV

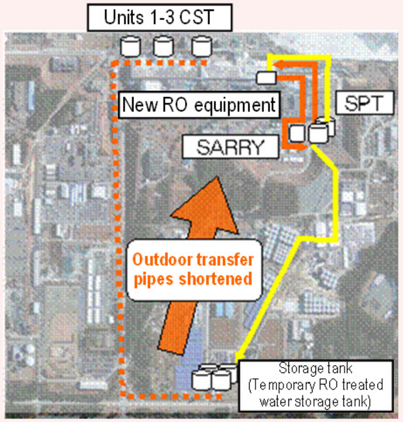
Progress toward decommissioning: Work related to circulation cooling and accumulated water treatment line

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

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





* 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 flange tanks, dismantling of flange tanks started in H1 east/H2 areas in May 2015. Dismantling of all flange tanks was completed in H1 east area (12 tanks) in October 2015, in H2 area (28 tanks) in March 2016 and in H4 area (56 tanks) in May 2017 and in H3 B area (31 tanks) in September 2017. Dismantling of flange tanks in H5 and H6 areas is underway.

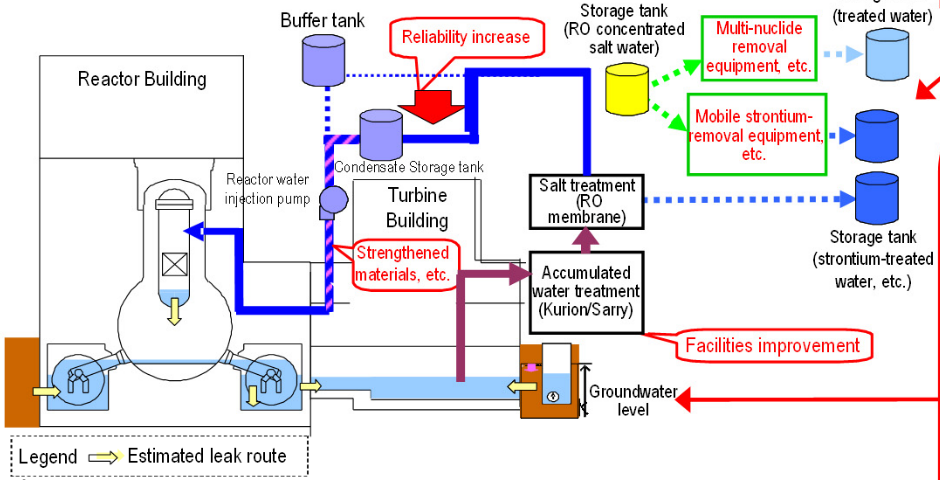

Start of dismantling in H1 east area

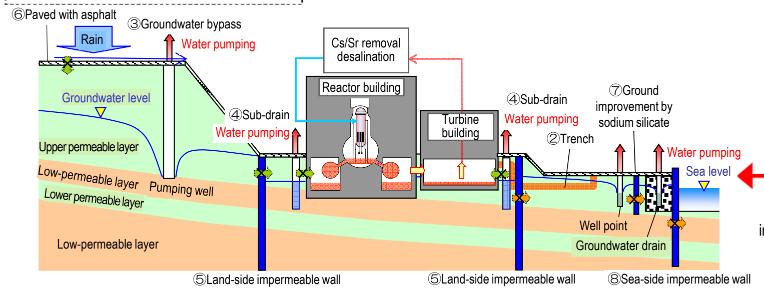

After dismantling in H1 east area

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

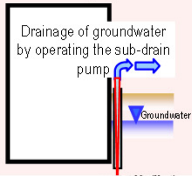
Contaminated water (RO concentrated salt water) is being treated using seven types of equipment including the multi-nuclide removal equipment (ALPS). Treatment of the RO concentrated salt water was completed on May 27, 2015, with the exception of the remaining water at the tank bottom. The remaining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



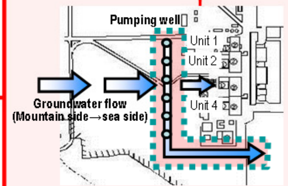


Preventing groundwater from flowing into the Reactor Buildings



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.

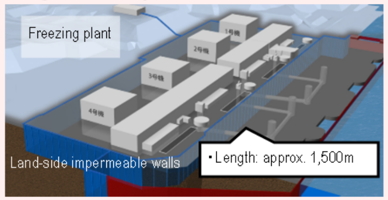
The pumped up groundwater is temporarily stored in tanks and released after TEPCO and a third-party organization have confirmed that its quality meets operational targets.

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. On the sea side, the underground temperature declined 0°C or less throughout the scope requiring freezing except for the unfrozen parts under the sea-water pipe trenches and the areas above groundwater level in October 2016.

Freezing started for two of seven unfrozen sections on the mountain side from December 2016, and four of the remaining five unfrozen sections from March 2017. Freezing of the remaining unfrozen section started in August 2017.

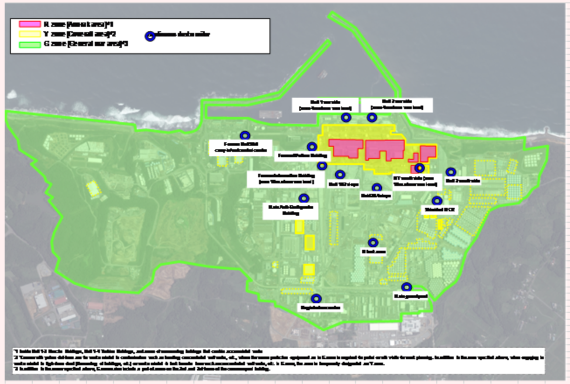
Progress toward decommissioning: Work to improve the environment within the site

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

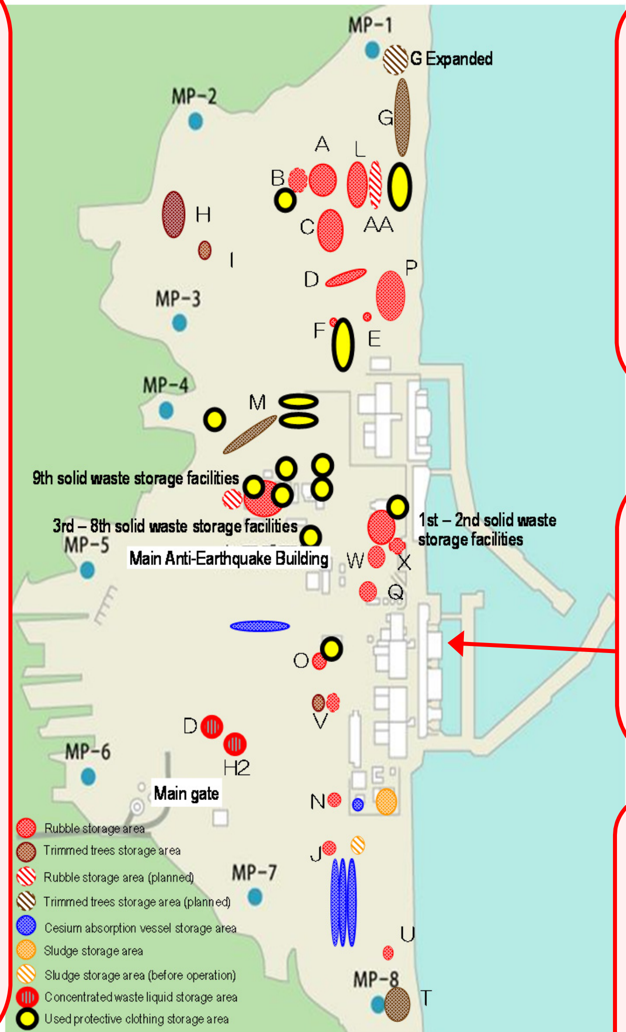
Based on the progress of measures to reduce environmental dosage on site, the site is categorized into two zones: highly contaminated area around Unit 1-4 buildings, etc. and other areas to optimize protective equipment according to each category aiming at improving safety and productivity by reducing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

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



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.