Document 1, The 4th Review Meeting on the Implementation Plan Regarding the Handling of ALPS Treated Water

Installation of New ALPS Treated Water Dilution/Discharge facilities and the Related Facility

11th January, 2022

TEPCO

Tokyo Electric Power Company Holdings, Inc.

The Japanese version shall prevail.

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1.1 (1. Overall Policy)

The significance of the discharge of ALPS treated water into the sea in the overall process of handling the Specified Nuclear Facility, and the role that the Discharge Facilities of ALPS Treated Water into the Sea are expected to play in reducing overall risks of the Specified Nuclear Facility

1.2 (2-1 Major issues to be reviewed based on the Nuclear Reactor Regulation Act)

(1) ocean discharge facility for ALPS treated water

(6) Evaluating the validity of the facility design in the event of failure

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1. Responses to major issues(*) concerning the content of the application for the Discharge Facilities of ALPS Treated Water into the Sea

*Document 1-2 for (The 3rd) Meeting for the Review on the Disposal of ALPS Treated Water

1.1 (1. Overall Policy)

The significance of the discharge of ALPS treated water into the sea in the overall process of handling the Specified Nuclear Facility, and the role that the Discharge Facilities of ALPS Treated Water into the Sea are expected to play in reducing overall risks of the Specified Nuclear Facility

Explanations are required on the significance of the discharge of ALPS treated water into the sea in the overall process of handling the Specified Nuclear Facility, and the role that the Discharge Facilities of ALPS Treated Water into the Sea are expected to play in reducing overall risks of the Specified Nuclear Facility.

Overall process of handling the Specified Nuclear Facility and reduction of total risks

- TEPCO will intend to reduce and optimize overall risks over the Specified Nuclear Facility in accordance with the latest mid- to long-term roadmap. (Implementation Plan I -1 Overall Process)

- To proceed the decommissioning work safely and steadily, such as retrieval of fuel debris and spent fuel, which are major risks at the Specified Nuclear Facility, effective use of resources is required, such as personnel involved in decommissioning works and the site of the Fukushima Daiichi NPS.

- Installing the ALPS Treated Water Dilution/Discharge facilities and the Related Facility, and then discharging the ALPS Treated Water stored in tanks creates spaces on the site for decommissioning works in a planned manner, which contributes to the fulfilment of the mid- to long-term roadmap. (See slides 4 to 6)

- The tanks containing ALPS Treated Water, etc. in the site, are continuously monitored for leakage and maintained appropriately in case of natural disasters, etc. However, installing the ALPS Treated Water Dilution/Discharge facilities and the Related Facility, and reducing the volume of water stored in the tanks enable the risk reduction, such as retrieval of fuel debris and spent fuel which has relatively high risks, that leads effective use of human resources, who have been working for the maintenance and management of the tanks.

1.1 (1 Overall Policy) (1)
[Supplement] Site use

Excerpt from the document 2 for the 91st Review Meeting on Monitoring and Evaluation of the Specified Nuclear Facility (the Title Changed)

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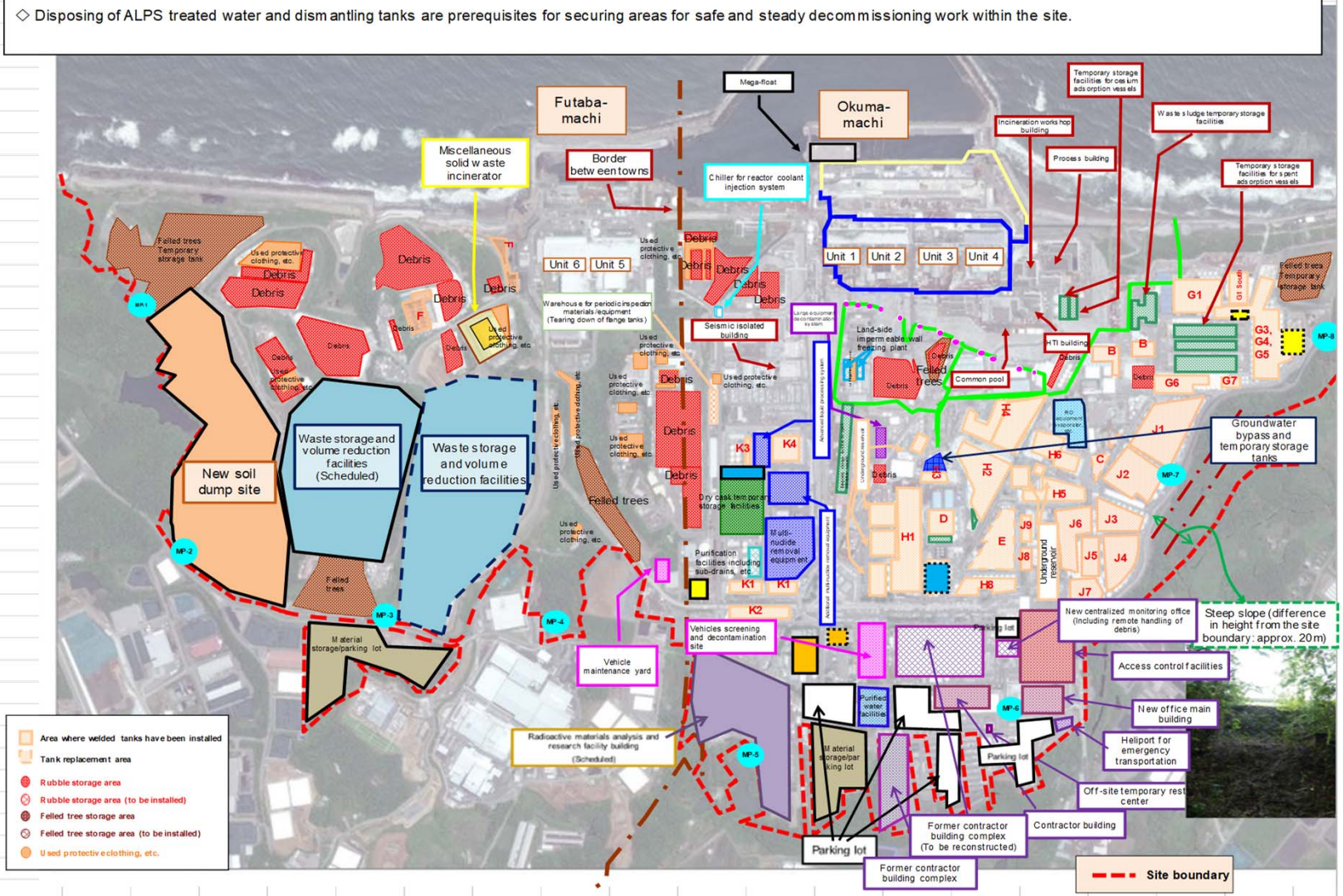
◇ The Fukushima Daiichi NPS site has only limited room for the installation of new tanks over the number planned at the moment.
◇ To carry out decommissioning work with higher risks than the work handling ALPS treated water, such as spent fuel removal and debris retrieval, the following facilities are needed.
- Facilities for storing spent fuel removed
- Maintenance facilities required for fuel debris retrieval
- Facilities required for storing waste to be generated
- Facilities for waste recycling
- Facilities for storing fuel debris retrieved
- Training facilities for fuel debris retrieval
- Analysis facilities for various samples
- Research facilities for fuel debris and radioactive waste
- Facilities necessary to ensure the safety of workers during work, etc.

◇ Disposing of ALPS treated water and dismantling tanks are prerequisites for securing areas for safe and steady decommissioning work within the site.



Note 1: This drawing indicates when construction is expected to start. The dismantling of tanks will take one or two years.
Note 1: Taking into account the work yards at the time of construction, a maximum of twice as much land will be temporarily required.
Note 1: The areas for facilities are assumptions at this time and may change as studies progress in the future or new knowledge is gained.

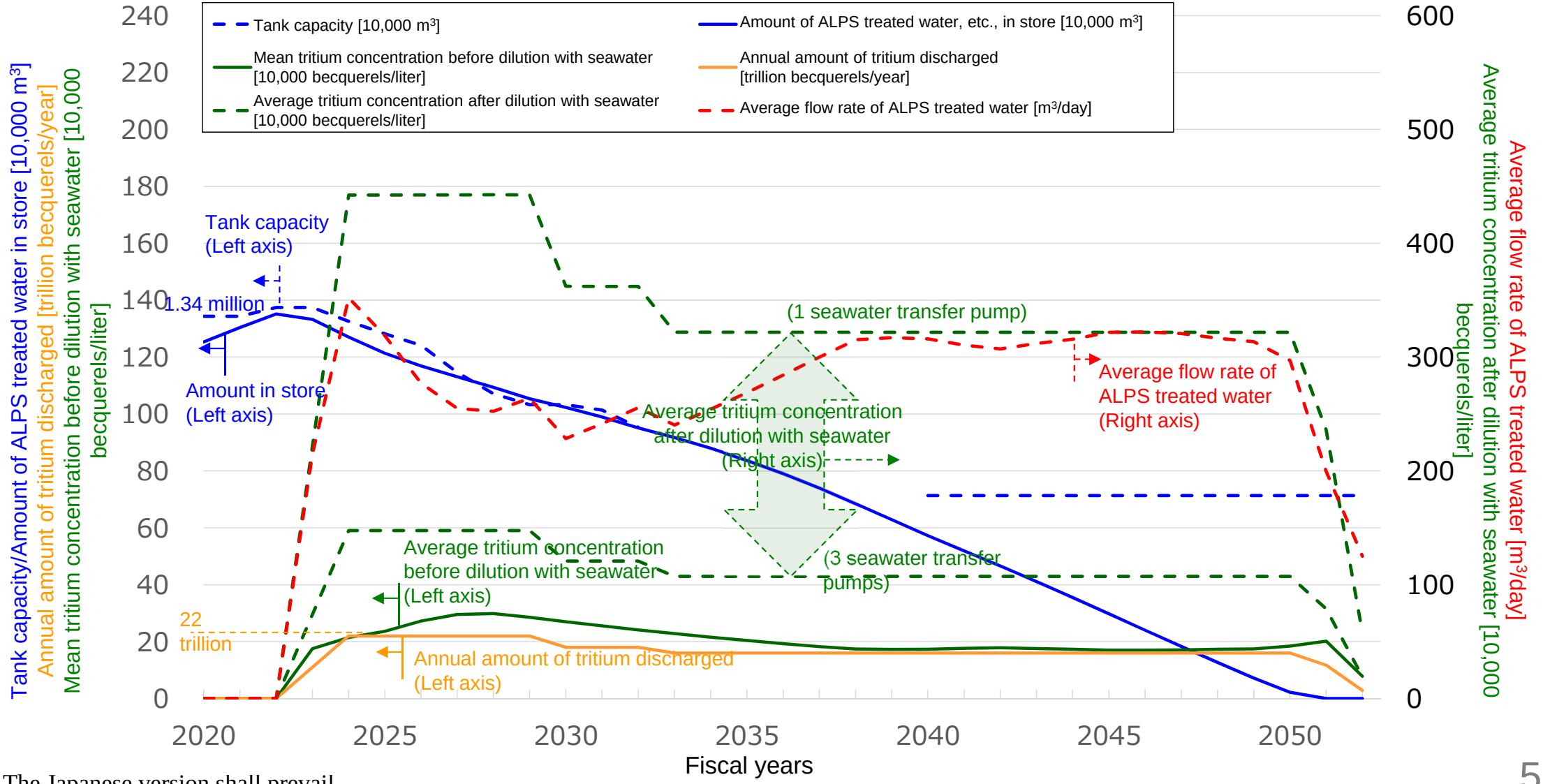
[Supplementary items]
○ This layout drawing is created based on the current usage of the site and the usage plan in the current phase.
○ As the decommissioning progresses, some facilities will be installed or decommissioned. Therefore, the plan will be reviewed as necessary.

The Japanese version shall prevail.

1.1 (1 Overall Policy) (1)

[Supplement] Discharge simulation (maximum total amount of tritium in buildings)

- FY 2023: 11 trillion becquerels/year (Start discharging a small amount of water with caution = half of the amount set for fiscal 2024 and subsequent years)
- FY 2024 to FY 2029: 22 trillion becquerels/year
- FY 2030 to FY 2032: 18 trillion becquerels/year
- FY 2033 and subsequent years: 16 trillion becquerels/year

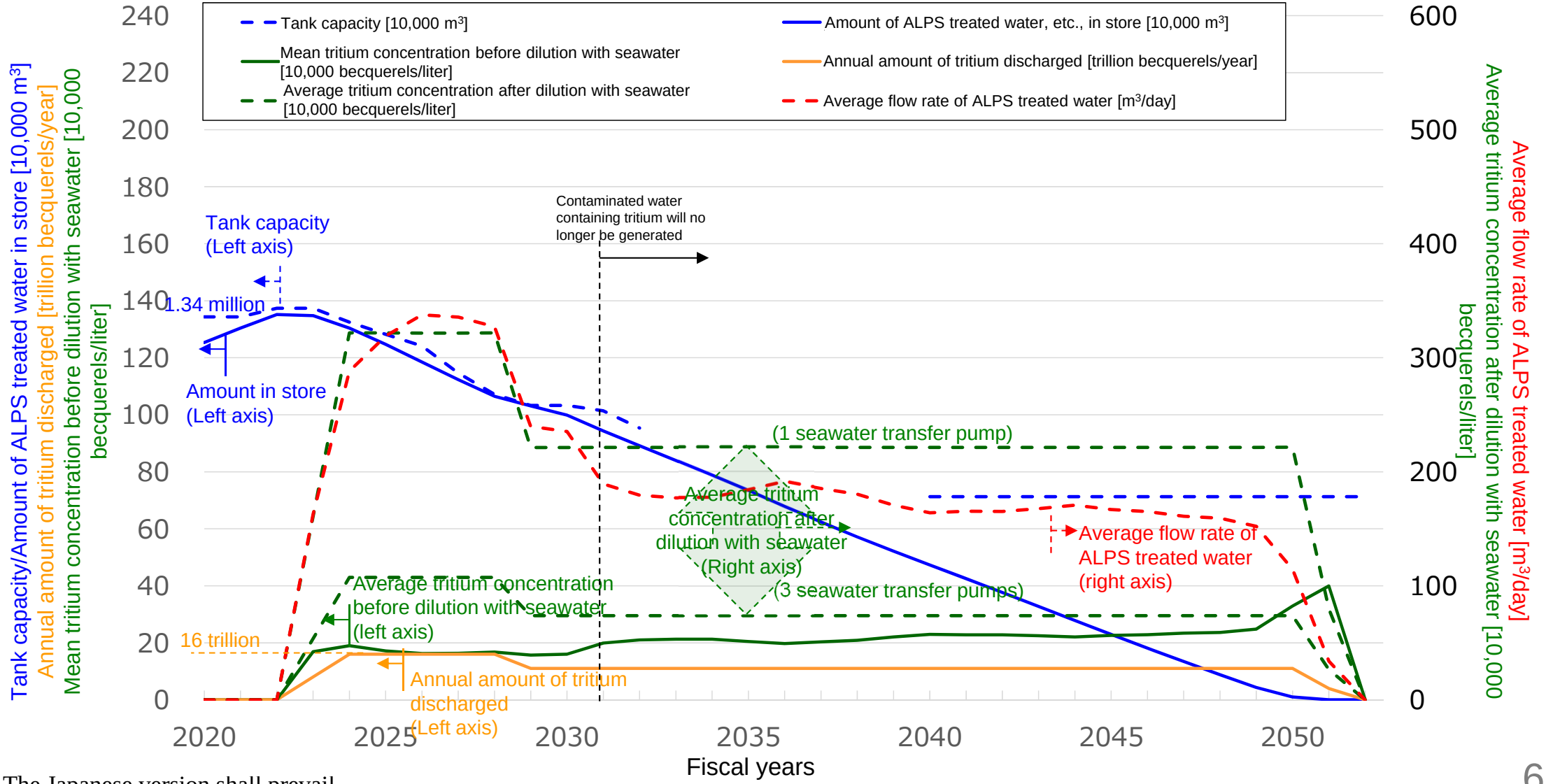


The Japanese version shall prevail.

1.1 (1 Overall Policy) (1)

[Supplement] Discharge simulation (minimum total amount of tritium in buildings)

- FY 2023: 8 trillion becquerels/year (Start discharging a small amount of water with caution = half of the amount set for fiscal 2024 and subsequent years)
- FY 2024 to FY 2028: 16 trillion becquerels/year
- FY 2029 and subsequent years: 11 trillion becquerels/year



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Basic design and operation concept

- In designing and operating the Discharge Facilities of ALPS Treated Water into the Sea, the following three items shall be ensured based on the basic policy announced by the government in April 2021: (1) the sum of ratios to regulatory concentration limit of radioactive materials other than tritium, contained in ALPS treated water to be discharged is less than 1, (2) the contaminated water to be discharged is diluted with seawater to the level that tritium concentration in it is less than 1,500 Bq/L, well below the legally required concentration of 60,000 Bq/L, and (3) the amount of tritium discharged is below 22 trillion Bq per year, the operational limit for the discharge set for the Fukushima Daiichi NPS before the accident. The annual amount of tritium discharged will be reviewed as appropriate in accordance with the progress of decommissioning.
- In order to prevent “unintended discharge of ALPS treated water into the sea” due to human error or equipment failure, interlocks and emergency isolation valves for preventing erroneous discharge will be provided. In addition, the facilities shall be designed and operated in a way that can minimize the discharge in the event of an “unintended discharge of ALPS treated water into the sea.”
- Appropriate measures will be taken against natural disasters such as earthquakes and tsunami as well, while taking into account the impact of such disasters, and measures taken on other facilities and equipment within the site of Fukushima Daiichi NPS.
- Assuming a failure of facilities and equipment, measures will be taken in advance in terms of design (duplication, etc.) and operation (preparation of backup equipment, etc.) so that the failed facilities and equipment can be restored immediately. Furthermore, the facilities and equipment shall be inspected and maintained periodically in accordance with their long-term maintenance management plan (to be developed).

1. Responses to major issues(*) concerning the content of the application for the Discharge Facilities of ALPS Treated Water into the Sea

*Document 1-2 for (The 3rd) Meeting for the Review on the Disposal of ALPS Treated Water

1.2 (2-1 Major issues to be reviewed based on the Nuclear Reactor Regulation Act)

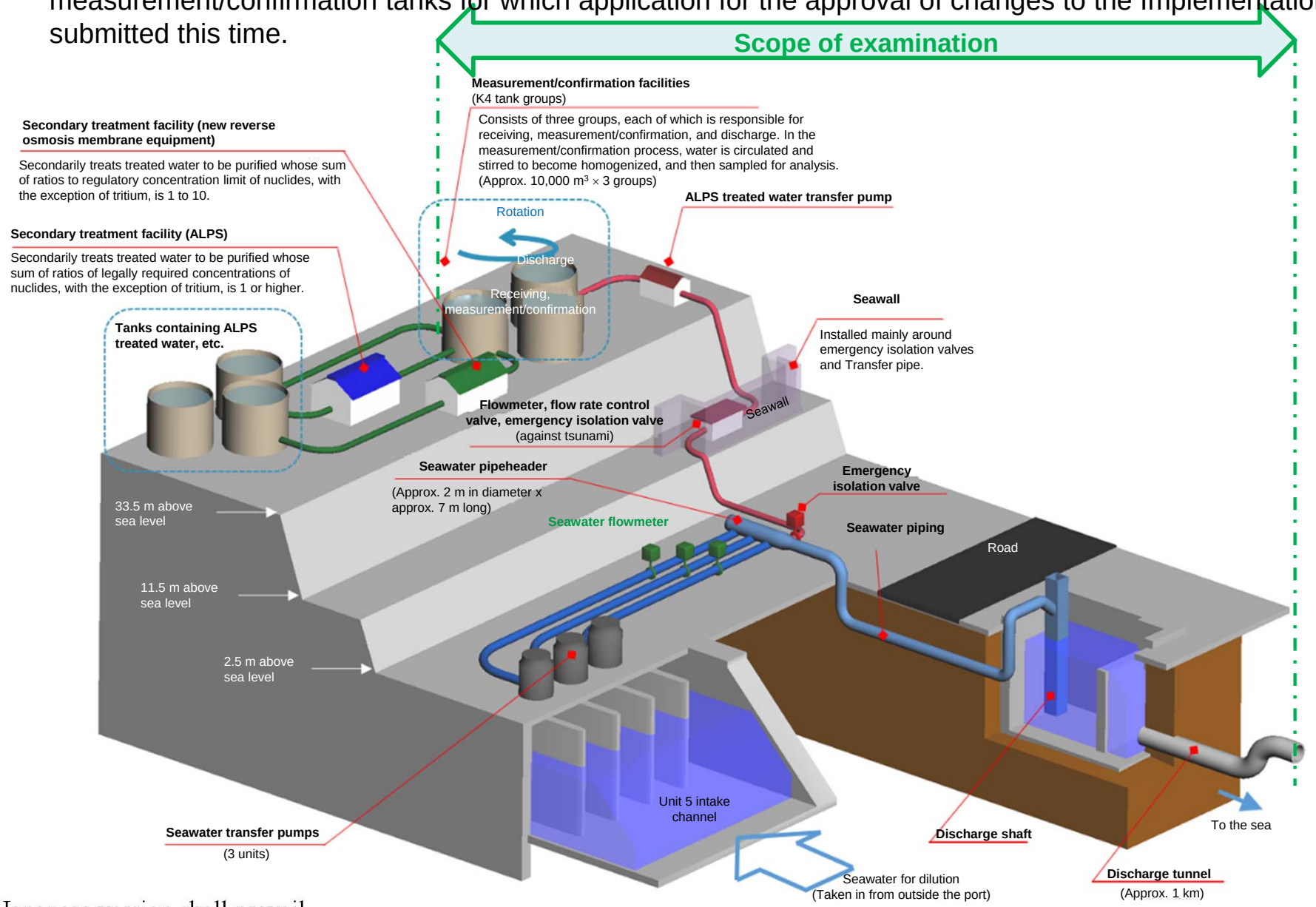
(1) ocean discharge facility

(6) Evaluating the validity of the facility design in the event of failure

- Explanations shall be given regarding facilities, systems, and procedures necessary to cope with postulated unintentional discharge of ALPS treated water into the sea due to trouble during discharge such as equipment failures (hereinafter referred to as “abnormal event”), and discharge amount after those measures are taken shall be evaluated.
- When performing the above mentioned evaluation, the most severe abnormal event shall be selected in terms of the amount of ALPS treated water discharged, and when analyzing, a single equipment failure that will lead to the most severe consequence shall be assumed.

1.2 (2-1 (1) (6) Evaluating the validity of the facility design in the event of failure)
(1) Scope of examination

- The scope of examination in this evaluation of the validity of the design of the ALPS Treated Water Dilution/Discharge Facilities and the Related Facility in the event of failure covers the area in the down-stream from the measurement/confirmation tanks for which application for the approval of changes to the Implementation Plan was submitted this time.



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1.2 (2-1 (1) (6) Evaluating the validity of the facility design in the event of failure)
(2) How to extract abnormal events (1/2)

[Extraction of abnormal events at the ALPS Treated Water Dilution/Discharge facilities]

- the ALPS Treated Water Dilution/Discharge facilities consist of a measurement/confirmation facility, a transfer facility, and a dilution facility.
- For these facilities, a fault tree analysis will be performed with the “unintended ocean discharge of ALPS treated water” defined as the top event to make sure that the risk of an unintended discharge is zero or extremely small even when single failure or single malfunction of any active component (including power source and driving systems, and instrumentation control systems) is assumed. By doing so, the validity of the design and operation shall be verified.
- The validity of design in the event of an external event will not be taken into account in the extraction of abnormal events because it will be verified in the Major Issue “2-1 (1) (5) Equipment structure and strength, and protection against natural disasters such as earthquakes and tsunami, etc.”

Facility		Representative component	Type of equipment	Water contained
ALPS Treated Water Dilution/Discharge facility	Measurement/ confirmation facility	Circulating pump	Active component	ALPS treated water
		Agitation equipment		
		Measurement/confirmation tank	Passive component	
		Circulating pipe		
	Transfer facility	Transfer pump	Active component	
		Emergency isolation valve*1		
		Transfer pipe	Passive component	
	Dilution facility	Seawater transfer pumps	Active component	Seawater
		Seawater pipe(before merging)	Passive component	
		Seawater pipe(after merging)		ALPS treated water diluted with seawater
		Discharge guide		
		Discharge shaft (upper-stream water tank)		

Abnormal events related to these facilities*2 will be extracted.

*2: The following abnormal events are expected to be extracted.
- Erroneous shutdown of seawater pumps
- Erroneous startup of transfer pumps
- Inoperative emergency isolation valves, etc.

close) as well as after the transfer is completed.

The Japanese version shall prevail.

1.2 (2-1 (1) (6) Evaluating the validity of the facility design in the event of failure)
(2) How to extract abnormal events (2/2)

[Extraction of abnormal events related to the discharge facility]

- Main components of the discharge facility consist of a discharge vertical shaft (down-stream storage), a water discharge tunnel, and a discharge outlet.
- Extraction approach for detection of abnormal events at the discharge facility will not be conducted due to the following reasons: Because the water contained in them is ALPS treated water diluted with seawater; the water runs through the bedrock layer, so little risk for leakage; and the facility has an seismic resistance structure.
- In the further review meetings, TEPCO will explain the fact that the discharge facility has a design that can withstand long-term use, including structural strength and seismic resistance.

Facility	Major facility	Type of equipment	Water contained
Discharge facility	Discharge vertical shaft (down-stream storage)	Passive component	ALPS treated water diluted with seawater
	Discharge tunnel		
	Outlet		

The following slides are for reference.

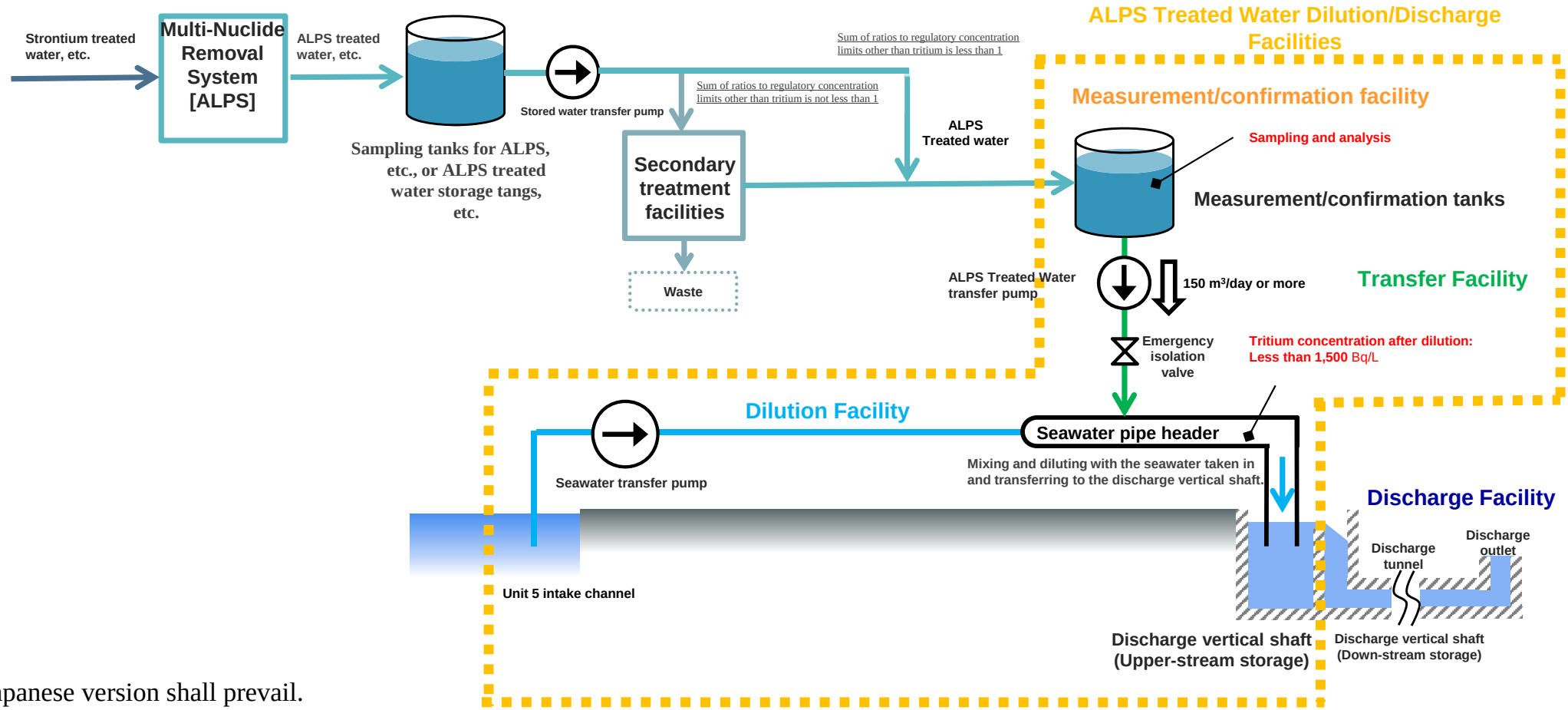
[Reference] Overview of the ALPS Treated Water Dilution/Discharge Facilities

Objective

The facilities ensure that the water treated by Multi-Nuclide Removal System (ALPS) until the radionuclide concentration becomes sufficiently low is the ALPS Treated Water (that is the water in which sum of the ratios to regulatory concentration limits other than tritium is less than 1), and dilute the treated water with seawater, then discharge it into the sea.

Facilities Overview

The Measurement/Confirmation Facility homogenizes the concentration of radionuclides all tanks of the tank group in the status of measurement/ confirmation, and then collects and analyzes samples to ensure that the water is ALPS treated water. Thereafter, the Transfer Facility sends the ALPS Treated Water to the seawater pipe header, and then the Dilution Facility dilutes the water with seawater taken in by the seawater transfer pump at the unit 5 intake channel until tritium concentration in it becomes less than 1,500 Bq/L, and discharge the water to the Discharge Facility.



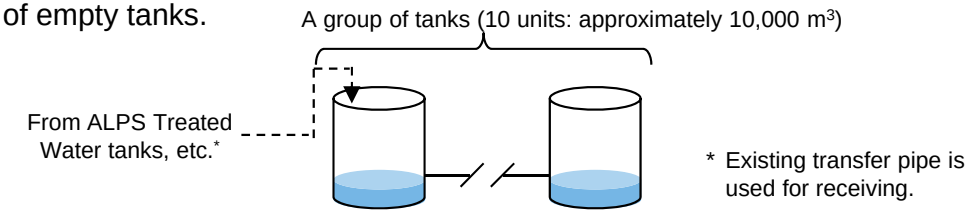
The Japanese version shall prevail.

[Reference] Overview of the ALPS Treated Water Dilution/Discharge Facilities (Measurement/confirmation facility)

- Measurement/confirmation facility
  - K4 area tanks (approx. 30 000 m^3 in total) are reused for the measurement/confirmation tanks, and each group from A to C consists of 10 tanks (approximately 1,000 m^3 per unit).
  - Each tank group takes the following steps (1) to (3) in rotation, and in the (2) measurement/confirmation process, water is circulated and stirred to become homogenized, and then sampled for analysis.

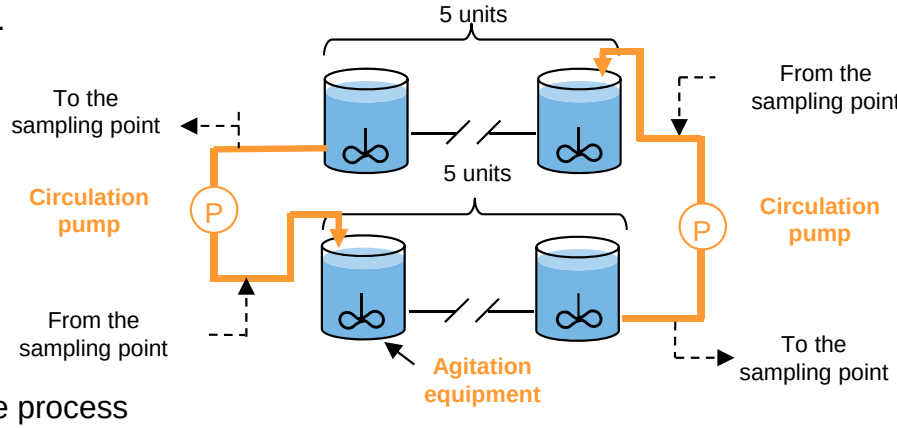
(1) Receiving process

ALPS Treated Water from ALPS Treated Water storage tanks, etc., is transferred into a group of empty tanks.



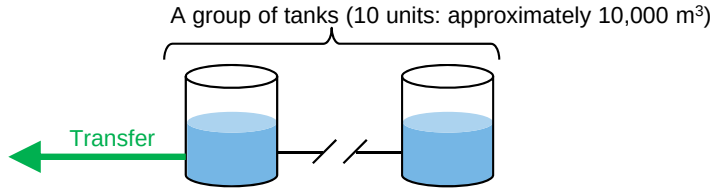
(2) Measurement/confirmation process

After the quality of water in the tank group is homogenized by the agitation equipment and circulation pumps, the water is sampled to check if it meets the discharge standard.

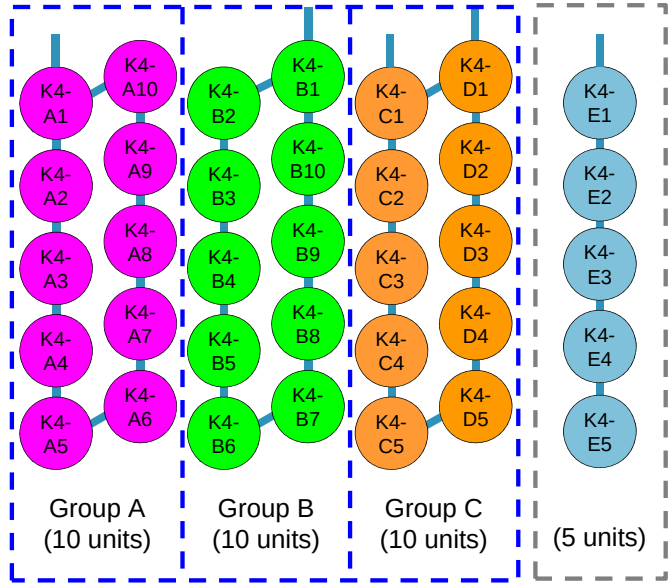


(3) Discharge process

After confirming that the ALPS Treated Water satisfies the discharge standard, the water is transferred to the Dilution Facility by the Transfer Facility.



K4 area tank groups: (35 units)



Chapter 2.50 ALPS Treated Water Dilution/Discharge Facilities

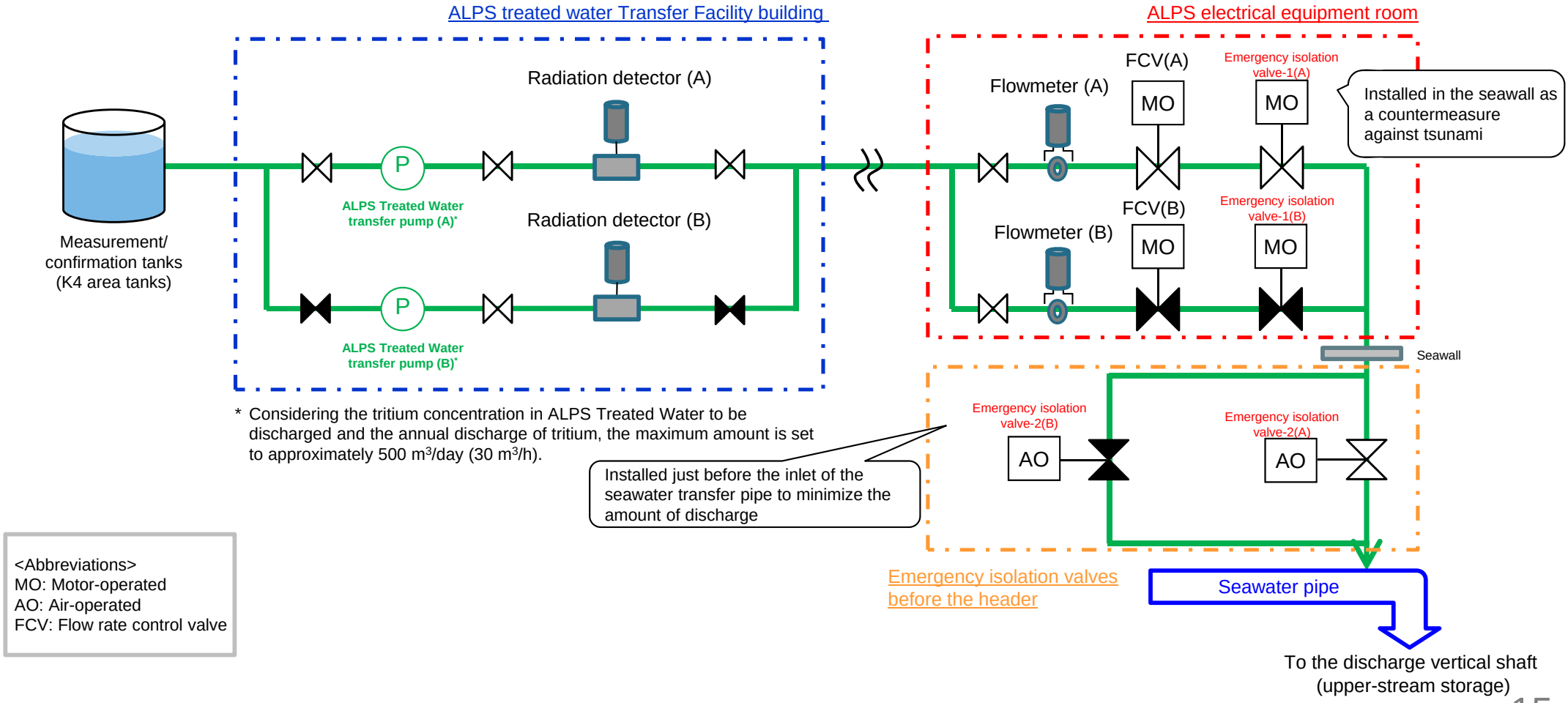
Chapter 2.5 ALPS Treated Water tanks

	Group A	Group B	Group C
1st cycle	Receiving	-	-
2nd cycle	Measurement/ confirmation	Receiving	-
3rd cycle	Discharge	Measurement/ confirmation	Receiving
4th cycle	Receiving	Discharge	Measurement/ confirmation
...	Measurement/ confirmation	Receiving	Discharge

The Japanese version shall prevail.

[Reference] Overview of the ALPS Treated Water Dilution/Discharge Facilities (Transfer facility)

- Transfer Facility
  - The Transfer Facility consists of ALPS Treated Water transfer pumps and transfer pipes.
  - Two ALPS Treated Water transfer pumps are prepared, a unit in operation and the other backup unit, to transfer ALPS Treated Water from measurement/confirmation tanks to the Dilution Facility.
  - Emergency isolation valves are provided both before the seawater piping header and in the seawall as a countermeasure against tsunami so that the transfer can be stopped immediately when an abnormality occurs.



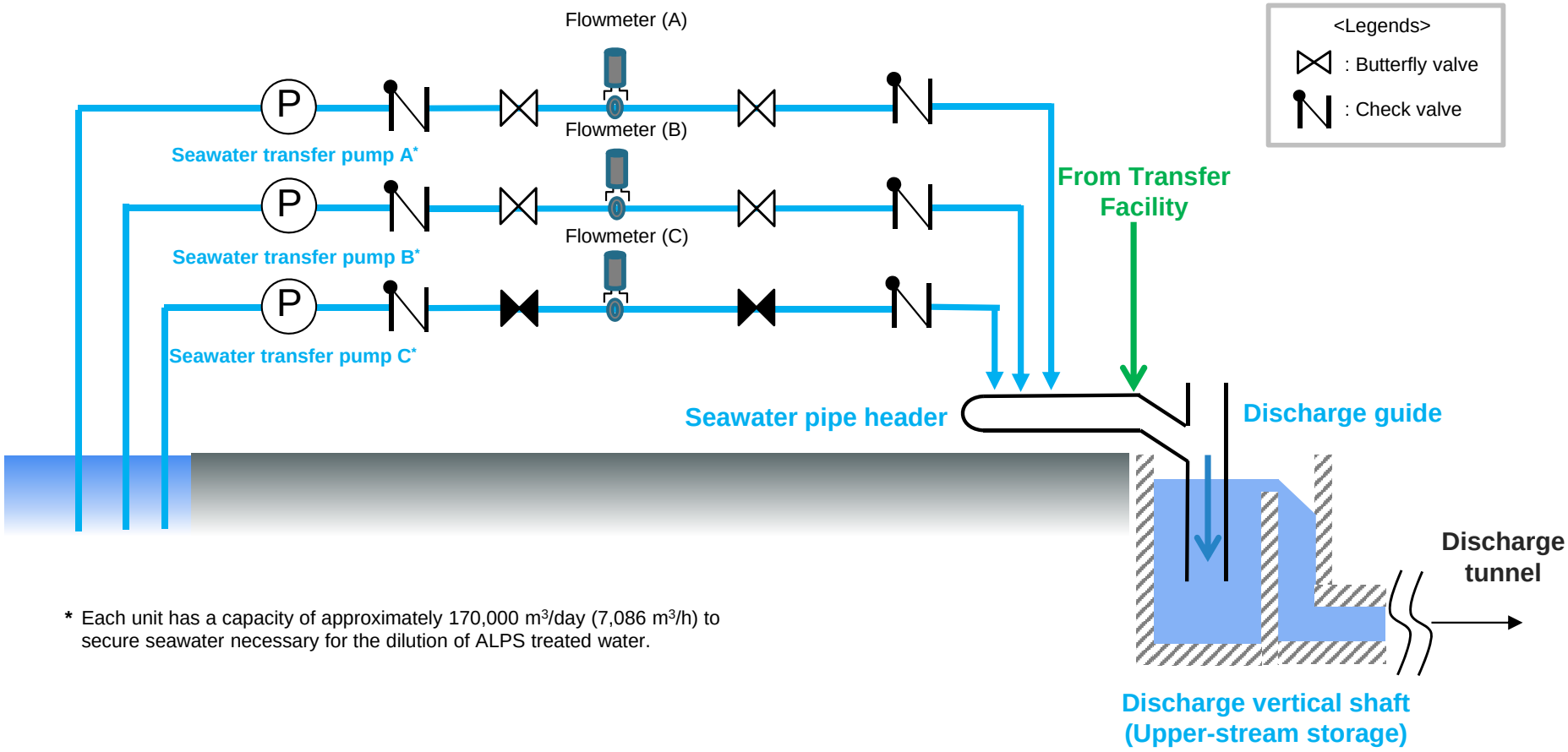
* Considering the tritium concentration in ALPS Treated Water to be discharged and the annual discharge of tritium, the maximum amount is set to approximately 500 m^3/day (30 m^3/h).

<Abbreviations>
MO: Motor-operated
AO: Air-operated
FCV: Flow rate control valve

The Japanese version shall prevail.

[Reference] Overview of the ALPS Treated Water Dilution/Discharge Facilities (Dilution Facility)

- Dilution Facility
  - Consisting of seawater transfer pumps, seawater pipe (including a header pipes), a discharge guide, and a discharge vertical shaft (upper-stream storage), the Dilution Facility diluted ALPS Treated Water with seawater, transfers it to the discharge vertical shaft (upper-stream storage), and discharge it to the Discharge Facility.
  - The seawater transfer pumps have a capacity that can dilute ALPS Treated Water transferred by the Transfer Facility 100 times or more.



* Each unit has a capacity of approximately 170,000 m³/day (7,086 m³/h) to secure seawater necessary for the dilution of ALPS treated water.

The Japanese version shall prevail.

[Reference] Overview of the related facility (Discharge Facility)

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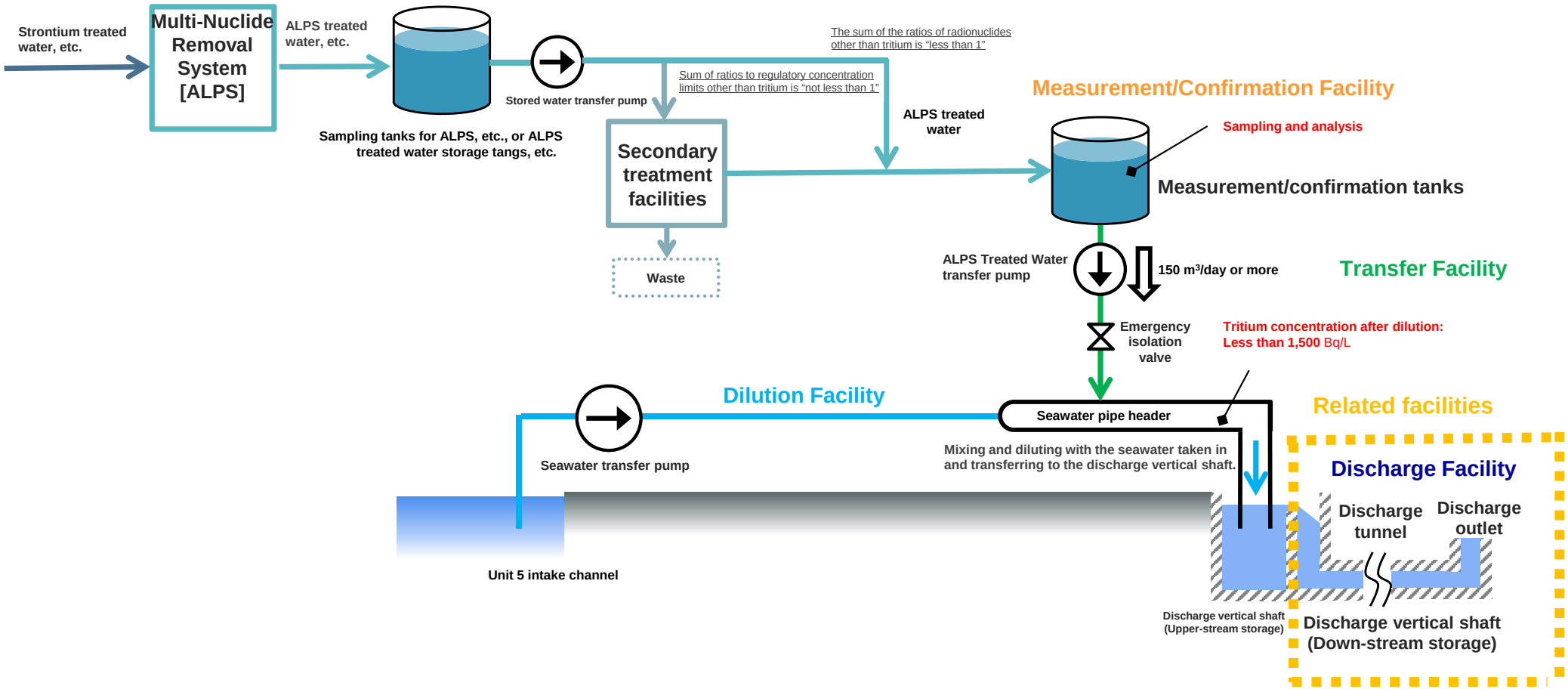
- Objective

  Drainage water is discharged from the ALPS Treated Water Dilution/Discharge Facilities (water diluted with seawater so that the sum of which ratios to regulatory concentration limit including all nuclides together with tritium is less than 1) into the sea from a location approximately 1 km away from the coast.

- Outline of the facilities

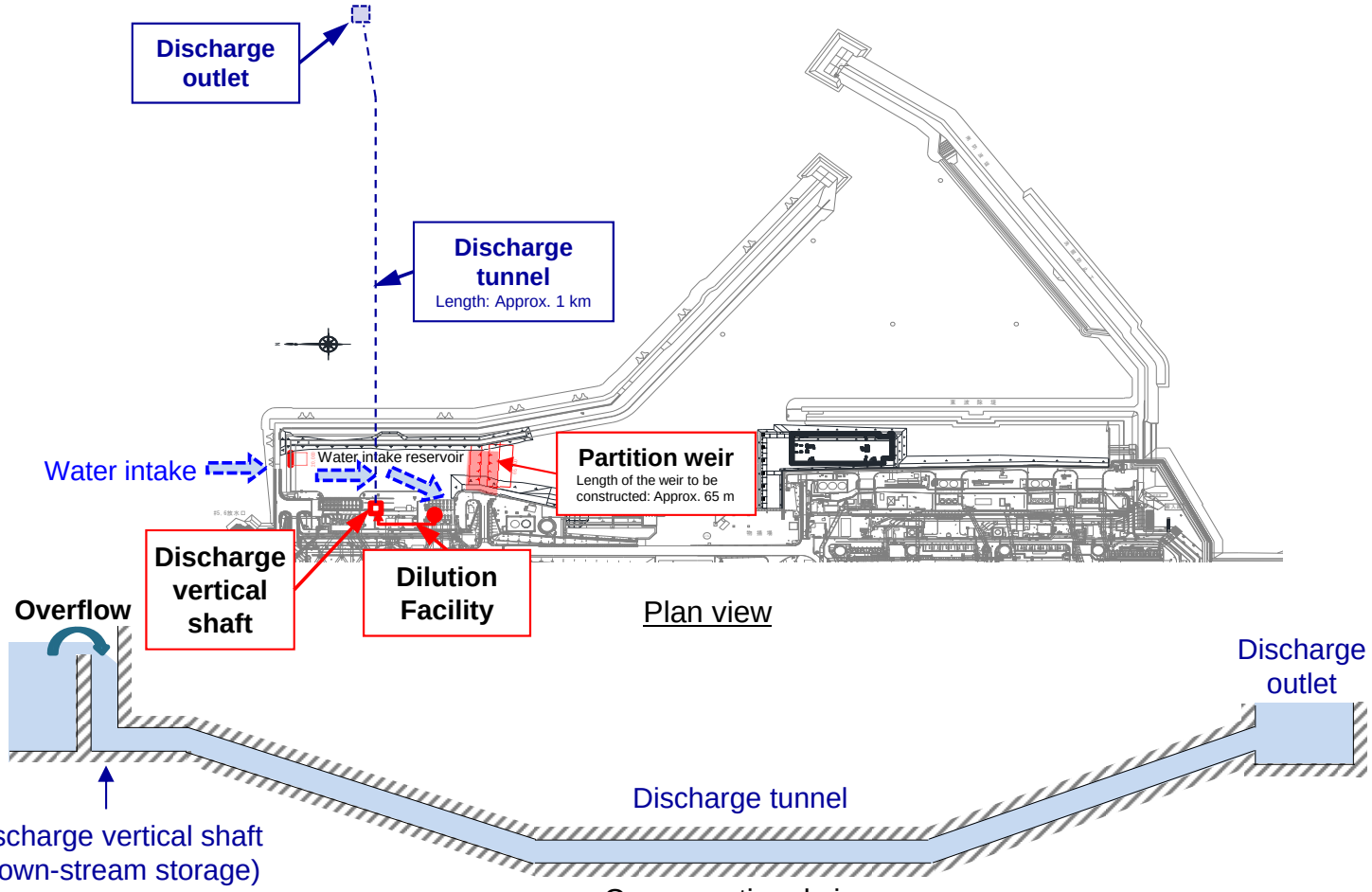
  The Discharge Facility consist of a discharge vertical shaft (down-stream storage), a discharge tunnel, and a discharge outlet to achieve the above objective.



The Japanese version shall prevail.

[Reference] Overview of the related facility (Discharge Facility) (1/2)

- Discharge Facility
  - Discharge Facility has a design so that they can transfer water flowing out over the partition wall in the discharge vertical shaft to the outlet, which is approximately 1 km away from the shore, by using the water head difference between water in the discharge vertical shaft (down-stream storage) and the sea surface. In addition, the design concept includes friction losses in the Discharge Facility and elevation of water surface.



[Reference] Overview of related facilities (Discharge Facility) (2/2)

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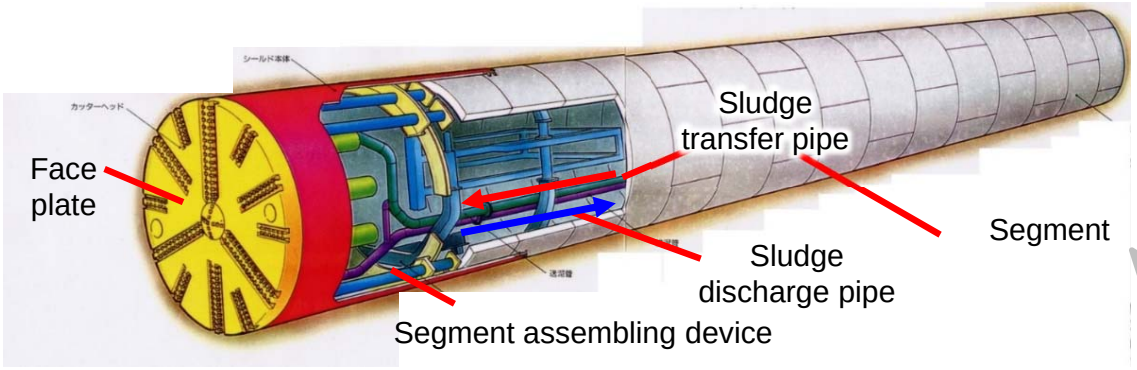
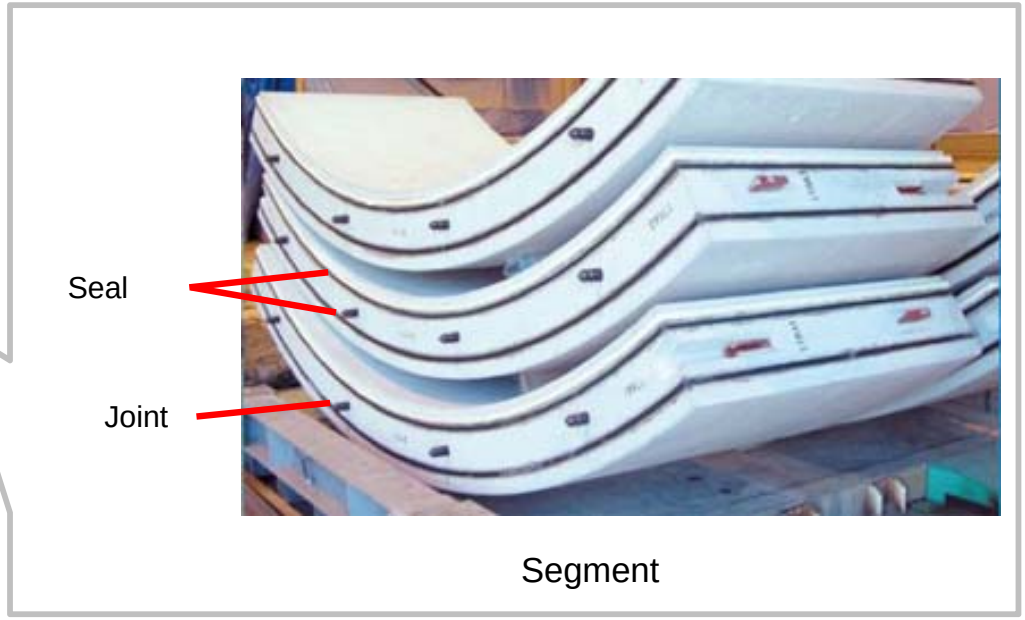
- Overview of the structural design
  - Water flows through the bedrock layer to minimize the leakage risk and to ensure a highly earthquake-resistant structure.
  - A shield method is adopted and double-layer seals are installed in the reinforced concrete segment to ensure water cut-off performance.
  - The tunnel body (segment) is designed considering the impacts of typhoons (high waves) and storm surges (sea level rise).

- Construction of tunnel (shield method)
  - As there are many discharge tunnels constructed by the shield method, this secure construction will minimize the possibility of trouble.



*Slurry shield method was adopted this time.

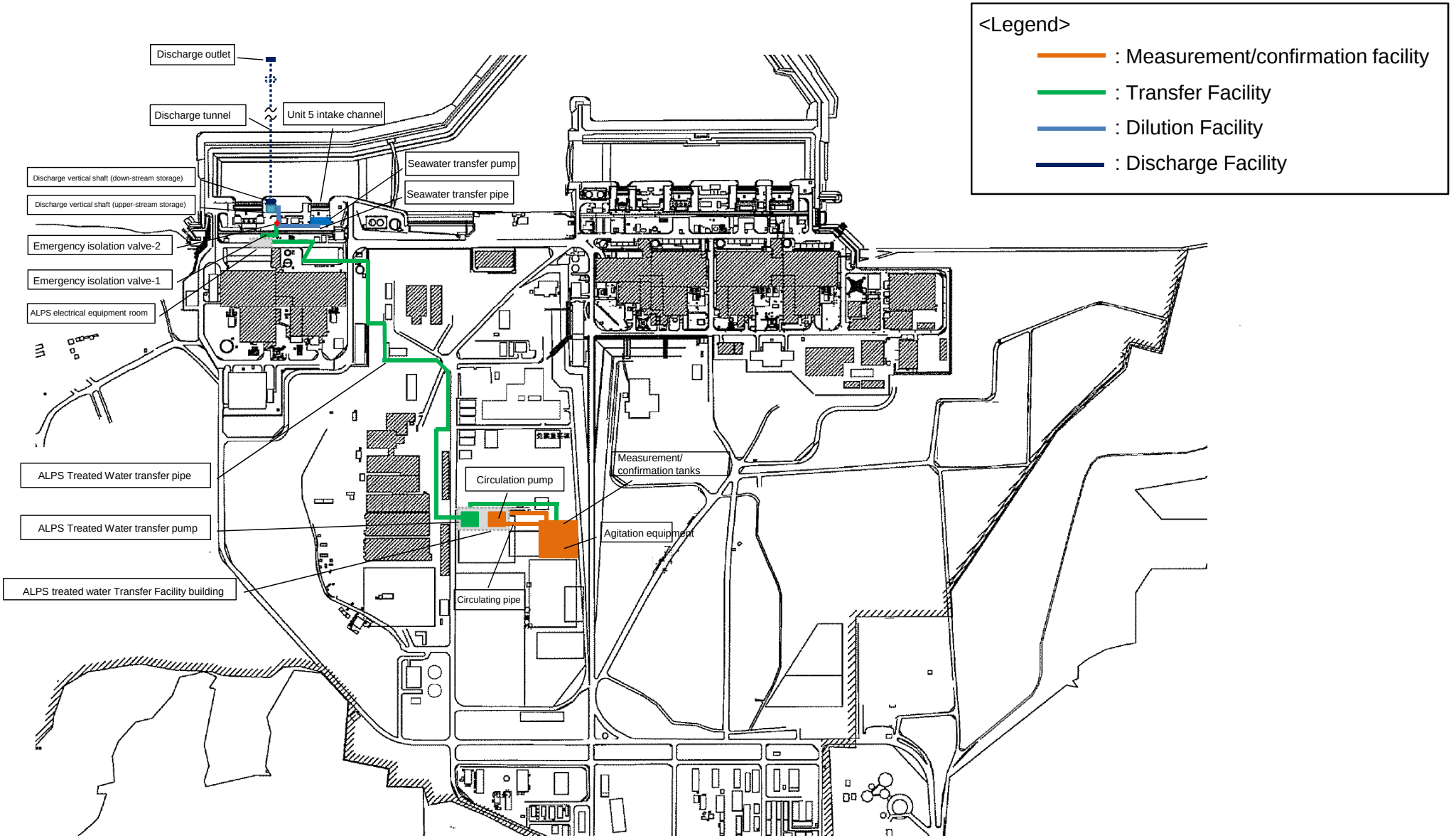
Schematic diagram of a shield machine



Segment

[Reference] Layout plan of ALPS Treated Water Dilution/Discharge Facilities and the related facility

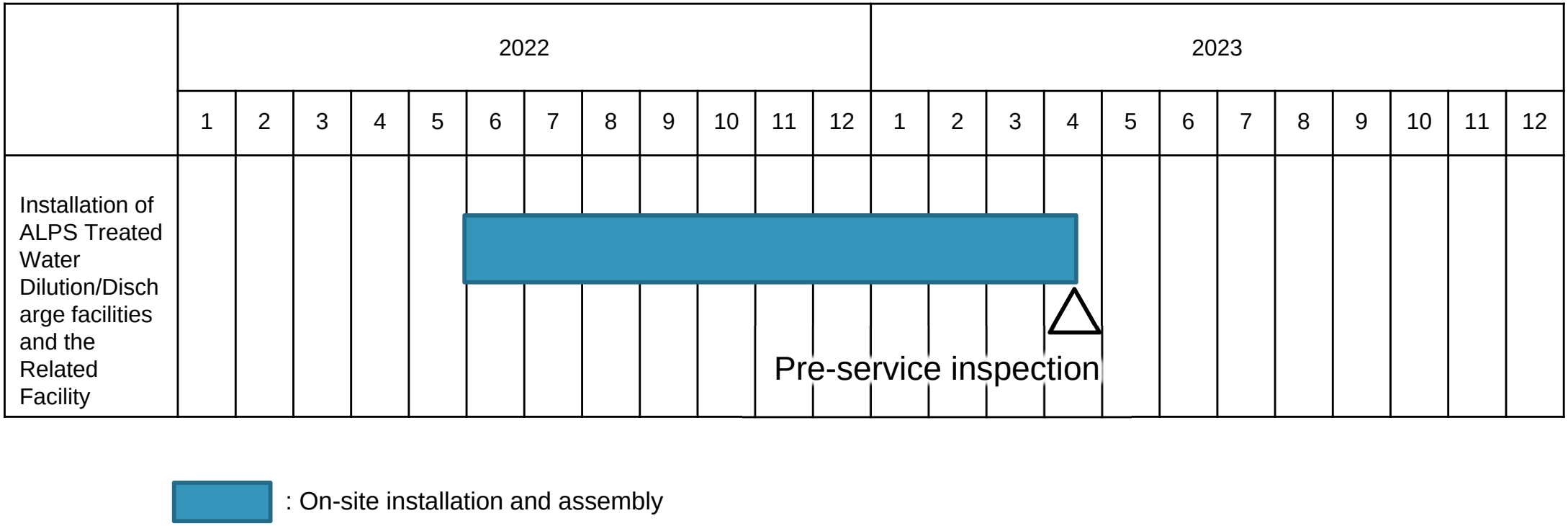
- The layout of ALPS Treated Water Dilution/Discharge Facilities and related facilities is as follows. (Implementation Plan: II-2-50-Attachment 1-2)



The Japanese version shall prevail.

[Reference] Installation schedule for ALPS Treated Water Dilution/Discharge facility and the related facility

- Once the approval is granted after review by the Nuclear Regulatory Authority, the on-site installation and assembly of the facilities will commence, with completion scheduled for around mid-April 2023. (Implementation Plan: II-2-50-Attachment 6-1)



[Reference] Facility overview for ensuring safety

Secondary treatment facility (new reverse osmosis membrane equipment)

Secondarily treats treated water to be purified in which the sum of ratios to regulatory concentration limits other than tritium is “1 to 10”.

Secondary treatment facility (ALPS)

Secondarily treats treated water to be purified in which the sum of ratios to regulatory concentration limits other than tritium is “not less than 1”.

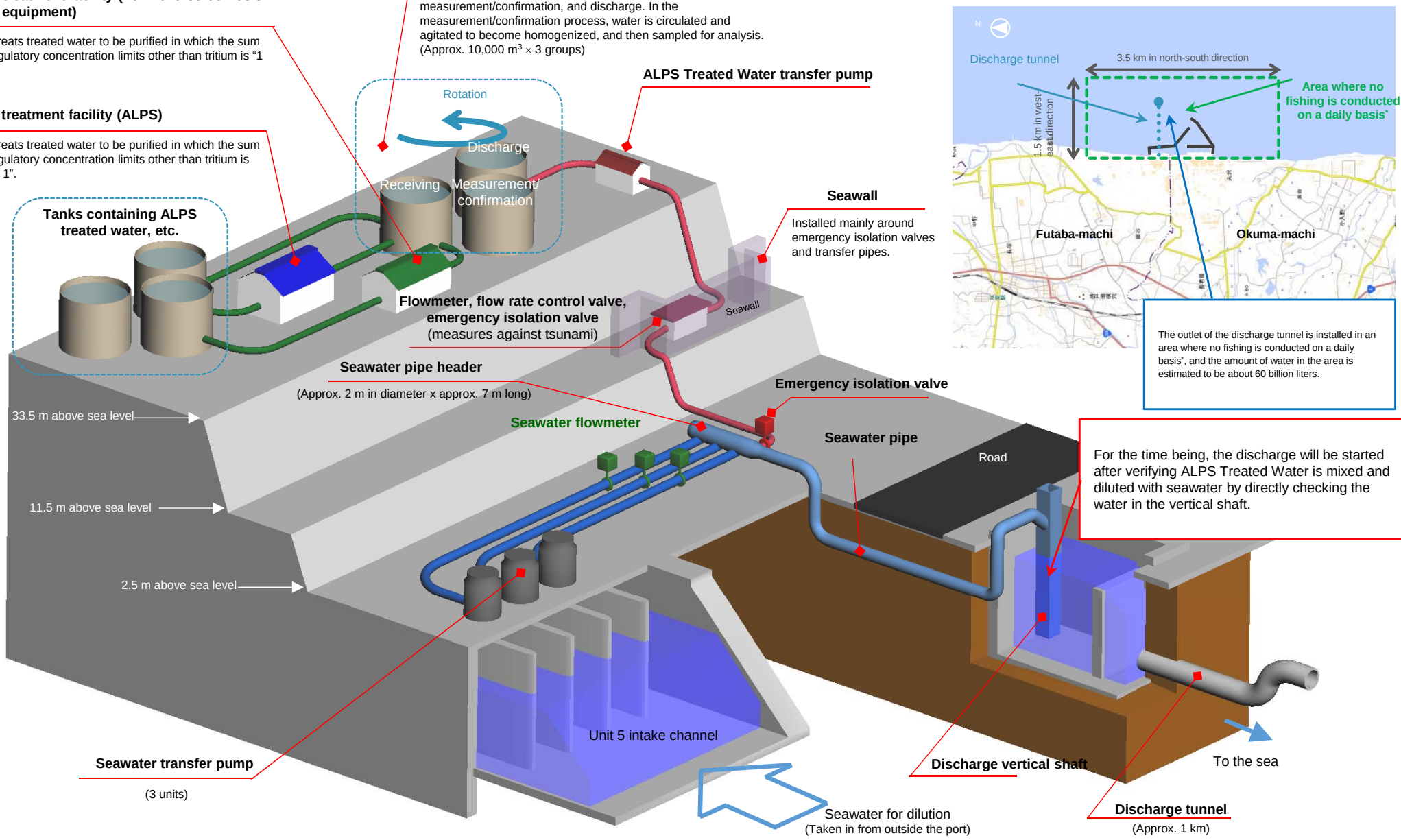
Measurement/confirmation facility (K4 tank groups)

Consists of 3 groups, each of which is responsible for receiving, measurement/confirmation, and discharge. In the measurement/confirmation process, water is circulated and agitated to become homogenized, and then sampled for analysis. (Approx. 10,000 m^3 × 3 groups)

ALPS Treated Water transfer pump

Seawall

Installed mainly around emergency isolation valves and transfer pipes.



Source: This map was created by Tokyo Electric Power Company Holdings, Inc. based on a map published by the Geographical Survey Institute (Electronic Map Web)
https://maps.gsi.go.jp/#13/37.422730/141.044970/&base=std&ls=std&disp=1&vs=c1j0h0k0l0u0t0z0r0s0m0f1

The outlet of the discharge tunnel is installed in an area where no fishing is conducted on a daily basis*, and the amount of water in the area is estimated to be about 60 billion liters.

For the time being, the discharge will be started after verifying ALPS Treated Water is mixed and diluted with seawater by directly checking the water in the vertical shaft.

*Area where common fishery rights are not set.

The Japanese version shall prevail.