Summary of Decommissioning and Contaminated Water Management

May 31, 2018

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

Main decommissioning works and steps

All fuel had been removed from Unit 4 SFP by December 22, 2014. Work continues toward fuel removal and debris (Note 1) retrieval from Unit 1-3.

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

Fuel Removal from SFP

Units 1 & 2 / Unit 3 / Unit 4

Rubble removal & dose reduction → Installing a Fuel removal handling machine → Fuel removal → 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.

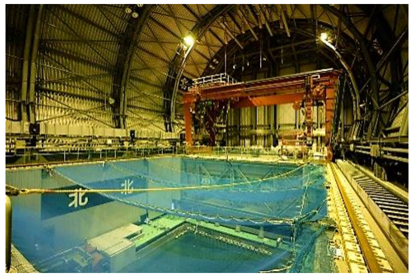
Dismantling Facilities

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

Toward fuel removal from the spent fuel pool

Toward fuel removal from Unit 3 SFP in mid-FY2018, works are underway with safety first.

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 fuel removal cover started from January 2017 and installation of all dome roofs was completed in February 2018.



Statius inside the cover for fuel removal (March 15, 2018)

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

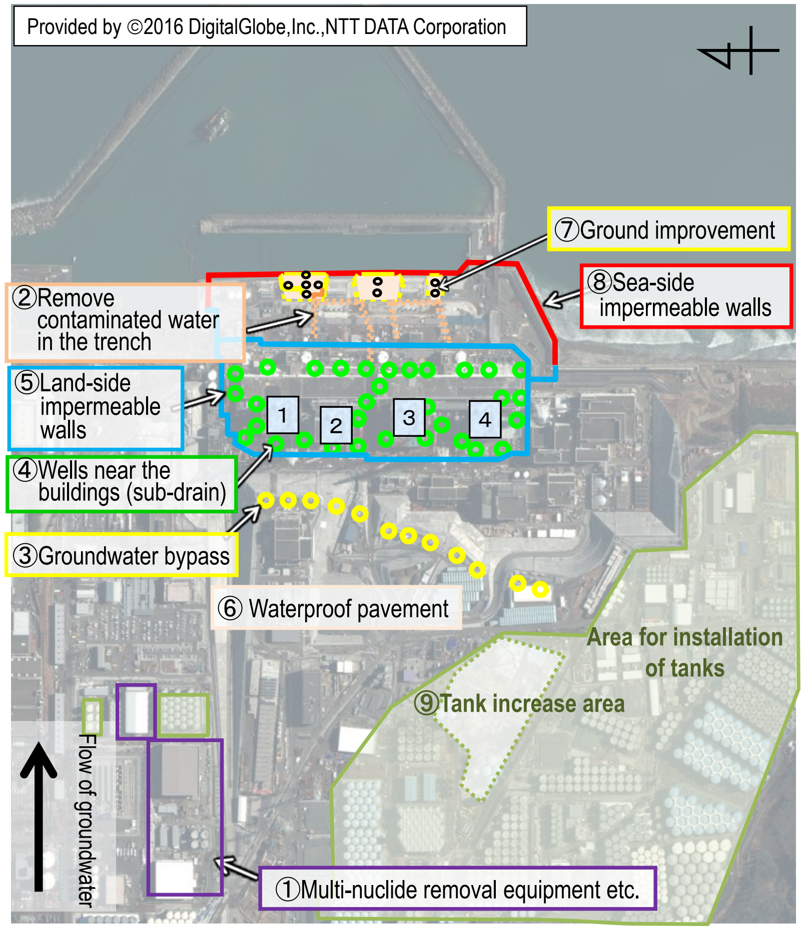
⑥ Waterproof pavement

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.
- 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℃ 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 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.

(Inside of the land-side impermeable wall)

(Outside of the land-side impermeable wall)

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)

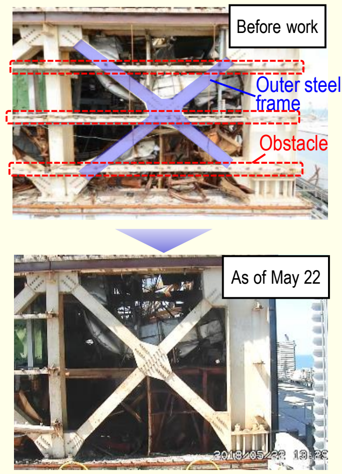
Progress status

◆ 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. 20-30°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 April 2018, the radiation exposure dose due to the release of radioactive materials from the Unit 1-4 Reactor Buildings was evaluated as less than 0.00023 mSv/year at the site boundary. The annual radiation dose from natural radiation is approx. 2.1 mSv/year (average in Japan).

Status toward fuel removal at Unit 1

As preparatory work to remove fuel from the Unit 1 spent fuel pool, rubble is being removed from the north side on the operating floor north side. Around the south side area of the operating floor in which the spent fuel pool is located, fuel assemblies may be damaged by rubble falling into the pool during the work. Preparatory work to protect the pool, etc. started on May 10. Obstacles which may interfere with the pool protection work are being removed carefully using equipment and a method to minimize the amount of dust generated. Removal of obstacles will continue. After installing cameras, etc. to monitor the work status, outer steel frames will be removed. Work will continue with safety first.



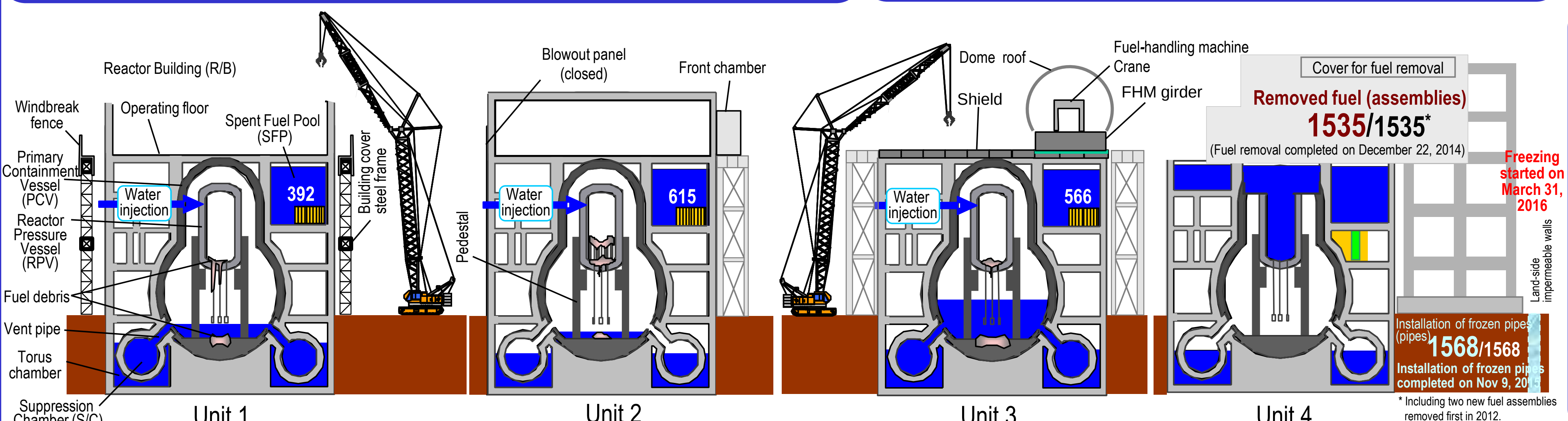
Status of rubble removal

Installation status of Unit 2 R/B west-side opening and future plan

As a part of preparation to remove fuel from the Unit 2 spent fuel pool, the inside of the operating floor will be investigated and work will be implemented to determine its status. Prior to the investigation, an opening which would allow access to the inside of the operating floor will be formed. Work to dismantle the wall using remote-controlled heavy machines started from May 28 in the front room. Appropriate measures to suppress dust scattering are being implemented during the work. No significant variation was detected in the dust density, etc. After forming an opening, the inside of the operating floor will be investigated, such as by acquiring images using a camera mounted on a remote-controlled robot, from late June. The results obtained in the investigation will be reflected in the work plan and the schedule to help examination toward fuel removal.

Status toward fuel removal at Unit 3

To help remove fuel from the Unit 3 spent fuel pool, a test operation of the fuel handling machine started on March 15. However, a failure was detected in the control panel of a crane which carried the transportation container for removed fuel, etc. from the operating floor to the ground. The cause is currently being investigated while the test operation of equipment except the crane continues as scheduled. After identifying the cause of the failure and examining the safety measures required, the process will be reviewed.

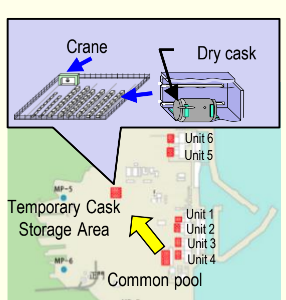


Communication failure of the subdrain water-level monitor

For water levels of subdrains installed around the Unit 1-4 buildings, monitoring from the Main Anti-Earthquake Building was suspended due to communication cables failing on May 18. After investigating the status of the location and replacing them with spare cables the same day, monitoring of water levels from the Main Anti-Earthquake Building resumed. An onsite inspection confirmed that subdrain water levels necessary to prevent stagnant water leaking had been maintained and no abnormality was detected during the monitoring suspension.

Transfer of spent fuel from the common pool to the Temporary Cask Custody Area

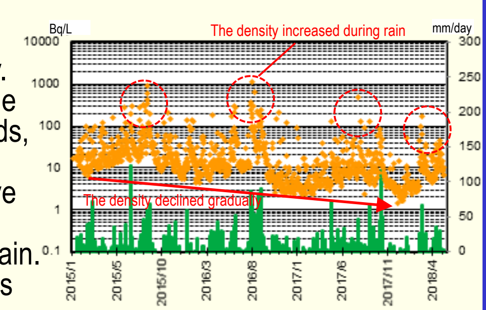
Fuel assemblies removed from the Unit 3 spent fuel pool will be transferred and stored in the common pool. To make space for the storage, a portion of fuel assemblies currently stored in the common pool are being transferred to the Temporary Cask Custody Area within the site from May 27. In the Temporary Cask Custody Area, to prevent any influence on the areas around the site, fuel assemblies will be stored under a stable conditions in dedicated containers (dry casks), which allow heat to be dissipated via by natural convection, shielding, etc. Preparation for fuel removal will continue.



Layout overview of the site

Measures to reduce the density in K drainage channel

In K drainage channel, which drained rainwater around Units 1-4, the density of drainage radioactive materials exceeded that of other drainage channels. The channel was investigated to identify the contamination source and measures were implemented to decline the density. Measures were conducted for each of the areas, such as the building roof and roads, as the investigation progressed. After implementation, the density of radioactive materials was found to be gradually declining except for an increase during rain. Measures for drainage channels, such as eliminating contamination sources to further reduce the density, will continue.



Cesium density in K drainage channel

Consideration toward investigation inside the Unit 2 PCV

Based on the results obtained in the investigation inside the Primary Containment Vessel (PCV) in January, examination is underway as part of an investigation to understand detailed conditions over a wider scope than in previous investigations. During the next investigation, a larger piece of equipment mounting instruments for 3D measurement will be used to collect information such as the location and distribution of deposits, including debris, which will be needed when examining fuel debris retrieval. Examination will continue while reviewing requirements to ensure safety, such as shielding to prevent excessive exposure.

Major initiatives – Locations on site

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* Data of Monitoring Posts (MP1-MP8.)

Data (10-minute values) of Monitoring Posts (MPs) measuring the airborne radiation rate around site boundaries showed 0.445 – 1.680 μSv/h (April 25 – May 29, 2018).

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.

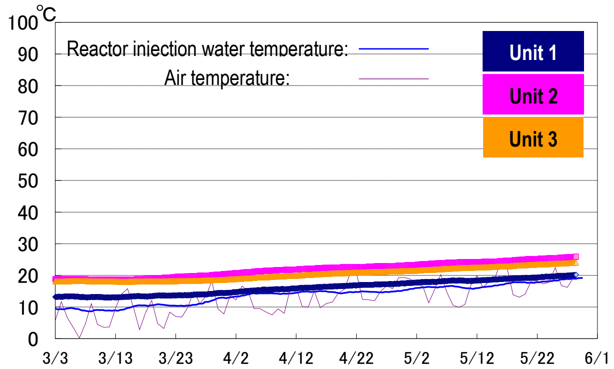
Therefore monitoring results at these points are lower than elsewhere in the power plant site.

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. ha*d* caused the surrounding radiation dose to decline significantly.

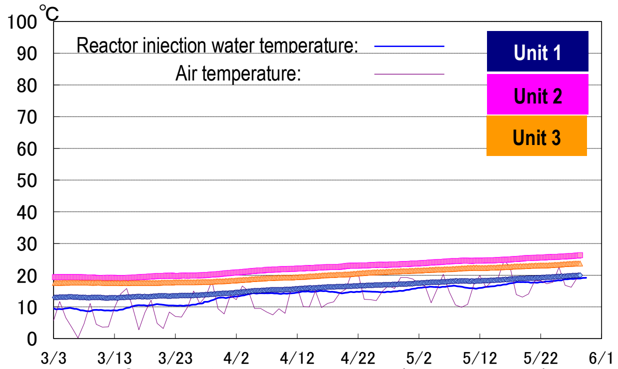
I. Confirmation of the reactor conditions

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



RPV bottom temperatures (recent quarter)



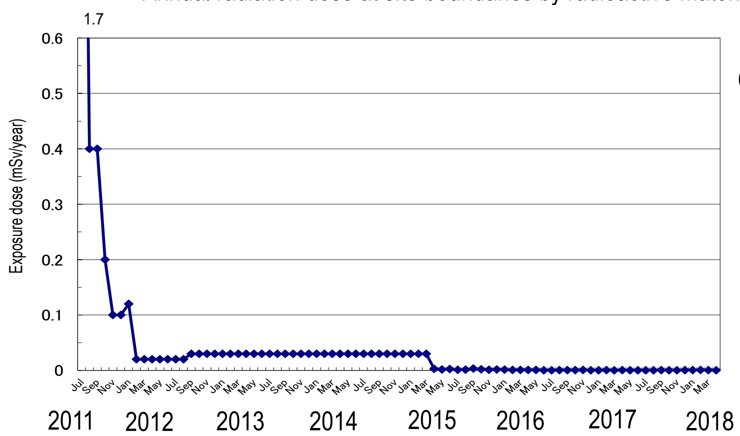
PCV gas phase temperatures (recent quarter)

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

2. Release of radioactive materials from the Reactor Buildings

As of April 2018, 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. 1.6×10^{-12} Bq/cm³ for Cs-134 and 6.4×10^{-12} Bq/cm³ for Cs-137, while the radiation exposure dose due to the release of radioactive materials there was less than 0.00023 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 0.445 – 1.680 μSv/h (April 25 – May 29, 2018)
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 stagnant 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 May 29, 2018, 379,255 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 May 29, 2018, a total of 537,058 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 May 29, 2018, a total of approx. 177,853 m³ had been pumped up and a volume of approx. less than 10 m³/day is being transferred from the groundwater drain to the Turbine Buildings (average for the period April 19 – May 23, 2018).
- As one of the multi-layered contaminated water management measures, in addition to waterproof pavement (facing) to prevent rainwater infiltrating into the ground, etc., facilities to enhance the subdrain treatment system were installed and went into operation from April 2018. These facilities increase the treatment capacity to 1,500 m³ and improve reliability.
- 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: 12 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 an 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 but increased during rainfall.

➢ Failure of remote monitoring of the subdrain water levels

- For water levels of subdrains installed around the Unit 1-4 buildings, monitoring from the Main Anti-Earthquake Building was suspended due to communication cables failing on May 18. After investigating the status of the location and replacing them with spare cables the same day, monitoring of water levels from the Main Anti-Earthquake Building resumed.
- An onsite inspection confirmed that subdrain water levels necessary to prevent stagnant water leaking had been maintained and no abnormality was detected during the monitoring suspension.

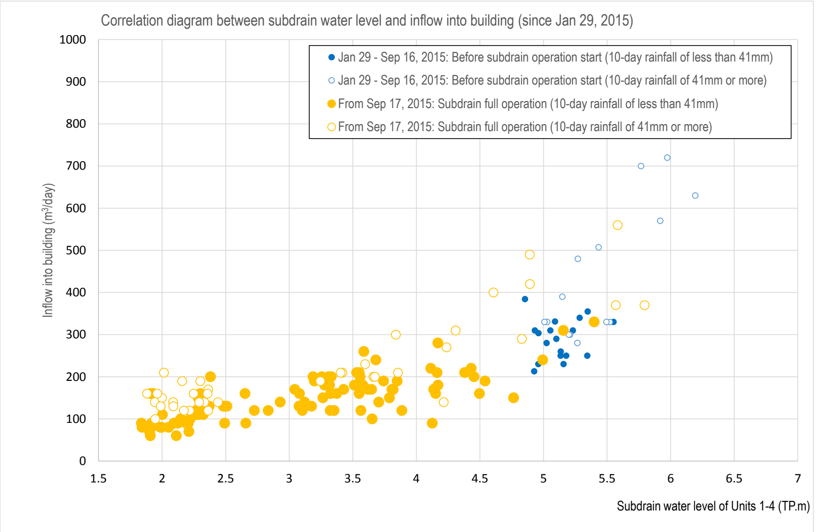


Figure 1: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Unit 1-4 subdrains

- 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, 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 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.

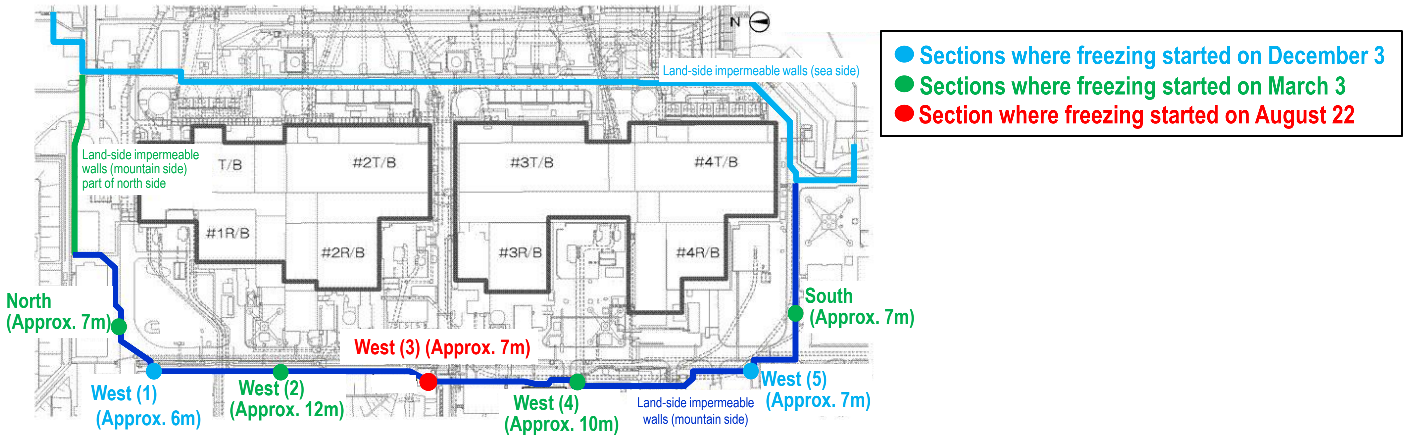
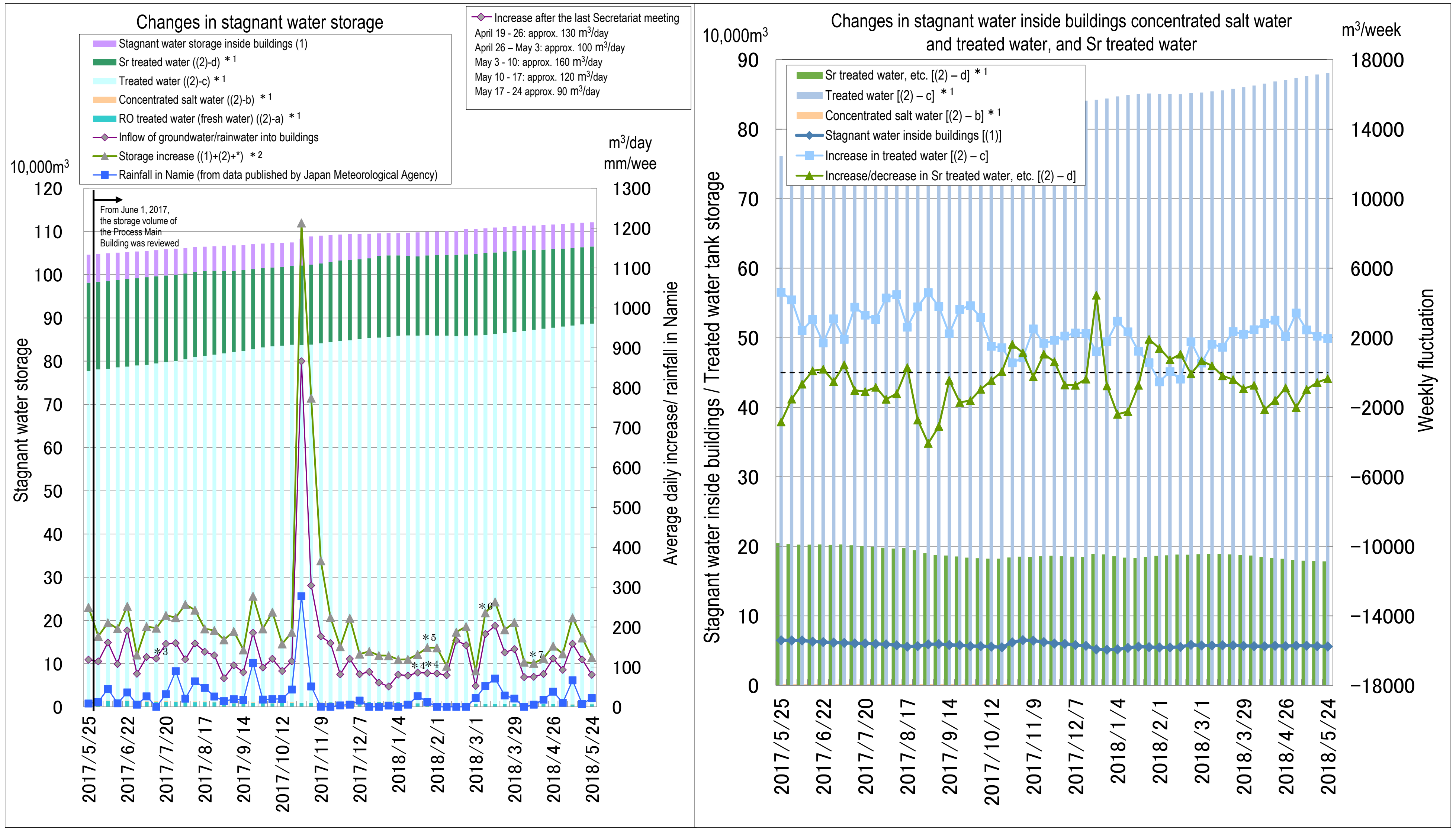


Figure 2: Closure of part of the land-side impermeable walls (on the mountain side)

➢ Construction status of the land-side impermeable walls

- A maintenance operation for the land-side impermeable walls to prevent frozen soil from thickening further has 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 maintenance operation range was expanded in March 2018.



As of May 24, 2018

*1: Water amount for which the water-level gauge indicates 0% or more
*2: To improve the accuracy of storage increase, the calculation method was reviewed as follows from February 9, 2017: (The revised method became effective from March 1, 2018)
[(Inflow of groundwater/rainwater into buildings) + (other transfer) + (chemical injection into ALPS)]
*3: 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 lower than assumed.
*4: Reevaluated by adding groundwater and rainwater inflow into the residual water areas (January 18 and 25, 2018)
*5: Reviewed because SARRY reverse cleaning water was added to "Storage increase." (January 25, 2018)
*6: The effect of calibration for the building water-level gauge was included in the following period: March 1-8, 2018 (Unit 3 Turbine Building).
*7: The method to calculate the chemical injection into ALPS was reviewed as follows: (Additional ALPS: The revised method became effective from April 12, 2018)
[(Outlet integrated flow rate) – (inlet integrated flow rate) – (sodium carbonate injection rate)]

Figure 3: Status of stagnant water storage

➢ 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 May 24, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 376,000, 435,000 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 May 24, 451,000 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 May 24, approx. 450,000 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 May 28, 2018, a total of 104,326 m³).

➢ Drippage from the pH meter of the existing ALPS coprecipitation tank

- On May 16, 2018, drippage was detected from a bag covering the pH meter of the existing ALPS coprecipitation tank. The leakage amount was approx. 1 × 2 cm. After closing the valves between which the pH meter was located, the drippage was confirmed as having ceased.
- The drippage was considered attributable to insufficient tightening during an inspection of the pH meter in April or the inclusion of a replaced O-ring.
- The pH meter will be overhauled.

➢ Leakage around the pH skid of the additional ALPS coprecipitation tank (B)

- On May 17, 2018, a puddle (approx. 50 cm × 50 cm × 1 mm) was detected around the coprecipitation tank inside the additional ALPS building.
- The puddle remained within the coprecipitation tank (B) pH skid of the building and no external leakage was detected.
- An investigation of the leakage part detected oozing from the gland of the bypass flow rate adjustment valve. After tightening the gland, the oozing was confirmed as having ceased.

➢ Oozing at the G3 west tank connection valve gland

- On May 21, 2018, a partner company worker detected oozing at the gland of a connection valve between tanks in the G3 west tank area storing strontium water.
- The ooze remained within the upper part (a plate for the insulator) of the connection valve cover and no leakage inside the fences was detected.
- After tightening and wiping the valve gland, the oozing was confirmed as having ceased.

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.
- As preparatory work to remove fuel from the Unit 1 spent fuel pool, rubble removal on the operating floor north side started from January 22.
- 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.
- Removed rubble is stored in solid waste storage facilities or elsewhere depending on the dose level.
- As preparatory work to remove fuel from the spent fuel pool, rubble is being removed from the north side on the operating floor.
- Around the south side area of the operating floor housing the spent fuel pool, fuel assemblies may be damaged by rubble falling into the pool during the work. Preparatory work to protect the pool, etc. started on May 10.
- Obstacles which may interfere with the pool protection work are being removed carefully using equipment and a method which minimizes the amount of dust generated.
- Removal of obstacles will continue. After installing cameras, etc. to monitor the work status, outer steel frames will be removed.

➢ Main work to help spent fuel removal at Unit 2

- As a part of preparation to remove fuel from the spent fuel pool, work to form an opening which would allow access to the inside of the operating floor started on April 16. A hole approx. 10 cm in diameter was made in a wall of the Reactor Building (core penetration) to inspect the contamination status on the inner wall. The result confirmed that the contamination density was equivalent to that on the 1st floor of the Reactor Building, which had been entered previously.
- As part of preparation to remove fuel from the spent fuel pool, the inside of the operating floor will be investigated and work will be implemented to determine its status.
- Prior to the investigation, an opening which would allow access to the inside of the operating floor will be formed. Work to dismantle the wall using remote-controlled heavy machines started from May 28 in the front room.
- Appropriate measures to suppress dust scattering are being implemented during the work. No significant variation was detected in the dust density, etc.
- After forming an opening, the inside of the operating floor will be investigated, such as by acquiring images using a camera mounted on a remote-controlled robot, from late June. The results obtained in the investigation will be reflected in the work plan and the schedule to help examination toward fuel removal.

➢ Main work to help remove spent fuel at Unit 3

- Installation of all dome roofs for the Unit 3 fuel removal cover was completed on February 23, 2018.
- To help remove fuel from the spent fuel pool, test operation of the fuel handling machine started on March 15. However, a failure was detected in the control panel of a crane which carried the transportation container for removed fuel, etc. from the operating floor to the ground. The cause is currently being investigated while the test operation of equipment, except for the crane, continues as scheduled.
- After identifying the cause of the failure and examining the safety measures required, the process will be reviewed.

➢ Internal transportation of spent fuel from the common pool to the Temporary Cask Custody Area

- Fuel assemblies removed from the Unit 3 spent fuel pool will be transferred and stored in the common pool.
- To make space for the storage, a portion of fuel assemblies currently stored in the common pool are being transferred to the Temporary Cask Custody Area within the site from May 27.
- In the Temporary Cask Custody Area, to prevent any influence on the areas around the site, fuel assemblies will be stored under stable conditions in dedicated containers (dry casks), which allow heat to be dissipated via natural convection, shielding, etc.

3. Retrieval of fuel debris

➢ Investigative results inside the Unit 2 PCV

- Based on the results obtained in the investigation inside the Primary Containment Vessel (PCV) in January, examination is underway as a part of an investigation to understand detailed conditions over a wider scope than in previous investigations.
- During the next investigation, a larger piece of equipment mounting instruments for 3D measurement will be used to collect information such as the location and distribution of deposits, including debris, which will be needed when examining fuel debris retrieval.
- Examination will continue while reviewing requirements to ensure safety, such as shielding to prevent excessive exposure.

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 tree

- As of the end of April 2018, the total storage volume of concrete and metal rubble was approx. 242,000 m³ (+4,700 m³ compared to at the end of March, with an area-occupation rate of 61%). The total storage volume of trimmed trees was approx. 133,900 m³ (- m³, with an area-occupation rate of 76%). The total storage volume of used protective clothing was approx. 56,000 m³ (-3,700 m³, with an area-occupation rate of 79%). The increase in rubble was mainly attributable to construction to install tanks, work related to rubble removal around the Unit 1-4 buildings and acceptance of rubble from the temporary storage area P1. The decrease in used protective clothing was mainly attributable to incineration operation.

➢ Management status of secondary waste from water treatment

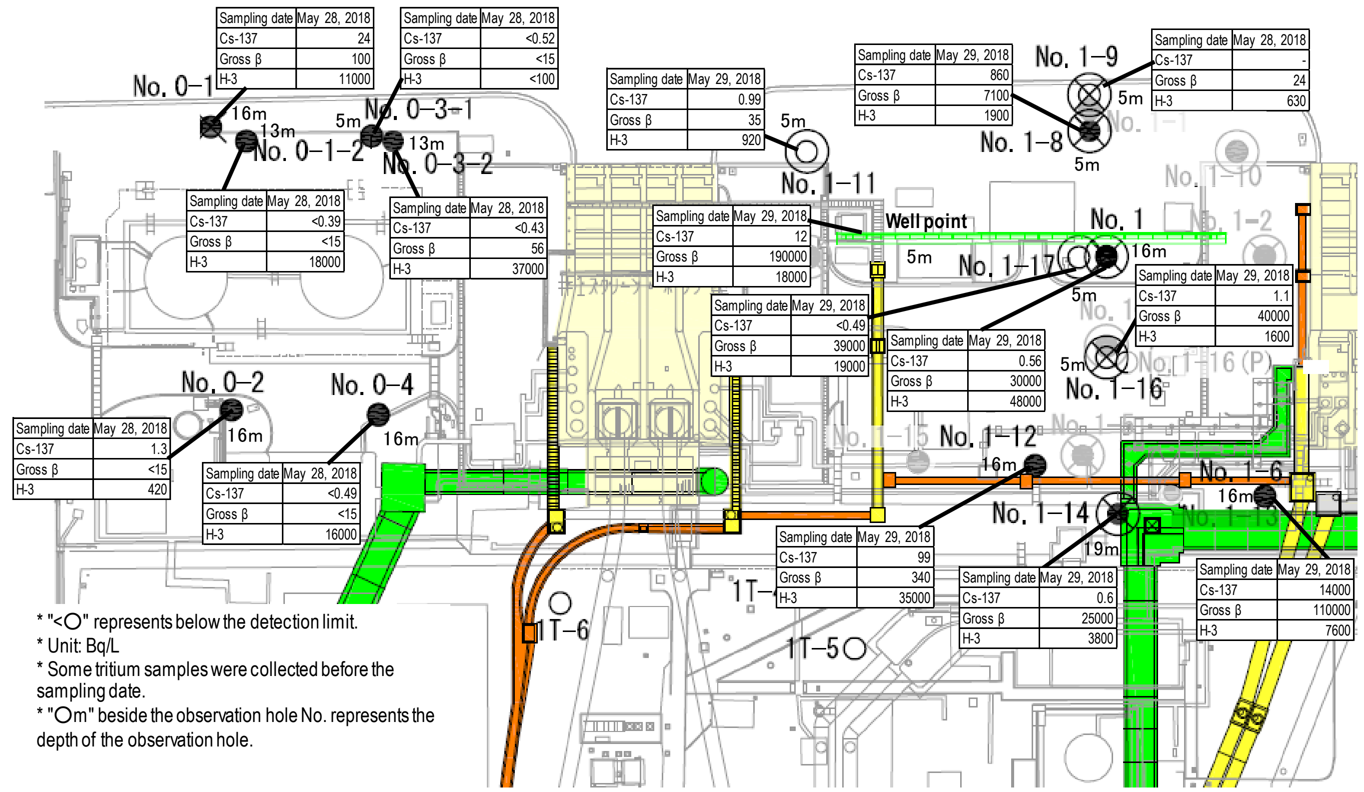
- As of May 3, 2018, the total storage volume of waste sludge was 597 m³ (area-occupation rate: 85%), while that of concentrated waste fluid was 9,364 m³ (area-occupation rate: 88%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment, etc., was 3,983 (area-occupation rate: 63%).

5. Reduction in radiation dose and mitigation of contamination

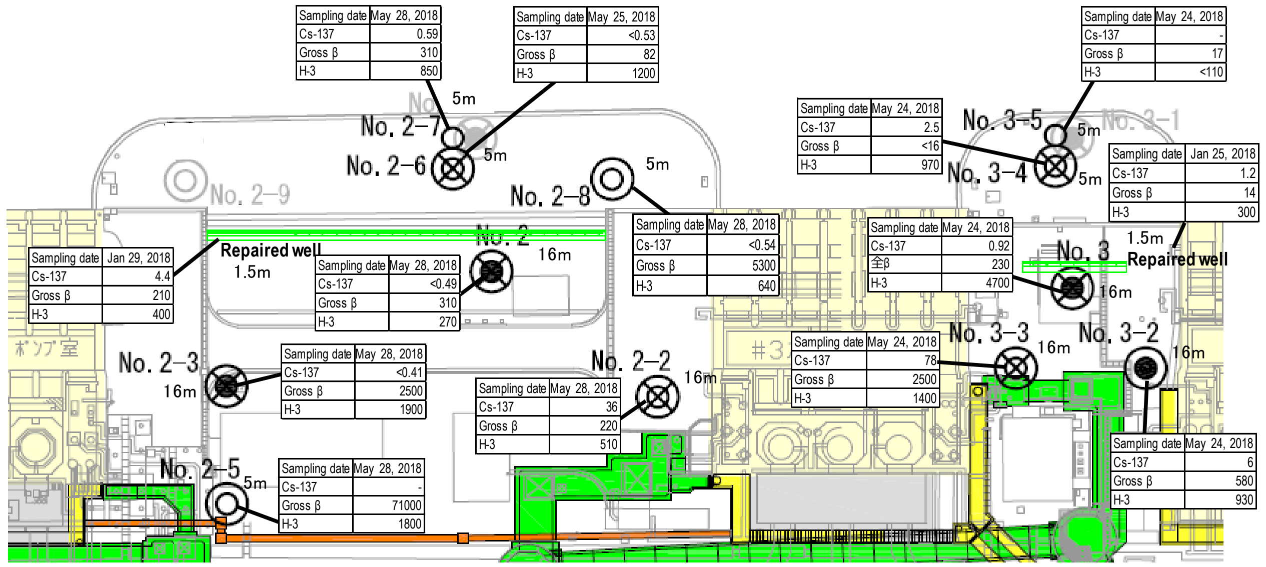
Effective dose-reduction at site boundaries and purification of port water to mitigate the impact of radiation on the external environment

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

- The H-3 density at No. 1-6 had been increasing from around 2,000Bq/L since November 2017 to around 15,000 Bq/L, declining since March 2018 and then increasing and currently stands at around 8,000 Bq/L.
- The H-3 density at No. 1-8 had been increasing from around 900Bq/L since December 2017 and currently stands at around 2,000 Bq/L.
- The density of gross β radioactive materials at No. 1-12 had been declining from 2,000 Bq/L since January 2018 and currently stands at around 400 Bq/L.
- The H-3 density at No. 1-16 had been declining from around 3,000Bq/L since March 2018 and currently stands at around 1,600 Bq/L.
- The H-3 density at No. 1-17 had been declining from around 30,000 Bq/L since December 2017 and currently stands at around 20,000 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).
- The H-3 density at No. 2-3 had been increasing from around 1,000 Bq/L since November 2017 and currently stands at around 2,000 Bq/L. The density of gross β radioactive materials at the same point had been increasing from around 600 Bq/L since December 2017 and currently stands at around 2,000 Bq/L.
- The H-3 density at No. 2-5 had been increasing from 700 Bq/L since November 2017 and currently stands at around 1,800 Bq/L. The density of gross β radioactive materials at the same point had been increasing from around 40,000 Bq/L since March 2018 and currently stands at around 70,000 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).
- The H-3 density at No. 3-4 had been declining from 2,000 Bq/L since January 2018 and currently stands at around 1,000 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 open channel area, densities have remained below the legal discharge limit except for the increase in cesium 137 and strontium 90 during heavy 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 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 below the legal discharge limit except for the increase in cesium 137 and strontium 90 during heavy rain but 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 below the legal discharge limit unchanged 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

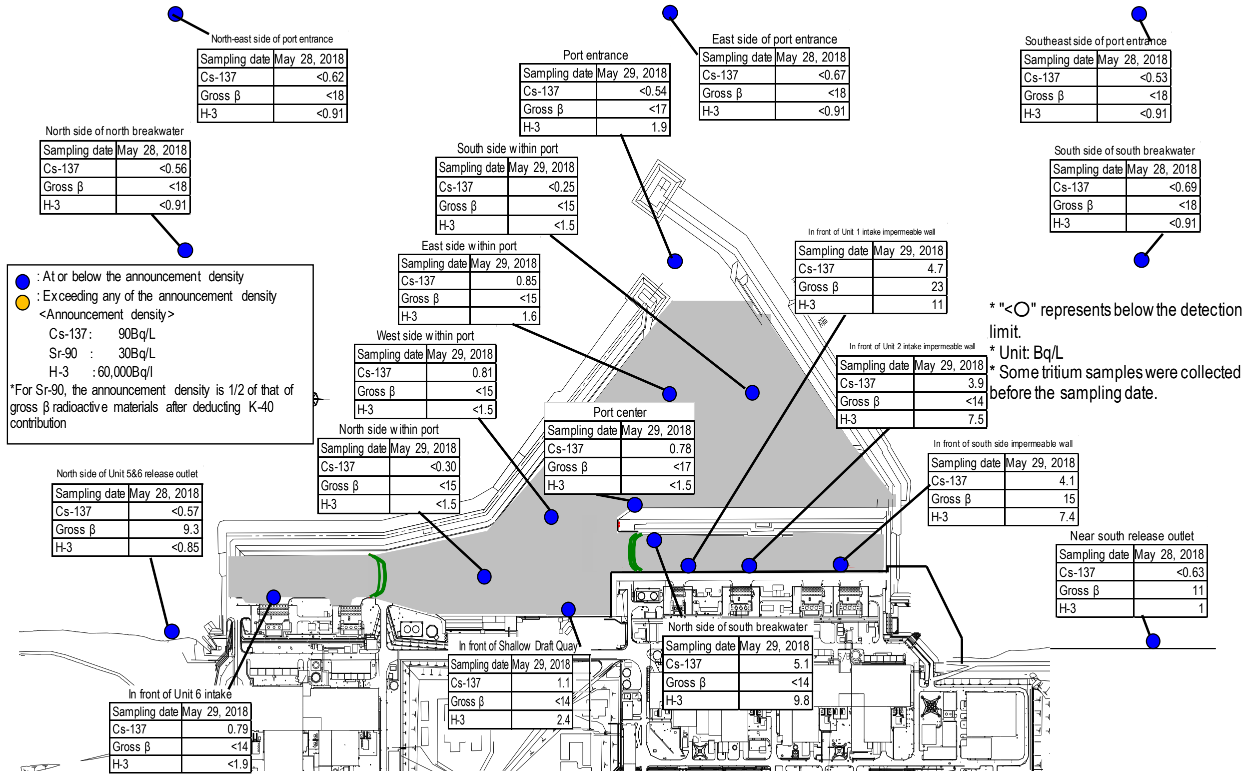


Figure 5: Seawater density around the port

➢ Measures to reduce the density in drainage channels

- In K drainage channel, which drained rainwater around Units 1-4, the density of drainage radioactive materials exceeded that of other drainage channels. The channel was investigated to identify the contamination source and measures were implemented to decline the density.
- Measures were conducted for each of the areas, such as the building roof and roads, as the investigation progressed. After implementation, the density of radioactive materials was found to be gradually declining, except for an increase during rain.
- Measures for drainage channels, such as eliminating contamination sources to further reduce the density, will continue.

6. 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 January to March 2018 was approx. 10,800 (TEPCO and partner company workers), which exceeded the monthly average number of actual workers (approx. 8,100). 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 June 2018 (approx. 4,190 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. 4,100 to 6,200 since FY2016 (see Figure 6).
- The number of workers from both within and outside Fukushima Prefecture declined. The local employment ratio (TEPCO and partner company workers) as of April 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. * The value for FY2017 is provisional. (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.

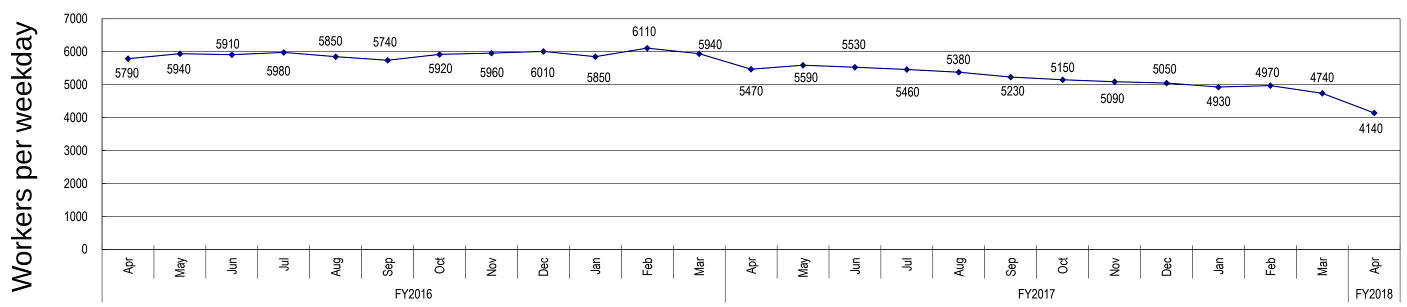


Figure 6: Changes in the average number of workers per weekday for each month since FY2016 (actual values)

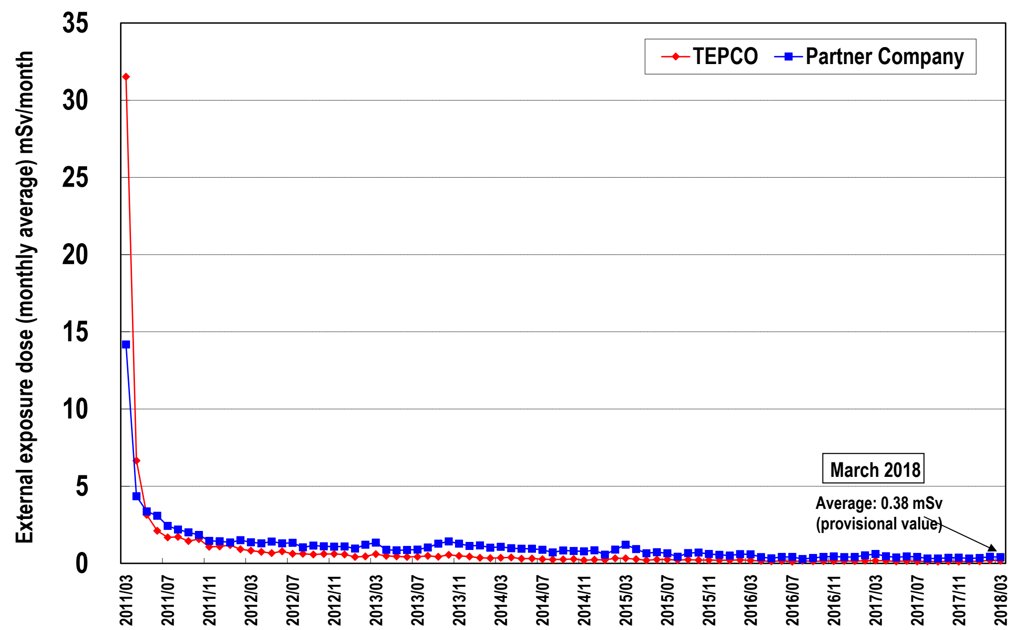


Figure 7: Changes in monthly individual worker exposure dose
(monthly average exposure dose since March 2011)

Status of influenza and norovirus cases (conclusion of infection and expansion-preventive measures)

- In response to the decline in influenza cases, measures to prevent infection and expansion were concluded at the end of April 2018. During this season (2017-2018), there were 317 influenza infections and 11 norovirus infections in total, while the totals for the entire previous season (2016-2017) showed 419 influenza infections and 19 norovirus infections respectively.

  Note: The above data is based on reports from TEPCO and partner companies, which include diagnoses at medical clinics outside the site. The subjects of this report were workers of partner companies and TEPCO in Fukushima Daiichi and Daini Nuclear Power Stations.
- The numbers declined by 102 for influenza cases and 8 for norovirus cases compared to the previous season.
- During this season, which saw epidemics in both A- and B-type influenza, the number of influenza cases increased nationwide. However, the number of influenza type A cases only declined by approx. 25% compared to that in the previous season and most influenza type B cases in this season involved younger patients. Consequently, in the power station, which was less affected by the increase in type B cases as a result, the nationwide epidemic trend of a decline in type A cases was reflected.
- Regarding norovirus, the number of cases remained low and no outbreak was confirmed, nor any food poisoning. These results demonstrate the effectiveness of measures to prevent infection and expansion.
- Though station-wide measures were concluded, measures to prevent infection and expansion will be taken when further infections are identified in the workplaces.

Status of heat stroke cases

- In FY2018, measures to further prevent heat stroke commenced from April to cope with the hottest season (in FY2017, from May).
- In FY2018, one worker suffered heat stroke due to work up until May 28 (in FY2017, no worker up until the end of May). Continued measures will be taken to prevent heat stroke.

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 May 21-29)"; 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(0.33) Below 1/10
Cesium-137: 9.0 (2013/10/17) → 0.85 Below 1/10
Gross β: 74 (2013/ 8/19) →ND(15) Below 1/4
Tritium: 67 (2013/ 8/19) → 1.6 Below 1/40

Cesium-134: 4.4 (2013/12/24) →ND(0.30) Below 1/10
Cesium-137: 10 (2013/12/24) → 0.81 Below 1/10
Gross β: 60 (2013/ 7/ 4) →ND(15) Below 1/4
Tritium: 59 (2013/ 8/19) →ND(1.5) Below 1/30

Cesium-134: 5.0 (2013/12/2) → ND(0.28) Below 1/10
Cesium-137: 8.4 (2013/12/2) → ND(0.30) Below 1/20
Gross β: 69 (2013/8/19) → ND(15) Below 1/4
Tritium: 52 (2013/8/19) → ND(1.5) Below 1/30

Cesium-134: 2.8 (2013/12/2) → ND(0.53) Below 1/5
Cesium-137: 5.8 (2013/12/2) → 0.79 Below 1/7
Gross β: 46 (2013/8/19) → ND(14) Below 1/3
Tritium: 24 (2013/8/19) → ND(1.9) Below 1/10

Cesium-134: ND(0.39)
Cesium-137: 0.78
Gross β: ND(17)
Tritium: ND(1.5) *

Cesium-134: 3.3 (2013/12/24) → ND(0.46) Below 1/7
Cesium-137: 7.3 (2013/10/11) → ND(0.54) Below 1/10
Gross β: 69 (2013/ 8/19) → ND(17) Below 1/4
Tritium: 68 (2013/ 8/19) → 1.9 Below 1/30

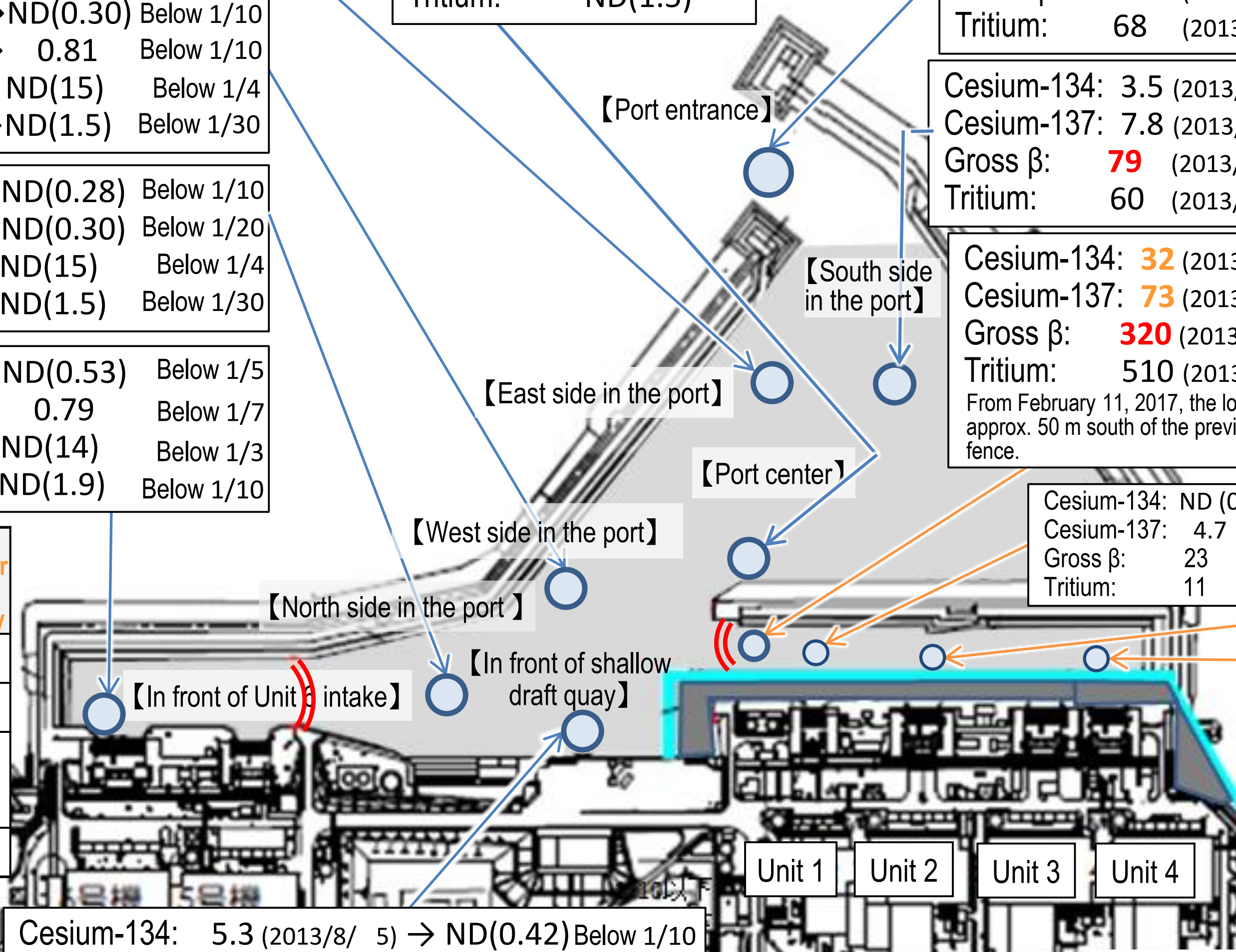
Cesium-134: 3.5 (2013/10/17) → ND(0.21) Below 1/10
Cesium-137: 7.8 (2013/10/17) → ND(0.25) Below 1/30
Gross β: 79 (2013/ 8/19) → ND(15) Below 1/5
Tritium: 60 (2013/ 8/19) → ND(1.5) Below 1/40

Cesium-134: 32 (2013/10/11) → ND(0.70) Below 1/40
Cesium-137: 73 (2013/10/11) → 5.1 Below 1/10
Gross β: 320 (2013/ 8/12) → ND(14) Below 1/20
Tritium: 510 (2013/ 9/ 2) → 9.8 Below 1/50
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 (0.94)
Cesium-137: 4.7
Gross β: 23
Tritium: 11 *

Cesium-134: ND (0.28)
Cesium-137: 3.9
Gross β: ND (14)
Tritium: 7.5 *

Cesium-134: ND (0.44)
Cesium-137: 4.1
Gross β: 15
Tritium: 7.4 *



	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(0.42) Below 1/10
Cesium-137: 8.6 (2013/8/ 5) → 1.1 Below 1/7
Gross β: 40 (2013/7/ 3) → ND(14) Below 1/2
Tritium: 340 (2013/6/26) → 2.4 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 May 30, 2018

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 May 21-29)

	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 (0.61)
Cesium-137: ND (2013) → ND (0.62)
Gross β: ND (2013) → ND (18)
Tritium: ND (2013) → ND (0.91)

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

Cesium-134: ND (2013) → ND (0.51)
Cesium-137: 1.6 (2013/10/18) → ND (0.67)
Gross β: ND (2013) → ND (18)
Tritium: 6.4 (2013/10/18) → ND (0.91) Below 1/7

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

Cesium-134: ND (2013) → ND (0.81)
Cesium-137: ND (2013) → ND (0.53)
Gross β: ND (2013) → ND (18)
Tritium: ND (2013) → ND (0.91)

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

Cesium-134: ND (2013) → ND (0.73)
Cesium-137: ND (2013) → ND (0.56)
Gross β: ND (2013) → ND (18)
Tritium: 4.7 (2013/ 8/18) → ND (0.91) Below 1/5

【Port entrance】

Cesium-134: 3.3 (2013/12/24) →ND (0.46) Below 1/7
Cesium-137: 7.3 (2013/10/11) →ND (0.54) 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)】

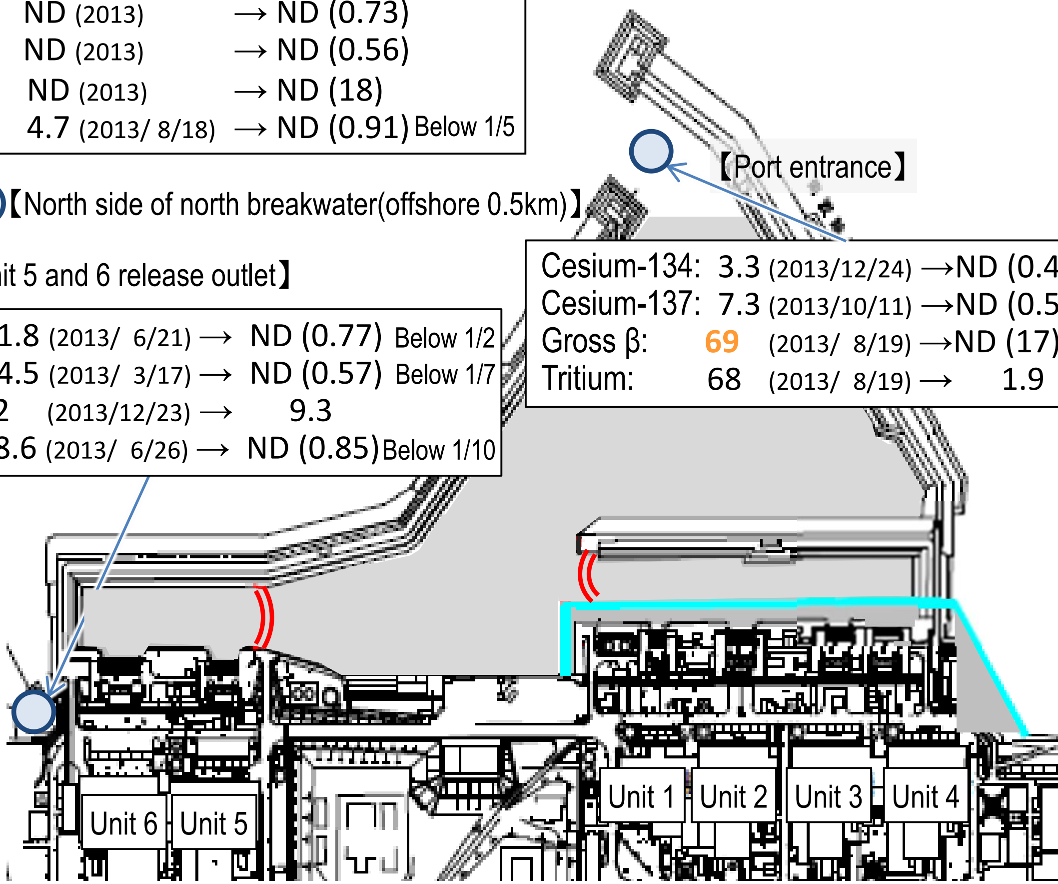
Cesium-134: ND (2013) → ND (0.66)
Cesium-137: ND (2013) → ND (0.69)
Gross β: ND (2013) → ND (18)
Tritium: ND (2013) → ND (0.91)

【North side of Unit 5 and 6 release outlet】

Cesium-134: 1.8 (2013/ 6/21) → ND (0.77) Below 1/2
Cesium-137: 4.5 (2013/ 3/17) → ND (0.57) Below 1/7
Gross β: 12 (2013/12/23) → 9.3
Tritium: 8.6 (2013/ 6/26) → ND (0.85) Below 1/10

【Near south release outlet】

Cesium-134: ND (2013) → ND (0.67)
Cesium-137: 3.0 (2013/ 7/15) → ND (0.63) Below 1/4
Gross β: 15 (2013/12/23) → 11
Tritium: 1.9 (2013/11/25) → 1.0



Sea side impermeable wall

Silt fence

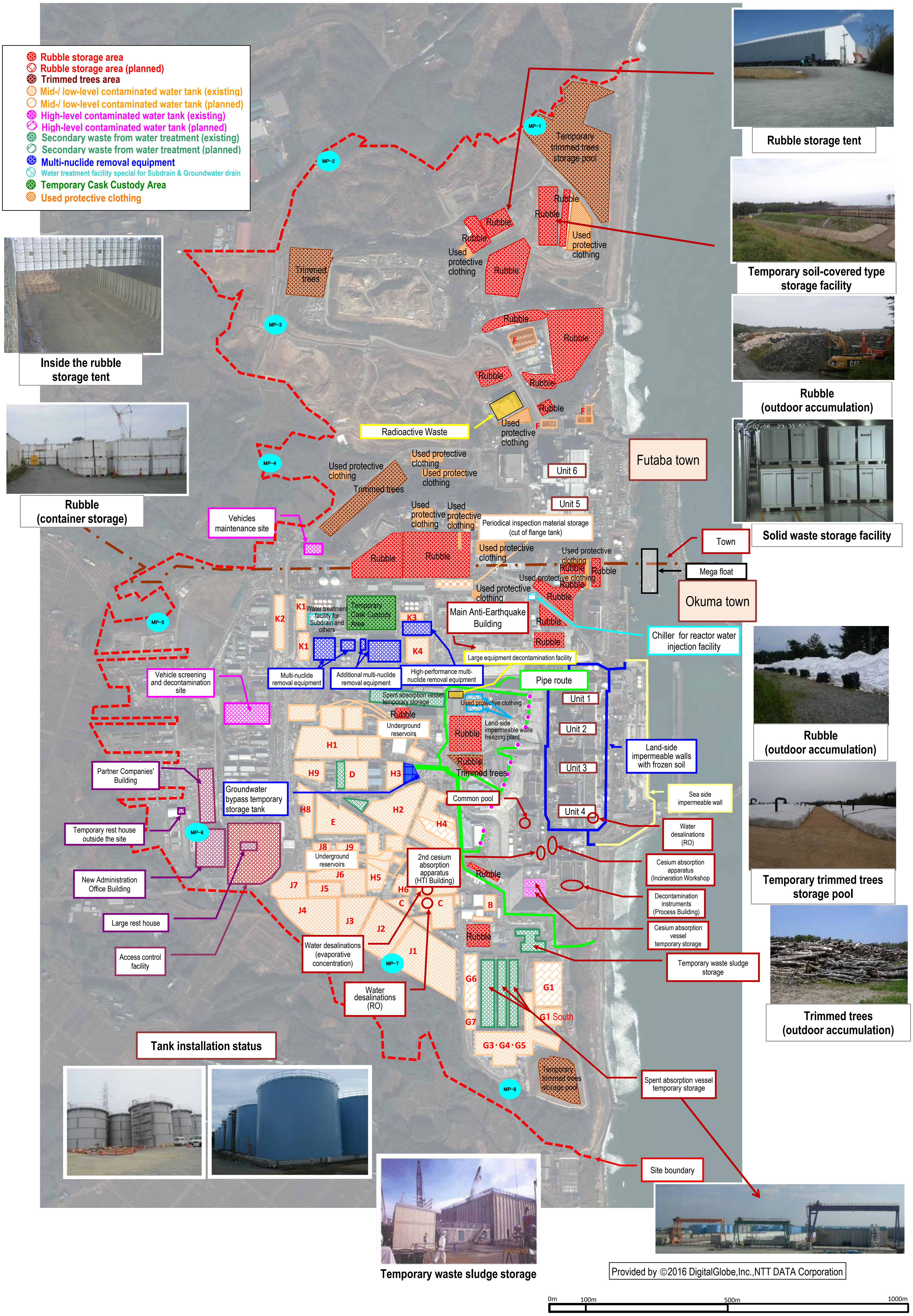
Note: The gross β measurement values include natural potassium 40 (approx. 12 Bq/L). They also include the contribution of yttrium 90, which radioactively balance strontium 90.

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. 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 May 30, 2018

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

TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site Layout



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, 2017. Modification of the pillars and beams of the building cover and installation of building cover were completed by December 19.
Rubble removal from the operating floor north side started from January 22, 2018. Rubble is being removed carefully by suction equipment.
No significant variation was identified around site boundaries where the density of radioactive materials was monitored and at onsite dust monitors during the above removal work.

<Installation status (January 22)>

<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.

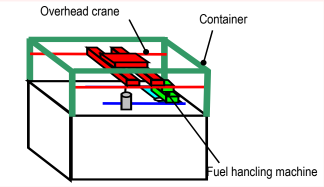


Image of Plan 1

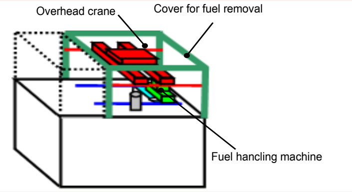


Image of Plan 2

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.
Work will continue with safety first toward fuel removal around mid-FY2018.

Installation of dome roof (February 21)

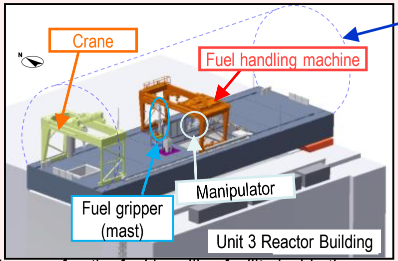


Image of entire fuel handling facility inside the cover

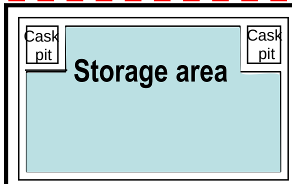
Unit 4

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.

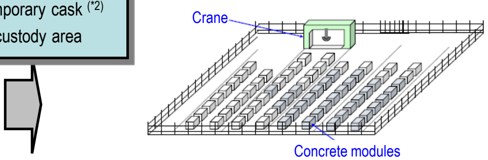
Common pool



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

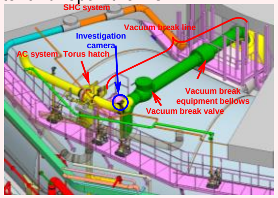
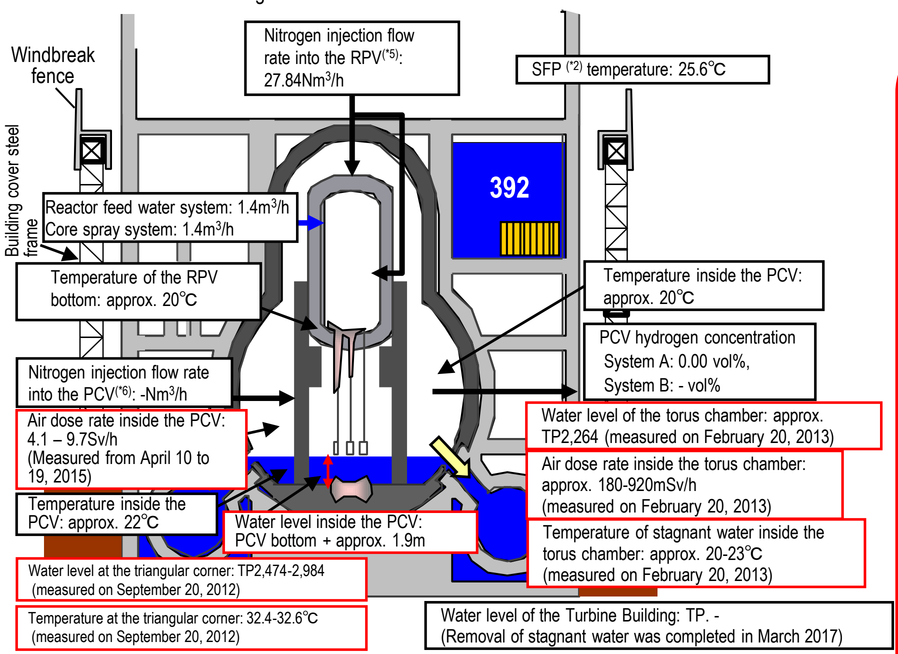


Image of the S/C upper part investigation

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, May 30, 2018

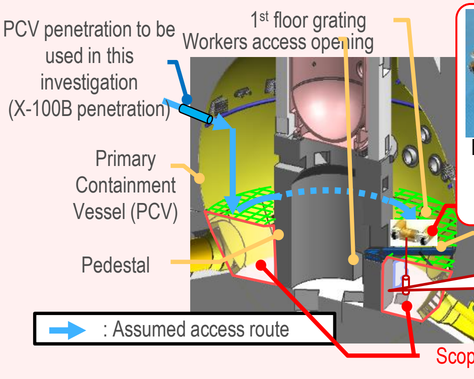
Investigations inside PCV	1st (Oct 2012)	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling stagnant water - Installing permanent monitoring instrumentation
	2nd (Apr 2015)	Confirming the status of PCV 1st floor - Acquiring images - Measuring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

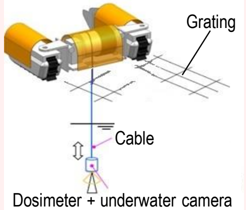


Image of hanging of dosimeter and camera

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

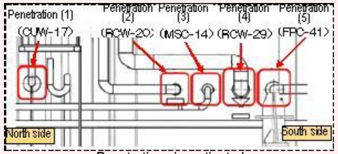
Installation of an RPV thermometer and permanent PCV supervisory instrumentation

(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

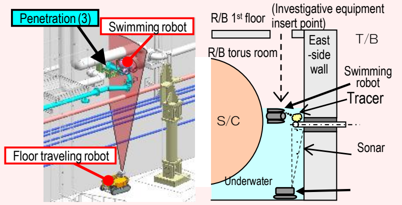
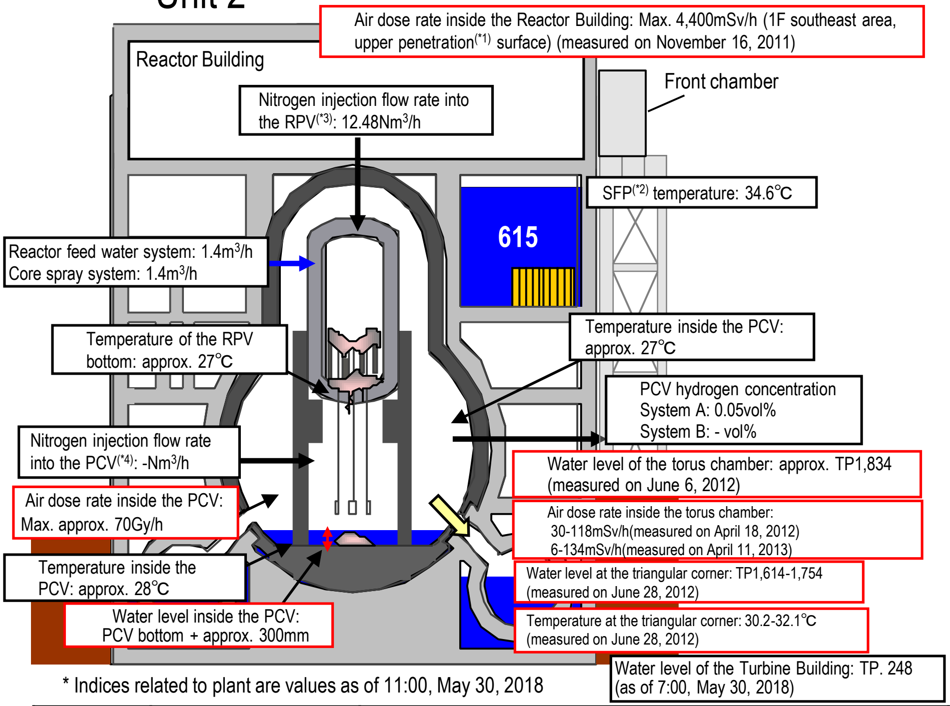


Image of the torus chamber east-side cross-sectional investigation

Unit 2



* Indices related to plant are values as of 11:00, May 30, 2018

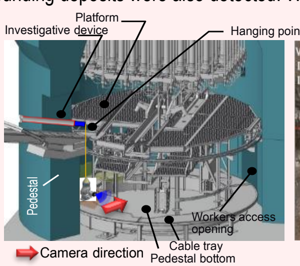
Investigations inside PCV	1st (Jan 2012)	- Acquiring images - Measuring air temperature
	2nd (Mar 2012)	- Confirming water surface - Measuring water temperature - Measuring dose rate
	3rd (Feb 2013 – Jun 2014)	- Acquiring images - Sampling stagnant water - Measuring water level - Installing permanent 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

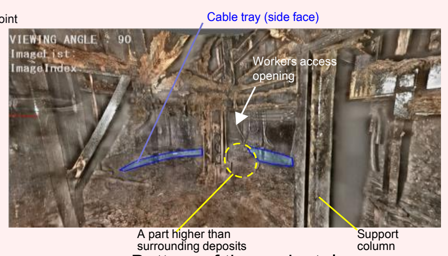
Prior to fuel debris retrieval, an investigation inside the PCV will be conducted to inspect the status there including the location of fuel debris.

[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.



Investigative status (image)



Bottom of the pedestal

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

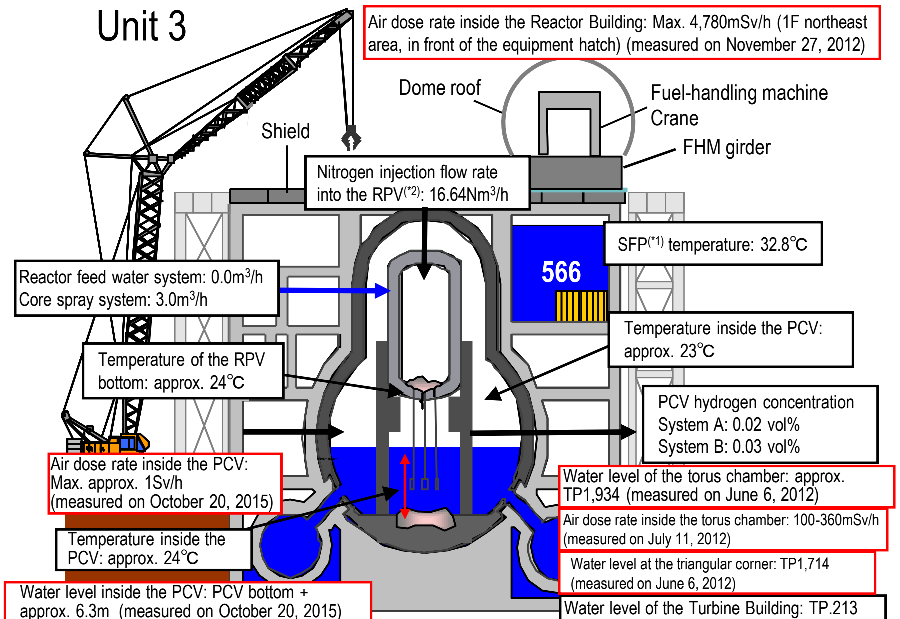
On January 18, 2014, a flow of water from around the door of the Steam Isolation Valve room in the Reactor Building Unit 3 1st floor northeast area to the nearby floor drain funnel (drain outlet) was detected. As the drain outlet connects with the underground part of the Reactor Building, there is no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

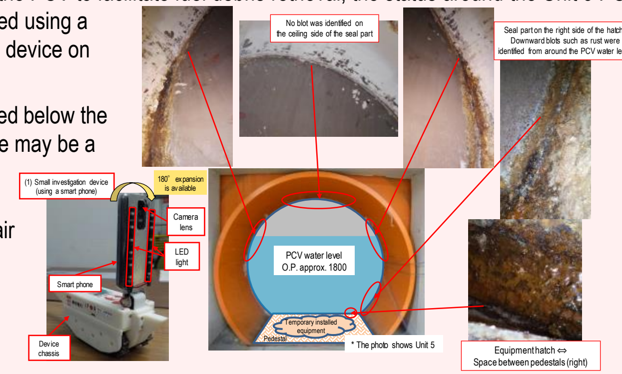


* Indices related to plant are values as of 11:00, May 30, 2018

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

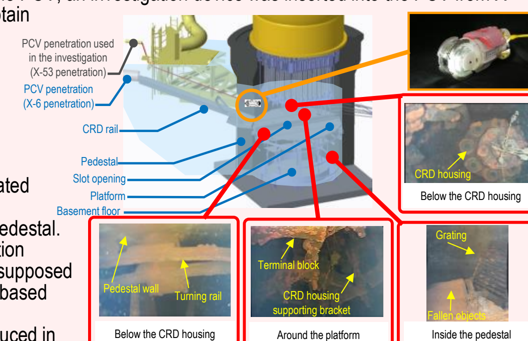


Investigation inside the PCV

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 stagnant 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

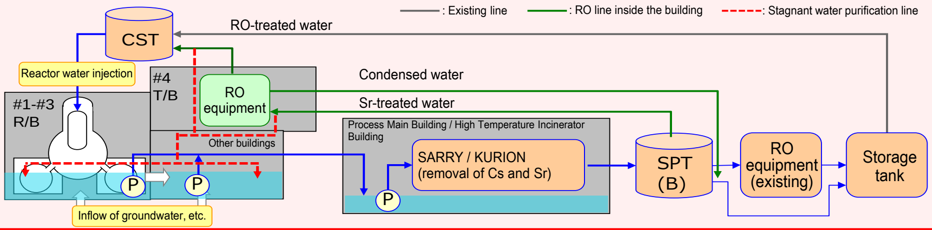
Progress toward decommissioning: Work related to circulation cooling and stagnant water treatment line

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.
- To accelerate efforts to reduce the radiation density in stagnant water inside the buildings, circulating purification of stagnant 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 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 stagnant 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 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, in H4 area (56 tanks) in May 2017, in H5 area (28 tanks) in July 2017 and in H3 B area (31 tanks) in September 2017. Dismantling of flange tanks in H6 area is underway.

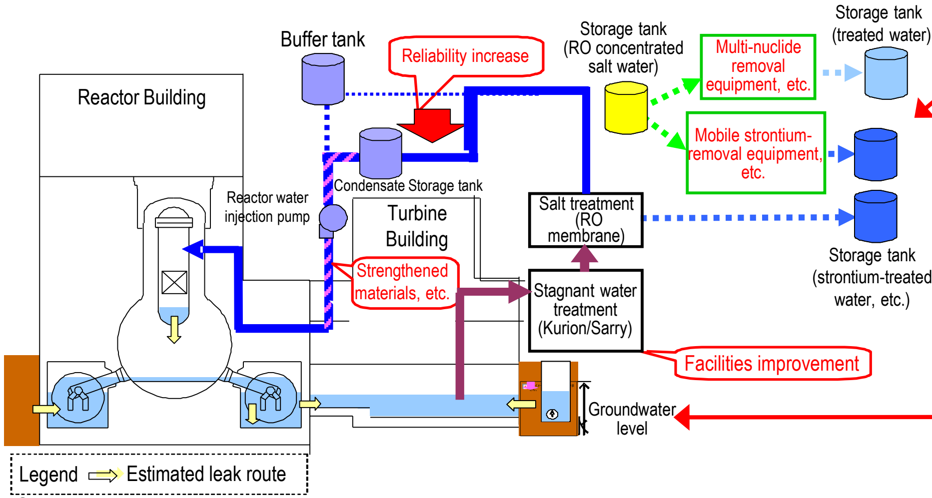

Start of dismantling in H1 east area

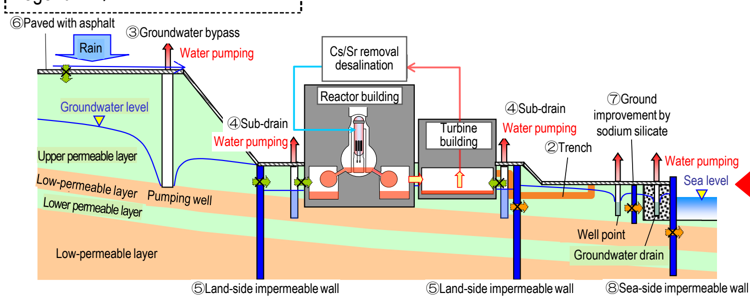

After dismantling in H1 east area

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

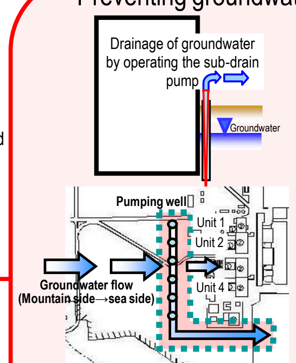
Contaminated water (RO concentrated salt water) is being treated using seven types of equipment including the multi-nuclide removal equipment (ALPS). Treatment of the RO concentrated salt water was completed on May 27, 2015, with the exception of the remaining water at the tank bottom. The remaining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

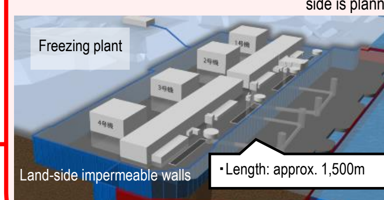
To reduce groundwater flowing into the buildings, pumping-up of groundwater from wells (subdrains) around the buildings started on September 3, 2015. Pumped-up groundwater was purified at dedicated facilities and released after TEPCO and a third-party organization confirmed that its quality met operational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



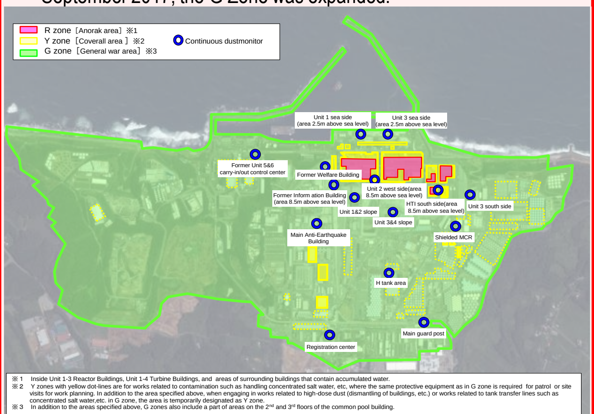
Progress toward decommissioning: Work to improve the environment within the site

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

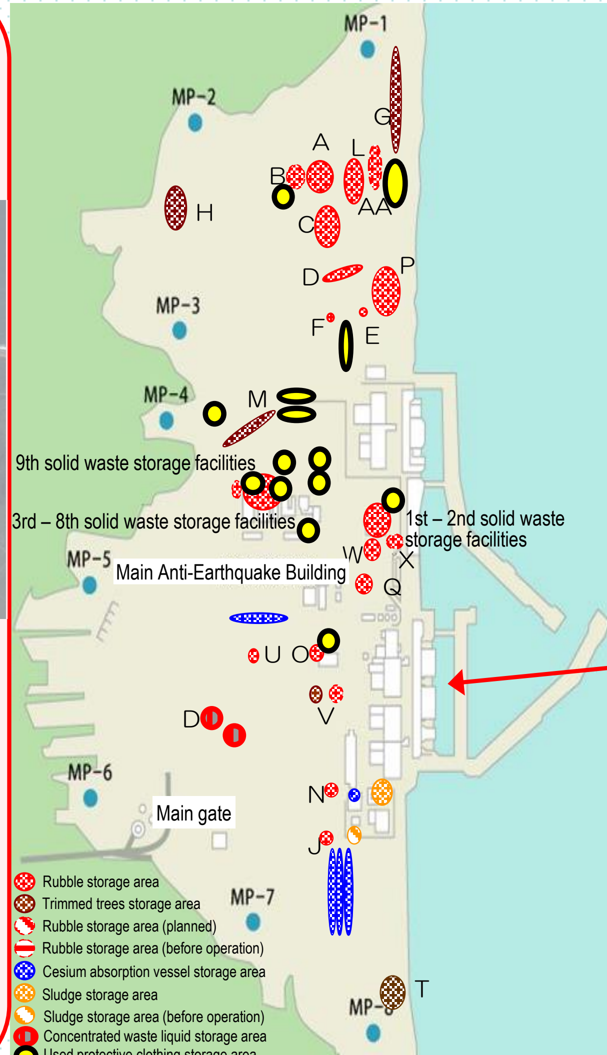
Based on the progress of measures to reduce environmental dosage on site, the site is categorized into two zones: highly contaminated area around Unit 1-4 buildings, etc. and other areas to optimize protective equipment according to each category aiming at improving safety and productivity by reducing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