Outline of Decommissioning and Contaminated Water Management

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

Main decommissioning work and steps

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

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

Fuel Removal from SFP

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

Units 1-6	Completion of fuel removal	Within 2031
Unit 1	Start of fuel removal	FY2027 - FY2028
Unit 2	Start of fuel removal	FY2024 - FY2026
Unit 3	Completion of fuel removal	Within FY2020
Unit 4	Completion of fuel removal	2014

Fuel Debris Retrieval

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

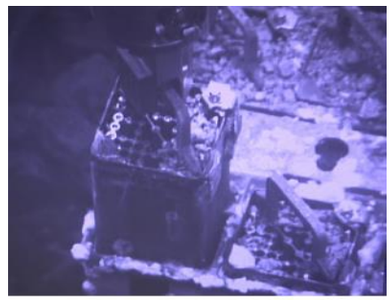
First unit	Start of fuel debris retrieval
Unit 2	Within 2021

Dismantling Facilities

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

Fuel removal from the spent fuel pool

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



Fuel removal (April 15, 2019)

Removed fuel (assemblies)
56/566
(As of January 30, 2020)

Contaminated water management proceeds with the following three efforts:

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

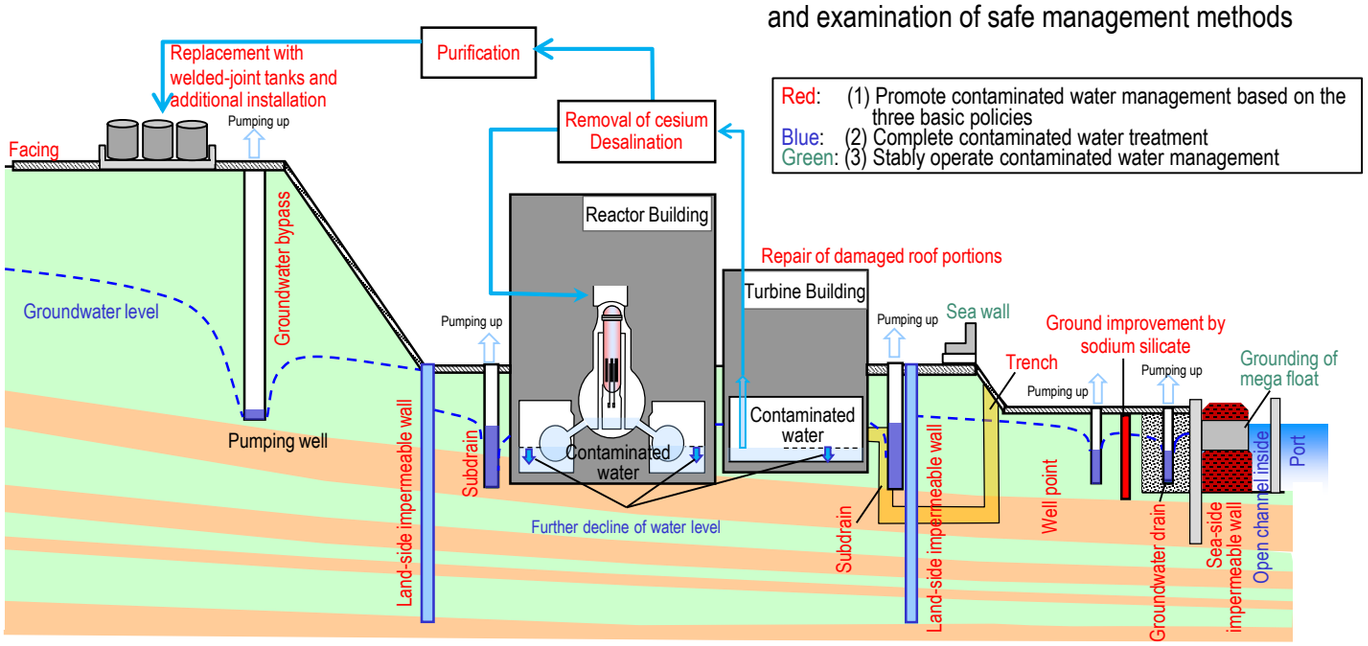
[Three basic policies]
1. "Remove" the source of water contamination
2. "Redirect" fresh water from contaminated areas
3. "Retain" contaminated water from leakage

(2) Effort to complete contaminated water treatment

4. Treatment of contaminated water in buildings (excluding Unit 1-3 Reactor Buildings, Process Main Building and High Temperature Incinerator Building)
5. Measures to remove α–nuclide and reduce the density in contaminated water
6. Measures to alleviate the radiation dose of Zeolite sandbags and examination of safe management methods

(3) Effort to stably operate contaminated water management

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



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

- Strontium-treated water from other equipment is being re-treated in the multi-nuclide removal equipment (ALPS) and stored in welded-joint tanks.
- Multi-layered contaminated water management measures, including land-side impermeable walls and subdrains, have stabilized the groundwater at a low level. The increase in the amount of contaminated water generated during rainfall is being suppressed by repairing damaged portions of building roofs, facing onsite, etc. Through these measures, the generation of contaminated water was reduced from approx. 540 m^3/day (in May FY2014) to approx. 170 m^3/day (in FY2018).
- Measures continue to be implemented to further suppress the generation of contaminated water to approx. 150 m^3/day within FY2020 and 100 m^3/day or less within 2025.

(2) Effort to complete contaminated water treatment

- Contaminated water levels in buildings declined as planned and connected parts between Units 1 and 2 and 3 and 4 were separated. For α-nuclide detected as the decline in water levels progressed, characteristics are being determined and treatment methods examined.
- Treatment of contaminated water in buildings will be completed within 2020, excluding Unit 1-3 Reactor Buildings, Process Main Building and High Temperature Incinerator Building. For Reactor Buildings, the amount of contaminated water there will be reduced from that at the end of 2020 during the period FY2022 - FY2024.
- For Zeolite sandbags on the basement floor of the Process Main Building and High Temperature Incinerator Building, measures to reduce the radiation dose are being examined toward stabilization.

(3) Effort to stably operate contaminated water management

- To prepare for tsunami, measures are being implemented, such as closing the openings of buildings, installing sea walls and transferring and grounding the mega float. For heavy rain, sandbags are being installed to suppress direct inflow to buildings while work to enhance drainage channels and other measures are being implemented as planned.

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

Progress status

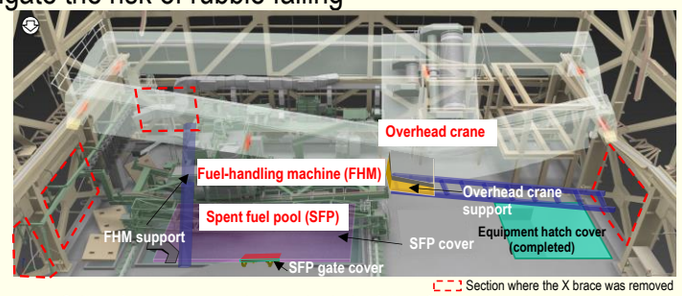
◆ The temperatures of the Reactor Pressure Vessel (RPV) and Primary Containment Vessel (PCV) of Units 1-3 have been maintained within the range of approx. 15-25°C[*1] over the past month. There was no significant change in the density of radioactive materials newly released from Reactor Buildings into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

* 1 The values varied somewhat, depending on the unit and location of the thermometer.
* 2 In December 2019, the radiation exposure dose due to the release of radioactive materials from the Unit 1-4 Reactor Buildings was evaluated at less than 0.00007 mSv/year at the site boundary. The annual radiation dose from natural radiation is approx. 2.1 mSv/year (average in Japan).

Implementation of measures to prevent potential falling of rubble and mitigate its influence at Unit 1

Toward fuel removal from Unit 1, rubble is being removed on the Rector Building. Before removing the fallen roof rubble over the spent fuel pool, support materials will be installed to prevent potential falling of the existing overhead crane and the fuel-handling machine under the fallen roof during rubble removal work. The spent fuel pool and pool gate will also be covered to mitigate the risk of rubble falling on the fuel and pool gate.

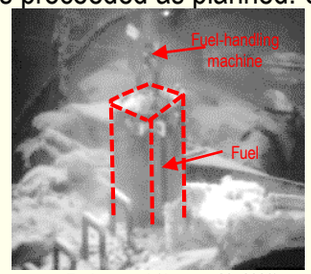
Training will be provided before the work to ensure proper preparation and these measures will be implemented sequentially from March 2020.



<Outline of overall measures to prevent potential falling of rubble and mitigate its influence>

Resumption of fuel removal from Unit 3

Toward resumption of fuel removal from Unit 3, rubble removal was ahead of fuel removal from September 2019 and defects detected during preparatory work after the periodical inspection were rectified. Fuel removal work resumed from December 23 and has proceeded as planned. Up until January 30, 56 fuel assemblies were removed and work continues with safety first.



<Fuel removal (January 20, 2020)>

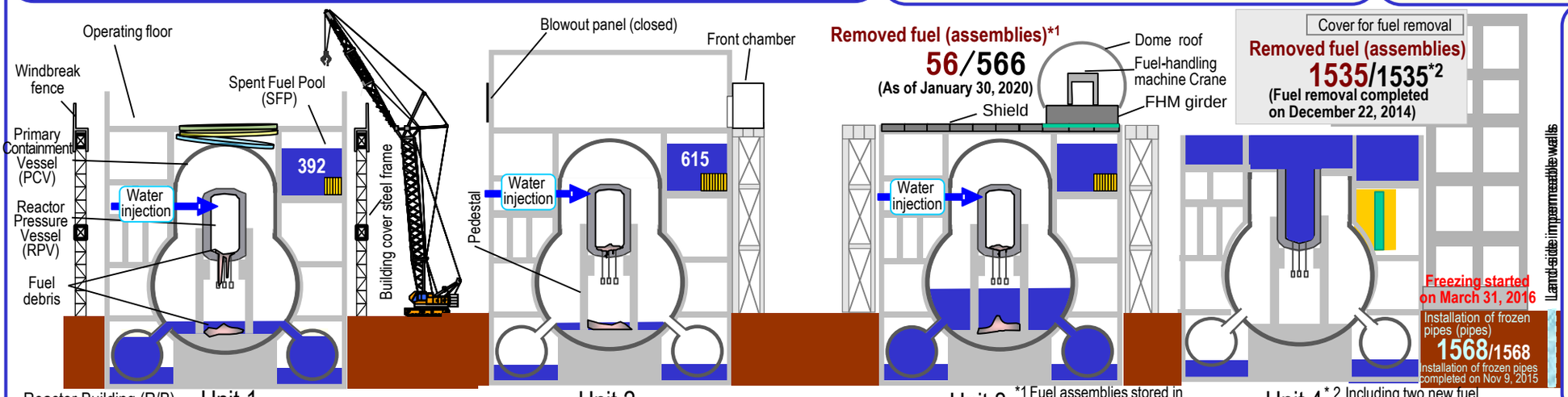
Test to check the cooling condition of Unit 3 fuel debris

Decay heat of fuel debris inside the reactor has been decreasing over time. For Units 1 and 2, to optimize the emergency response procedures, tests involving temporarily suspending water injection to the reactor were conducted and the results showed that the temperature changed almost as predicted before the tests.

For Unit 3, a similar test will be conducted from February 3 (suspension period: February 3 – 5, approx. 48 hours*).

(* The test will continue until February 17, including the period sequentially recovering the injection volume)

During the test period, temperatures and dust will be monitored. Measures including immediately resuming water injection, increasing the water injection volume and injecting boric acid solution will be taken when any abnormality is detected to ensure work safety first.



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

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

Revision of the Mid-and-Long-Term Roadmap

At the Inter-Ministerial Council for Contaminated Water and Decommissioning Issues held on December 27, the Mid-and-Long-Term Roadmap was revised.

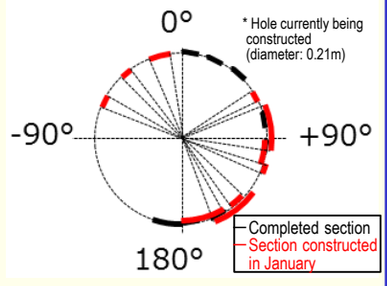
As resident return and reconstruction in the surrounding areas have gradually progressed, this revision sets a new basic principle of "coexistence of reconstruction and decommissioning" to promote symbiosis with the local communities, refine the intermediate process and optimize the whole decommissioning work. Key points include starting the fuel-debris retrieval from Unit 2 and completing the fuel removal from the spent fuel pool throughout all Units 1-6 by the end of 2031.

Resumption of construction work for the Unit 1 access route

For the internal investigation of the Unit 1 primary containment vessel (PCV), an access route is being constructed. Data to help optimize the cutting time was collected for the period January 14-24 with the cutting amount per day varying depending on the implementation part.

The collected data is currently being analyzed and evaluated to help consider how best to optimize the management method, including measures to suppress dust scattering during the work.

After completing the ongoing construction of a hole, PCV internals will be cleaned within March 2020 and the subsequent construction of an access route will start from around April.



<Image of the cutting range>

Further improvement of work environment based on workers' feedback

With the aim of improving the work environment in the Fukushima Daiichi Nuclear Power Station, the 10th questionnaire survey was conducted, to which approx. 4,500 workers responded. The results showed that many respondents evaluated their work in this NPS as rewarding and had a sense of mission and that the concerns of workers and their family members about radiation had been alleviated.

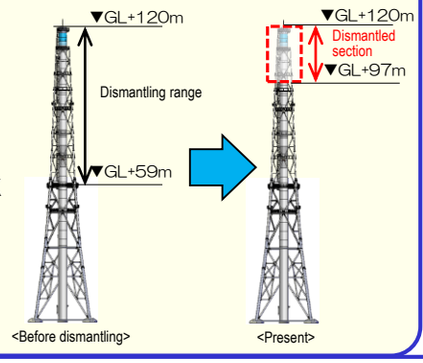
At the same time, the number of workers who intended to continue working in this NPS had declined and some areas requiring improvement were spotlighted, such as the fact that workers felt unsafe at certain places within and outside the site.

Efforts to improve labor conditions will continue based on workers' opinions and feedback.

Dismantling for the 10th block of the Unit 1/2 exhaust stack

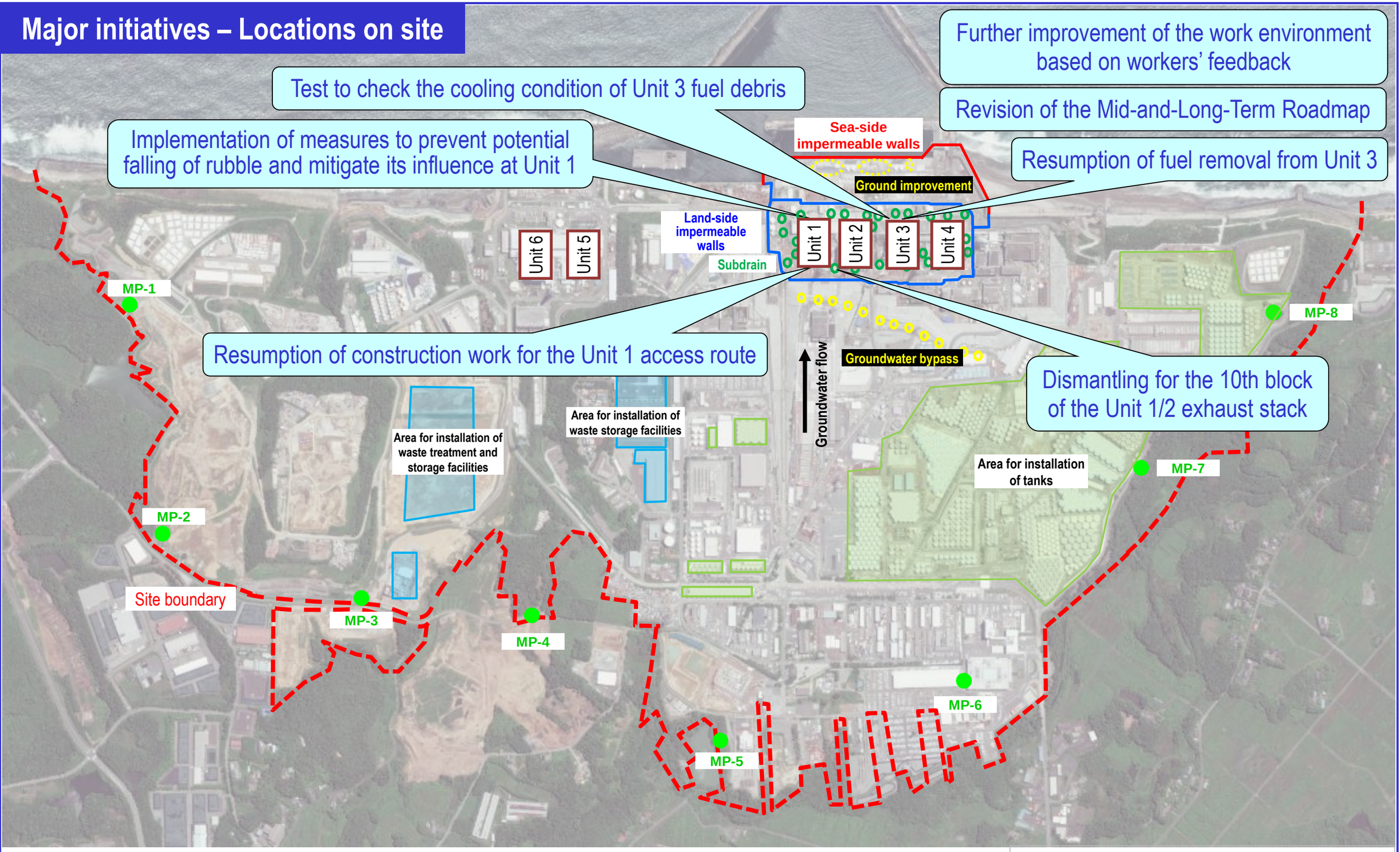
Dismantling of the 6th block started from December 20 and through the following steady work, dismantling of the 10th block was completed on January 23.

After an intermission lasting approx. three weeks in February due to legal inspection for the crane, work will be resumed and continue with safety first toward completion in early May.



<Before dismantling> <Present>

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 0.370 – 1.324 μSv/h (December 18, 2019 – January 28, 2020).

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

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

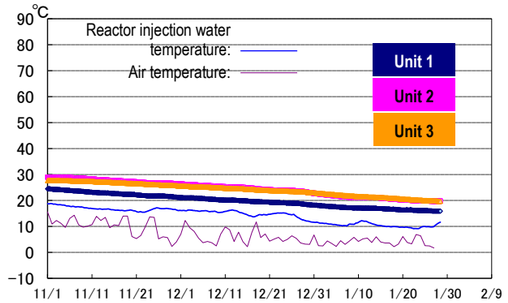
The radiation shielding panels around monitoring post No. 6, which is one of the instruments used to measure the radiation dose at the power station site boundary, were taken off from July 10-11, 2013, since further deforestation, etc. ha***d*** caused the surrounding radiation dose to decline significantly.

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

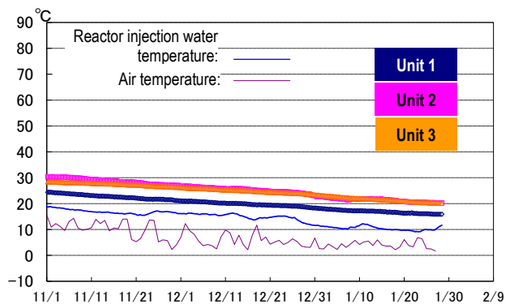
I. Confirmation of the reactor conditions

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



RPV bottom temperatures (recent quarter)



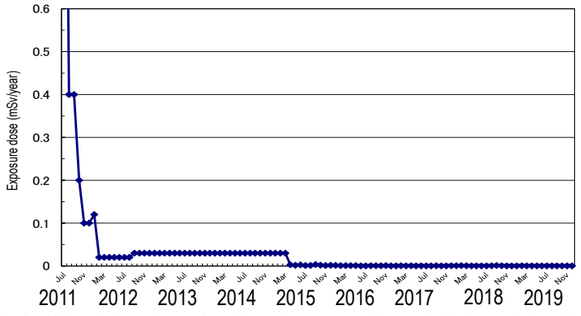
PCV gas phase temperatures (recent quarter)

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

2. Release of radioactive materials from the Reactor Buildings

As of December 2019, the density of the radioactive materials newly released from Reactor Building Units 1-4 into the air and measured at the site boundary was evaluated at approx. 1.9×10^{-12} Bq/cm³ and 6.8×10^{-12} Bq/cm³ for Cs-134 and Cs-137 respectively, while the radiation exposure dose due to the release of radioactive materials there was less than 0.00007 mSv/year.

1.7 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]: 2×10^{-5} Bq/cm³
[Cs-137]: 3×10^{-5} Bq/cm³

* Data of Monitoring Posts (MP1-MP8).
Data of Monitoring Posts (MPs) measuring the air dose rate around the site boundary showed 0.370 – 1.324 μSv/h (December 18, 2019 – January 28, 2020).
To measure the variation in the air dose rate of MP2-MP8 more accurately, environmental improvement (tree trimming, removal of surface soil and shielding around the MPs) was completed.

Note 1: Different formulas and coefficients were used to evaluate the radiation dose in the facility operation plan and monthly report. The evaluation methods were integrated in September 2012. As the fuel removal from the spent fuel pool (SFP) commenced for Unit 4, the radiation exposure dose from Unit 4 was added to the items subject to evaluation since November 2013. The evaluation has been changed to a method considering the values of continuous dust monitors since FY2015, with data to be evaluated monthly and announced the following month.

Note 2: Radiation dose was calculated using the evaluation values of release amount from Units 1-4 and Units 5 and 6. The radiation dose of Unit 5 and 6 was evaluated based on expected release amount during operation until September 2019 but the evaluation method was reviewed and changed to calculate based on the actual measurement results of Units 5 and 6 from October.

3. Other indices

There was no significant change in indices, including the pressure in the PCV and the PCV radioactivity density (Xe-135) for monitoring criticality, nor was any 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.

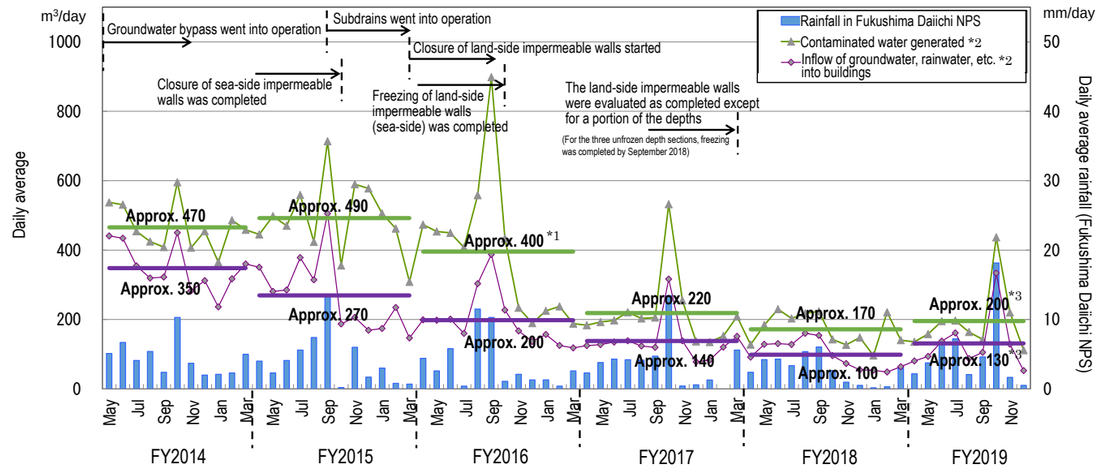
II. Progress status by each plan

1. Contaminated water management

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

➢ Status of contaminated water generated

- Multi-layered measures, including pumping up by subdrains and land-side impermeable walls, which were implemented to control the continued generation of contaminated water, suppress the groundwater inflow into buildings.
- Following the steady implementation of "redirecting" measures (groundwater bypass, subdrains, land-side impermeable walls and other measures), the generation amount reduced from approx. 470 m³/day (the FY2014 average) when the measures were first launched to approx. 170 m³/day (the FY2018 average).
- Measures will continue to further reduce the volume of contaminated water generated.



*1 Values differ from those announced at the 20th Committee on Countermeasures for Contaminated Water Treatment (held on August 25, 2017) because the method of calculating the contaminated water volume generated was reviewed on March 1, 2018. Details of the review are described in the materials for the 50th and 51st meetings of the Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment.
*2: The monthly daily average is derived from the daily average from the previous Thursday to the last Wednesday, which is calculated based on the data measured at 7:00 on every Thursday.
*3: The average (provisional value) for the period April – December 2019.

Figure 1: Changes in contaminated water generated and inflow of groundwater, rainwater, into buildings

➢ Operation of the groundwater bypass

- From April 9, 2014, the operation of 12 groundwater bypass pumping wells commenced sequentially to pump up groundwater. The release then started from May 21, 2014, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until January 28, 2020, 526,416 m³ of groundwater had been released. The pumped-up groundwater was temporarily stored in tanks and released after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Pumps are inspected and cleaned as required based on their operational status.

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

- To reduce the level of groundwater flowing into the buildings, work began to pump up groundwater from wells (subdrains) around the buildings on September 3, 2015. The pumped-up groundwater was then purified at dedicated facilities and released from September 14, 2015, in the presence of officials from the Intergovernmental Liaison Office for the Decommissioning and Contaminated Water Issue of the Cabinet Office. Up until January 28, 2020, a total of 845,812 m³ had been drained after TEPCO and a third-party organization had confirmed that its quality met operational targets.
- Due to the rising level of the groundwater drain pond after the sea-side impermeable walls had been closed, pumping started on November 5, 2015. Up until January 28, 2020, a total of approx. 227,512 m³ had been pumped up and a volume of under 10 m³/day is being transferred from the groundwater drain to the Turbine Buildings (average for the period December 12, 2019 - January 22, 2020).
- As one of the multi-layered contaminated-water management measures, in addition to waterproof pavement (facing

aiming to improve the work environment and prevent rainwater infiltration: as of the end of December 2019, approx. 94% of the planned area (1,450,000 m² onsite) had been completed) to suppress 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 m³/day and improving reliability. Operational efficiency was also improved to treat up to 2,000 m³/day for almost one week during the peak period.

- To maintain the 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. Work to recover another pit started from November 2019 (No. 49 pit).
- To eliminate the need to suspend water pumping while cleaning the subdrain transfer pipe, the pipe will be duplicated. Installation of the pipe and ancillary facilities was completed.
- Since the subdrains went into operation, the inflow to buildings tended to decline to under 150 m³/day when the subdrain water level declined below T.P. 3.0 m but increased during rainfall.

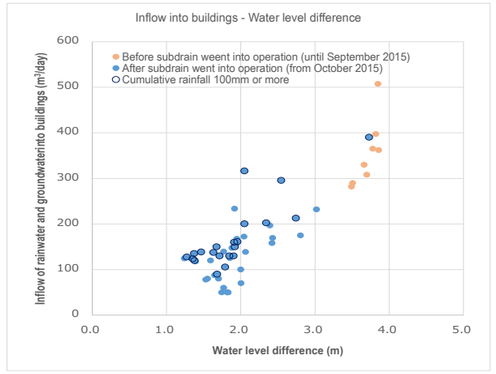


Figure 2: Correlation between inflow such as groundwater and rainwater into buildings and the water level of Units 1-4 subdrains

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

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

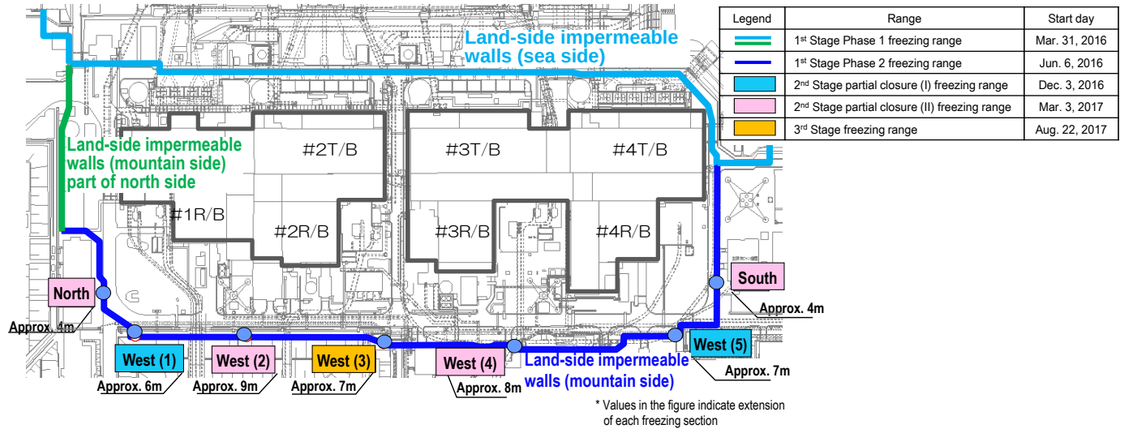


Figure 3: Closure parts of the land-side impermeable walls (on the mountain side)

➢ Operation of multi-nuclide removal equipment

- Regarding the multi-nuclide removal equipment (existing and high-performance), hot tests using radioactive water 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 January 23, 2020, the volumes treated by existing, additional and high-performance multi-nuclide removal equipment were approx. 426,000, 616,000 and 103,000 m³, respectively (including approx. 9,500 m³ stored in the J1(D) tank, which contained water with highly concentrated radioactive materials at the System B outlet of the existing multi-nuclide removal equipment).
- To reduce the risks of strontium-treated water, treatment using existing, additional and high-performance multi-nuclide removal equipment has been underway (existing: from December 4, 2015; additional: from May 27, 2015; high-performance: from April 15, 2015). Up until January 23, 2020, approx. 671,000 m³ had been treated.

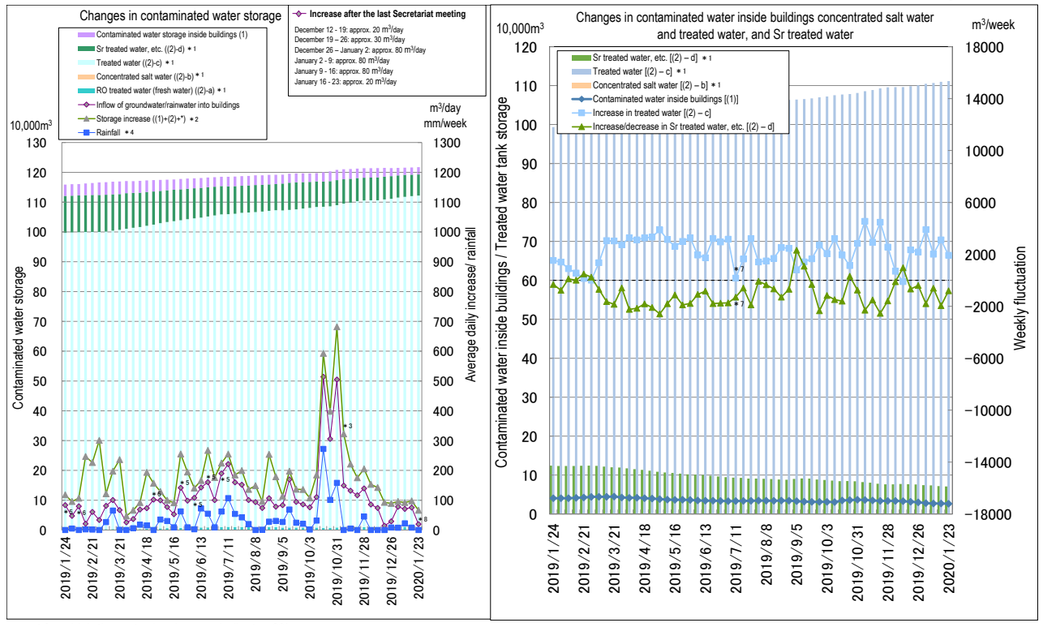
➢ Toward reducing the risk of contaminated water stored in tanks

- Treatment measures comprising the removal of strontium by cesium-adsorption apparatus (KURION) (from January 6, 2015), 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 January 23, 2020, approx. 566,000 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 January 27, 2020, a total of 148,145 m³).

As of January 23, 2020



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

*2: To detect storage increases more accurately, the calculation method was reviewed as follows from February 9, 2017: (The revised method was applied from March 1, 2018)
[(Inflow of groundwater/rainwater into buildings) + (other transfer) + (chemical injection into ALPS)]

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

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

*5: Considered attributable to the increased inflow of groundwater, rainwater and others to buildings due to the decline in the level of contaminated water in buildings.
(January 17, April 22, May 16 and 30, June 13 and 27, 2019)

*6: Water-level gauges were replaced (February 7 – March 7, 2019)

*7: 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 and others changed. However, the actual treated volumes were approx. 2,200 m³/week for treated water and approx. 1,100 m³/week for Sr-treated water and others (July 11, 2019).

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

Figure 4: Status of contaminated water storage

➢ Decline of water levels in brine tanks for the land-side impermeable walls

- On December 26, 2019, declining water levels were detected in some brine tanks for the land-side impermeable walls. The header pipe of “6 block 1” in the downstream was isolated and after confirming that the variation of water levels in the tanks had ceased, the part was investigated to identify areas of leakage.
- The investigation confirmed leakage at four frozen pipes. Joints and valves of the leakage points were replaced and after soundness was confirmed, brine was recirculated. Monitoring of water levels in tanks continues.

➢ Deviation from the limiting condition for operation in the water-level difference between the Unit 2 Turbine Building northeast area and the nearby subdrain [LCO deviation event]

- On January 29, 2020, an inspection to check any influence of rainfall on water levels in each building area detected an increase in the water level in the northeast area of the Unit 2 Turbine Building, where the water-level gauge was exposed and the difference from the water level in the nearby subdrain did not satisfy the limiting condition for operation (LCO). No significant variation was detected in plant parameters, or readings of monitoring posts and drainage-channel monitors.
- Pumping at all subdrains around Units 1-4 was suspended immediately. After preparation is completed, water in that area will be drained.

➢ Progress status of contaminated water treatment in buildings

- For contaminated water in Unit 4 buildings, work to decrease water levels began earlier than in other buildings from late April 2019. However, water that could not be transferred by the existing contaminated-water transfer equipment remained in the Turbine Building and the Radioactive Waste Treatment Building.
- After preparation was completed, transfer of the remaining water by temporary pumps started from December 19, 2019 and was completed by January 17 for the time being and the floor surface was exposed.
- Permanent pumps will be installed to maintain the exposure of the floor surface.

2. Fuel removal from the spent fuel pools

Work to help remove spent fuel from the pool is progressing steadily while ensuring seismic capacity and safety. The removal of spent fuel from the Unit 4 pool commenced on November 18, 2013 and was completed by December 22, 2014

➢ Main work to help spent fuel removal at Unit 1

- From January 22, 2018, toward fuel removal from the spent fuel pool (SFP), work began to remove rubble on the north side of the operating floor. Once removed, the rubble is stored in solid waste storage facilities or elsewhere depending on the dose level.
- 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.
- From March 18, 2019, the removal of small rubble in the east-side area around the SFP started using pliers and suction equipment, while from July 9, small rubble removal on the south side of the SFP started.
- The well plug, which was considered misaligned from its normal position due to the influence of the hydrogen explosion at the time of the accident, was investigated for the period July 17 – August 26, 2019, by taking photos using a camera, measuring the air dose rate and collecting 3D images.
- A prior investigation on September 27, 2019 confirmed the lack of any obstacle which may affect the plan to install the cover over the SFP, the absence of any heavy object such as a concrete block, as detected in Unit 3 and the fact that panel- and bar-shaped rubble pieces were scattered on the rack.
- After examining two methods: (i) installing a cover after rubble removal and (ii) initially installing a large cover over the Reactor Building and then removing rubble inside the cover, method (ii) was selected to ensure safer and more secure removal.
- Before removing the fallen roof rubble over the spent fuel pool, support materials will be installed to prevent potential falling of the existing overhead crane and the fuel-handling machine under the fallen roof during rubble removal work. The spent fuel pool and pool gate will also be covered to mitigate the risk of rubble falling on the fuel and pool gate.
- Training will be provided before the work to ensure proper preparation and these measures will be implemented sequentially from March 2020.

➢ Main work to help spent fuel removal at Unit 2

- On November 6, 2018, before investigating with a work plan to dismantle the Reactor Building rooftop and other tasks in mind, work to move and contain the remaining objects on the operating floor (1st round) was completed.
- On February 1, 2019, an investigation to measure the radiation dose on the floor, walls and ceiling inside the operating floor and confirm the contamination status was completed. After analyzing the investigative results, the “contamination 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 (2nd round) started, such as materials and equipment which may hinder installation of the fuel-handling facility and other work. The 2nd round mainly included moving the remaining small objects and placing them in the container. The work also included cleaning the floor to suppress dust scattering and was completed on August 21.
- From September 10, 2019, work to move and contain the remaining objects on the operating floor (3rd round) started, such as materials and equipment which may hinder the installation of the fuel-handling facility and other work. The 3rd round mainly includes moving the remaining large objects and placing them in the container as well as transporting

containers and remaining objects temporarily stored inside the operating floor outside.

- For fuel removal methods, based on the investigative results inside the operating floor from November 2018 to February 2019, a method to access from a small opening installed on the south side of the building was selected with aspects such as dust management and lower work exposure in mind (the method previously examined had involved fully dismantling the upper part of the building).

➢ Main process to help fuel removal at Unit 3

- From April 15, 2019, the removal of 514 spent fuel assemblies and 52 non-irradiated fuel assemblies (566 assemblies in total) stored in the spent fuel pool started. Seven non-irradiated fuel assemblies were then loaded into the transportation cask and transported to the common pool on April 23. The first fuel removal was completed on April 25.
- From July 4, 2019, fuel removal was resumed and up until July 21, 28 of all 566 fuel assemblies had been removed.
- The periodical inspection of the fuel-handling facility, which started on July 24, 2019, was completed on September 2, 2019. Some defective rotations of the tensile truss and mast were detected during the following adjustment work toward resumption of the fuel removal. In response, parts were replaced and the operation checked to confirm there was no problem.
- During an operation check using dummy fuel, however, interference of cans inside the transportation cask and dummy fuel was identified on December 14, 2019. Though the following investigation confirmed slight leaning of the FHM mast, countermeasures, including a review of the procedures, were implemented.
- Fuel removal work was resumed from December 23, 2019 and has proceeded as planned. Up until January 30, 2020, 56 fuel assemblies were removed and work continues with safety first.

➢ Progress status of dismantling work for the Unit 1/2 exhaust stack

- Dismantling of the 6th block started from December 20, 2019 and through the following steady work, dismantling of the 10th block was completed on January 23, 2020.
- After an intermission lasting approx. three weeks in February 2020 due to legal inspection for the crane, work will be resumed and continue with safety first toward completion in early May.

3. Retrieval of fuel debris

➢ Construction of an access route for the internal investigation of the Unit 1 PCV

- For the internal investigation of the Unit 1 primary containment vessel (PCV), an access route is being constructed. Data to help optimize the cutting time was collected for the period January 14-24, 2020 with the cutting amount per day varying depending on the implementation part.
- The collected data is currently being analyzed and evaluated to help consider how best to optimize the management method, including measures to suppress dust scattering during the work.
- After completing the ongoing construction of a hole, PCV internals will be cleaned within March 2020 and the subsequent construction of an access route will start from around April.

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 December 2019, the total storage volume of the concrete and metal rubble was approx. 284,100 m³ (+2,600 m³ compared to at the end of November with an area-occupation rate of 71%). The total storage volume of trimmed trees was approx. 134,100 m³ (slight increase, with an area-occupation rate of 76%). The total storage volume of used protective clothing was approx. 48,200 m³ (-1,700 m³, with an area-occupation rate of 71%). The increase in rubble was mainly attributable to tank-related construction and work related to rubble removal around Unit 1-4 buildings, while the decrease in used protective clothing was attributable to the incinerator operation.

➢ Management status of secondary waste from water treatment

- As of January 9, 2020, the total storage volume of waste sludge was 597 m³ (area-occupation rate: 85%), while that of concentrated waste fluid was 9,345 m³ (area-occupation rate: 91%). The total number of stored spent vessels, High-Integrity Containers (HICs) for multi-nuclide removal equipment and other vessels, was 4,614 (area-occupation rate: 72%).

5. Reactor cooling

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

➢ Test results to check the cooling condition of Unit 1 fuel debris

- To optimize the emergency response procedures and for other improvements, a test involving temporarily suspending water injection to the reactor was conducted at Unit 1 in October 2019 (approx. 49 hours).
- The increase in temperature due to suspension of water injection was almost within the assumed range. The temperature evaluation using a heat balance model almost reproduced the RPV bottom and PCV temperatures.
- At the same time, a detailed check of temperature data obtained in the test confirmed that a portion of the present evaluation model did not reproduce the actual machine sufficiently. Improvement of the evaluation model will be examined based on the results of the planned test at Unit 3.

➢ Test to suspend cooling of Unit 3 fuel debris

- A test involving temporarily suspending water injection to the reactor will be conducted from February 3, 2020 (suspension period: February 3 – 5, approx. 48 hours; following which the test will continue until February 17 including the period sequentially recovering the injection volume).
- During the test period, temperatures and dust will be monitored. Measures including immediately resuming water injection, increasing the water injection volume and injecting boric acid solution will be taken when any abnormality is detected to ensure work safety first.

6. Reduction in radiation dose and mitigation of contamination

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

➢ Operation start of PSF monitor in K and other drainage channels

- To detect leakage of contaminated water (mainly β-nuclide Sr-90), PSF monitors were installed at K, A and Shallow-Draft-Quay drainage channels. Based on the positive results of their trial operation onsite, full-scale operation will start from January 31, 2020 at K drainage channel and from late February at A and Shallow-Draft-Quay drainage channels.
- For the K drainage channel, where indicated values tend to increase due to the effect of fallout during rainfall, a discrimination-type PSF monitor, which has separate detectors for β- + γ-rays and γ-ray solely to measure β-ray (contribution of Sr-90) using the difference in measurement values from two detectors, is installed.

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

- At No. 1-9, the density of gross β radioactive materials has been repeatedly increasing and declining from around 20 Bq/L since April 2019 and currently stands at around 60 Bq/L.
- At No. 1-12, the density of gross β radioactive materials has been increasing from around 500 Bq/L since December 2019 and currently stands at around 2,000 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).
- At No. 2-3, the H-3 density had been declining from around 6,000 Bq/L since August 2019, then increasing and currently stands at around 8,300 Bq/L. The density of gross β radioactive materials at the same point had been declining from around 14,000 Bq/L to around 5,000 Bq/L since August 2019, then increasing and currently stands at around 13,000 Bq/L.

- At No. 2-5, the H-3 density had been declining from around 2,300 Bq/L to less than 120 Bq/L since June 2019, then repeatedly increasing and declining and currently stands at around 500 Bq/L. The density of gross β radioactive materials at the same point had been declining from around 65,000 Bq/L to around 500 Bq/L since September 2019, then increasing and currently stands at around 70,000 Bq/L.
- At No. 2-6, the density of gross β radioactive materials had been increasing from around 100 Bq/L since May 2019 and currently stands at around 250 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 Units 1-4 intake open channel area, 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 rainfall. They have also been declining following the completed installation and the connection of steel pipe sheet piles for the sea-side impermeable walls. The density of Cs-137 has remained slightly higher in front of the south side impermeable walls and slightly lower on the north side of the east breakwater since March 20, 2019, when the silt fence was transferred to the center of the open channel due to mega float-related construction.
- In the 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 rainfall. They have remained below the level of those in the Units 1-4 intake open channel area and been declining following the completed installation and connection of steel pipe sheet piles for the sea-side impermeable walls.
- In the area outside the port, regarding the densities of radioactive materials in seawater, those of Cs-137 and Sr-90 declined and remained low after steel pipe sheet piles for the sea-side impermeable walls were installed and connected.

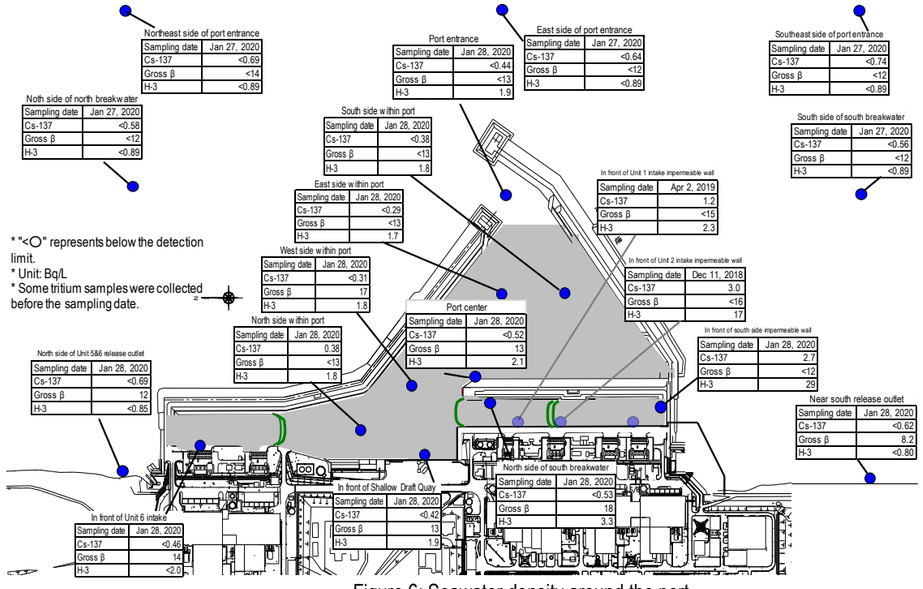
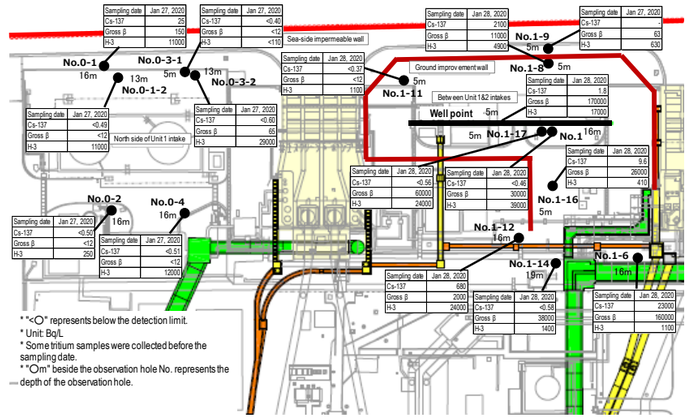
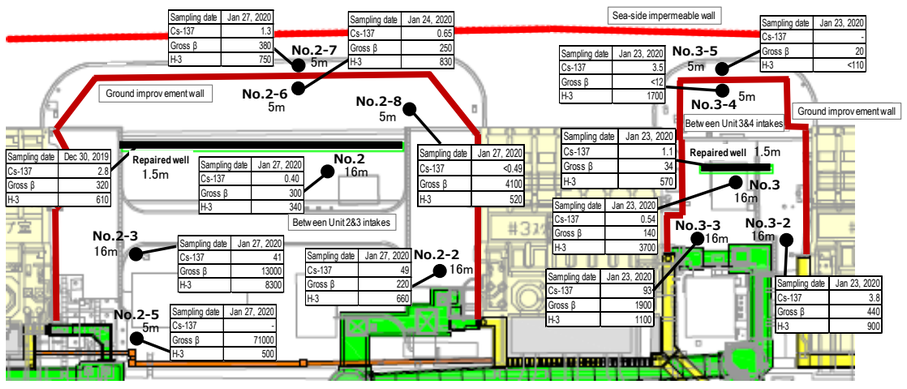


Figure 6: Seawater density around the port



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



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

Figure 5: Groundwater density on the Turbine Building east side

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

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

➢ Staff management

- The monthly average total of personnel registered for at least one day per month to work on site during the past quarter from September to November 2019 was approx. 9,000 (TEPCO and partner company workers), which exceeded the monthly average number of actual workers (approx. 6,700). 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 February 2020 (approx. 4,200 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 from within Fukushima Prefecture decreased. The local employment ratio (TEPCO and partner company workers) as of December 2019 has remained constant at around 60%.
- The monthly average exposure dose of workers remained at approx. approx. 0.39, 0.36 and 0.32 mSv/month during FY2016, FY2017 and FY2018 respectively. (Reference: Annual average exposure dose 20 mSv/year ≒ 1.7 mSv/month)
- For most workers, the exposure dose was sufficiently within the limit and allowed them to continue engaging in radiation work.

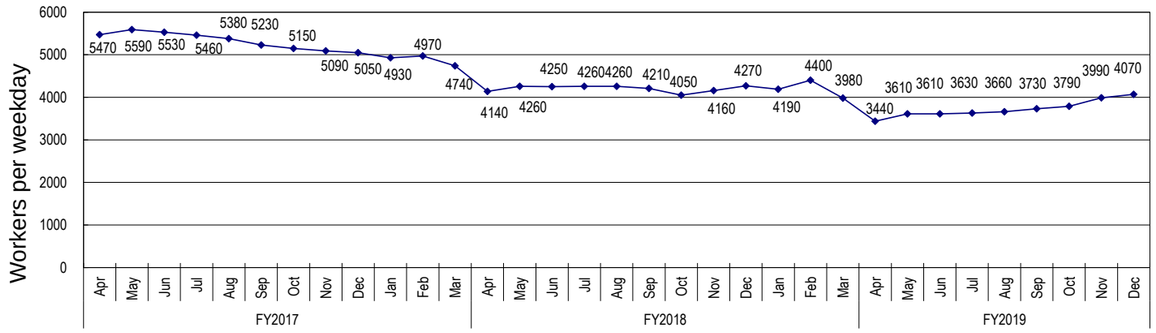


Figure 7: Changes in the average number of workers per weekday for each month since FY2017 (actual values)

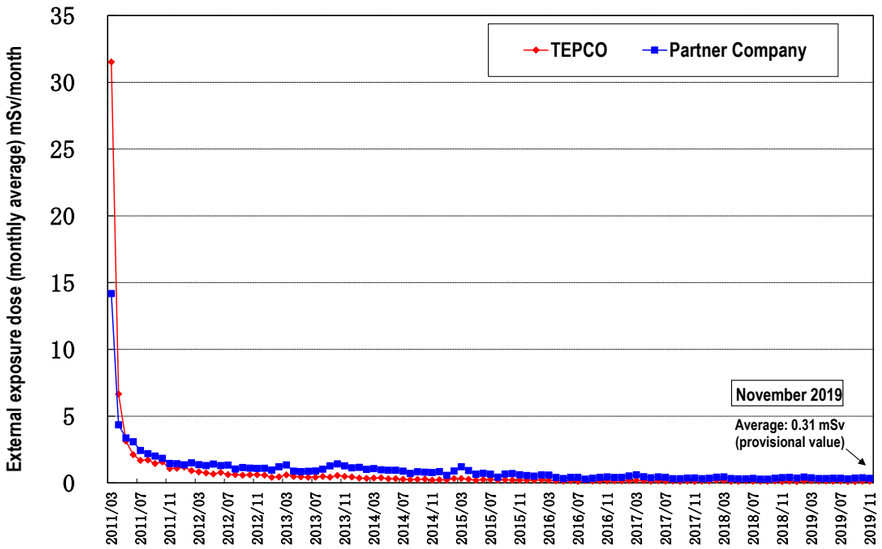


Figure 8: Changes in monthly individual worker exposure dose
(monthly average exposure dose since March 2011)

➢ Measures to prevent infection and expansion of influenza and norovirus

- Since November, measures for influenza and norovirus have been implemented, including free influenza vaccinations (subsidized by TEPCO HD) in the Fukushima Daiichi Nuclear Power Station (from November 13 to December 13, 2019) for partner company workers. Free influenza vaccinations are also provided at medical clinics around the site (from December 2, 2019 to January 30, 2020). As of January 24, 2020, a total of 6,083 workers had been vaccinated. In addition, a comprehensive range of other measures is also being implemented, including daily actions to prevent infection and expansion (measuring body temperature, health checks and monitoring infection status) and response after detecting possible infections (swift exit of possible patients and control of entry, mandatory wearing of masks in working spaces, etc.).

➢ Status of influenza and norovirus cases

- Until the 4th week of 2020 (January 20-26, 2020), 146 influenza infections and nine norovirus infections were recorded. The totals for the same period for the previous season showed 182 cases of influenza and eight norovirus infections.

➢ 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 prime contractors confirmed reexamination at medical institutions and the subsequent status of workers who were diagnosed as requiring “detailed examination and treatment” in the health checkup, with TEPCO confirming the operation status by the prime contractors.
- The recent report on the management status of the health checkup during the second quarter (July – September) in FY2019 confirmed that the prime contractors had provided appropriate guidance and properly managed the operation under the scheme. The report on the follow-up status during the first quarter in FY2019 and before confirmed that responses to workers, which had not been completed by the time of the previous report, were being provided on an ongoing basis. Checking of operations will continue.

➢ Results of the 10th questionnaire survey for workers to improve the work environment

- With the aim of improving the work environment in the Fukushima Daiichi Nuclear Power Station, the 10th questionnaire survey was conducted, to which approx. 4,500 workers responded (with a collection rate of approx. 95%, a 0.8% increase compared to the previous survey).
- The results showed that many respondents evaluated their work in this NPS as rewarding and had a sense of mission and that the concerns of workers and their family members about radiation had been alleviated.
- At the same time, the number of workers who intended to continue working in this NPS had declined and some areas requiring improvement were spotlighted such as the fact that workers felt unsafe at certain places within and outside the site.
- Efforts to improve labor conditions will continue based on workers’ opinions and feedback.

8. Others

➢ Revision of the Mid-and-Long-Term Roadmap toward Decommissioning of the Fukushima Daiichi NPS

- At the Inter-Ministerial Council for Contaminated Water and Decommissioning Issues held on December 27, 2019, the Mid-and-Long-Term Roadmap was revised.
- As resident return and reconstruction in the surrounding areas have gradually progressed, this revision sets a new basic principle of “coexistence of reconstruction and decommissioning” to promote symbiosis with the local communities, refine the intermediate process and optimize the whole decommissioning work. Key points include starting the fuel-debris retrieval from Unit 2 and completing the fuel removal from the spent fuel pool throughout all Units 1-6 by the end of 2031.

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 January 22-28)"; unit (Bq/L); ND represents a value below the detection limit

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

Sea side impermeable wall

Silt fence

Cesium-134: 3.3 (2013/10/17) →ND(0.24) Below 1/10
Cesium-137: 9.0 (2013/10/17) →ND(0.29) Below 1/30
Gross β: 74 (2013/ 8/19) →ND(13) Below 1/5
Tritium: 67 (2013/ 8/19) → 1.7 Below 1/30

Cesium-134: 4.4 (2013/12/24) →ND(0.26) Below 1/10
Cesium-137: 10 (2013/12/24) →ND(0.31) Below 1/30
Gross β: 60 (2013/ 7/ 4) → 17 Below 1/3
Tritium: 59 (2013/ 8/19) → 1.8 Below 1/30

Cesium-134: 5.0 (2013/12/2) → ND(0.37) Below 1/10
Cesium-137: 8.4 (2013/12/2) → 0.38 Below 1/20
Gross β: 69 (2013/8/19) → ND(13) Below 1/5
Tritium: 52 (2013/8/19) → 1.8 Below 1/20

Cesium-134: 2.8 (2013/12/2) → ND(0.37) Below 1/7
Cesium-137: 5.8 (2013/12/2) → ND(0.46) Below 1/10
Gross β: 46 (2013/8/19) → 14 Below 1/3
Tritium: 24 (2013/8/19) → ND(2.0) Below 1/10

	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

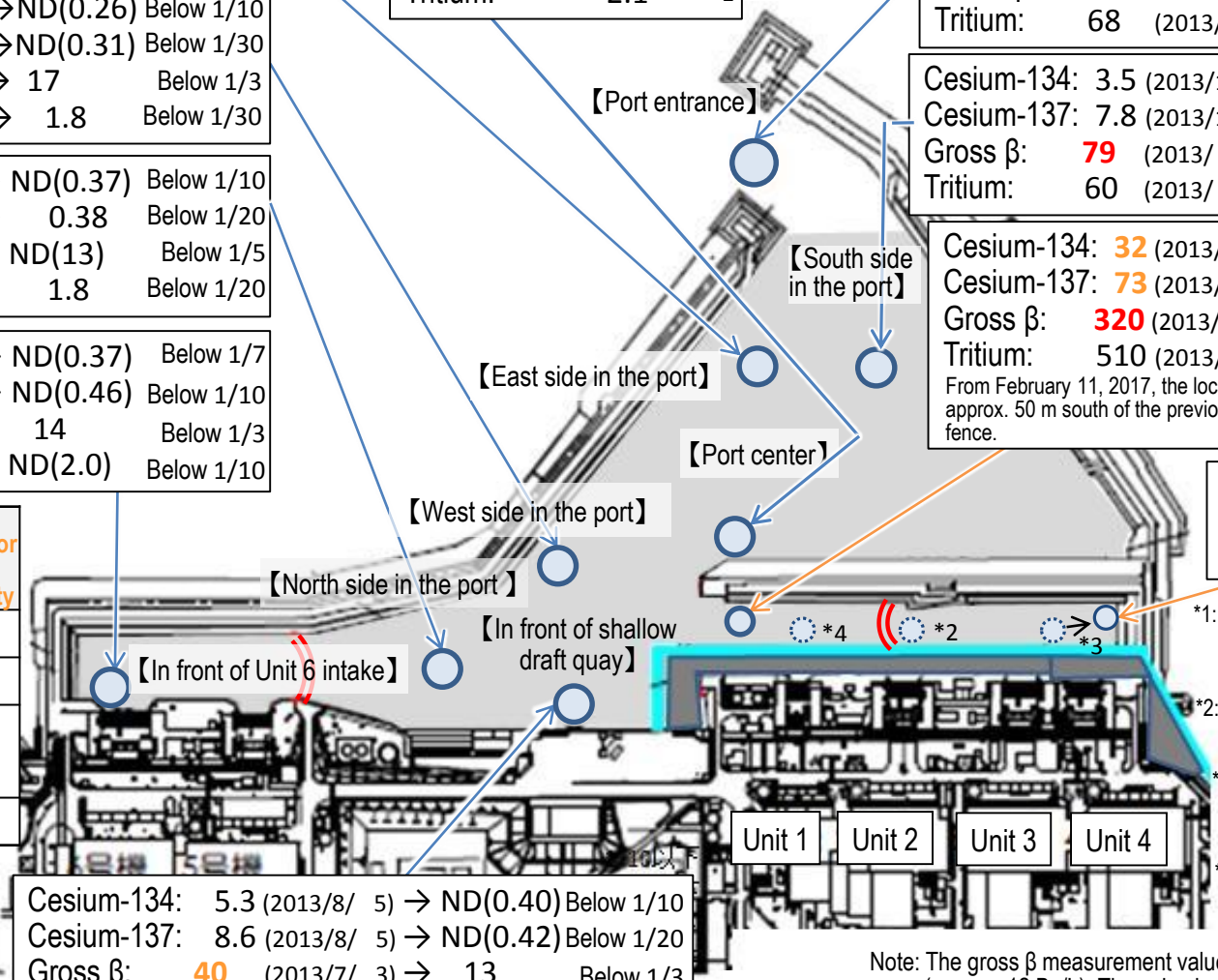
Cesium-134: ND(0.49)
Cesium-137: ND(0.52)
Gross β: 13
Tritium: 2.1 *1

Cesium-134: 3.3 (2013/12/24) →ND(0.41) Below 1/8
Cesium-137: 7.3 (2013/10/11) →ND(0.44) Below 1/10
Gross β: 69 (2013/ 8/19) →ND(13) Below 1/5
Tritium: 68 (2013/ 8/19) → 1.9 Below 1/30

Cesium-134: 3.5 (2013/10/17) → ND(0.32) Below 1/10
Cesium-137: 7.8 (2013/10/17) → ND(0.38) Below 1/20
Gross β: 79 (2013/ 8/19) → ND(13) Below 1/6
Tritium: 60 (2013/ 8/19) → 1.8 Below 1/30

Cesium-134: 32 (2013/10/11) →ND(0.39) Below 1/80
Cesium-137: 73 (2013/10/11) →ND(0.53) Below 1/100
Gross β: 320 (2013/ 8/12) → 18 Below 1/10
Tritium: 510 (2013/ 9/ 2) → 3.3 Below 1/100
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(0.60)
Cesium-137: 2.7
Gross β: ND(12)
Tritium: 29 *1



Cesium-134: 5.3 (2013/8/ 5) → ND(0.40) Below 1/10
Cesium-137: 8.6 (2013/8/ 5) → ND(0.42) Below 1/20
Gross β: 40 (2013/7/ 3) → 13 Below 1/3
Tritium: 340 (2013/6/26) → 1.9 Below 1/100

*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 January 29, 2020

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 January 22-28)

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 (0.74)
Cesium-137: ND (2013) → ND (0.69)
Gross β: ND (2013) → ND (14)
Tritium: ND (2013) → ND (0.89)

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

Cesium-134: ND (2013) → ND (0.63)
Cesium-137: 1.6 (2013/10/18) → ND (0.64) Below 1/2
Gross β: ND (2013) → ND (12)
Tritium: 6.4 (2013/10/18) → ND (0.89) Below 1/7

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

Cesium-134: ND (2013) → ND (0.77)
Cesium-137: ND (2013) → ND (0.74)
Gross β: ND (2013) → ND (12)
Tritium: ND (2013) → ND (0.89)

Cesium-134: ND (2013) → ND (0.54)
Cesium-137: ND (2013) → ND (0.58)
Gross β: ND (2013) → ND (12)
Tritium: 4.7 (2013/ 8/18) → ND (0.89) Below 1/5

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

【Port entrance】

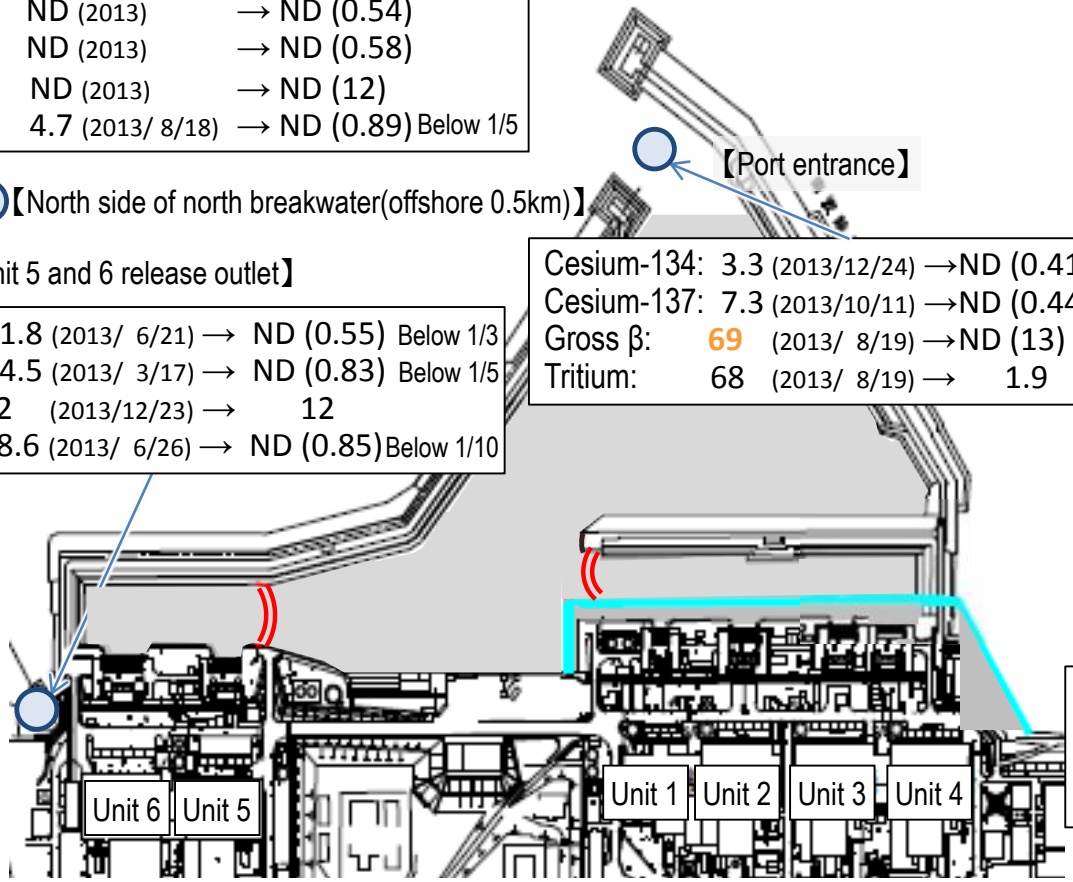
Cesium-134: 3.3 (2013/12/24) →ND (0.41) Below 1/8
Cesium-137: 7.3 (2013/10/11) →ND (0.44) Below 1/10
Gross β: 69 (2013/ 8/19) →ND (13) Below 1/5
Tritium: 68 (2013/ 8/19) → 1.9 Below 1/30

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

Cesium-134: ND (2013) → ND (0.43)
Cesium-137: ND (2013) → ND (0.56)
Gross β: ND (2013) → ND (12)
Tritium: ND (2013) → ND (0.89)

【North side of Unit 5 and 6 release outlet】

Cesium-134: 1.8 (2013/ 6/21) → ND (0.55) Below 1/3
Cesium-137: 4.5 (2013/ 3/17) → ND (0.83) Below 1/5
Gross β: 12 (2013/12/23) → 12
Tritium: 8.6 (2013/ 6/26) → ND (0.85) Below 1/10



Cesium-134: ND (2013) → ND (0.78)
Cesium-137: 3.0 (2013/ 7/15) → ND (0.62) Below 1/4
Gross β: 15 (2013/12/23) → 8.2
Tritium: 1.9 (2013/11/25) → ND (0.85) Below 1/2

【Near south release outlet】

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 January 29, 2020

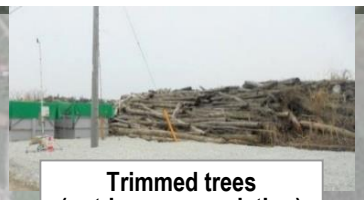
Source: TEPCO website, Analysis results on nuclides of radioactive materials around Fukushima Daiichi Nuclear Power Station, http://www.tepco.co.jp/nu/fukushima-np/f1/smp/index-j.html

Appendix 2

January 30, 2020

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



Trimmed trees (outdoor accumulation)

Temporary trimmed trees storage pool

Temporary soil-covered type storage facility

Rubble storage tent

Rubble (outdoor accumulation)

Inside the rubble storage tent

Rubble (covered by sheet)

Solid waste storage facility

Rubble (container storage)

Futaba town

Okuma town

MP-1
MP-2
MP-3
MP-4
MP-5
MP-6
MP-7
MP-8

Trimmed trees
Used protective clothing
Rubble
F
Temporary trimmed trees storage pool
Radioactive Waste Incinerator
Unit 6
Unit 5
Periodical inspection material storage (cut of flange tank)
Vehicles maintenance site
Mega float
Town boundary
JAEA Site Management Building
Water treatment facility for Subdrain and others
Temporary Soil-Covering Area
K1
K2
K3
K4
Main Anti-Earthquake Building
Chiller for reactor water injection facility
Vehicle screening and decontamination site
Multi-nuclide removal equipment
Additional multi-nuclide removal equipment
High-performance multi-nuclide removal equipment
Large equipment decontamination facility
Pipe route
Spent absorption vessel temporary storage
Underground reservoirs
Land-side impermeable walls freezing plant
Unit 1
Unit 2
Unit 3
Unit 4
Land-side impermeable walls with frozen soil
Sea side impermeable wall
Partner Companies' Building
Groundwater bypass temporary storage tank
H1
H2
H3
H4
H5
H6
H8
H9
D
E
Common pool
Water desalinations (RO)
Temporary rest house outside the site
New Administration Office Building
Large rest house
Access control facility
J1
J2
J3
J4
J5
J6
J7
J8
J9
C
B
Cesium absorption apparatus (Incineration Workshop Building)
Decontamination instruments (Process Building)
3rd cesium adsorption apparatus (Onsite Bunker Building)
2nd cesium adsorption apparatus (HTI Building)
Cesium absorption vessel temporary storage
Water desalinations (evaporative concentration)
Water desalinations (RO)
G1
G1 South
G3・G4・G5
G6
G7
Temporary trimmed trees storage pool
Site boundary

Tank installation status

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.

0m 100m 500m 1000m

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

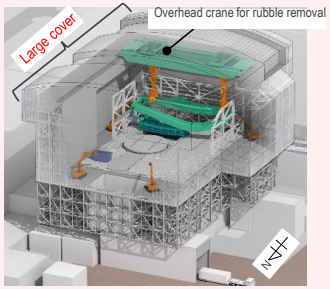
January 30, 2020
Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

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

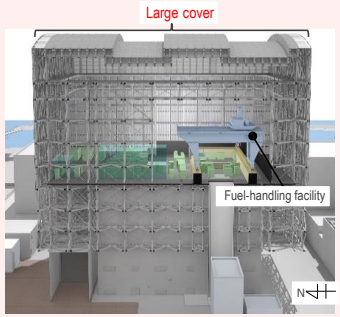
Unit 1

Toward fuel removal from the Unit 1 spent fuel pool, investigations have been implemented to ascertain the conditions of the fallen roof on the south side and the contamination of the well plug. Based on the results of these investigations, "the method to initially install a large cover over the Reactor Building and then remove rubble inside the cover" was selected to ensure a safer and more secure removal. Details of the selected method will be designed and the process of fuel removal will be refined.

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



Rubble removal (image)

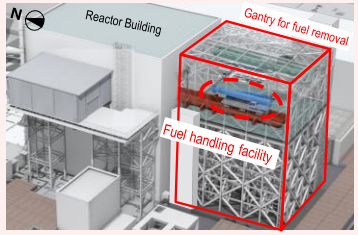


Fuel removal (image)

Unit 2

Toward fuel removal from the Unit 2 spent fuel pool, based on findings from internal operating floor investigations from November 2018 to February 2019, instead of fully dismantling the upper part of the building, the decision was made to install a small opening on the south side and use a boom crane. The changed method will be established and the fuel removal process refined.

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

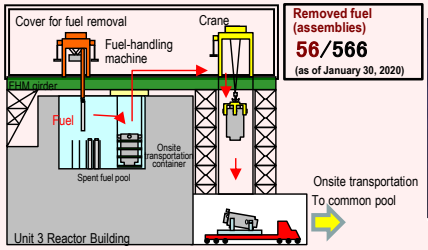


Overview of fuel removal (bird's-eye view)

Unit 3

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

Installation of dome roof (February 21, 2019)



Overview of the fuel-handling facility inside the cover


Fuel removal status (April 15, 2019)

Unit 4

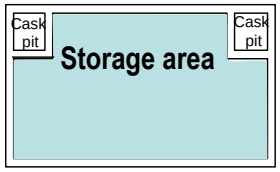
In the Mid- and Long-Term Roadmap, the target of Phase 1 involved commencing fuel removal from inside the spent fuel pool (SFP) of the 1st Unit within two years of completion of Step 2 (by December 2013). On November 18, 2013, fuel removal from Unit 4, or the 1st Unit, commenced and Phase 2 of the roadmap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

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


Fuel removal status

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

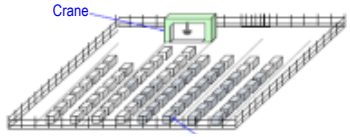
Common pool



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

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

Temporary cask (*2) custody area



Spent fuel is accepted from the common pool

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

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

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

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

Investigation into TIP Room of the Unit 1 Reactor Building

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

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

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

Leak point

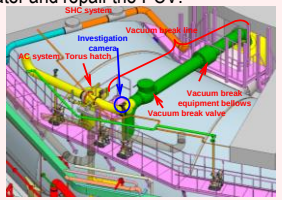
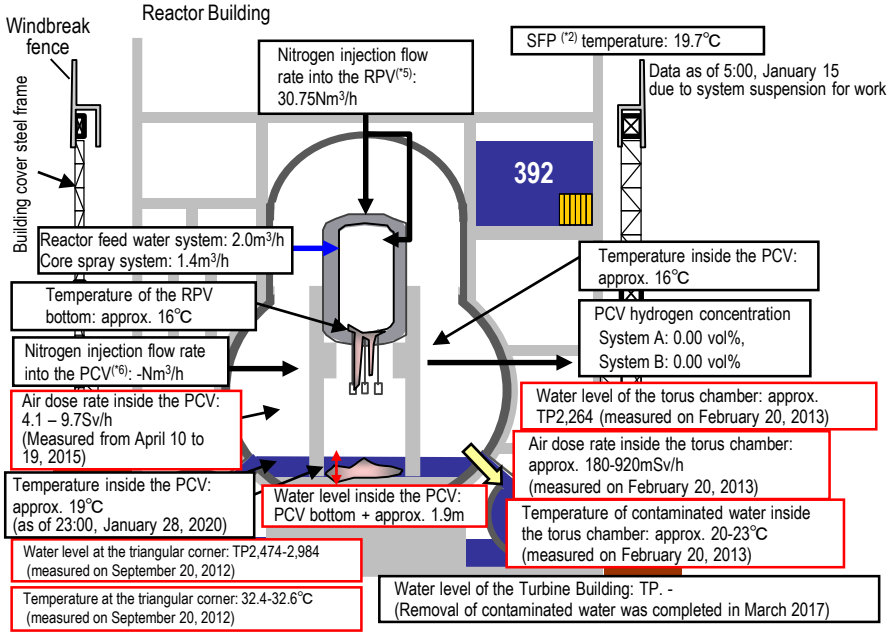


Image of the S/C upper part investigation

Unit 1

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



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

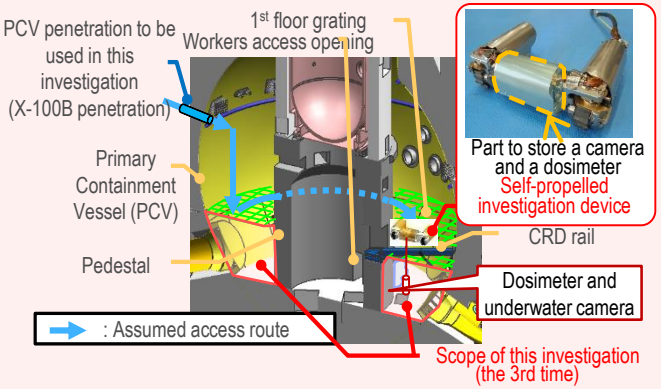
Investigations inside PCV	1st (Oct 2012)	- Acquiring images - Measuring air temperature and dose rate - Measuring water level and temperature - Sampling contaminated water - Installing permanent monitoring instrumentation
	2nd (Apr 2015)	Confirming the status of PCV 1st floor - Acquiring images - Measuring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

Status of investigation inside the PCV

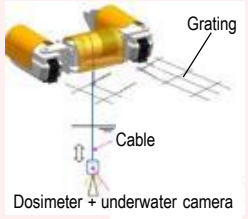
Prior to fuel debris retrieval, an investigation inside the PCV will be conducted to inspect the status there including the location of fuel debris.

[Investigative outline]

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



<Image of investigation inside the PCV>



Dosimeter + underwater camera
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)

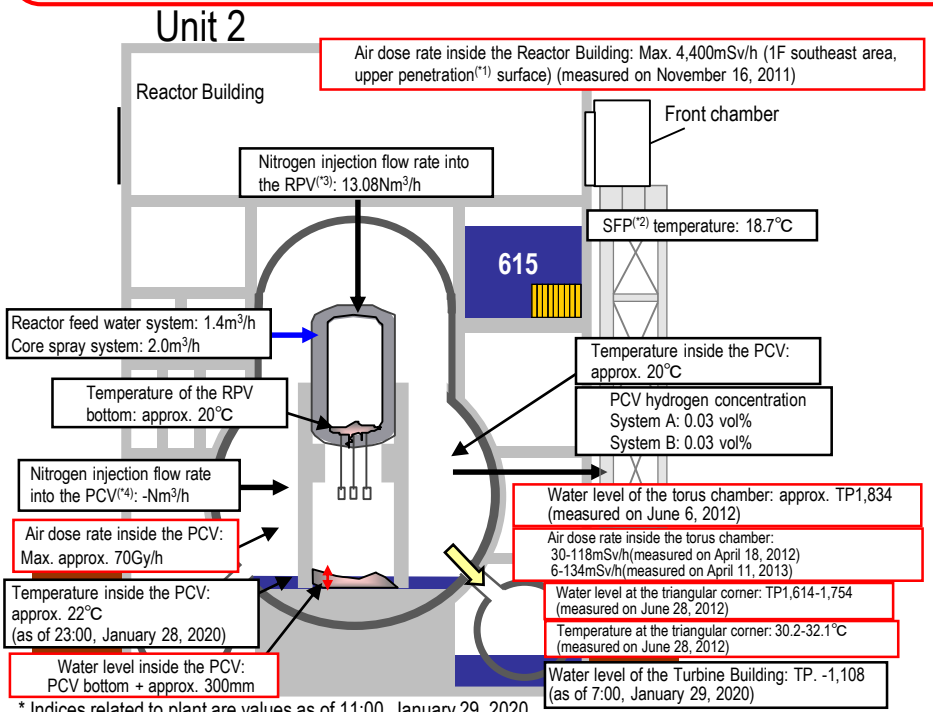
Progress toward decommissioning: Works to identify the plant status and toward fuel debris retrieval

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.

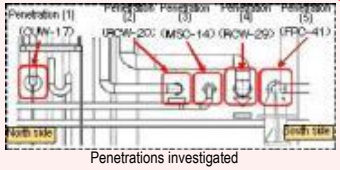


* Indices related to plant are values as of 11:00, January 29, 2020

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

Investigative results on torus chamber walls

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



Penetrations investigated

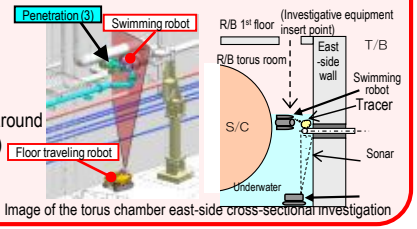


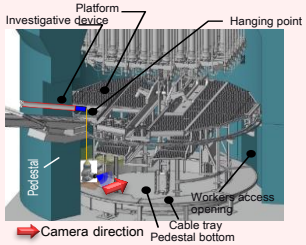
Image of the torus chamber east-side cross-sectional investigation

Status of investigation inside the PCV

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

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

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



Investigative status (image)

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

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

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

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

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

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

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

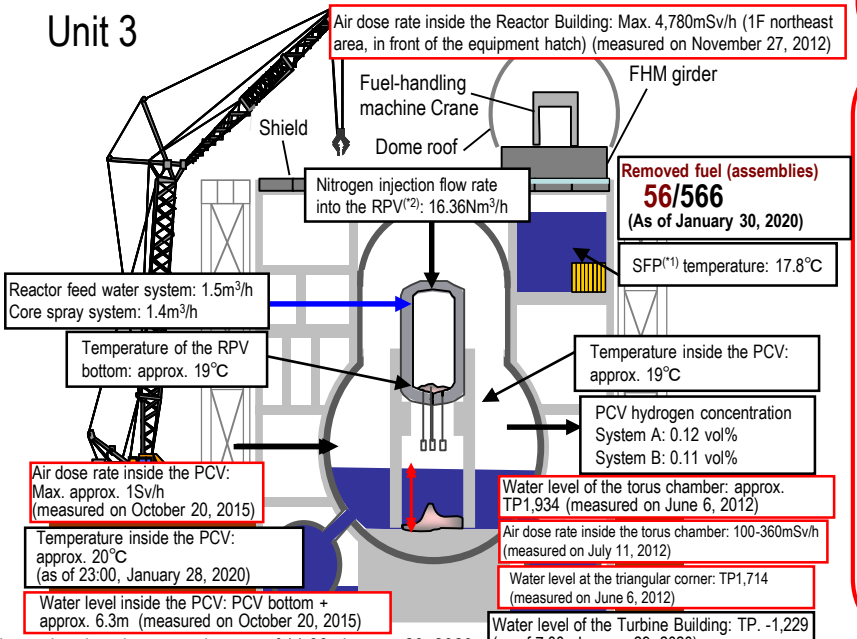
Water flow was detected from the Main Steam Isolation Valve* room

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

From April 23, 2014, image data has been acquired by camera and the radiation dose measured via pipes for measurement instrumentation, which connect the air-conditioning room on the Reactor Building 2nd floor with the Main Steam Isolation Valve Room on the 1st floor. On May 15, 2014, water flow from the expansion joint of one Main Steam Line was detected.

This is the first leak from PCV detected in the Unit 3. Based on the images collected in this investigation, the leak volume will be estimated and the need for additional investigations will be examined. The investigative results will also be utilized to examine water stoppage and PCV repair methods.

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

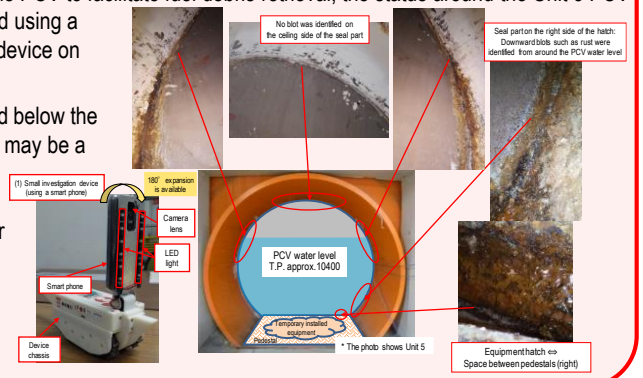


* Indices related to plant are values as of 11:00, January 29, 2020

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

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

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

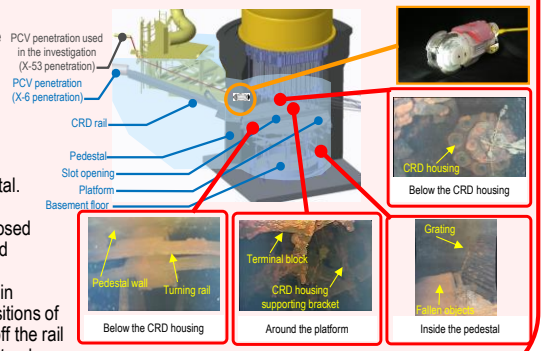


Investigation inside the PCV

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

[Investigative outline]

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



Status inside the pedestal

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

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

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

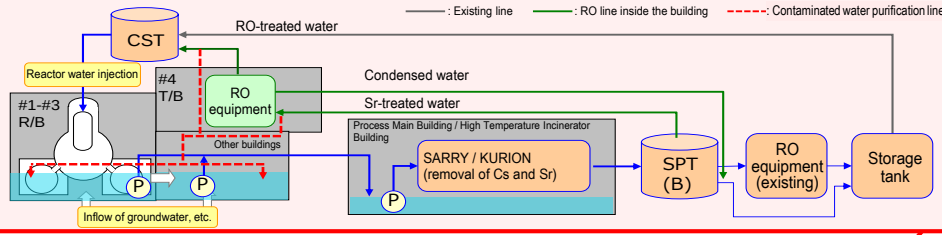
Progress toward decommissioning: Work related to circulation cooling and contaminated water treatment line

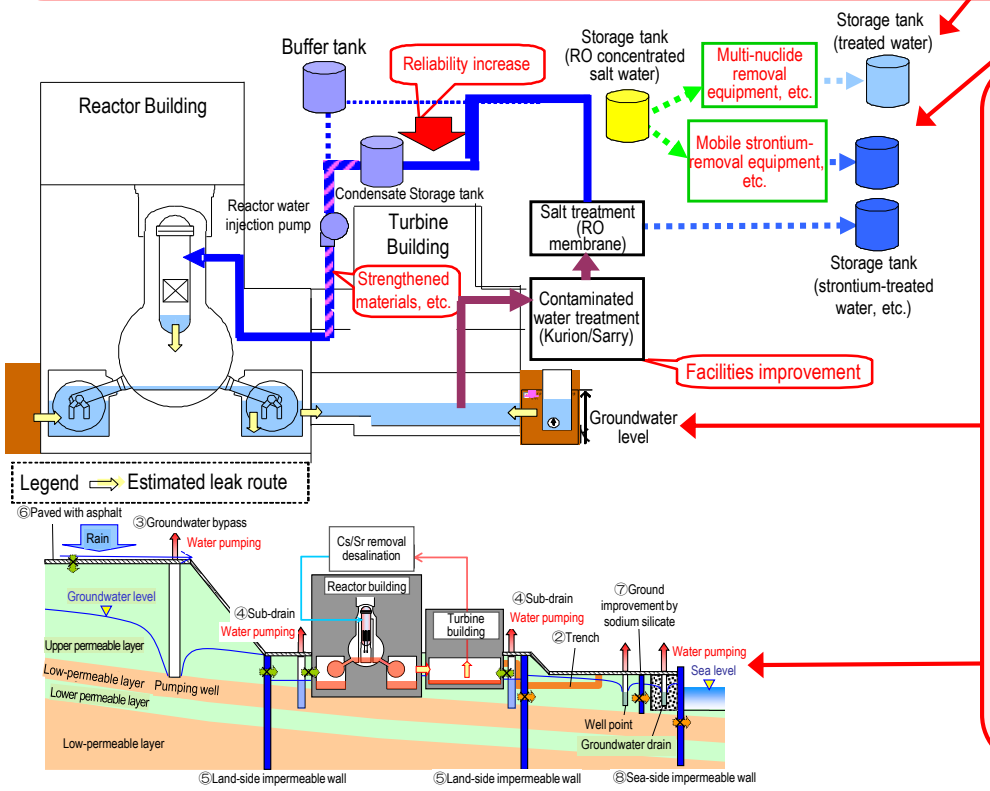
Immediate target | Stably continue reactor cooling and contaminated water treatment, and improve reliability

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

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

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





Progress status of dismantling of flange tanks

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


Start of dismantling in H1 east area

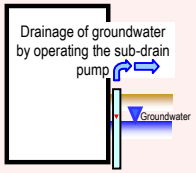

After dismantling in H1 east area

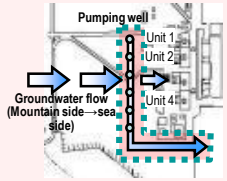
Completion of purification of contaminated water (RO concentrated salt water)

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

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

Preventing groundwater from flowing into the Reactor Buildings





Reducing groundwater inflow by pumping sub-drain water

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

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

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

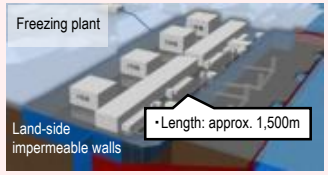
The pumped up groundwater is temporarily stored in tanks and released after TEPCO and a third-party organization have confirmed that its quality meets operational targets.

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

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

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

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



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

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

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

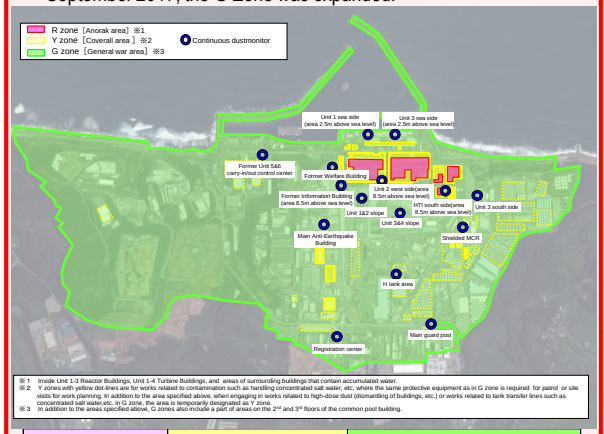
Progress toward decommissioning: Work to improve the environment within the site

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

Optimization of radioactive protective equipment

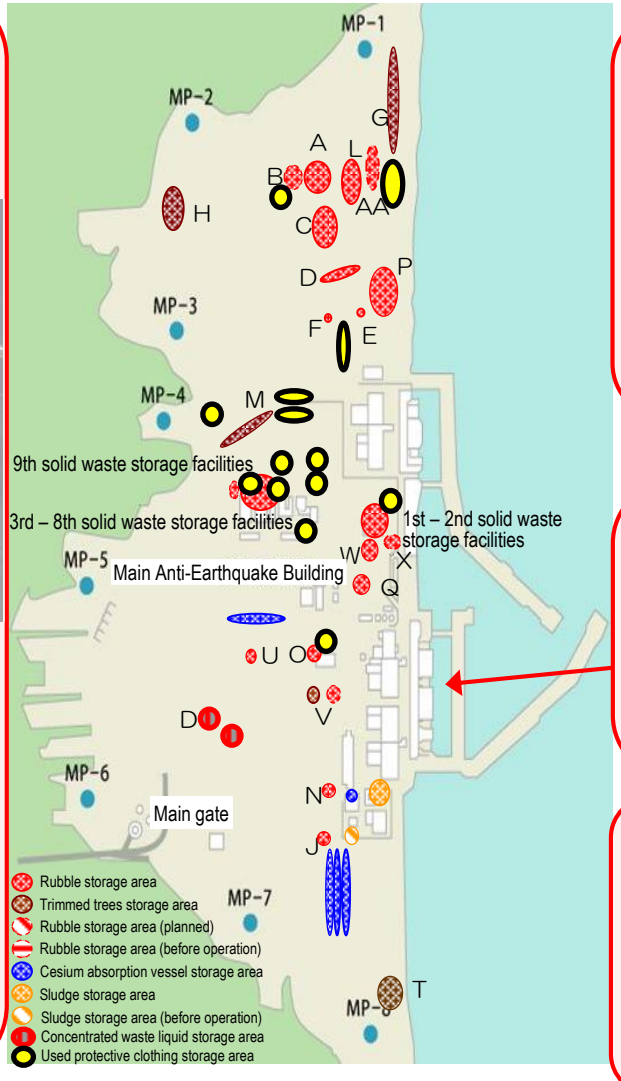
Based on the progress of measures to reduce environmental dosage on site, the site is categorized into two zones: highly contaminated area around Unit 1-4 buildings, etc. and other areas to optimize protective equipment according to each category aiming at improving safety and productivity by reducing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

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



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.