Document 1-1, the 10th 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

February 25, 2022

TEPCO

Tokyo Electric Power Company Holdings, Inc.

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

*Document 1-2 for (The 3rd) Review Meeting on the Implementation Plan Regarding the Handling of ALPS Treated Water

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

(1) Discharge facility of ALPS Treated Water into the Sea

[2] Homogenization of radioactive concentration in ALPS treated water in the tanks before discharging into the sea

- Explanations must be provided regarding the method for homogenizing the radioactive concentration in ALPS treated water in the K4 area tanks before discharging into the sea and the validity of the method.

2-1 (1) [2] Homogenization of radioactive concentration in ALPS treated water in tanks before discharging into the sea

1. Homogenization of radioactive concentration in ALPS treated water in tanks

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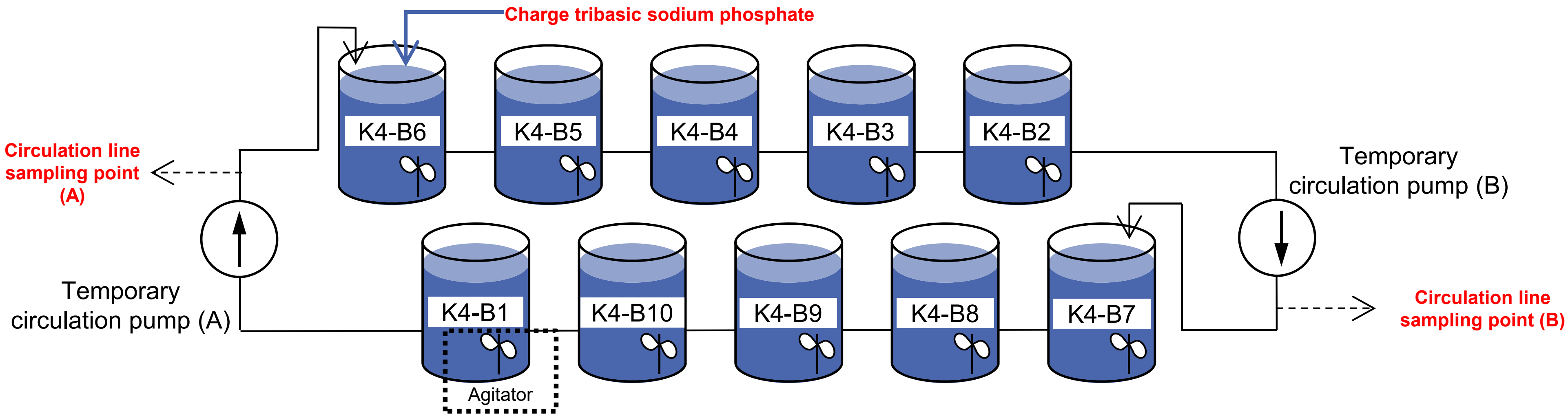
- The discharge operation at the ALPS Treated Water Dilution / Discharge Facilities performs 10 tank units per discharge cycle. Sampling will be conducted before the discharge to ensure that the ALPS Treated Water in the tanks satisfies the discharge standards.
- In accordance with the “Guidelines for the Measurement of Radioactive Materials to be Released from Light Water Nuclear Reactor Facilities”, to homogenize the radioactive concentration in the water, agitation equipment installed in each tanks stir the water together with circulation pumps circulate the water across the tanks in a tank group for sampling of represent water.
- Agitation demonstration test, performed in November 2021, revealed the homogenization effect of agitation in a single tank. Then, circulation and agitation test is scheduled in February 2022 (see the figure below) with 10 connected tanks to confirm the homogenization effect of the facility configuration of this system of 10 interconnected tanks.



Agitation demonstration test: Performed in November 2021
<u>Circulation and agitation demonstration test: Performed in February 2022</u>

2-1 (1) [2] Homogenization of radioactive concentration in ALPS treated water in tanks before discharging into the sea
2. Plan for the circulation and agitation demonstration test

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- In the circulation and agitation demonstration test, the effect of homogenizing phosphate and tritium concentrations will be confirmed according to the plan shown in the table below.

Date of testing	February 7, 2022 - February 13, 2022		
Testing time	Approx. 144 hours		
Tanks subject to the test	K4-Group B (10 units)		
Reagent*1	Tribasic sodium phosphate*2 (Charged through the manhole on the top plate of K4-B6 tank)		
Sampling	Before the test	During the test*3	After the test
Sampling point	Tanks from K4-B1 to B10 Middle (5 m)	2 points in the circulation line	Tanks from K4-B1 to B10 Upper (10 m)/Middle (5 m)/Lower (1 m)
Sampling volume	10 units of 1-liter samples	28 units of 1-liter samples*5	30 units of 6-liter samples
Subjects to be analyzed	Phosphate*4	Phosphate*5	Phosphate + 7 major nuclides*6 + tritium

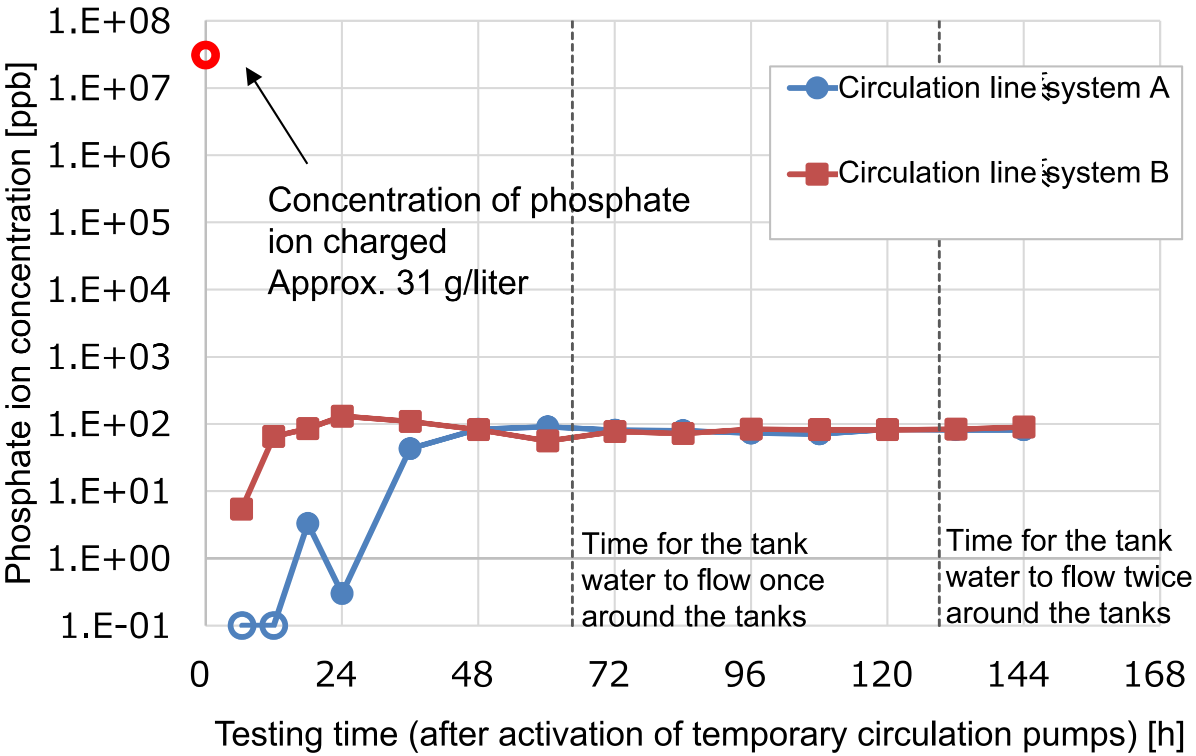
*1: A reagent that does not exist in the tanks is charged to monitor the concentration distribution in the tanks.
*2: The volume of tribasic sodium phosphate to be charged is set to about one-hundredth of the drainage standard prescribed by the Fukushima prefectural ordinance (phosphorus content: “8 ppm/day on average”), having no environmental impact.
*3: Sampling is performed every six hours for 24 hours starting from the beginning of the testing, and then every 12 hours during the period from 24 to 144 hours after the start.
*4: Before the test, the concentrations of the major 7 nuclides (Cs-134, Cs-137, Sr-90, I-129, Ru-106, Co-60, Sb-125) and tritium are not analyzed because they have already been measured.
*5: Samples of 6 litters are collected only 6, 72, and 144 hours after the start, and the major 7 nuclides and tritium are also analyzed in addition to phosphate.
*6: Major 7 nuclides (Cs-134, Cs-137, Sr-90, I-129, Ru-106, Co-60, Sb-125)

3. Results of the circulation and agitation demonstration test (phosphate ion concentration in samples)

- In the circulation and agitation demonstration test, the concentration of phosphate ion in the tribasic sodium phosphate solution charged in the K4-B6 tanks (approximately 23.7 liters) is about 31 g/liter, and the theoretical value of phosphate ion concentration after dilution in the K4-Group B tanks (approx. 9168.7 m^3) is about 80 ppb.
- The results of the phosphate ion concentration in the samples after the temporary circulation pumps are activated are shown below.
  - After approximately 65 hours have passed since the start of the test (the time for the tank water to flow once around the tanks*1), the mean concentration is 80 ppb.

    (The mean value of the data obtained from 72 hours after the start of the test onward. Standard deviation is 5 ppb)
  - After approximately 130 hours have passed since the start of the test (the time for the tank water to flow twice around the tanks*1), the mean concentration is 84.5 ppb.

*1: Estimated based on the minimum flow rate of the temporary circulation pumps measured during the test, 142 m^3/h, and the tank water volume of 9168.7 m^3.



Testing time [h]	Phosphate ion Concentration (System A)	Phosphate ion Concentration (Line B)
6.4	0.1	5.4
12	0.1	65
18	3.3	85
24	0.3	131
36	43	109
48	84	82
60	91	56
72	81	77
84	80	72
96	73	84
108	71	82
120	83	82
132	82	84
144	82	90

1st round (6.4–60 h)

2nd round (72–144 h)

*: Unit (ppb)

The Japanese version shall prevail.

4. Results of the circulation and agitation demonstration test (phosphate ion concentration in tanks after the test)

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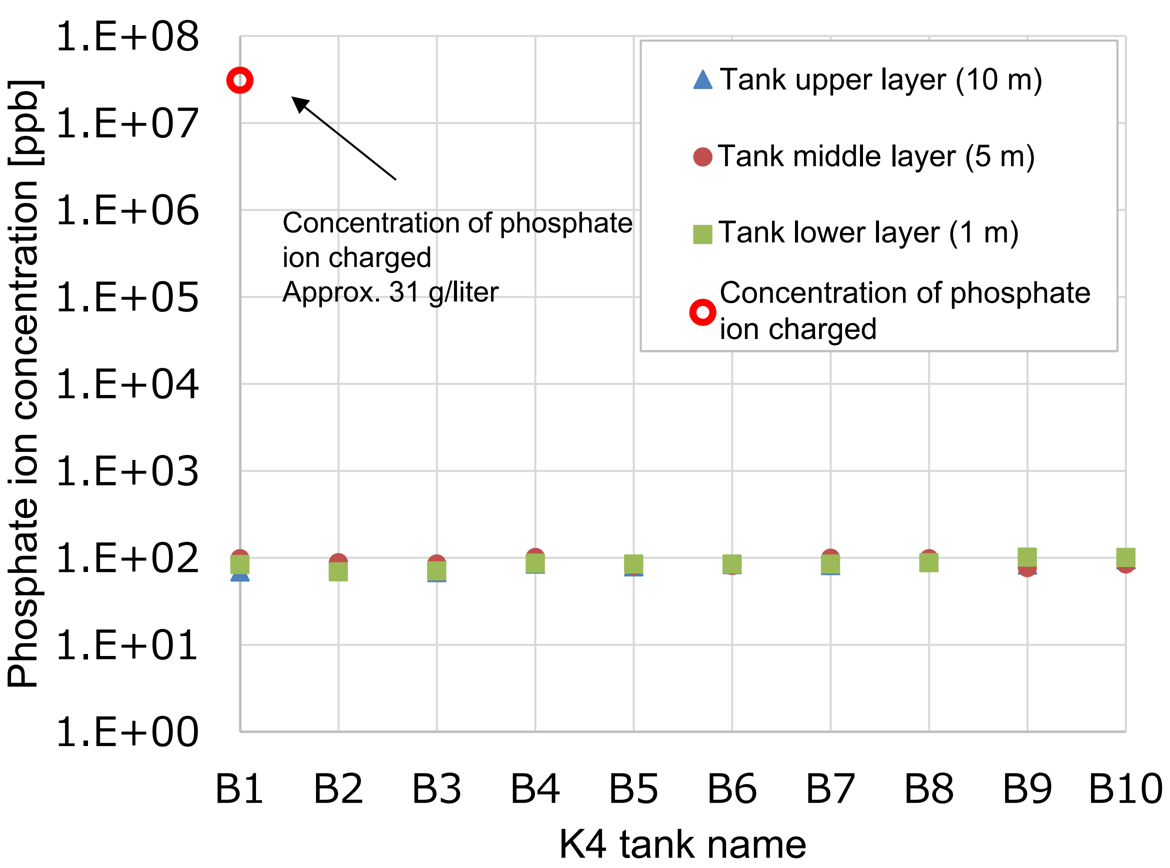
- At the point when 144 hours have passed after the start-up of the temporary circulation pumps, the phosphate ion concentration in the samples collected from the upper (10 m), middle (5 m), and lower (1 m) layers of each 10 tanks varies slightly. Still, the mean phosphate ion concentration in each tank is 86 ppb, close to the theoretical value of 80 ppb. The result shows that phosphate was distributed throughout the tanks.



Tank name	Tank upper layer (10m)	Tank middle layer (5m)	Tank lower layer (1m)	Mean value
K4-B1	69.0	98.0	84.0	83.7
K4-B2	82.0	88.0	69.0	79.7
K4-B3	68.0	85.0	71.0	74.7
K4-B4	85.0	101.0	87.0	91.0
K4-B5	79.0	82.0	85.0	82.0
K4-B6	84.0	82.0	85.0	83.7
K4-B7	82.0	99.0	85.0	88.7
K4-B8	89.0	98.0	88.0	91.7
K4-B9	83.0	77.0	102.0	87.3
K4-B10	95.0	85.0	101.0	93.7

Overall mean: 86 ppb
Standard deviation: 9 ppb
Relative standard deviation: 10.5%

*: Unit (ppb)

2-1 (1) [2] Homogenization of radioactive concentration in ALPS treated water in tanks before discharging into the sea
5. Results of the circulation and agitation demonstration test (tritium concentration in tanks after the test)

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- When a sampling test was performed for 10 tanks in the past, the mean tritium concentration was 1.61 × 10^5 Bq/L with a standard deviation of 0.13 × 10^5 Bq/L. Compared to that, after the circulation and agitation demonstration test (144 hrs.), the mean concentration was 1.51×10^5 Bq/L with a standard deviation of 0.029 × 10^5 Bq/L, which has verified that the combined operation of agitation equipment and circulation pumps can effectively homogenize tritium concentration in the 10 tanks.

Tank name	Tritium concentration* before the test (× 10^5) [Bq/L]	Tritium concentration in the tank lower layer after the test (× 10^5) [Bq/L]	Tritium concentration in the tank middle layer after the test (× 10^5) [Bq/L]	Tritium concentration in the tank upper layer after the test (× 10^5) [Bq/L]	Mean tritium concentration in tanks after the test (× 10^5) [Bq/L]
K4-B1	1.94	1.53	1.51	1.54	1.53
K4-B2	1.63	1.51	1.42	1.50	1.48
K4-B3	1.49	1.51	1.53	1.48	1.50
K4-B4	1.54	1.53	1.48	1.51	1.51
K4-B5	1.67	1.53	1.47	1.55	1.52
K4-B6	1.69	1.52	1.51	1.52	1.52
K4-B7	1.58	1.45	1.53	1.49	1.49
K4-B8	1.50	1.49	1.50	1.48	1.49
K4-B9	1.44	1.50	1.52	1.54	1.52
K4-B10	1.61	1.51	1.54	1.55	1.53
Mean	**1.61**	**1.51**			-
Standard deviation σ	**0.13**	**0.029**			-
Relative standard deviation	**8.1%**	**1.9%**			-

* Sampling from the K4-B1 tank was performed on May 22, 2020, and from K4-B2 to B10 tanks from June 9 to 22 of 2021 in the middle layer of the tanks.

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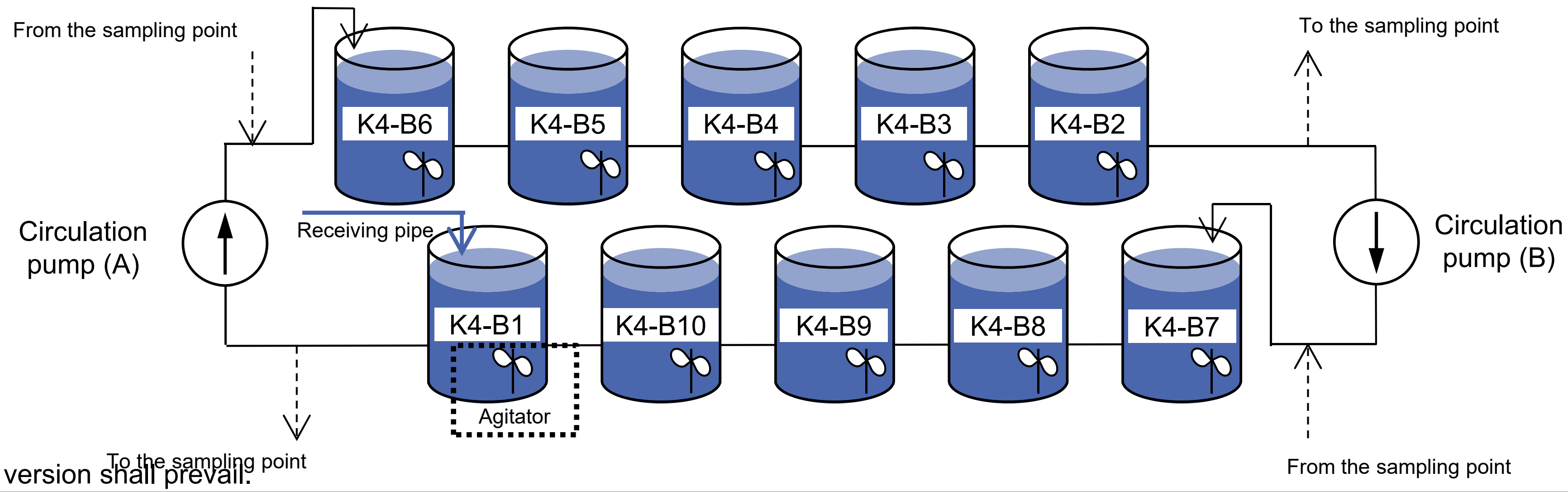
6. Summary of the results of the circulation and agitation demonstration test

- Based on the results of the circulation and agitation demonstration test, we concluded that the circulation and agitation operation enables the collection of representative samples.
  - This test started in a very conservative initial state, in which the entire amount of tribasic sodium phosphate was charged into one tank (K4-B6) before the start of the test. Even so, after the tank water flowed twice around the tanks, the mean phosphate concentration in the water sampled from the circulation line sampling points (A) and (B) was 84.5 ppb, which is approximately equal to the theoretical value of 80 ppb.
  - Due to the conservative initial conditions, the mean phosphate concentration in the water collected from the tanks was 86 ppb with a standard deviation of 9 ppb, and a slight variation was observed. On the other hand, the mean tritium concentration in the tanks was 1.51×10^5 Bq/L with a standard deviation of 0.029×10^5 Bq/L, which means that the circulation and agitation operation has a homogenization effect.

- Judging from the test results, the same facility configuration as in the present test, shown in the figure below, will be adopted. The operation time of the circulation and agitation will be set to a value that allows the tank water to flow twice around the tanks for the time being after the start of discharge.
- The circulation and agitation operation time will be verified using a tracer, if necessary, to optimize the operation time.



2. Responses to issues pointed out* at the review meeting, etc.

*: Documents 2-2, Attachment 2 for (the 97th) Specified Nuclear Facilities Monitoring and Assessment Review Meeting

Issues pointed out [1]

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

(1) Discharge facility of ALPS Treated Water into the Sea

[2] Homogenization of radioactive concentration in ALPS treated water in tanks before discharging into the sea

- If sedimentary radioactive materials are present in the tanks, they may accumulate at each tank rotation (receiving, measurement/confirmation, and discharge). Therefore, how to deal with the influence of the water remaining in the tanks must be explained.

2-1 (1) [2] Homogenization of radioactive concentration in ALPS treated water in tanks before discharging into the sea
[1]-1. Influence of water remained in measurement/confirmation tanks.

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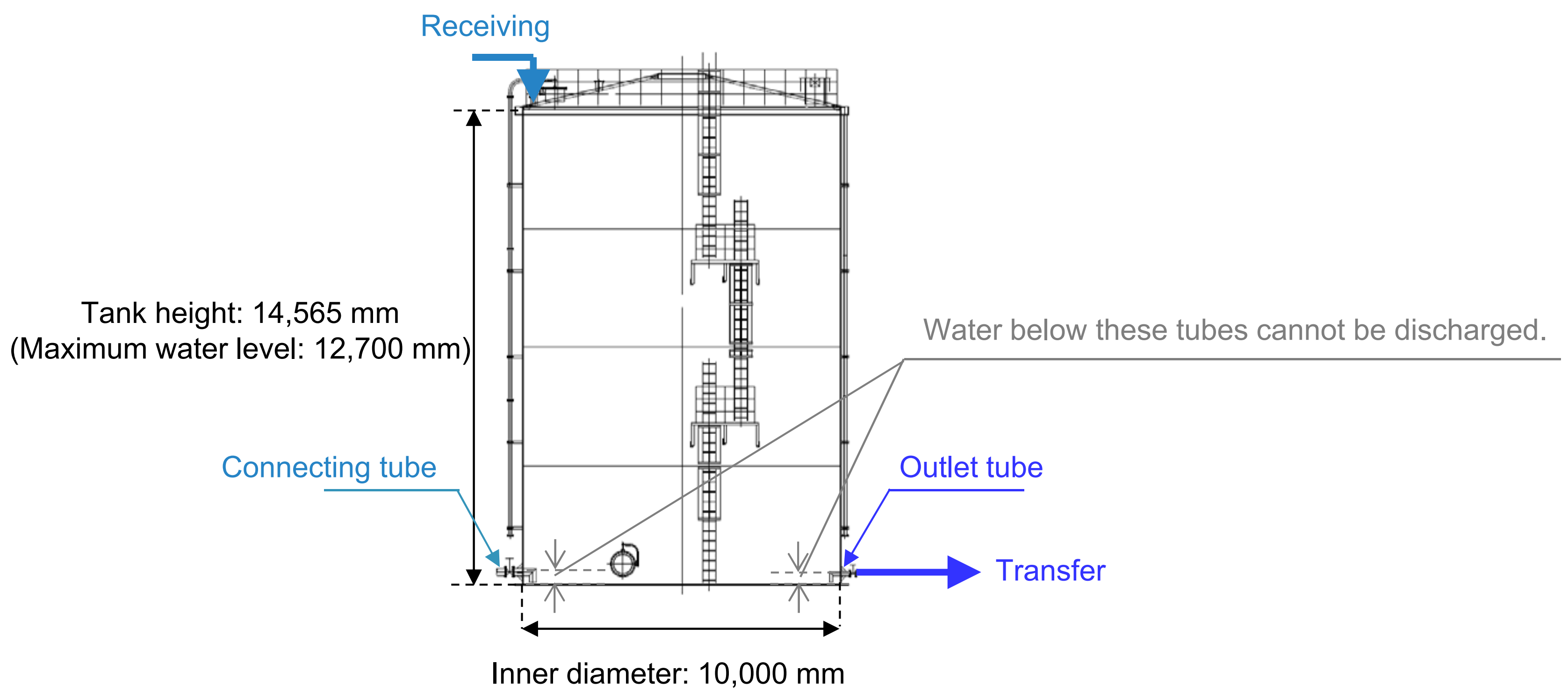
- Under the normal ALPS treated water discharge operation into the sea, it is impossible to discharge water below the outlet and connecting tubes in the measurement/confirmation tanks. Therefore, according to the plan, new ALPS treated water will be accepted with residual ALPS treated water built up on the bottom.
- To ensure that the ALPS treated water is mixed well, enough circulation and agitation time will be secured to enable the tank water to flow twice or more around the tanks for the time being after the start of discharge (See page 8).
- To address concerns about sedimentary materials, ALPS treated water will be made to flow through a filter to be on the safe side before receiving it from the tanks of ALPS treated water, etc., to the measurement/confirmation tanks, and tanks in the K4 area will be cleaned up before using them as the measurement/confirmation tanks.



Measurement/confirmation tank (K4 tanks are used)

The Japanese version shall prevail.

2. Responses to issues pointed out* at the review meeting, etc.

*: Documents 2-2, Attachment 2 for (the 97th) Specified Nuclear Facilities Monitoring and Assessment Review Meeting

Issues pointed out [2]

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

(2) Safety measures at the time of discharge into the sea

- Points where misoperation may occur must be identified while taking a broad perspective of all processes from receiving and measurement/confirmation to discharge. Then, reasons (basic concept) why it has been determined to provide functions to prevent misoperation at some points, such as interlocks, must be explained.

(1) Discharge facility of ALPS Treated Water into the Sea

[4] How to detect abnormalities and stop the discharge of ALPS treated water into the sea

- An explanation must be provided about whether other facilities will be manipulated or not in the event of a malfunction of an emergency isolation valve during normal operation. As procedures for diactivation the discharge operation, the manipulation of emergency isolation valves is required in some cases, while it is not in others. The details of the stop procedures in both cases must be explained, and with regards to the former emergency isolation valves, their role and rationale for the number of units set must be clarified.

2-1 (2) Safety measures at the time of discharge into the sea
[2]-1. Operational plan

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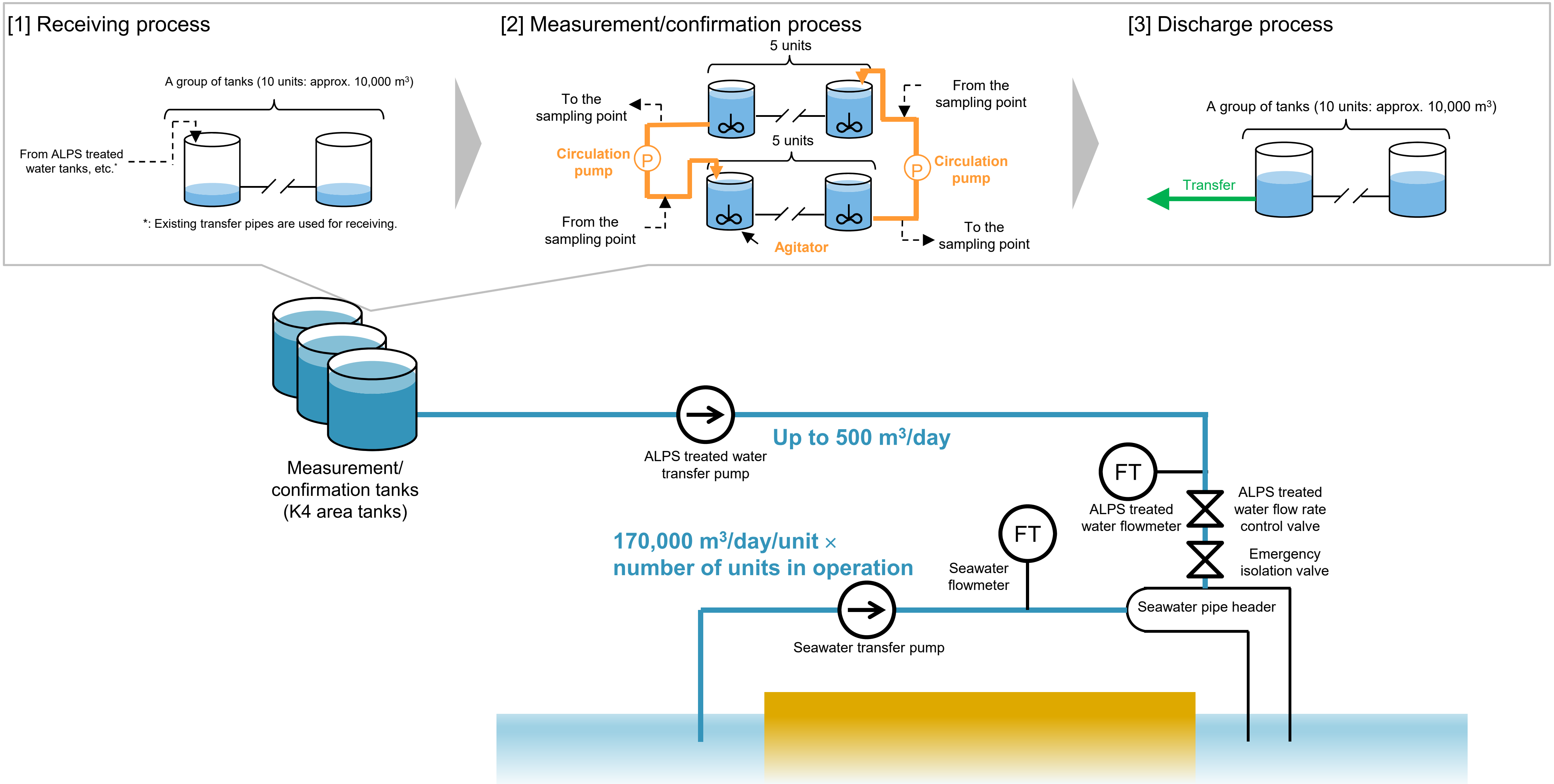
- The ALPS treated water Dilution/Discharge Facilities are planned to take the following steps [1] to [3], and three tank groups will be operated in rotation. Operations and procedures to be taken during the series of steps will be explained.



The Japanese version shall prevail.

2-1 (2) Safety measures at the time of discharge into the sea
[2]-2. Details of the operational plan

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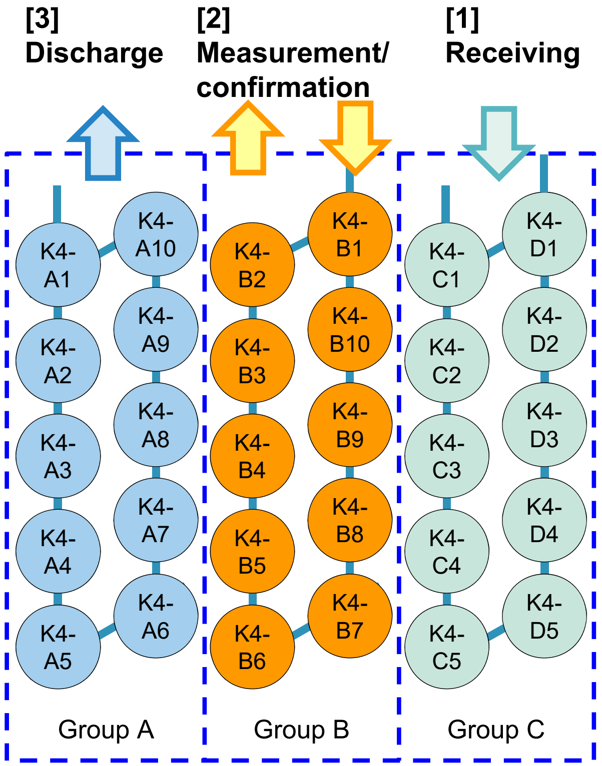
- Procedures for the processes from [1] receiving, [2] measurement/confirmation, to [3] discharge are as follows (refer to the following pages for procedures for each step).

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



The three groups of measurement/confirmation tanks

[1] Receiving process*1

*1: Almost the same as the receiving procedure to existing tanks.

(dotted box) : Trigger operation/state

Preparation, start-up, operation → **End of operation** → **Standby for the measurement/ confirmation process**

1. Operation to start receiving (Double-action)
   - (1) Line up valves in receiving line
   - (2) Open receiving line boundary valves
2. Operation to start up the transfer pump of the source
   - (1) Start up transfer pumps
3. Checking water levels in measurement/ confirmation tanks
   - (1) Stop transfer pumps Close receiving line boundary valves

[2] Measurement/confirmation

Preparation, start-up, operation → Sampling → **End of operation** → **Preparation for transfer process**

1. Operation to execute the measurement/ confirmation process (Double-action)
   - (1) Start up agitators
   - (2) Open circulation line boundary valves
   - (3) Control flow with FCVs*2
   - (4) Start up circulation pumps
   - (5) Monitor operation time and integrated flow rate
2. Operation time and integrated flow rate reach the setpoints
   - (1) Stop circulation pumps, close FCVs*2
   - (2) Close circulation line boundary valves
3. Operation to stop the measurement/ confirmation process (Double-action)
   - (1) Stop agitators

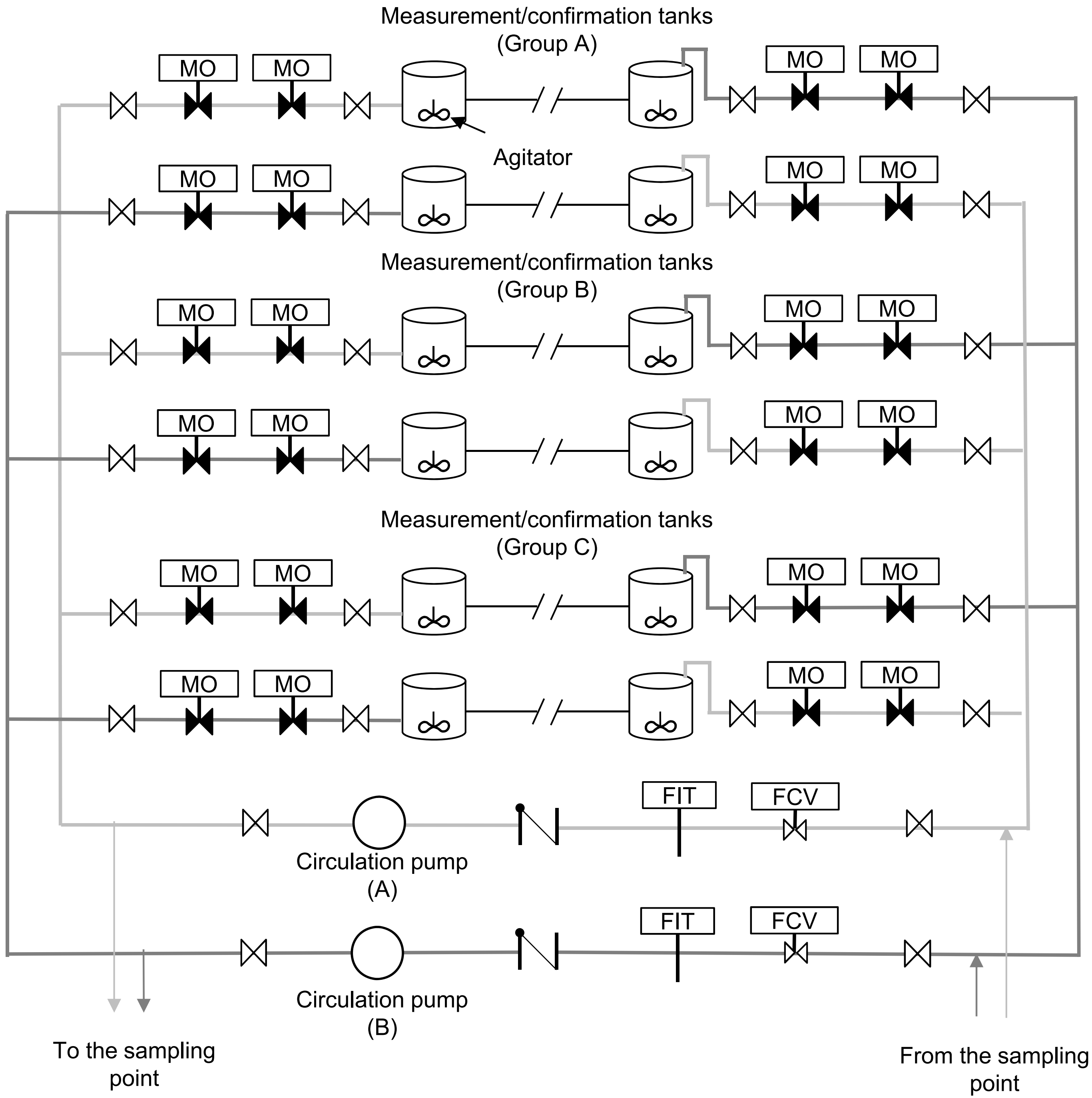
[3] Discharge process

Preparation of Dilution facility → **Input of analysis results** → **Discharge operation** → **Completion of discharge** → **Standby for receiving process**

1. Operation to start up seawater transfer pumps (Double-action)
   - (1) Start up seawater transfer pumps
   - (2) Open seawater transfer pump discharge /seawater pipe header inlet valves
   - (3) Monitor seawater flow rate
2. Input of tritium concentration (reading by scanners, etc. + Double-check)
3. Discharge operation (key switch)
4. Run ALPS treated water transfer process (Double-action)
   - (1) Open transfer facility boundary valves
   - (2) Start up transfer pumps
   - (3) Open emergency isolation and other motor-operated valves
   - (4) Control flow with FCVs*2
5. Tank water level decreased
6. Stop discharge (Automatic)
   - (1) Close FCVs*2
   - (2) Stop transfer pumps
   - (3) Close emergency isolation and other motor-operated valves

*2: Flow rate control valve

2-1 (2) Safety measures at the time of discharge into the sea
[Supplement] Facility conditions in the measurement/confirmation process
[1] (Before start-up operation)



<Abbreviations>
MO: Motor-operated
FCV: Flow rate control valve
FIT: Flow indicator

The Japanese version shall prevail.

2-1 (2) Safety measures at the time of discharge into the sea
[Supplement] Equipment conditions in the measurement/confirmation process
[2] (Start-up - Operation)

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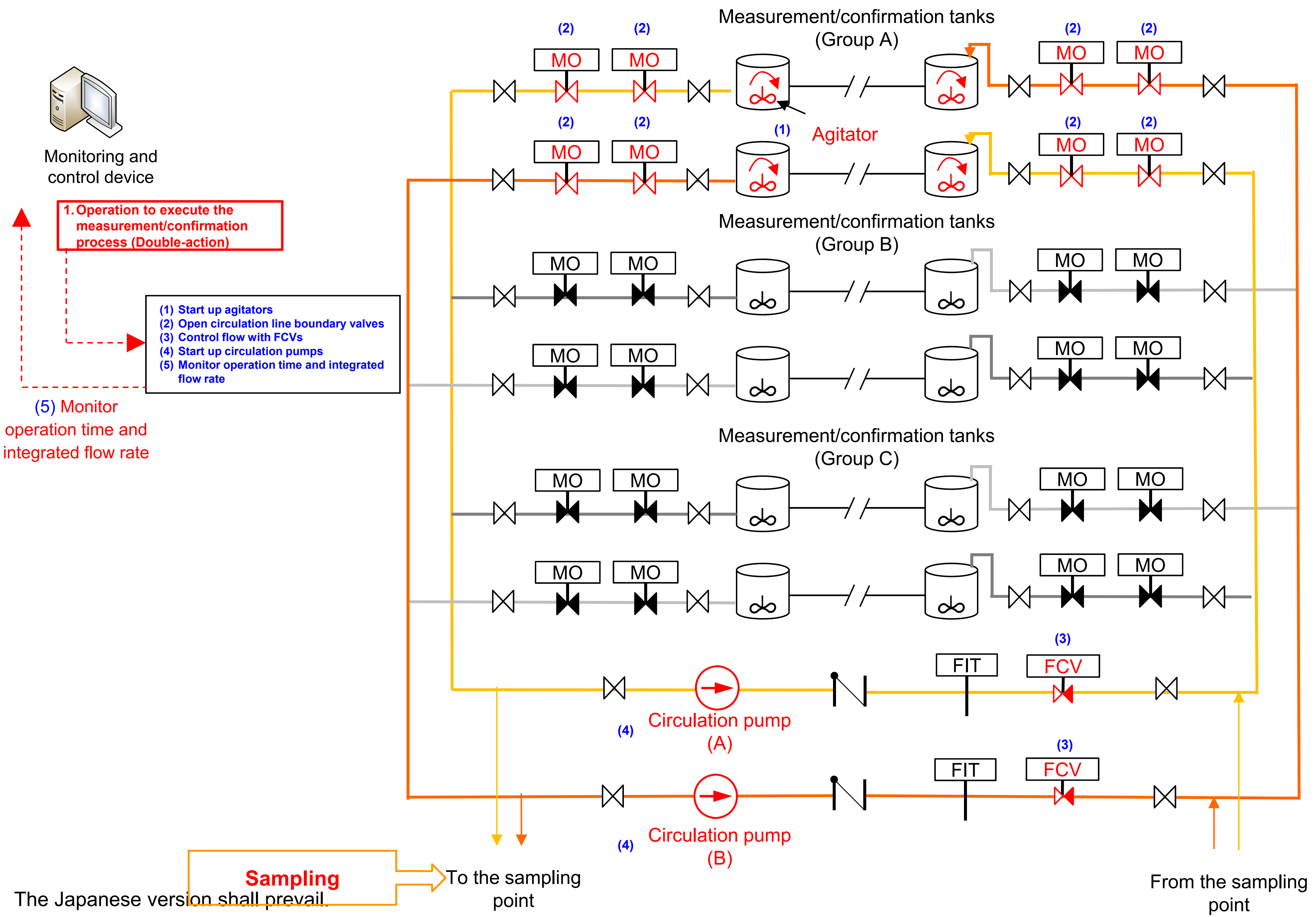
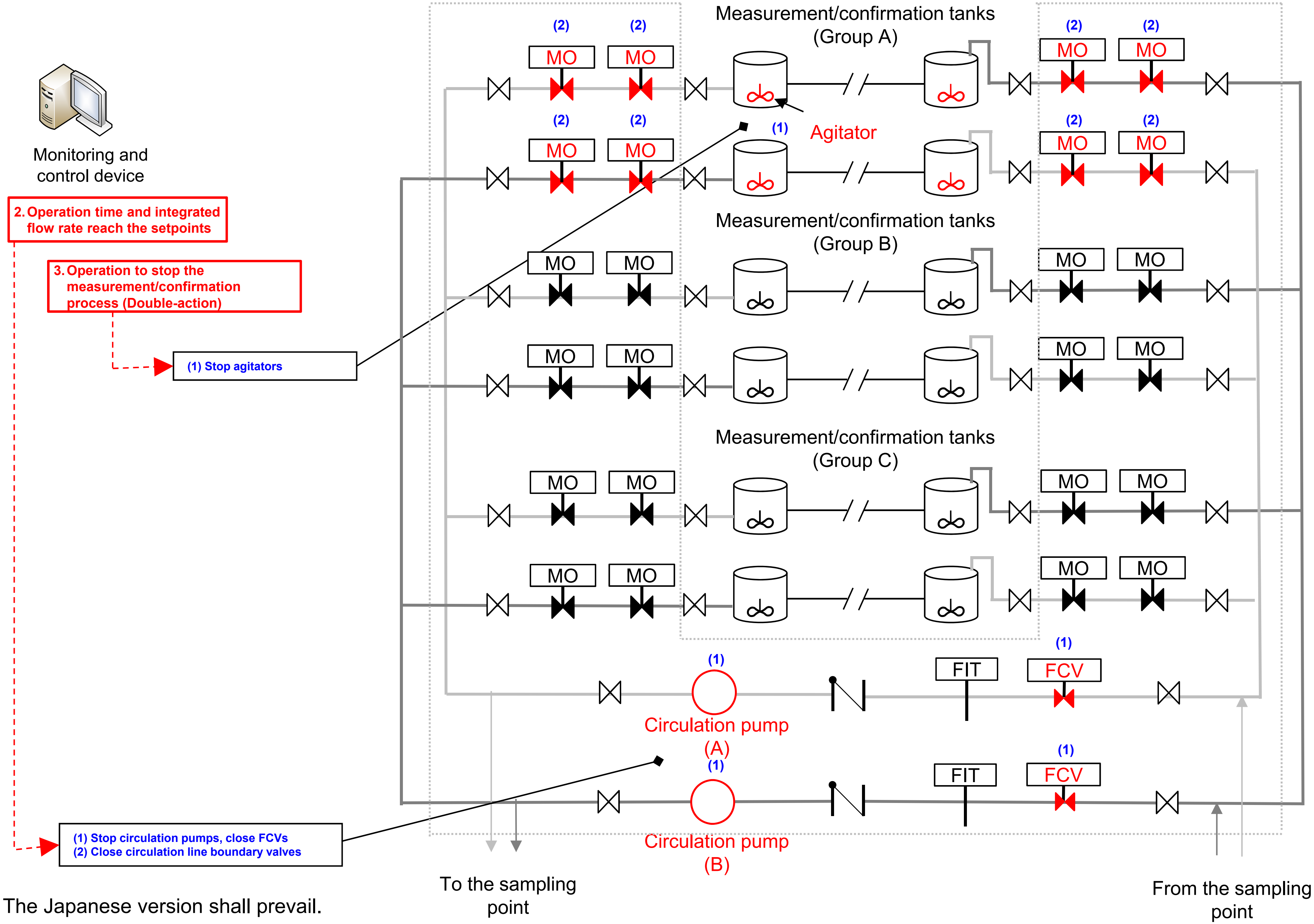


The Japanese version shall prevail.

2-1 (2) Safety measures at the time of discharge into the sea
[Supplement] Equipment conditions in the measurement/confirmation process
[3] (Operation - Stop)



The Japanese version shall prevail.

2-1 (2) Safety measures at the time of discharge into the sea
[Supplement] Equipment conditions in the discharge process
[1] (Before start-up operation)

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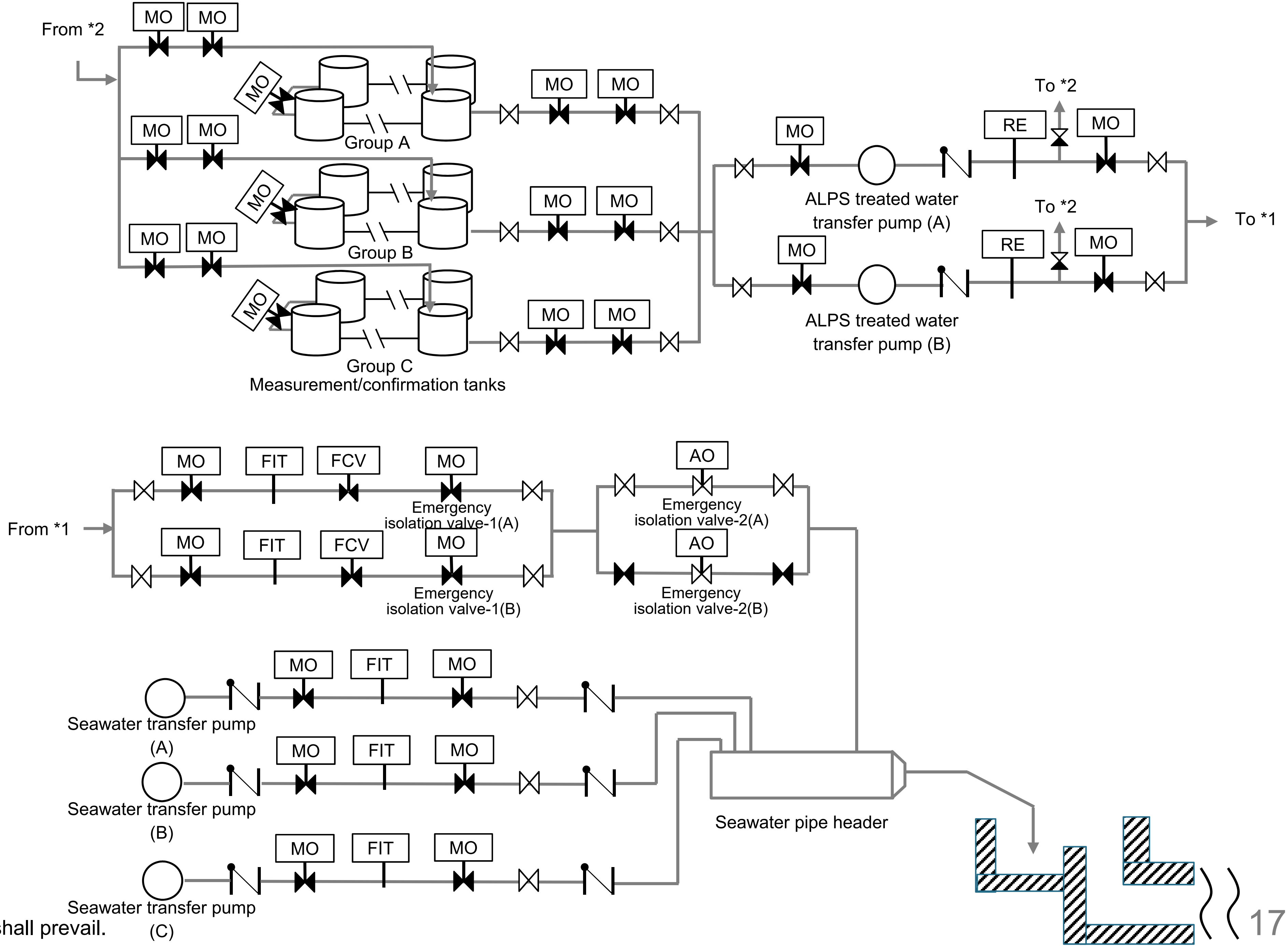

<Abbreviations>
MO: Motor-operated
AO: Air-operated
FCV: Flow rate control valve
FIT: Flow indicator
RE: Radiation detector

The Japanese version shall prevail.

2-1 (2) Safety measures at the time of discharge into the sea
[Supplement] Equipment conditions in the discharge process
[2] (Start-up of Dilution facility)

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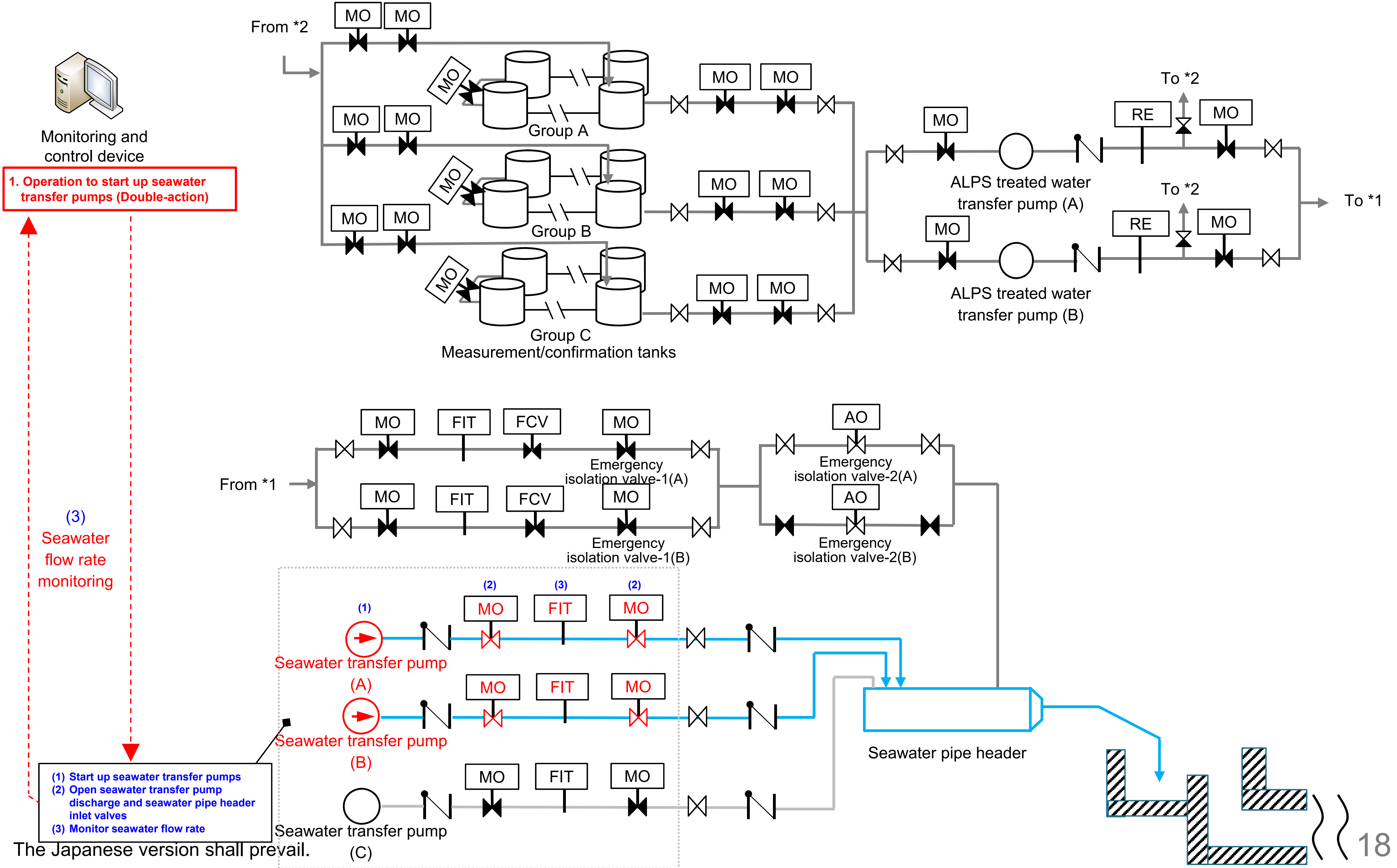
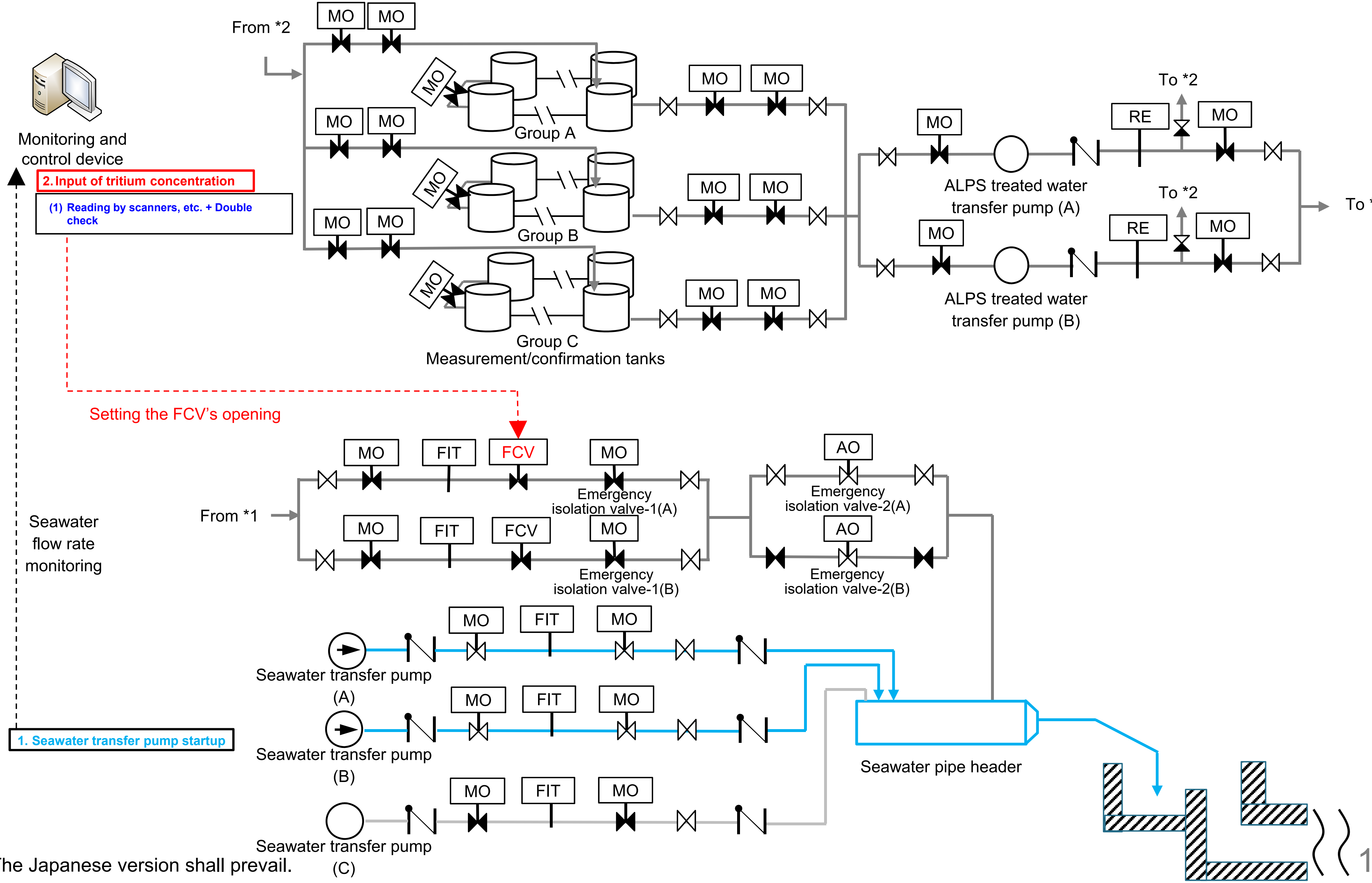
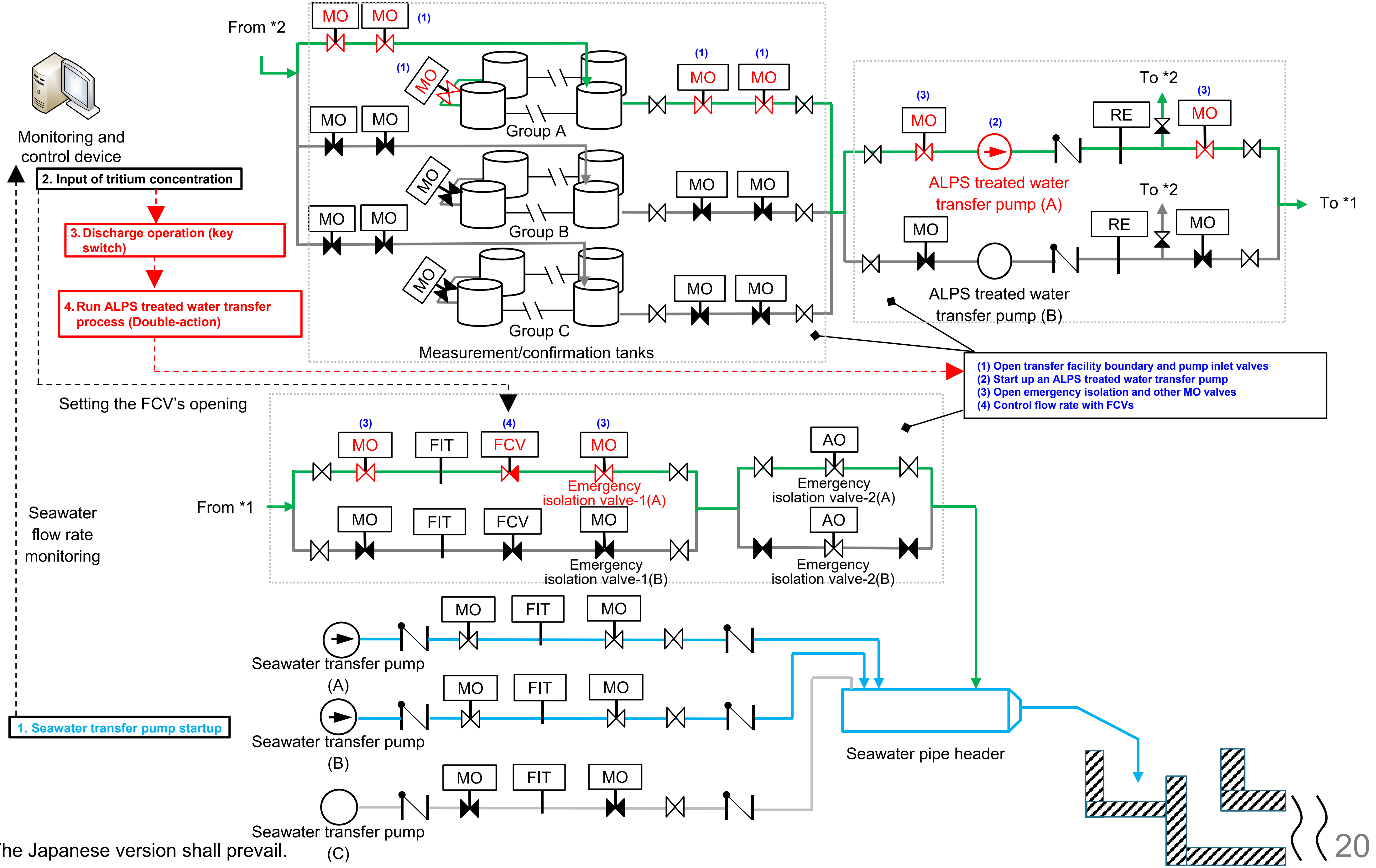


2-1 (2) Safety measures at the time of discharge into the sea
[Supplement] Equipment conditions in the discharge process
[3] (Input of tritium concentration - Setting FCV opening)

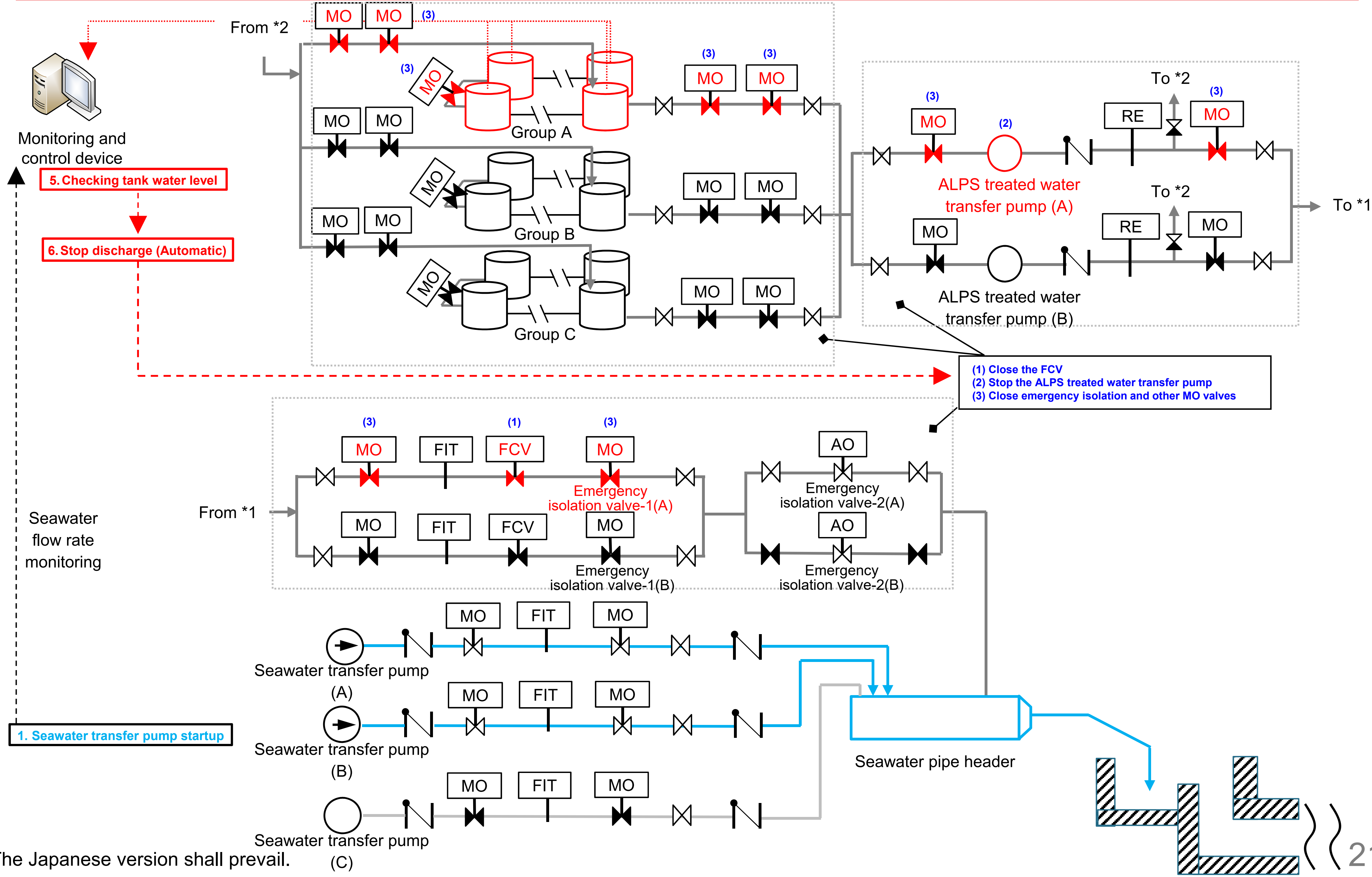


The Japanese version shall prevail.

2-1 (2) Safety measures at the time of discharge into the sea
[Supplement] Equipment conditions in the discharge process
[4] (Discharge operation - Starting transfer of ALPS treated water)



2-1 (2) Safety measures at the time of discharge into the sea
[Supplement] Equipment conditions in the discharge process
[5] (Completion of discharge - Stop of facilities)



2-1 (2) Safety measures at the time of discharge into the sea
[2]-3. Emergency shutdown

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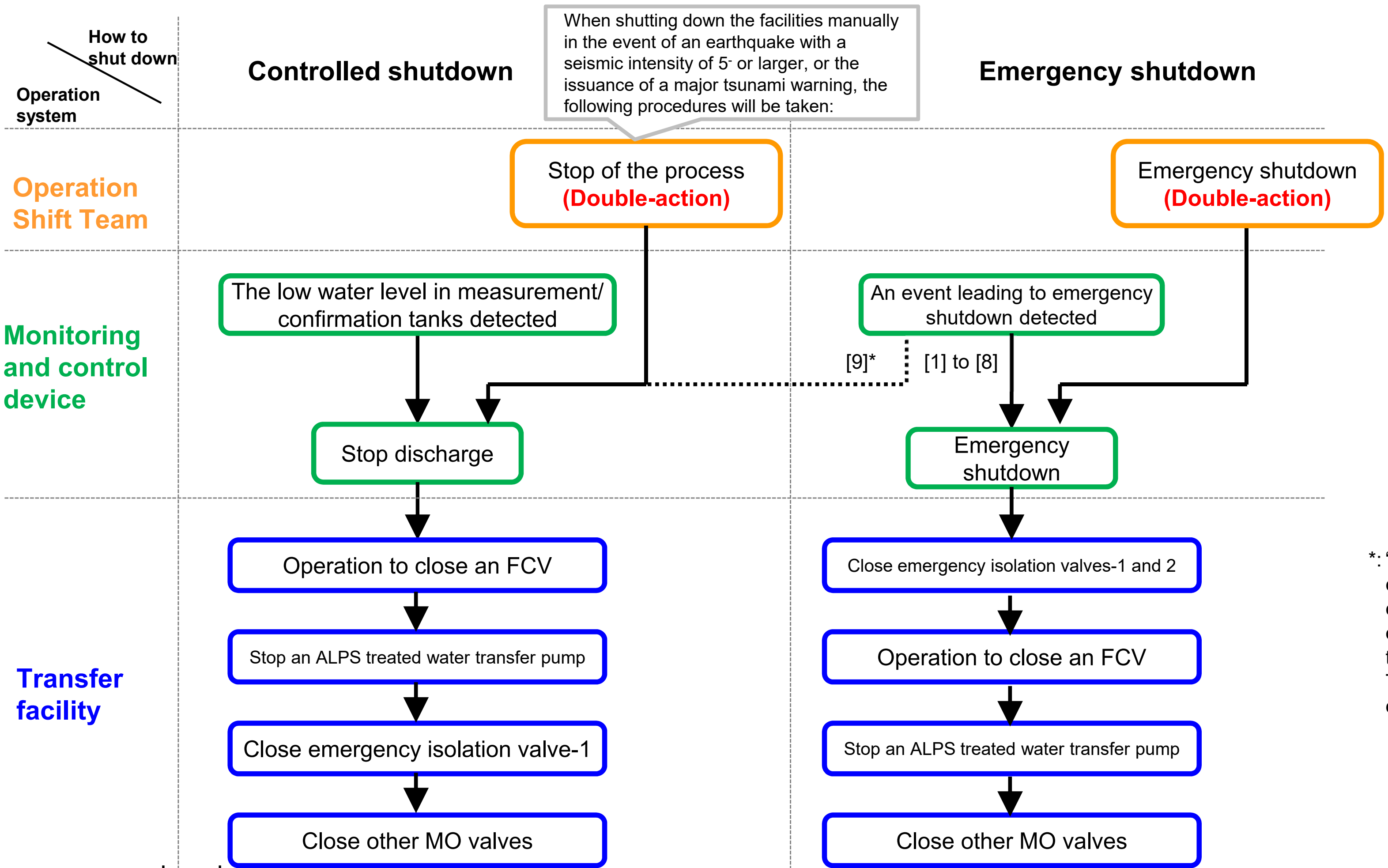
- During the discharge of the ALPS treated water, in addition to normal shutdown, the facilities may be shut down as an emergency measure when abnormalities, such as deviation from normal operation, are detected.
- In both normal and emergency shutdown cases, almost the same shutdown and operation commands will be input.
  (Only the manipulation of emergency isolation valve-2 is different. Emergency isolation valve-2 is to be operated only at the time of emergency shutdown or inspections).
- Except for manual shutdowns, all facility shutdowns are designed to be controlled by the monitoring and control device, which detects the status of the facilities.



Events leading to emergency shutdown

[1] ALPS treated water flowmeter failure
[2] Seawater flowmeter failure
[3] ALPS treated water flow rate high
[4] Seawater flow rate low
[5] ALPS treated water transfer pump trip
[6] Seawater transfer pump trip
[7] Radiation monitor panel, major failure
[8] Radiation monitor high
[9] Emergency isolation valve panel, both system communication abnormalities

*: "[9] Emergency isolation valve panel, both system communication abnormalities" assumes a communication error of the control panels for the emergency isolation valves, and it is assumed that there is no problem with the system operation. Therefore, the same procedures as those for the controlled stop of discharge are to be taken.

The Japanese version shall prevail.

2-1 (2) Safety measures at the time of discharge into the sea
[Supplement] Equipment conditions in the discharge process [6] (Emergency shutdown)

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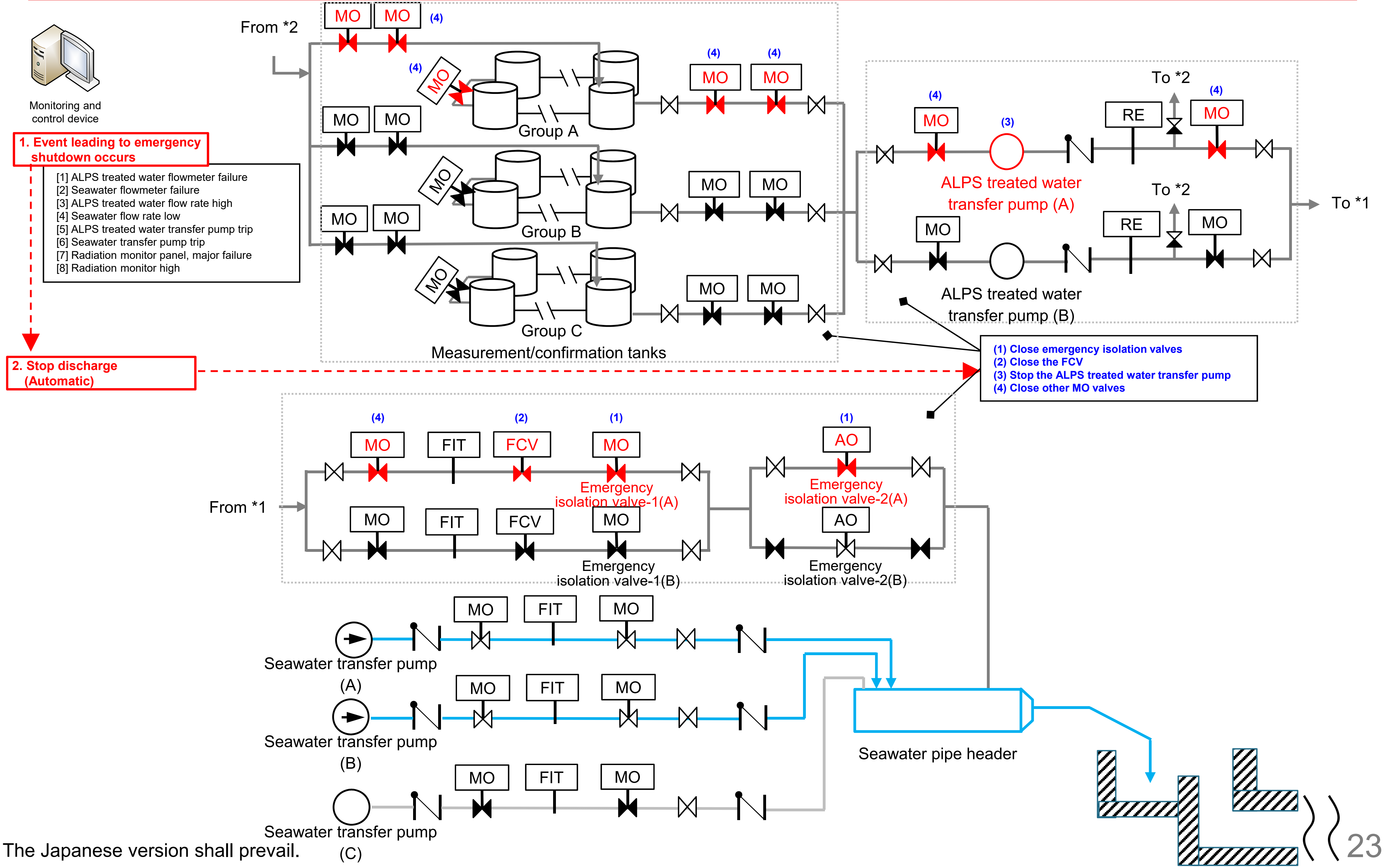

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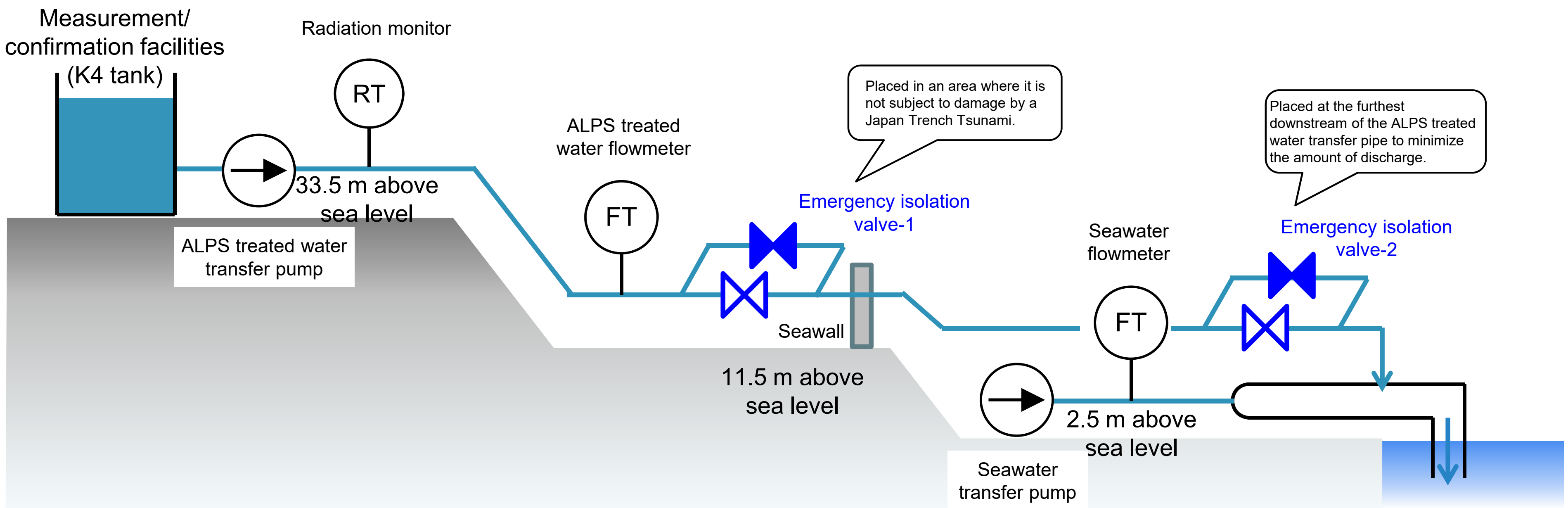
2-1 (1) [4] How to detect abnormalities and stop the discharge of ALPS treated water into the sea
[Reference] Expected role and design of the emergency isolation valve

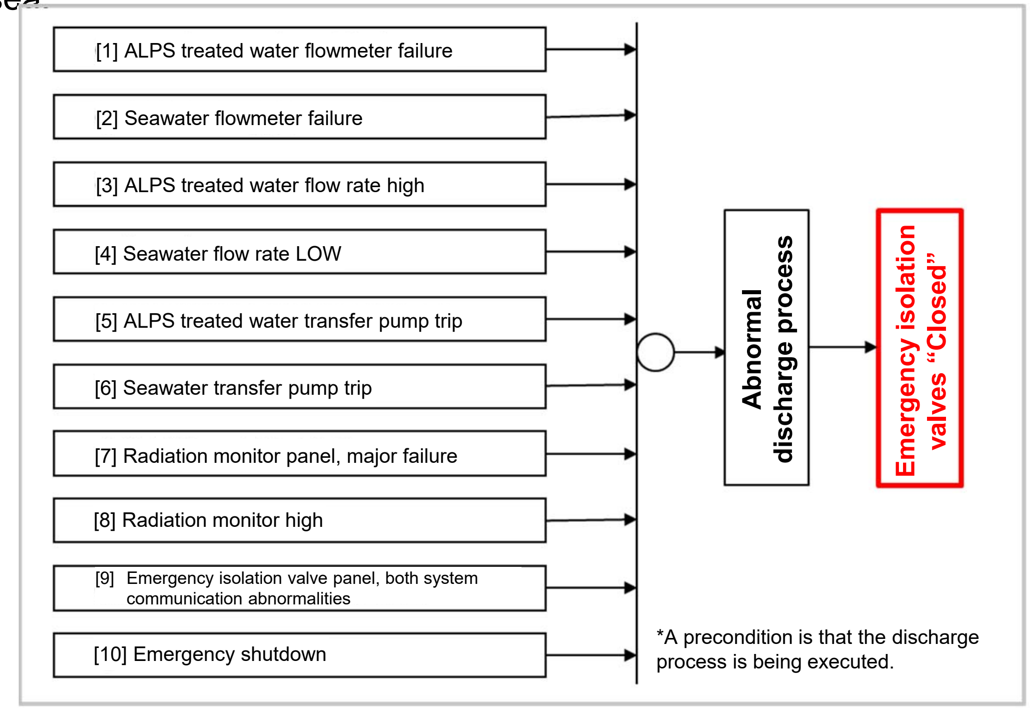
- The emergency isolation valves provided in the ALPS treated water transfer line have a function to stop the discharge of ALPS treated water into the sea by closing without manual operation in the event of detecting an abnormality that deviates from normal operation.
- The emergency isolation valves are made dual-redundant in series, and their installation position, working methods, and design concept are as follows:

Design	Emergency isolation valve-1	Emergency isolation valve-2
Location of installation	Location not subject to damage by tsunami	Placed at the furthest downstream of ALPS treated water transfer pipe to minimize the amount of discharge during valve operation.
Operating system	Motor-operated (it takes 10 seconds from opening to closing)	AO (it takes 2 seconds from opening to closing)
Concept of design	Two systems are installed and, in the event of failure or maintenance, the system can be switched by opening and closing the front and rear valves to keep the facility availability.	(Same as on the left)

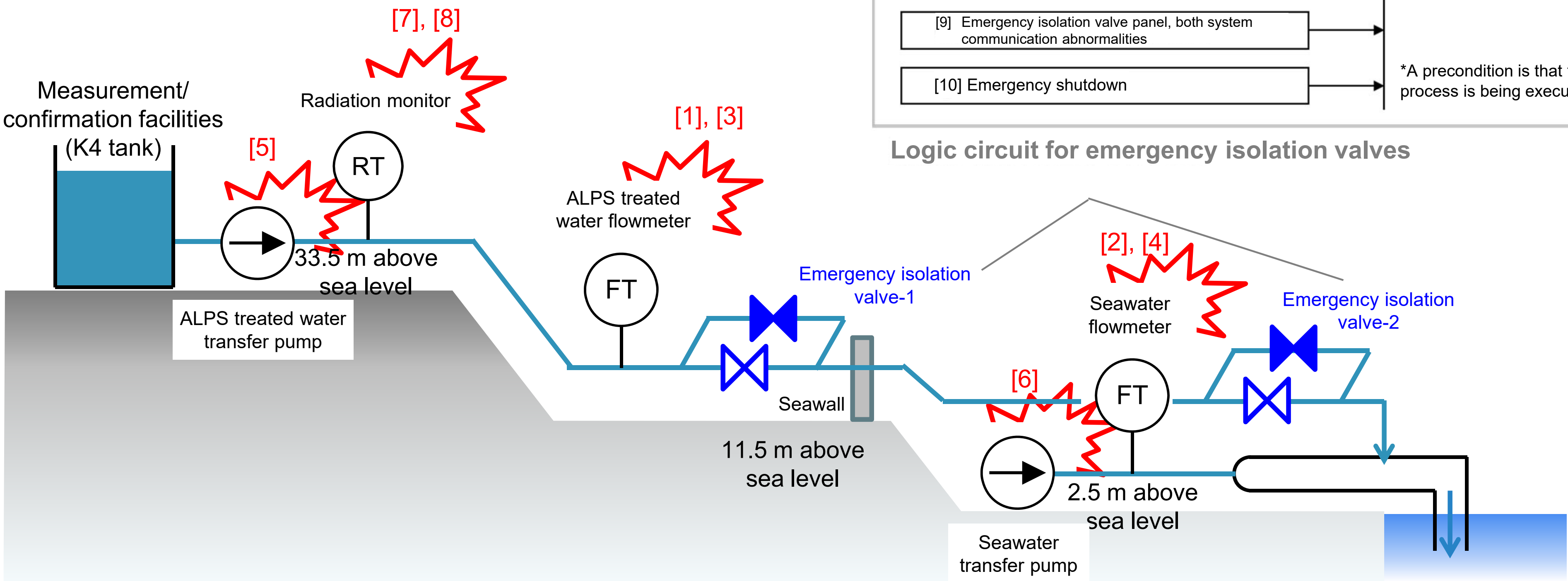


2-1 (1) [4] How to detect abnormalities and stop the discharge of ALPS treated water into the sea
[Reference] Operating conditions of emergency isolation valves

- The operating conditions under which the emergency isolation valve is “closed ” are as shown in the figure below, which is designed to prevent “unintentional discharge of ALPS treated water into the sea.”
- The logic is that when various kinds of abnormalities are detected, the sound seawater transfer system will continue the operation and dilution as much as possible.



Logic circuit for emergency isolation valves



[Reference] Specifications for emergency isolation valves

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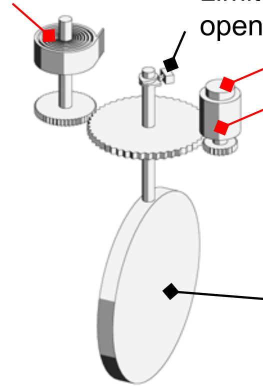
Emergency isolation valve-1 (MO valve)

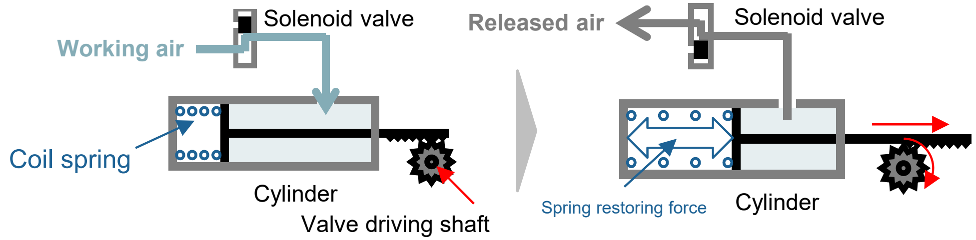
- Spring return type motor-operated emergency isolation valve, which closes fully in the event of loss of power
  - The motor is activated to wind the spring to fully open the valve.
  - Once the valve is fully opened, the built-in brake will be activated to keep the wound-up spring from moving back (under normal operation).
  - With the loss of power, the brake will be released, and the valve will be closed by the force of the spring.
  - Open → Close: within 10 seconds



Outline of the structure of emergency isolation valve-1

Emergency isolation valve-2 (AO valve)

- Air-operated emergency isolation valve, which closes fully in the event of loss of power
  - The piston in the cylinder is pressurized, and the linear motion generated by the movement of the piston is converted into rotary motion (to drive the valve).
  - This valve has a coil spring in it, and when the solenoid valve of the working air is de-energized at the time of power outage, the air in the cylinder is released to move the piston.
  - Open → Close: about 2 seconds

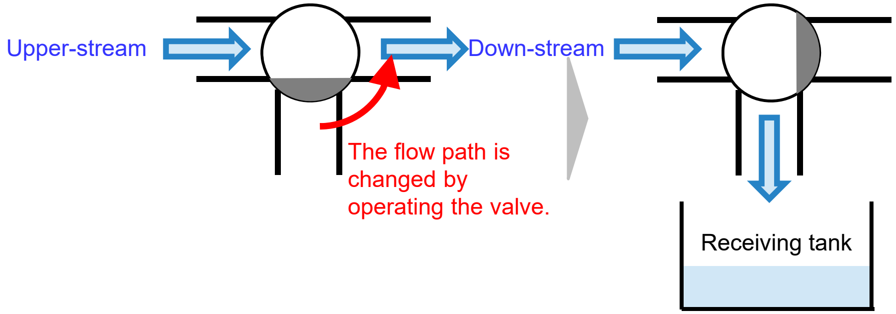


The cylinder is filled with air to maintain the valve "Open."

Once the solenoid valve is de-energized, the air in the cylinder will be released, and the valve driving shaft will be moved by the restoring force of the spring.

- Measures against water hammers
  - Since the emergency isolation valve-2 is designed to shut off the discharge as quickly as possible, countermeasures against water hammers must be taken. Therefore, a three-way valve is adopted.

→ The receiving tank is designed to have a capacity of 1.1 m^3 or more, that is, the volume larger than the amount of water transferred when the emergency isolation valve-1 is closed and the amount contained in the piping from the emergency isolation valve-1 to the emergency isolation valve-2.



The Japanese version shall prevail.

2. Responses to issues pointed out* at the review meeting, etc.

*: Documents 2-2, Attachment 2 for (the 97th) Specified Nuclear Facilities Monitoring and Assessment Review Meeting

Issues pointed out [3]

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

(1) Discharge facility of ALPS Treated Water into the Sea

[5] Structure and strength of equipment, protection against natural phenomena such as earthquakes and tsunamis, prevention of misoperation, reliability, etc.

- Regarding the monitoring and control device, the frequency of registration operations and the areas requiring human intervention must be clearly indicated.

  It is also important to comprehensively consider where and what errors can occur. From the viewpoint of preventing human errors, it is sometimes considered that human intervention should be minimized. On the other hand, however, such an idea can cause the device to become a black box. Therefore, misoperation prevention measures that are appropriate from a comprehensive perspective must be clarified.

[3]-1. Points where misoperation can occur and concept for interlock

- The countermeasures to prevent misoperation by operators and other postulated misoperation occurring while the ALPS treated water Dilution/Discharge Facilities are in service are summarized as follows.

No.	Possible misoperation
[1]	Pressing a wrong operation button when manipulating facilities.
[2]	Pressing a wrong button because all of the operation buttons are identical.
[3]	Making mistakes during the transcription of measured tritium concentration into the monitoring and control device.

No.	Countermeasures
[1]	Double-actions are required when manipulating facilities (After pressing an operation button, the operator has to confirm whether to move on to the following process).
[2]	Key switches are adopted for critical operations (discharge operation).
[3]	The measured tritium concentrations are input to the monitoring and control device by mechanical means, such as a scanner*.

*: Before inputting data into the monitoring control device, entered values are checked by two or more people to ensure they are correct.

- In addition to the above measures, in order to further augment the function to prevent "unintentional discharge of ALPS treated water into the sea", an interlock is provided to stop proceeding to the following process (including the operation of equipment), mainly even when an operation that cannot be undone is performed by mistake.

✓ <u>Release of radioactive materials from measurement/confirmation tanks due to lack of confirmation</u>
→ Even when a wrong tank group is selected for measurement and confirmation by mistake, the operation of the equipment will be stopped.

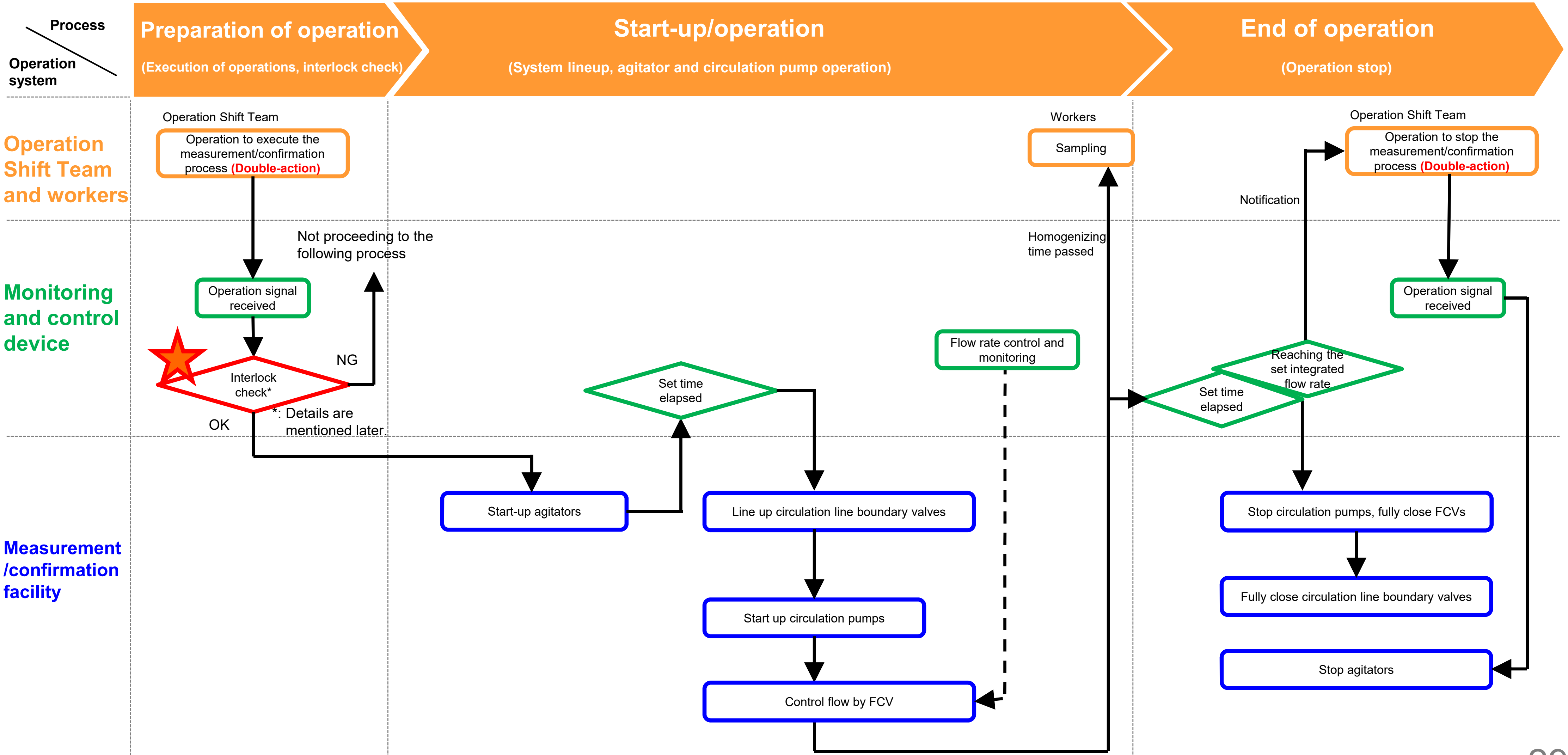
✓ <u>Discharge of water with a tritium concentration of 1,500 Bq/L or more after dilution with seawater</u>
→ If the tritium concentration is not below the discharge limit or the dilution ratio is not acceptable, the system cannot proceed to the following process (discharge operation).

Document 1-1 (amended) for The 7th Review Meeting on the Implementation Plan Regarding the Handling of ALPS Treated Water

2-1 (1) [5] Structure and strength of equipment, protection against natural phenomena such as earthquakes and tsunamis, etc.

[Reference] Operating procedures for Measurement/confirmation facility

- The operating procedures for the Measurement/confirmation facility are as follows.
  - The measurement/confirmation process is designed to start operation automatically after selecting the target tank group and executing the operation procedure.
  - To prevent mixing and accidental discharge of water between tank groups, a monitoring and control device is provided with an interlock to check that only selected tank groups are in the measurement/confirmation process and that the boundary valves are fully closed.



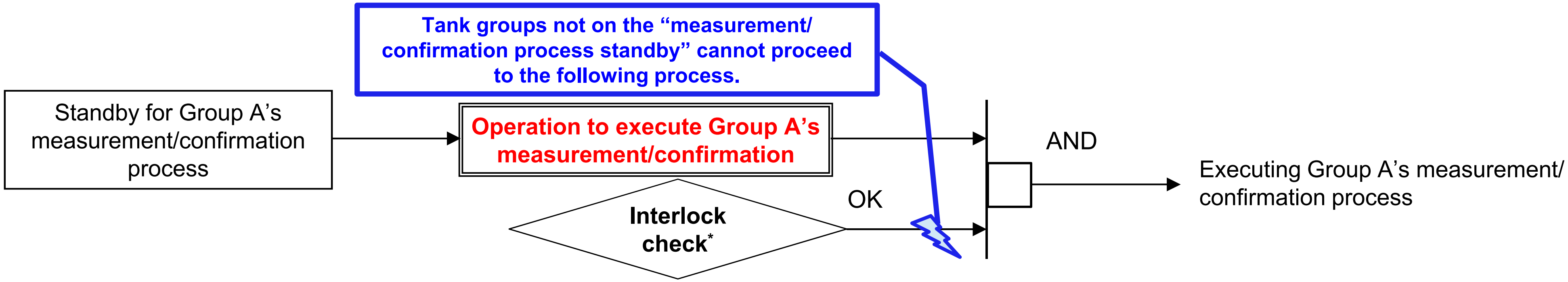
The Japanese version shall prevail.

2-1 (1) [5] Structure and strength of equipment, protection against natural phenomena such as earthquakes and tsunamis, etc.

[Reference] Interlock in the measurement/confirmation process

Operation to execute the measurement/confirmation process

(Example) When moving to Group A's measurement/confirmation process.



***: Interlock check**

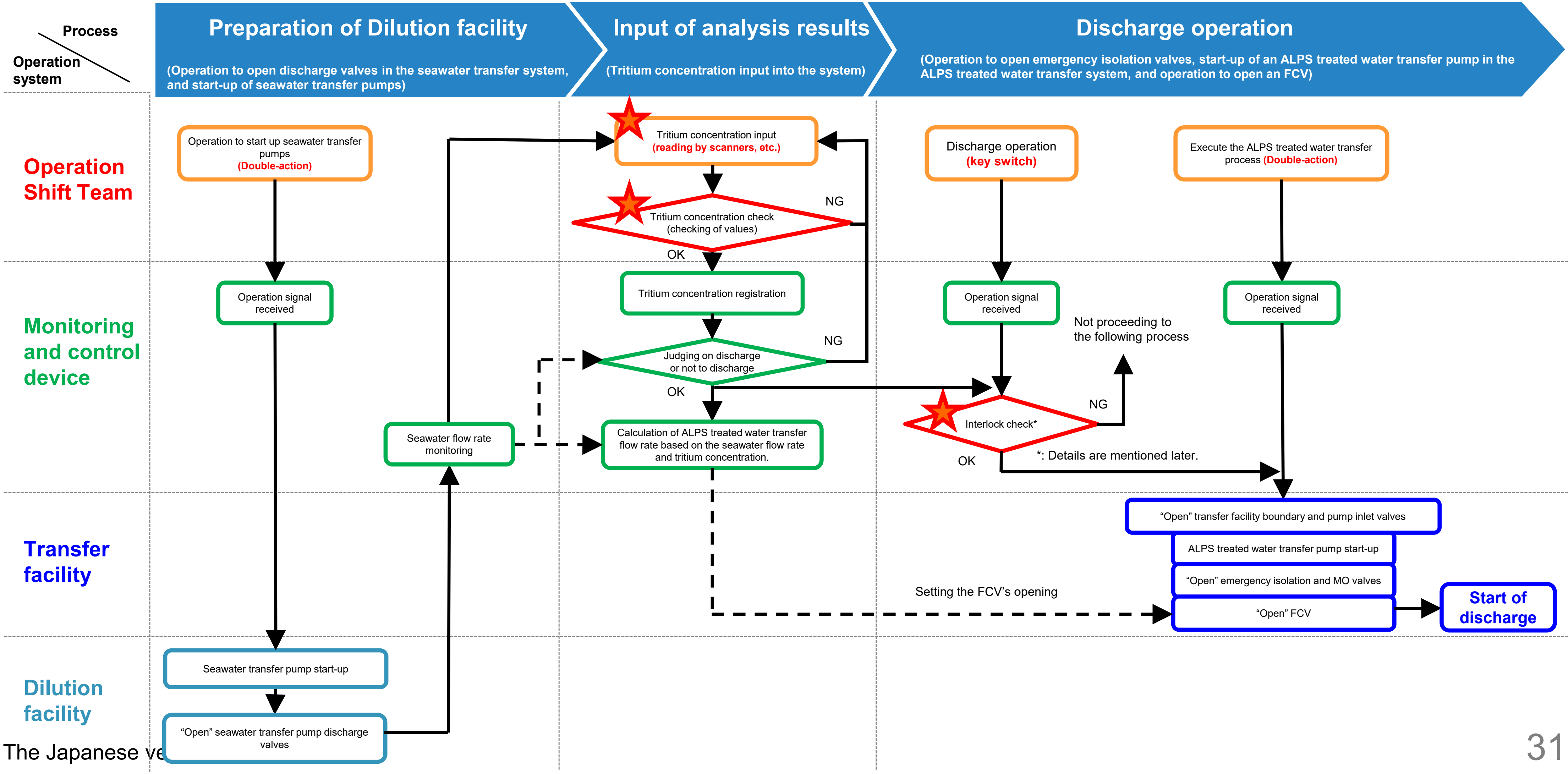
- ✓ Group A should be on the "measurement/confirmation process standby" (it should be lower than "circulating water level high") -> Check the condition of the target tank group.
- ✓ Groups B and C should not be in the measurement/confirmation process -> Check the condition of the other tank groups.
- ✓ Circulation line switching valves of Groups B and C should be "fully closed" -> Check the condition of the valves (to prevent water mixing in other tank groups)

(Example) Even if, due to human error, the tank group for implementing the measurement/confirmation is mistaken and **[Operation to execute Group B's measurement/confirmation process]** is performed, it cannot proceed to the "measurement/confirmation process" when the applicable tank group is not in the "measurement/confirmation process standby" (in the "receiving process" or in the "discharge process").

2-1 (1) [5] Structure and strength of equipment, protection against natural phenomena such as earthquakes and tsunamis, etc.

[Reference] Operating procedures for transfer facility/Dilution facility

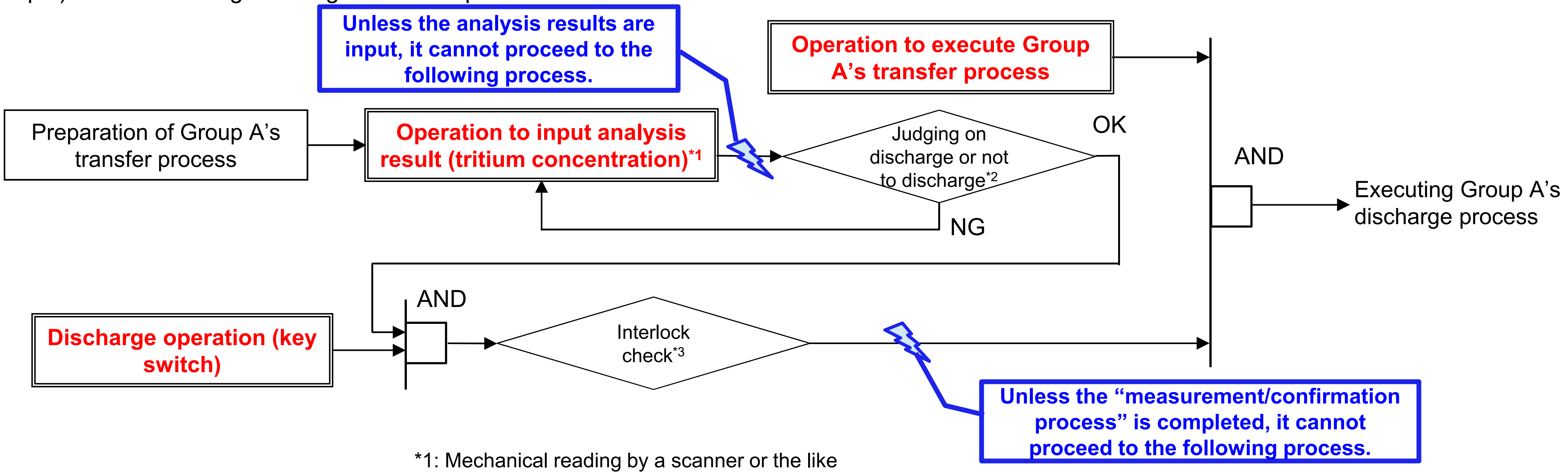
- The operating procedures for discharging ALPS treated water are as follows.
  - To prevent human error, the tritium concentrations should be mechanically imported to the monitoring and control device, such as by scanners (several people will check if the entered values are correct).
  - To prevent accidental discharge, the monitoring and control device is provided with an interlock to check that selected tank groups have completed the measurement/confirmation process and that the boundary valves of other tank groups are fully closed.



2-1 (1) [5] Structure and strength of equipment, protection against natural phenomena such as earthquakes and tsunamis, etc.
[Reference] Interlock in the discharge process

Discharge operation

(Example) When executing discharge from Group A



*1: Mechanical reading by a scanner or the like

***2: Judging on discharge or not to discharge** ✓ Check that the water can be diluted to the specified concentration against the volume of seawater for dilution (the number of seawater pumps in operation).
***3: Interlock check** ✓ Group A should be in preparation for the transfer process. (The previous process, measurement/confirmation process, must have been completed) ⇒ Confirm that no process has been skipped. ✓ The discharge switching valves for Groups B and C should be "fully closed." ⇒ It prevents the discharge of water from tank groups that are not subject to discharge. ✓ Seawater transfer pumps should be operating. ⇒ It prevents the discharge of undiluted ALPS treated water. ✓ The key switch should be in "discharge permitted." ⇒ It prevents misoperation resulting from changing operation procedures.

(Example 1) Even if the **[Operation to execute Group A's transfer process]** is performed with an incomplete analysis of the ALPS treated water by human error, it cannot proceed to the following process unless the analysis result is input.

(Example 2) Even if the **[Operation to execute Group B's transfer process]** is performed by human error, it cannot proceed to the "discharge process" unless the previous process, "measurement/confirmation process," has been completed.

The Japanese version shall prevail.

2. Responses to issues pointed out* at the review meeting, etc.

*: Documents 2-2, Attachment 2 for (the 97th) Specified Nuclear Facilities Monitoring and Assessment Review Meeting

Issues pointed out [4]

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

(1) Discharge facility of ALPS Treated Water into the Sea

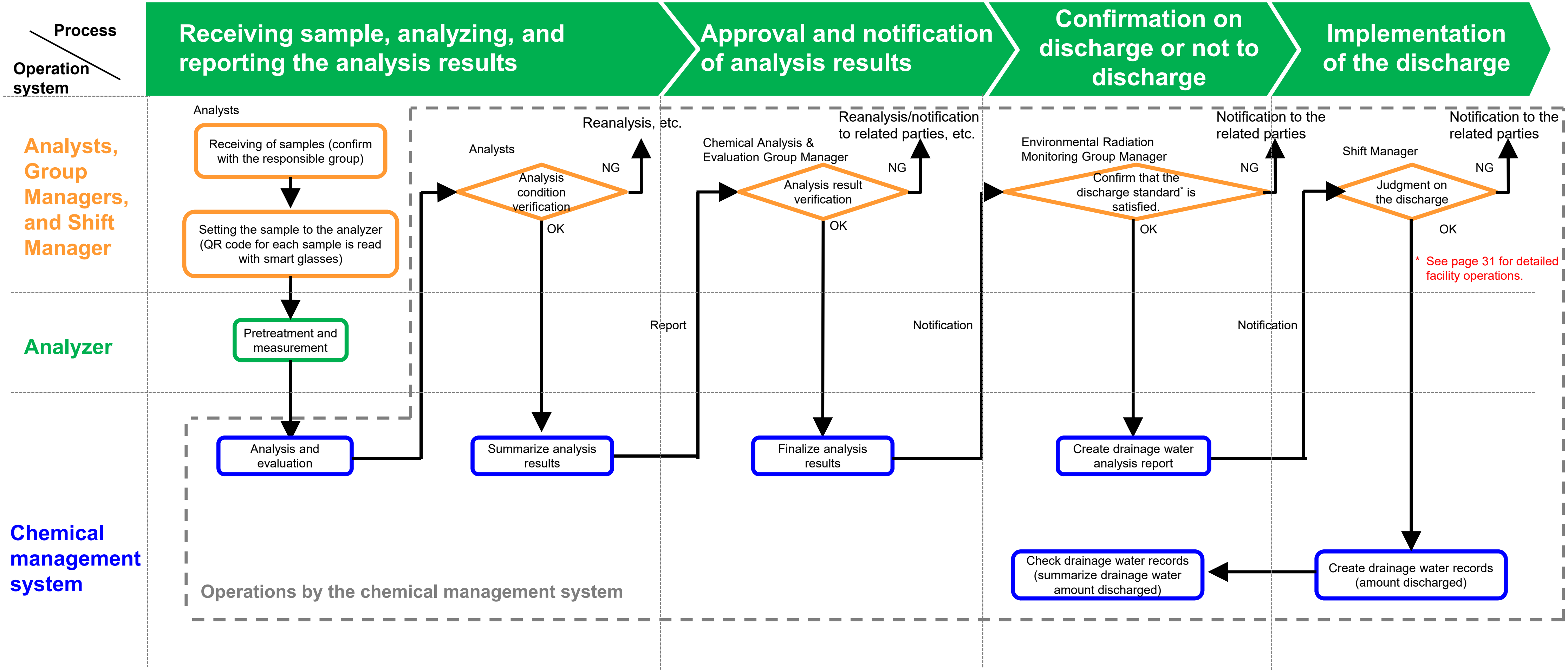
[5] Structure and strength of equipment, protection against natural phenomena such as earthquakes and tsunamis, prevention of misoperation, reliability, etc.

- According to the analysis procedures, most processes are implemented within the core system to prevent human errors. An explanation must be made about what measures and mechanisms are established to enable operators to ensure that the system is appropriately carrying out analyses.

2-1 (1) [5] Structure and strength of equipment, protection against natural phenomena such as earthquakes and tsunamis, etc.

[4]-1 Analysis procedures

- The post-sampling operating procedures for the Measurement/confirmation facility are as follows:
  - After measurement by the analyzer, confirmation/approval work is carried out by the core system (hereinafter referred to as "chemical management system") (There is no manual calculation or transcription).
  - All actions performed by the chemical management system are designed to be recorded.



*: Ensure that the ALPS treated water in the tank group subject to discharge is being measured.
Ensure that the sum of the ratios to regulatory concentration limits of radionuclides other than tritium in the target water is less than 1.

The Japanese version shall prevail.

[4]-2. Verification points in the analysis procedures

- Verification points in the analysis procedures are as follows:

	Points to be verified	Quality assurance
Analysts	✓ Check the received assay samples against the analysis schedule. ✓ Implement and check analysis operation and sample measurement according to the analysis procedures. ✓ **Check analysis conditions (measurement equipment, measurement time, sample volume).**	ISO/IEC17025 ISO9001
Chemical Analysis & Evaluation Group Manager	✓ **Verify the analysis results reported from the chemical management system.** • Input data such as sample name and analysis conditions. • Validity of analysis results (comparison with the past trend of analysis values, etc.) ✓ Report to the Environmental Radiation Monitoring Group Manager*	Part 1, Chapter III, Implementation Plan Article 3 (Quality Management System Plan) *Acts based on Article 41 (Management of Radioactive Liquid Waste, etc.)
Environmental Radiation Monitoring Group Manager	✓ **Judge whether to permit water discharge based on the analysis results notified from the chemical management system.*** • Ensure that the analysis was performed for the tank group subject to discharge. • Ensure that the analysis results satisfy the discharge standard.	
Shift Manager	✓ Verify the wastewater analysis results reported by the Environmental Radiation Monitoring Group Manager. • Judgment on the discharge	

2-1 (1) [5] Structure and strength of equipment, protection against natural phenomena such as earthquakes and tsunamis, etc.

[Reference] Quality control of the analysis process

- A mechanism has been established to keep the analysis process at a certain quality and detect data abnormalities.

Data assessment room — Core system: Chemical management system

- Analysis planning (Manual input) → Request for analysis (Manual input) → Acceptance of analysis request → Sampling instruction → Sample label QR code
- Analysis result report (Auto creation) → Preparation of data for publication (Auto creation)

Sampling QR code

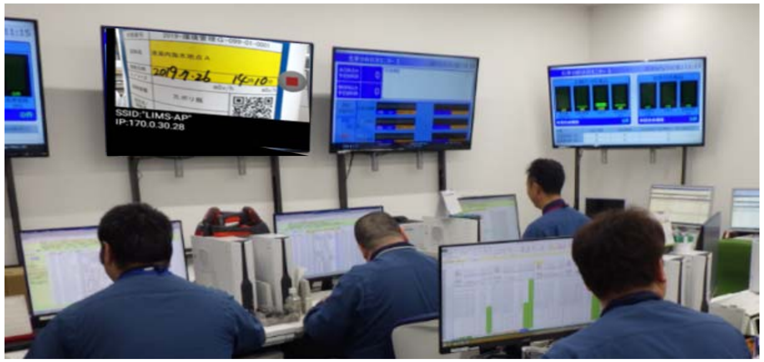
Chemical analysis data collection system (LIMS) — Analysis room: On-site

Analysis instructions

- Receiving of samples QR code → Sample pretreatment QR code → Analysis of samples QR code → Analysis results (Auto creation)
- Management of analyzed samples QR code

- Automatic import of measurement values
- Automatic calculation of concentrations, etc.
- Automatic graph plotting and display

<Analysis room: On-site>
Input voice and send images following the instructions displayed on the smart glasses



<Data assessment room>
Input data to LIMS terminals from camera images

[Register sample data when the data of the analyst matches the data confirmed by the supervisor in the assessment room]

2-1 (1) [5] Structure and strength of equipment, protection against natural phenomena such as earthquakes and tsunamis, etc.

[Reference] Quality control of the analysis process

TEPCO

Activities at TEPCO

- Since FY 2020, the usage of procedures and compliance with specifications have been regularly checked at the on-site analysis room (This initiative is being rolled out targeting all analysis work performed in the 1F site).
- In order to ensure the quality and safety of work, all analysts are required to follow the same procedures even when they take turns: Ensure the continuity of data.
- The method to check procedures is standardized.
- Even third-party companies are required to submit work procedures by the specifications so that TEPCO will be further involved in the quality control of work processes.
- The following initiatives are to prevent quality assurance activities and safety management from stagnating.
  - Contractors are instructed to identify risks through pre-work safety assessments before starting operations. TEPCO explains past nonconformance cases, reminds them to adhere to rules, and provides guidance.
  - With the aim of maintaining performances, meetings are held every month with contractors to discuss issues in analysis work and the implementation status of measures to prevent recurrence of past nonconformance.
  - With the aim of ensuring safety in the field and the quality of work, field patrols are performed every month with contractors to check analysis work, and unsafe conditions are extracted.
  - Last fiscal year, TEPCO started to check the implementation status of analysis procedures established by contractors. TEPCO identifies areas for improvement regarding operations and instructs them to take corrective actions.

Activities at contractors

- Procedures will be improved to become easier to use, such as by describing applicable official laws and publicly available literature.
- In order to ensure the quality and safety of work, a system is established to enable all analysts to follow the same procedures even when they take turns: Ensure the continuity of data.

2. Responses to issues pointed out[*] at the review meeting, etc.

*: Documents 2-2, Attachment 2 for (the 97th) Specified Nuclear Facilities Monitoring and Assessment Review Meeting

Issues pointed out [5]

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

(1) Discharge facility of ALPS Treated Water into the Sea

[1] Control and monitoring of mixing/dilution ratio of ALPS treated water with seawater

- The real-time tritium concentration after dilution with seawater is calculated using the ratio of the volume of dilution water to the volume of treated water, and the reliability of the flow rate measurement is important. Therefore, the specific design of the facilities must be clarified.
- An explanation must be made regarding the errors of ALPS treated water flowmeters and seawater flowmeters and how the tritium concentration in the dilution seawater will be set while taking into account the errors.

[4] How to detect abnormalities and stop the discharge of ALPS treated water into the sea

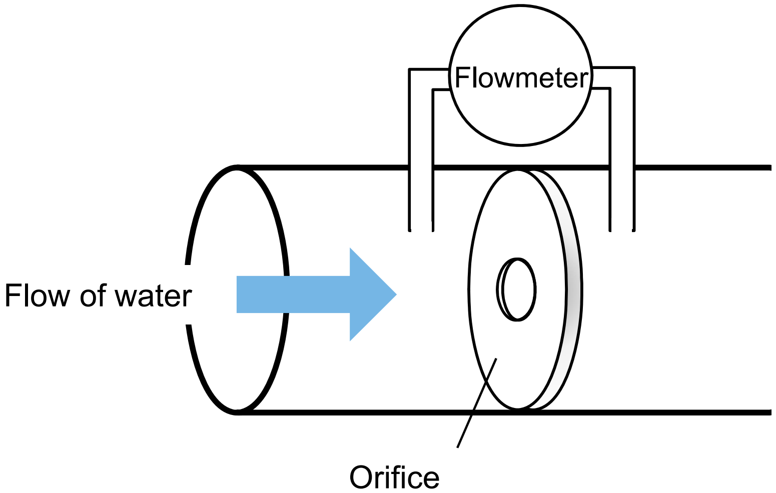
- Based on the results of the validity assessment of facilities in case of failure, the ALPS treated water flowmeter is to be made dual-redundant. When there is a certain difference between the indicated values of the two systems and the difference is regarded as abnormal, how will the abnormal values be set in consideration of the fluctuation of the flowmeters must be explained together with the concept.

[5]-1. Flowmeter specifications

TEPCO

- In the ALPS treated water Dilution/Discharge Facilities, ALPS treated water and seawater flow rates will be measured with “differential pressure-type flowmeters (orifice).”*1
- Each flowmeter consists of a detector, a computation element (including the indicator). The specifications and configuration are as follows:
- When setting the flow rate of ALPS treated water and assessing the tritium concentration after dilution with seawater to ensure that the tritium concentration after dilution with seawater is below 1,500 Bq/L, the instrument error is taken into account to obtain a conservative result.

*1: A measurement system in which an orifice (throttle valve) is installed in the flow path, and the difference (differential pressure) in pressure between the front and back of the orifice is detected and converted to a flow rate.

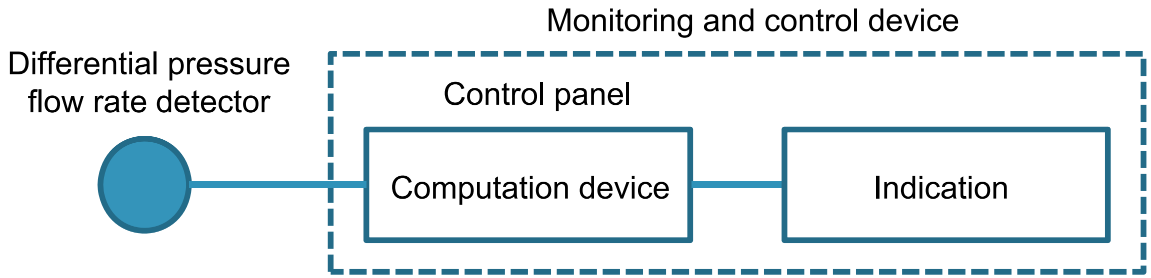


Measuring using a differential pressure flowmeter (orifice)

Flowmeter specifications

Measurement system	Differential pressure type (Orifice)
Specification (Orifice)	JIS Z 8762-2*2
Measurement range	0 to 40 m^3/h (ALPS treated water) 0 to 10,000 m^3/h (seawater)
Instrument error	± 2.1% FS (ALPS treated water, seawater)

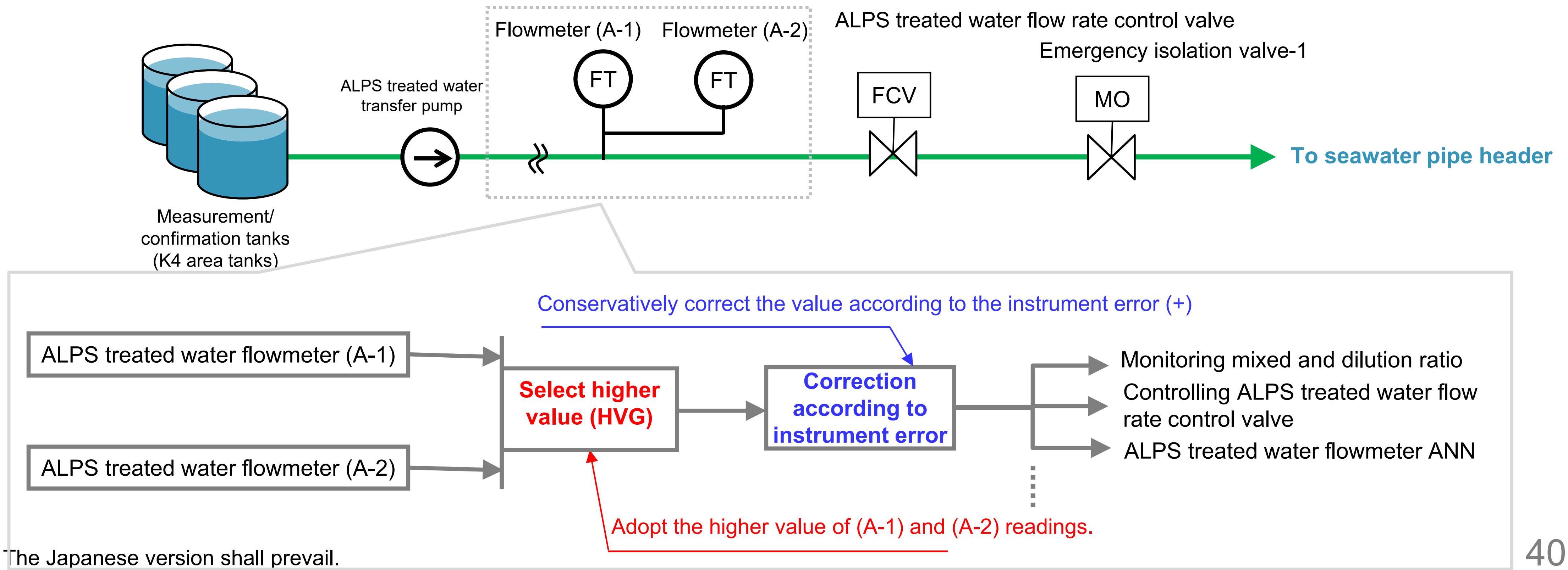
*2: Measurement of fluid flow using pressure differential devices inserted in circular cross-section conduits running full−Part 2: Orifice plates



[5]-2 Controlling the flow rate of ALPS treated water

TEPCO

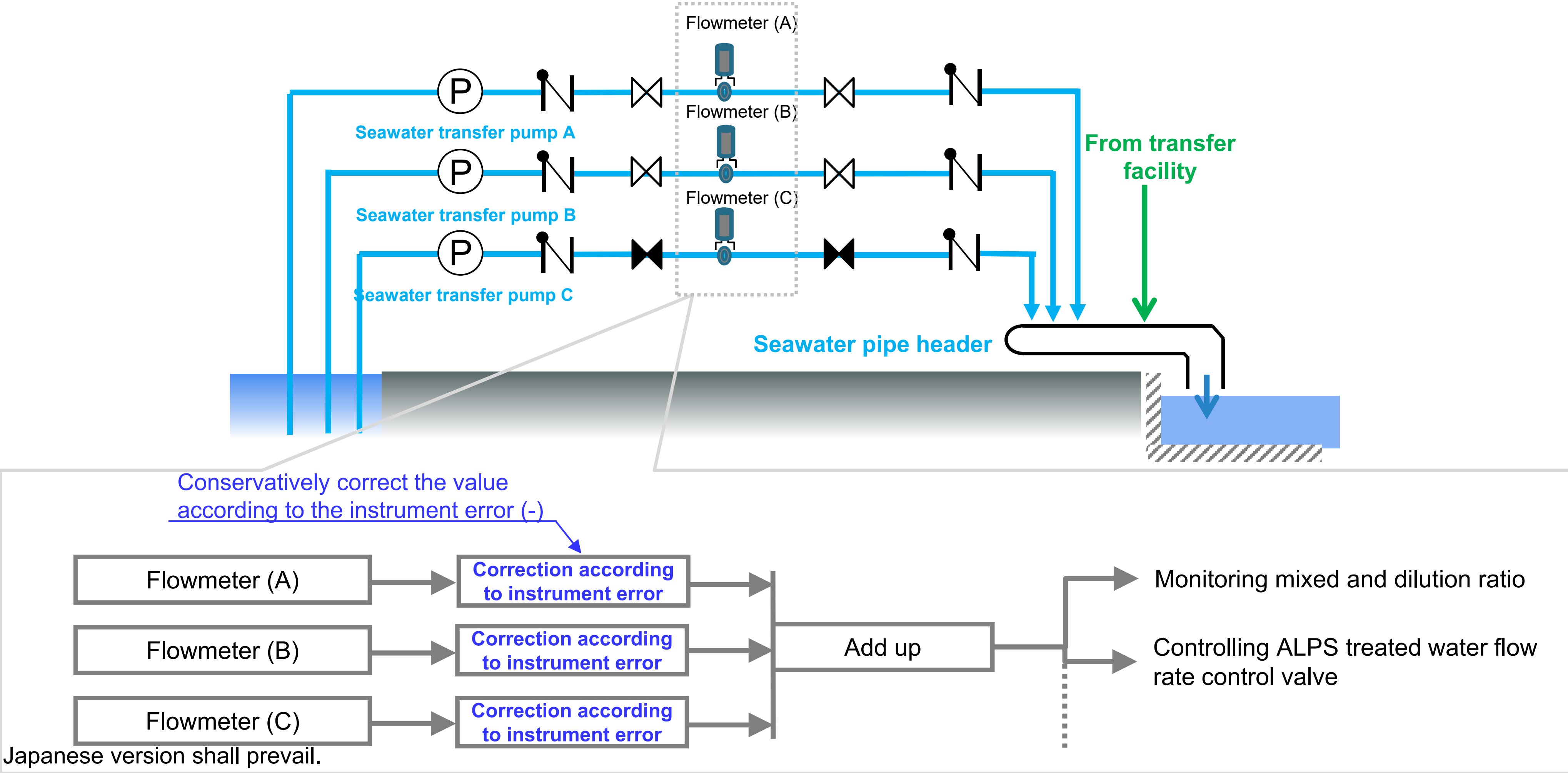
- Equipped with ALPS treated water transfer pumps, flowmeters, and ALPS treated water flow rate control valves, the transfer facility are designed to enable constant flow rate monitoring. Furthermore, the flowmeter is made dual-redundant to perform the flow rate measurement appropriately even when a single equipment failure occurs.
- In the dual-redundant flowmeter system, values that will lead to more conservative results will be adopted to monitor the mixing and dilution rate and control the ALPS treated water flow rate control valve. Measurement values for the monitoring and control will also take into account the instrument error. In addition, the dual-redundant flowmeters mutually monitor each other's flow rate. When a deviation larger than an instrument error occurs, they will detect it as an abnormality, issuing an alert to stop the discharge.
- An upper limit flow is set for the flowmeters depending on the set dilution rate. When the flow rate reaches the upper limit or in the event of a failure of the flowmeters, an alert activates for early detection of any abnormalities.



The Japanese version shall prevail.

2-1 (1) [1] Control and monitoring of mixing/dilution ratio of ALPS treated water with seawater
[5]-3. Controlling the flow rate of seawater

- Equipped with seawater transfer pumps and flowmeters, the dilution facility is designed to constantly monitor the flow rate in each operating system.
- The instrument error is incorporated in the measurement values used to monitor the mixing and dilution ratio and control the ALPS treated water flow rate control valves.
- In addition, the operating systems mutually monitor the flow rates. When a deviation larger than the instrument error or a flowmeter failure occurs, they will detect it as an abnormality, issuing an alert to stop the discharge.



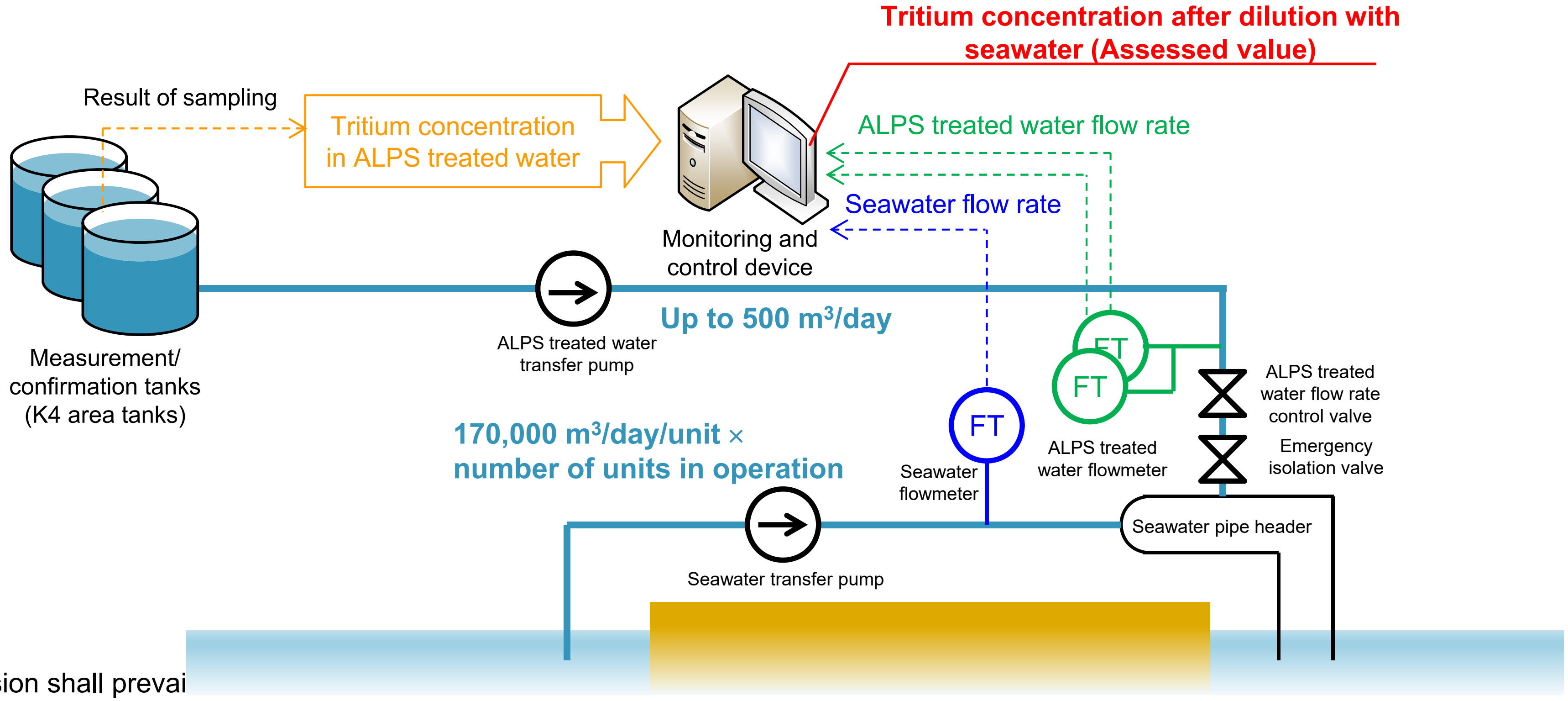
2-1 (1) [1] Control and monitoring of mixing/dilution ratio of ALPS treated water with seawater
[5]-4 Monitoring the mixing/dilution ratio of ALPS treated water with seawater (1/2)

TEPCO

- Before discharging ALPS treated water into the sea, tritium concentration in the ALPS treated water after dilution with seawater is assessed using the tritium concentration in ALPS treated water that was measured and confirmed by the Measurement/confirmation facility and the flow rates of ALPS treated water and seawater at the discharge into the sea.
- During the discharge into the sea, the flow rates of ALPS treated water and seawater are monitored to ensure that the tritium concentration after dilution with seawater is below 1,500 Bq/L. In the assessment process, and the uncertainty of analyses into the tritiuinstrument error is incorporated into the flow rates of ALPS treated water and seawater m concentration in ALPS treated water. By doing so, measurement values leading to conservative results are adopted for the assessment and monitoring.

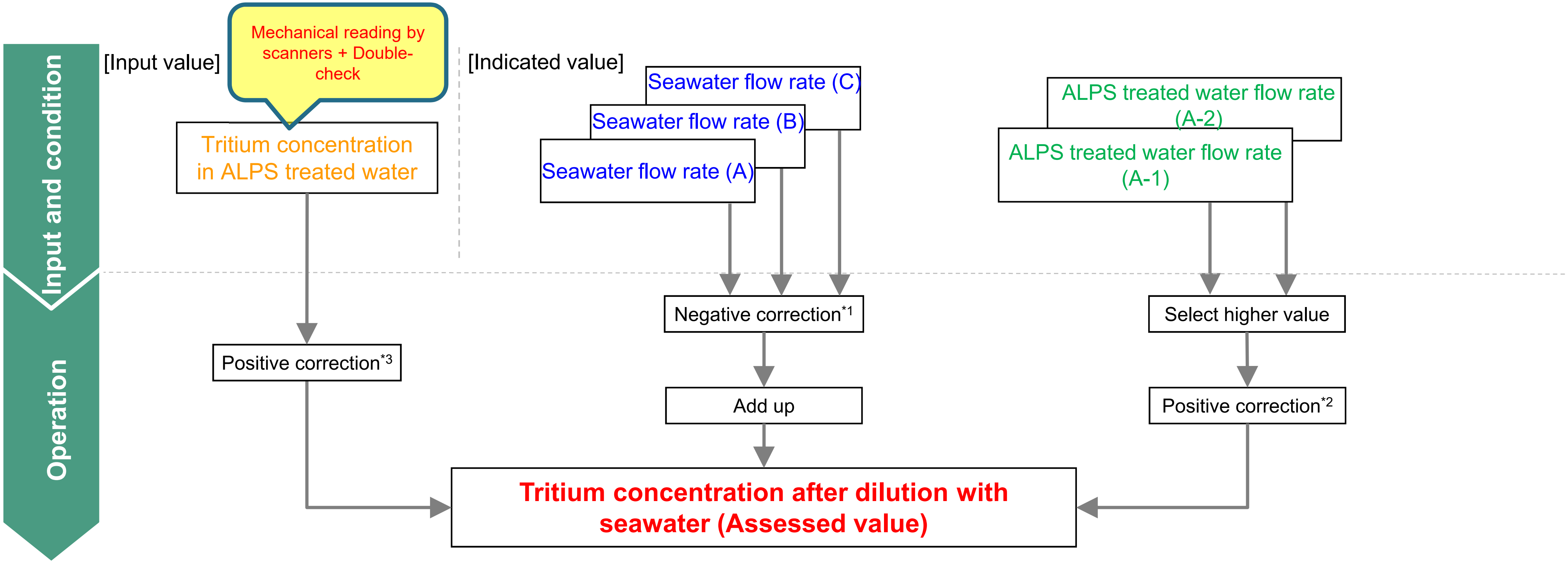
○ Formula for the assessment of tritium concentration

$$\text{Tritium concentration after dilution with seawater (Assessed value)} = \frac{\text{Tritium concentration in ALPS treated water} \times \text{ALPS treated water flow rate}}{\text{ALPS treated water flow rate} + \text{Seawater flow rate}}$$



2-1 (1) [1] Control and monitoring of mixing/dilution ratio of ALPS treated water with seawater
[5]-4 Monitoring the mixing/dilution ratio of ALPS treated water with seawater (2/2)

- The details of the assessment of tritium concentration after dilution with seawater are as follows.
- The monitoring and control device calculates and assesses the concentration in consideration of the instrument error in the flow rates of ALPS treated water and seawater and the uncertainty of analyses.



*1: Assuming a non-conservative case due to an error of instruments (when the actual flow rate is lower than the indicated value), the value is corrected according to the instrument error (2.1% FS).
*2: Assuming a non-conservative case due to an error of instruments (when the actual flow rate is higher than the indicated value), the value is corrected according to the instrument error (2.1% FS).
*3: Assuming a non-conservative case due to an uncertainty of analyses (when the actual concentration is higher than the analysis value), the value is corrected according to the uncertainty ([Tentative] 10%).

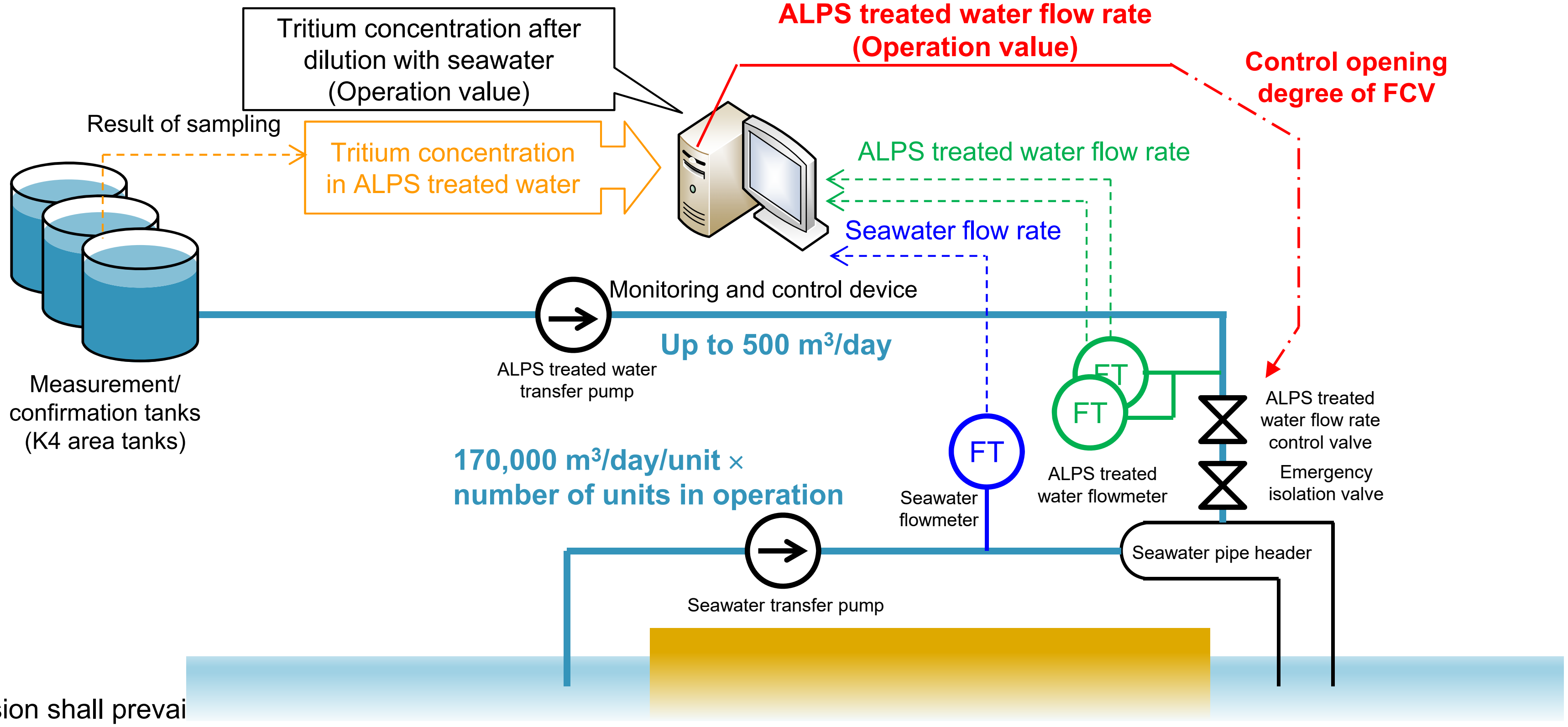
[5]-5 Controlling the mixing/dilution ratio of ALPS treated water with seawater (1/2)

TEPCO

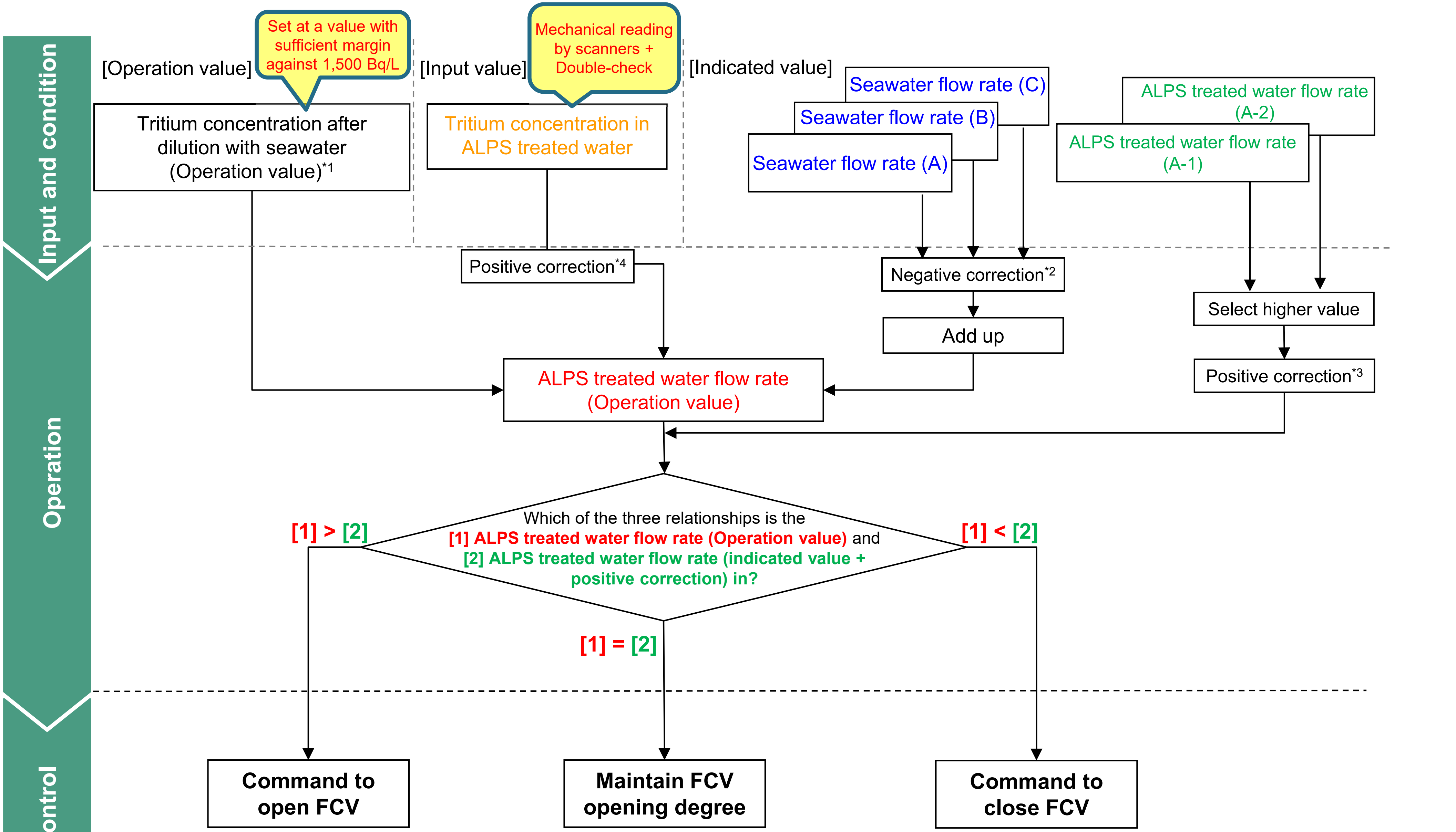
- The flow rate of ALPS treated water is calculated using the following formula, converted from the formula for the calculation of tritium concentration after dilution with seawater, and the opening degree of the ALPS treated water flow rate control valves is adjusted accordingly.
- The opening degree of ALPS treated water control valves are controlled as follows: an operation value is set for the tritium concentration after dilution with seawater (a value with a sufficient margin against 1,500 Bq/L), and then while monitoring the difference between the calculated ALPS treated water flow rate (operation value) and actual indication value, the opening degree of flow rate control valves are adjusted accordingly. In the assessment process, instrument error is incorporated into the flow rates and the uncertainty of analyses into the tritium concentration in ALPS treated water. By doing so, measurement values leading to conservative results are adopted for calculations.

○ Formula to calculate the ALPS treated water flow rate

$$\text{ALPS treated water flow rate (Operation value)} = \frac{\text{Seawater flow rate} \times \text{tritium concentration after dilution with seawater (Operation value)}}{\text{Tritium concentration in ALPS treated water} - \text{tritium concentration after dilution with seawater (Operation value)}}$$



2-1 (1) [1] Control and monitoring of mixing/dilution ratio of ALPS treated water with seawater
[5]-5 Controlling the mixing/dilution ratio of ALPS treated water with seawater (2/2)



*1: The concentration is registered into the monitoring and control device before the facilities are put into service. Unless there is a change in the planned conditions, it must not be changed in principle.
*2: Assuming a non-conservative case due to error of instruments (when the actual flow rate is lower than the indicated value), the value is corrected according to the instrument error (2.1% FS).
*3: Assuming a non-conservative case due to error of instruments (when the actual flow rate is higher than the indicated value), the value is corrected according to the instrument error (2.1% FS).
*4: Assuming a non-conservative case due to an uncertainty of analyses (when the actual concentration is higher than the analysis value), the value is corrected according to the uncertainty ([Tentative] 10%).

The Japanese version shall prevail.

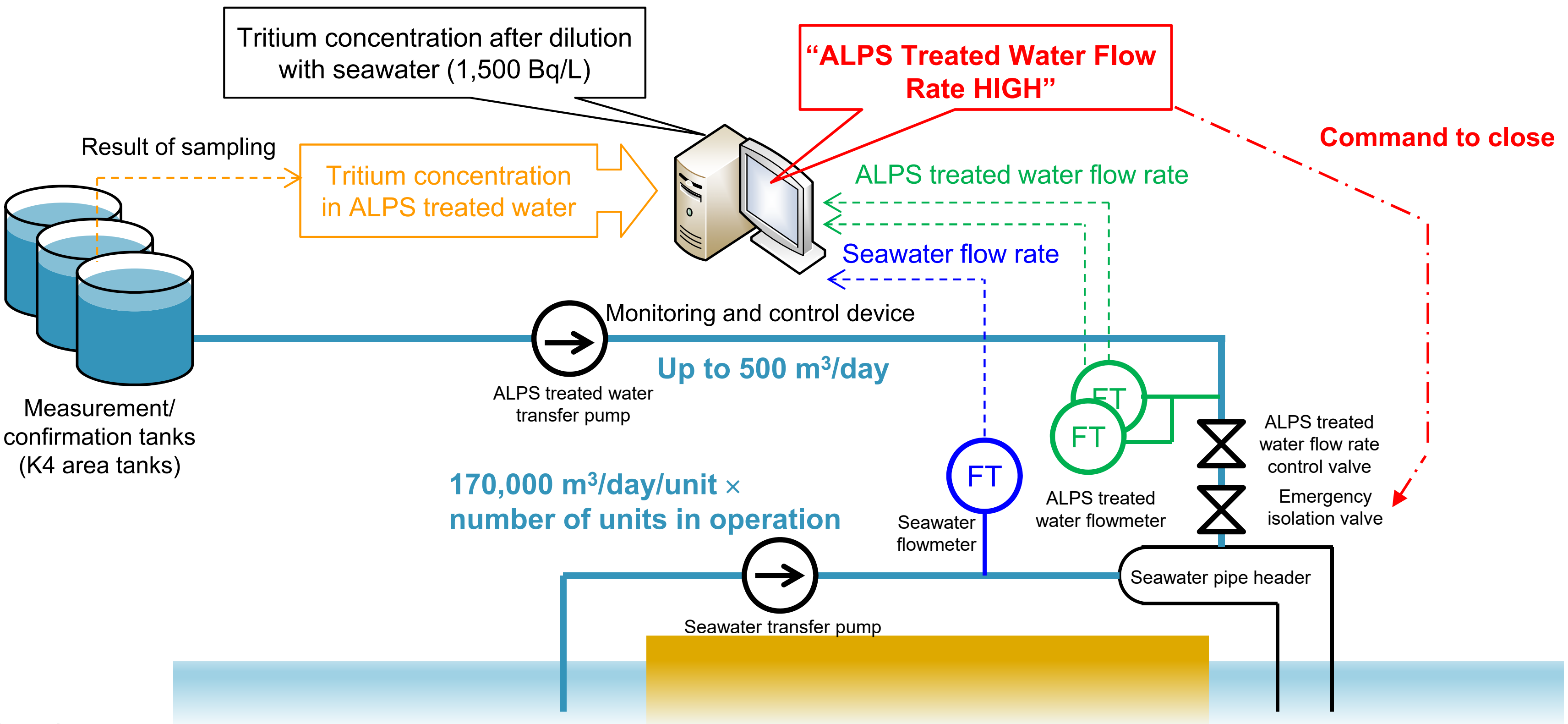
[5]-6. Concept of setting "ALPS Treated Water Flow Rate HIGH" (1/2)

TEPCO

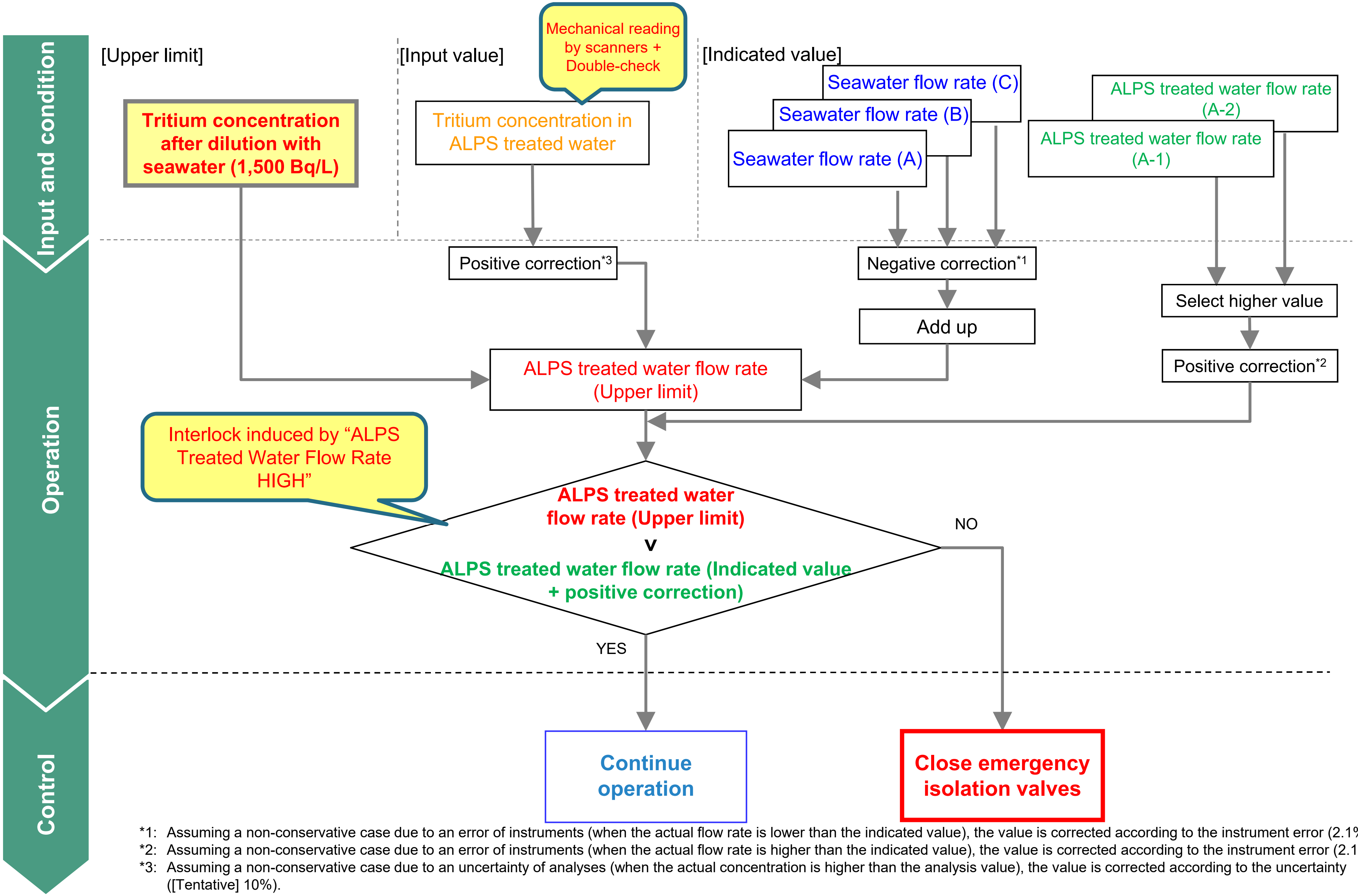
- The upper limit is set for the flow rate of ALPS treated water under the condition that the tritium concentration after dilution is 1,500 Bq/L. When the concentration reaches the upper limit, an alert will be issued, and the emergency isolation valve will be shut off.

○ Formula to calculate the ALPS treated water flow rate

$$\text{ALPS treated water flow rate (Upper limit)} = \frac{\text{Seawater flow rate} \times \text{tritium concentration after dilution with seawater (1,500 Bq/L)}}{\text{Tritium concentration in ALPS treated water} - \text{tritium concentration after dilution with seawater (1,500 Bq/L)}}$$



2-1 (1) [1] Control and monitoring of mixing/dilution ratio of ALPS treated water with seawater [5]-6. Concept of setting "ALPS Treated Water Flow Rate HIGH" (2/2)



*1: Assuming a non-conservative case due to an error of instruments (when the actual flow rate is lower than the indicated value), the value is corrected according to the instrument error (2.1% FS).
*2: Assuming a non-conservative case due to an error of instruments (when the actual flow rate is higher than the indicated value), the value is corrected according to the instrument error (2.1% FS).
*3: Assuming a non-conservative case due to an uncertainty of analyses (when the actual concentration is higher than the analysis value), the value is corrected according to the uncertainty ([Tentative] 10%).

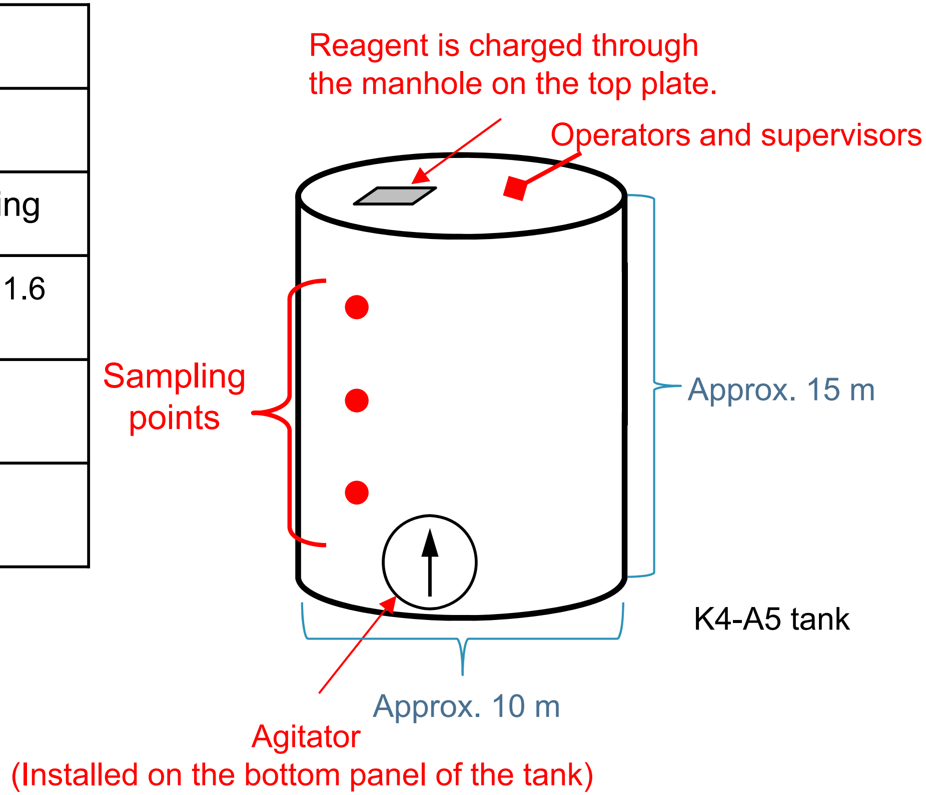
The following slides are for reference.

[Reference] Agitation demonstration test plan (1/2)

- In the agitation demonstration test to be conducted this time, agitators will be installed at the bottom of the tanks, and the operation of the agitators will be checked. In addition, the agitation effect will be evaluated by charging a reagent into the tanks.
- Circulation demonstration test to analyze 8 nuclides*1 and the same reagent is scheduled to be performed with K4-Group B tanks in February 2022.

*1: The major 7 nuclides (Cs-134, Cs-137, Sr-90, I-129, Ru-106, Co-60, Sb-125) and tritium

Date of testing	November 23, 2021
Testing time	About 8 hours
Sampling	Every approx. 30 min/9 times including pre-test sampling
Sampling volume	1 liter from each of the three sampling points (upper (11.6 m), middle (7.6 m), and lower (2.6 m) parts of the tank)
Subjects to be analyzed	Reagent*2
Tanks subject to the test	K4-A5



*2: Since there is no difference in the density of tritium concentration in the measurement/confirmation tanks, a reagent that does not exist in the tanks (tribasic sodium phosphate*3) is charged to check the concentration distribution.
*3: The volume of tribasic sodium phosphate to be charged is set to about one-hundredth of the drainage standard prescribed by the Fukushima prefectural ordinance (phosphorus content: “8 ppm/day on average”), having no environmental impact.

The Japanese version shall prevail.

[Reference] Agitation demonstration test plan (2/2)

TEPCO

[Agitation demonstration test]

Date of demonstration test : November 23, 2021
Testing time : 5 hours 25 minutes (agitation time: 4 hours)
Sampling : Every approx. 30 minutes
Sampling volume : 1 liter from each of the three sampling points (upper (11.6 m), middle (7.6 m), and lower (2.6 m) parts of the tank)
Subjects to be analyzed : phosphate* (Difference from a theoretical average of 80 ppb was confirmed)
Tanks subject to the test : K4-A5

[Testing method]

8:00 Perform sampling (1st) before agitation testing
8:30 Charge tribasic sodium phosphate solution (about 2.6 L)
9:00 Activate an agitator
9:30 Deactivate the agitator (agitation time: 30 min)
9:30~ Perform sampling (2nd) after confirming that the water surface in the tank is stable

After that, sampling will be performed 9 times in total while activating and deactivating the agitator repeatedly (scheduled to finish at around 16:30). After completion, the sample bottles (27 bottles in total) will be submitted to the units 5/6 hot laboratory.

* Put the tracer (tribasic sodium phosphate*2) into the tank and check the concentration distribution.
- The volume of tribasic sodium phosphate to be charged is set to about one-hundredth of the drainage standard prescribed by the Fukushima prefectural ordinance, having no environmental impact.
- The concentration is measured by absorption photometry.

Agitator

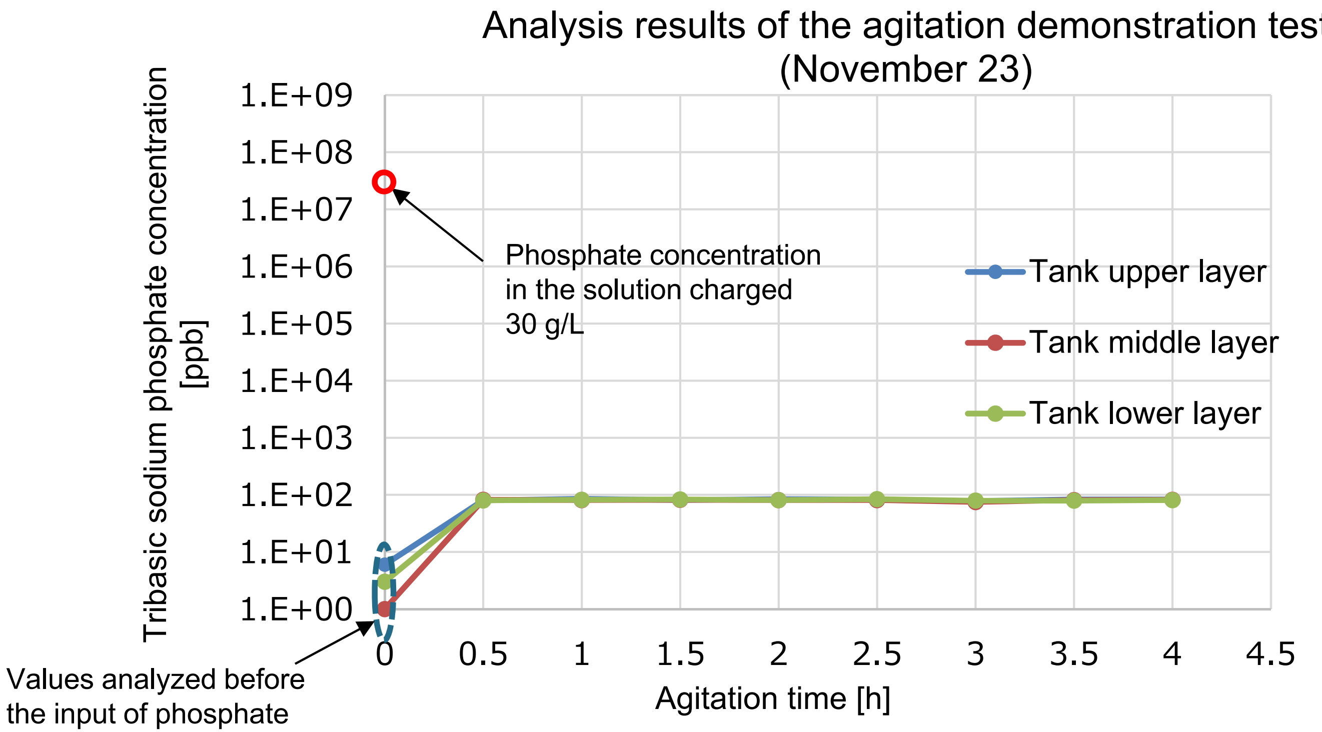
Water surface in the tank while the agitator is in operation (Picture shot at T/R)

Water sampling on the day of the agitation demonstration test

The Japanese version shall prevail.

[Reference] Result of the agitation demonstration test

- The concentration of about 2.6 liters of tribasic sodium phosphate that was charged in the tank was about 30 g/l, and the theoretical concentration, when diluted with about 970 m^3 of water contained in the tank, is about 80 ppb.
- After agitation with the agitator for 30 minutes, the tribasic sodium phosphate concentration in the sample was stable at around 80 ppb, which shows that **the agitator has an agitation effect** (The standard deviation σ from the standard sample of 80 ppb is 3.0 ppb).



(ppb)

	1st (0 h)	2nd (0.5 h)	3rd (1.0 h)	4th (1.5 h)	5th (2.0 h)	6th (2.5 h)	7th (3.0 h)	8th (3.5 h)	9th (4.0 h)
Upper layer	6	80	85	81	84	83	78	83	83
Middle layer	1	82	81	82	81	81	75	81	82
Lower layer	3	80	82	83	81	84	79	79	81

[Reference] Overview of the ALPS treated water Dilution/Discharge Facilities

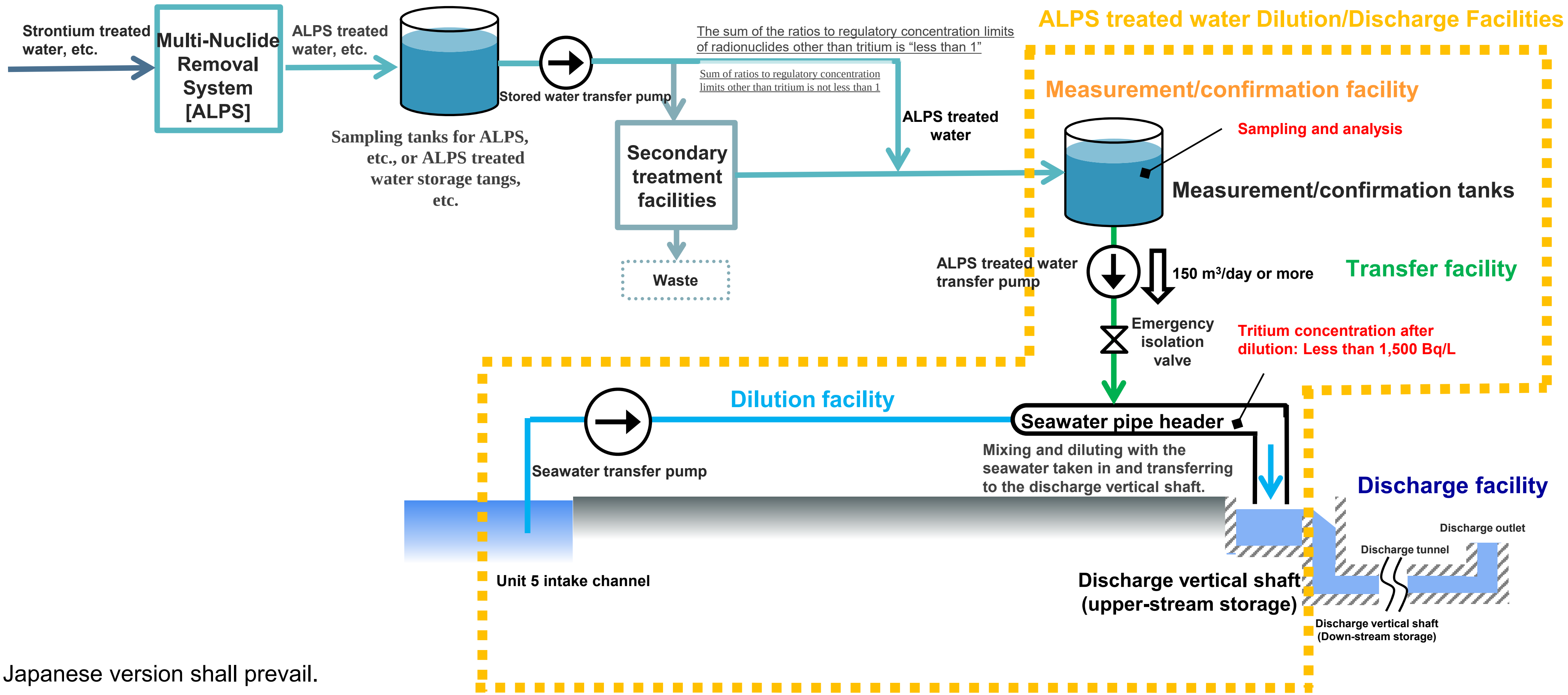
TEPCO

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)

Excerpt from document 2-1, The 97th Specified Nuclear Facilities Monitoring and Assessment Review Meeting

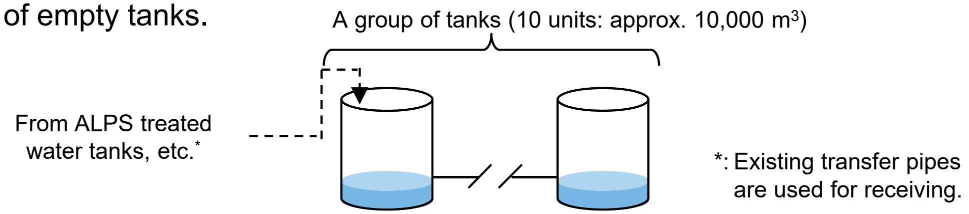
TEPCO

Measurement/Confirmation facility

- K4 area tanks (approx. 30 000 m³ in total) are reused for the Measurement/Confirmation tanks, and each group from A to C consists of 10 tanks (approximately 1,000 m³ 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.

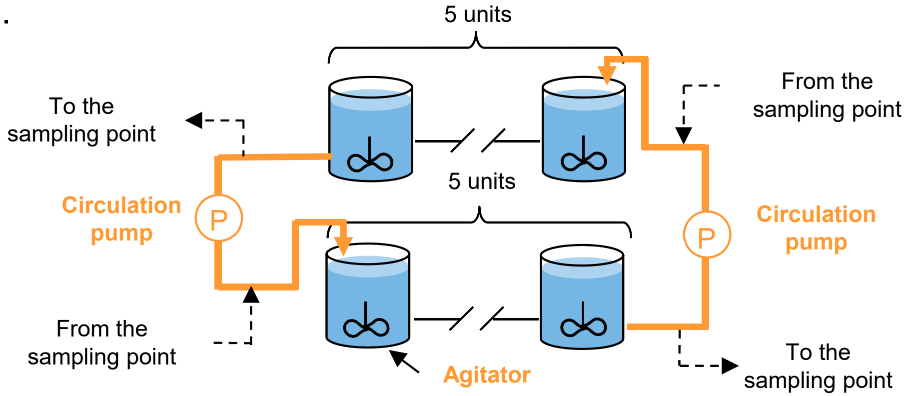
(1) Receiving process

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



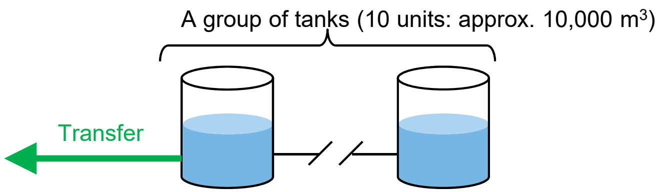
(2) Measurement/Confirmation process

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.

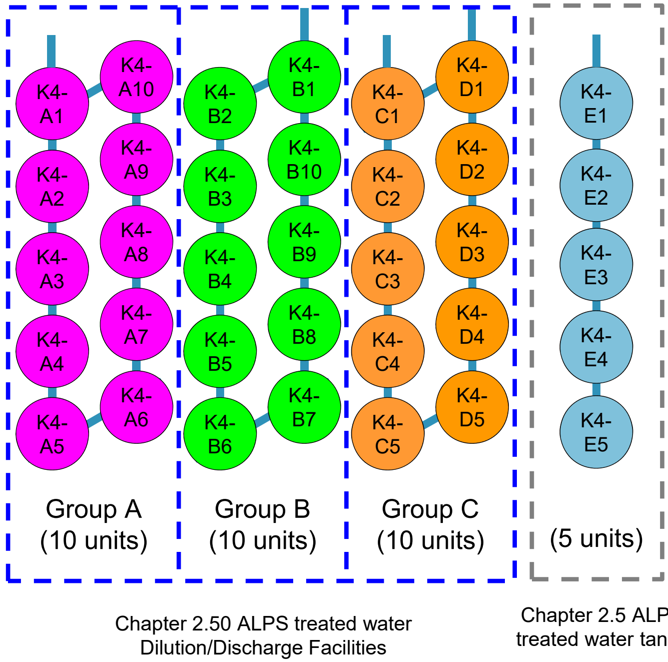


(3) Discharge process

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



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

The Japanese version shall prevail.

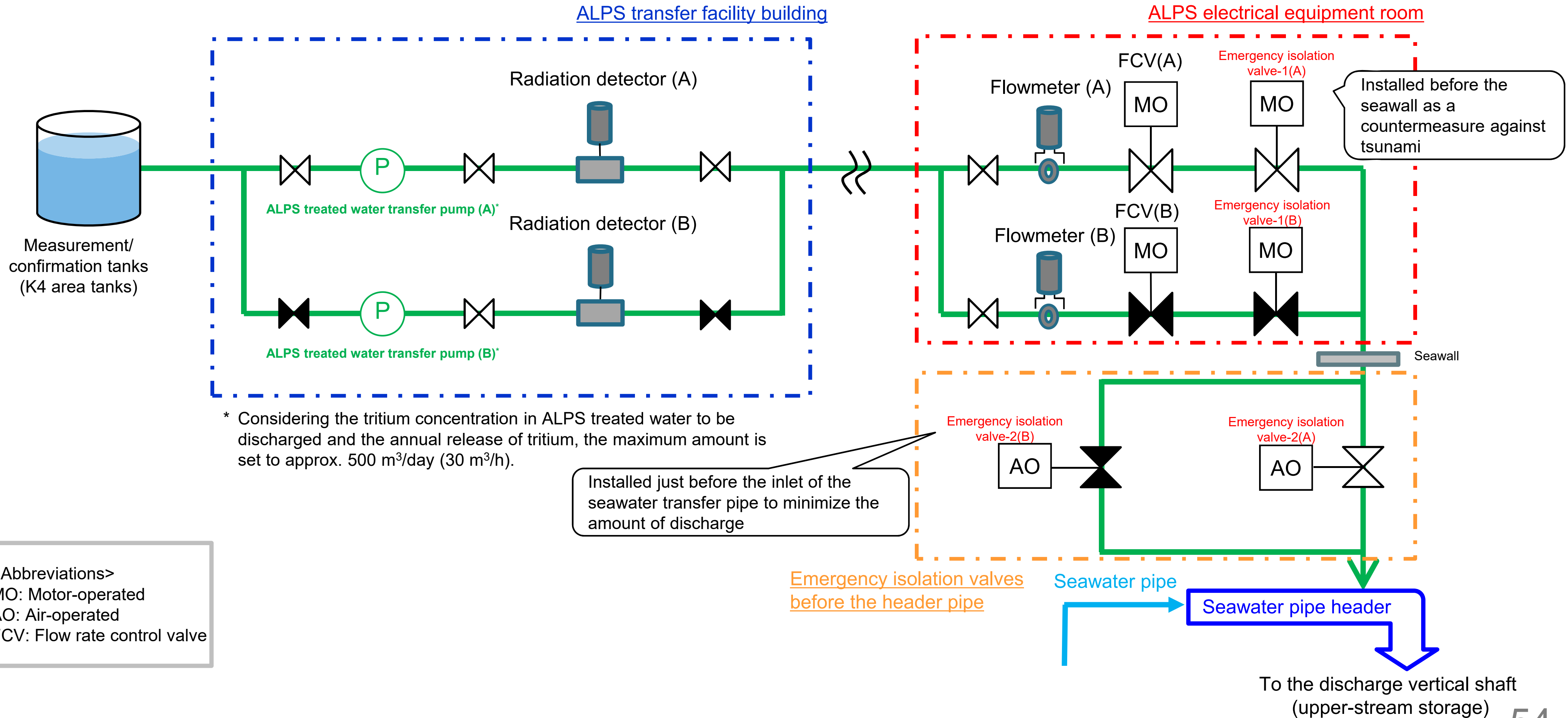
Excerpt from document 2-1, The 97th Specified Nuclear Facilities Monitoring and Assessment Review Meeting

TEPCO

[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 release of tritium, the maximum amount is set to approx. 500 m^3/day (30 m^3/h).

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

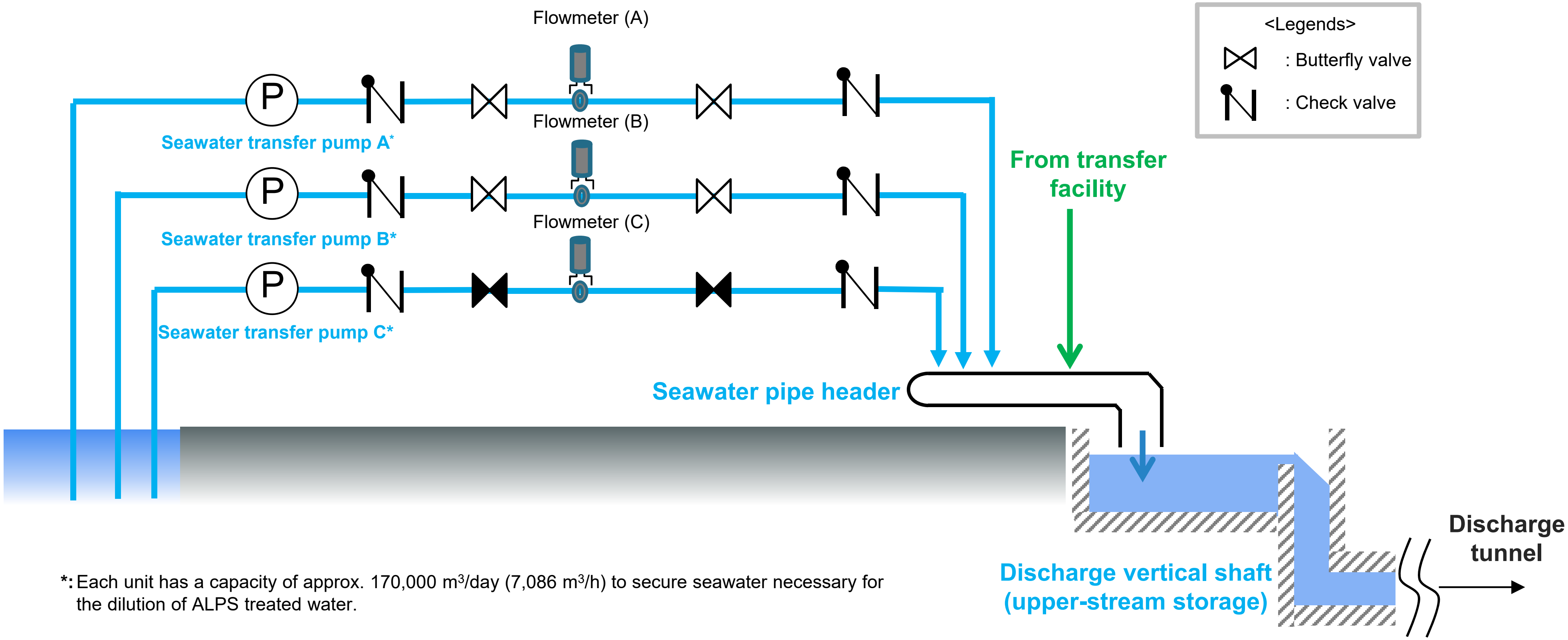
The Japanese version shall prevail.

TEPCO

[Reference] Overview of the ALPS treated water Dilution/Discharge Facilities (Dilution facility)

Dilution facility

- Consisting of seawater transfer pumps, seawater pipes (including a header pipe), and a discharge vertical shaft (upper-stream storage), the Dilution facility dilute ALPS treated water with seawater, transfer 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.

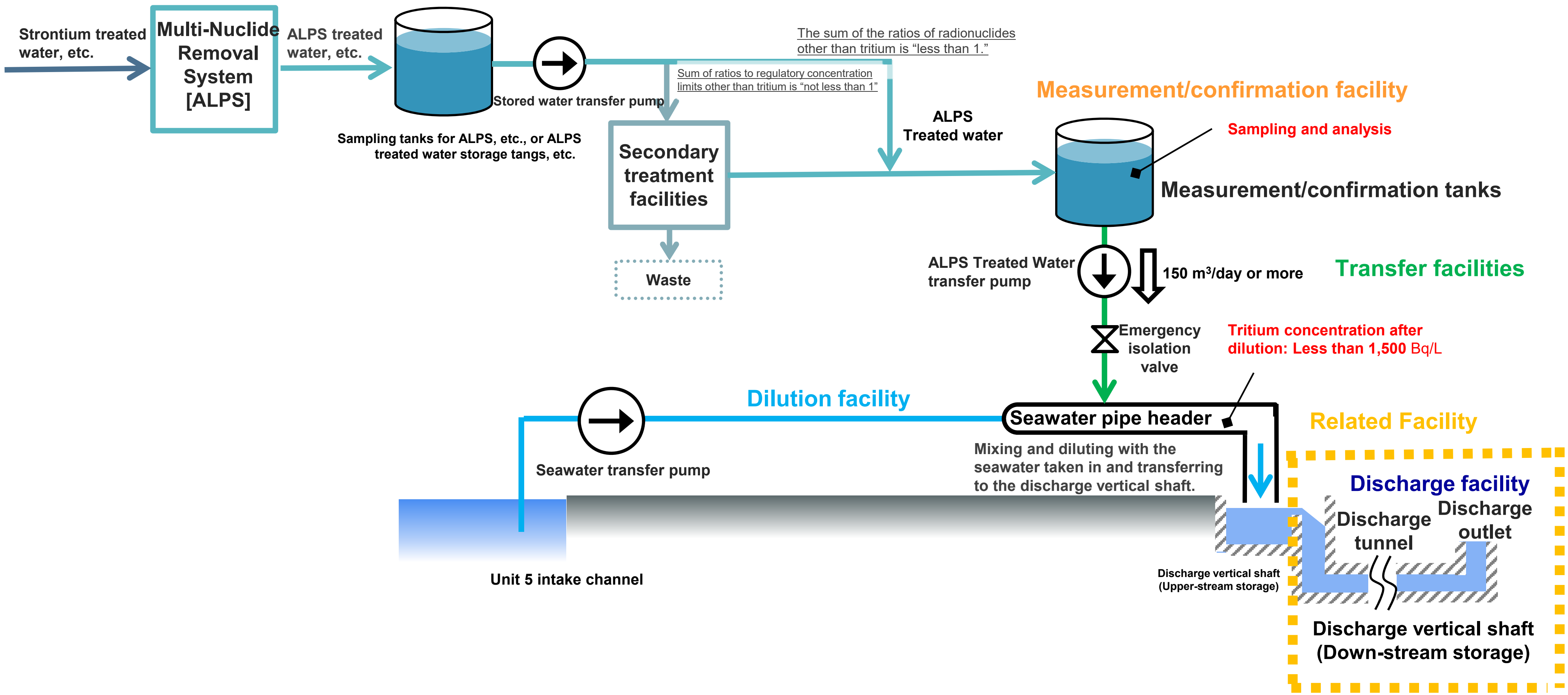


*: Each unit has a capacity of approx. 170,000 m^3/day (7,086 m^3/h) to secure seawater necessary for the dilution of ALPS treated water.

[Reference] Overview of Related Facility (Discharge facility)

TEPCO

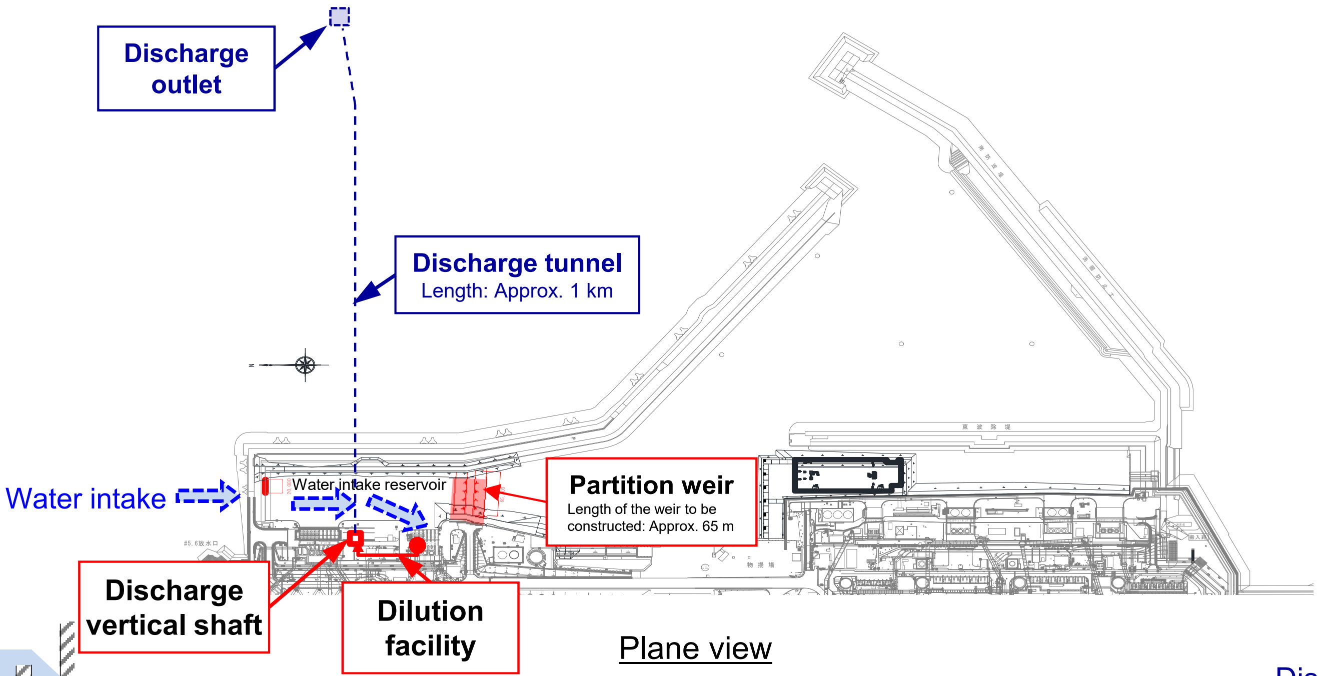
- **Objective**
  Drainage water is discharged from the ALPS Treated Water Dilution/Discharge Facilities (water diluted with seawater that satisfies the sum of the ratios to regulatory concentrations limits of all radionuclides including tritium is less than 1) into the sea from a location approximately 1 km away from the coast.
- **Facility overview**
  The discharge facility consists of a discharge vertical shaft (down-stream storage), a discharge tunnel, and a discharge outlet to achieve the above objective.



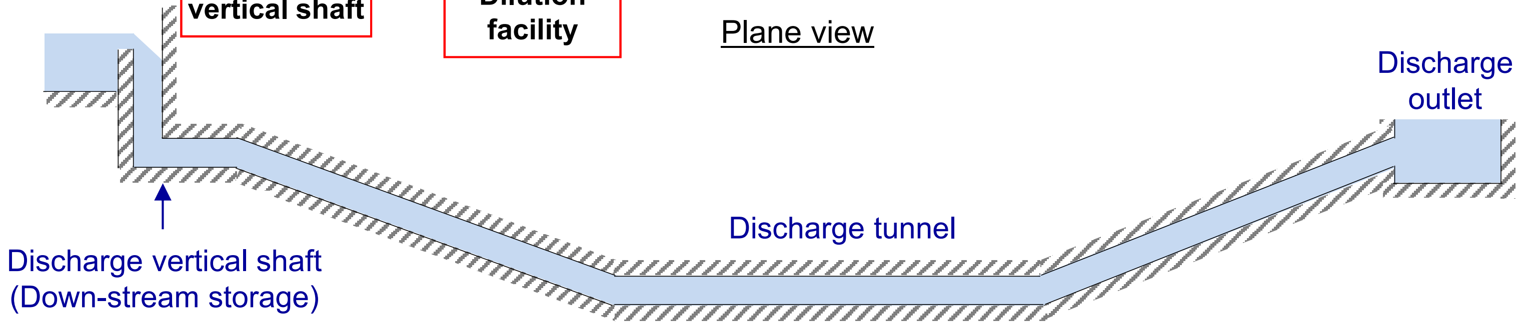
[Reference] Overview of Related Facility (Discharge facility) (1/2)

TEPCO

- 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.



Plane view



Sectional view

[Reference] Overview of Related Facility (Discharge facility) (2/2)

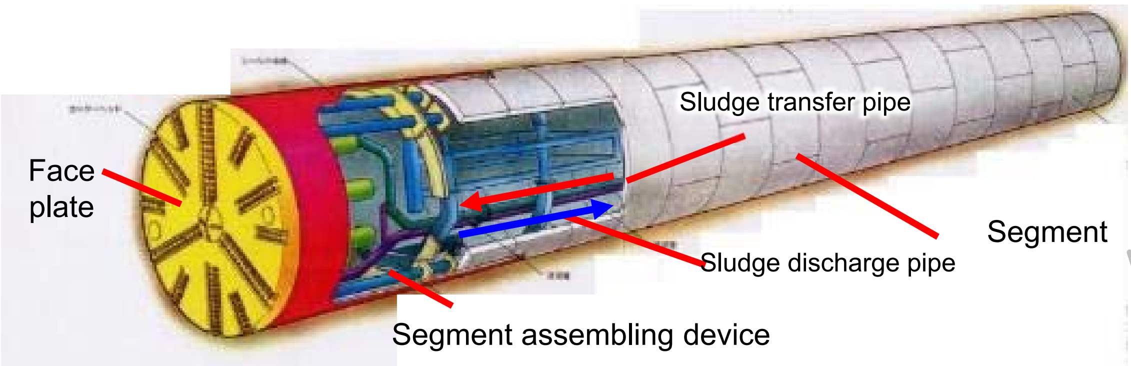
TEPCO

Overview of the structural design

- Water is made to flow 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, secure construction will minimize the possibility of trouble.



*: The slurry shield method was adopted this time.

Schematic diagram of a shield machine

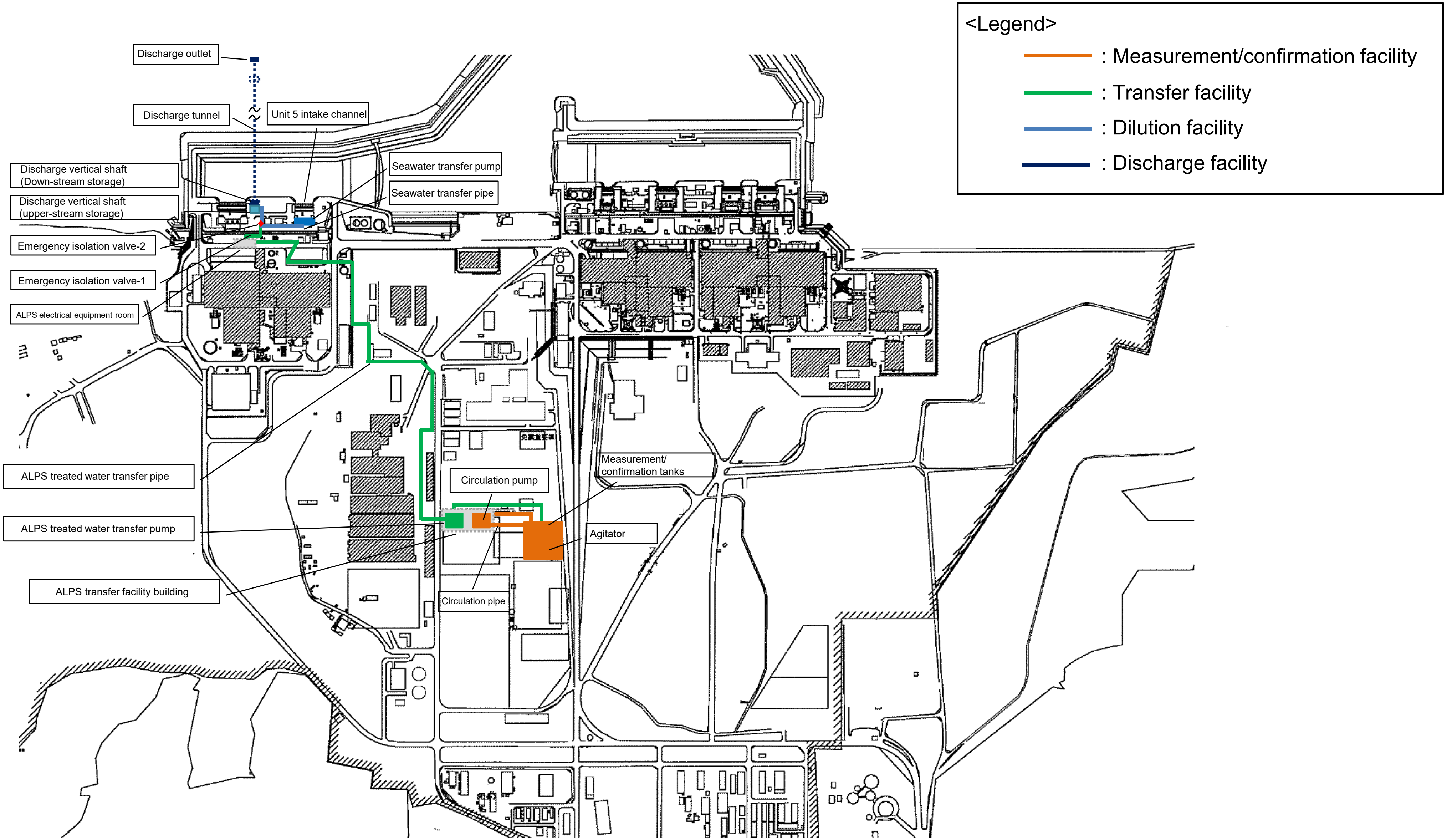
Segment

[Reference] Layout plan of ALPS treated water Dilution/Discharge Facilities and Related Facility

Excerpt from document 2-1, The 97th Specified Nuclear Facilities Monitoring and Assessment Review Meeting

TEPCO

- The layout of ALPS treated water Dilution/Discharge Facilities and Related Facility is as follows. (Implementation Plan: II-2-50-Attachment 1-2)



The Japanese version shall prevail.

TEPCO

[Reference] Installation schedule for ALPS treated water Dilution/Discharge Facilities and Related Facility

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