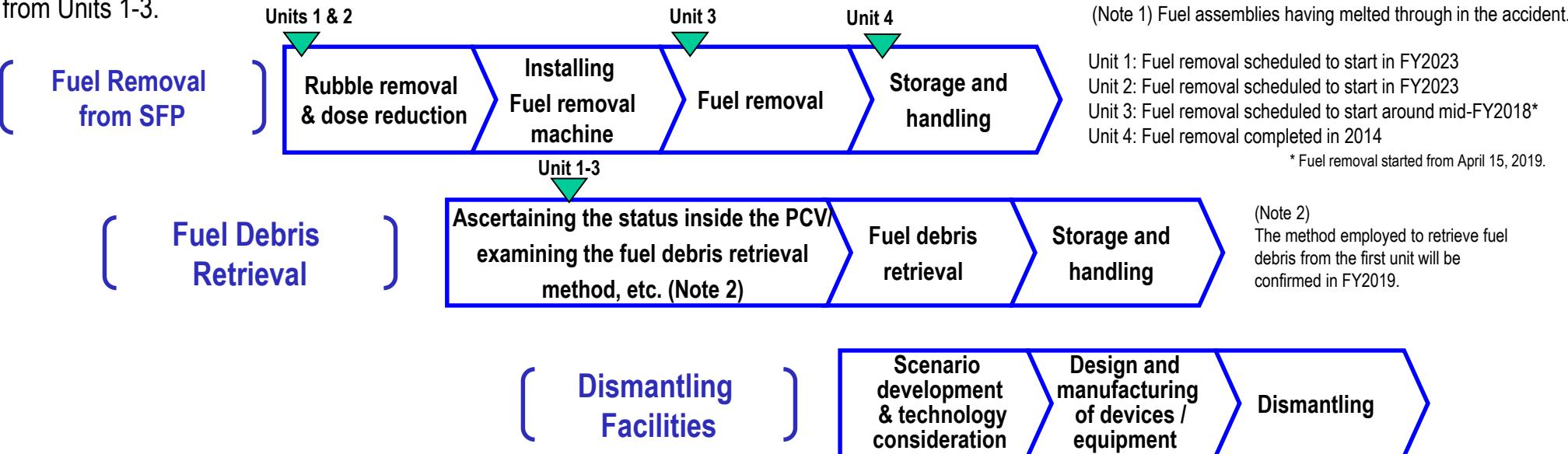


## Main decommissioning work and steps

Fuel removal from the Unit 4 SFP was completed on December 22, 2014 and removal from the Unit 3 SFP has been underway since April 15, 2019. Dust density in the surrounding environment is being monitored and work is being implemented with safety first. Work continues sequentially toward the start of fuel removal from Units 1 and 2 and debris (Note 1) retrieval from Units 1-3.



### Toward fuel removal from the spent fuel pool

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

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



Status of fuel removal (April 15, 2019)

## Three principles behind contaminated water countermeasures

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

### 1. Remove contamination sources

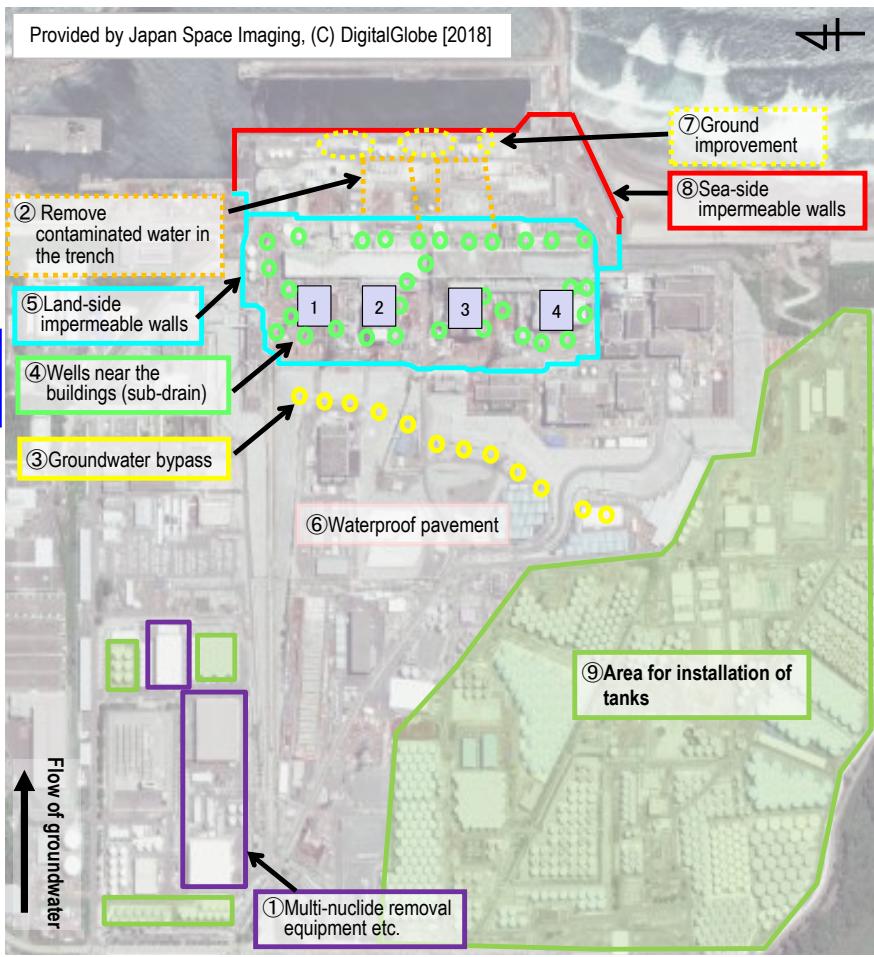
- Purification by using Multi-nuclide removal equipment, etc.
  - Remove contaminated water from the trench (Note 3)
- (Note 3) Underground tunnel containing pipes.

### 2. Redirect groundwater from contamination sources

- Pump up groundwater for bypass
- Pump up groundwater near buildings
- Land-side impermeable walls (Frozen-soil walls)
- Waterproof pavement

### 3. Prevent leakage of contaminated water

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



### Multi-nuclide removal equipment (ALPS), etc.

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



(High-performance multi-nuclide removal equipment)

### Reducing the generation of contaminated water through multi-layered measures

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



Inside the land-side impermeable wall Outside the land-side impermeable wall

### Replacing flanged tanks with welded-joint tanks

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



(Installed welded-joint tanks)

# Progress status

◆ 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<sup>\*1</sup> over the past month. There was no significant change in the density of radioactive materials newly released from Reactor Buildings into the air<sup>\*2</sup>. It was concluded that the comprehensive cold shutdown condition had been maintained.

\*1 The values varied somewhat, depending on the unit and location of the thermometer.  
 \*2 In June 2019, the radiation exposure dose due to the release of radioactive materials from the Unit 1-4 Reactor Buildings was evaluated at less than 0.00025 mSv/year at the site boundary. The annual radiation dose from natural radiation is approx. 2.1 mSv/year (average in Japan).

## Start of investigation into the Unit 1 well plug

Toward fuel removal from the spent fuel pool, an investigation started from July 17 to examine how to handle the well plug, which was considered as having been misaligned due to the influence of the hydrogen explosion at the time of the accident.

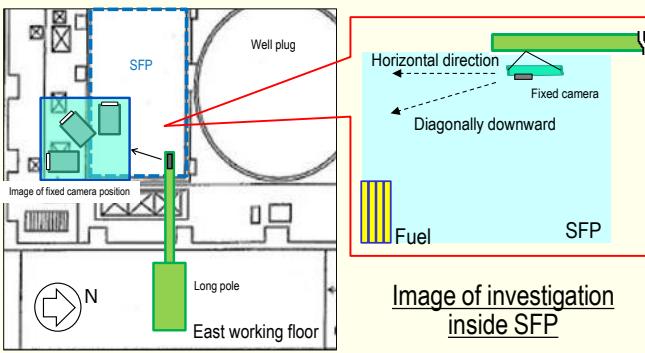
In this investigation, two robots (for investigation and monitoring) will be used to measure 3D-images, air dose rate, etc.



## Investigation inside the Unit 1 spent fuel pool in August

Toward fuel removal from the spent fuel pool (SFP), the fallen roof over the SFP will be removed. To prevent the anticipated risk of small rubble, and other objects falling during removal and any influence on the soundness of fuel, the SFP will be covered before the work.

As preparation, the condition inside the pool will be investigated using a underwater camera in August.

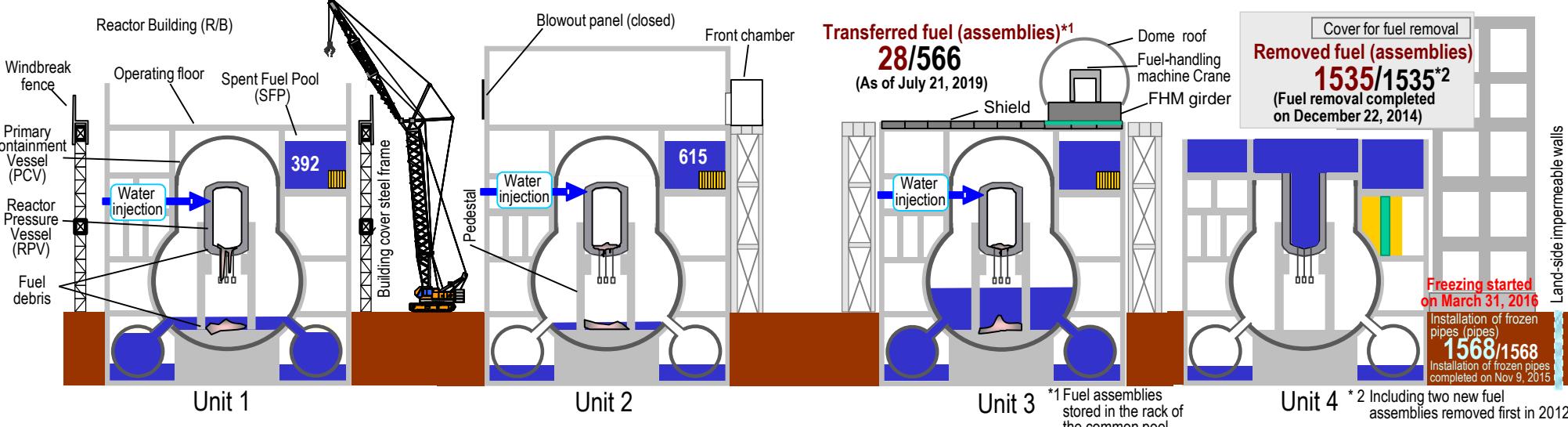


## Completion of non-irradiated fuel (28 assemblies) removal at Unit 3

Fuel removal was resumed from July 4 and removal of 21 non-irradiated fuel assemblies was completed within July as planned. Up until July 21, 28 of all 566 fuel assemblies had been removed.

During the removal, no significant variation was detected in the dust density in the surrounding environment.

On July 17 and 21, leakage from the joint of a hose for working fluid of the fuel-handling facility carrying working fluid was detected. The cause will be investigated, measures implemented and similar parts checked, and other works in the facility inspection, which started from July 24, to resume fuel and rubble removal from early September.



## Start of Unit 1/2 exhaust stack dismantling from August

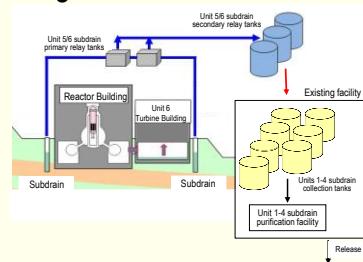
Prior to starting the dismantling of the Unit 1/2 exhaust stack, measures were implemented to extend the lifting length of the crane. Construction of the roadbed was completed on July 10 and it was confirmed that sufficient lifting length had been obtained as of July 18.

As part of efforts to complete the dismantling of the exhaust stack within FY2019, work will start from early August 2019 with safety first while checking the influence on the surrounding environment.

## Toward recovery of Unit 5/6 subdrain from FY2021

The groundwater level around the Unit 5/6 buildings remained high. There is a risk of important facilities being flooded by groundwater inflow due to aging building penetrations and other factors.

To eliminate this risk, examination toward recovering the Unit 5/6 subdrain from FY2021 started. Pumped up subdrain water will be transferred to Unit 1-4 subdrain purification facilities for treatment. Scope to utilize the capacity born in the Unit 5/6 building contaminated-water treatment equipment will also be examined for treatment of accumulated water onsite.

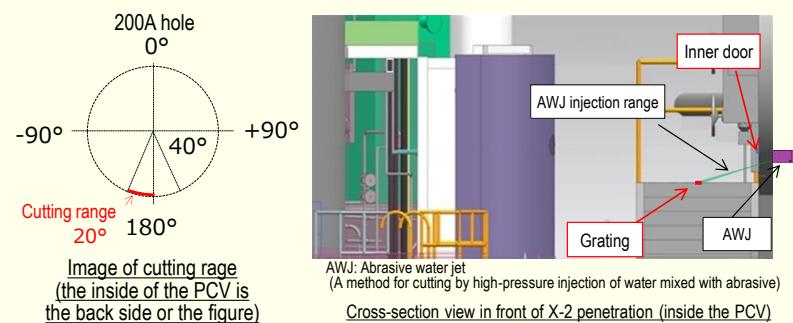


## Resumption of work to create an access route at Unit 1 within July

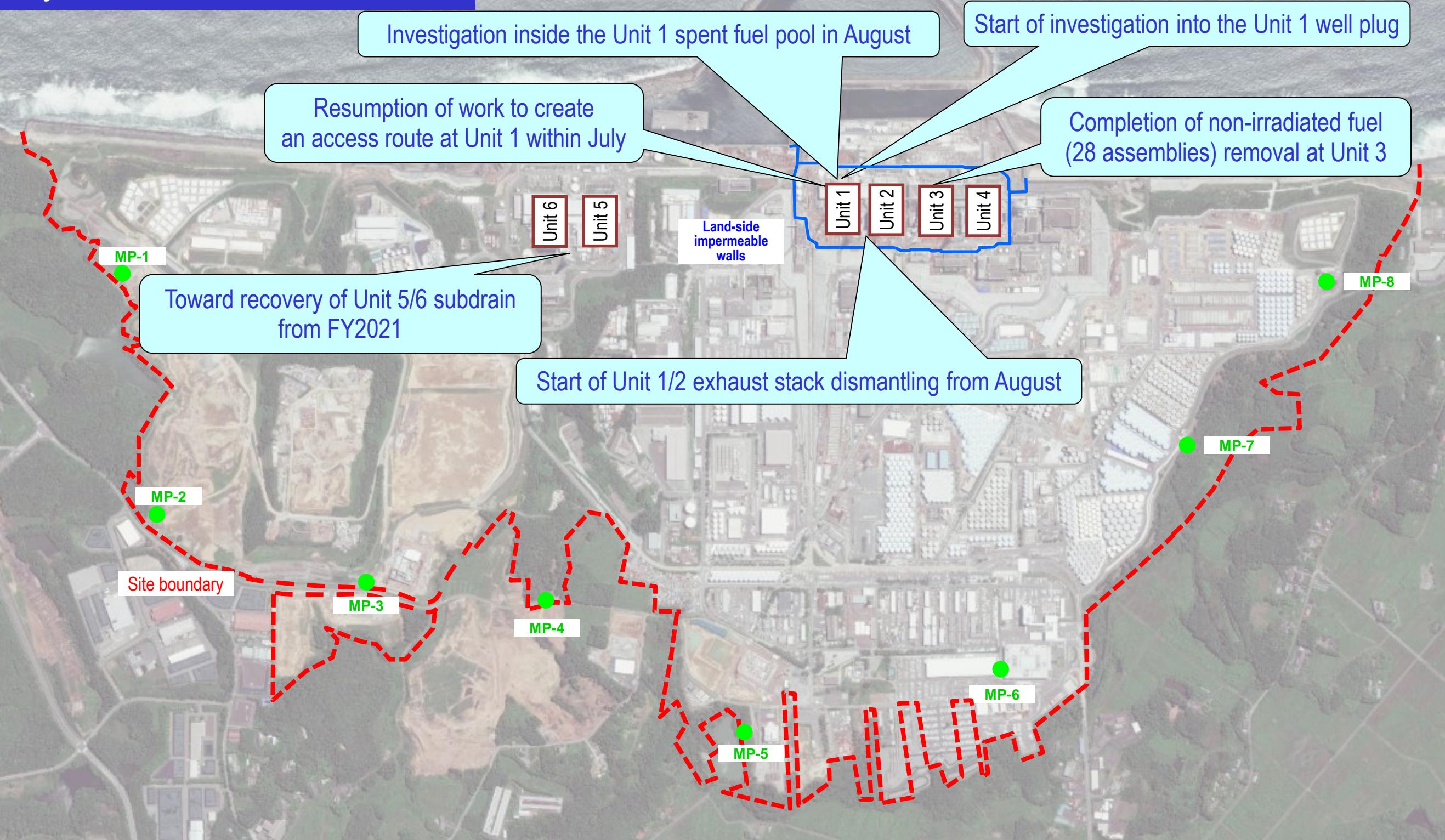
Prior to investigating the inside of the Primary Containment Vessel (PCV), an access route was being constructed. On June 4, 2019, during drilling of the inner door of the X-2 penetration, monitoring data showed that the dust density of the temporarily-installed monitor had exceeded the criteria value set for work management.

This was considered attributable to the influence of high-pressure water during the drilling, which was poured on the grating inside the PCV and scattered dust. For future drilling and other works, the cutting scope will be changed within a range with less influence to understand the tendency of dust density during drilling.

The work will resume in around late July 2019. After obtaining sufficient knowledge about dust scattering, the inner door will be drilled and obstacles inside the PCV will be cut sequentially from late August onwards.



# Major initiatives – Locations on site



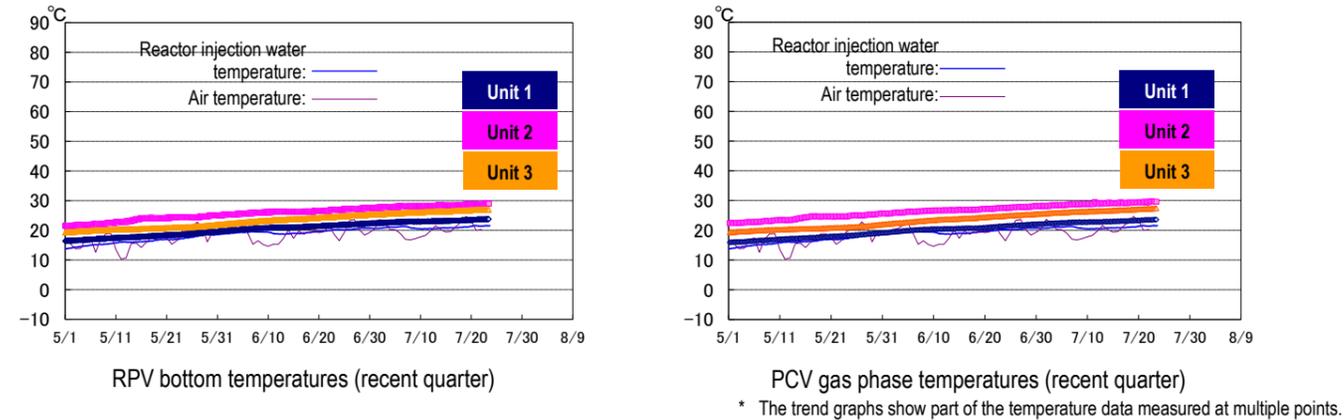
\* Data of Monitoring Posts (MP1-MP8.)  
 Data (10-minute values) of Monitoring Posts (MPs) measuring the airborne radiation rate around site boundaries showed 0.409 – 1.330  $\mu\text{Sv/h}$  (June 26 – July 23, 2019).  
 We improved the measurement conditions of monitoring posts 2 to 8 to measure the air-dose rate precisely. Construction work, such as tree-clearing, surface soil removal and shield wall setting, were implemented from February 10 to April 18, 2012.  
 Therefore, monitoring results at these points are lower than elsewhere in the power plant site.  
 The radiation shielding panels around monitoring post No. 6, which is one of the instruments used to measure the radiation dose at the power station site boundary, were taken off from July 10-11, 2013, since further deforestation, and other works had caused the surrounding radiation dose to decline significantly.

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

## I. Confirmation of the reactor conditions

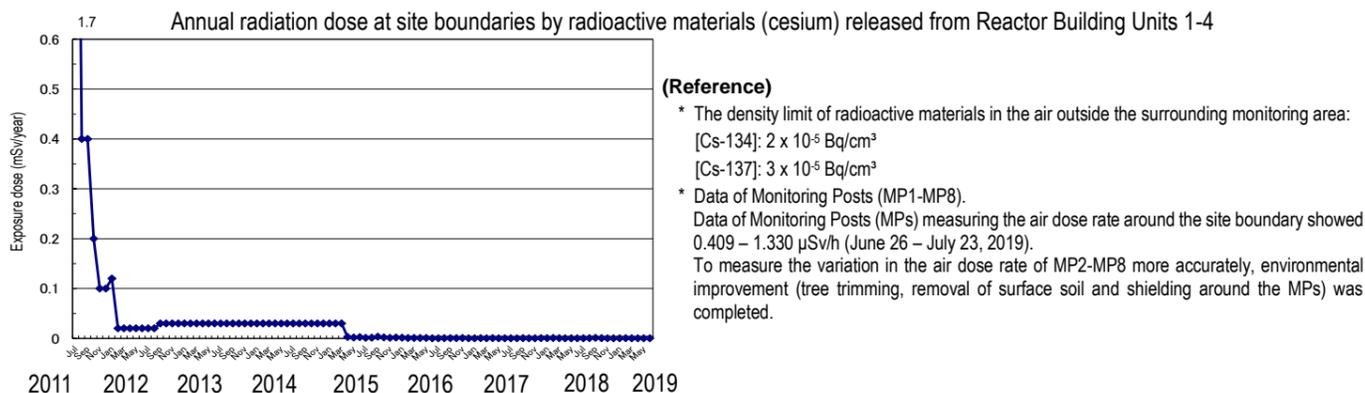
### 1. Temperatures inside the reactors

Through continuous reactor cooling by water injection, the temperatures of the Reactor Pressure Vessel (RPV) bottom and the Primary Containment Vessel (PCV) gas phase were maintained within the range of approx. 20 to 30°C for the past month, though they varied depending on the unit and location of the thermometer.



### 2. Release of radioactive materials from the Reactor Buildings

As of June 2019, the density of radioactive materials newly released from Reactor Building Units 1-4 into the air and measured at the site boundary was evaluated at approx.  $2.9 \times 10^{-12}$  and  $5.6 \times 10^{-12}$  Bq/cm<sup>3</sup> for Cs-134 and -137 respectively, while the radiation exposure dose due to the release of radioactive materials there was less than 0.00025 mSv/year.



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

### 3. Other indices

There was no significant change in indices, including the pressure in the PCV and the PCV radioactivity density (Xe-135) for monitoring criticality, nor was any abnormality in the cold shutdown condition or criticality sign detected.

Based on the above, it was confirmed that the comprehensive cold shutdown condition had been maintained and the reactors remained in a stabilized condition.

## II. Progress status by each plan

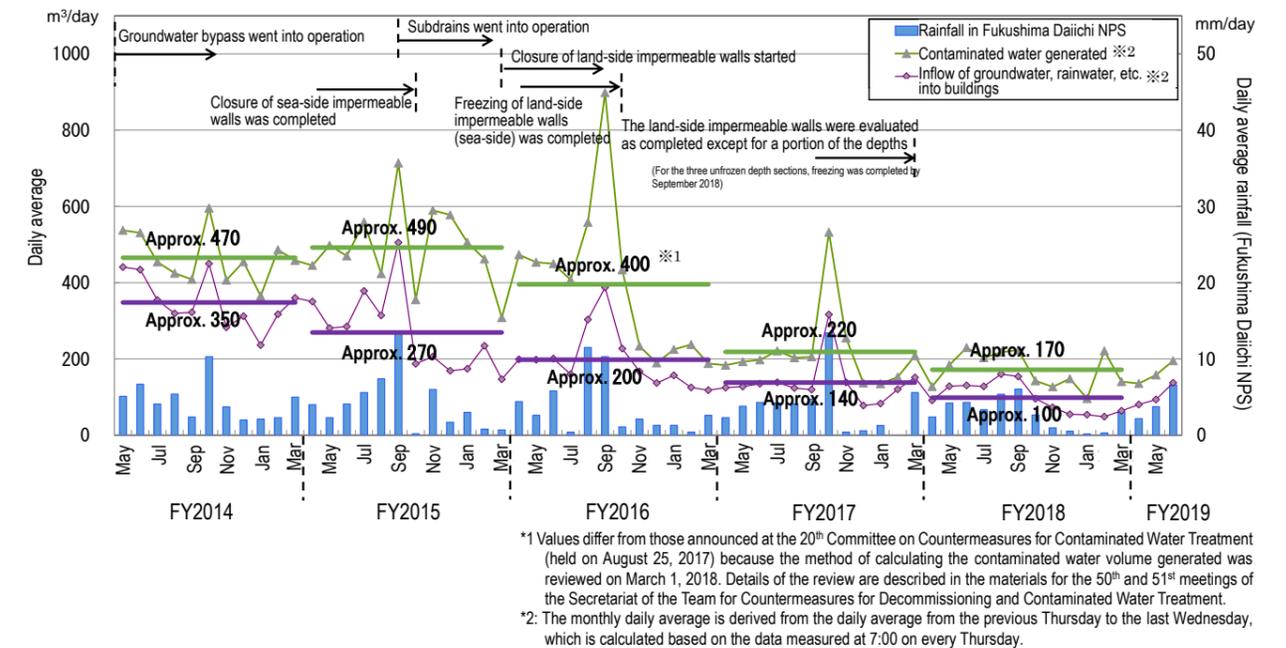
### 1. Contaminated water management

*In accordance with the three principles "remove" contamination sources, "redirect" groundwater from contamination sources and "prevent leakage" of contaminated water, multi-layered contaminated water management measures have been implemented to stably control groundwater.*

#### ➤ Status of contaminated water generated

- Multi-layered measures, including pumping up by subdrains and land-side impermeable walls, which were implemented to control the continued generation of contaminated water, suppress the groundwater inflow into buildings.

- Following the steady implementation of "redirecting" measures (groundwater bypass, subdrains, land-side impermeable walls, etc.), the generation amount reduced from approx. 470 m<sup>3</sup>/day (the FY2014 average) when the measures were first launched to approx. 170 m<sup>3</sup>/day (the FY2018 average), though it varied depending on rainfall, etc.
- Measures will continue to further reduce the volume of contaminated water generated.



#### ➤ Operation of the groundwater bypass

- From April 9, 2014, the operation of 12 groundwater bypass pumping wells commenced sequentially to pump up groundwater. The release then started from May 21, 2014, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until July 23, 2019, 482,379 m<sup>3</sup> of groundwater had been released. The pumped-up groundwater was temporarily stored in tanks and released after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Pumps are inspected and cleaned as required based on their operational status.

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

- To reduce the level of groundwater flowing into the buildings, work began to pump up groundwater from wells (subdrains) around the buildings on September 3, 2015. The pumped-up groundwater was then purified at dedicated facilities and released from September 14, 2015, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until July 23, 2019, a total of 720,898 m<sup>3</sup> had been drained after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Due to the rising level of the groundwater drain pond after the sea-side impermeable walls had been closed, pumping started on November 5, 2015. Up until July 23, 2019, a total of approx. 206,778 m<sup>3</sup> had been pumped up and a volume of under 10 m<sup>3</sup>/day is being transferred from the groundwater drain to the Turbine Buildings (average for the period June 20 – July 17, 2019).
- As one of the multi-layered contaminated-water management measures, in addition to waterproof pavement (facing; as of the end of June 2019, approx. 94% of the planned area was completed) to prevent rainwater infiltrating the ground, facilities to enhance the subdrain treatment system were installed and went into operation from April 2018, increasing the treatment capacity from 900 to 1,500 m<sup>3</sup>/day and improving reliability. Operational efficiency was also improved to treat up to 2,000 m<sup>3</sup>/day for almost one week during the peak period.
- To maintain the level of groundwater pumped up from the subdrains, work to install additional subdrain pits and recover those already in place is underway. The additional pits are scheduled to begin operation sequentially from a pit for which work was completed (12 of 14 pits went into operation). For recovered pits, work for all three pits scheduled was completed, all of which went into operation from December 26, 2018.

- To eliminate the need to suspend water pumping while cleaning the subdrain transfer pipe, the pipe will be duplicated. Installation of the pipe and ancillary facilities was completed.
- Since the subdrains went into operation, the inflow into buildings tended to decline to under 150 m<sup>3</sup>/day when the subdrain water level declined below T.P. 3.0 m but increased during rainfall.

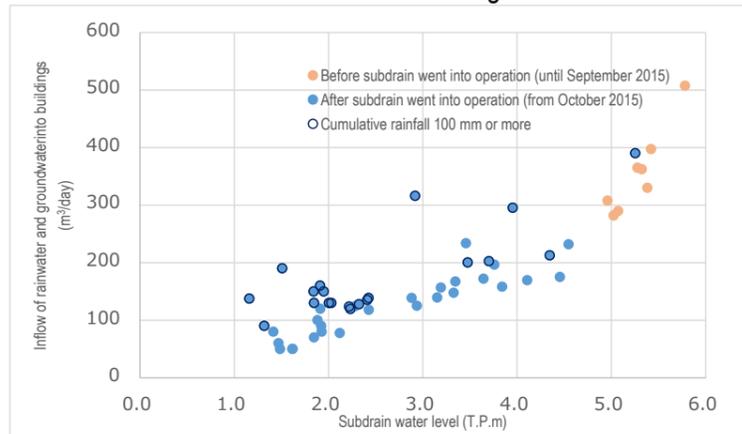


Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Unit 1-4 subdrains

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

- An operation to maintain the land-side impermeable walls and prevent the frozen soil from thickening further continued from May 2017 on the north and south sides and started from November 2017 on the east side, where frozen soil of sufficient thickness was identified. The scope of the maintenance operation was expanded in March 2018.
- In March 2018, construction of the land-side impermeable walls was completed, except for a portion of the depth, based on a monitoring result showing that the underground temperature had declined below 0°C in almost all areas, while on the mountain side, the difference between the inside and outside increased to approx. 4-5 m. The 21<sup>st</sup> Committee on Countermeasures for Contaminated-Water Treatment, held on March 7, 2018, evaluated that together with the function of subdrains and other measures, a water-level management system to stably control groundwater and isolate the buildings from it had been established and allowed a significant reduction in the amount of contaminated water generated.
- A supplementary method was implemented for the unfrozen depth and it was confirmed that the temperature of this portion had declined below 0°C by September 2018. From February 2019, maintenance operation started at all sections.
- The groundwater level in the area inside the land-side impermeable walls has been declining every year. On the mountain side, the difference between the inside and outside increased to approx. 4-5 m. The water level in the bank area has remained low (T.P. 1.6-1.7 m) compared to the ground surface (T.P. 2.5 m).

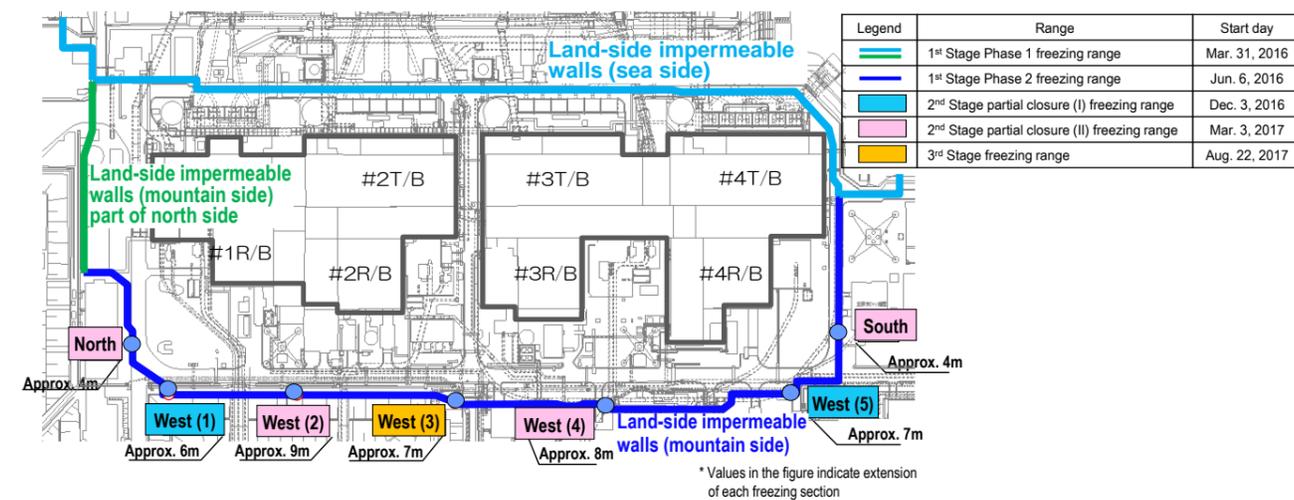


Figure 3: Closure of part of the land-side impermeable walls (on the mountain side)

### ➤ Operation of multi-nuclide removal equipment

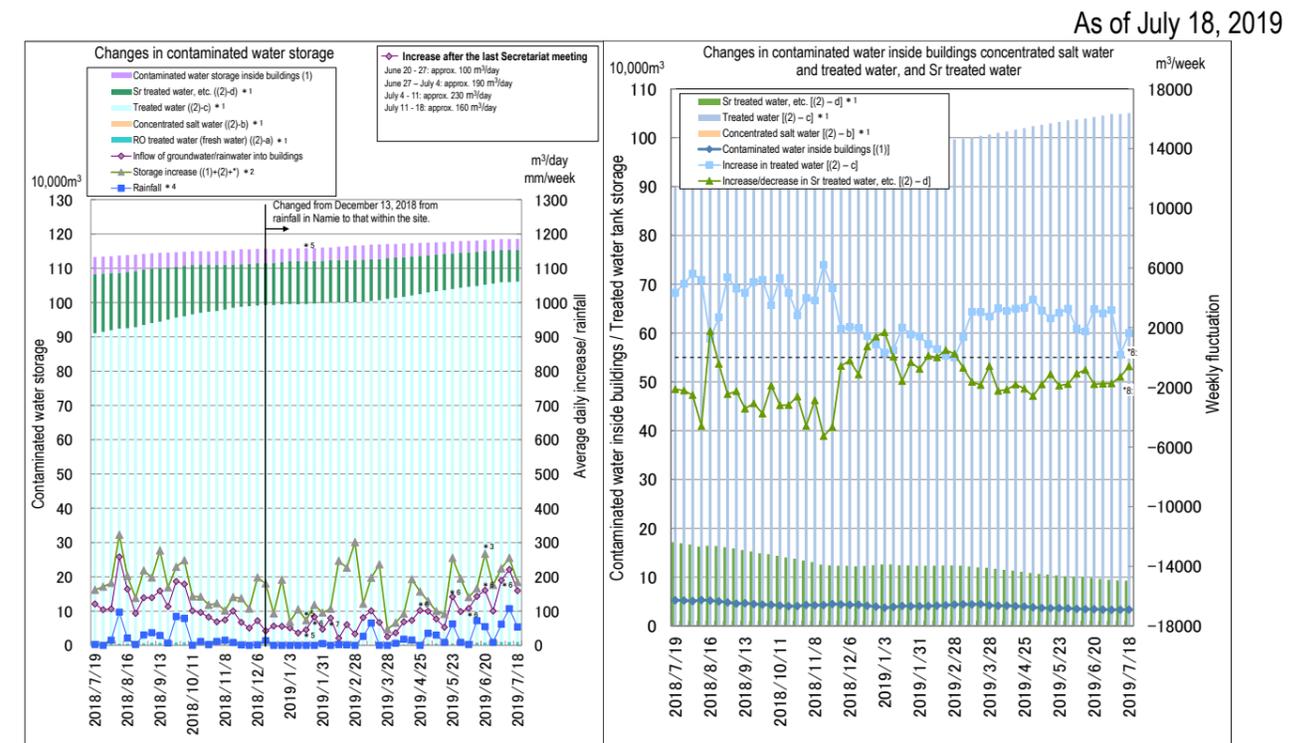
- Regarding the multi-nuclide removal equipment (existing and high-performance), hot tests using radioactive water were underway (for existing equipment, System A: from March 30, 2013, System B: from June 13, 2013, System C: from September 27, 2013; and for high-performance equipment, from October 18, 2014). The additional multi-nuclide removal equipment went into full-scale operation from October 16, 2017.
- As of July 18, 2019, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 411,000, 570,000 and 103,000 m<sup>3</sup>, respectively (including approx. 9,500 m<sup>3</sup> stored in the J1(D) tank, which contained water with highly concentrated radioactive materials at the System B outlet of the existing multi-nuclide removal equipment).
- To reduce the risks of strontium-treated water, treatment using existing, additional and high-performance multi-nuclide removal equipment has been underway (existing: from December 4, 2015; additional: from May 27, 2015; high-performance: from April 15, 2015). Up until July 18, 2019, approx. 611,000 m<sup>3</sup> had been treated.

### ➤ Toward risk reduction of contaminated water stored in tanks

- Treatment measures comprising the removal of strontium by cesium-adsorption apparatus (KURION) (from January 6, 2015), the secondary cesium-adsorption apparatus (SARRY) (from December 26, 2014) and the third cesium-adsorption apparatus (SARRY II) (from July 12, 2019) have been underway. Up until July 18, 2019, approx. 528,000 m<sup>3</sup> 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 July 22, 2019, a total of 131,845 m<sup>3</sup>).



\*1: Water amount for which the water-level gauge indicates 0% or more  
 \*2: To detect storage increases more accurately, the calculation method was reviewed as follows from February 9, 2017: (The revised method was applied from March 1, 2018) [(Inflow of groundwater/rainwater into buildings) + (other transfer) + (chemical injection into ALPS)]  
 \*3: The storage amount increased due to transfer to buildings in association with the decommissioning work. (The transferred amount comprised ①Transfer from On-site Bunker Building to Process Main Building: approx. 70 m<sup>3</sup>/day, ②ALPS waste chemical: 13 m<sup>3</sup>/day, ③Transfer from wells and groundwater drains: approx. 12 m<sup>3</sup>/day, etc.)  
 \*4: Changed from December 13, 2018 from rainfall in Namie to that within the site.  
 \*5: Since January 17, 2019, Unit 3 C/B contaminated water has been managed in addition to contaminated water storage in buildings. For the inflow of groundwater, rainwater, etc. to buildings and increase in storage have been reflected since January 24, 2019.  
 \*6: Considered attributable to the increased inflow of groundwater, rainwater, etc. to buildings due to the decline in the level of contaminated water in buildings. (January 17, April 22, May 16 and 30, June 13 and 27, 2019)  
 \*7: Water-level gauges were replaced (February 7 – March 7, 2019)  
 \*8: Calculation methods for water volume and the capacity of tanks, which had varied in each tank area, were unified in all areas. By this unification, the calculated increase in treated water and variation in Sr-treated water, etc. changed. However, the actual treated volumes were approx. 2200 m<sup>3</sup>/week for treated water and approx. 1100 m<sup>3</sup>/week for Sr-treated water, etc. (July 11, 2019).

Figure 4: Status of contaminated water storage

- Measures to shutoff groundwater inflow to the Onsite Bunker Building
  - From mid-November 2018, the groundwater inflow to the Onsite Bunker Building increased.
  - On June 20, 2019, the core was removed near the funnel and the inflow condition of the core section was investigated to identify the cause. The investigation detected a vinyl hose laid there, which was supposed to continue to near the outer walls of the building.
  - Work to fill cement-based water glass in the vinyl hose and close the groundwater inflow route will start from August 2019.
- Measures to suppress dust scattering during dismantling of flanged tanks using new “laser decontamination” technology
  - To suppress scattering of radioactive materials during the dismantling of used flanged tanks, their insides were painted. Instead of the painting, new technology in the form of a “laser decontamination method”, which removed attached radioactive materials, was introduced from July 2019.
  - As well as suppressing the scattering of radioactive materials, this method can reduce exposure during work by reducing the surface dose inside the tanks.
- Transfer of accumulated water in the connection of the Unit 2 seawater pipe trench and the building
  - For the Unit 2 seawater pipe trench, filling and closure work started from November 2014 and was completed in March 2017 except for the connection with the Unit 2 Turbine Building south side. From March 2019, filling and closure of the connection with the building started.
  - There was a plan to transfer accumulated water (gross  $\beta$  radiation density:  $1.8 \times 10^8$  Bq/L, water volume: approx. 140 m<sup>3</sup>) for the period June 19 to mid-July, 2019. However, obstacles were detected in the drilling part during the work prior to water transfer. The drilling part was relocated and drilling was resumed there.
  - Based on the inspection results of the condition inside the trench at the resumed drilling part, the water transfer process will be reviewed.
- Leakage within the fenced-in area at the cross-flow filter skid of the additional multi-nuclide removal equipment System C
  - On July 5, 2019, an alarm “cross-flow filter skid 1 leakage” indicating operation of the leakage detector was issued at the additional multi-nuclide equipment System C. An onsite inspection confirmed water leakage over an area of approx. 2 m × 3 m × 1 mm (depth) on the floor under the back pulse pot and approx. 0.1 m × 2 m × 20 mm (depth) within the basin for the leakage detector. The leaked water remained within the fenced-in area and had no external influence. The leakage ceased when use of the equipment was suspended.
  - Analysis of the leaked water revealed cesium 134:  $2.9 \times 10^2$  Bq/L, cesium 137:  $3.9 \times 10^3$  Bq/L and gross  $\beta$  radioactivity:  $8.0 \times 10^4$  Bq/L. The leakage was considered system water from the additional multi-nuclide removal equipment and the water was wiped away.
  - The cause will be investigated and measures examined.
- Leakage within the fenced-in area from the drain line of the existing multi-nuclide removal equipment System A
  - On July 11, 2019, dripping water was detected from the screwed part of the closure cap in the area downstream of the drain valve for the existing multi-nuclide removal equipment System A. The leakage (over an area of approx. 0.1 m × 0.1 m × 1 mm) remained within the fenced-in area and had no external influence. After tightening the cap, the leakage ceased.
  - Analysis of the leaked water revealed cesium 134:  $6.7 \times 10^3$  Bq/L, cesium 137:  $9.2 \times 10^4$  Bq/L, and gross  $\beta$  radioactivity:  $2.0 \times 10^7$  Bq/L. The water was wiped away.
  - The leakage was considered attributable to a loosened sheet pass and closure cap of the drain valve. After recovering the system by installing a closure flange in the area downstream of the drain valve, operating was resumed from July 18, 2019.

## 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 the amount of dust scattering during rubble removal, started on October 31, 2017 and was completed by December 19, 2017.
  - From January 22, 2018, toward fuel removal from the spent fuel pool (SFP), careful work began to remove rubble on the north side of the operating floor using suction equipment. No significant variation was identified around the site boundaries, where the density of radioactive materials was monitored and at onsite dust monitors during the above removal work. Once removed, the rubble is stored in solid waste storage facilities or elsewhere depending on the dose level.
  - Before formulating a plan to remove rubble around the SFP, an onsite investigation started from July 23, 2018 and was completed on August 2, 2018.
  - To create an access route for preparatory work to protect the SFP, work to remove four sections of X-braces (one each on the west and south sides and two on the east side, respectively) started from September 19, 2018 and all planned four sections had been removed by December 20, 2018.
  - On March 6, 2019, the creation of an access route from the west working floor was completed and the floor opening was covered to prevent small rubble falling from the operating floor during the work.
  - From March 18, 2019, the removal of small rubble in the east-side area around the SFP started using pliers and suction equipment. From July 9, 2019, small rubble removal on the south side of the SFP started.
  - From July 17, 2019, an investigation started to examine how best to handle the well plug, which was considered as having been misaligned due to the influence of the hydrogen explosion at the time of the accident. In this investigation, two robots (for investigation and monitoring) will be used to measure 3D-images, air dose rate, etc.
  - The H-section steel on the well plug, which may interfere with future work, will be removed from late August 2019.
  - To obtain information needed prior to formulating future work plans, the south side of the Reactor Building will be investigated by inserting investigative equipment from the opening of the fallen roof in August 2019.
  - The fallen roof over the SFP will be removed. To prevent the anticipated risk of small rubble, and other objects falling during the removal and any influence on the soundness of fuel, the SFP will be covered before the work. As preparation, the condition inside the pool will be investigated using an underwater camera in August 2019.
- Main work to help spent fuel removal at Unit 2
  - On November 6, 2018, before the investigation toward formulating a work plan to dismantle the Reactor Building rooftop, and other works, work to move and contain the remaining objects on the operating floor (1<sup>st</sup> round) was completed.
  - On February 1, 2019, an investigation to measure the radiation dose on the floor, walls and ceiling inside the operating floor and confirm the contamination status was completed. After analyzing the investigative results, the “contamination density distribution” throughout the entire operating floor was obtained, based on which the air dose rate inside the operating floor could be evaluated. A shielding design and measures to prevent radioactive material scattering will be examined.
  - From April 8, 2019, work to move and contain the remaining objects on the operating floor (2<sup>nd</sup> round) got underway, such as materials and equipment which may hinder fuel removal work. The 2<sup>nd</sup> round included placing the remaining objects in the container and cleaning the floor to suppress dust scattering, none of which were scheduled in the 1<sup>st</sup> round. The status of dust density is being monitored to steadily implement the work with safety first.
  - Based on the results obtained from investigations conducted inside the operating floor to date, it was considered that limited work could be implemented there. To reduce the risk of dust scattering while dismantling the building and ensure work could be implemented more securely and safely, methods, including an approach to access from the south side and minimize the scope of dismantling the upper part of the operating floor, are being examined.

### ➤ Main process to help fuel removal at Unit 3

- Regarding the fuel-handling machine (FHM) and crane, consecutive defects have occurred since the test operation started on March 15, 2018.
- On August 8, 2018, an alarm was issued during the pre-operation inspection of the FHM, whereupon operation was suspended. This was attributable to disconnection due to rainwater ingress corrosion into the cable connection. Abnormalities were also detected in several control cables.
- On August 15, 2018, an alarm on the crane was triggered during work to clear materials and equipment, whereupon the crane operation was suspended.
- On September 29, 2018, to determine the risks of defects in fuel-handling facilities, the FHM was temporarily recovered and a safety inspection (operation check and facility inspection) started. For 14 defects detected in the safety inspection, measures were completed on January 27, 2019.
- On February 8, 2019, a function check after cable replacement was completed.
- On February 14, 2019, review of recovery measures in the event of defects was held and training for fuel removal using dummy fuel and the transport container got underway. During the training, seven defects were detected, although it was confirmed that these did not constitute safety problems that could lead to fuel, rubble falling.
- From March 15, 2019, the rubble removal training inside the pool started.
- From April 15, 2019, removal of 514 spent fuel assemblies and 52 non-irradiated fuel assemblies (a total of 566 assemblies) stored in the spent fuel pool started. Seven non-irradiated fuel assemblies were then loaded in the transport container and transported to the common pool on April 23, 2019. The first fuel removal was completed on April 25, 2019.
- From July 4, 2019, fuel removal was resumed and the removal of 21 non-irradiated fuel assemblies was completed within July as planned. Up until July 21, 2019, 28 of all 566 fuel assemblies had been removed. During the removal, no significant variation was detected in the dust density in the surrounding environment.
- On July 17 and 21, 2019, leakage from the joint of a hose for working fluid of the fuel-handling facility carrying working fluid was detected. The cause will be investigated, measures implemented and similar parts checked, and other works in the facility inspection, which started from July 24, to resume fuel and rubble removal from early September 2019.

### ➤ Plan to dismantle the Unit 1/2 exhaust stack

- On May 11, 2019, as part of preparation to dismantle the Unit 1/2 exhaust stack, the feasibility of installing mockup dismantling equipment on top of the exhaust stack was checked using a crane for dismantling. The check confirmed that the planned lifting length (the distance from the crane hook to the exhaust stack top) differed from the actual lifting length and underlined the need to extend the lifting height of the crane by raising the boom and jib after moving the crane closer.
- Construction of the roadbed was completed on July 10, 2019 to extend the lifting length of the crane and it was confirmed that sufficient lifting length had been obtained as of July 18, 2019.
- As part of efforts to complete the dismantling of the exhaust stack within FY2019, work will start from early August 2019 with safety first while checking the influence on the surrounding environment.

## 3. Retrieval of fuel debris

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

- Prior to investigating the inside of the Primary Containment Vessel (PCV), an access route was being constructed. On June 4, 2019, during drilling of the inner door of the X-2 penetration, monitoring data showed that the dust density of the temporarily installed monitor had exceeded the criteria value set for work management. The value had declined to the density level before the work in several hours.
- This was considered attributable to the influence of high-pressure water during the drilling, which was poured on the grating inside the PCV and scattered dust. For future drilling, and other works, the cutting scope will be changed within a range with less influence to understand the tendency of dust density during drilling.

- The work will resume in around late July 2019. After obtaining sufficient knowledge about dust scattering, the inner door will be drilled and obstacles inside the PCV will be cut sequentially from late August 2019 onwards.

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

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

### ➤ Management status of the rubble and trimmed trees

- As of the end of June 2019, the total storage volume of the concrete and metal rubble was approx. 272,700 m<sup>3</sup> (+1,500 m<sup>3</sup> compared to at the end of May with an area-occupation rate of 68%). The total storage volume of trimmed trees was approx. 134,100 m<sup>3</sup> (±0 m<sup>3</sup>, with an area-occupation rate of 76%). The total storage volume of used protective clothing was approx. 56,200 m<sup>3</sup> (+800 m<sup>3</sup>, with an area-occupation rate of 82%). The increase in rubble was mainly attributable to construction related to rubble removal around Units 1-4, while the increase in used protective clothing was attributable to the acceptance of used protective clothing.

### ➤ Management status of secondary waste from water treatment

- As of July 4, 2019, the total storage volume of waste sludge was 597 m<sup>3</sup> (area-occupation rate: 85%), while that of concentrated waste fluid was 9,364 m<sup>3</sup> (area-occupation rate: 91%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment and other vessels, was 4,418 (area-occupation rate: 69%).

### ➤ Status of measures concerning water leakage at the Radioactive Waste Incinerator

- On May 27, 2019, water leakage was detected around the ash conveyer of the Radioactive Waste Incinerator System A during operation. Following suspension of the facility and isolating the incinerator auxiliary equipment cooling water system, the leakage was confirmed as having ceased.
- The leakage was considered attributable to the tripping of the air compressor spraying cooling water of the exhaust gas cooler, which was located in the preceding stage of the ash conveyer. Cooling water could not be sprayed normally and flew into the ash conveyer.
- To help prevent any recurrence, measures to avoid suspension of all air compressors will be implemented and the influence on equipment of the leakage will be surveyed. After confirming the soundness of equipment, incinerator operation is set to resume from August 2019.

## 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

- At No. 1-6, the H-3 density has been repeatedly declining and increasing since March 2018 and currently stands at around 900 Bq/L.
- At No. 1-8, the H-3 density had been increasing from around 2,000 Bq/L since December 2018 and currently stands at around 4,300 Bq/L.
- At No. 1-9, the density of gross β radioactive materials has been repeatedly increasing and declining around 20 Bq/L since April 2019 and currently stands at around 20 Bq/L.
- At No. 1-12, the density of gross β radioactive materials had been increasing from around 200 Bq/L since December 2018 and currently stands at around 1,600 Bq/L. Since August 15, 2013, pumping of groundwater continued (at the well point between the Unit 1 and 2 intakes: August 15, 2013 – October 13, 2015 and from October 24; at the repaired well: October 14 - 23, 2015).
- At No. 2-3, the H-3 density had been increasing from around 4,000 Bq/L since March 2019 and currently stands at around 6,000 Bq/L. The density of gross β radioactive materials at the same point had been increasing from around 8,000 Bq/L since April 2019 and currently stands at around 13,000 Bq/L.
- At No. 2-5, the H-3 density had been decreasing from around 2,300 Bq/L since June 2019 and currently stands at

around 120 Bq/L. The density of gross  $\beta$  radioactive materials at the same point had been decreasing from around 80,000 Bq/L since June 2019 and currently stands at around 8,200 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 densities of radioactive materials in drainage channels have remained constant, despite increasing during rainfall.
- In the Unit 1-4 intake open channel area, densities of radioactive materials in seawater have remained below the legal discharge limit except for the increase in Cs-137 and Sr-90 during rain. They have also been declining following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls. The density of Cs-137 has been decreasing since March 20, 2019, when the silt fence was transferred to the center of the open channel.
- In the area within the port, densities of radioactive materials in seawater have remained below the legal discharge limit, while increasing in Cs-137 and Sr-90 below the legal discharge limit during rain. They have remained below the level of those in the Unit 1-4 intake open channel area and been declining following the completed installation and connection of steel pipe sheet piles for the sea-side impermeable walls.
- In the area outside the port, regarding the densities of radioactive materials in seawater, those of Cs-137 and Sr-90 declined and remained low after the installation and connection of steel pipe sheet piles for the sea-side impermeable walls were completed.

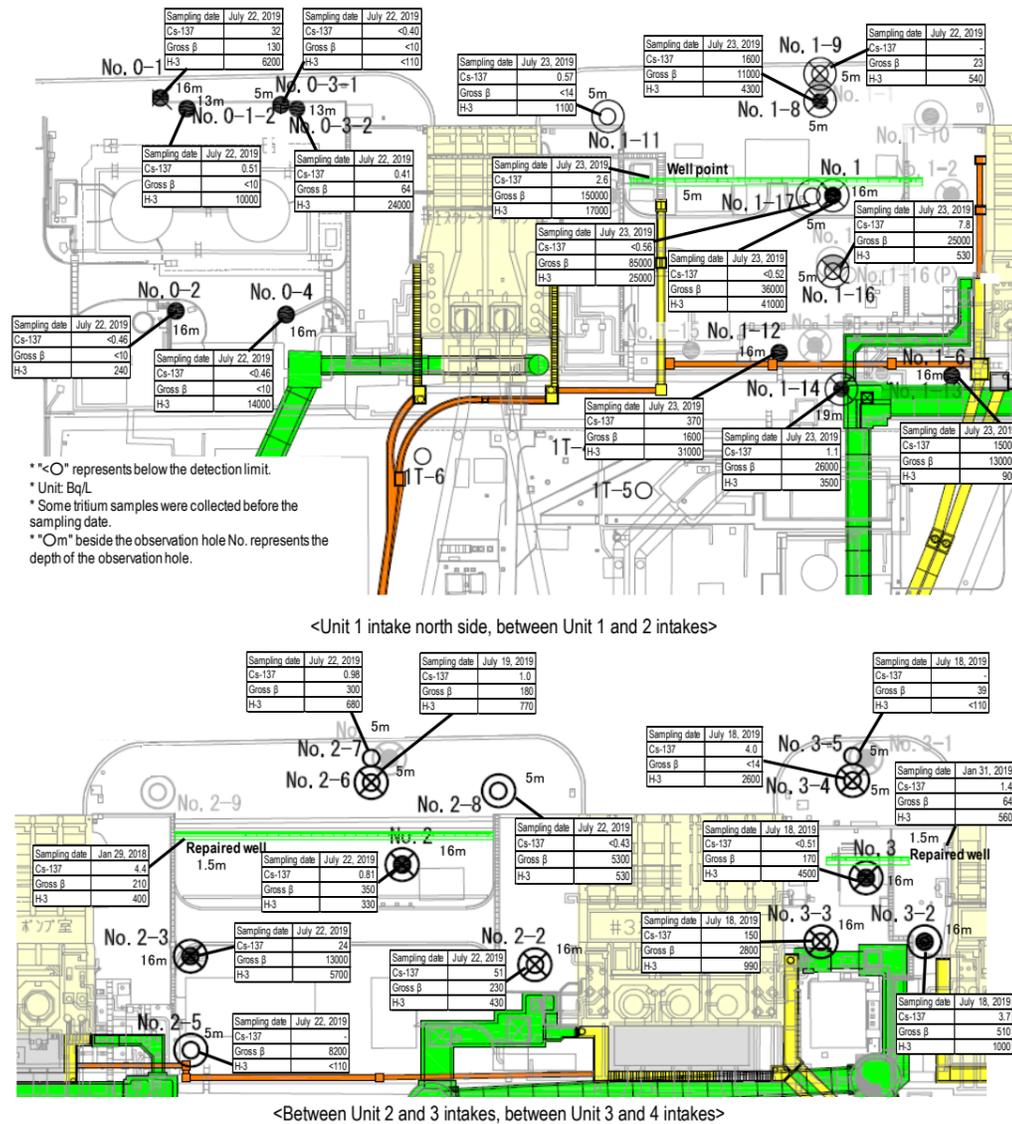


Figure 5: Groundwater density on the Turbine Building east side

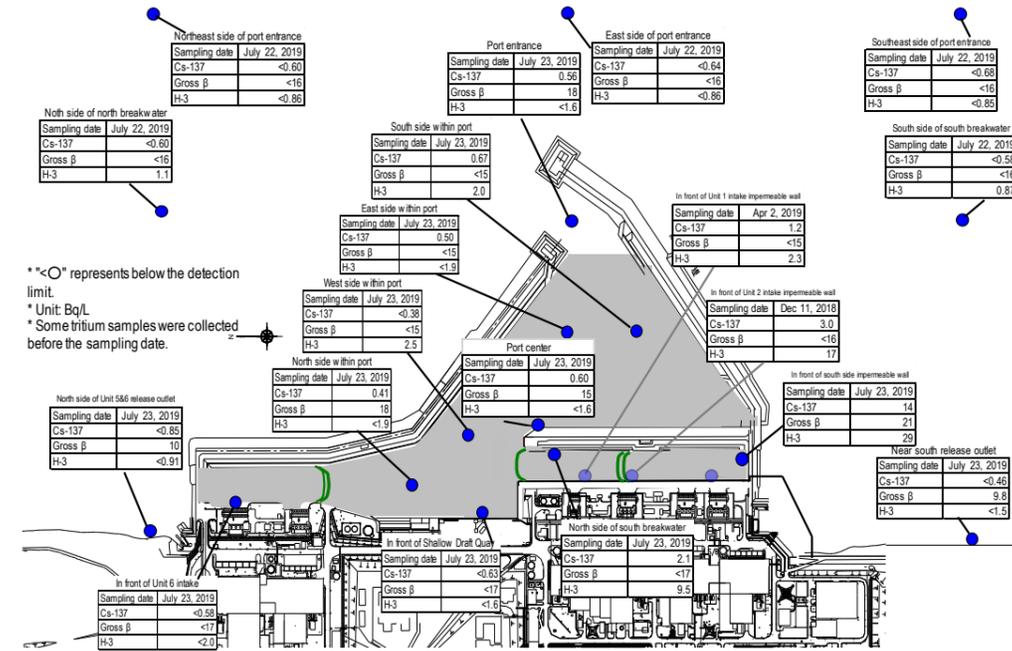


Figure 6: Seawater density around the port

## 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 personnel registered for at least one day per month to work on site during the past quarter from March to May 2019 was approx. 9,000 (TEPCO and partner company workers), which exceeded the monthly average number of actual workers (approx. 6,600). Accordingly, sufficient personnel are registered to work on site.
- It was confirmed with the prime contractors that the estimated manpower necessary for the work in August 2019 (approx. 3,540 per day: TEPCO and partner company workers) would be secured at present. The average numbers of workers per day per month (actual values) were maintained, with approx. 3,400 to 5,600 since FY2017 (see Figure 7).
- The number of workers within Fukushima Prefecture increased. The local employment ratio (TEPCO and partner company workers) as of June 2019 has remained constant at around 60%.
- The monthly average exposure dose of workers remained at approx. approx. 0.39 mSv/month during FY2016, approx. 0.36 mSv/month during FY2017 and approx. approx. 0.32 mSv/month during FY2018. (Reference: Annual average exposure dose 20 mSv/year  $\div$  1.7 mSv/month)
- For most workers, the exposure dose was sufficiently within the limit and allowed them to continue engaging in radiation work.

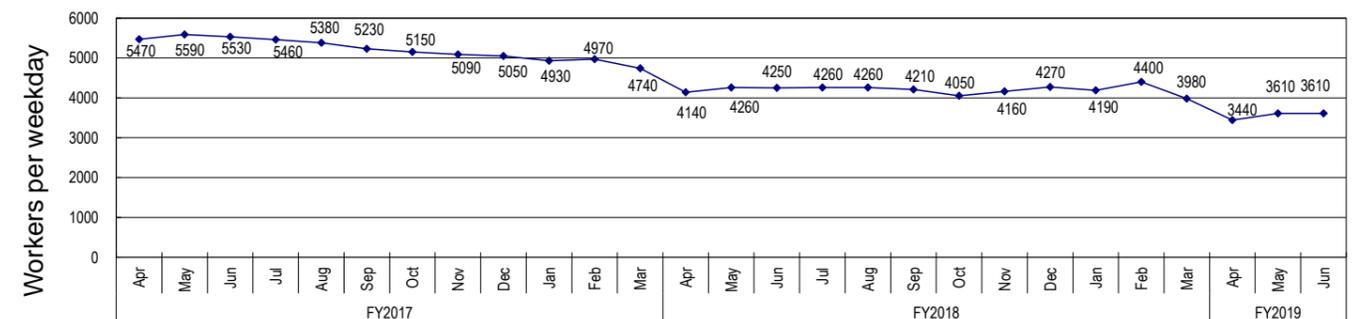


Figure 7: Changes in the average number of workers per weekday for each month since FY2017 (actual values)

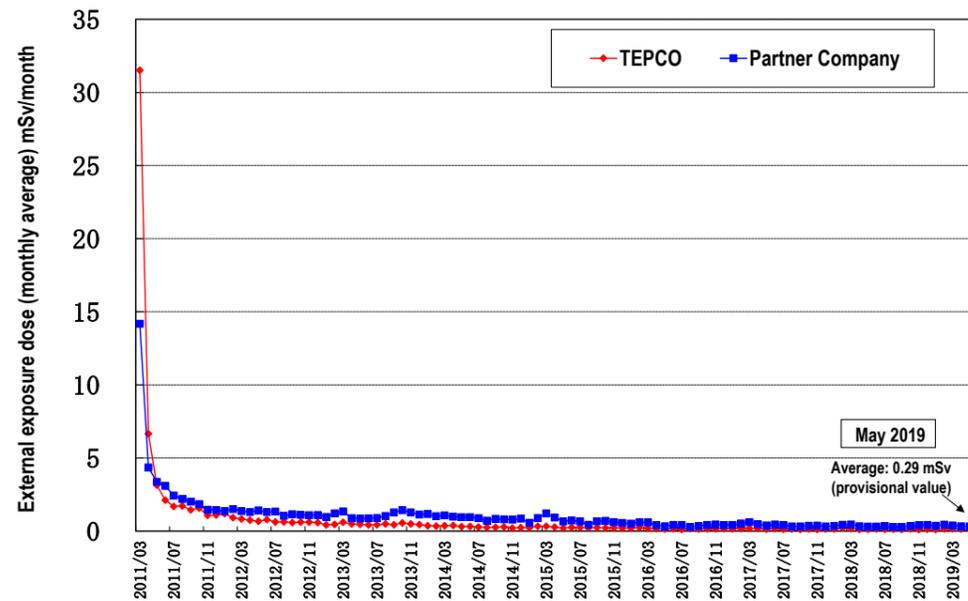


Figure 8: Changes in monthly individual worker exposure dose (monthly average exposure dose since March 2011)

#### ➤ Status of heat stroke cases

- In FY2019, measures to further prevent heat stroke commenced from April to cope with the hottest season.
- In FY2019, one worker suffered heat stroke due to work up until July 22 (in FY2018, three workers up until the end of July). Continued measures will be taken to prevent heat stroke.

#### ➤ Health management of workers in the Fukushima Daiichi NPS

- As health management measures in line with the guidelines of the Ministry of Health, Labour and Welfare (issued in August 2015), a scheme was established and operated, whereby primary contractors confirmed reexamination at medical institutions and the subsequent status of workers who were diagnosed as requiring “detailed examination and treatment” in the health checkup, with TEPCO confirming the operation status by the primary contractors.
- The recent report on the management status of the health checkup during the fourth quarter (January – March) in FY2018 confirmed that the primary contractors had provided appropriate guidance and properly managed the operation under the scheme. The report on the follow-up status during the third quarter in FY2018 and before confirmed that responses to workers, which had not been completed by the time of the previous report, were being provided on an ongoing basis. Checking of operations will continue.

### 7. Others

#### ➤ Recovery of Unit 5/6 subdrain facilities

- The groundwater level around the Unit 5/6 buildings remained high. There is a risk of important facilities being flooded by groundwater inflow due to aging building penetrations, and other factors.
- To eliminate this risk, examination toward recovering the Unit 5/6 subdrain from FY2021 started. Pumped-up subdrain water will be transferred to Unit 1-4 subdrain purification facilities for treatment. Scope to utilize the capacity born in the Unit 5/6 building contaminated-water treatment equipment will also be examined to treat accumulated water onsite.

#### ➤ Deviation from the limiting condition for operation (LCO) at the Unit 5 emergency diesel power generator (B)

- On July 16, 2019, an excess liquid level of the valve oiling tank of the Unit 5 emergency diesel power generation (D/G) (B) was confirmed. An onsite investigation detected a potential mixture of light oil for D/G fuel into lubricant in the valve oiling tank. The power generator was removed from the waiting status for inspection.
- Unit 5 emergency D/G (A) could not be used due to the regular inspection. In addition, it was also decided that the

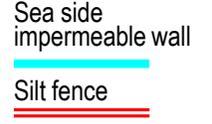
limiting condition for operation (LCO) (Article 61, Emergency Diesel Power Generation, Part 2) could not be satisfied.

- On July 19, 2019, the regular inspection of the Unit 5 emergency D/G (A) was completed and it was confirmed that the LOC could be satisfied.
- To investigate the cause for mixture of light oil, pressurization on the light oil side was inspected and the inspection detected loosened joints (screw type) for fuel valves of some cylinders, which were supposed to have been loosened when the valve was removed from the fuel injection test equipment.
- An operation check after replacing the metal packing of the part and tightening the joints confirmed that there was no leakage.
- As recurrence prevention measures, set marks will be placed on the relevant parts before removing the test equipment and tightening of fuel valve joint parts will be checked for other cylinders.

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

“The highest value” → “the latest value (sampled during July 15-23)”; unit (Bq/L); ND represents a value below the detection limit

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



Cesium-134: 3.3 (2013/10/17) → ND(0.34) Below 1/9  
Cesium-137: 9.0 (2013/10/17) → 0.50 Below 1/10  
Gross β: **74** (2013/ 8/19) → ND(15) Below 1/4  
Tritium: 67 (2013/ 8/19) → ND(1.9) Below 1/30

Cesium-134: 4.4 (2013/12/24) → ND(0.34) Below 1/10  
Cesium-137: **10** (2013/12/24) → ND(0.38) Below 1/20  
Gross β: **60** (2013/ 7/ 4) → ND(15) Below 1/4  
Tritium: 59 (2013/ 8/19) → 2.5 Below 1/20

Cesium-134: 5.0 (2013/12/2) → ND(0.35) Below 1/10  
Cesium-137: 8.4 (2013/12/2) → 0.41 Below 1/20  
Gross β: **69** (2013/8/19) → 18 Below 1/3  
Tritium: 52 (2013/8/19) → ND(1.9) Below 1/20

Cesium-134: 2.8 (2013/12/2) → ND(0.37) Below 1/7  
Cesium-137: 5.8 (2013/12/2) → ND(0.58) Below 1/10  
Gross β: **46** (2013/8/19) → ND(17) Below 1/2  
Tritium: 24 (2013/8/19) → ND(2.0) Below 1/10

Cesium-134: ND(0.53)  
Cesium-137: 0.60  
Gross β: 15  
Tritium: ND(1.6) \*1

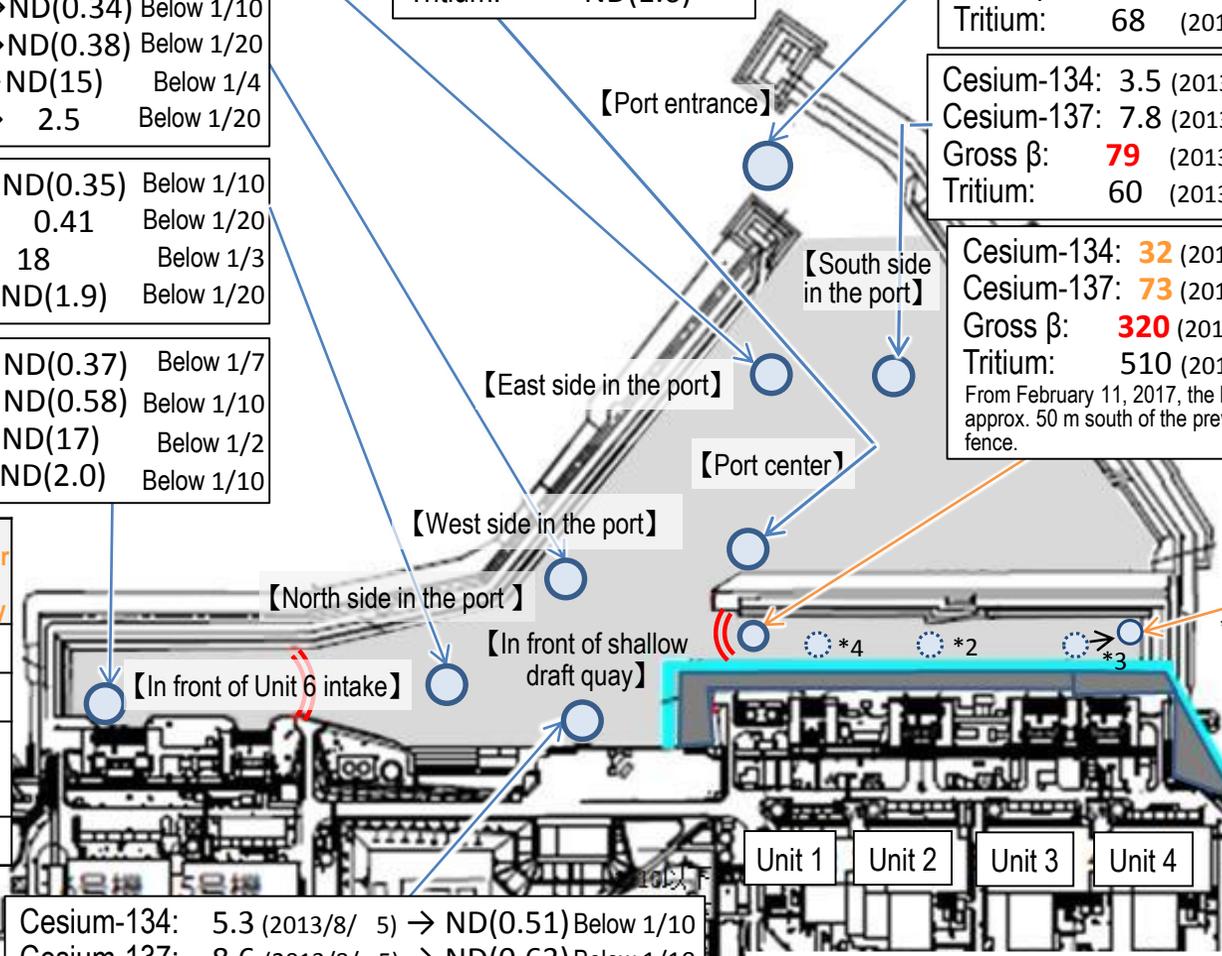
Cesium-134: 3.3 (2013/12/24) → ND(0.47) Below 1/7  
Cesium-137: 7.3 (2013/10/11) → 0.56 Below 1/10  
Gross β: **69** (2013/ 8/19) → 18 Below 1/3  
Tritium: 68 (2013/ 8/19) → ND(1.6) Below 1/40

Cesium-134: 3.5 (2013/10/17) → ND(0.34) Below 1/10  
Cesium-137: 7.8 (2013/10/17) → 0.67 Below 1/10  
Gross β: **79** (2013/ 8/19) → ND(15) Below 1/5  
Tritium: 60 (2013/ 8/19) → 2.0 Below 1/30

Cesium-134: **32** (2013/10/11) → ND(0.52) Below 1/60  
Cesium-137: **73** (2013/10/11) → 2.1 Below 1/30  
Gross β: **320** (2013/ 8/12) → ND(17) Below 1/10  
Tritium: 510 (2013/ 9/ 2) → 9.5 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: 0.93  
Cesium-137: 14  
Gross β: 21  
Tritium: 29 \*1

	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(0.51) Below 1/10  
Cesium-137: 8.6 (2013/8/ 5) → ND(0.63) Below 1/10  
Gross β: **40** (2013/7/ 3) → ND(17) Below 1/2  
Tritium: 340 (2013/6/26) → ND(1.6) Below 1/200

\*1: Monitoring commenced in or after March 2014. Monitoring inside the sea-side impermeable walls was finished because of the landfill.  
\*2: For the point, monitoring was finished from December 12, 2018 due to preparatory work for transfer of mega float.  
\*3: For the point, monitoring point was moved from February 6, 2019 due to preparatory work for transfer of mega float.  
\*4: For the point, monitoring was finished from April 3, 2019 due to preparatory work for transfer of mega float.

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 July 24, 2019

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

(The latest values sampled during July 15-23)

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

	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

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

Cesium-134: ND (2013) → ND (0.65)  
 Cesium-137: ND (2013) → ND (0.60)  
 Gross β: ND (2013) → ND (16)  
 Tritium: ND (2013) → ND (0.86)

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

Cesium-134: ND (2013) → ND (0.70)  
 Cesium-137: 1.6 (2013/10/18) → ND (0.64) Below 1/2  
 Gross β: ND (2013) → ND (16)  
 Tritium: 6.4 (2013/10/18) → ND (0.86) Below 1/7

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

Cesium-134: ND (2013) → ND (0.83)  
 Cesium-137: ND (2013) → ND (0.68)  
 Gross β: ND (2013) → ND (16)  
 Tritium: ND (2013) → ND (0.85)

Cesium-134: ND (2013) → ND (0.79)  
 Cesium-137: ND (2013) → ND (0.60)  
 Gross β: ND (2013) → ND (16)  
 Tritium: 4.7 (2013/ 8/18) → 1.1 Below 1/4

【Port entrance】

Cesium-134: 3.3 (2013/12/24) → ND (0.47) Below 1/7  
 Cesium-137: 7.3 (2013/10/11) → 0.56 Below 1/10  
 Gross β: 69 (2013/ 8/19) → 18 Below 1/3  
 Tritium: 68 (2013/ 8/19) → ND (1.6) Below 1/40

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

Cesium-134: ND (2013) → ND (0.65)  
 Cesium-137: ND (2013) → ND (0.58)  
 Gross β: ND (2013) → ND (16)  
 Tritium: ND (2013) → 0.87

【North side of Unit 5 and 6 release outlet】

Cesium-134: 1.8 (2013/ 6/21) → ND (0.58) Below 1/3  
 Cesium-137: 4.5 (2013/ 3/17) → ND (0.59) Below 1/7  
 Gross β: 12 (2013/12/23) → 10  
 Tritium: 8.6 (2013/ 6/26) → ND (0.91) Below 1/9

Cesium-134: ND (2013) → ND (0.57)  
 Cesium-137: 3.0 (2013/ 7/15) → ND (0.46) Below 1/6  
 Gross β: 15 (2013/12/23) → 9.8  
 Tritium: 1.9 (2013/11/25) → ND (0.90) Below 1/2

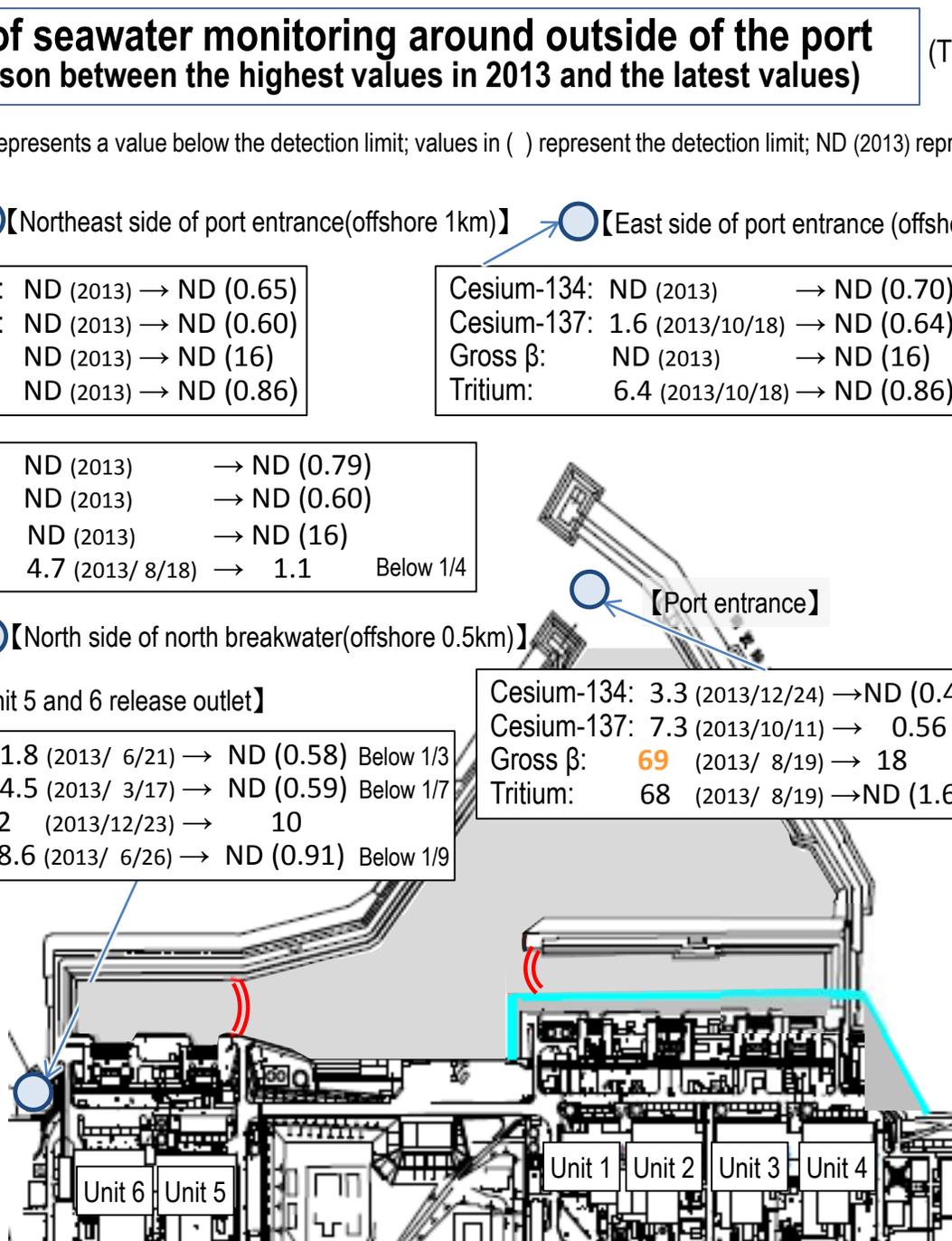
【Near south release outlet】

Sea side impermeable wall  
 Silt fence

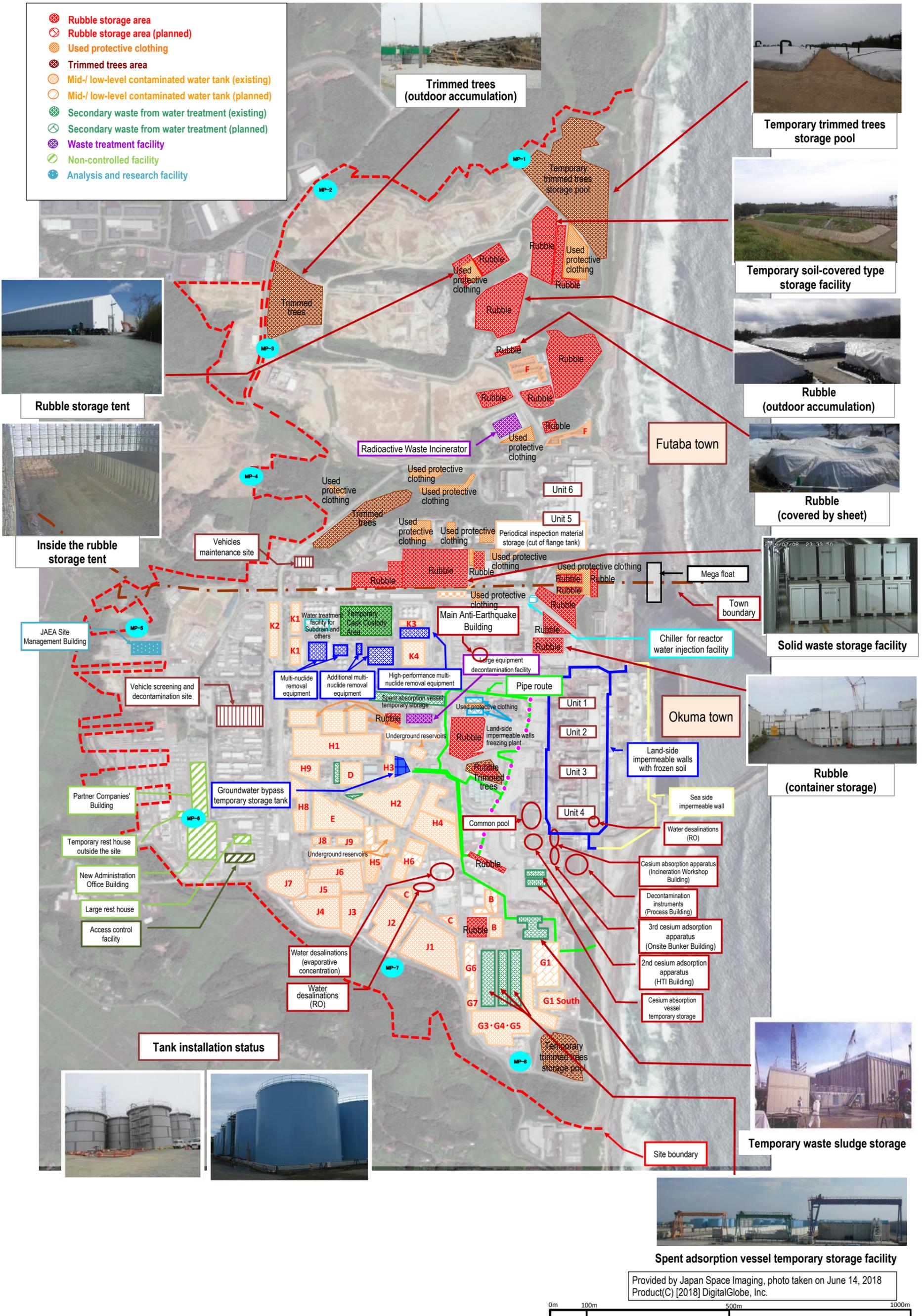
Note: Because safety of the sampling points was unassured due to the influence of Typhoon No. 10 in 2016, samples were taken from approx. 330 m south of the Unit 1-4 release outlet. Samples were also taken from a point approx. 280m south from the same release outlet from January 27, 2017 and approx.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

Summary of TEPCO data as of July 24, 2019

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



# TEPCO Holdings Fukushima Daiichi Nuclear Power Station Site Layout



- Rubble storage area
- Rubble storage area (planned)
- Used protective clothing
- Trimmed trees area
- Mid-/ low-level contaminated water tank (existing)
- Mid-/ low-level contaminated water tank (planned)
- Secondary waste from water treatment (existing)
- Secondary waste from water treatment (planned)
- Waste treatment facility
- Non-controlled facility
- Analysis and research facility



Rubble storage tent



Inside the rubble storage tent



Temporary trimmed trees storage pool



Temporary soil-covered type storage facility



Rubble (outdoor accumulation)



Rubble (covered by sheet)



Solid waste storage facility



Rubble (container storage)



Temporary waste sludge storage



Spent adsorption vessel temporary storage facility

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



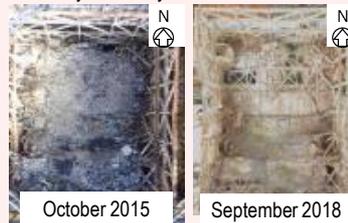
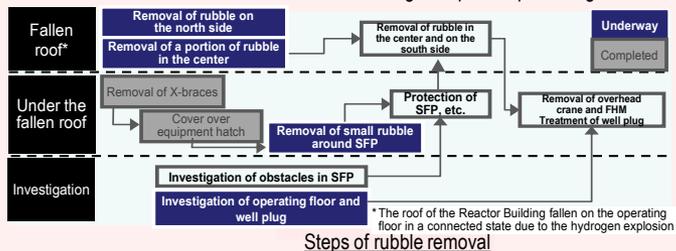
## Progress toward decommissioning: Fuel removal from the spent fuel pool (SFP)

Immediate target

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

## Unit 1

Toward fuel removal from the spent fuel pool, there is a plan to install a dedicated cover for fuel removal over the top floor of the Reactor Building (operating floor). On November 10, 2016, removal of all roof panels and wall panels of the building cover was completed. On May 11, 2017, removal of pillars and beams of the building cover was completed. On December 19, 2017, modification of the pillars and beams of the building cover and installation windbreak fences were completed. From March 18, 2019, removal of small rubble in the east-side area around the SFP started as an initial step using pliers and suction equipment. From July 9, 2019, small rubble removal on the south side of the SFP started. Rubble removal and investigation prior to protecting the SFP, etc. are currently underway.

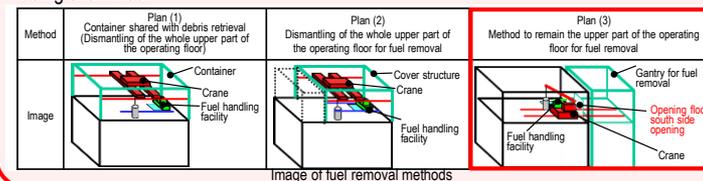


&lt;Status of the operating floor&gt;

## Unit 2

Toward fuel removal and debris retrieval in the Unit 2 spent fuel pool, the scope of dismantling and modification of the existing Reactor Building rooftop is examined. Based on the investigative results inside the operating floor, etc., methods are being examined from the perspective of ensuring safety during work, controlling influence on the outside of the power station, and removing fuel rapidly to reduce risks.

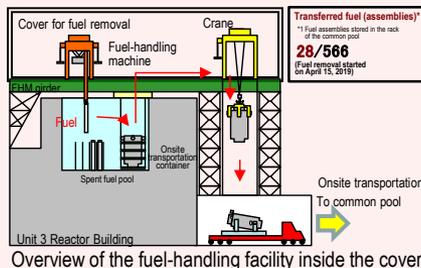
In addition to Plan (1) in which the whole upper part of the operating floor is dismantled and the container of poor fuel is shared with debris retrieval and Plan (2) in which a cover for pool fuel retrieval is separately installed, a method which minimizes the range of dismantling the upper part of the operating floor and accesses from the south side is being examined.



## Unit 3

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

Toward fuel removal, the rubble retrieval training inside the pool, which was scheduled in conjunction with fuel removal training, started from March 15, 2019, and started fuel removal from April 15, 2019.



## 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 1<sup>st</sup> Unit within two years of completion of Step 2 (by December 2013). On November 18, 2013, fuel removal from Unit 4, or the 1<sup>st</sup> 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.

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



## Common pool

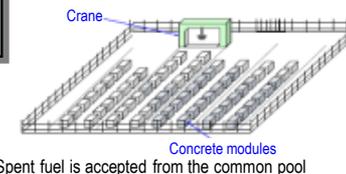


An open space will be maintained in the common pool (Transfer to the temporary cask custody area)

## 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)
- Fuel removal from the Unit 3 spent fuel pool began to be received (from April 2019)

## Temporary cask (\*) custody area



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.

## &lt;Glossary&gt;

- (\*) 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.
- (\*) Cask: Transportation container for samples and equipment, including radioactive materials.

**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<sup>(1)</sup>. (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<sup>(2)</sup> (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<sup>(3)</sup>)

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



Leak point

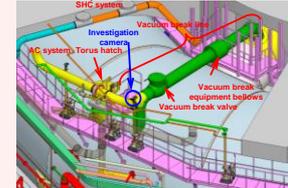
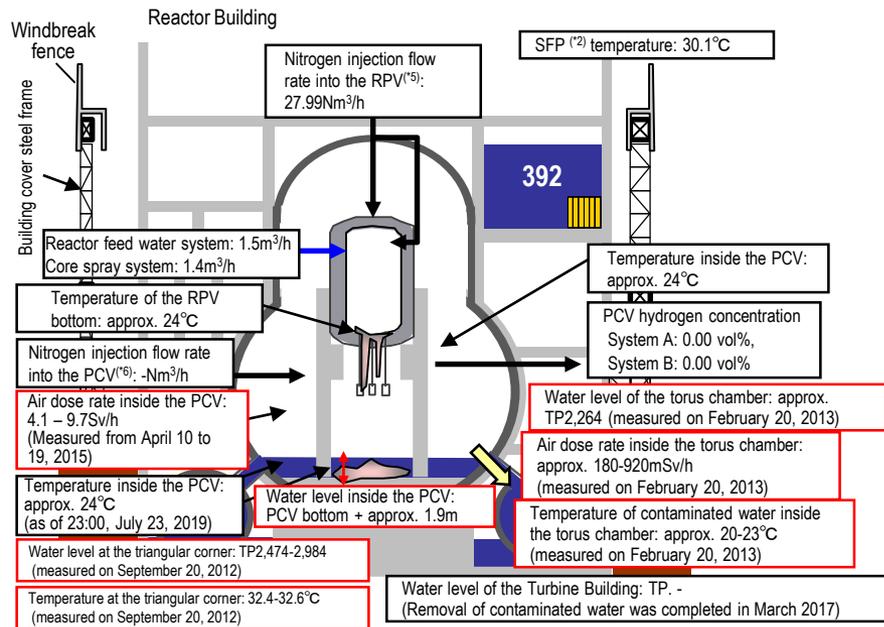


Image of the S/C upper part investigation

## Unit 1

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



\* Indices related to the plant are values as of 11:00, July 24, 2019

### 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:  $\phi$  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.

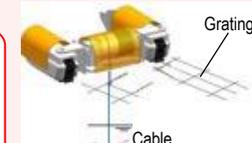
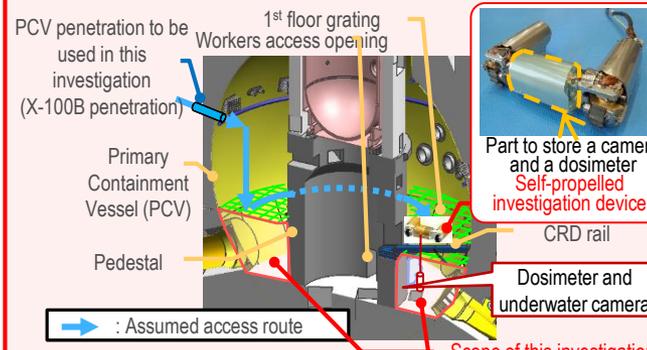


Image of hanging of dosimeter and camera



Image near the bottom

<Image of investigation inside the PCV>

### 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)

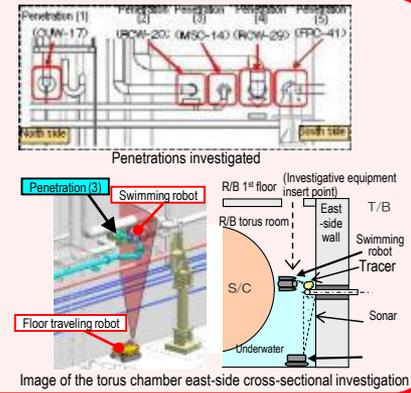
**Immediate target** Identify the plant status and commence R&D and decontamination toward fuel debris retrieval

Installation of an RPV thermometer and permanent PCV supervisory instrumentation

- 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.
- 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

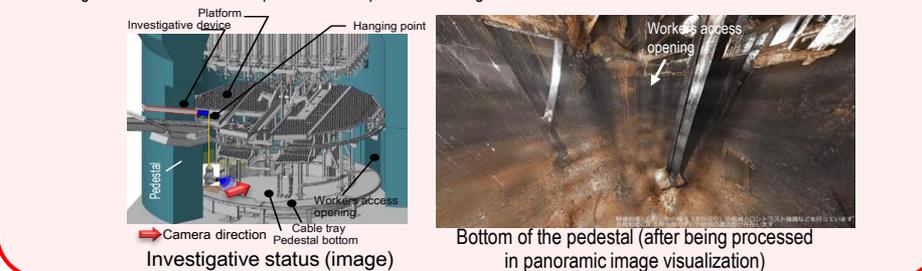
- The torus chamber walls were investigated (on the north side of the east-side walls) using equipment specially developed for that purpose (a swimming robot and a floor traveling robot).
- At the east-side wall pipe penetrations (five points), "the status" and "existence of flow" were checked.
- A demonstration 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 (\*) 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)



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

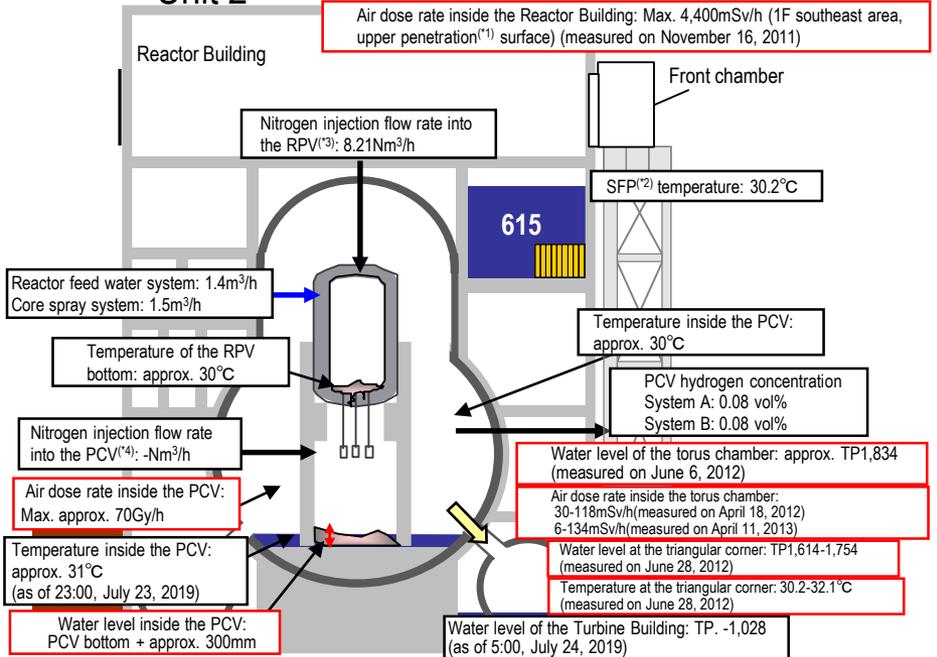


Capturing the location of fuel debris inside the reactor by measurement using muons

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

Unit 2



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

Investigations inside PCV	1st (Jan 2012)	2nd (Mar 2012)	3rd (Feb 2013 - Jun 2014)	4th (Jan - Feb 2017)
	- Acquiring images - Measuring air temperature	- Confirming water surface - Measuring water temperature - Measuring dose rate	- Acquiring images - Sampling contaminated water - Measuring water level - Installing permanent monitoring instrumentation	- 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			

**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.

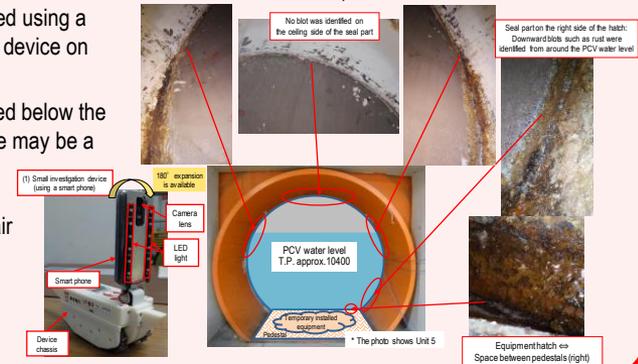
\* Main Steam Isolation Valve: A valve to shut off the steam generated from the Reactor in an emergency

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

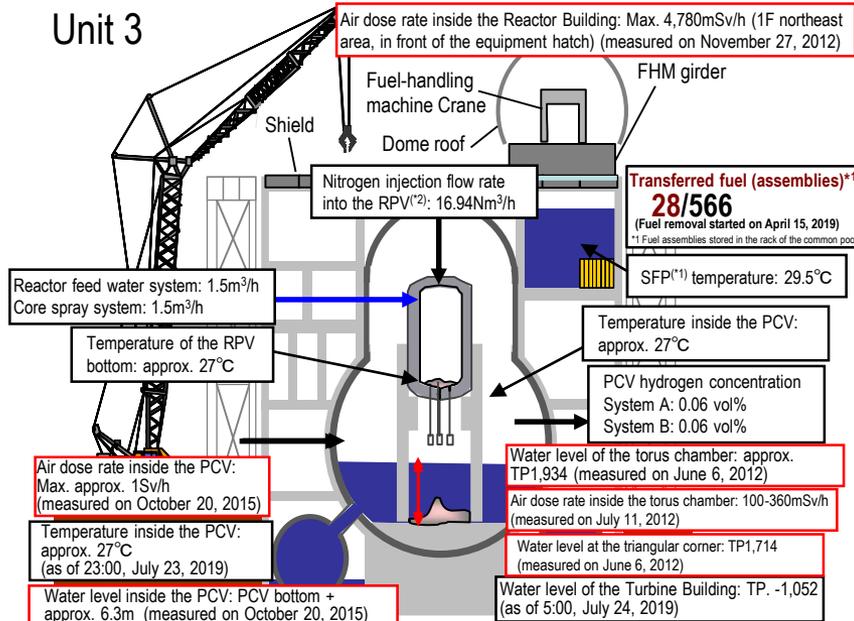
- As part of the investigation into the PCV to facilitate fuel debris retrieval, the status around the Unit 3 PCV equipment hatch was investigated using a small self-traveling investigation device on November 26, 2015.

- 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.



### Unit 3



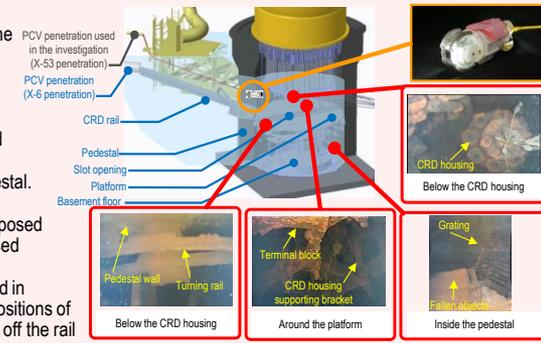
\* Indices related to plant are values as of 11:00, July 24, 2019

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



Status inside the pedestal

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

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

<Glossary>

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

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

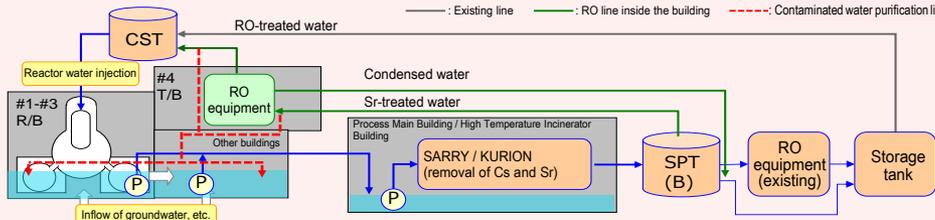
## Immediate target

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

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

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

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



### Progress status of dismantling of flange tanks

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



Start of dismantling in H1 east area

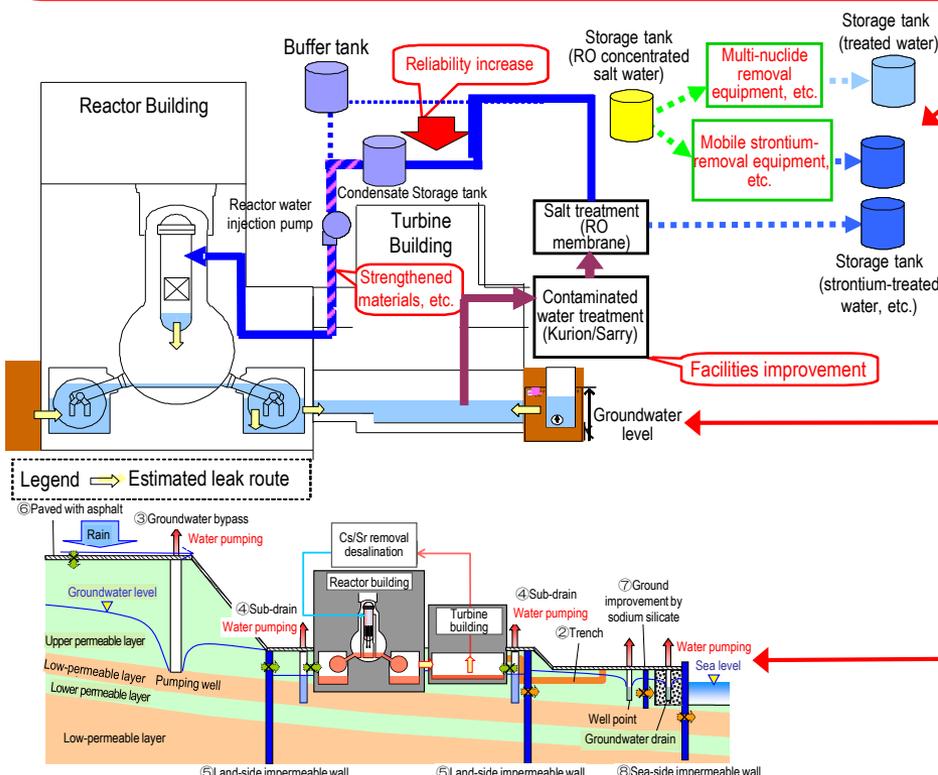


After dismantling in H1 east area

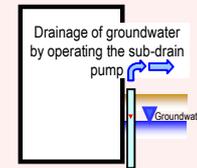
### Completion of purification of contaminated water (RO concentrated salt water)

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

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



### Preventing groundwater from flowing into the Reactor Buildings



#### Reducing groundwater inflow by pumping sub-drain water

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

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

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

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

Through periodical monitoring, pumping of wells and tanks is operated appropriately.

At the observation holes installed at a height equivalent to the buildings, the trend showing a decline in groundwater levels is checked.

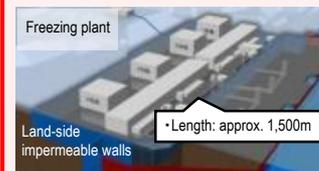
The analytical results on groundwater inflow into the buildings based on existing data showed a declining trend.

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

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

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

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



Freezing plant  
 Land-side impermeable walls  
 Length: approx. 1,500m

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

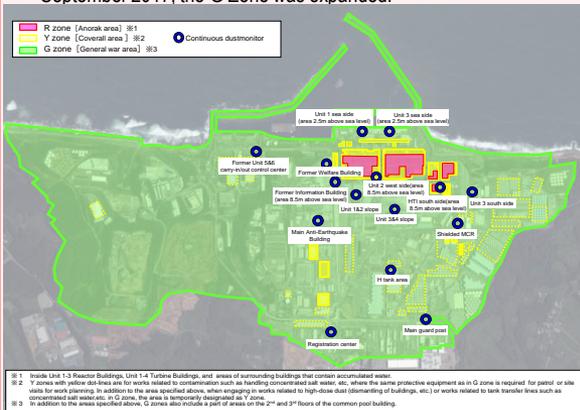
### Immediate targets

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

### Optimization of radioactive protective equipment

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

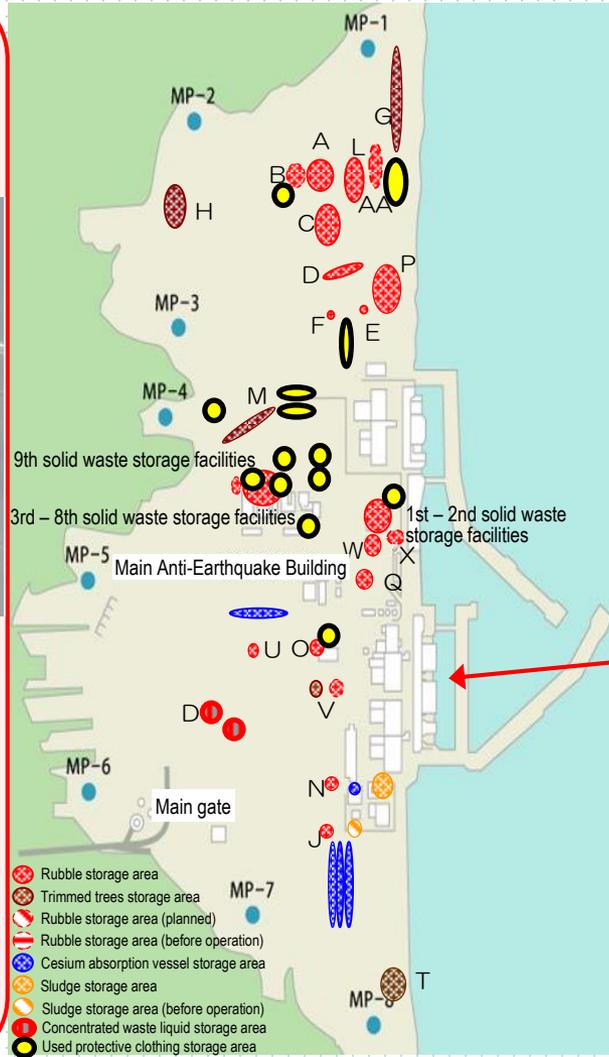
From March 2016, limited operation started. From March and September 2017, the G Zone was expanded.



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

R zone (Anorak area)	Y zone (Coverall area)	G zone (General wear)
Full-face mask 	Full-face or half-face masks 	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.)



- ☒ Rubble storage area
- ☒ Trimmed trees storage area
- ☒ Rubble storage area (planned)
- ☒ Rubble storage area (before operation)
- ☒ Cesium absorption vessel storage area
- ☒ Sludge storage area
- ☒ Sludge storage area (before operation)
- ☒ Concentrated waste liquid storage area
- ☒ Used protective clothing storage area

### 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.

