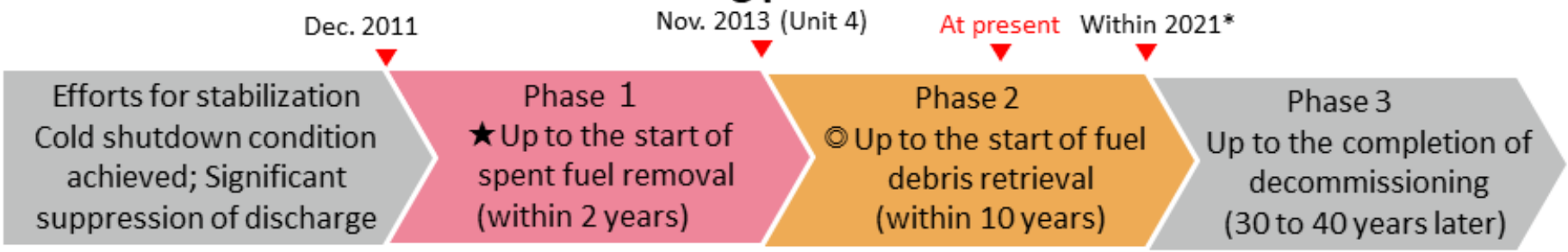
Efforts and Progress for Decommissioning

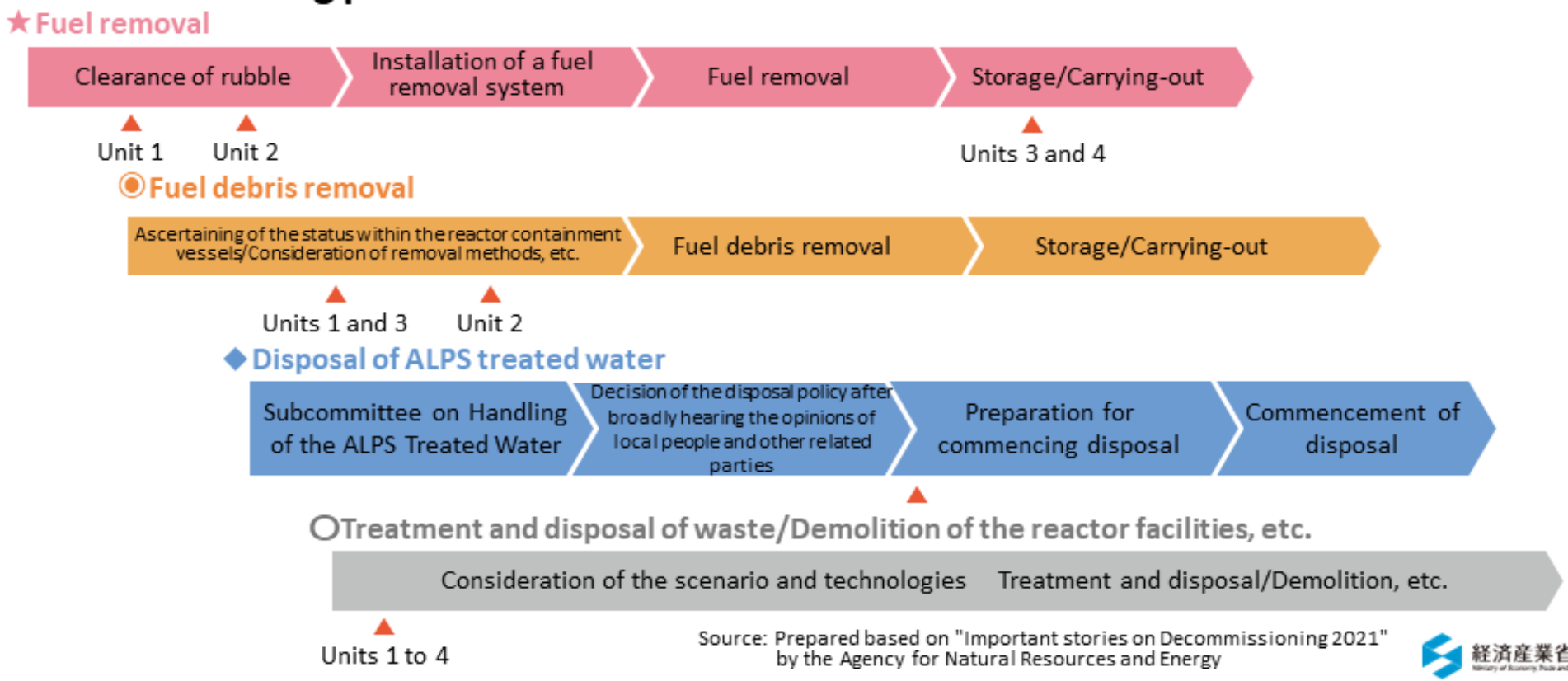
# Procedures for Decommissioning and Contaminated Water and Treated Water Management at TEPCO's Fukushima Daiichi NPS

## Overall framework of decommissioning procedures




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

## Decommissioning procedures




Source: Prepared based on "Important stories on Decommissioning 2021" by the Agency for Natural Resources and Energy

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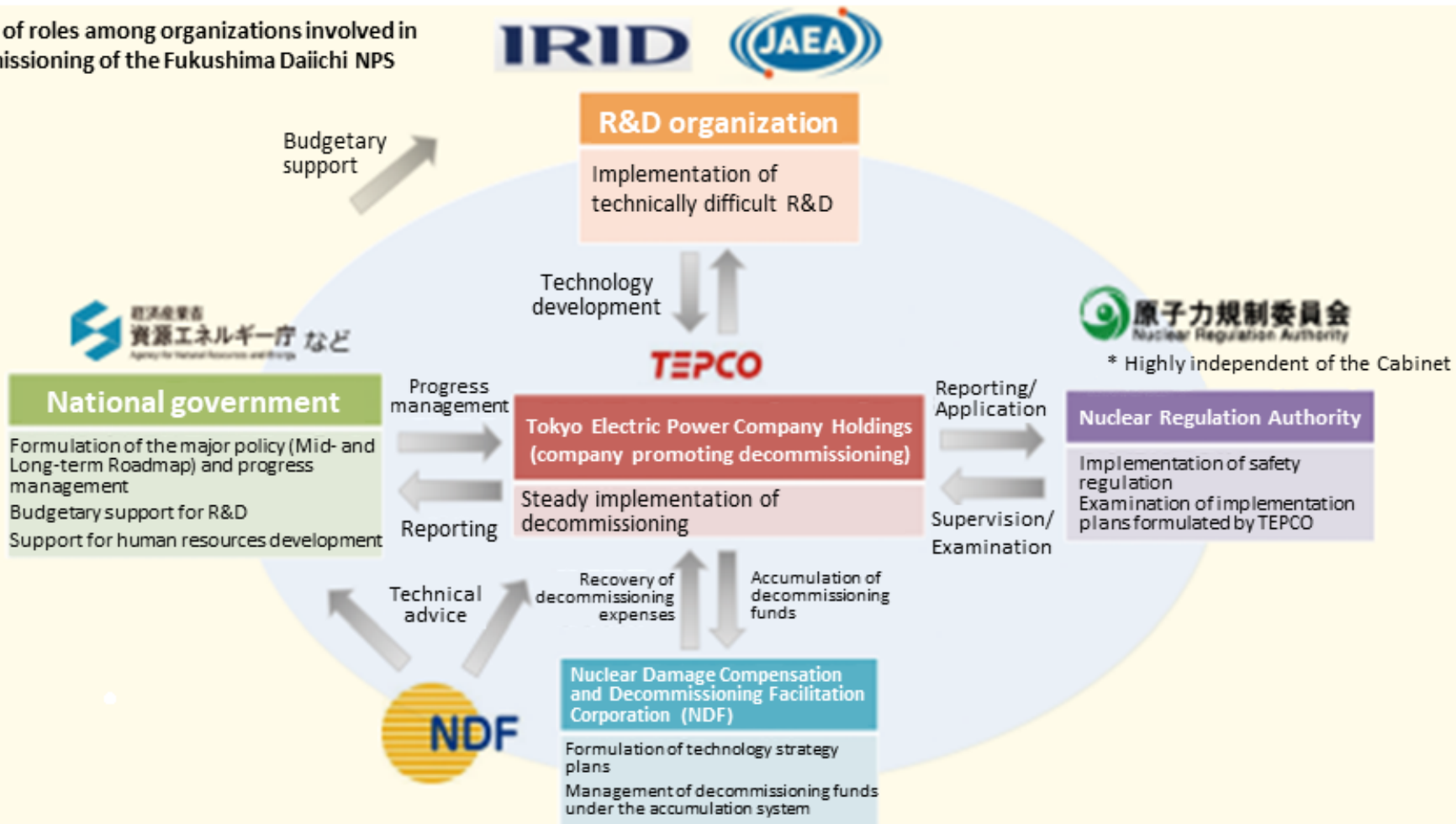
# Organizations and Tasks

Decommissioning work is being carried out in cooperation with local companies and other organizations, as well as with the collective wisdom from Japan and abroad.

**Division of roles among organizations involved in decommissioning of the Fukushima Daiichi NPS**




Source: Prepared based on "Important Information on Decommissioning 2021" by the Agency for Natural Resources and Energy

# Progress in Efforts for Decommissioning

## Current status of Units 1 to 4

○Situation differs by unit, and methods of carrying out measures and progress are also different.

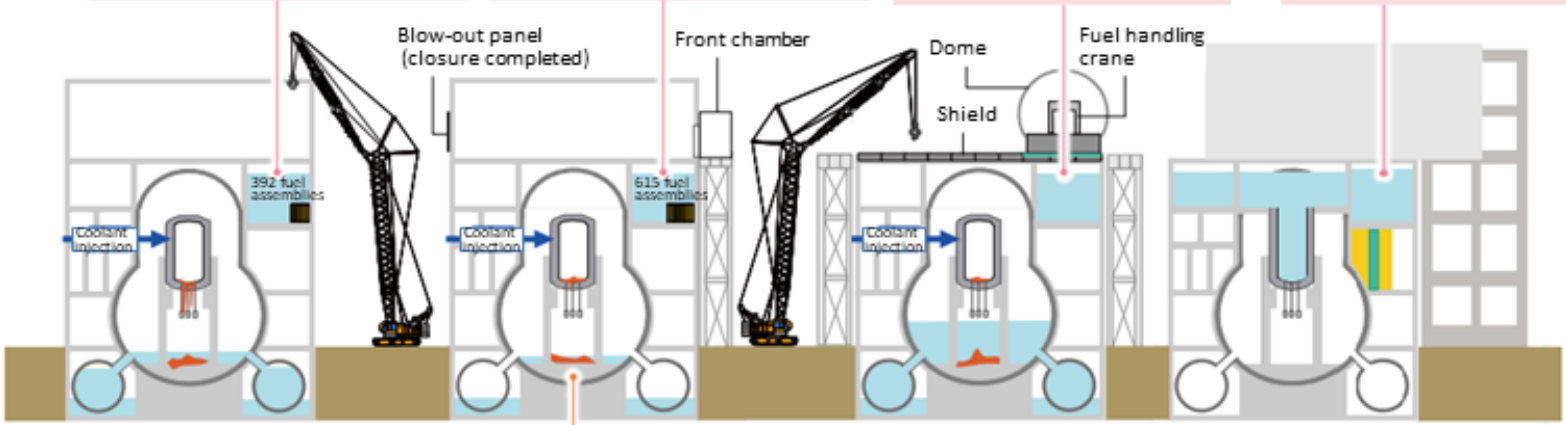
★Fuel removal

To be commenced in 2027 to 2028

To be commenced in 2024 to 2026

Completed in February 2021 (566 fuel assemblies)

Completed in December 2014 (1535 fuel assemblies)




◉Fuel debris removal

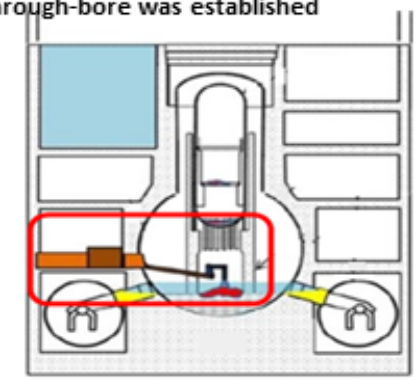
Scheduled to commence removal at Unit 2 on a trial basis

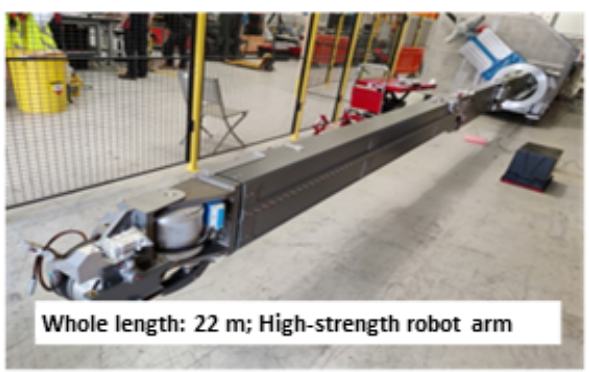
* No accident occurred in Units 5 and 6, but fuel removal work will be conducted sequentially for these units as well.

## Future plan for fuel debris removal

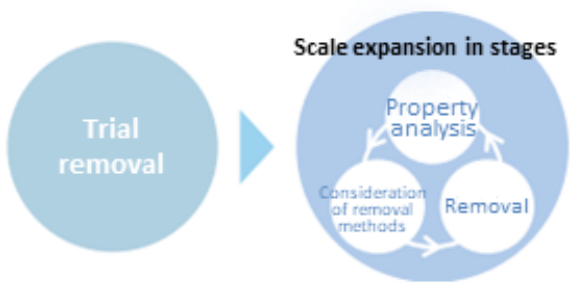
○ Removal work on a trial basis will be commenced at Unit 2 first and the scale of the removal work will be expanded in stages.

A. removal method of inserting a robot arm into a containment vessel through a small through-bore was established





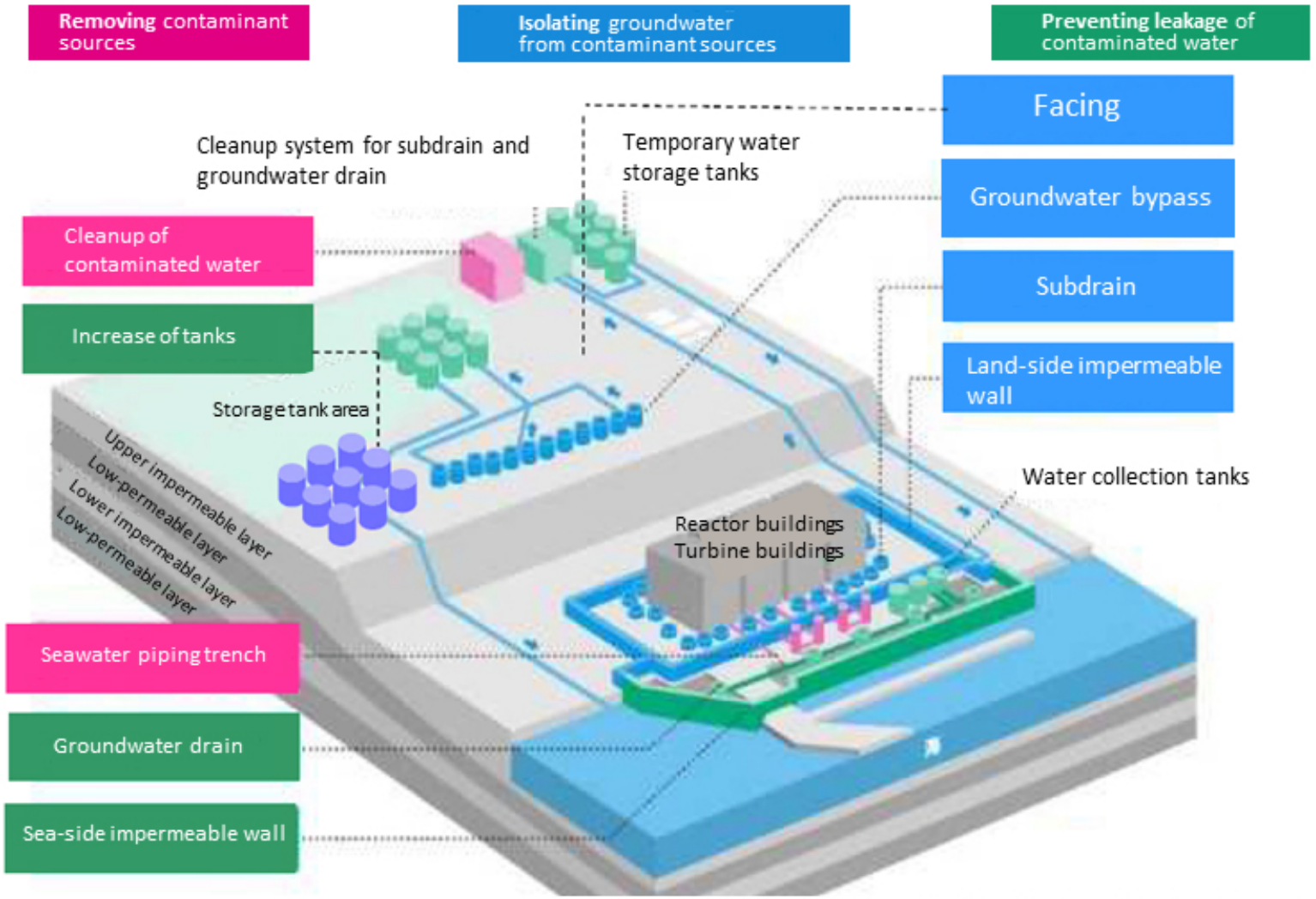
Whole length: 22 m; High-strength robot arm




Source: Prepared based on "Important Information on Decommissioning 2021" by the Agency for Natural Resources and Energy

# 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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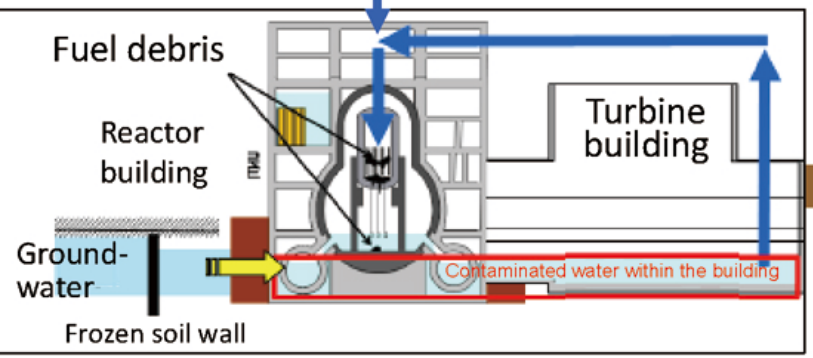
# ALPS Treated Water – Purification of Contaminated Water –

■ 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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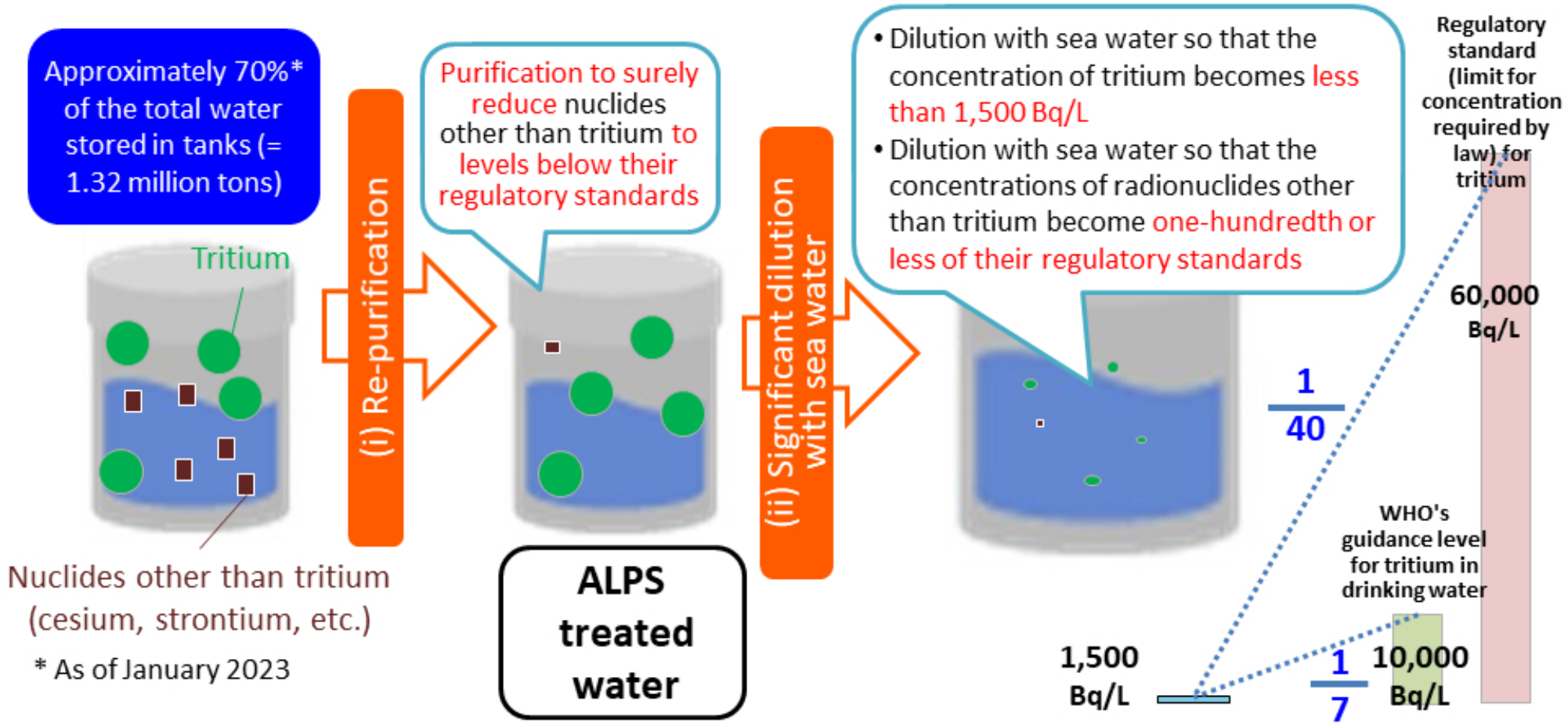
# Treatment Method for Water Stored in Tanks

- 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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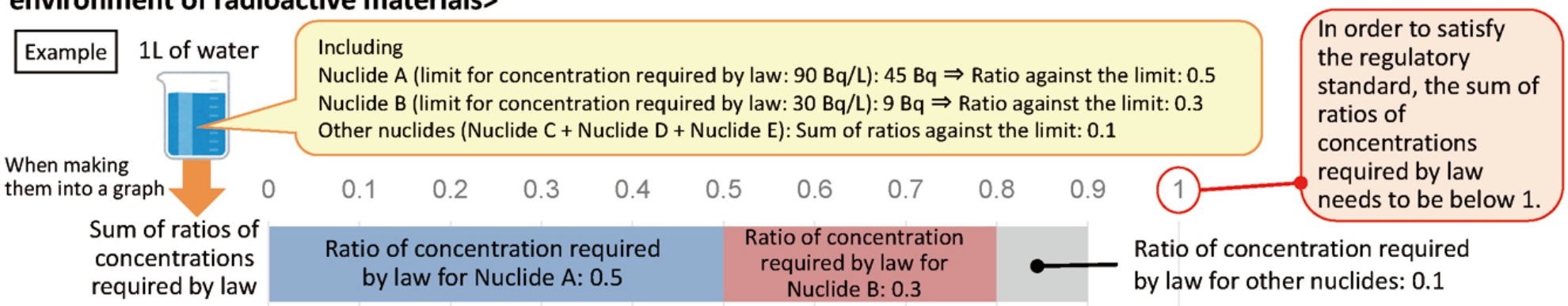
# Regulatory Standards for Discharging Radioactive Materials into the Environment

- 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

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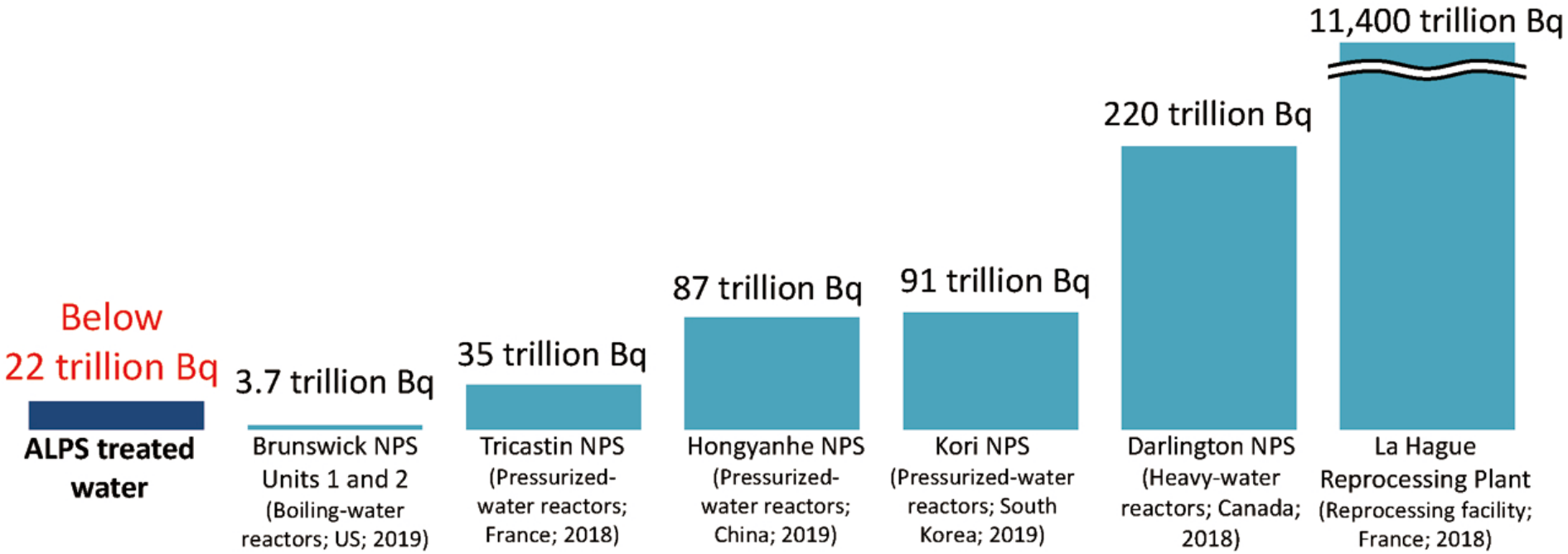
# Annual Discharge Amounts of Tritium - International Comparison -

- 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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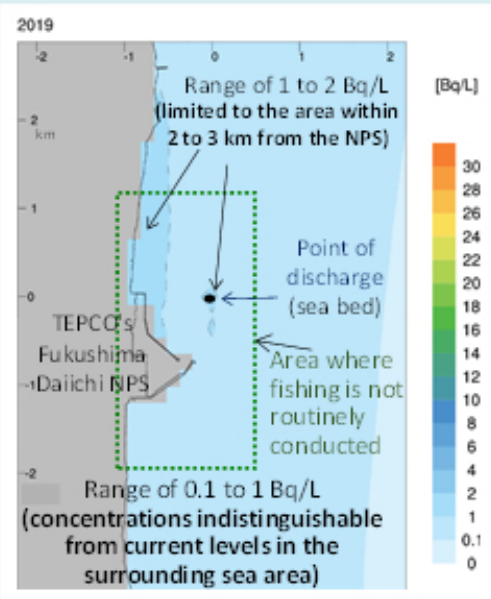
# Assessment of the Radiological Impact of Discharge of ALPS Treated Water into the Sea

■ 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 humans is assessed to be approx. 1/1,000,000 to 1/100,000 of the exposure doses (2.1 mSv/y) of Japanese people from natural radiation.




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 "Radiological Environmental Impact Assessment Report Regarding the Discharge of ALPS Treated Water into the Sea (Construction stage)" (November 2022) by Tokyo Electric Power Company Holdings, https://www.tepco.co.jp/press/release/2022/pdf4/221114j0101.pdf#page=289

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# IAEA Review of Safety Aspects of Handling of ALPS Treated Water

- Continuous technical reviews have been/will be conducted by the IAEA, before, during, and after the discharge of ALPS treated water into the sea to assess its conformity with the IAEA's safety standards.
- The first IAEA review was conducted in February 2022, and a report summarizing its findings was published in April of the same year. Tokyo Electric Power Company Holdings revised the implementation plan and radiological impact assessment report and enhanced their content.

## IAEA Review

i. Review the radiological characterization of ALPS treated water and the discharge plan, intensively focused on the aspect of safety
ii. Review the process of the Nuclear Regulation Authority, the body responsible for safety regulation
iii. Corroborate the data published by Japan by conducting monitoring of ALPS treated water and radioactive materials in the environment as an independent organization

Major items subject to the review in February 2022

- Assessment of the radiological characterization of materials contained in ALPS treated water to be discharged
- Safety of the ALPS treated water discharge process (devices, etc. to be used for discharge)
- Radiological Environment Impact Assessment

Revise of the implementation plan and radiological environmental impact assessment, etc., and further enhancement of its content

(Source) Prepared based on the "Safe and secured disposal of treated water for reconstruction and decommissioning (iv) IAEA's review of the safety of ALPS treated water (https://www.enecho.meti.go.jp/about/special/johoteikyo/shorisui04.html) by the Agency for Natural Resources and Energy

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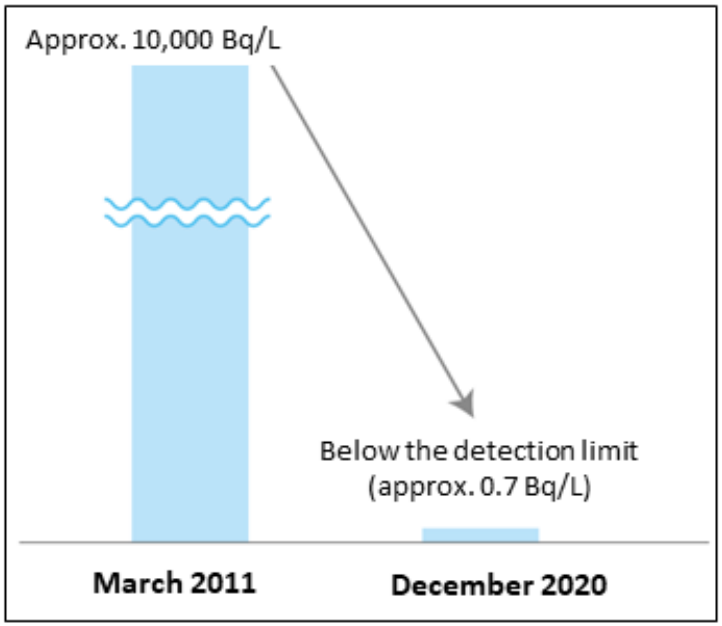
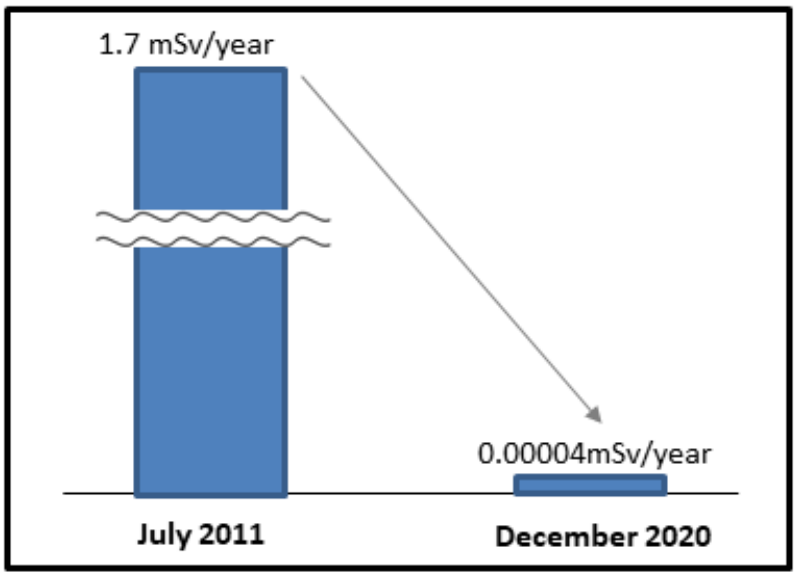
# Reduction of Effects in Surrounding Environment and Preventive Measures against Earthquakes and Tsunamis

■Radioactivity concentrations (Cesium 137) in Seawater near the NPS (around the south outlet)




■Assessed annual exposure dose at the boundary of the premises due to the radioactive materials (Cesium) discharged from reactor buildings of Units 1 to 4




Source: Prepared based on "Important Information on Decommissioning 2021" by the Agency for Natural Resources and Energy

■Measures against earthquakes and tsunamis

Securing of power sources in an emergency

In preparation for power loss, ordinary power sources have been made multifaceted 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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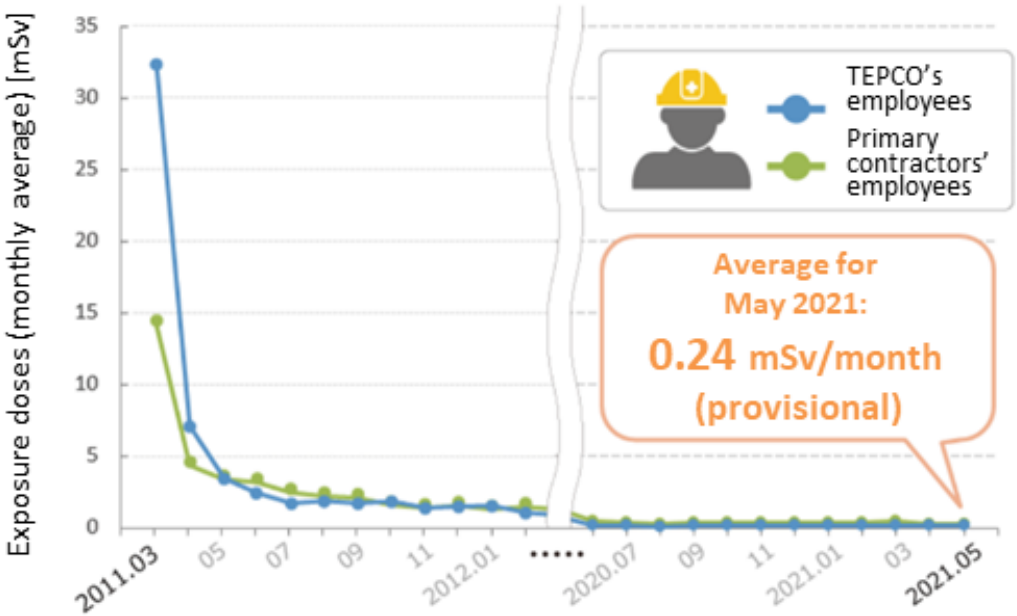
# Improvement of Working Environment at TEPCO's Fukushima Daiichi NPS

## ■ Changes in occupational workers' monthly personal exposure doses




Source (upper): Prepared based on the website of the Tokyo Electric Power Company (https://www.tepco.co.jp/decommission/progress/environment/)
Source (lower): Prepared based on "Important Information on Decommissioning 2021" by the Agency for Natural Resources and Energy

## Workers' working environment

The large rest house has a dining room and a convenience store.

Emergency physicians are stationed at all hours.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