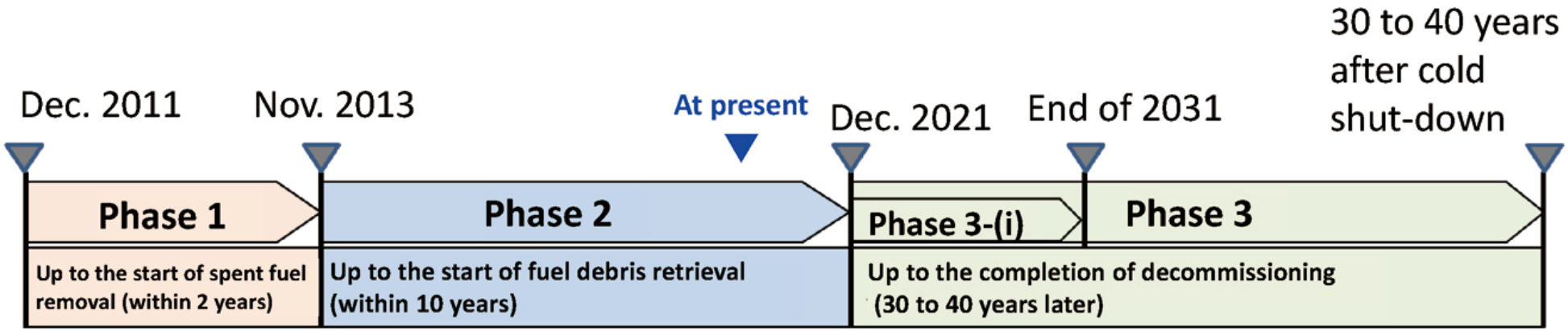
Procedures for Decommissioning and Contaminated Water Management at TEPCO's Fukushima Daiichi NPS

Overall framework of decommissioning procedures



- ○ Decommissioning procedures by roughly dividing the whole process into three phases
- ○ This overall framework is maintained in the Mid- and Long-term Roadmap revised in December 2019.
- ○ Fuel debris removal is scheduled to commence by the end of 2021, starting with Unit 2.

* Fuel debris removal work may be delayed for around one year due to delay in the development of relevant equipment caused by the spread of the COVID-19 infection.

Efforts and Progress for Decommissioning

Reduction of Effects in Surrounding Environment

Land area

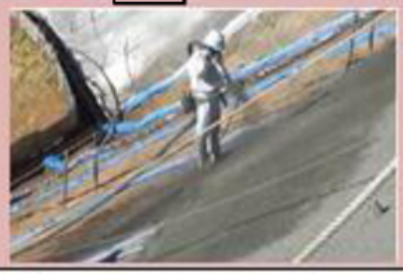
Testing of antiscattering agents for their dust holding capacity

Antiscattering agents are used

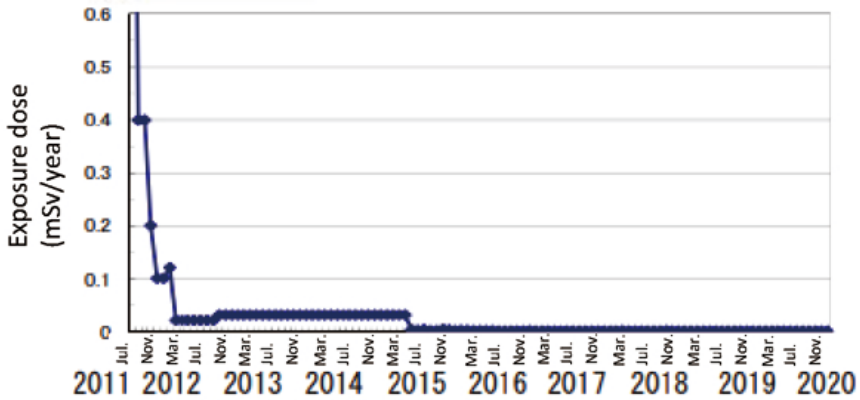
Antiscattering agents are not used

Scattering of radioactive materials is suppressed by spraying antiscattering agents under the condition of instantaneous wind velocity up to 50m/s.

Cover the premises of the Fukushima Daiichi NPS with mortar to suppress scattering of radioactive materials



Evaluation of annual exposure doses at the site boundary due to Cs from reactor buildings of Unit 1 to Unit 4



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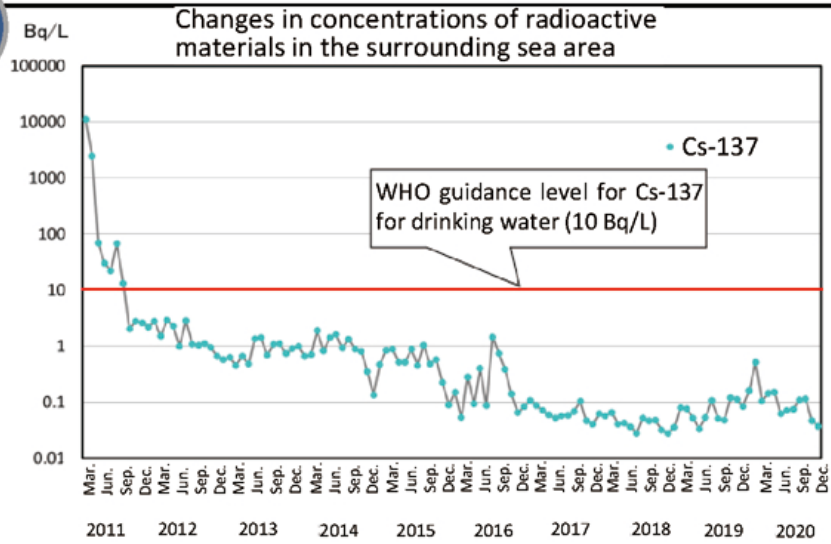
Sea area

Changes in concentrations of radioactive materials in the surrounding sea area



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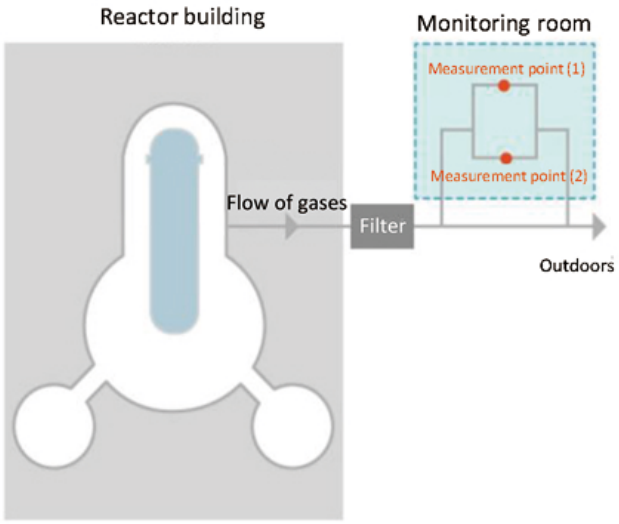
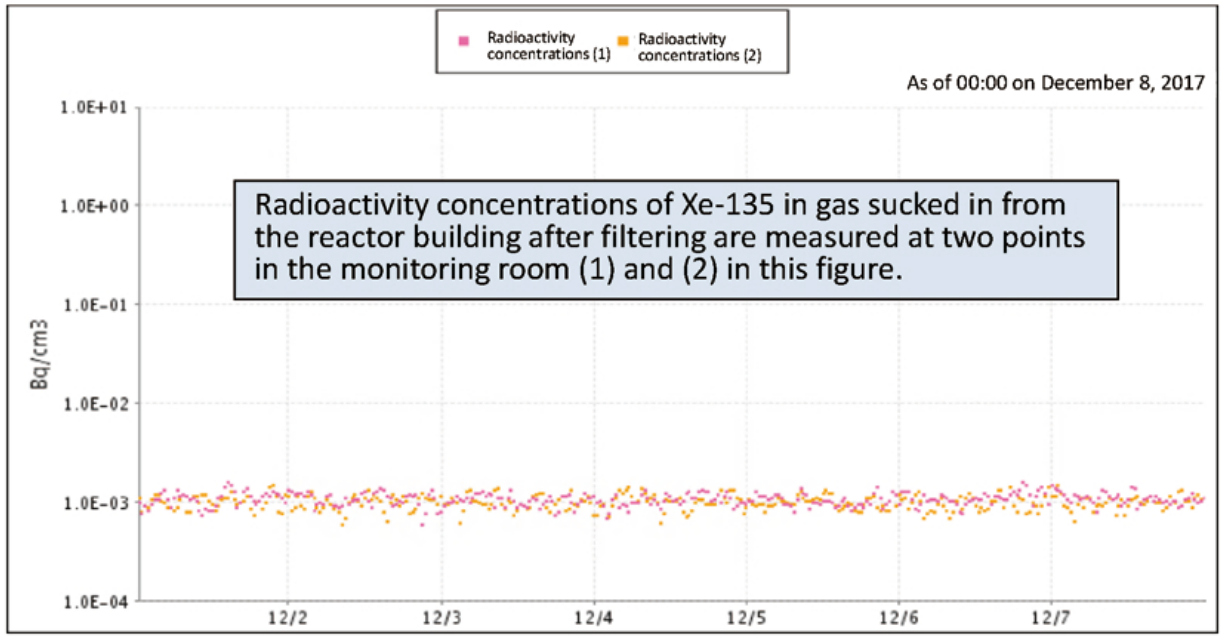
Efforts and Progress for Decommissioning

Measures against Recriticality and Future Earthquakes and Tsunamis

■ Amount of noble gases generated





Prepared by the Ministry of Economy, Trade and Industry based on materials published by TEPCO

■ Measures against earthquakes and tsunamis

Through computer analyses and other means, it has been confirmed that reactor buildings and other major facilities are sound enough to withstand any earthquakes or tsunamis equivalent to or even bigger than the Great East Japan Earthquake.

Securing of power sources in an emergency

In preparation for power loss, ordinary power sources have been multiplexed and emergency power supply vehicles and gas turbine vehicles are put in place. These vehicles are to be used to supply power to water injection facilities in an emergency.


Water injection drill


Emergency power supply vehicle


Fire engines

Backup power sources such as emergency power supply vehicles and water injection means such as fire engines are placed at a higher area where tsunamis are unlikely to reach.


Tide embankment
(Source: Website of Tokyo Electric Power Company)

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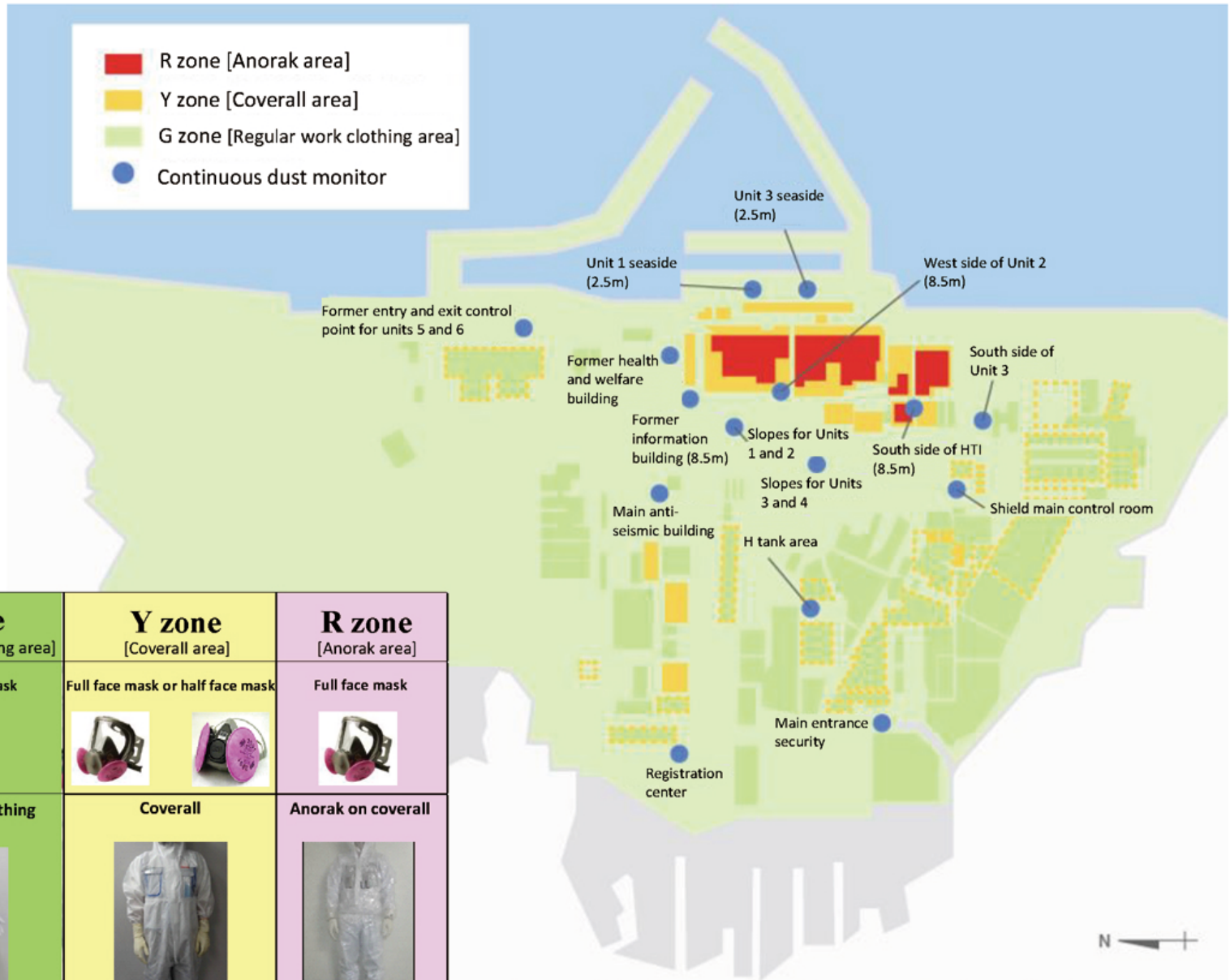
Efforts and Progress for Decommissioning

Improvement of Working Environment at TEPCO's Fukushima Daiichi NPS



G zone [Regular work clothing area]	Y zone [Coverall area]	R zone [Anorak area]
Disposable dust mask	Full face mask or half face mask	Full face mask
Regular work clothing	Coverall	Anorak on coverall

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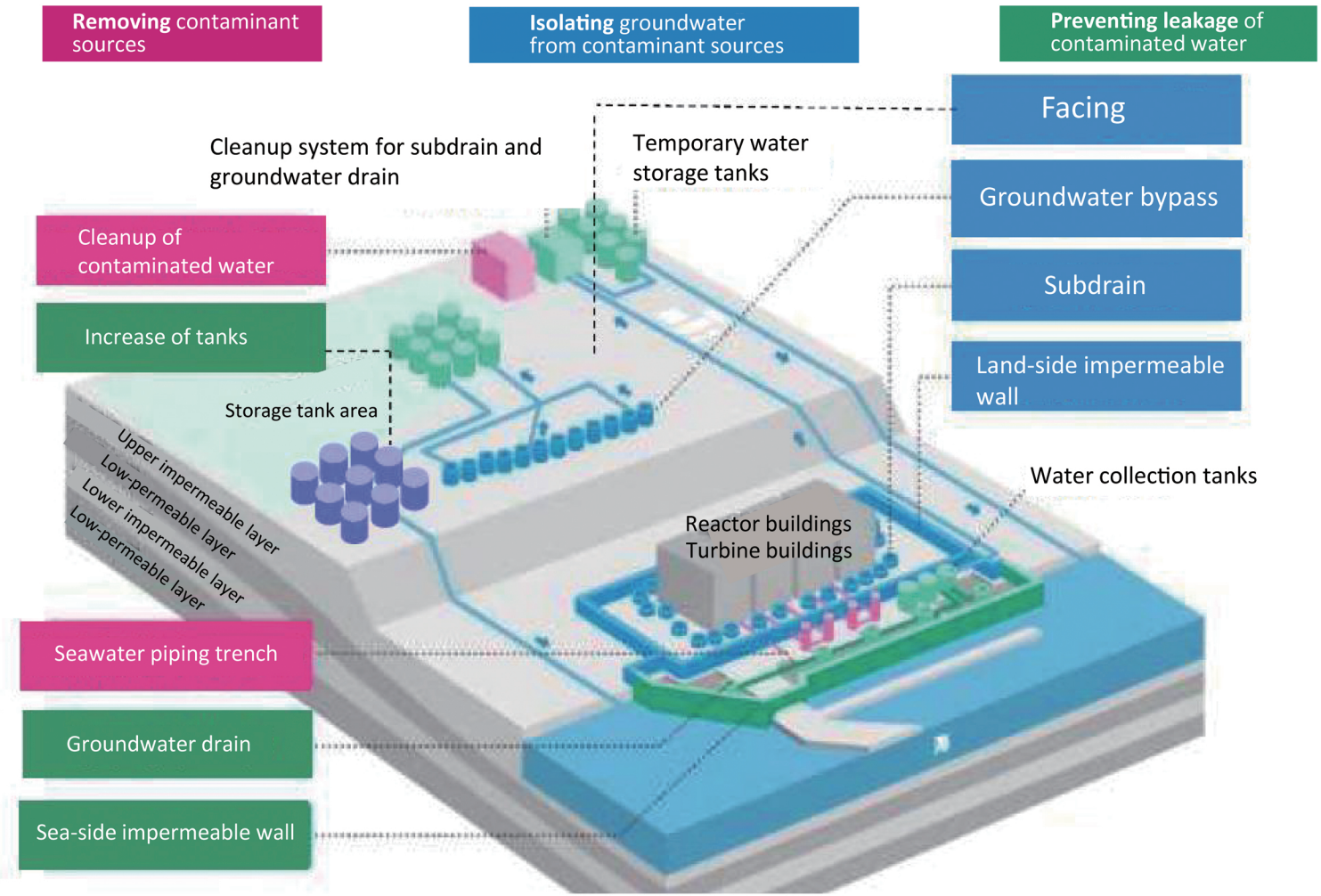
Measures against Contaminated Water

Preventive and multi-layered measures are being taken against contaminated water based on policies of (i) removing contaminant sources, (ii) isolating groundwater from contaminant sources, and (iii) preventing leakage of contaminated water.



Prepared by the Ministry of Economy, Trade and Industry based on the materials of Tokyo Electric Power Company

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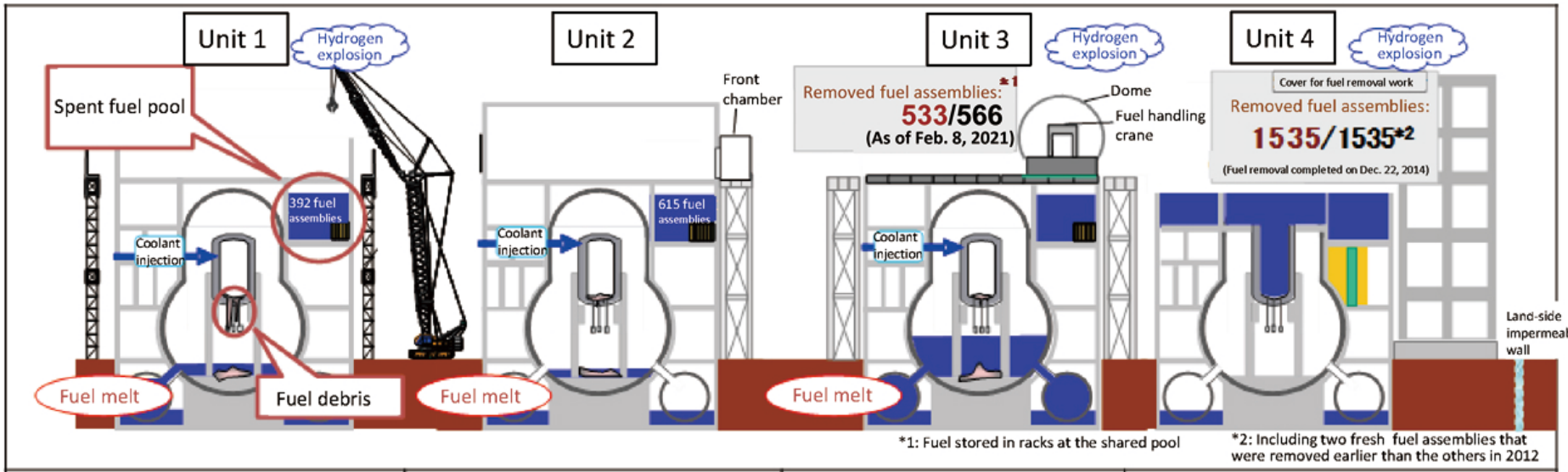
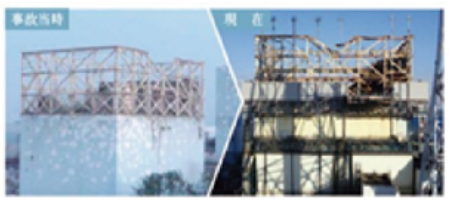
Progress in Efforts for Decommissioning

Current status of Unit 1 to Unit 4 at the Fukushima Daiichi NPS

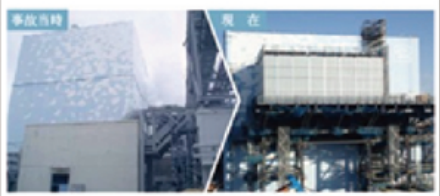
- For Units 1 and 2, preparation work for fuel removal from spent fuel pools is underway (clearance of rubble at operating floors, etc.). At Unit 3, fuel removal from spent fuel pools was commenced.
- At Unit 2, removal of fuel that melted at the time of the accident and then solidified (fuel debris) will be commenced on a trial basis within 2021 and the removal work will be expanded thereafter in stages.





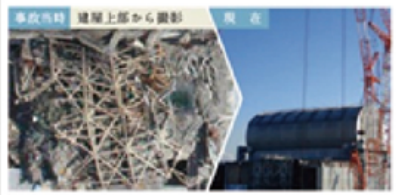
Commencement of clearance of rubble on the operating floor in the upper part of the building [Jan. 2018]

Commencement of fuel removal from spent fuel pools: FY2027-FY2028



Commencement of moving and clearance of leftover objects on the operating floor [Nov. 2018]

Commencement of fuel removal from spent fuel pools: FY2024-FY2026



Commencement of fuel removal from spent fuel pools [Apr. 2019]

Fuel removal completed: FY2020

Fuel removal completed

There is no fuel debris.

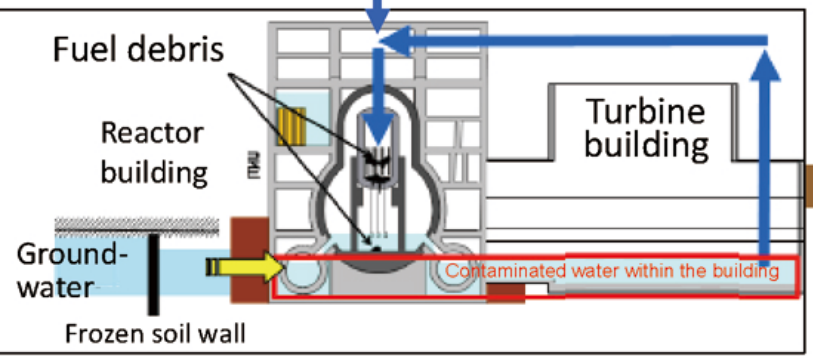
Commencement of fuel debris removal (Unit 2):Within 2021

Efforts and Progress for Decommissioning

ALPS Treated Water – Purification of Contaminated Water –

■ Contaminated water with radioactive materials is being generated after the accident at TEPCO's Fukushima Daiichi NPS. "ALPS treated water" refers to the water that has been treated by the Advanced Liquid Processing System (ALPS) and other equipment and has been purified to a level where contained radioactive materials, except for tritium, satisfy the regulatory standards for discharge into the environment.

Freshwater obtained through desalination is used as coolant.



Contaminated water

Purification treatment of cesium and strontium

SARRY

Kurion

Separate fresh water

Desalinator

Purification treatment of 62 types of radioactive materials other than tritium

Advanced Liquid Processing System (ALPS)

- Pre-treatment facilities (coprecipitation treatment)
- Adsorption tower

Water that satisfies the regulatory standards for environmental discharge with regard to radioactive materials, except for tritium, contained therein

Water that does not satisfy the regulatory standards for discharge into the environment with regard to radioactive materials, except for tritium, contained therein

Secondary treatment using ALPS or reverse osmosis membrane equipment

ALPS treated water

(Source) Prepared based on "Fukushima Daiichi Nuclear Power Station: Contaminated water management: What is 'slurry'? Why is it generated? How is it stored?" by the Agency for Natural Resources and Energy (https://www.enecho.meti.go.jp/en/category/special/article/detail_157.html)

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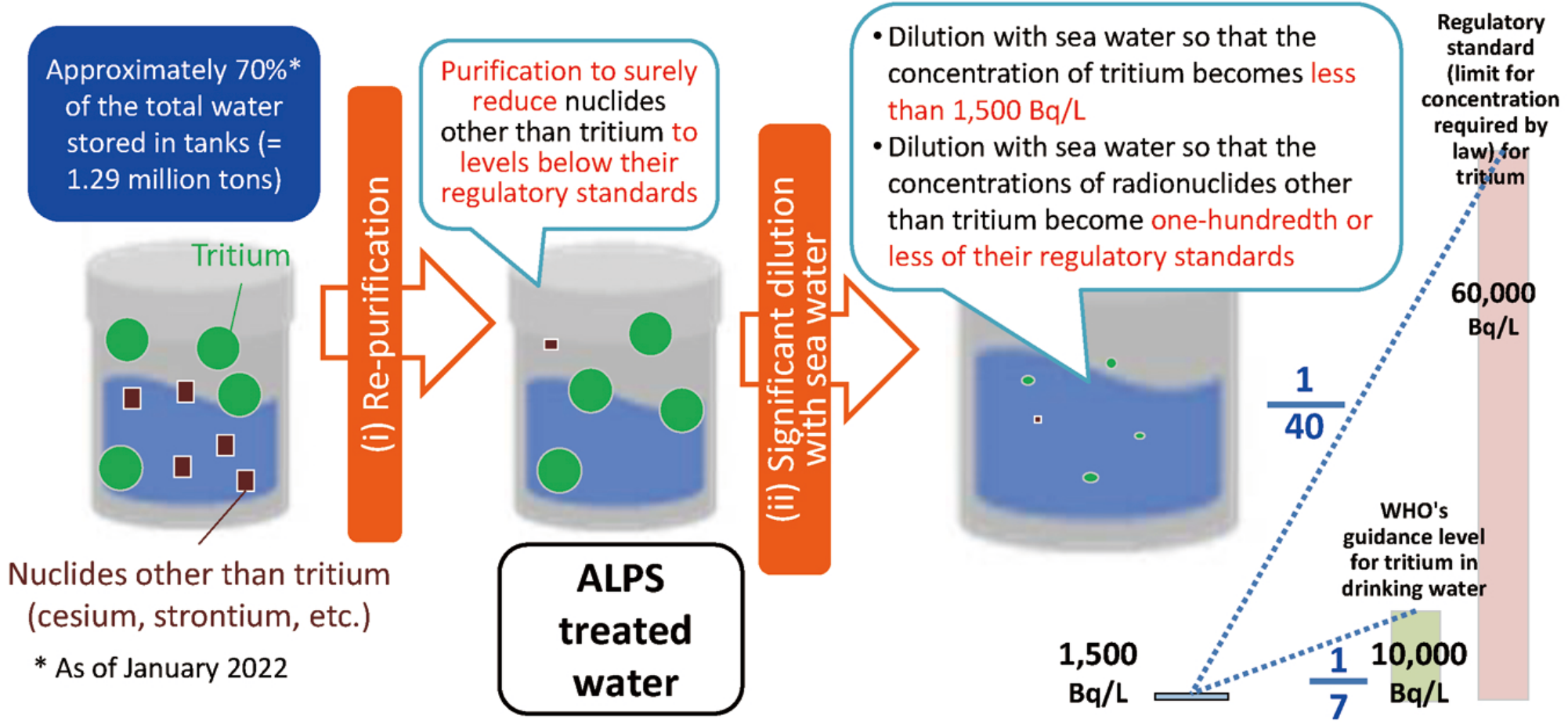
Efforts and Progress for Decommissioning

Treatment Method for Water Stored in Tanks

- Reduce concentrations of the radioactive materials contained in treated water far below the regulatory standards through 1) re-purification of radionuclides other than tritium; and 2) dilution by more than 100 times with sea water.
- Discharge water into the sea from TEPCO's Fukushima Daiichi NPS, and conduct monitoring before and after the discharge (evaluation and review by third parties, such as an international organization).



(Source) "ALPS Treated Water" (website of the Ministry of Economy, Trade and Industry) (https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/atw.html)

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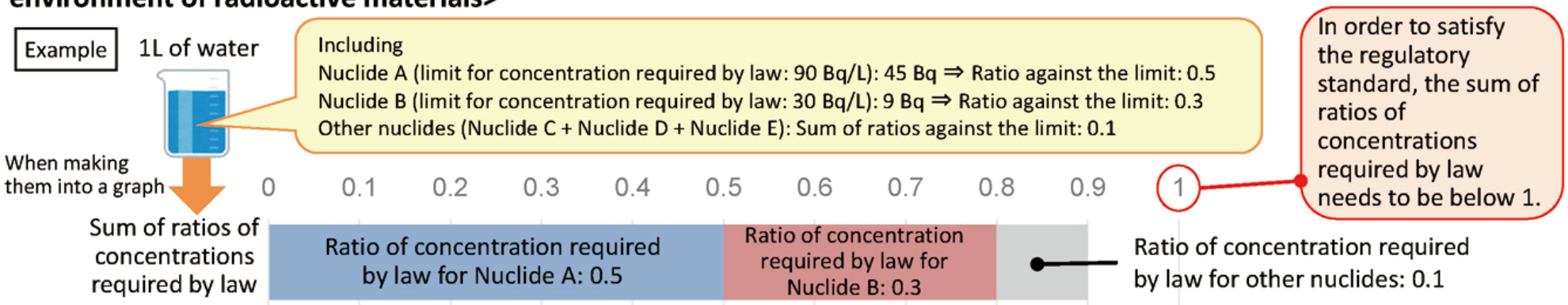
Efforts and Progress for Decommissioning

Regulatory Standards for Discharging Radioactive Materials into the Environment

- Whether the regulatory standard is satisfied or not is evaluated based on the sum of radiation effects caused by all types of contained nuclides, irrespective of whether the reactor is an operating one or a damaged one (based on the sum of effects converted to those on human beings, not based on types or numbers of nuclides).
- Contaminated water at TEPCO's Fukushima Daiichi NPS contains radioactive nuclides unique to the broken-down reactors (such as cesium and strontium), but these are surely removed to levels below the regulatory standards by the use of the Advanced Liquid Processing System (ALPS) and other equipment.

< Concept of the sum of ratios of concentrations required by law, the regulatory standard for discharge into the environment of radioactive materials>



[Reference] Results of the performance test regarding re-purification by the use of ALPS and other equipment (sum of ratios of concentrations required by law and ratios against the limits for major nuclides)

	Cobalt 60	Cesium 137	Strontium 90	Iodine 129	Other nuclides	Sum for nuclides other than tritium (sum of ratios of concentrations required by law)
Ratio against the limit for concentration required by law	0.0017	0.0021	0.0012	0.13	0.215	0.35

Dilution by more than 100 times so that the sum of the ratios of concentrations required by law for all radioactive materials including tritium becomes less than 1

(Source) Prepared based on "First priority is given to safety and security; Measures related to contaminated water in Fukushima (iv): Regulatory standards for radioactive materials" (https://www.enecho.meti.go.jp/about/special/johoteikyo/osensuitaisaku04.html) (in Japanese) and "Safe and secured disposal of treated water for reconstruction and decommissioning (ii): Secondary treatment and other nuclides contained in treated water" (https://www.enecho.meti.go.jp/about/special/johoteikyo/shorisui02.html) (in Japanese) by the Agency for Natural Resources and Energy, and "Performance test regarding secondary treatment of ALPS treated water" by Tokyo Electric Power Company Holdings

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Nuclides Other than Tritium

- Contaminated water generated at TEPCO's Fukushima Daiichi NPS not only contains tritium but also contains Cesium 137, Strontium 90 and other radioactive materials which are seldom detected in water discharged from ordinary nuclear power stations.
- Out of those radioactive materials, 62 types of nuclides that are likely to be contained in the contaminated water at certain levels in consideration of regulatory standards respectively set for those types of nuclides are purified by the use of the Advanced Liquid Processing System (ALPS) and other equipment to the extent that their concentrations become below those regulatory standards.

Nuclides to be purified using ALPS (62 types)

- Cesium 137
- Cesium 134
- Strontium 90
- Cobalt 60
- Antimony 125
- Ruthenium 106
- Iodine 129
- ・
- ・
- ・
- Technetium 99

Major seven types

55 types

- Carbon 14
- ・
- ・
- ・

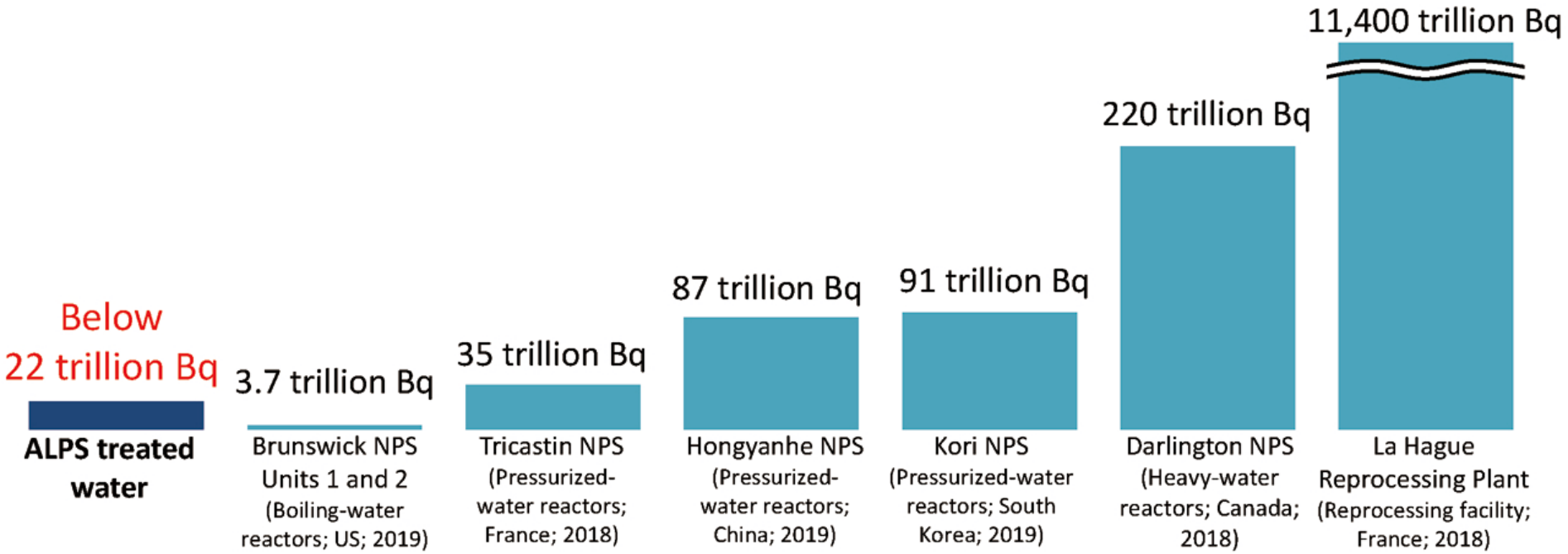
Other nuclides

(Source) Prepared based on "Advanced Liquid Processing System (ALPS)" (https://www.tepco.co.jp/nu/fukushima-np/f1/genkyo/fp_cc/fp_alps/) (in Japanese) and "Performance test regarding secondary treatment of ALPS treated water," etc. by Tokyo Electric Power Company Holdings

Efforts and Progress for Decommissioning

Annual Discharge Amounts of Tritium - International Comparison -

- The total amount of tritium at the time of discharge of ALPS treated water is below 22 trillion Bq per year (operational target value prior to the accident).
- Tritium is discharged as liquid waste into the sea or rivers or into the air through ventilation, etc. also at other nuclear power stations and reprocessing facilities inside and outside Japan in compliance with the laws and regulations of respective countries.



Annual discharge amounts of tritium (liquid) from ALPS treated water and at nuclear facilities around the world

(Source) Prepared based on "ALPS Treated Water" on the website of the Ministry of Economy, Trade and Industry (https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/atw.html)

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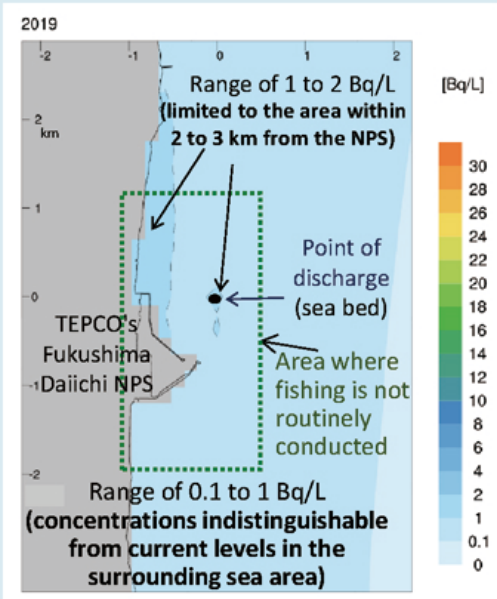
Efforts and Progress for Decommissioning

Assessment of the Potential Radiological Impact of Discharge of ALPS Treated Water into the Sea

■ When discharging ALPS treated water into the sea, dilution is to be surely conducted and the diffusion and potential radiological impacts on humans and marine environment are to be scientifically assessed. Monitoring before and after the discharge will also be strengthened and enhanced.

< Assessment of potential impact on the marine environment>

- Results of the dispersion simulation
  The surrounding sea area where the tritium concentration was assessed to increase from the current level (0.1 to 1 Bq/L) is limited to the area within 2 to 3 km from the NPS. Even in this sea area, the sea water sufficiently satisfies the regulatory standard for tritium in Japan and the WHO's guideline for drinking-water quality.
- Assessment on exposure doses of the general public
  The impact on people who consume marine products at the national average was assessed to be approx. 1/120,000 to approx. 1/1,000 of the average annual exposure doses of Japanese people due to natural radiation (2.1 mSv/y).



Around the NPS [Enlarged]
(Largest value in scale at 30Bq/L)

< Environmental monitoring>

- The Government of Japan and relevant sectors will strengthen and enhance sea area monitoring before and after the discharge so that concentrations of tritium etc. in the sea can be compared.
- The credibility of analysis is to be secured by obtaining cooperation from the IAEA.

(Source) Prepared based on the "Announcement of the Basic Policy on Handling of the ALPS Treated Water at TEPCO's Fukushima Daiichi Nuclear Power Station (FDNPS)" (https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/pr_bpalps.pdf) by the Agency for Natural Resources and Energy and the "Radiological Impact Assessment Report Regarding the Discharge of ALPS Treated Water into the Sea (Design stage)" (November 2021) (https://www.tepco.co.jp/press/release/2021/1657175_8711.html) by Tokyo Electric Power Company Holdings

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