Application No. FDEC-R4-38
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Nuclear Regulatory Authority

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Partial Revision of the Application for approval to amend the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility

TEPCO partially revise Application for approval to amend the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility, which submitted on Dec. 21, 2021 (Application No. FDEC-R3-175) and partially revised on Apr. 28, 2022 (Application No. FDEC-R4-23), as per the attached document.

END

The Japanese version shall prevail.

Regard to the "Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility" and the "Annexes to the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility," the following sections shall be attached.

The amended part, the reason for the amendment, and the contents of the amendment shall be as follows:

〇Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility

The following amendments are made to installation of the ALPS treated water dilution/discharge facilities and the related facility, and discharge of ALPS treated water into the sea, according to the Optimization of description.

Concurrently, other approved Implementation Plans are reflected.

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I Overall Process and Risk Assessment of Specified Nuclear Facility

2 Risk Assessment

2.1 Concept of Risk Assessment

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・No amendment

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・Optimization of description

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・No amendment

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・Optimization of description

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・No amendment
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2 Structure and Equipment of the Specified Nuclear Facility and Construction Plan
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・Optimization of description

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・Reflection of another approved Implementation Plan

2.50 ALPS Treated Water Dilution/Discharge Facilities and the Related Facility

Body

・Optimization of description

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・Optimization of description

Attachment-2

・Optimization of description

Attachment-3

・Optimization of description

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・Optimization of description

Attachment-5

・Optimization of description

Attachment-6

・No amendment

Attachment-7

・Optimization of description

III Safety of Specified Nuclear Facility

Part 2 Safety Measures on Unit 5 and 6

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Article 88

・No amendment

Supplementary Provisions

・Reflection of another approved Implementation Plan

Part 3 (Supplementary Explanation Regarding Safety)

1 Supplementary Explanation regarding Operation Management

1.9 Operation Management of the ALPS Treated Water Dilution/Discharge Facilities

・Optimization of description

2 Supplementary Explanation regarding Management of Radioactive Waste, etc.

2.1 Management of Radioactive Waste, etc.

2.1.2 Management of Radioactive Liquid Waste, etc.

・No amendment

2.2 Dose Assessment

2.2.3 Dose Assessment by Radioactive Liquid Waste, etc.

・Reflection of another approved Implementation Plan

3 Supplementary Explanation regarding Radiation Management

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・No amendment

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・No amendment

〇Annexes to the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility

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・No amendment

Annex 27 Supplementary Explanation of ALPS Treated Water Dilution/Discharge Facilities

I Structural Strength of ALPS Treated Water Dilution/Discharge Facilities

・No amendment

II Tolerance of nominal values for ALPS Treated Water Dilution/Discharge Facilities

・No amendment

〇Reference Material

・No amendment

End

Comparison Table of amendments in the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility (Table of Contents)

Current	Revised	Reason for Revision
Introduction I Overall Process and Risk Assessment of Specified Nuclear Facilities (Omission) II Design and equipment of specified nuclear facilities (Omission) 2.49 Intake Facility in Unit 3 reactor containment・・・・・・・・・・・・・・・II-2-49-1	Introduction I Overall Process and Risk Assessment of Specified Nuclear Facilities (Omission) II Design and equipment of specified nuclear facilities (Omission) 2.49 Intake Facility in Unit 3 reactor containment・・・・・・・・・・・・・II-2-49-1 2.50 ALPS Treated Water Dilution/Discharge Facilities and Related Facility・・II-2-50-1	Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility
III Safety of Specified Nuclear Facilities (Omission) Part 3 (Supplementary Explanation Regarding Safety) (Omission) 1.8 Operation Management of Groundwater Drain・・・・・・・・・・・・・・III-3-1-8-1 2 Supplementary Explanation of the Management of Radioactive Waste, etc. (Omitted below)	III Safety of Specified Nuclear Facilities (Omission) Part 3 (Supplementary Explanation Regarding Safety) (Omission) 1.8 Operation Management of Groundwater Drain・・・・・・・・・・・・・III-3-1-8-1 1.9 Operation Management of ALPS Treated Water Dilution/Discharge Facilities・III-3-1-9-1 2 Supplementary explanation regarding Management of Radioactive Waste, etc. (Omitted below)	Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility, and optimization of the description

The Japanese version shall prevail.

Current	Revised	Reason for Revision
2 Risk assessment 2.1 Concept of risk assessment (Omission) (3) Items to be considered at the time of risk assessment When implementing a risk assessment based on the aforementioned procedures, by considering the following items, organize risks at the specified nuclear power facility systematically so that they can be viewed as a whole. a. Amount and type of radioactive materials By implementation of risk assessment, considering radioactive material's quantity (inventory) and type (debris, fuel assemblies, contaminated water, etc.) from the viewpoint of the source of radioactive materials, it is possible to rationally evaluate the necessity and urgency of countermeasures and to carry out an approach for appropriate and efficient risk reduction. (Omitted below)	2 Risk assessment 2.1 Concept of risk assessment (Omission) (3) Items to be considered at the time of risk assessment When implementing a risk assessment based on the aforementioned procedures, by considering the following items, organize risks at the specified nuclear power facility systematically so that they can be viewed as a whole. a. Amount and type of radioactive materials By implementation of risk assessment, considering radioactive material's quantity (inventory) and type (debris, fuel assemblies, high levels of radioactive contaminated water generated in reactor buildings by injection of water into reactors, infiltration of rainwater, infiltration of groundwater (hereinafter "contaminated water", etc.) from the viewpoint of the source of radioactive materials, it is possible to rationally evaluate the necessity and urgency of countermeasures and to carry out an approach for appropriate and efficient risk reduction. (Omitted below)	Optimization of the description

The Japanese version shall prevail.

Current	Revised	Reason for Revision
2.3.7 Radioactive Waste As an assumed risk of radioactive waste in the specified nuclear power facility, leakage of radioactive liquid waste, such as contaminated water, to the outside of the system is considered. However, the possibility of leakage of radioactive liquid waste to the outside of the system of the specified nuclear power facility is kept sufficiently low by taking various measures as follows. The concentration of radioactive materials will decrease by continuing the water treatment of contaminated water, and the degree of impact on the environment will be reduced continually even if leakage from the facility occurs. [Measures to reduce the risk of leakage from facilities] • Conversion of pressure hose to polyethylene pipe	2.3.7 Radioactive Waste As an assumed risk of radioactive waste in the specified nuclear power facility, leakage of radioactive liquid waste, such as contaminated water, to the outside of the system is considered. However, the possibility of leakage of radioactive liquid waste to the outside of the system of the specified nuclear power facility is kept sufficiently low by taking various measures as follows. The concentration of radioactive materials will decrease by continuing the water treatment of contaminated water, and the degree of impact on the environment will be reduced continually even if leakage from the facility occurs. [Measures to reduce the risk of leakage from facilities] • Conversion of pressure hose to polyethylene pipe • Through discharge of water treated by ALPS of which sum of the ratio of radioactive materials contained in contaminated water other than tritium to concentration limit stipulated in the Notification to Establish Requirements for Operational Safety and Physical Protection of Specified Nuclear Fuel Materials of the Nuclear Reactors at TEPCO's FDNPS (hereinafter "notification") is less than 1 (hereinafter "ALPS treated water"), dismantle and removal of tanks storing the ALPS treated water, etc. (hereinafter "medium/low concentration tank").	Addition in accordance with the description of risk reduction measures along with discharge of ALPS treated water
[Measures to reduce the risk of leakage expansion] • Installation of weirs and sandbags around tanks • Making the drainage channel into the culvert • Installation of leakage detectors and monitoring cameras As for radioactive gas waste, the release of radioactive gas at the time of temperature rise in the containment vessel is considered as a risk, and this is included in the risk assessment related to water injection stop for fuel debris. For radioactive solid waste, due to its low fluidity and diffusivity, it is included in the risk evaluation related to the direct ray and skyshine ray from each facility within the site showed in I.2.2.	[Measures to reduce the risk of leakage expansion] • Installation of weirs and sandbags around the medium and low concentration tanks • Making the drainage channel into the culvert • Installation of leakage detectors and monitoring cameras As for radioactive gas waste, the release of radioactive gas at the time of temperature rise in the containment vessel is considered as a risk, and this is included in the risk assessment related to water injection stop for fuel debris. For radioactive solid waste, due to its low fluidity and diffusivity, it is included in the risk evaluation related to the direct ray and skyshine ray from the specified nuclear facility within the site.	Optimization of the description

The Japanese version shall prevail.

Current	Revised	Reason for Revision
2.4 Future Risk Reduction Measures for the Specified Nuclear Facility At present, the effective dose outside the site caused by the additional discharge from the specified nuclear facility is kept low (see 2-2)). In addition, it is evaluated that the impact on the outside of the site is sufficiently low in the risk assessment assuming the event that occurs in the abnormal case of fuel debris and spent fuel containing many radioactive materials (see 2-3).	2.4 Future Risk Reduction Measures for the Specified Nuclear Facility At present, the effective dose outside the site caused by the additional discharge from the specified nuclear facility is kept low (see 2-2). In addition, it is evaluated that the impact on the outside of the site is sufficiently low in the risk assessment assuming the event that occurs in the abnormal case of fuel debris and spent fuel containing many radioactive materials (see 2-3).	
There are various risks to be tackled over short and medium term, which are represented in the items, such as further activities towards the steady state of the plant, efforts to reduce radiation dose and prevent the spread of contamination for the entire power station, and fuel removal from spent fuel pool, and these are shown in Table 2.4-1. Table 2.4-1 summarizes the representative risks considered, measures and target timing planned to be implemented for risk reduction for each item, and confirmation was made based on the viewpoint of confirming the appropriateness of the risk reduction measures shown in 2.1. To reduce the risk of the entire specified nuclear facility, particularly as a matter of immediate concern, efforts will be made (1) reduction in the amount of contaminated water generated and reduction in the amount of contaminated water stored through reliable treatment (2) early removal of spent fuel from spent fuel pools with priority. Additionally, to reduce individual risks shown in the table, various measures such as measures to improve the reliability of facilities will be planned and implemented in the future. These individual measures will be confirmed based on the viewpoint of confirming the appropriateness of risk reduction measures, and the effectiveness, necessity, timing, etc., of implementation are going to be thoroughly examined and optimized from the viewpoint of expected risk reduction and safety, exposure, environmental impact, etc., and are going to be reflected in the Implementation Plan as necessary.	In the future, risk reduction measures will be carried out for various risks existing in the Fukushima Daiichi NPS which should be tackled over short and medium term, based on the latest "Medium-Term Risk Reduction Target Map for TEPCO Fukushima Daiichi NPS (hereinafter "risk map.")" There are various risks which are represented in each item, such as further activities towards the steady state of the plant, efforts to reduce radiation dose and prevent the spread of contamination for the entire power station, and fuel removal from spent fuel pool. Measures planned to be implemented for risk reduction for each item will be confirmed based on the viewpoint of confirming the appropriateness of risk reduction measures, and the effectiveness, necessity, timing, etc., of implementation will be thoroughly examined and optimized from the viewpoint of expected risk reduction and safety, exposure, environmental impact, etc., and will be reflected in the Implementation Plan as necessary.	Optimization of the description (clarifying description of the risk reduction action in accordance with "Medium-Term Risk Reduction Target Map for TEPCO Fukushima Daiichi NPS")
	With the discharge of ALPS treated water into the sea, which is to be implemented in "Implemantation Plan I 2.3.7 Radioactive Waste", through the effective use of resources, such as the site concerning decommissioning, the entire process according to the Mid-and-Long-Term Roadmap will be achieved and risk reduction measures based on the risk map will be carried out.	Optimization of the description (clarifying description on overall concept on discharge of ALPS treated water)
	2.4.1 Attachment Attachment-1 Risk reduction measures planned to be implemented and appropriateness	Optimization of the description (Description changed on the "Risk reduction measures to be implemented and appropriateness")

The Japanese version shall prevail.

Current

2.4 Future risk reduction measures for specified nuclear facilities

(Omitted)

Table 2.4-1 Risk reduction measures planned to be implemented and appropriateness (1/8)

Road Map Related Items		Assumed risks	Risk reduction measures		Purpose	Target timing	Adequacy of individual measures
Plans for maintaining and continuity stable plant conditions	Reactor cooling plan	・Risk of loss of monitoring for reactor cold shutdown conditions due to medium-to long-term thermometer failure	New installation of alternative thermometers for reactor pressure vessels		Regarding existing thermometers of reactor pressure vessels, locations where temperature monitoring is possible shall be selected so that additional thermometers can be installed in preparation for failure of existing thermometers, and backup of temperature monitoring of each unit shall be maintained.	Unit 2: October 2012 Installation at one location Unit 1: A mock-up test was conducted on the pipe modification method in the middle of fiscal 2013, and the construction method was established. Unit 3: Implemented environmental improvements by March 2014, conducted on-site surveys, and implemented candidate lines	①If the thermometer fails because it cannot be maintained and the usable thermometer is no longer available, monitoring of the cooling condition becomes impossible. ②Temperature can no longer be monitored, but there is no direct impact on the risk of additional release of radioactive material. ③Since both new and old thermometers are installed in the building, the risk for external events is small. ④There is an increase in the possibility that existing thermometers will fail due to deterioration. ⑤Since there are many troubles with the thermometer of Unit 2, it is reasonable to prioritize the installation of Unit 2. The installation of Units 1 and 2 is also planned to be considered. ⑥Though there is no risk of directly increasing by implementing measures, the exposure dose increases because the dose in the installation environment is high. ⑦ Investigate the installation timing, location, and method in preparation for deterioration of the existing pressure vessel thermometers and other instruments.
			Installation of monitoring instruments in container		As for the existing thermometers in the reactor container, an alternative thermometer will be inserted from the container penetration for direct monitoring of the cold shutdown condition inside the reactor container, because maintenance and replacement will not be possible in the event of a failure.	Unit 1: installed in October 2012 Unit 2: installed in September 2012, Adjusting the timing of additional installation Unit 3: Scheduled to be installed by the end of March 2014	①If the thermometer fails due to unavailability of maintenance, and the usable thermometer runs out, monitoring of the cooling condition in the container becomes impossible. ②Temperature can no longer be monitored, but there is no direct impact on the risk of additional release of radioactive material. ③Since both new and old thermometers are installed in the building, the risk for external events is small. ④There is an increase in the possibility that existing thermometers will fail due to deterioration. ⑤Since the radiation dose in the reactor building of Unit 3 is high, it is reasonable to give priority to the installation of Units 1 and 2. Plans will be drawn up for the installation of Unit 3 as soon as possible after improving the environment so that installation work can be carried out. ⑥Though there is no risk of directly increasing by implementing measures, the exposure dose increases because the dose in the installation environment is high. ⑦ Investigate the timing, location, and method of installation in preparation for deterioration of existing containment thermometers and other instruments.
		・Risk of the function stop of water injection ・Risk of the release of radioactive substances outside of the system	Measures to improve reliability of cooling water source with circulating injection	Change of operation to condensate storage tank and use of polyethylene pipe for condensate storage tank reactor water injection pump pipe	Regarding the reactor water injection equipment, the increase in the water source retention amount and the earthquake resistance of the water source will be attempted by changing the water source from a temporary buffer tank to an existing condensate storage tank. In addition, by shortening the piping distance and installing new polyethylene piping, loss of water injection function and leakage risk will be reduced.	Started operation in July 2013	①Equipment of water injection to the reactor already have diversity and redundancy, and although a certain level of reliability has been ensured, the expected further reliability improvement cannot be attempted. ②The risk of additional emission of radioactive materials in the event of a shutdown of the the function of water injection to the reactor is large. ③The risk is reduced because the earthquake resistance of the water source increases by changing the water source to a condensate storage tank. ④It is considered that it can be used for a long time by appropriate maintenance even using the current equipment, and the change of the time-related risk is small. ⑤Improving the reliability of equipment of water injection to the reactor should be implemented as soon as possible to contribute to risk reduction, and it has already been implemented. ⑥Though there is no risk of directly increasing by implementing measures, the exposure dose increases because the dose in the installation environment is high. ⑦There is no risk that measures cannot be implemented.
				Measures to prevent off-site release in the event of a leak (consideration of installation of weirs, leak detection equipment, etc.)	Weirs and leak detector shall be installed to prevent off-site release and detect leaks in the pipe of the reactor water injection facility at an early stage.	Completed at the end of December 2012	①The risk of additional release of radioactive material in the event of a leak is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to prevent the spread of leakage, and the risk of equipment damage against external events does not change. ④The purpose is to prevent leakage from spreading, and the risk does not change in time. ⑤It is desirable to implement it as early as possible, and it has been already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
				Measures to transform temprarily houses to permanent houses	The prevention of equipment failure due to external events such as typhoons, salt damage, and freezing will be attempted by placing pumps, etc., of the reactor water injection equipment in a permanently installed house, etc.	Completed at the end of December 2012	①External event risk such as freezing is not reduced. ②The risk of additional emission of radioactive materials in the event of a shutdown of the the function of water injection to the reactor is large. ③Permanent temporary housing reduces the risk of external events. ④The temporary house is to be permanently installed, and the time risk does not change. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
			Establishment of circulation loop in the reactor building		A circulation loop that does not pass through equipment installed outside the building, such as a water treatment facility, is formed to reduce the risk of release to the outside of the system. In addition, by using the accumulated water in the building as the cooling water as it	Completed at the end of March 2015	①Leakage risk from general circulation loop is not reduced. ②Reduce leakage risk by reducing the length of loops laid outdoors. ③Installation in the building reduces the risk of external events related to weather, etc. ④It is considered that it can be used for a long time by appropriate maintenance even in the current equipment, and the change of the time-related risk is small. ⑤As a preliminary step to constructing the circulation loop in the

Revised

2.4 Future risk reduction measures for specified nuclear facilities

(Omitted)

Attachment-1

Risk reduction measures planned to be implemented and appropriateness (1/8)

Road Map Related Items		Assumed risks	Risk reduction measures		Purpose	Response status	Adequacy of individual measures
Plans for maintaining and continuing the stable plant conditions	Reactor cooling plan	・Risk of loss of monitoring of reactor cold shutdown conditions due to medium-to long-term thermometer failure	New installation of alternative thermometers for reactor pressure vessels		Regarding existing thermometers of reactor pressure vessels, locations where temperature monitoring is possible shall be selected so that additional thermometers can be installed in preparation for failure of existing thermometers, and backup of temperature monitoring of each unit shall be maintained.	Unit 2: Completed installation in October 2012 Units 1 and 3: Reported that installation was difficult from the viewpoint of feasibility of work and feasibility of installing thermometers in April 2019 (conducted monthly thermometer reliability evaluation)	①If the thermometer fails because it cannot be maintained and the usable thermometer is no longer available, monitoring of the cooling condition becomes impossible. ②Temperature can no longer be monitored, but there is no direct impact on the risk of additional release of radioactive material. ③Since both new and old thermometers are installed in the building, the risk for external events is small. ④There is an increase in the possibility that existing thermometers will fail due to deterioration. ⑤Since there are many troubles with the thermometer of Unit 2, it is reasonable to prioritize the installation of Unit 2. The installation of Units 1 and 2 is also planned to be considered. ⑥Though there is no risk of directly increasing by implementing measures, the exposure dose increases because the dose in the installation environment is high. ⑦Investigate the installation timing, location, and method in preparation for deterioration of the existing pressure vessel thermometers and other instruments.
			Installation of monitoring instruments in the reactor container		As for the existing thermometers in the reactor container, an alternative thermometer will be inserted from the container penetration for direct monitoring of the cold shutdown condition inside the reactor container, because maintenance and replacement will not be possible in the event of a failure.	Unit 1: Completed installation in October 2012 Unit 2: Completed installation in September 2012 Additional installation completed in August 2013 Unit 3: Completed installation in December 2015	①If the thermometer fails due to unavailability of maintenance, and the usable thermometer runs out, monitoring of the cooling condition in the container becomes impossible. ②Temperature can no longer be monitored, but there is no direct impact on the risk of additional release of radioactive material. ③Since both new and old thermometers are installed in the building, the risk for external events is small. ④There is an increase in the possibility that existing thermometers will fail due to deterioration. ⑤Since the radiation dose in the reactor building of Unit 3 is high, it is reasonable to give priority to the installation of Units 1 and 2. Plans will be drawn up for the installation of Unit 3 as soon as possible after improving the environment so that installation work can be carried out. ⑥Though there is no risk of directly increasing by implementing measures, the exposure dose increases because the dose in the installation environment is high. ⑦ Investigate the timing, location, and method of installation in preparation for deterioration of existing containment thermometers and other instruments.
		・Risk of stopping the water injection function ・Risk of off-system release of radioactive material	Measures to improve reliability of circulating injection cooling water source	Change of operation to condensate storage tank and use of polyethylene pipe for condensate storage tank reactor water injection pump piping	Regarding the reactor water injection equipment, the increase in the water source retention amount and the earthquake resistance of the water source will be attempted by changing the water source from a temporary buffer tank to an existing condensate storage tank. In addition, by shortening the piping distance and installing new polyethylene piping, loss of water injection function and leakage risk will be reduced.	July 2013 Commencement of operation of condensate storage tanks February 2014 Completion of polyethylene piping measures for condensate storage tank reactor water injection pump pipe	①Equipment of water injection to the reactor already have diversity and redundancy, and although a certain level of reliability has been ensured, the expected further reliability improvement cannot be attempted. ②The risk of additional emission of radioactive materials in the event of a shutdown of the the function of water injection to the reactor is large. ③The risk is reduced because the earthquake resistance of the water source increases by changing the water source to a condensate storage tank. ④It is considered that it can be used for a long time by appropriate maintenance even in the current equipment, and the change of the time-related risk is small. ⑤Improving the reliability of equipment of water injection to the reactor should be implemented as soon as possible to contribute to risk reduction, and it has already been implemented. ⑥Though there is no risk of directly increasing by implementing measures, the exposure dose increases because the dose in the installation environment is high. ⑦There is no risk that measures cannot be implemented.
				Measures to prevent off-site release in the event of a leak (consideration of installation of weirs, leak detection equipment, etc.)	Weirs and leak detector shall be installed to prevent off-site release and detect leaks in the pipe of the reactor water injection facility at an early stage.	Completed installation in December 2013	①The risk of additional release of radioactive material in the event of a leak is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to prevent the spread of leakage, and the risk of equipment damage against external events does not change. ④The purpose is to prevent leakage from spreading, and the risk does not change in time. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
				Measures to transform tempraly houses to permanent houses	The prevention of equipment failure due to external events such as typhoons, salt damage, and freezing will be attempted by placing pumps, etc., of the reactor water injection equipment in a permanently installed house, etc.	Completed installation in February 2013	①External event risk such as freezing is not reduced. ②The risk of additional emission of radioactive materials in the event of a shutdown of the the function of water injection to the reactor is large. ③Permanent temporary housing reduces the risk of external events. ④The temporary house is to be permanently installed, and the time risk does not change. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
			Establishment of circulation loop in the building		A circulation loop that does not pass through equipment installed outside the building, such as a water treatment facility, is formed to reduce the risk of release to the outside of the system. In addition, by using the accumulated water in the building as the cooling water as it is, a system can be constructed to increase the reactor water injection volume without depending on the treatment	Started operation in October 2016 (The accumulated water circulation cooling of the building is under consideration in conjunction with the removal of fuel debris.)	①Leakage risk from general circulation loop is not reduced. ②Reduce leakage risk by reducing the length of loops laid outdoors. ③Installation in the building reduces the risk of external events related to weather, etc. ④It is considered that it can be used for a long time by appropriate maintenance even in the current equipment, and the change of the time-related risk is small. ⑤As a preliminary step to constructing the circulation loop in the building, it is necessary to consider the water intake site including the accumulated water quality, the interference with the working environment and the containment water cut-off work, etc., and therefore investigations

Reason for Revison

Update the description of response status and optimization of the description

Current	Revised	Reason for Revison

Current

				is, a system can be constructed to increase the reactor water injection volume without depending on the treatment volume of the water treatment facility, etc. or the amount of water leaked from the reactor container.		building, it is necessary to consider the water intake site including the accumulated water quality, the interference with the working environment and the containment water cut-off work, etc., and therefore investigations and studies are being carried out for implementation so that measures can be taken by the target time. ⑥In addition to the exposure risk of workers, there is a risk of high dose in the building. ⑦Consideration should be given to monitoring the tendency of accumulated water quality, optimizing the line configuration, and improving the environment such as decontamination, so that effective measures can be taken.

Table 2.4-1 Risk reduction measures planned to be implemented and appropriateness (2/8)

Road Map Related Items		Assumed risks	Risk reduction measures	Purpose	Target timing	Adequacy of individual measures
Plans for maintaining and continuity stable plant conditions	Reactor cooling plan	・Risk of loss of inert atmosphere maintenance function in the reactor pressure vessel and container	Addition of nitrogen supply equipment to reactor pressure vessels and container	Nitrogen supply equipment is operated on one of the two normally used container and maintains sufficient performance to maintain the hydrogen concentration in the reactor container below the flammable concentration (4%). Even if the operation unit stops, there is enough time to start up the spare equipment (more than 100 hours). Therefore, there is no problem with the operation of one unit in regular use. However, for further reliability improvement, one more unit of normal nitrogen gas separation equipment will be installed.	Completed at the end of March 2013	①Although the nitrogen-enclosed equipment in the reactor container ensures redundancy by installing a nitrogen supply device equipped with an emergency power supply, when inspections involving long-term shutdowns of the normal equipment are conducted, the normal equipment becomes a single state. ②Since the redundancy of the equipment is ensured even in the present equipment installation status, and the shutdown margin time when the operation unit stops is sufficiently ensured (100 hours or more), it is considered that the possibility of hydrogen explosion is kept sufficiently low even without further reliability improvement measures at this time. ③The risk for external events is reduced by installing it on a higher ground. ④The risk of failure of the nitrogen supply equipment increases due to the aging deterioration of the equipment, but the installation of additional equipment enables more appropriate maintenance management. ⑤ Improving the reliability of the nitrogen supply equipment contributes to the risk reduction, so it is desirable to carry out it at an early stage. ⑥The risk of implementing measures is small. ⑦There is no risk that it cannot be implemented.
			Encapsulation of nitrogen gas in equipment with confirmed retention of hydrogen	Equipment for which high concentration of hydrogen retention, such as the suppression chamber (S/C) gas phase section, has been confirmed, is brought into an inert state by encapsulation of nitrogen gas or the like.	Unit 1 S/C: Completed (Considering a policy of nitrogen encapsulation) Unit 2 S/C: In response since the first half of fiscal 2013 Unit 3 S/C: Investigation of residual hydrogen in the gas phase of the enclosed space in the S/C is under way.	①The high concentration of hydrogen in the suppression chamber, which was confirmed this time, is considered to be a residue, although it occurred at the beginning of the accident. Considering the low oxygen concentration and the fact that it has been stably present in the closed space until now, hydrogen explosion is considered to be of low urgency to occur. However, this situation continues unless hydrogen purging is performed. ②Although there is a risk that radioactive material will be released in case a hydrogen explosion occurs, however this measure can be reduced, since the suppression chamber is a part of the container and there is a possibility that the residual amount of hydrogen is large depending on the volume of the closed space, ③Hydrogen purge reduces the risk of hydrogen explosion for external events. ④It is considered that the temporal risk does not increase drastically, because it has maintained a stable state until now after the accident and the contribution of radiolysis of water is thought to be small, and because the inert state is maintained by nitrogen inclusion in the container and the hydrogen concentration is monitored by the container gas management facility. ⑤Considering the related works such as the suppression chamber repair work and the field dose environment, it is necessary to carefully conduct field investigations, etc., and to implement measures as soon as possible when high concentration of hydrogen is confirmed. ⑥Since it is a high dose work in the building, it is necessary to carry out the work with monitoring the behavior of hydrogen concentration in view of the exposure risk of workers. ⑦It is necessary to examine nitrogen encapsulation method so that hydrogen purge can be safely carried out based on the situation in the field.

Table 2.4-1 Risk reduction measures planned to be implemented and appropriateness (3/8)

Road Map Related Items		Assumed risks	Risk reduction measures		Purpose	Target timing	Adequacy of individual measures
Plans for maintaining and continuity stable plant conditions	Accumulated water treatment plan	・Risk of off-system emission of radioactive material	Improvement of reliability of accumulated water treatment equipment	Use of polyethylene pipes for pressure-resistant hoses around accumulated water transfer and desalination equipment	By replacing the parts where pressure-resistant hoses are used in the accumulated water transfer and treatment facilities with more reliable polyethylene pipes, etc., the leakage risk of accumulated water and treated water, risk of damage to other facilities due to leakage water, and risk of deterioration of the working environment in the event of leakage will be reduced.	Completed at the end of December 2013	①The risk of additional emission of radioactive material from the accumulated water transfer line is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③By replacing with polyethylene pipes, etc., the risk of external events such as earthquakes will be reduced. ④By replacing with polyethylene pipes, etc., the risk of equipment deterioration damage in time is reduced. ⑤It is desirable to implement it as early as possible, and it has been already implemented. ⑥The risk of implementing measures is small. ⑦If polyethylene pipes, etc., cannot be laid, instead of it, using weirs to prevent leakage from spreading, etc.
				Expansion of tanks and replacement of RO concentrated water temporary storage tanks	Increase tanks to secure storage areas for accumulated water or treated water.	Report a plan for additional tanks every six months	①Day-to-day increasing storage of accumulated water is eliminated and there is a risk that it cannot be stored. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to ensure storage volume, and the risk for external events does not change. ④Leakage risk increases due to aging of the tank. ⑤In order to secure a storage location, it is necessary to systematically increase the capacity, and it has already been implemented. ⑥Leakage risk increases due to the increase in accumulated and treated water storage.

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				volume of the water treatment facility, etc. or the amount of water leaked from the reactor container.		and studies are being carried out for implementation so that measures can be taken by the target time. ⑥In addition to the exposure risk of workers, there is a risk of high dose in the building. ⑦ Consideration should be given to monitoring the tendency of accumulated water quality, optimizing the line configuration, and improving the environment such as decontamination, so that effective measures can be taken.

Risk reduction measures planned to be implemented and appropriateness (2/8)

Road Map Related Items		Assumed risks	Risk reduction measures	Purpose	Response status	Adequacy of individual measures
Plans for maintaining and continuing the stable plant conditions	Reactor cooling plan	・Risk of loss of inert atmosphere maintenance function in the reactor pressure vessel and container	Addition of nitrogen supply equipment to reactor pressure vessels and container	Nitrogen supply equipment is operated on one of the two normally used container and maintains sufficient performance to maintain the hydrogen concentration in the reactor container below the flammable concentration (4%). Even if the operation unit stops, there is enough time to start up the spare equipment (more than 100 hours). Therefore, there is no problem with the operation of one unit in regular use. However, for further reliability improvement, one more unit of normal nitrogen gas separation equipment will be installed.	Completed installation in March 2013	①Although the nitrogen-enclosed equipment in the reactor container ensures redundancy by installing a nitrogen supply device equipped with an emergency power supply, when inspections involving long-term shutdowns of the normal equipment are conducted, the normal equipment becomes a single state. ②Since the redundancy of the equipment is ensured even in the present equipment installation status, and the shutdown margin time when the operation unit stops is sufficiently ensured (100 hours or more), it is considered that the possibility of hydrogen explosion is kept sufficiently low even without further reliability improvement measures at this time. ③The risk for external events is reduced by installing it on a higher ground. ④The risk of failure of the nitrogen supply equipment increases due to the aging deterioration of the equipment, but the installation of additional equipment enables more appropriate maintenance management. ⑤Improving the reliability of the nitrogen supply equipment contributes to the risk reduction, so it is desirable to carry out it at an early stage. ⑥The risk of implementing measures is small. ⑦There is no risk that it cannot be implemented.
			Encapsulation of nitrogen gas in equipment with confirmed retention of hydrogen	Equipment for which high concentration of hydrogen retention, such as the suppression chamber (S/C) gas phase section, has been confirmed, is brought into an inert state by encapsulation of nitrogen gas or the like.	Unit 1: Working since October 2012 Unit 2: Compliant since May 2013 Unit 3: Research of residual hydrogen in the gas phase of the enclosed space in the S/C is under way.	①The high concentration of hydrogen in the suppression chamber, which was confirmed this time, is considered to be a residue, although it occurred at the beginning of the accident. Considering the low oxygen concentration and the fact that it has been stably present in the closed space until now, hydrogen explosion is considered to be of low urgency to occur. However, this situation continues unless hydrogen purging is performed. ②Although there is a risk that radioactive material will be released in case a hydrogen explosion occurs, however this measure can be reduced, since the suppression chamber is a part of the container and there is a possibility that the residual amount of hydrogen is large depending on the volume of the closed space, ③Hydrogen purge reduces the risk of hydrogen explosion for external events. ④It is considered that the temporal risk does not increase drastically, because it has maintained a stable state until now after the accident and the contribution of radiolysis of water is thought to be small, and because the inert state is maintained by nitrogen inclusion in the container and the hydrogen concentration is monitored by the container gas management facility. ⑤Considering the related works such as the suppression chamber repair work and the field dose environment, it is necessary to carefully conduct field investigations, etc., and to implement measures as soon as possible when high concentration of hydrogen is confirmed. ⑥Since it is a high dose work in the building, it is necessary to carry out the work with monitoring the behavior of hydrogen concentration in view of the exposure risk of workers. ⑦It is necessary to examine nitrogen encapsulation method so that hydrogen purge can be safely carried out based on the situation in the field.

Risk reduction measures planned to be implemented and appropriateness (3/8)

Road Map Related Items		Assumed risks	Risk reduction measures		Purpose	Response status	Adequacy of individual measures
Plans for maintaining and continuing the stable plant	Accumulated water treatment plan	・Risk of off-system release of radioactive material	Improvement of reliability of contaminated water treatment equipment, etc.	Use of polyethylene pipes for pressure-resistant hoses around accumulated water transfer and desalination equipment	By replacing the parts where pressure-resistant hoses are used in the accumulated water transfer and treatment facilities with more reliable polyethylene pipes, etc., the leakage risk of accumulated water and treated water, risk of damage to other facilities due to leakage water, and risk of deterioration of the working environment in the event of leakage will be reduced.	Measures completed in August 2012	①The risk of additional emission of radioactive material from the accumulated water transfer line is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③By replacing with polyethylene pipes, etc., the risk of external events such as earthquakes will be reduced. ④By replacing with polyethylene pipes, etc., the risk of equipment deterioration damage in time is reduced. ⑤It is desirable to implement it as early as possible, and it has been already implemented. ⑥The risk of implementing measures is small. ⑦If polyethylene pipes, etc., cannot be laid, instead of it, using weirs to prevent leakage from spreading, etc.

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						⑦Since there is a limit to the tank installation location, it is necessary to surely implement measures to reduce the inflow of groundwater as a mitigation measure.
			Installation of weirs, etc. in tank areas	Early detection of leaks from storage tanks and prevention of expansion outside the system in the event of a large-scale leak by installing weirs, etc., in the tank area	Implemented sequentially according to tank installation	①The risk of additional release of radioactive material in the event of a leak is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to prevent leakage from spreading, and the risk for external events does not change. ④The purpose is to prevent leakage from spreading, and the risk does not change in time. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
			Installation of multi-nuclide removal equipment	By removing radionuclides (excluding tritium) contained in the treated water of the contaminated water treatment facility to a sufficiently low concentration by this facility, the environmental impact at the time of leakage will be reduced by reducing the amount of stored contaminated water and reducing the radioactive concentration of the stored water in the tank.	A-series hot test started in March 2013	① Contaminated water containing a large amount of radioactive materials is retained, and the risk of leakage is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The risk of leakage of contaminated water containing a large amount of radioactive material from a tank or the like from an external event due to the treatment of contaminated water can be reduced. ④Due to delayed operation of the multi-nuclide removal facility, the risk of leakage of contaminated water containing a large amount of radioactive materials from tanks, etc. increases due to an increase in the amount of polluted water storage. ⑤It is necessary to conduct it as early as possible, and a hot test is being carried out. ⑥Long-term storage of secondary waste and leakage risk occur. ⑦There is no risk that measures cannot be implemented, but if they cannot be implemented, additional tanks are installed to store contaminated water.
			Sequential implementation of water cutoff and recovery from possible trenches	Retained water in the trench is collected to prevent leakage outside the system.	Considered by end of March 2013 Sequential shut-off and collection of water from possible trenches, etc. Seawater pipe trenches of Units 2 and 3: Completed removal of contaminated water in trenches within fiscal 2014	①The risk of accumulated water flowing out of the premises due to tsunami intrusion, etc., will not be reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③By implementing measures, the risk of accumulated water flowing out of the premises due to tsunami intrusion, etc., will be reduced. ④The diffusion of highly concentrated accumulated water in the sound part of concrete was evaluated, though the appropriate management was carried out even at present. Rollers and trenches are at risk of reaching the outer surface in 10-13 years. ⑤It is desirable to examine the feasibility of the water cut-off method and implement it sequentially from possible trenches. In parallel, tsunami measures will be implemented. ⑥Though the risk of implementing the countermeasure is small, the treatment of the accumulated water in the trench is necessary. ⑦It is necessary to examine the water stopping method, etc. based on the situation of the site.
			Countermeasures against tsunami in buildings (closing of openings in buildings and making watertight)	Closing and water tightening of the building openings will be carried out to prevent tsunamis exceeding the temporary tide breakwaters from entering through the building openings and high-concentration accumulated water accumulated in the basement of the building from leaking out of the system.	Continued study was conducted until the end of March 2013. Implement measures according to the status of study	①The risk of accumulated water flowing out of the premises due to tsunami intrusion, etc., will not be reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③By implementing measures, the risk of accumulated water flowing out of the premises due to tsunami intrusion, etc., will be reduced. ④The inventory in the accumulated water is going to be reduced by the continuation of the water treatment, while the change of the time risk is small, while the appropriate management is carried out at present. ⑤Considering the site conditions, it is desirable that measures be taken as soon as possible for the areas where countermeasures are necessary. ⑥The risk of implementing measures is small. ⑦It is necessary to examine the water stopping method, etc. based on the situation of the site.

Table 2.4-1 Risk reduction measures planned to be implemented and appropriateness (4/8)

Road Map Related Items		Assumed risks	Risk reduction measures	Purpose	Target timing	Adequacy of individual measures
Plans for maintaining and continuity stable plant conditions	Accumulated water treatment plan	・Risk of increased generation of accumulated water	Recovery of sub drain	Reduction of groundwater inflow into the building will be attempted by restoring the facility (sub-drain) for pumping up groundwater around the building and lowering the groundwater level.	From fiscal 2013: Sub-drain recovery	①Since the amount of groundwater inflow into the building does not decrease, the risk of increase of contaminated water is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to reduce groundwater inflow, and the risk for external events does not change. ④Although the inventory of accumulated water will be reduced by continuing water treatment, The risk of leakage of accumulated water in the building increases because the inflow of groundwater to the building cannot be reduced. ⑤It is necessary to carry out it as soon as possible, and a restoration plan is under consideration. ⑥ Though the risk of implementing countermeasures is small, remediation of sub-drain water is necessary. ⑦ As other measures to reduce the inflow of groundwater, the groundwater inflow will be suppressed by operating the groundwater bypass at an early stage.
			Installation of groundwater bypass	Since the groundwater around the building flows from the mountain side toward the sea side, the groundwater level around the building is gradually lowered by pumping up the groundwater at	Conducted step by step as soon as ready	①Since the amount of groundwater inflow into the building does not decrease, the risk of increase of contaminated water is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to reduce groundwater inflow, and the risk for

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			Expansion of medium-and low-concentration tanks and replacement of RO concentrated water temporary storage tanks	Increase the number of low- and medium-concentration tanks to secure a storage area for ALPS treated water.	Completion of installation of medium to low density tanks with target capacity in December 2020 (1,370,000 m^3 in total)	①Day-to-day increasing storage of ALPS treated water is eliminated and there is a risk that it cannot be stored. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to ensure storage volume, and the risk for external events does not change. ④Leakage risk increases due to aging of mediu- and low -concentration tanks. ⑤In order to secure a storage location, it is necessary to systematically increase the capacity, and it has already been implemented. ⑥Leakage risk increases due to the increase in accumulated and treated water storage. ⑦Since there is a limit to the site where the medium-and low-concentration tanks are installed, it is necessary to surely implement measures to reduce the inflow of groundwater as a mitigation measure.
			Installation of weirs, etc. in medium- and low-concentration tank areas	Early detection of leaks from storage tanks and prevention of large-scale leaks from spreading outside the system by installing weirs, etc., in medium-and low-concentration tank areas	Implemented sequentially according to the installation of medium- and low- concentration tanks. Measures have been implemented to prevent leakage of medium and low-density tanks of the target capacity (1,370,000 m^3).	①The risk of additional release of radioactive material in the event of a leak is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to prevent leakage from spreading, and the risk for external events does not change. ④The purpose is to prevent leakage from spreading, and the risk does not change in time. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
			Installation of multi-nuclide removal equipment	By removing the radionuclides (excluding tritium) contained in the treated water of the contaminated water treatment facility to a sufficiently low concentration, this facility will reduce the amount of polluted water storage and the environmental impact in the case of leakage by reducing the radioactivity concentration of the medium- and low-concentration tank storage water.	Existing ALPS: Full-scale operation started in March 2022 Additional ALPS: Full-scale operation started in October 2017 High-performance ALPS: hot-tested in October 2014	①Contaminated water containing a large amount of radioactive materials is retained, and the risk of leakage is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The risk of leakage of contaminated water containing a large amount of radioactive material from a medium- and low-concentration tank or the like from an external event due to the treatment of contaminated water can be reduced. ④Due to delayed operation of the multi-nuclide removal facility, the risk of leakage of contaminated water containing a large amount of radioactive materials from medium- and low- concentration tanks, etc. increases due to an increase in the amount of polluted water storage. ⑤It is necessary to conduct it as early as possible, and a hot test is being carried out. ⑥Long-term storage of secondary waste and leakage risk occur. ⑦There is no risk that measures cannot be implemented, but if they cannot be implemented, a medium- and low-concentration tank will be added to store contaminated water.
			Sequential implementation of water cutoff and recovery from possible trenches	Retained water in the trench is collected to prevent leakage outside the system.	The action of cutoff and recovery has been implemented in order of possible trenches, etc. Removal of contaminated water in the trench of seawater piping completed Unit 2: June 2015 (transfer of accumulated water in the trench completed) March 2017 (vertical shaft filling completed) Unit 3: July 2015 (transfer of accumulated water in the trench completed) August 2015 (vertical shaft filling completed) Unit 4: December 2015 (accumulated water transfer in the trench completed, vertical shaft filling completed) Unit 1: Response	①The risk of accumulated water flowing out of the premises due to tsunami intrusion, etc., will not be reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③By implementing measures, the risk of accumulated water flowing out of the premises due to tsunami intrusion, etc., will be reduced. ④Though the appropriate management is carried out even at present, there is a risk that the trench part reaches the outer surface in 10-13 years, when the diffusion of high-concentration accumulated water in the sound part of concrete is evaluated. ⑤It is desirable to examine the feasibility of the water cut-off method and implement it sequentially from possible trenches. In parallel, tsunami measures will be implemented. ⑥Though the risk of implementing the countermeasure is small, the treatment of the accumulated water in the trench is necessary. ⑦It is necessary to examine the water stopping method, etc. based on the situation of the site.

Risk reduction measures planned to be implemented and appropriateness (4/8)

Road Map Related Items		Assumed risks	Risk reduction measures	Purpose	Response status	Adequacy of individual measures
Plans for maintaining and continuingtable plant conditions	Accumulated water treatment plan	・Risk of off-system release of radioactive material	Countermeasures against tsunami in buildings (closing of openings in buildings and making watertight)	Closing and watertightening of the building openings will be carried out to prevent tsunamis exceeding the temporary tide breakwaters from entering through the building openings and high-concentration accumulated water accumulated in the basement of the building from leaking out of the system.	January 2022: Closing of the openings to the building (total of 127 locations) completed.	①The risk of accumulated water flowing out of the premises due to tsunami intrusion, etc., will not be reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③By implementing measures, the risk of accumulated water flowing out of the premises due to tsunami intrusion, etc., will be reduced. ④The inventory in the accumulated water is going to be reduced by the continuation of the water treatment, while the change of the time risk is small, while the appropriate management is carried out at present. ⑤Considering the site conditions, it is desirable that measures be taken as soon as possible for the areas where countermeasures are necessary. ⑥The risk of implementing measures is small. ⑦It is necessary to examine the water stopping method, etc. based on the situation of the site.

The Japanese version shall prevail.

Comparison Table of amendments in the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility (Chapter I, 2.4 Future Risk Reduction Measures, Attachment-1)

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				the high plateau on the building mountain side and changing its flow channel to bypass the sea, thereby reducing the amount of groundwater inflow into the building.		external events does not change. ④Though the inventory in the accumulated water is going to be reduced by the continuation of the water treatment, the leakage risk of the accumulated water in the building increases, because the inflow of the groundwater to the building cannot be reduced. ⑤Since there is no interference work, it is desirable to carry out it as early as possible. ⑥The groundwater level around the building is too low due to the operation of the pumping well, and it is necessary to respond to the risk of contaminated water flowing out of the building and the risk of contaminated groundwater being drawn into the pumping well of the bypass and released into the sea area. ⑦When groundwater inflow to the building does not decrease as expected even when pumping wells are operated, it is necessary to secure water treatment and storage locations.

Table 2.4-1 Risk reduction measures planned to be implemented and appropriateness (5/8)

Road Map Related Items		Assumed risks	Risk reduction measures	Purpose	Target timing	Adequacy of individual measures
Plans for maintaining and continuity stable plant conditions	For electrical system equipment Improved reliability	・Risk of power shutdown due to a single failure	Installation of high-voltage buses in turbine buildings and change of suppliers of critical loads	Reliability is improved by making it possible to supply the critical load supplied by one system from the high-voltage bus in the two systems installed on the second floor of the turbine building.	Installation of high-pressure bus in the turbine building: Completed by the end of February 2013 Change in suppliers of critical loads: Completed at the end of July 2013	①As for the important loads that are powered by one system, some functions can be maintained by small generators in the event of a loss of power, but the risk of loss of function will not be reduced. ②In addition to contributing to the further improvement of the reliability of highly important reactor water injection equipment, the additional release risk of radioactive materials due to fuel damage can be reduced because power can be supplied from two systems for some of the dynamic components of the spent fuel pool facilities. ③Power loss risk against tsunami is reduced by being able to be supplied from high-voltage bus lines in the premises installed on the second floor of the turbine building. ④In the long term, the risk of loss of power to critical loads due to ageing degradation failures of electrical installations increases. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
		・Risk of loss of power caused by flood of tsunami	Improved waterproofing of common pool buildings	Improve the waterproof property as a tsunami countermeasure for the common pool building where common diesel generators A.B are installed in the plant.	Completed at the end of September 2013	①The risk of loss of the power supply function of the common diesel generator in the plant due to the penetration of tsunami into the shared pool building will not be reduced. ②The risk of additional emission of radioactive materials due to fuel damage will be reduced because the power supply function of the common diesel generator in the plant can be maintained by preventing the intrusion of tsunamis into the shared pool building. ③Risk of loss of power supply function of common diesel generators in the plant due to tsunami can be reduced. ④There is no change in the risk over time. ⑤It is desirable to carry out it as early as possible, and the examination is proceeding for the implementation. ⑥The risk of implementing measures is small. ⑦It is necessary to examine the method based on the situation of the site.
		・ estoration delay risk during power loss	Securing materials for small generators, power supplydpanels, cables, etc.	In preparation for abnormal situations involving a total loss of AC power due to tsunamis or earthquakes, materials such as outdoor lighting necessary for restoration work of important facility will be secured.	Completed at the end of March 2013	①There is a risk that emergency restoration work for important equipment will be delayed due to the absence of outdoor lighting, etc. in the event of an abnormality accompanied by a total loss of AC power supply due to tsunamis or earthquakes. ②Though there is no additional release risk of radioactive materials, there is a risk that emergency restoration work of important facility will be delayed due to the absence of illumination in the event of an abnormality such as a total loss of AC power supply. ③There is no risk to external events for securing restoration materials. ④There is no change in the risk over time. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
			Seismic isolation building for in-house high-voltage bus M/C (including emergency D/G M/C) Installation of remote monitoring and operation equipment	It will enable remote monitoring and operation from the Seismic Isolation Building and will enable early detection of abnormalities.	Completed at the end of December 2012	①There is a risk that recovery work will be delayed due to delayed detection of abnormalities, etc. when the power supply is lost. ②The risk of additional emission of radioactive materials due to damage to fuel, etc., will be reduced because it is possible to prevent the long-term loss of the power supply function of important loads of reactor water injection facilities, etc. by implementing measures. ③Implementation of countermeasures will reduce the risk of long-term loss of the power supply function for external events.

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		・Risk of increased generation of accumulated water	Recovery of sub drain	Reduction of groundwater inflow into the building will be attempted by restoring the facility (sub-drain) for pumping up groundwater around the building and lowering the groundwater level.	Sep. 2015: Sub-drain began operation	①Since the amount of groundwater inflow into the building does not decrease, the risk of increase of contaminated water is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to reduce groundwater inflow, and the risk for external events does not change. ④Though the inventory in the accumulated water is going to be reduced by the continuation of the water treatment, the leakage risk of the accumulated water in the building increases, because the inflow of the groundwater to the building can not be reduced. ⑤It is necessary to carry out it as soon as possible, and a restoration plan is under consideration. ⑥Though the risk of implementing countermeasures is small, remediation of sub-drain water is necessary. ⑦As other measures to reduce the inflow of groundwater, the groundwater inflow will be suppressed by operating the groundwater bypass at an early stage.
		・Risk of increased generation of accumulated water	Installation of groundwater bypass	Since the groundwater around the building flows from the mountain side toward the sea side, the groundwater level around the building is gradually lowered by pumping up the groundwater at the high plateau on the building mountain side and changing its flow channel to bypass the sea, thereby reducing the amount of groundwater inflow into the building.	May 2014: Groundwater bypass began operation	①Since the amount of groundwater inflow into the building does not decrease, the risk of increase of contaminated water is not reduced. ②The risk of additional emission of radioactive materials in the event of a leak is large. ③The purpose is to reduce groundwater inflow, and the risk for external events does not change. ④Though the inventory in the accumulated water is going to be reduced by the continuation of the water treatment, the leakage risk of the accumulated water in the building increases, because the inflow of the groundwater to the building can not be reduced. ⑤Since there is no interference work, it is desirable to carry out it as early as possible. ⑥The groundwater level around the building is too low due to the operation of the pumping well, and it is necessary to respond to the risk of contaminated water flowing out of the building and the risk of contaminated groundwater being drawn into the pumping well of the bypass and released into the sea area. ⑦When groundwater inflow to the building does not decrease as expected even when pumping wells are operated, it is necessary to secure water treatment and storage locations.

Risk reduction measures planned to be implemented and appropriateness (5/8)

Road Map Related Items		Assumed risks	Risk reduction measures	Purpose	Response status	Adequacy of individual measures
Plans for maintaining and continuity stable plant conditions	For electrical system equipment Improved reliability	・Due to a single failure Power shutdown risk	Installation of high-voltage buses in turbine buildings and change of suppliers of critical loads	Reliability is improved by making it possible to supply the critical load supplied by one system from the high-voltage bus in the two systems installed on the second floor of the turbine building.	Completed installation of high-pressure bus in the turbine building in May 2013 Completed change in suppliers of critical loads in July 2013	①As for the important loads that are powered by one system, some functions can be maintained by small generators in the event of a loss of power, but the risk of loss of function will not be reduced. ②In addition to contributing to the further improvement of the reliability of highly important reactor water injection equipment, the additional release risk of radioactive materials due to fuel damage can be reduced because power can be supplied from two systems for some of the dynamic components of the spent fuel pool facilities. ③Power loss risk against tsunami is reduced by being able to be supplied from high-voltage bus lines in the premises installed on the second floor of the turbine building. ④In the long term, the risk of loss of power to critical loads due to ageing degradation failures of electrical installations increases. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
		・Risk of loss of power caused by flood of tsunami	Improved waterproofing of common pool buildings	Improve the waterproof property as a tsunami countermeasure for the common pool building where common diesel generators A.B are installed in the plant.	Completed countermeasures in September 2013	①The risk of loss of the power supply function of the common diesel generator in the plant due to the penetration of tsunami into the shared pool building will not be reduced. ②The risk of additional emission of radioactive materials due to fuel damage will be reduced because the power supply function of the common diesel generator in the plant can be maintained by preventing the intrusion of tsunamis into the shared pool building. ③Risk of loss of power supply function of common diesel generators in the plant due to tsunami can be reduced. ④There is no change in the risk over time. ⑤It is desirable to carry out it as early as possible, and the examination is proceeding for the implementation. ⑥The risk of implementing measures is small. ⑦It is necessary to examine the method based on the situation of the site.
		・Restoration delay risk during power loss	Securing materials for small generators, power supply panels, cables, etc.	In preparation for abnormal situations involving a total loss of AC power due to tsunamis or earthquakes, materials such as outdoor lighting necessary for restoration work of important facility will be secured.	Completed countermeasures in March 2013	①There is a risk that emergency restoration work for important equipment will be delayed due to the absence of outdoor lighting, etc. in the event of an abnormality accompanied by a total loss of AC power supply due to tsunamis or earthquakes. ②Though there is no additional release risk of radioactive materials, there is a risk that emergency restoration work of important facility will be delayed due to the absence of illumination in the event of an abnormality such as a total loss of AC power supply. ③There is no risk to external events for securing restoration materials. ④There is no change in the risk over time. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.

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					④There is no change in the risk over time. ⑤It is desirable to carry out as early as possible, and it has already been completed. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.

Table 2.4-1 Risk reduction measures planned to be implemented and appropriateness (6/8)

Road Map Related Items	Assumed risks	Risk reduction measures	Purpose	Target timing	Adequacy of individual measures
Plans to reduce the radiation dose and prevent the spread of pollution throughout the entire power plant / Prevention plan for marine pollution spread	・Risk of radioactive materials emission into the sea through its leak into groundwater	Impervious wall installation	Prevent contaminated groundwater from flowing into the ocean through permeable layers in the ground if contaminated water in the building runs out into groundwater	Completed in mid-fiscal 2014	①The risk of contaminated water leaking into the ocean, etc. when contaminated water leaks into groundwater is not reduced. ②If contaminated water runs out into groundwater, the additional release risk of radioactive material is large. ③If the contaminated water storage facility in the site is damaged, the risk for external events can be reduced because the impervious wall serves as a stop to the contaminated water outflow. ④The purpose is to stop the outflow of contaminated water, and there is no temporal change of the risk. ⑤Since there is no interference work, it is desirable to install it at an early stage, and it has already been implemented. ⑥The amount of stored water in the premises increases due to the water pumped up by groundwater drain. ⑦There is no risk that measures cannot be implemented.
	・Risk of the spread of radioactive materials in ports to the sea	Dredging, Covering, etc. of Inner Sea Seeds of Ports	For the purpose of removing contaminated soil from the seabed and securing navigation routes and berths for large ships for the purpose of improving the environment in ports, dredging and covering of seabed soil in ports will be carried out. The dredged soil will be temporarily accumulated outside the route and berth area, and the accumulated soil will be covered to prevent re-diffusion.	Start from mid-FY2013 onward	①The risk of sea bed soil in the harbor re-diffusing due to waves, etc., and discharging it outside the harbor is not reduced. ②The additional release risk of radioactive materials is large when the seabed soil is re-diffused due to waves, etc. ③Implementation of countermeasures reduces the risk of re-diffusion of seabed soil due to external events. ④The purpose is to prevent the diffusion of seabed soil, and there is no temporal change in the risk. ⑤Investigate the timing of vessel navigation and maritime work congestion in ports and harbors. ⑥The risk becomes small by choosing the construction method in which the sea bed soil does not re-diffuse. ⑦There is no risk that measures cannot be implemented.
Plan for radioactive waste management and reduction of radiation dose at the boundary of the site / Rubble, etc.	・Risk of on-site exposure	Expansion of facilities for temporary storage of rubble cover Or additional shielding of temporary storage area A	To achieve a site boundary dose of less than 1 mSv/year due to rubble and contaminated water, etc. that have occurred since the occurrence of the accident stored in the facility, additional storage facilities for rubble, etc. will be installed. These operations also reduce the atmospheric dose throughout the site, which also improves the working environment.	Completed at the end of March 2013	①Required for "Items to Take Measures", and if no measures are taken, it will be difficult to achieve the target of less than 1 mSv/year of the boundary dose at the site as of the end of March 2013. ②The purpose is to achieve the target of the site boundary dose, and the risk of additional emission of radioactive materials is small. ③By implementing countermeasures, the risk of scattering of rubble, etc. caused by tornadoes, etc. is reduced. ④The purpose is to achieve the target of the site boundary dose, and there is no change in the risk over time. ⑤The target is to be achieved by the end of fiscal 2012, and the work is already being carried out. ⑥Exposure to workers, etc. is generated by implementing measures. Therefore, it is necessary to appropriately implement dose control, etc. ⑦If measures cannot be taken, the site boundary dose of less than 1 mSv/year as of the end of March 2013 could not be achieved due to rubble and contaminated water, etc. that have occurred since the occurrence of the accident stored in the facility. It should be noted that alternative measures are difficult because of time constraints. In addition, since the storage facility installation location is limited, it is necessary to reduce the volume of radioactive waste, etc., without fail.
		Installation of earth-covering logging temporary storage tanks		Completed at the end of March 2013	
Secondary waste from	・Risk of on-site exposure ・Outside the system of radioactive materials Release risk	Installation of temporary storage facilities for spent cesium adsorption towers (facilities No. 3 and No. 4)		Facility No.3: In April 2013 Facility No.4: Started	
		Shielding the adsorption tower storage facility and replacement the adsorption tower		Shielding installation: Completed in early March 2013 Replacementt: Completed at the end of September 2013	
Gaseous Waste	・Outside the system of radioactive materials Release risk	Closing the Blow Out Panel of Unit 2	Control the emission of radioactive materials from the reactor building to the atmosphere by closing the blow-out panel of the reactor building of Unit 2.	Completed at the end of March 2013	①If measures are not taken, the state in which radioactive materials are released from the reactor building will continue. ②There is no change in the additional release risk if there is no change in the state of the reactor. ③Implementation of countermeasures reduces the risk of external events such as storms. ④There is no change in the risk over time. ⑤Though it is necessary to carry out it early, it is carried out after the installation of the air conditioning equipment is completed, because the worsening of the working environment in the reactor building is feared by closing the blow-out panel. ⑥Since the worsening of the working environment in the reactor building is a concern by implementing countermeasures, it is necessary to install air conditioning equipment to improve them. ⑦It is necessary to examine the method based on the situation of the site, etc..
		Installation of covers for taking out spent fuel at Units 3 and 4, and installation and operation of ventilation equipment with filters	When fuel is taken out of the spent fuel pool, covers and ventilation equipment shall be installed to control the emission of radioactive materials into the atmosphere due to the soaring of radioactive materials during operation.	Unit 3: Started taking out in the first half of fiscal 2015 Unit 4: Take-off started in November 2013	①If measures are not taken, the risk of releasing radioactive materials will not be reduced due to soaring associated with spent fuel unloading operations. ②The risk of additional emission of radioactive materials due to soaring associated with spent fuel unloading operations is large. ③Installation of the cover can reduce the risk of deterioration of workability due to wind and rain. ④There is no change in the risk over time. ⑤It is necessary to carry out it at an early stage, and the construction is already carried out. ⑥Exposure to workers, etc. is generated by implementing measures. Therefore, it is necessary to appropriately implement dose control, etc. ⑦It is necessary to examine methods, etc. based on the situation of the site, and there is a risk that the removal work of spent fuel will be delayed depending on the situation of the site.

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		Seismic isolation building for in-house high-voltage bus M/C (including emergency D/G M/C) Installation of remote monitoring and operation equipment	It will enable remote monitoring and operation from the Seismic Isolation Building and will enable early detection of abnormalities.	Completed countermeasures in January 2013	①There is a risk that recovery work will be delayed due to delayed detection of abnormalities, etc. when the power supply is lost. ②The risk of additional emission of radioactive materials due to damage to fuel, etc., will be reduced because it is possible to prevent the long-term loss of the power supply function of important loads of reactor water injection facilities, etc. by implementing measures. ③Implementation of countermeasures will reduce the risk of long-term loss of the power supply function for external events. ④There is no change in the risk over time. ⑤It is desirable to carry out as early as possible, and it has already been completed. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.

Risk reduction measures planned to be implemented and appropriateness (6/8)

Road Map Related Items	Assumed risks	Risk reduction measures	Purpose	Response status	Adequacy of individual measures
Plans to reduce the radiation dose and prevent the spread of pollution throughout the entire power plant / Prevention plan for marine pollution spread	・Risk of radioactive materials emission into the sea through its leak into groundwater	Impervious wall installation	Prevent contaminated groundwater from flowing into the ocean through permeable layers in the ground if contaminated water in the building runs out into groundwater	Octber 2015: Completion of Countermeasures	①The risk of contaminated water leaking into the ocean, etc. when contaminated water leaks into groundwater is not reduced. ②If contaminated water runs out into groundwater, the additional release risk of radioactive material is large. ③If the contaminated water storage facility in the site is damaged, the risk for external events can be reduced because the impervious wall serves as a stop to the contaminated water outflow. ④The purpose is to stop the outflow of contaminated water, and there is no temporal change of the risk. ⑤Since there is no interference work, it is desirable to install it at an early stage, and it has already been implemented. ⑥The amount of stored water in the premises increases due to the water pumped up by groundwater drain. ⑦There is no risk that measures cannot be implemented.
	・Risk of the spread of radioactive materials in ports to the sea	Dredging, Covering, etc. of Inner Sea Seeds of Ports	For the purpose of removing contaminated soil from the seabed and securing navigation routes and berths for large ships for the purpose of improving the environment in ports, dredging and covering of seabed soil in ports will be carried out. The dredged soil will be temporarily accumulated outside the route and berth area, and the accumulated soil will be covered to prevent re-diffusion.	December 2016: Completion of Countermeasures	①The risk of sea bed soil in the harbor re-diffusing due to waves, etc., and discharging it outside the harbor is not reduced. ②The additional release risk of radioactive materials is large when the seabed soil is re-diffused due to waves, etc. ③Implementation of countermeasures reduces the risk of re-diffusion of seabed soil due to external events. ④The purpose is to prevent the diffusion of seabed soil, and there is no temporal change in the risk. ⑤Investigate the timing of vessel navigation and maritime work congestion in ports and harbors. ⑥The risk becomes small by choosing the construction method in which the sea bed soil does not re-diffuse. ⑦There is no risk that measures cannot be implemented.
Plan for radioactive waste management and reduction of radiation dose at the boundary of the site / Rubble, etc.	・Risk of on-site exposure	Expansion of facilities for temporary storage of rubble cover Or additional shielding of temporary storage area A	To achieve a site boundary dose of less than 1 mSv/year due to rubble and contaminated water, etc. that have occurred since the occurrence of the accident stored in the facility, additional storage facilities for rubble, etc. will be installed. These operations also reduce the atmospheric dose throughout the site, which also improves the working environment.	June 2015: Installed	①Required for "Items to Take Measures", and if no measures are taken, it will be difficult to achieve the target of less than 1 mSv/year of the boundary dose at the site as of the end of March 2013. ②The purpose is to achieve the target of the site boundary dose, and the risk of additional emission of radioactive materials is small. ③By implementing countermeasures, the risk of scattering of rubble, etc. caused by tornadoes, etc. is reduced. ④The purpose is to achieve the target of the site boundary dose, and there is no change in the risk over time. ⑤The target is to be achieved by the end of fiscal 2012, and the work is already being carried out. ⑥ Exposure to workers, etc. is generated by implementing measures. Therefore, it is necessary to appropriately implement dose control, etc. ⑦If measures cannot be taken, the site boundary dose of less than 1 mSv/year as of the end of March 2013 could not be achieved due to rubble and contaminated water, etc. that have occurred since the occurrence of the accident stored in the facility. It should be noted that alternative measures are difficult because of time constraints. In addition, since the storage facility installation location is limited, it is necessary to reduce the volume of radioactive waste, etc., without fail.
		Installation of earth-covering logging temporary storage tanks		December 2012: Installed	
Water treatment secondary Waste	・Risk of on-site exposure ・Outside the system of radioactive materials emission risk	Installation of temporary storage facilities for spent cesium adsorption towers (facilities No. 3 and No. 4)		Facility No.3: February 2014 Installed F0acility No. 4: June 2013 Installed	
		Shielding the adsorption tower storage facility and replacement the adsorption tower		Shielding installtion: Completed cinstllation in March 2013 Replacement: Replaced in March 2014	
Gas Waste	・Outside the system of radioactive materials Release risk	Closing the Blow Out Panel of Unit 2	Control the emission of radioactive materials from the reactor building to the atmosphere by closing the blow-out panel of the reactor building of Unit 2.	Closing completed in March 2013	①If measures are not taken, the state in which radioactive materials are released from the reactor building will continue. ②There is no change in the additional release risk if there is no change in the state of the reactor. ③Implementation of countermeasures reduces the risk of external events such as storms. ④There is no change in the risk over time. ⑤Though it is necessary to carry out it early, it is carried out after the installation of the air conditioning equipment is completed, because the worsening of the working environment in the reactor building is feared by closing the blow-out panel. ⑥Since the worsening of the working environment in the reactor building is a concern by implementing countermeasures, it is necessary to install air conditioning equipment to improve them. ⑦It is necessary to examine the method based about the site, etc..
		Installation of covers for taking out spent fuel at Units 3 and 4, and installation and operation of ventilation equipment with filters	When fuel is taken out of the spent fuel pool, covers and ventilation equipment shall be installed to control the emission of radioactive materials into the atmosphere due to the soaring of radioactive materials during operation.	Unit 3: Fuel removal cover installed completed in February 2018 Unit 4: Installation of cover for fuel removal completed in November 2013 Unit 3: Installation of ventilating air conditioning equipment completed in June 2018 Unit 4: Installation of ventilation air conditioning equipment completed in October 2013	①If measures are not taken, the risk of releasing radioactive materials will not be reduced due to soaring associated with spent fuel unloading operations. ②The risk of additional emission of radioactive materials due to soaring associated with spent fuel unloading operations is large. ③Installation of the cover can reduce the risk of deterioration of workability due to wind and rain. ④There is no change in the risk over time. ⑤ It is necessary to carry out it at an early stage, and the construction is already carried out. ⑥ Exposure to workers, etc. is generated by implementing measures. Therefore, it is necessary to appropriately implement

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Current	Revised	Reason for Revison

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	On-site decontamination plan	・Risk of on-site exposure	Formulation and implementation of on-site decontamination plans	As the process exposure is reduced by reducing the atmospheric dose in the site, the no-mask area, etc. will be enlarged to reduce the workload of workers.	Progressively planned and implemented	①If no measures are taken, the atmospheric dose on the site will not be reduced. ②The purpose is to control the exposure, and the risk of additional emission of radioactive materials is small. ③Risk for external events is small. ④There is no change in the risk over time. ⑤Since the object range is wide and there are some places where the atmospheric dose is very high, it is necessary to carry out systematically by stepping on the stage. At present, based on the recognition, the area in which the effect is comparatively expected is selected, and the work is carried out. ⑥Implementation of measures increases the exposure of workers, etc. Therefore, it is necessary to appropriately implement dose control, etc. ⑦It is necessary to examine the decontamination method according to the dose in the field.

Table 2.4-1 Risk reduction measures planned to be implemented and appropriateness (7/8)

Road Map Related Items		Assumed risks	Risk reduction measures		Purpose	Target timing	Adequacy of individual measures
Fuel removal plan from the spent fuel pool	Spent fuel pools of Units 1 to 4	・Risk of loss of cooling function	Measures for Improving Reliability of Spent Fuel Pool Circulation Cooling Facilities in Units 1 to 4	Making backup supply	Regarding SFP cooling, cooling and purification of pools are continually being carried out using cooling equipment installed after the earthquake. Since an event in which the cooling function temporarily stops occurred due to a failure of the equipment installed last year, etc., spare parts will be secured and power supplies will be multiplexed to prevent these recurrences.	Completed at the end of March 2013	①The risk of temporary loss of cooling function due to power shutdown, etc., is not reduced. ②The additional release risk of radioactive material from spent fuel in the event of a long-term loss of cooling function is large. ③Risks for external events continue. ④In the long term, the risk of loss of power to critical loads due to ageing degradation failures of electrical installations increases. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
				On-site power supply (M/C) multiplexing		Completed at the end of March 2013	
			Transfer of fuel from Units 1 to 4 Spent Fuel Pool to Common Pool		About 3000 fuel assemblies were stored in the spent fuel pools of Units 1 to 4 (Units 1: 392, Units 2: 615, Units 3: 566, Units 4: 1533). To remove these decay heat, a spent fuel pool circulation cooling system has been installed after the earthquake. Since these cooling facilities were installed immediately after the earthquake, measures have been taken to ensure that the cooling function can continue by implementing measures to improve reliability, etc. If these functions are stopped for a long time, the decay heat of spent fuel may cause the spent fuel to melt and release radioactive materials into the atmosphere in the worst case. For this reason, spent fuel is transferred to a shared pool with a more reliable cooling function, low atmospheric dose, and easy to manage, and stored and managed.	Unit 3: Started taking out in the first half of fiscal 2015 Unit 4: Take-off started in November 2013 Units 1 and 2: The plan will be narrowed down or revised or changed according to the judgment points. Unit 1 (shortest): Start of take-out in the first half of fiscal 2017 Unit 2 (minimum): Launch in the second half of fiscal 2017	①When the cooling function of spent fuel is stopped for a long time, the risk of spent fuel melting and releasing radioactive materials into the atmosphere is not reduced in the worst case due to the decay heat of spent fuel. ②The risk of additional release of radioactive material from spent fuel in the event of prolonged loss of cooling function is large. ③Receiving spent fuel in the spent fuel pools of Units 1 to 4 into the shared pool reduces the risk of loss of cooling function due to the impacts of external events such as earthquakes and tsunamis in the spent fuel pools. ④Risk increases over time due to degradation of cooling equipment. On the other hand, the decay energy of spent fuel decreases by continuing the cooling function for a long time, and the time until it reaches the control value becomes longer even if the equipment stops and the water temperature of the pool rises. ⑤Removal of rubble, etc., from the upper part of the reactor building, installation of fuel removal covers and fuel handling equipment, etc. are necessary for extracting spent fuel, and these must be done in advance. As soon as these preparations are completed, it is necessary to carry out them at an early stage. ⑥In order to transfer spent fuel to a shared pool, etc., it is necessary to take measures to prevent fuel from falling during transfer, etc. In addition, if it is a high dose atmosphere, it is also necessary to consider decontamination, etc. work, and it is necessary to appropriately carry out exposure control, etc. for workers. ⑦If removal becomes impossible due to the impacts of rubble or deformation of the fuel handle, the fuel debris removal process in the post-process may be affected. Therefore, these handling methods are being investigated.
	Shared pool	・Lack of storage capacity Risk	Fuel transfer from shared pools to temporary storage facilities		The common pool already has 6377 storage units against 6840 storage units. In the future, to receive spent fuel from the spent fuel pool, the spent fuel, which has been sufficiently cooled, will be transferred to the dry cask to secure the fuel receiving capacity of the shared pool.	Implemented in stages from June 2013 onward	①If measures are not taken, it becomes difficult to transfer fuel from the spent fuel pool, and the risk, etc., in the event of loss of cooling function in the spent fuel pool will not be reduced. ②The additional release risk of radioactive material from spent fuel in the event of a long-term loss of cooling function is large. ③The risk of tsunami is reduced by transferring to a dry cask and moving to a high-level temporary storage facility. ④If measures are not taken, it becomes difficult to transfer fuel from the spent fuel pool, and the risk, etc., in the event of loss of cooling function in the spent fuel pool will not be reduced. ⑤It is necessary to carry out systematically to secure free space for the removal of spent fuel. ⑥Take measures to prevent fuel from falling during cask transfer, etc. ⑦It is the handling work which has been proven from the past, but it is necessary to examine the process control so that the delay by the congestion of fuel dispensing work and acceptance work in the shared pool does not occur.
		・Risk of corrosion of damaged casks	Cask transfer from cask storage building to common pool		The cask storage building has a dry fuel cask that has been stored since before the earthquake. The cask is exposed to seawater and other water due to the impacts of the earthquake, and there are concerns about the effects of corrosion and other factors. In	Completed in May 2013	①If measures are not taken, the materials of concern, such as the integrity of the sealing function, will not be removed. ②Spent fuel (a total of 408 tubes in nine casks) is already stored in the dry fuel cask, and the control function of radioactive material release from the stored spent fuel cannot be confirmed unless the integrity of the sealing function, etc. of the cask is confirmed and maintained. ③If tsunamis, etc., occur again, seawater, etc., may flood the cask

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						dose control, etc. ⑦It is necessary to examine methods, etc. based on the situation of the site, and there is a risk that the removal work of spent fuel will be delayed depending on the situation of the site.
On-site decontamination plan	・Risk of on-site exposure	Formulation and implementation of on-site decontamination plans		As the process exposure is reduced by reducing the atmospheric dose in the site, the no-mask area, etc. will be enlarged to reduce the workload of workers.	Since May 2018, decontamination, paving, and other measures have enabled 96% of the entire premises to be worked with general work clothing and light equipment such as dust masks.	①If no measures are taken, the atmospheric dose on the site will not be reduced. ②The purpose is to control the exposure, and the risk of additional emission of radioactive materials is small. ③Risk for external events is small. ④There is no change in the risk over time. ⑤Since the object range is wide and there are some places where the atmospheric dose is very high, it is necessary to carry out systematically by stepping on the stage. At present, based on the recognition, the area in which the effect is comparatively expected is selected, and the work is carried out. ⑥Implementation of measures increases the exposure of workers, etc. Therefore, it is necessary to appropriately implement dose control, etc. ⑦ It is necessary to examine the decontamination method according to the dose in the field.

Risk reduction measures planned to be implemented and appropriateness (7/8)

Road Map Related Items		Assumed risks	Risk reduction measures		Purpose	Response status	Adequacy of individual measures
Fuel removal plan from the spent fuel pool	Spent fuel pools of Units 1 to 4	Risk of loss of cooling function	Measures for Improving Reliability of Spent Fuel Pool Circulation Cooling Facilities in Units 1 to 4	Making backup supply	Regarding SFP cooling, cooling and purification of pools are continually being carried out using cooling equipment installed after the earthquake. Since an event in which the cooling function temporarily stops occurred due to a failure of the equipment installed last year, etc., spare parts will be secured and power supplies will be multiplexed to prevent these recurrences.	Cuntereasures completed in April 2013	①The risk of temporary loss of cooling function due to power shutdown, etc., is not reduced. ②The additional release risk of radioactive material from spent fuel in the event of a long-term loss of cooling function is large. ③ Risks for external events continue. ④In the long term, the risk of loss of power to critical loads due to ageing degradation failures of electrical installations increases. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.
				On-site power supply (M/C) multiplexing		Units 1 and 2: Countermeasures completed in March 2013 Units 3 and 4: Countermeasures completed in June 2013	
			Transfer of fuel from Units 1 to 4 Spent Fuel Pool to Common Pool		About 3000 fuel assemblies were stored in the spent fuel pools of Units 1 to 4 (Units 1: 392, Units 2: 615, Units 3: 566, Units 4: 1533). To remove these decay heat, a spent fuel pool circulation cooling system has been installed after the earthquake. Since these cooling facilities were installed immediately after the earthquake, measures have been taken to ensure that the cooling function can continue by implementing measures to improve reliability, etc. If these functions are stopped for a long time, the decay heat of spent fuel may cause the spent fuel to melt and release radioactive materials into the atmosphere in the worst case. For this reason, spent fuel is transferred to a shared pool with a more reliable cooling function, low atmospheric dose, and easy to manage, and stored and managed.	Unit 1: Beginning removal of fuel from FY2027 to FY2028 Unit 2: Beginning removal of fuel from FY2024 to FY2026 Unit 3: Fuel removal completed in February 2021 Unit 4: Fuel removal completed in December 2014	①When the cooling function of spent fuel is stopped for a long time, the risk of spent fuel melting and releasing radioactive materials into the atmosphere is not reduced in the worst case due to the decay heat of spent fuel. ②The risk of additional release of radioactive material from spent fuel in the event of prolonged loss of cooling function is large. ③Receiving spent fuel in the spent fuel pools of Units 1 to 4 into the shared pool reduces the risk of loss of cooling function due to the impacts of external events such as earthquakes and tsunamis in the spent fuel pools. ④ Risk increases over time due to degradation of cooling equipment. On the other hand, the decay energy of spent fuel decreases by continuing the cooling function for a long time, and the time until it reaches the control value becomes longer even if the equipment stops and the water temperature of the pool rises. ⑤Removal of rubble, etc., from the upper part of the reactor building, installation of fuel removal covers and fuel handling equipment, etc. are necessary for extracting spent fuel, and these must be done in advance. As soon as these preparations are completed, it is necessary to carry out them at an early stage. ⑥In order to transfer spent fuel to a shared pool, etc., it is necessary to take measures to prevent fuel from falling during transfer, etc. In addition, if it is a high dose atmosphere, it is also necessary to consider decontamination, etc. work, and it is necessary to appropriately carry out exposure control, etc. for workers. ⑦If removal becomes impossible due to the impacts of rubble or deformation of the fuel handle, the fuel debris removal process in the post-process may be affected. Therefore, these handling methods are being investigated.
	Shared pool	・Risk of insufficient storage capacity	Fuel transfer from shared pools to temporary storage facilities		The common pool already has 6377 storage units against 6840 storage units. In the future, to receive spent fuel from the spent fuel pool, the spent fuel, which has been sufficiently cooled, will be transferred to the dry cask to secure the fuel receiving capacity of the shared pool.	Implemented in stages from June 2013 onward	①If measures are not taken, it becomes difficult to transfer fuel from the spent fuel pool, and the risk, etc., in the event of loss of cooling function in the spent fuel pool will not be reduced. ②The additional release risk of radioactive material from spent fuel in the event of a long-term loss of cooling function is large. ③The risk of tsunami is reduced by transferring to a dry cask and moving to a high-level temporary storage facility. ④If measures are not taken, it becomes difficult to transfer fuel from the spent fuel pool, and the risk, etc., in the event of loss of cooling function in the spent fuel pool will not be reduced. ⑤It is necessary to carry out systematically to secure free space for the removal of spent fuel. ⑥Take measures to prevent fuel from falling during cask transfer, etc. ⑦It is the handling work which has been proven from the past, but it is necessary to examine the process control so that the delay by the congestion of fuel dispensing work and acceptance work in the shared pool does not occur.
		・Risk of corrosion of	Cask transfer from cask storage building to common pool		The cask storage building has a dry fuel cask that has been stored since before the earthquake. The cask is exposed to seawater and other water due to the impacts of the	Completed in May 2013	①If measures are not taken, the materials of concern, such as the integrity of the sealing function, will not be removed. ②Spent fuel (a total of 408 tubes in nine casks) is already stored in the dry fuel cask, and the control function of radioactive material release from the stored spent fuel cannot be confirmed

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				addition, although it is confirmed that there is no abnormality in the dose and temperature measurements during patrol, the regular monitoring system is in a situation where it cannot be used. Therefore, these casks are transferred to the common pool to check the soundness of the cask body.		storage building, affecting the integrity of the sealing function of the cask, etc. ④The integrity of the sealing function of the cask may be impaired due to the progress of corrosion, etc. ⑤The plan is to carry out these restoration works sequentially as soon as the preparation for transferring the cask from the cask storage building and the preparation of the shared pool on the receiving side are completed. ⑥Take measures to prevent the cask from falling during transfer, etc., when transferring the cask. ⑦Monitoring should be considered.
		・ Risk of loss of cooling function	Common pool M/C installation	Improve reliability and maintain cooling function by restoring M/C(A)(B) for power supply facilities in shared pools.	Completed at the end of July 2013	①The risk of temporary loss of cooling function due to power shutdown, etc., is not reduced. ②The additional release risk of radioactive material from spent fuel in the event of a long-term loss of cooling function is large. ③Risks for external events continue. ④In the long term, the risk of loss of power to critical loads due to ageing degradation failures of electrical installations increases. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.

Table 2.4-1 Risk reduction measures planned to be implemented and appropriateness (8/8)

Road Map Related Items		Assumed risks	Risk reduction measures	Purpose	Target timing	Adequacy of individual measures
Plan for dismantling, radioactive waste processing and disposal of nuclear reactor facilities	Plan for the processing and disposal of radioactive waste	・ Risk of capacity shortage of waste storage	Installation of miscellaneous solid waste incineration facilities	Incineration facilities shall be installed to incinerate and reduce the volume of radioactive solid waste, etc. generated on the premises.	Completed installation in the second half of fiscal 2014	①If measures are not taken, the amount of radioactive solid waste to be stored will increase, and operations related to storage and management will continue. ②There is an increase in radioactive solid waste, etc., but the risk of additional emission of radioactive materials is small. ③Storage materials may be scattered due to external events such as fire. ④If measures are not taken, the storage risk of radioactive solid wastes, etc., increases in time. ⑤Countermeasures are necessary from the construction of the building and require time for a long period of time. It is already in design at present, and the work is proceeding toward the start of service in the second half of H26. ⑥There is a possibility of releasing radioactive materials into the atmosphere from incinerating radioactive solid waste, etc. Therefore, appropriate treatment facilities shall be installed and emission control shall be carried out to confirm that there is no effect on the outside of the site. ⑦If measures cannot be taken, the storage area should be secured continuously.
Other	Fire prevention measures	・Risk of fire spreading near power stations and in-plant	Formation and maintenance of fire belts Formulation and implementation of fire prevention measures in power stations	To protect important facilities at power stations from large-scale fires near power stations, fire prevention belts will be formed, and measures will be formulated and implemented to protect important facilities from fires in power stations and prevent the spread of fires.	Completed at the end of March 2013 2013 Dec.	①In the event of a large-scale fire inside and outside the power plant site, there is a possibility of loss of function of the facility and soaring of radioactive materials. ②There is an additional release risk of radioactive material from a large-scale fire. ③By implementing countermeasures, the risk can be reduced against external events such as large-scale fires. ④Risk does not change over time. ⑤It is necessary to carry out systematically. ⑥Cutting of new forests is required for the formation of fire prevention belts, and secure of storage area and countermeasures against spontaneous ignition of felled trees are required. ⑦It is necessary to investigate and implement measures according to the situation of the site (monitoring by cameras, installation of fire reports, patrols, etc.), to strive for early detection of fires, and to construct a system that enables quick initial extinguishing of fires.

Revised

		damaged casks		earthquake, and there are concerns about the effects of corrosion and other factors. In addition, although it is confirmed that there is no abnormality in the dose and temperature measurements during patrol, the regular monitoring system is in a situation where it cannot be used. Therefore, these casks are transferred to the common pool to check the soundness of the cask body.		unless the integrity of the sealing function, etc. of the cask is confirmed and maintained. ③If tsunamis, etc., occur again, seawater, etc., may flood the cask storage building, affecting the integrity of the sealing function of the cask, etc. ④The integrity of the sealing function of the cask may be impaired due to the progress of corrosion, etc. ⑤The plan is to carry out these restoration works sequentially as soon as the preparation for transferring the cask from the cask storage building and the preparation of the shared pool on the receiving side are completed. ⑥Take measures to prevent the cask from falling during transfer, etc., when transferring the cask. ⑦Monitoring should be considered.
		・Risk of loss of cooling function	Common pool M/C installation	Improve reliability and maintain cooling function by restoring M/C(A)(B) for power supply facilities in shared pools.	September 2013: Installetion completed	①The risk of temporary loss of cooling function due to power shutdown, etc., is not reduced. ②The additional release risk of radioactive material from spent fuel in the event of a long-term loss of cooling function is large. ③Risks for external events continue. ④In the long term, the risk of loss of power to critical loads due to ageing degradation failures of electrical installations increases. ⑤It is desirable to implement it as early as possible, and it is already implemented. ⑥The risk of implementing measures is small. ⑦There is no risk that measures cannot be implemented.

Risk reduction measures planned to be implemented and appropriateness (8/8)

Road Map Related Items		Assumed risks	Risk reduction measures	Purpose	Response status	Adequacy of individual measures
Plan for dismantling, radioactive waste processing and disposal of	Plan for the processing and disposal of radioactive waste	・Risk of capacity shortage of waste storage	Installation of miscellaneous solid waste incineration facilities	Incineration facilities shall be installed to incinerate and reduce the volume of radioactive solid waste, etc. generated on the premises.	March 2016: Started operation	①If measures are not taken, the amount of radioactive solid waste to be stored will increase, and operations related to storage and management will continue. ②There is an increase in radioactive solid waste, etc., but the risk of additional emission of radioactive materials is small. ③Storage materials may be scattered due to external events such as fire. ④If measures are not taken, the storage risk of radioactive solid wastes, etc., increases in time. ⑤Countermeasures are required from building construction and require time for a long period of time. It is already in design at present, and the work is proceeding toward the start of service in the second half of H26. ⑥There is a possibility of releasing radioactive materials into the atmosphere from incinerating radioactive solid waste, etc. Therefore, appropriate treatment facilities shall be installed and emission control shall be carried out to confirm that there is no effect on the outside of the site. ⑦If measures cannot be taken, the storage area should be secured continuously.
Other	Fire prevention measures	・Risk of fire spreading near power stations and in-plant	Formation and maintenance of fire belts Formulation and implementation of fire prevention measures in power stations	To protect important facilities at power stations from large-scale fires in the vicinity of power stations, fire prevention belts will be formed, and measures will be formulated and implemented to protect important facilities from fires in power stations and prevent the spread of fires.	Fire belts have been set and conducted continuous maintenance. Continue to implement fire prevention measures	①In the event of a large-scale fire inside and outside the power plant site, there is a possibility of loss of function of the facility and soaring of radioactive materials. ②There is an additional release risk of radioactive material from a large-scale fire. ③By implementing countermeasures, the risk can be reduced against external events such as large-scale fires. ④Risk does not change over time. ⑤It is necessary to carry out systematically. ⑥Cutting of new forests is required for the formation of fire prevention belts, and secure of storage area and countermeasures against spontaneous ignition of felled trees are required. ⑦It is necessary to investigate and implement measures according to the situation of the site (monitoring by cameras, installation of fire reports, patrols, etc.), to strive for early detection of fires, and to construct a system that enables quick initial extinguishing of fires.

Reason for Revison

Current	Revised							Reason for Revison
		Plan towards securing sites	• Risk of shortage of sites for the construction of facilities for achieving the entire process of specified nuclear power facility and reducing risks in accordance with the risk map	Installation of ALPS treated water dilution and discharge facilities and related facilities	It is necessary to construct new facilities (fuel debris storage facilities, etc.) in the future to achieve the entire process of specified nuclear power facility and reduce the risk based on the risk map. For the purpose of securing the site for building the facilities, in order to dismantle the medium and low concentration tanks and reduce the amount of stored water of ALPS treated water, ALPS treated water dilution and discharge facilities and related facilities will be installed based on the design and operation that would allow the ocean discharge of the amount of ALPS treated water exceeding the amount of contaminated water generated.	Inspections before use scheduled to be completed in mid-April 2023	①If measures are not implemented, facilities for the installation of required facilities for decommissioning cannot be provided, and the achievement of the entire process and risk reduction according to the risk map are not implemented. ②Storage of ALPS treated water before the ocean discharge will continue, but by storing in welded tanks and constructing weirs in the storage tank area, the risk of additional discharge of radioactive materials will remain almost the same as before the ocean discharge. ③By implementing measures, it is possible to reduce the leakage risk of contaminated water stored in the medium and low concentration tanks and ALPS treated water due to external events to outside the system. ④The storage quantity of ALPS treated water, etc., increases, impacting on securing the site for the installation of the required facilities for decommissioning. ⑤The timing is in line with the government's fundamental policy. ⑥ALPS treated water will be discharged into the sea, which results in discharge of tritium exceeding the ratio to regulatory concentration limit 1. The effect on the environment is suppressed by the following design and operation: Confirmation of concentration in the measurement/ confirmation facilities, dilution over 100 times, release amount of tritium after the dilution is less than 1,500 Bq/L, and annual tritium release amount is less than 22 trillion Bq/year. Dismantle and removal method of welded tanks needs to be established and storage management of solid waste generated are required. ⑦Since steady discharge of ALPS treated water into the sea is required for a long period of time, design and operation should be carried out taking into consideration possible equipment failures, etc.	Addition in accordance with discharge of ALPS treated water into the sea

Comparison Table of amendments in the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility (Chapter II, 1.9 Treatment, Storage and Management of Radioactive Liquid Waste)

Current	Revised	Reason for Revision
1.9 Treatment, Storage and Management of Radioactive Liquid Waste <Units 1-4> ○ Appropriate treatment for the control of the amount of waste generated and for the reduction in the concentration of radioactive materials. Regarding the radioactive liquid waste treated in the radioactive liquid waste treatment facility, the treated water should be stored. In addition, the contaminated water generated in the facility should be treated for purification such as adsorption by the contaminated water treatment facility to reduce radioactive materials. The treated water generated by the purification treatment should be stored, and the desalinated treated water should be reused for cooling water of the reactor, etc., to control the amount of new contaminated water generated. ○ Securing sufficient storage capacity Storage capacity is secured by installation of additional tanks and reducing treated water. ○ Shielding, prevention of leakage and prevention of spread of contamination. Appropriate materials for equipment should be used to prevent shielding and leakage, such as materials corresponding to the environment where the equipment is installed and the properties of internal fluid inside the equipment. The equipment should be installed in the independent section or weirs should be installed in the surrounding area to take measure to prevent the spread of contamination. ○ Reduction in the dose around the site as much as possible. By implementing the above three items and making continued improvement, the dose around the site associated with the treatment and storage of radioactive liquid waste is reduced as much as possible. ○ Structures (treatment and storage facilities) with sufficient shielding capability that are resistant to leakage and spread of contamination. For the treatment and storage facilities handling contaminated water, etc., measures such as installing shielding at places where people may approach should be taken from the viewpoint of dose reduction for workers. In addition, the relevant facilities are installed in the independent section, or weirs are set up in the surrounding area to take measures against the spread of leakage so that in the event of leakage, water leaked does not flow outside the site through the drainage channel. Detail, please refer bellow: II.2.5, II2.6, II.2.16, II.2.36, II.2.37, II.2.39, III.3.2.1 (Omitted below)	1.9 Treatment, Storage and Management of Radioactive Liquid Waste <Units 1-4> ○ Appropriate treatment for the control of the amount of waste generated and for the reduction in the concentration of radioactive materials. Regarding the radioactive liquid waste treated in the radioactive liquid waste treatment facility, the treated water should be stored. In addition, the contaminated water generated in the facility should be treated for purification such as adsorption by the contaminated water treatment facility to reduce radioactive materials. The treated water generated by the purification treatment should be stored, and the desalinated treated water should be reused for cooling water of the reactor, etc., to control the amount of new contaminated water generated. ○ Securing sufficient storage capacity Storage capacity is secured by installation of additional tanks and reducing treated water. ○ Shielding, prevention of leakage and prevention of spread of contamination. Appropriate materials for equipment should be used to prevent shielding and leakage, such as materials corresponding to the environment where the equipment is installed and the properties of internal fluid inside the equipment. The equipment should be installed in the independent section or weirs should be installed in the surrounding area to take measure to prevent the spread of contamination. ○ Reduction in the dose around the site as much as possible. By implementing the above three items and making continued improvement, the dose around the site associated with the treatment and storage of radioactive liquid waste is reduced as much as possible. ○ Structures (treatment and storage facilities) with sufficient shielding capability that are resistant to leakage and spread of contamination. For the treatment and storage facilities handling contaminated water, etc., measures such as installing shielding at places where people may approach should be taken from the viewpoint of dose reduction for workers. In addition, the relevant facilities are installed in the independent section, or weirs are set up in the surrounding area to take measures against the spread of leakage so that in the event of leakage, water leaked does not flow outside the site through the drainage channel. ○ Management of radioactive liquid waste, etc. Of radioactive liquid waste treated in the radioactive liquid waste treatment facility, when dischraging ALPS treated water that satisfy the criteria that the sum of the ratios to regulatory concentrations limits of nuclides other than tritium is less than 1, the concentration of the radioactive material in the discharged water should be reduced by dilution with a large amount of seawater in order to reduce the effective dose at the site boundary as much as possible. Detail, please refer bellow: II.2.5, II2.6, II.2.16, II.2.36, II.2.50, III.3.1.9, III.3.2.1 (Omitted below)	Addition in accordance with the discharge of ALPS treated water into the sea

The Japanese version shall prevail.

Current	Revised	Reason for Revision
1.14 Design Considerations ○ The facility's design shall appropriately consider the following matters in consideration of the degree of safety importance. (1) Applicable standards and criteria Structures, systems and components with safety functions, concerning design, material selection, manufacture, and inspection, shall conform to the standards and criteria deemed appropriate in consideration of the importance of the safety functions to be performed by them. (2)Design considerations against natural phenomena • Structures, systems and components with safety functions shall be designed to appropriate seismic resisitance that classified in accordance with the guideline for reviewing seismic design. If it is impossible to satisfy the requirement, the design that takes into account the diversity is adopted as necessary. • Structures, systems and components with safety functions are designed so that the safety of the facilities is not impaired by possible natural phenomena other than earthquakes (tsunami, heavy rain, typhoon, tornado, etc.). In the designing, diversity is considered as well when necessary. Structures, systems and components with safety functions of particularly high importance are designed in consideration of the most severe case of the possible natural phenomena or the case where the accident load is appropriately combined with natural forces.	1.14 Design Considerations ○ The facility's design shall appropriately consider the following matters in consideration of the degree of safety importance. (1) Applicable standards and criteria Structures, systems and components with safety functions, concerning design, material selection, manufacture, and inspection, shall conform to the standards and criteria deemed appropriate in consideration of the importance of the safety functions to be performed by them. (2)Design considerations against natural phenomena • Structures, systems and components with safety functions are classified in terms of seismic design in consideration of the importance of the safety function, impacts on the safety caused when the function is lost due to earthquakes (impacts on public exposures), influence on the decommissioning work, etc. while using the seismic categories for facilities for processing or handling unsealed nuclear fuel materials as a guide, and are designed so that they can withstand the design seismic forces that are considered appropriate. If it is impossible to satisfy the requirement, the design that takes into account the diversity is adopted as necessary. • Structures, systems and components with safety functions are designed so that the safety of the facilities is not impaired by possible natural phenomena other than earthquakes (tsunami, heavy rain, typhoon, tornado, etc.). In the designing, diversity is considered as well when necessary. Structures, systems and components with safety functions of particularly high importance are designed in consideration of the most severe case of the possible natural phenomena or the case where the accident load is appropriately combined with natural forces.	Optimization of the description (clarifying description of the design considerations for earthquake in accordance with "Point of view of seismic motion and its application for seismic design of TEPCO Fukushima Daiichi NPS")
(3) Design considerations for external human events • The assumed external human events include aircraft crashing, dam collapse and explosion. The aircraft crashing probability at this specific nuclear facility was evaluated for the civil aircraft, the Self-Defense Force aircraft, and the U.S. military aircraft based on accident results and others until now (No. GKHK-21-270, reevaluation results of the probability of aircraft crashing to a commercial power reactor facility (October 30, 2009). The result is approximately 3.6×10^{-8} times/reactor-year, less than 1.0×10^{-7} times/reactor-year. Therefore, there is no need to consider aircraft crashing. In addition, there is neither a river near the specific nuclear facility that could affect the specific nuclear facility due to dam collapse, or facilities for manufacturing and storing explosives that could compromise the safety of the specific nuclear facility due to explosion.	(3) Design considerations for external human events • The assumed external human events include aircraft crashing, dam collapse and explosion, and collision of a drifted ship to harbor. The aircraft crashing probability at this specific nuclear facility was evaluated for the civil aircraft, the Self-Defense Force aircraft, and the U.S. military aircraft based on accident results and others until now (No. GKHK-21-270, reevaluation results of the probability of aircraft crashing to a commercial power reactor facility (October 30, 2009). The result is approximately 3.6×10^{-8} times/reactor-year, less than 1.0×10^{-7} times/reactor-year. Therefore, there is no need to consider aircraft crashing. In addition, there is neither a river near the specific nuclear facility that could affect the specific nuclear facility due to dam collapse, or facilities for manufacturing and storing explosives that could compromise the safety of the specific nuclear facility due to explosion. In addition, considering the clearance from the nearest route and the flow direction of the surrounding sea area, the collision of vessels passing through the route does not compromise the safety function of the specified nuclear facility.	Addition of design consideration for impact of drifted ships
• The following measures shall be taken in order to prevent illegal access by third parties to structures, systems, and components with safety functions, sabotage, and illegal transfer of nuclear materials. ① Establish areas containing structures, systems, and components with safety functions, and establish protected areas with physical barriers surrounding them to uphold approaching and access control to these areas thoroughly. ② Dsign to establish a detection facility and perform centralized monitoring, such as alarm and image monitoring. ③ Establish a communication facility with the outside.	• The following measures shall be taken in order to prevent illegal access by third parties to structures, systems, and components with safety functions, sabotage (including illegal access acts such as cyberterrorism), and illegal transfer of nuclear materials. ① Establish areas containing structures, systems, and components with safety functions, and establish protected areas with physical barriers surrounding them to uphold approaching and access control to these areas thoroughly. ② Design to establish a detection facility and perform centralized monitoring, such as alarm and image monitoring. ③ Establish a communication facility with the outside.	Optimization of the description
(Omission)	(Omission)	
(7) Consideration for preventing erroneous operation • In order to prevent operator misoperation, that the status of the facility can be accurately and swiftly grasped by instrument indications and alarm indications, in addition to paying attention to the layout of panels and the operability of operating instruments, etc, shall be taken. In addition, care shall be taken to prevent errors during maintenance and inspection.	(7) Consideration for preventing erroneous operation • In order to prevent operator misoperation, appropriate measures such that the status of the facility can be accurately and swiftly grasped by instrument indications and alarm indications, in addition to paying attention to the layout of panels and the operability of operating instruments, etc, shall be taken. In addition, care shall be taken to prevent errors during maintenance and inspection.	Optimization of the description

The Japanese version shall prevail.

Current	Revised	Reason for Revision
(Omission)	(Omission)	
(Not currently listed)	1.14.1 Attachment Attachment-1 Impact Assessment for Collision of Ships	Addition of impact assessment on collision of drifted ships

Current	Revised	Reason for Revision
(Not currently listed)	Attachment-1 Impact Assessment for Collision of Ships (New description) (Omitted below)	Newly described on impact and design consideration of collision of drifted ships

Current	Revised	Reason for Rivision
2.5.2 Basic Specifications 2.5.2.1 Main Specifications 2.5.2.1.1 Contaminated water treatment facilities, storage facilities (tanks, etc.) and related facilities (transfer pipes, transfer pumps, etc.) (Omission) (46) Storage Tanks for ALPS Treated Water, etc. ※1, 3 Total capacity (nominal) 1,153,489 m^3 (expansion if necessary) Cardinal number 820 units (additional if necessary) Volume (single unit) 700m^3, 1,000m^3, 1,060m^3, 1,140m^3, 1,160m^3, 1,200m^3, 1,220m^3, 1,235m^3, 1,330m^3, 1,356m^3, 2,400m^3, 2,900m^3 /unit*2 Materials SS400, SM400A, SM400B, SM400C, SM490A, SM490C Thickness (side plate) 12mm (700m^3, 1,000m^3, 1,160m^3, 1,200m^3, 1,220m^3, 1,235m^3, 1,330m^3, 1,356m^3), 18.8mm (2,400m^3), 15mm (1,000m^3, 1,060m^3, 1,140m^3, 1,330m^3, 2,900m^3), 16mm (700m^3) ※1 Nominal capacity and operational capacity is different from nominal capacity. ※2 Operating capacity shall be up to 100% water level gauge. ※3 The nominal capacity of tanks to be added in the future (J6, K1 North, K2, K1 South, H1, J7, J4 (1160m^3), H1 East, J8, K3, J9, K4, H2, H4 North, H4 South, G1 South, H5, H6 (I), B, B South, H3, H6 (II), G6, G1, G4 South, G4 North, and G5 Area) shall be the upper limit of the operating water level. (Omitted below)	2.5.2 Basic Specifications 2.5.2.1 Main Specifications 2.5.2.1.1 Contaminated water treatment facilities, storage facilities (tanks, etc.) and related facilities (transfer pipes, transfer pumps, etc.) (Omission) (46) Storage Tanks for ALPS Treated Water, etc. ※1, 3, 4 Total capacity (nominal) 1,153,489 m^3 (expansion if necessary) Cardinal number 820 units (additional if necessary) Volume (single unit) 700m^3, 1,000m^3, 1,060m^3, 1,140m^3, 1,160m^3, 1,200m^3, 1,220m^3, 1,235m^3, 1,330m^3, 1,356m^3, 2,400m^3, 2,900m^3 /unit*2 Materials SS400, SM400A, SM400B, SM400C, SM490A, SM490C Thickness (side plate) 12mm (700m^3, 1,000m^3, 1,160m^3, 1,200m^3, 1,220m^3, 1,235m^3, 1,330m^3, 1,356m^3), 18.8mm (2,400m^3), 15mm (1,000m^3, 1,060m^3, 1,140m^3, 1,330m^3, 2,900m^3), 16mm (700m^3) ※1 Nominal capacity and operational capacity is different from nominal capacity. ※2 Operating capacity shall be up to 100% water level gauge. ※3 The nominal capacity of tanks to be added in the future (J6, K1 North, K2, K1 South, H1, J7, J4 (1160m^3), H1 East, J8, K3, J9, K4, H2, H4 North, H4 South, G1 South, H5, H6 (I), B, B South, H3, H6 (II), G6, G1, G4 South, G4 North, and G5 Area) shall be the upper limit of the operating water level. ※4 A portion of the K4 area tanks is used as measurement/confirmation tank in "II 2.50 ALPS Treated Water Dilution/Discharge Facilities and Related Facilities". (Omitted below)	Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Current

Attachment 12

Policy on Design and Confirmation of Medium-and Low-Concentration Tanks

(Omission)

Appendix 6

Table 2 Weir Contents of Foundation Outer Weir in Each Tank Installation Area (1/2)

Installation Location	Tank Installation Cardinal number	Assumed leakage		Foundation perimeter weir Weir volume (m^3)	(planned value)			
		Cardinal number	Capacity (m^3)		Foundation circumference Area inside the weir (m^2)	Tank Proprietary area (m^2)	Pooled Area (m^2)	Foundation perimeter weir Height (m)
			①	②※1	③	④	⑤※2	⑥※3
(Omission)								
K4	35	1.75	1,750	2,190 or more	5,145	2,944	2,201	0.995 or more
(Omission)								

※1 ②=⑤×⑥
Since the height of the weir around the foundation differs depending on the location in J2, H3, G4 North, the weir content is shown in the sum. Since the G3 West and G7 share the outer peripheral weir of the foundation, the estimated leakage capacity and the weir capacity of the outer peripheral weir of the foundation are shown in total.
※2 ⑤=③-④
※3 ⑥=① ⑤ +0.2 (20cm margin)
The height of the weir around the foundation of J2, H3 is calculated by calculating the height of the weir capable of storing the assumed leakage volume, and adding 20 centimeters to each of the heights.
※4 J2, H3, G3 north and G4 north have different basal altitudes depending on the location, so the planned values are shown.
※5 Rainwater recovery tank for 1 of 40 units
※6 Rainwater recovery tank for 1 of 12 tanks
※7 12 of 41 units are post-RO fresh water receiving tanks (RO treated water storage tanks and evaporation concentrated water storage tanks)

(Omission)

Appendix 7

Effective dose by direct rays and sky-shine rays from low- and midum level concentration tanks (cylinder form)

(Omission)

2.1.11 K4 Area

Evaluation result of the direct rays and skyshine rays at the dose evaluation point (No. 70) of its vicinity was 0.0001 mSv/y and that indicats low impact to the site boundary dose. Evaluation results of the direct rays and skyshine rays at the highest dose evaluation point on the site boundary, indicates lower than that of its vicinity, and it finds that the impact to the site boundary is also small.

Revised

Attachment 12

Policy on Design and Confirmation of Medium-and Low-Concentration Tanks

(Omission)

Appendix 6

Table 2 Weir Contents of Foundation Outer Weir in Each Tank Installation Area (1/2)

Installation Location	Tank Installation Cardinal number	Assumed leakage		Foundation perimeter weir Weir volume (m^3)	(planned value)			
		Cardinal number	Capacity (m^3)		Foundation circumference Area inside the weir (m^2)	Tank Proprietary area (m^2)	Pooled Area (m^2)	Foundation perimeter weir Height (m)
			①	②※1	③	④	⑤※2	⑥※3
(Omission)								
K4	35※8	1.75	1,750	2,190 or more	5,145	2,944	2,201	0.995 or more
(Omission)								

※1 ②=⑤×⑥
Since the height of the weir around the foundation differs depending on the location in J2, H3, G4 North, the weir content is shown in the sum. Since the G3 West and G7 share the outer peripheral weir of the foundation, the estimated leakage capacity and the weir capacity of the outer peripheral weir of the foundation are shown in total.
※2 ⑤=③-④
※3 ⑥=① ⑤ +0.2 (20cm margin)
The height of the weir around the foundation of J2, H3 is calculated by calculating the height of the weir capable of storing the assumed leakage volume, and adding 20 centimeters to each of the heights.
※4 J2, H3, G3 north and G4 north have different basal altitudes depending on the location, so the planned values are shown.
※5 Rainwater recovery tank for 1 of 40 units
※6 Rainwater recovery tank for 1 of 12 tanks
※7 12 of 41 units are post-RO fresh water receiving tanks (RO treated water storage tanks and evaporation concentrated water storage tanks)
※8 30 out of 35 tanks are measurement/confirmation tanks in "II 2.50 ALPS Treated Water Dilution/Discharge Facilities and Related Facilities."

(Omission)

Appendix 7

Effective dose by direct rays and sky-shine rays from low- and midum level concentration tanks (cylinder form)

(Omission)

2.1.11 K4 Area※

Evaluation result of the direct rays and skyshine rays at the dose evaluation point (No. 70) of its vicinity was 0.0001 mSv/y and that indicats low impact to the site boundary dose. Evaluation results of the direct rays and skyshine rays at the highest dose evaluation point on the site boundary, indicates lower than that of its vicinity, and it finds that the impact to the site boundary is also small.

※Some tanks in the K4 tank area are usable as tamks for measurement/comfirmation tanks described in "II 2. 50 ALPS treated water dilution/discharge facilities and the related facility".

Reason for Rivision

Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

The Japanese version shall prevail.

Comparison Table of amendments in the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility (Chapter II, 2.5 Contaminated Water Treatment Facilities, etc., Attachment-12)

Current

Appendix 8

(Omission)

(Supplementary Appendix) Number of Storage Tanks for RO Concentrated Water, ALPS Treated Water, etc., Sr Treated Water and Concentrated Liquid Waste by Area

Area	Tank Nominal Capacity [m^3]	(39) Storage Tanks for RO concentrated water	(46) Storage Tanks for ALPS Treated Water, etc.	(60) Storage Tanks for Sr treated water	(61) Storage Tanks for Concentrated liquid waste
(Omission)					
K4	1,000		35		
(Omission)					

(Omission)

Reference material

Assessment to the Midium- and Low- Concentration Tanks as Sesimic S Class Facility

For reference, an assessment to the medium- and low-concentration tanks on the areas of J2, J3, J4, J6, K1 north, K2, K1 south, H1 east, J8, K3, J9, H4 North, H4 south, G1 South, H5, H6 (I), H3, and H6 (II) is conducted as sesimic S class facility. The overturning assessment was conducted comparing culculated overturning moment by an earthquake and stable moment by deadweight. The result reveald that the overturning moment by an earthquake is smaller than the stable moment by deadweight, and no overturning will be occurred.

(Omitted below)

Revised

Appendix 8

(Omission)

(Supplementary Appendix) Number of Storage Tanks for RO Concentrated Water, ALPS Treated Water, etc., Sr Treated Water and Concentrated Liquid Waste by Area

Area	Tank Nominal Capacity [m^3]	(39) Storage Tanks for RO concentrated water	(46) Storage Tanks for ALPS Treated Water, etc.	(60) Storage Tanks for Sr treated water	(61) Storage Tanks for Concentrated liquid waste
(Omission)					
K4	1,000		35※		
(Omission)					

※ 30 tanks of K4 area will be used as measurement/confirmation tank in "II 2.50 ALPS Treated Water Dilution/Discharge Facilities and Related Facilities".

(Omission)

Reference material

Overturning Assessment to the Midium- and Low- Concentration Tanks when Applied 3.6Ci of Static Seismic Force

For reference, an assessment to the medium- and low-concentration tanks on the areas of J2, J3, J4, J6, K1 north, K2, K1 south, H1 east, J8, K3, J9, H4 North, H4 south, G1 South, H5, H6 (I), H3, and H6 (II) is conducted when applied 3.6Ci of static seismic force. The overturning assessment was conducted comparing culculated overturning moment by an earthquake and stable moment by deadweight. The result reveald that the overturning moment by an earthquake is smaller than the stable moment by deadweight, and no overturning will be occurred.

(Omitted below)

Reason for Rivision

Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Optimization of the description

Current

2.16.1.2 Basic specifications
2.16.1.2.1 Main specifications
(1) Advance Liquid Processing System

(Omission)

(34) Pipe

(Omission)

Main pipe specifications (3/4)

Name	Specifications	
From the outlet of the advance liquid processing system to treated water storage tanks or tanks※ (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 1.0MPa 1.15MPa 40℃
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Equivalent to 150A Equivalent to 200A Polyethylene 0.98MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	150A/Sch.40 100A/Sch.40 SUS316L 0.98MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 SUS316L 1.0MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	40A/Sch.40 65A/Sch.40 100A/Sch.40 150A/Sch.40 200A/Sch.40 STPG370+ lining 0.98MPa 40℃
From the transfer pump outlet for the advance liquid processing system to the inlet of the advance liquid processing system (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	65A/Sch.80 100A/Sch.80 STPG370 1.15MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 STPG370+ lining 0.98MPa 40℃

※Storage tank for ALPS treated water, etc., RO concentrated water or Sr treated water

Main pipe specifications (4/4)

Name	Specifications	
From the entrance of the building for the advance liquid processing system to the storage tank for soda carbonate (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 65A Polyethylene 0.5MPa 60℃
From the carbonated soda storage tank to the coprecipitation tank (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	125A/Sch.40 65A/Sch.40 50A/Sch.40 40A/Sch.40 25A/Sch.40 SUS316L 0.5MPa 40℃
(steel pipe)	Nominal diameter/thickness	65A/Sch.40

Revised

2.16.1.2 Basic specifications
2.16.1.2.1 Main specifications
(1) Advance Liquid Processing System

(Omission)

(34) Pipe

(Omission)

Main pipe specifications (3/4)

Name	Specifications	
From the outlet of the advance liquid processing system to※2 treated water storage tanks※1 (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 1.0MPa 1.15MPa 40℃
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Equivalent to 150A Equivalent to 200A Polyethylene 0.98MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	150A/Sch.40 100A/Sch.40 SUS316L 0.98MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 SUS316L 1.0MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	40A/Sch.40 65A/Sch.40 100A/Sch.40 150A/Sch.40 200A/Sch.40 STPG370+ lining 0.98MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.20S SUS316LTP 0.98MPa 40℃
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Synthetic rubber 0.98MPa 40℃

Main pipe specifications (4/4)

Name	Specifications	
From the transfer pump outlet for the advance liquid processing system to the inlet of the advance liquid processing system (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	65A/Sch.80 100A/Sch.80 STPG370 1.15MPa 40℃
(steel pipe)	Nominal diameter/thickness Material Max. working pressure	100A/Sch.40 STPG370+ lining 0.98MPa

Reason for Revision

Addition of main pipe specifications in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

The Japanese version shall prevail.

Current

	 Material Max. working pressure Max. working temperature	40A/Sch.40 SUS316L 0.5MPa 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 40A EPDM 0.5MPa 40°C 60°C

(Omitted below)

Revised

	Max. working temperature	40°C
From the entrance of the building for the advance liquid processing system to the storage tank for soda carbonate (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 65A Polyethylene 0.5MPa 60°C
From the carbonated soda storage tank to the coprecipitation tank (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	125A/Sch.40 65A/Sch.40 50A/Sch.40 40A/Sch.40 25A/Sch.40 SUS316L 0.5MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	65A/Sch.40 40A/Sch.40 SUS316L 0.5MPa 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 40A EPDM 0.5MPa 40°C 60°C

※1: Storage tank for ALPS treated water, etc., RO concentrated water or Sr treated water

※2: Parts of the pipe to the K4 Area Tank shall also be used as "II 2 50 ALPS Treated Water Dilution/Discharge Facilities and Related Facility ".

(Omitted below)

Reason for Revision

Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Current	Revised	Reason for Revision

Current

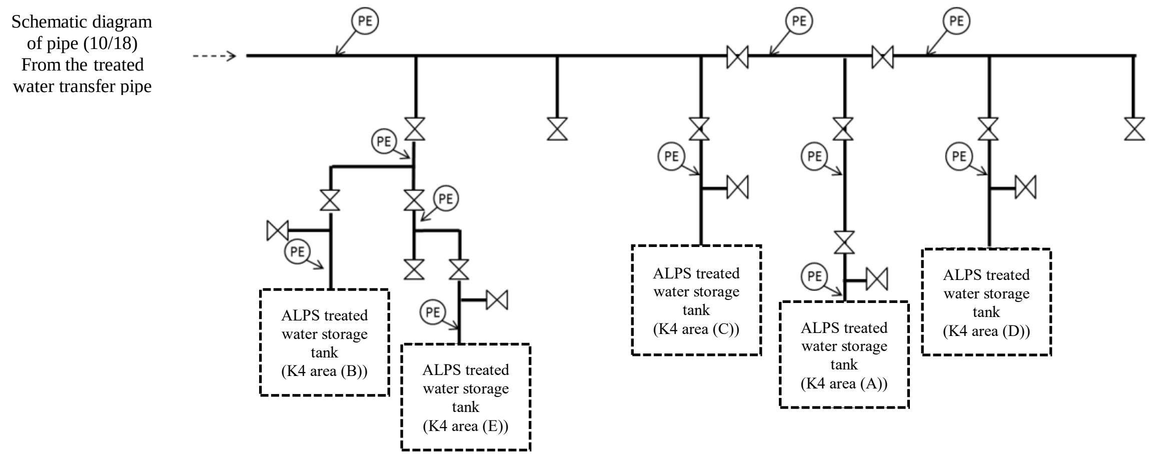
Attachment-2

Assessment Result of Structural Strength and Seismic Resistance of Radioactive Liquid Waste Treatment Facilities, etc.

(Omission)

1.2.6 Pipe
1.2.6.1 Structural strength assessment
1.2.6.1.1 Pipe (steel pipe)
1.2.6.1.1.1 Evaluation point

(Omission)



Legend symbols
PE: Polyethylene pipe

Numbers correspoinds to the numbers of 1.2.6.1.1.3

*Materials indicated are shown to the extent that the materials not be changed.
Materials composition is subject to change.

Figure-1 Schemetic diagram of pipes (11/18)

(Omitted below)

Revised

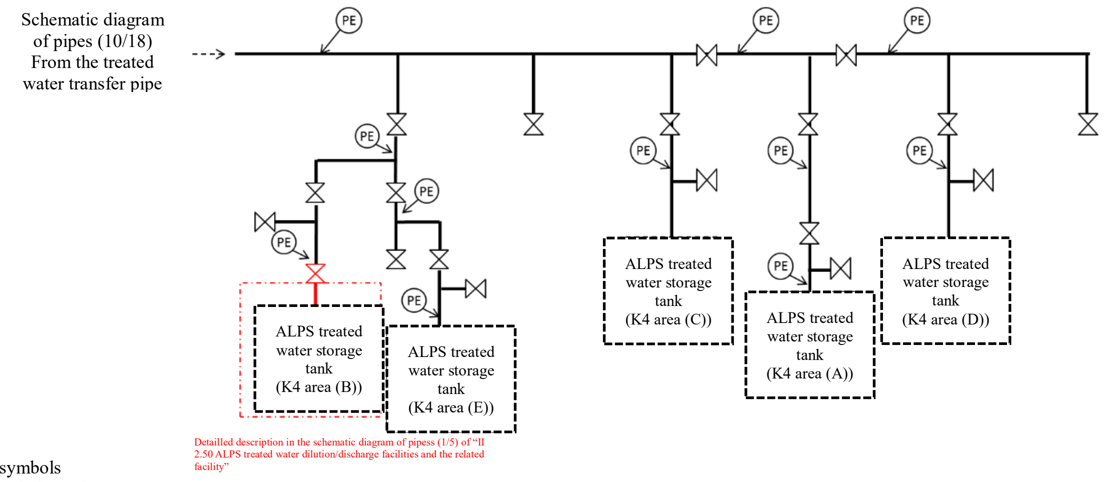
Attachment-2

Assessment Result of Structural Strength and Seismic Resistance of Radioactive Liquid Waste Treatment Facilities, etc.

(Omission)

1.2.6 Pipe
1.2.6.1 Structural strength assessment
1.2.6.1.1 Pipe (steel pipe)
1.2.6.1.1.1 Evaluation point

(Omission)



Legend symbols
PE: Polyethylene pipe

Numbers correspoinds to the numbers of 1.2.6.1.1.3

*Materials indicated are shown to the extent that the materials not be changed.
Materials composition is subject to changeShould the material structure be changed

Figure-1 Schametic diagram of pipes (11/18)

(Omitted below)

Reason for Revision

Modification of the schematic diagram of pipess in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Current	Revised	Reason for Revision
Attachment-9 Confirmation Items of Advance Liquid Processing System Major confirmation items related to the multinuclide removal facility are shown in Table-1 to 14. (Omitted below)	Attachment-9 Confirmation Items of Advance Liquid Processing System Major confirmation items related to the multinuclide removal facility are shown in Table-1 to 14. The main items to be checked regarding pipes (steel pipes, polyethylene pipes, pressure-resistant hoses) that are used in conjunction with ALPS treated water dilution/discharge facilities and related facility are shown in "II 2 50 ALPS Treated Water Dilution/Discharge Facilities and Related Facility". (Omitted below)	Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

The Japanese version shall prevail.

Current	Revised	Reason for Revision
2.16.2.2 Basic specifications 2.16.2.2.1 System Specifications (1) Extended multi-nuclide removal facility (4) Piping Main pipe specifications (Omission) Main pipe specifications (Omission) Main pipe specifications (Omission)	2.16.2.2 Basic specifications 2.16.2.2.1 System Specifications (1) Extended multi-nuclide removal facility (4) Piping Main pipe specifications (1/8) (Omission) Main pipe specifications (2/8) (Omission) Main pipe specifications (3/8) (Omission)	 Optimization of the description

The Japanese version shall prevail.

Current

Main pipe specifications

Name	Specifications	
From the sample tank outlet to storage tanks for ALPS treated water, etc., RO concentrated water and Sr treated water (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 80A/Sch.40 50A/Sch.40 SUS316L 0.98MPa 0°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 SUS316L 0.98MPa 60°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 STPG370 + lining 0.98MPa 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 200A Equivalent to 100A Polyethylene Hydrostatic head 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
From the transfer pump skid for additional ALPS to the inlet valve skid of the additional multi-nuclide removal facility (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C

Main pipe specifications

(Omission)

Main pipe specifications

(Omission)

Revised

Main pipe specifications (4/8)

Name	Specifications	
From the sample tank outlet to storage tanks※2 for ALPS treated water, etc., RO concentrated water and Sr treated water (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 80A/Sch.40 50A/Sch.40 SUS316L 0.98MPa 0°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 SUS316L 0.98MPa 60°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 STPG370 + lining 0.98MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.20S SUS316LTP 0.98MPa 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 200A Equivalent to 100A Polyethylene Hydrostatic head 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Synthetic rubber 0.98MPa 40°C
From the transfer pump skid for additional ALPS to the inlet valve skid of the additional multi-nuclide removal facility (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C

Main pipe specifications (5/8)

(Omission)

Main pipe specifications (6/8)

(Omission)

Reason for Revision

Optimization of the description

Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Optimization of the description

The Japanese version shall prevail.

Current

Main pipe specifications

Name	Specifications	
From the carbonated soda storage tank to the entrance of the building for the advance liquid processing system (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	65A/Sch.40 SUS316L Hydrostatic head 60°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	80A/Sch.40 65A/Sch.40 50A/Sch.40 SUS316L 0.5MPa 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 65A PTFE Hydrostatic head 60°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 75A Polyethylene 0.5MPa 60°C

※ Some of the piping specifications (nominal diameter, thickness, and material) may not be used depending on the site construction status.

Main pipe specifications

Name	Specifications	
From the branch of the transfer channel of the treated water receiving tank to the inlet of the reaction/agglomeration tank ※ (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 STPG370 + lining 0.98MPa 60°C
From reaction/agglomeration tank outlet to precipitation tank inlet ※ (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	150A/Sch.40 SUS316L Hydrostatic head 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 150A EPDM Hydrostatic head 60°C
From the precipitation tank outlet to the supernatant water tank inlet※ (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	150A/Sch.40 SUS316L Hydrostatic head 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 150A EPDM Hydrostatic head 60°C

※Installed in two series

Revised

Main pipe specifications (7/8)

Name	Specifications	
From the carbonated soda storage tank to the entrance of the building for the advance liquid processing system (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	65A/Sch.40 SUS316L Hydrostatic head 60°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	80A/Sch.40 65A/Sch.40 50A/Sch.40 SUS316L 0.5MPa 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 65A PTFE Hydrostatic head 60°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 75A Polyethylene 0.5MPa 60°C
From the branch of the transfer channel of the treated water receiving tank to the inlet of the reaction/agglomeration tank※3 (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 STPG370 + lining 0.98MPa 60°C
From reaction/agglomeration tank outlet to precipitation tank inlet※3 (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	150A/Sch.40 SUS316L Hydrostatic head 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 150A EPDM Hydrostatic head 60°C
From the precipitation tank outlet to the supernatant water tank inlet※3 (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	150A/Sch.40 SUS316L Hydrostatic head 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 150A EPDM Hydrostatic head 60°C

Reason for Revision

Optimization of the description

Optimization of the description

The Japanese version shall prevail.

Current

Main pipe specifications

Name	Specifications	
From the outlet of the supernatant water tank to the merge section of the transfer passage of the supply tank ※ (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 SUS316L Hydrostatic head 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 50A EPDM Hydrostatic head 60°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 32A/Sch.40 SUS316L 0.98MPa 60°C
From sedimentation tank outlet to reaction/agglomeration tank ※ (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 SUS316L Hydrostatic head 60°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 40A/Sch.40 32A/Sch.40 25A/Sch.40 SUS316L 0.98MPa 60°C
From cross-flow filter circulation line branch to reaction/agglomeration tank ※ (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	40A/Sch.40 25A/Sch.40 15A/Sch.40 SUS316L 0.98MPa 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 25A EPDM 0.98MPa 60°C
From the branch of the transfer passage of the storage tank for sodium carbonate to the inlet of the reaction/agglomeration tank ※ (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	25A/Sch.40 SUS316L 0.5MPa 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 25A EPDM 0.5MPa 60°C

※Installed in two series

(Omitted below)

Revised

Main pipe specifications (8/8)

Name	Specifications	
From the outlet of the supernatant water tank to the merge section of the transfer passage of the supply tank※3 (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 SUS316L Hydrostatic head 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 50A EPDM Hydrostatic head 60°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 32A/Sch.40 SUS316L 0.98MPa 60°C
From sedimentation tank outlet to reaction/agglomeration tank※3 (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 SUS316L Hydrostatic head 60°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	50A/Sch.40 40A/Sch.40 32A/Sch.40 25A/Sch.40 SUS316L 0.98MPa 60°C
From cross-flow filter circulation line branch to reaction/agglomeration tank※3 (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	40A/Sch.40 25A/Sch.40 15A/Sch.40 SUS316L 0.98MPa 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 25A EPDM 0.98MPa 60°C
From the branch of the transfer passage of the storage tank for sodium carbonate to the inlet of the reaction/agglomeration tank※3 (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	25A/Sch.40 SUS316L 0.5MPa 60°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 25A EPDM 0.5MPa 60°C

※1: Some of the piping specifications (nominal diameter, thickness, and material) may not be used depending on the site construction status.
※2: Parts of the pipes to the K4 Area Tank shall also be used as "II 2 50 ALPS Treated Water Dilution/Discharge Facilities and the Related Facility".
※3: Installed in 3:2 series

(Omitted below)

Reason for Revision

Optimization of the description

Optimization of the description
Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

The Japanese version shall prevail.

Current	Revised	Reason for Revision

Current

Attachment-4

Strength Calculation Sheet of Aditional Advance Liquid Processing System

(Omission)

2.4 Main piping

2.4.1 Evaluation point

Figure-4 shows the points for strength evaluation.

(Omission)

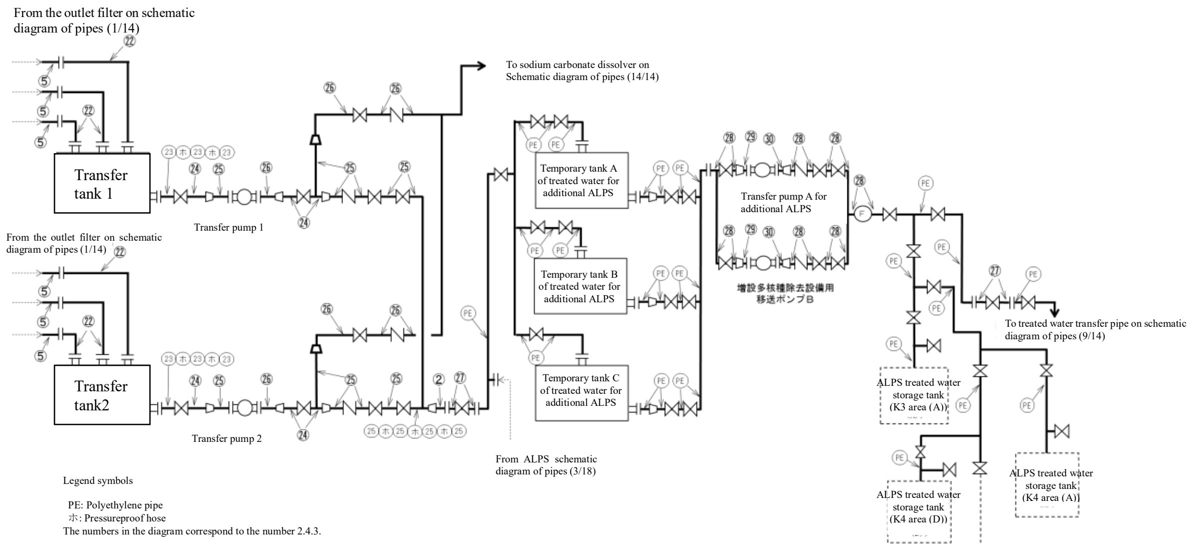


Figure-4 Schematic diagram of pipes (8/14)

(Omitted below)

Revised

Attachment-4

Strength Calculation Sheet of Aditional Advance Liquid Processing System

(Omission)

2.4 Main piping

2.4.1 Evaluation point

Figure-4 shows the points for strength evaluation.

(Omission)

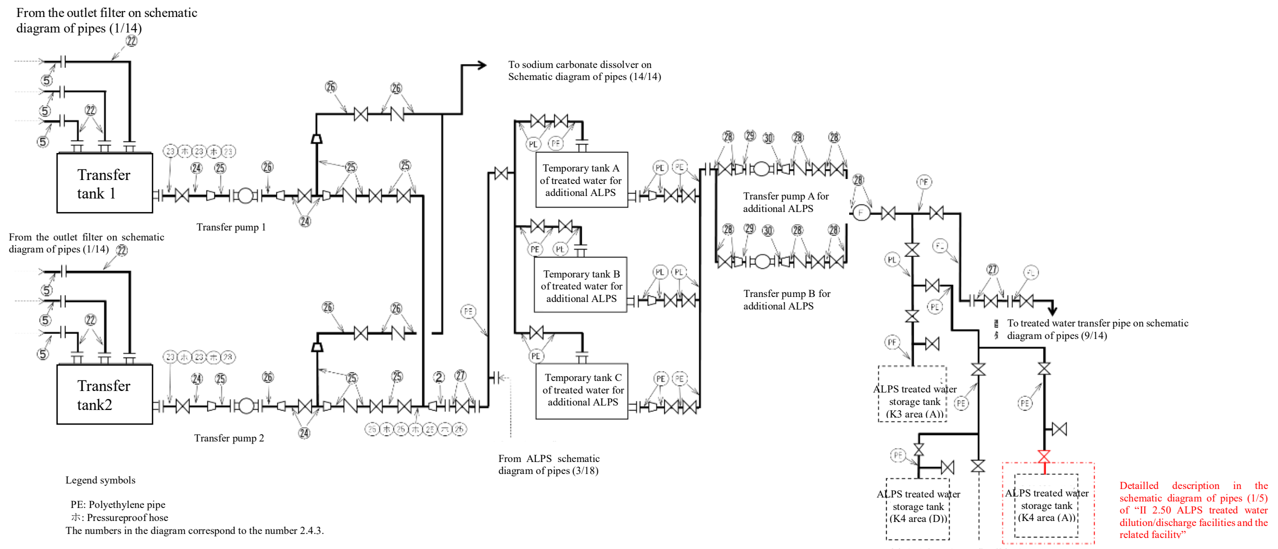


Figure-4 Schematic diagram of pipes (8/14)

(Omitted below)

Reason for Revision

Modification of the schematic diagram of pipess in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Current	Revised	Reason for Revision
Attachment-9 Confirmation Items of Additional Advance Liquid Processing System Major items to be confirmed for the additional advance liquid processing sytem are shown in Table-1 to 12. (Omitted below)	Attachment-9 Confirmation Items of Additional Advance Liquid Processing System Major items to be confirmed for the additional advance liquid processing sytem are shown in Table-1 to 12. The main items to be checked regarding pipes (steel pipes, polyethylene pipes, pressure-resistant hoses) that are used in conjunction with ALPS treated water dilution/discharge facilities and related facility are shown in "II 2 50 ALPS Treated Water Dilution/Discharge Facilities and Related Facility". (Omitted below)	Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

The Japanese version shall prevail.

Before change	After change	Reason for change
2.16.3.2 Basic Specifications 2.16.3.2.1 System Specifications (1) High-performance advance liquid processing system (Omission) (3) Piping Main pipe specifications (Omission) Main pipe specifications (Omission) Main pipe specifications (Omission) Main pipe specifications (Omission) Main pipe specifications (Omission)	2.16.3.2 Basic Specifications 2.16.3.2.1 System Specifications (1) High-performance advance liquid processing system (Omission) (3) Piping Main pipe specifications (1/8) (Omission) Main pipe specifications (2/8) (Omission) Main pipe specifications (3/8) (Omission) Main pipe specifications (4/8) (Omission) Main pipe specifications (5/8) (Omission) Main pipe specifications (6/8) (Omission)	Optimization of the description

The Japanese version shall prevail.

Before change

Main pipe specifications

Name	Specifications	
From the sample tank outlet to storage tanks for ALPS treated water, etc., RO concentrated water and Sr treated water (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 80A/Sch.40 50A/Sch.40 SUS316L 0.98MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 STPT410+ lining 0.98MPa 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 200A Equivalent to 100A Polyethylene Hydrostatic head 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
From the transfer pump skid for the high-performance advance liquid processing system to the supply tank (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 150A/Sch.40 STPT410+ lining 0.98MPa 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C

After change

Main pipe specifications (7/8)

Name	Specifications	
From the sample tank outlet to storage tanks※2 for ALPS treated water, etc., RO concentrated water and Sr treated water (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 80A/Sch.40 50A/Sch.40 SUS316L 0.98MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 STPT410+ lining 0.98MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.20S SUS316LTP 0.98MPa 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 200A Equivalent to 100A Polyethylene Hydrostatic head 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
(pressure-resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Synthetic rubber 0.98MPa 40°C
From the transfer pump skid for the high-performance advance liquid processing system to the supply tank (steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 150A/Sch.40 STPT410+ lining 0.98MPa 40°C
(polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C

Reason for change

Optimization of the description

Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Before change

Main pipe specifications

Name	Specifications	
From the outlet of the pipe unit to the inlet of supply tank A/B (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 STPT410+ lining 0.98MPa 40°C
From adsorption tower unit 1 to preprocessing filter unit A/B (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Equivalent to 80A Polyethylene 1.03MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 STPT410+ lining 1.03MPa 40°C
From the preprocessing filter unit A to preprocessing filter unit B (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 80A Polyethylene 1.03MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	80A/Sch.40 STPT410+ lining 1.03MPa 40°C
From the outlet of the pretreatment filter unit A to the inlet of the pretreatment filter unit B (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 80A Polyethylene 1.03MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	80A/Sch.40 STPT410+ lining 1.03MPa 40°C
From the preprocessing filter unit A/B to adsorption tower unit 1 (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 80A Polyethylene 1.03MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	80A/Sch.40 STPT410+ lining 1.03MPa 40°C

Note 1 Use pipes used as transfer pipes in ‘2.5 Contaminated Water Treatment Equipment, etc.’
Note 2 SUS316L material is not used for the piping around the adsorption tower containing the activated carbon and the adsorption tower under low-pH conditions.
※ Some of the piping specifications (nominal diameter, thickness, and material) may not be used depending on the site construction status.

(omitted below)

After change

Main pipe specifications (8/8)

Name	Specifications	
From the outlet of the pipe unit to the inlet of supply tank A/B (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 STPT410+ lining 0.98MPa 40°C
From adsorption tower unit 1 to preprocessing filter unit A/B (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Equivalent to 80A Polyethylene 1.03MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch.40 STPT410+ lining 1.03MPa 40°C
From the preprocessing filter unit A to preprocessing filter unit B (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 80A Polyethylene 1.03MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	80A/Sch.40 STPT410+ lining 1.03MPa 40°C
From the outlet of the pretreatment filter unit A to the inlet of the pretreatment filter unit B (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 80A Polyethylene 1.03MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	80A/Sch.40 STPT410+ lining 1.03MPa 40°C
From the preprocessing filter unit A/B to adsorption tower unit 1 (polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 80A Polyethylene 1.03MPa 40°C
(steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	80A/Sch.40 STPT410+ lining 1.03MPa 40°C

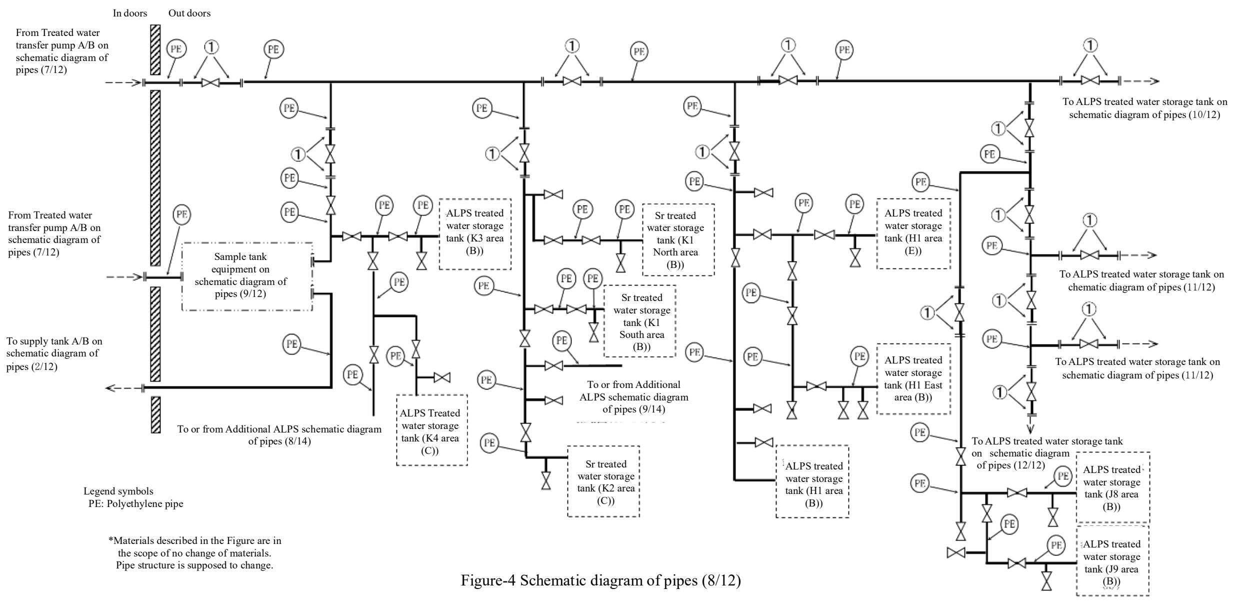
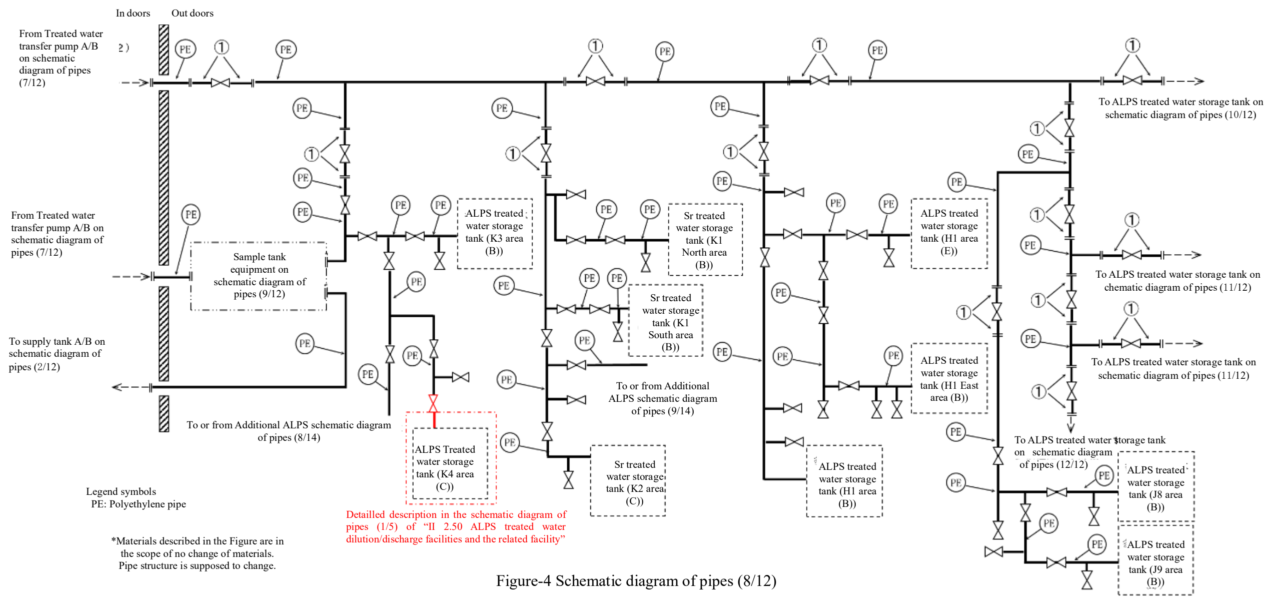
Note 1 Use pipes used as transfer pipes in “2.5 Contaminated Water Treatment Equipment, etc.”
Note 2 SUS316L material is not used for the pipe around the adsorption tower containing the activated carbon and the adsorption tower under low-pH conditions.
※1: Some of the pipe specifications (nominal diameter, thickness, and material) may not be used depending on the site construction status.
※2: Parts of the pipes to the K4 Area Tank shall also be used as "II 2 50 ALPS Treated Water Dilution/Discharge Facilities and the Related Facility".

(omitted below)

Reason for change

Optimization of the description

Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Current	Revised	Reason for Revision
Attachment-4 Calculation sheet on the strength of the high-performance multinuclide removal facility (Omission) 2.4 Main pipe 2.4.1 Evaluation point Figure-4 shows the points for strength evaluation. (Omission)  Figure-4 Schematic diagram of pipes (8/12) (Omitted below)	Attachment-4 Calculation sheet on the strength of the high-performance multinuclide removal facility (Omission) 2.4 Main pipe 2.4.1 Evaluation point Figure-4 shows the points for strength evaluation. (Omission)  Figure-4 Schematic diagram of pipes (8/12) (Omitted below)	Modification of the schematic diagram of pipes in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Before change	After change	Reason for change
Attachment-8 Confirmation Items of High-Performance Advance Liquid Processing System The main items to be confirmed for the high-performance advance liquid processing sytem are shown in Table-1 to 13. (Omitted below)	Attachment-8 Confirmation Items of High-Performance Advance Liquid Processing System The main items to be confirmed for the high-performance advance liquid processing sytem are shown in Table-1 to 13. The main items to be checked regarding pipes (steel pipes, polyethylene pipes, pressure-resistant hoses) that are used in conjunction with ALPS treated water dilution/discharge facilities and related facility are shown in "II 2 50 ALPS Treated Water Dilution/Discharge Facilities and Related Facility". (Omitted below)	Addition in accordance with the installation of ALPS treated water dilution/discharge facilities and related facility

Current	Revised	Reason for Revision
(Not currently listed)	2.50 ALPS Treated Water Dilution/Discharge Facilities and Related Facility (New described) (Omitted below)	Newly described of ALPS treated water dilution/discharge facilities and related facilities

Current	Revised	Reason for Revision
(Radioactive liquid waste management) Article 88 Discharge of radioactive waste into the sea shall not be made without the consent of the relevant ministerial agencies. 2. The GM of chemical analysis & evaluation group should conduct the measurement on items in the Table 88-1 with designated frequency in the same Table and inform the measurement result to the GM of release and environment monitaring group. At the same time, the GM of release and environment monitaring group should manage the following and inform the measurement results to Shift Supervisor. (1) The 3 month average of the radioactive materials concentration in the drain water from the condenser cooling water release should not exceed the legal limit of the concentration applicable to the area outside the surrounding monitored area. (2) Effort should be made that the radioactive material release volume (excluding Tritium) by the condenser cooling water should not exceed the release management limit stipulated in the Table 88-2. (3) Effort should be made that the Tritium release volume by the condenser cooling water should not exceed the release management limit stipulated in the Table 88-3. 3. Shift Supervisor, when releasing the radioactive liquid waste, should oversee the drain monitor and release from the condenser cooling water release opening.	(Radioactive liquid waste management) Article 88 Discharge of radioactive waste into the sea shall not be made without the consent of the relevant ministerial agencies. 2. The GM of chemical analysis & evaluation group should conduct the measurement on items in the Table 88-1 with designated frequency in the same Table and inform the measurement result to the GM of release and environment monitaring group. At the same time, the GM of release and environment monitaring group should manage the following and inform the measurement results to Shift Supervisor. (1) The 3 month average of the radioactive materials concentration in the drain water from the condenser cooling water release should not exceed the legal limit of the concentration applicable to the area outside the surrounding monitored area. (2) Effort should be made that the radioactive material release volume (excluding Tritium) by the condenser cooling water should not exceed the release management limit stipulated in the Table 88-2. (3) Effort should be made that the Tritium release volume by the condenser cooling water should not exceed the release management limit stipulated in the Table 88-3. 3. Shift Supervisor, when releasing the radioactive liquid waste, should oversee the drain monitor and release from the condenser cooling water release opening.	

Current

Table 88-1

Classification	Measurement Item	Kind of measuring device	Measurement frequency	Place to take sample from
Radioactive liquid waste	Concentration of radioactive materials (Major nuclides source of gamma ray	Radioactivity measuring device of the sample	Every time of discharge	・Collecting tank ・Sample tank
	Concentration of Tritium	Radioactivity measuring device of the sample	Once a month	

Table 88-2

Item	The release management target
Radioactive liquid waste (excluding Tritium)	2.5 x 10^{11} Bq / y

Table 88-3

Item	The release management limit
Tritium	2.5 x 10^{13} Bq / y

Revised

Table 88-1

Classification	Measurement Item	Kind of measuring device	Measurement frequency	Place to take sample from
Radioactive liquid waste	Concentration of radioactive materials (Major nuclides source of gamma ray	Radioactivity measuring device of the sample	Every time of discharge	・Collecting tank ・Sample tank
	Concentration of Tritium	Radioactivity measuring device of the sample	Once a month	

Table 88-2

Item	The release management target
Radioactive liquid waste (excluding Tritium)	2.5 x 10^{11} Bq / y

Table 88-3

Item	The release management limit
Tritium	2.5 x 10^{13} Bq / y

※1 2.2 x 10^{13} Bq/yr. shall not be exceeded in total with discharge water in accordance with Part 1, Article 41.

Reason for Revision: Amendment related to the installation of ALPS treated water discharge/dilution facilities

The Japanese version shall prevail.

Current	Revised	Revised reason
Supplementary Provisions Supplementary Provisions (Notification No. 2205093, May 9, 2022) (Effective Date) Article 1 This provision shall come into effect on May 9, 2022. 2. Articles 4, 5, 95, 97, and 98 shall be enforced within 30 days from the date of approval of this application for approval to amend the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility or the date of approval of the application for approval to amend the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility (IV Protection of Special Nuclear Fuel Material) submitted on January 14, 2022, whichever is later. The provisions then in force shall remain applicable until that date. (Omitted below)	Supplementary Provisions Supplementary Provisions ( ) (Effective Date) Article 1 This provision shall come into force within ten days from the date of approval by the Nuclear Regulatory Authority. Supplementary Provisions (Notification No. 2205093, May 9, 2022) (Effective Date) Article 1 This provision shall come into effect on May 9, 2022. 2. Articles 4, 5, 95, 97, and 98 shall be enforced within 30 days from the date of approval of this application for approval to amend the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility or the date of approval of the application for approval to amend the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility (IV Protection of Special Nuclear Fuel Material) submitted on January 14, 2022, whichever is later. The provisions then in force shall remain applicable until that date. (Omitted below)	

Current	Revised	Reason for Revision
(Not currently listed)	1.9 Operation Management of the ALPS Treatment Water Dilution/Discharge Facilities (Newly described) (Omitted below)	Newly described in relation to Operation managenment of ALPS treated water Dilution/Discharge Facilities

The Japanese version shall prevail.

Current	Revised	Reason for Revision
2.1.2 Management of Radioactive Liquid Waste, etc. 2.1.2.1 Overview (Omission) (2) Radioactive liquid waste, etc. (liquid generated after the accident) Radioactive liquid wastes generated after the accident include the following. Water has been injected into the reactors of Units 1 to 3 to cool down the reactors, but the injected water has leaked into the reactor buildings, etc., and has remained as stagnant water. The contaminated water is stored inside the buildings and tanks, etc. to prevent from leaking outside. A portion of the contaminated water is purified by the contaminated water treatment facility to reduce radioactive materials. The treated water generated by the purification process is stored in tanks, and the desalinated treated water is reused by injecting into the reactors. The treated water from the contaminated water treatment facility and the water from the outlet of the treatment facility is treated to reduce radioactive materials (except tritium) using a radionuclide removal system, and then the treated water is stored in tanks.	2.1.2 Management of Radioactive Liquid Waste, etc. 2.1.2.2 Overview (Omission) (2) Radioactive liquid waste, etc. (liquid generated after the accident) Radioactive liquid wastes generated after the accident include the following. Water has been injected into the reactors of Units 1 to 3 to cool down the reactors, but the injected water has leaked into the reactor buildings, etc., and has remained as stagnant water. The contaminated water is stored inside the buildings and tanks, etc. to prevent from leaking outside. A portion of the contaminated water is purified by the contaminated water treatment facility to reduce radioactive materials. The treated water generated by the purification process is stored in tanks, and the desalinated treated water is reused by injecting into the reactors. The treated water from the contaminated water treatment facility and the water from the outlet of the treatment facility is treated to reduce radioactive materials (except tritium) using a radionuclide removal system, and then the treated water is stored in tanks. The ALPS treated water that satisfies the sum of ratios to regulatory concentration limits, other than tritium less than 1 will be diluted with seawater and then discharged into the sea.	Addition in accordance with the discharge of ALPS treated water into the sea
The seawater and ground water that flowed into the turbine buildings of Units 5 and 6, and the rainwater in the weir where the concentration of radioactive materials exceeds the criteria for sprinkling water will be transferred to the storage facility (tanks) as stagnant water and stored, and part of it is treated as follows and sprinkled in the premisis ① Treated by treatment unit and desalinization equipment ② Treated by treatment equipment and desalinization equipment ③ Treated by treatment unit (Omission) 2.1.2.3 Radioactive Liquid Waste to be Managed and Management Methods (Omission) (5) Liquid waste management methods	The seawater and ground water that flowed into the turbine buildings of Units 5 and 6, and the rainwater in the weir where the concentration of radioactive materials exceeds the criteria for sprinkling water will be transferred to the storage facility (tanks) as stagnant water and stored, and part of it is treated as follows and sprinkled in the premisis ① Treated by treatment unit and desalinization equipment ② Treated by treatment equipment and desalinization equipment ③ Treated by treatment unit (Omission) 2.1.2.3 Radioactive Liquid Waste to be Managed and Management Methods (Omission) (5) Liquid waste management methods ALPS treated water is analyzed for its radionuclides other than tritirum and tritirum in the measurement/confirmation facility prior to discharge, and it is confirmed that the water satisfy the criteria. In addition, ALPS treated water is discharege after diluting with seawater using dilution facility in order to reduce tritirum concentration. When analyzing radionuclides contained in ALPS treated water, the following items shall be mainly implemented in order to secure the objectivity and reliability of the analytical methods and results by establishing a system required for the said analytical work after clarifying the resources (analyzers, analysts, etc.) required for the analysis according to such as the radionuclides to be measured, in accordance with the Quality Management System Plan stipulated in Article 3, Part 1 of Chapter III of the Implementation Plan. ・In addition to procuring analysts from subcontractors that have obtained certifications such as the International Organization for Standardization (ISO) related to the analysis of specific nuclides, education and training will be used to manage the competence of analysts and those supervising their analysis. ・In consideration of the resources, etc. required for the analysis of the Fukushima Daiichi NPS as a whole, an analytical system will be established that clarifies the roles within the organization, including subcontractors.	Addition about the concept of analysis method, system, selection of target nuclides for measurement and evaluation in relation to ALPS treated water

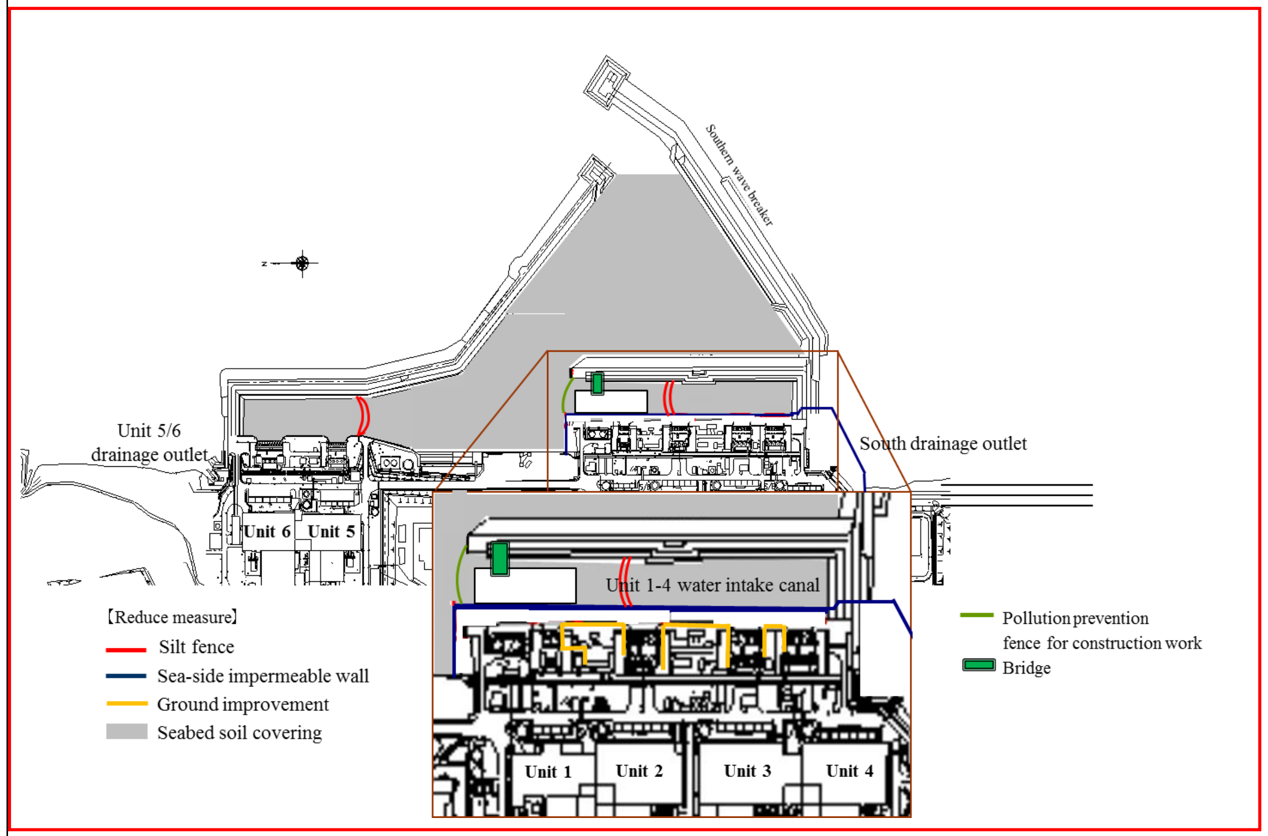
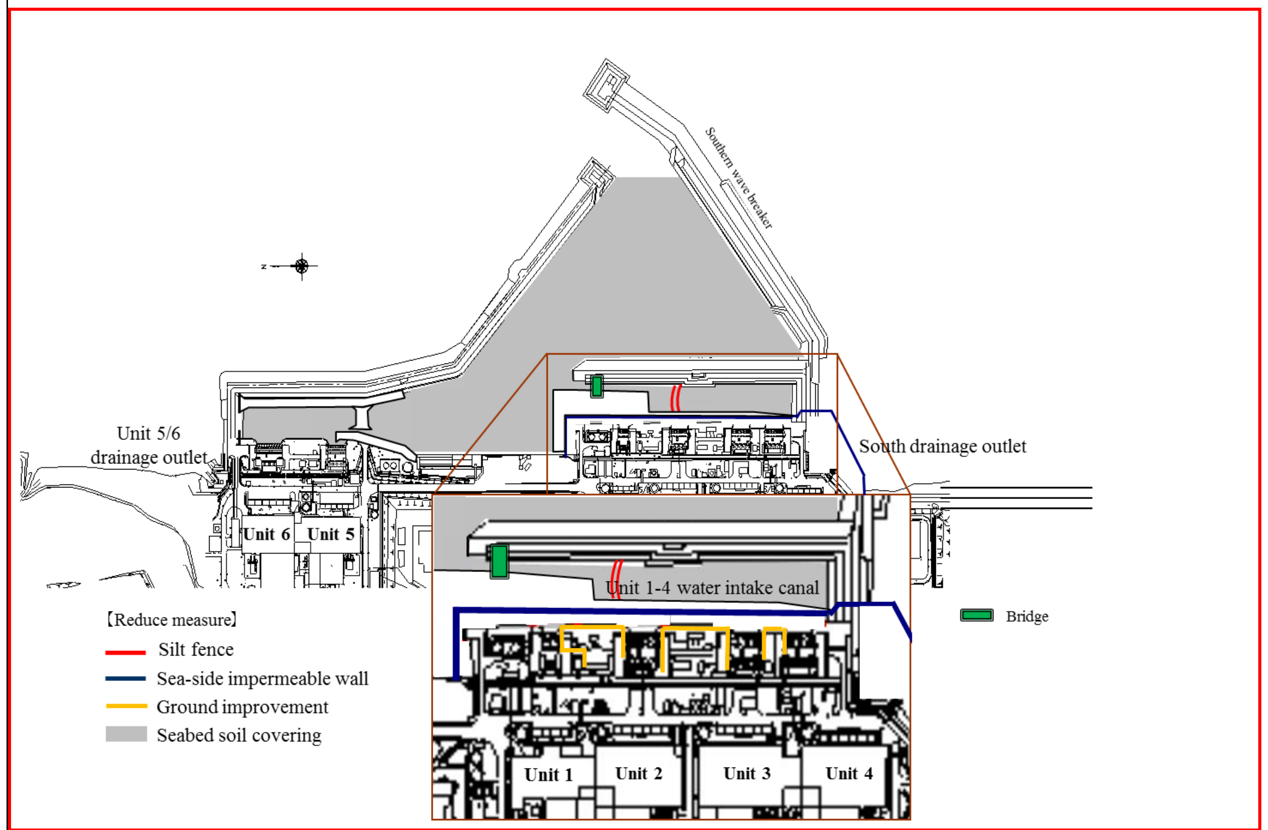
The Japanese version shall prevail.

Current	Revised	Reason for Revision
	・Analytical assessments will be conducted using an analytical method based on the official method, and the validity and verification of the analytical method and quantitative evaluation of analytical data, including uncertainty of analytical results, will be conducted while obtaining the participation of a third-party analytical organization with expertise in the analysis.	
The water shall be drained after analyzing the major nuclides and confirming that the criteria are satisfied. (In the pre-drainage analysis, Sr-90 shall be assessed in the same method as in (4) Recycling.) If the criteria are not satisfied, the water shall not be drained. Investigate the cause and implement countermeasures before discharging	The water of groundwater by-pass and the treated water within and the sub-drain purification equipment shall be drained after analyzing the major nuclides and confirming that the criteria are satisfied. (In the pre-drainage analysis, Sr-90 shall be assessed in the same method as in (4) Recycling.) If the criteria are not satisfied, the water shall not be drained. Investigate the cause and implement countermeasures before discharging	
(Omission)	(Omission)	
① Pre-discharge analysis When discharging radioactive liquid waste, etc., sampling should be carried out in advance in tanks, etc., and the concentration of radioactive materials should be measured, and the waste should be discharged if it meets the following criteria, and if it does not meet the criteria, necessary treatment (purification treatment, etc.) should be carried out. The nuclides to be assessed in the analysis before discharge shall be major nuclides. Discharge to the ocean will not be carried out without the approval of the relevant ministries.	① Pre-discharge analysis When discharging radioactive liquid waste, etc., sampling should be carried out in advance in tanks, etc., and the concentration of radioactive materials should be measured, and the waste should be discharged if it meets the following criteria, and if it does not meet the criteria, necessary treatment (purification treatment, etc.) should be carried out. Discharge to the ocean will not be carried out without the approval of the relevant ministries.	Sentences deleted
	For ALPS treated water, it shall be confirmed that tritium concentration is less than 1 million Bq/L, and that the sum of ratios to regulatory concentration limit other than tritium is less than 1 by measurement, etc. In addition, the discharge flow rate and seawater flow rate for dilution are set so that the tritium concentration in the discharge vertical shaft (upper-stream storage) is less than 1,500Bq/L and more than 100 times diluted with seawater. The total amount of discharged tritium stipulated in Chapter III of Implementation Plan (Article 41 of Part 1 and Article 88 of Part2) shall be within the range of 22 TBq/year. The radionuclides to be measured other than TRITIRUM and concentration confirmation methods shall be stipulated in the in-house manual. The concepts of identification of radionuclides other than tritium in ALPS treated water and subsequent selection of radionuclides to be measured and evaluated are as follows. ・ The sum of the total of radioactivity concentration obtained by adding carbon 14 and technetium 99 to the seven major nuclides of ALPS treated water and gross β measured values is not allowed to indicate the presence of radionuclides other than the current 64 nuclides. In addition, some nuclides subject to removal by ALPS will exist small amount for decay at the time of discharging ALPS treated water into the sea, so that it is considered that the sum of ratio to reglulatory concentration limits of radionuclides other than tritium is less than 1. ・ In order to ensure that the sum of ratios to regulatory concentration limit is less than 1, a radionuclide to be measured and evaluated will be selected after thorough verification of the presence of radionuclides in contaminated water is conducted based on domestic knowledge and findings of decommissioning and buried facilities.	Addition in accordance with the discharge of ALPS treated water into the sea
For the water of groundwater by-pass, it shall be confirmed that Cs-134 is less than 1Bq/L, Cs-137 is less than 1Bq/L, Sr-90 is less than 5Bq/L, and the H-3 is less than 1,500Bq/L by measurement.	For the water of groundwater by-pass, it shall be confirmed that Cs-134 is less than 1Bq/L, Cs-137 is less than 1Bq/L, Sr-90 is less than 5Bq/L, and the tritium is less than 1,500Bq/L by measurement.	Optimization of the description
For the treated water within the sub-drain and other remediation equipment, it shall be confirmed that Cs-134 is less than 1Bq/L, Cs-137 is less than 1Bq/L, Sr-90 is less than 3(1)	For the treated water within the sub-drain and other remediation equipment, it shall be confirmed that Cs-134 is less than 1Bq/L, Cs-137 is less than 1Bq/L, Sr-90 is less than 3(1)	

Current	Revised	Reason for Revision
Bq/L*, H-3 is less than 1,500Bq/L by measurement, as well as that no other artificial gamma-ray emitting have not been detected during the above measurement. (* Sr-90 shall be confirmed to be less than 1Bq/L at approx. once every 10 days) In addition to the treated water, the water pumped up to collection tanks shall be confirmed to be less than 1,500Bq/L by H-3 measurement. (Omitted below)	Bq/L*, tritium is less than 1,500Bq/L by measurement, as well as that no other artificial gamma-ray emitting have not been detected during the above measurement. (* Sr-90 shall be confirmed to be less than 1Bq/L at approx. once every 10 days) In addition to the treated water, the water pumped up to collection tanks shall be confirmed to be less than 1,500Bq/L by tritium measurement. (Omitted below)	

Current	Revised	Reason for Revision
2.2.3 Dose Assessment by Radioactive Liquid Waste, etc. 2.2.3.1 Dose assessment method (1) Nuclides to be assessed For the treated water within sub-drain and other treatment equipment. Cs-134, Cs-137, Sr-90, H-3 (hereinafter "major nuclides") and 37 other nuclides (total 41 nuclides*) shall be regarded as nuclides to be assessed. (* For the detail of 41 nuclides, refer to "III, Part 3, 2.1.2 Control of radioactive liquid waste, etc.") (Omission) 2.2.3.2 Dose assessment in each system (1) System to be assessed Dose assessment shall be performed on the following systems. ○Drainage system ・Water in groundwater bypass ・Rainwater inside the barrier ・Treated water from sub-drains and other water treatment facilities (Omission) (2) Dose assessment for drain For the water in groundwater bypass, its effective dose is 0.22 mSv/year because the water is treated after confirming that the following operational subjects are satisfied. (Omitted below)	2.2.3 Dose Assessment by Radioactive Liquid Waste, etc. 2.2.3.1 Dose assessment method (1) Nuclides to be assessed For ALPS treated water, radionuclides other than tritium and tritium shall be assessed. The selection of radionuclides other than tritium shall be stipulated in 3.2.1.2.3 (5) "Management of Radioactive Liquid Waste, etc." For the treated water within sub-drain and other treatment equipment. Cs-134, Cs-137, Sr-90, H-3 (hereinafter "major nuclides") and 37 other nuclides (total 41 nuclides*) shall be regarded as nuclides to be assessed. (* For the detail of 41 nuclides, refer to "III, Part 3, 2.1.2 Control of radioactive liquid waste, etc.") (Omission) 2.2.3.2 Dose assessment in each system (1) System to be assessed Dose assessment shall be performed on the following systems. ○Drainage system ・ALPS treated water ・Water in groundwater bypass ・Rainwater inside the barrier ・Treated water from sub-drains and other water treatment facilities (Omission) (2) Dose assessment for drain For ALPS treated water, the sum of ratios to regulatory concentration limt of radionuclides other than tritium shall be confirmed to be less than 1 prior to discharge by measurement, etc. The water to be discharge is diluted (100 times or more) with seawater and it will be dischraged while the tritium concentration is controlled to be less than 1,500Bq/L. Effective dose of tritium is calculated from opration limit of 1,500 Bq/L divided by tritium concentration limit stipulated in notification, and effective dose of the other nuclides other than tritium is calculated from the sum of ratios to regulatory concentration limit of 1 before dilution devided by minimum dilution ratio (100 times). So that the sum of effective dose for each nuclide is 0.035 mSv/year. For the water in groundwater bypass, its effective dose is 0.22 mSv/year because the water is treated after confirming that the following operational subjects are satisfied. (Omitted below)	Addition in accordance with discharge of ALPS treated water into the sea

The Japanese version shall prevail.

Current	Revised	Reason for Revision
3.1.4 Reduction of radioactive materials in seawater, seabed soil, groundwater and drainage channels in ports and harbors (Omission) 3.1.4.3 Basic Approach to Reduction Measures (Omission) (3) Measures to reduce the concentration of radioactive materials in water in drains (Omission)	3.1.4 Reduction of radioactive materials in seawater, seabed soil, groundwater and drainage channels in ports and harbors (Omission) 3.1.4.3 Basic Approach to Reduction Measures (Omission) (3) Measures to reduce the concentration of radioactive materials in water in drains (Omission)	
	(4) Measures to reduce the radioactive concentration of seawater intake for ALPS treated water dilution/discharge facilities and related facility Fig. 4 shows the conceptual diagram of the seawater intake facility. As for the water intake method, the water intake canal of Units 5 and 6 will be partitioned from the port of power station on the side of the water intake canal of Units 1 to 4 with a partition dike (the riprap sloping weir + sheet), and a part of the north side of the North Breakwater Permeation Prevention Work will be modified (partially removed), and seawater for dilution will be intake from outside the port of power station on the north side of the outlet of Units 5 and 6. By constructing partition dike, the inflow of seawater with a relatively high concentration of radioactive materials from the side of the water intake canal of Units 1 to 4 will be suppressed.	Addition of measures to reduce radioactive materials in seawater intake in accordance with the installation of ALPS treated water dilution/discharge facilities and the related facility
 Fig. 1 Measures to Reduce Radioactive Materials in Seawater and Seabed Soil in the Port, and Groundwater	 Fig. 1 Measures to Reduce Radioactive Materials in Seawater and Seabed Soil in the Port, and Groundwater	Addtion of installation of partitioning dikes for discharge of ALPS treated water into the sea Optimization of the description (reflection of drawings in line with actual conditions of the site)

Current

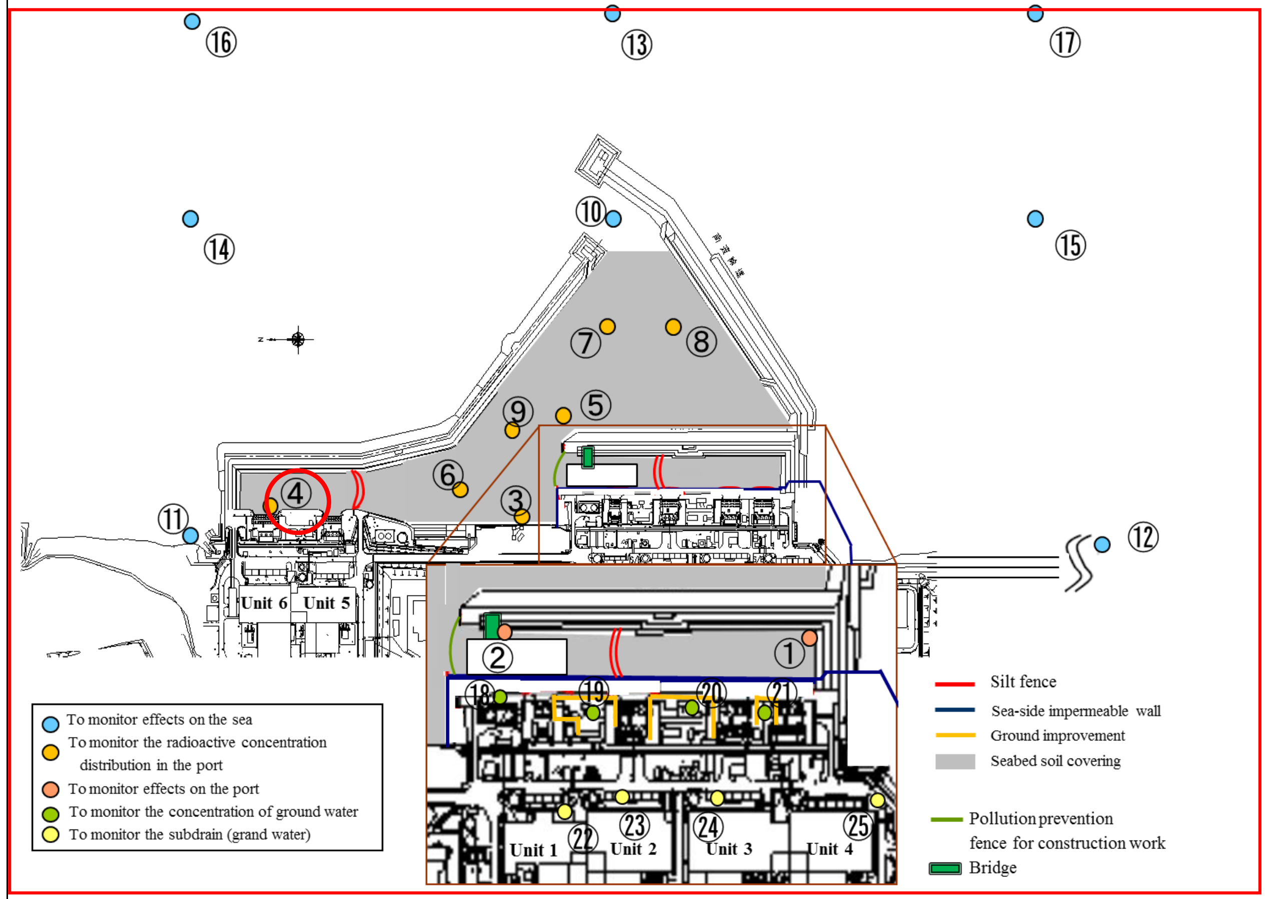


Fig. 2 Plans for monitoring seawater inside and outside port and groundwater (sampling points)

(Omission)

Table 1. Monitoring plans for seawater, groundwater, and drainage channels inside and outside ports (analysis items, frequency)

Area	Sampling point		Analysis items and frequencies			
			Gamma ray	H-3	Gross β	Sr-90
In the Unit 1-4 water intake canal	①	Southern part of Unit 1-4 water intake canal (in front of the impermeable wall) ※1	Once a day	Once a week	Once a day	Once a week
	②	Northern part of Unit 1-4 water intake canal (north of eastern wave breaker) ※1	Once a day	Once a week	Once a day	Once a week
In the port	③	In front of shallow draft quay ※1	Once a day	Once a week	Once a day	Once a week
	④	In front of Unit 6 water intake ※1	Once a day	Once a week	Once a day	-
	⑤	Central area in the port ※1	Once a day	Once a week	Once a day	Once a week
	⑥	Northern area in the port ※1	Once a day	Once a week	Once a day	Once a week
	⑦	Eastern area in the port ※1	Once a day	Once a week	Once a day	-
	⑧	Southern area in the port ※1	Once a day	Once a week	Once a day	-
	⑨	Western area in the port ※1	Once a day	Once a week	Once a day	-
	⑩	Port entrance ※1	Once a day	Once a week	Once a day	Once a week

(Omission)

Revised

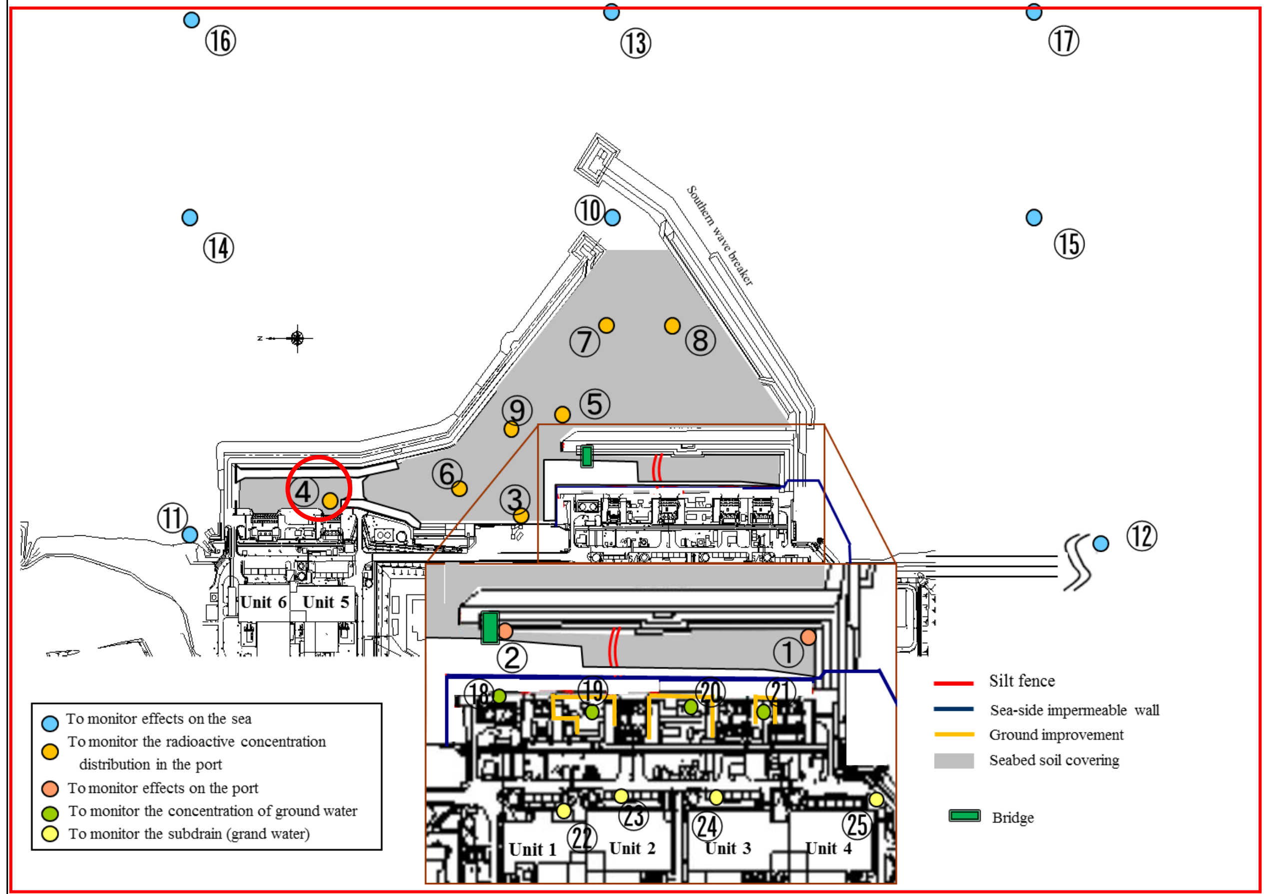


Fig. 2 Plans for monitoring seawater inside and outside port and groundwater (sampling points)

(Omission)

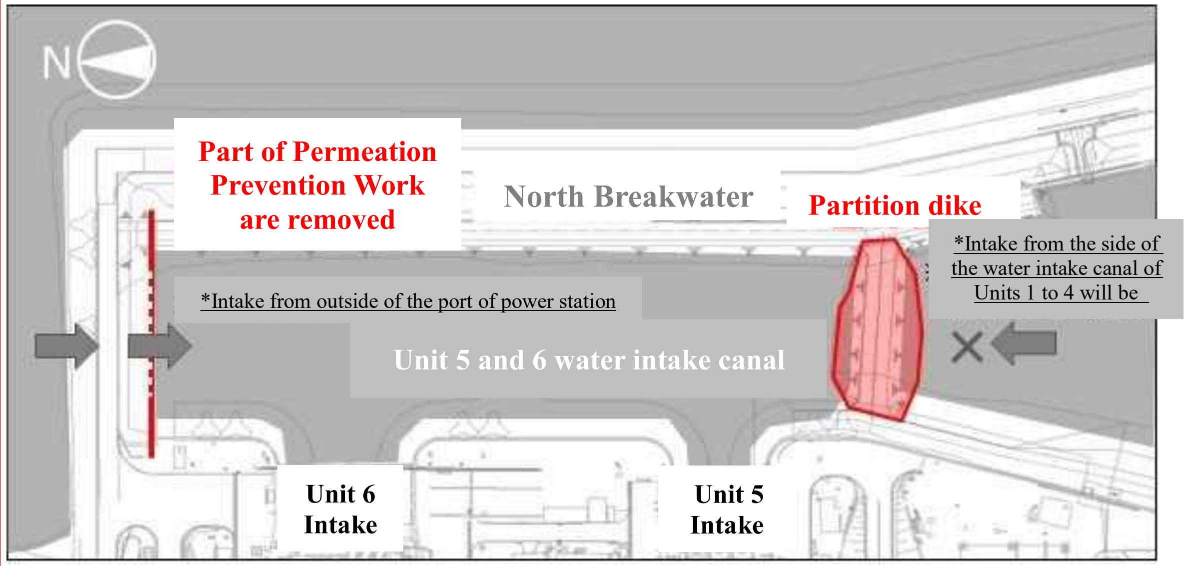
Table 1. Monitoring plans for seawater, groundwater, and drainage channels inside and outside ports (analysis items, frequency)

Area	Sampling point		Analysis items and frequencies			
			Gamma ray	H-3	Gross β	Sr-90
In the Unit 1-4 water intake canal	①	Southern part of Unit 1-4 water intake canal (in front of the impermeable wall) ※1	Once a day	Once a week	Once a day	Once a week
	②	Northern part of Unit 1-4 water intake canal (north of eastern wave breaker) ※1	Once a day	Once a week	Once a day	Once a week
In the port	③	In front of shallow draft quay ※1	Once a day	Once a week	Once a day	Once a week
	④	In front of Unit 5 water intake ※1	Once a day	Once a week	Once a day	-
	⑤	Central area in the port ※1	Once a day	Once a week	Once a day	Once a week
	⑥	Northern area in the port ※1	Once a day	Once a week	Once a day	Once a week
	⑦	Eastern area in the port ※1	Once a day	Once a week	Once a day	-
	⑧	Southern area in the port ※1	Once a day	Once a week	Once a day	-
	⑨	Western area in the port ※1	Once a day	Once a week	Once a day	-
	⑩	Port entrance ※1	Once a day	Once a week	Once a day	Once a week

(Omission)

Reason for Revision

Addtion of installation of partitioning dikes for discharge of ALPS treated water into the sea
Optimization of the description (reflection of drawings in line with actual conditions of the site)

Current	Revised	Reason for Revision
	 Fig.4 Conceptual Drawing of Seawater Intake Facilities	

The Japanese version shall prevail.

Current	Revised	Reason for Revision
VI Enhancing Public Acceptance on the Implementation of the Plan (Omission)	VI Enhancing Public Acceptance on the Implementation of the Plan (Omission)	
As for local residents, opportunities for communications shall be expanded further by executing direct information sharing and explanations from our company through the internet, insertion of the company publicity materials into publicity magazines of local governments, utilization of media such as advertisements in local papers, and mutual communication activities. Also, indirect information deliveries shall be made by news and newspaper articles through mass media, such as press releases and periodic press conferences. In these activities, impact of the understanding promotion and its progress shall be obtained by analyzing trend of local voices heard during these mutual communication activities, and efforts shall be made for further understanding promotion.	As for local residents, opportunities for communications shall be expanded further by executing direct information sharing and explanations from our company through the internet, insertion of the company publicity materials into publicity magazines of local governments, utilization of media such as advertisements in local papers, and mutual communication activities such as tours and visits at Fukushima Daiichi Nuclear Power Station. Also, indirect information deliveries shall be made by news and newspaper articles through mass media, such as press releases and periodic press conferences. In these activities, impact of the understanding promotion and its progress shall be obtained by analyzing trend of local voices heard during these mutual communication activities, and efforts shall be made for further understanding promotion.	Optimization of the description
To local governments which act as windows to local residents, through notifications based on "Agreement for securing safety of surrounding areas of nuclear power stations" and "Agreement on reporting and communication related to nuclear power stations," both of which have been executed with each municipality*2, information is delivered periodically about progress of plant decommissioning, etc., and promptly about unplanned shutdown of cooling system for nuclear fuel or unplanned shutdown of the nitrogen injection facility. Also, responses shall be made actively for "Committee of persons in charge of notification and communication" and "Fukushima prefecture safety oversight council regarding decommissioning of nuclear power plants," for both of which Fukushima prefecture serves as a secretariat, delivering explanations from the planning stage about the decommissioning and activities for the implementation plan, while hearing opinions from the members of the committee and the council sincerely. In addition, invitations shall be made for local governments, etc., for visits directly to the plant field.	To local governments which act as windows to local residents, through notifications based on "Agreement for securing safety of surrounding areas regarding execution of decommissioning, etc. of TEPCO's Fukushima Daiichi Nuclear Power Station" and "Agreement of securing safety of surrounding municipalities regarding execution of decommissioning, etc. of TEPCO's Fukushima Daiichi Nuclear Power Station," both of which have been executed with each municipality*2, information is delivered periodically about progress of plant decommissioning, etc., and promptly about shutdown of cooling functions for nuclear fuel or shutdown of the nitrogen injection facility. Also, responses shall be made actively for "Committee of persons in charge of notification and communication" and "Fukushima prefecture safety oversight council regarding decommissioning of nuclear power plants," for both of which Fukushima prefecture serves as a secretariat, delivering explanations from the planning stage about the decommissioning and activities for the implementation plan, while hearing opinions from the members of the committee and the council sincerely. In addition, invitations shall be made for local governments, etc., for visits directly to the plant field.	
(Omission)	(Omission)	
For the understanding promotion activities, while the activities are going on, improvement and reviews are to be conducted continuously for further understanding promotion, with efforts to make it better based on instructions and proposals from the Social Comunication Office *3 as a direct report to the president.	For the understanding promotion activities, while the activities are going on, improvement and reviews are to be conducted continuously for further understanding promotion, with efforts to make it better based on instructions and proposals from Corporate Communications Office*3 of Public Relations & Corporate Communications Unit and D&D Information & Planning Management Office*4.	Additon of D&D Information & Planning Management Office
*1: Unplanned shutdown of the fuel cooling system (water injection facility of reactor pressure vessel/ container, nitrogen injection facility of reactor pressure vessel, spent fuel pool facilities, PCV gas management facilities), wide-spanning outage of on-site electric power source, concern of contaminated water leakage to outside of the premise, etc.	*1: Unplanned shutdown of the fuel cooling system (water injection facility of reactor pressure vessel/ container, nitrogen injection facility of reactor pressure vessel, spent fuel pool facilities, PCV gas management facilities), wide-spanning outage of on-site electric power source, concern of contaminated water leakage to outside of the premise, etc.	
*2. Fukushima Prefecture, Okuma Town, Futaba Town, Naraha Town, Tomioka Town, Hirono Town, Namie Town, Iwaki City, Tamura City, Minamisoma City, Kawamata Town, Kawauchi Village, Katsurao Village and Iitate Village	*2. Fukushima Prefecture, Okuma Town, Futaba Town, Naraha Town, Tomioka Town, Hirono Town, Namie Town, Iwaki City, Tamura City, Minamisoma City, Kawamata Town, Kawauchi Village, Katsurao Village and Iitate Village	
*3: Established on April 10, 2013 as a direct report to the president, with the objective of making appropriate communications toward the society, activities to foster social sensitivity through training, etc., and activities of conversation leveraging risk communicators, and proposals are	*3: With the objective of making appropriate communications toward the society, and activities of public hearings/publicity leveraging risk communicators who belong to Corporate Communications Office are conducted, and proposals are made to each department inside the company for the appropriate information disclosures at the time of troubles	Optimization of the description

The Japanese version shall prevail.

Current	Revised	Reason for Revision
made to each department inside the company for the appropriate information disclosures at the time of troubles	*4: An organization established on August 1, 2021, directly under the Chief Decommissioning Officer as the headquarters within the Fukushima Daiichi Decontamination and Decommissioning Engineering Company, in order to enable information dissemination and facility installation in response to local perspectives at the event of troubles, medium-scale disasters and emergencies, as well as upon making progress in the decommissioning activities.	Additon in accordance with establishment of D&D Information & Planning Management Office

The Japanese version shall prevail.

Current	Revised	Revised Reason
Annexes of the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility Annex (Omission) Annex 26 Supplementary information on Intake Facilities in Unit 3 reactor containment I. Structural Strength and Seismic resistance of Intake Facilities in Unit 3 reactor containment Annex 28 Supplementary infomation on Fuel Removing Facility from the Spent Fuel Pool of Unit 2 I Supplementary explanation material for Fuel Removing Platform II Ventilation Equipment Ventilation Air Volume III Calculation Form for Seismic Resistance of Shields Installed on the Floor of the Operating Floor of the Reactor Building IV 1/2Ss450 Assessment for Fuel Handling Machine and Fuel Removing Platform of Unit 2 V Calculation Form for Exposure Assessment in Case of Damage to Fuel Handling Machine of Unit 2	Annexes of the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility Annex (Omission) Annex 26 Supplementary information on Intake Facilities in Unit 3 reactor containment I. Structural Strength and Seismic resistance of Intake Facilities in Unit 3 reactor containment Annex 27 Supplementary information on the ALPS Treated Water Dilution/Discharge Facilities I Structural Strength of ALPS Treated Water Dilution/Discharge Facilities II Tolerance of nominal values for ALPS Treated Water Dilution/Discharge Facilities Annex 28 Supplementary infomation on Fuel Removing Facility from the Spent Fuel Pool of Unit 2 I Supplementary explanation material for Fuel Removing Platform II Ventilation Equipment Ventilation Air Volume III Calculation Form for Seismic Resistance of Shields Installed on the Floor of the Operating Floor of the Reactor Building IV 1/2Ss450 Assessment for Fuel Handling Machine and Fuel Removing Platform of Unit 2 V Calculation Form for Exposure Assessment in Case of Damage to Fuel Handling Machine of Unit 2	Addition in accordance with the installation of ALPS Treated Water Dilution/Discharge Facilities

The Japanese version shall prevail.

Current	Revised	Rivised Reason
(Not currently listed)	Annex 27 Supplementary information on the ALPS Treated Water Dilution/Discharge Facilities (Newly described) (Omitted below)	New description to the installation of ALPS Treated Water Dilution/Discharge Facilities

The Japanese version shall prevail.

Current	Revised	Reason for Revision
(Not currently listed)	Reference Material Action in response to "Basic Policy on handling of ALPS treated water at the Tokyo Electric Power Company Holdings' Fukushima Daiichi Nuclear Power Station" (Newly described) (Omitted below)	Additon of reference material

Current	Revised	Reason for Revison
(Not currently listed) (Omitted below)	Attachment-1 Action in Response to the Basic Policy of the Government (Newly described) (Omitted below)	Additon of action in response to the basic policy of the government

Current	Revised	Reason for Revision
(Not currently listed) (Omitted below)	Attachment-2 Radiological Impact Assessment Report Regarding the Discharge of ALPS Treated Water into the Sea (Design stage / Revised version) (Newly described) (Omitted below)	Addtion of radiological impact assessment report regarding the discharge of ALPS treated water into the sea (design stage / revised version)

Table of Contents

(Refer to comparison table for any amendments)

The Japanese version shall prevail.

2. Risk Assessment

2.1 Concept of Risk Assessment

(Refer to comparison table for any amendments)

2.3.7 Radioactive Waste

(Refer to comparison table for any amendments)

2.4 Future Risk Reduction Measures of Specified Nuclear Facility

(Refer to comparison table for any amendments)

Risk Reduction Measures to be Implemented and Appropriateness

(Refer to comparison table for any amendments)

1.9 Treatment, Storage and Management of Radioactive Liquid Waste

(Refer to comparison table for any amendments)

1.14 Design Considerations

(Refer to comparison table for any amendments)

Impact Assessment for Collision of Ships

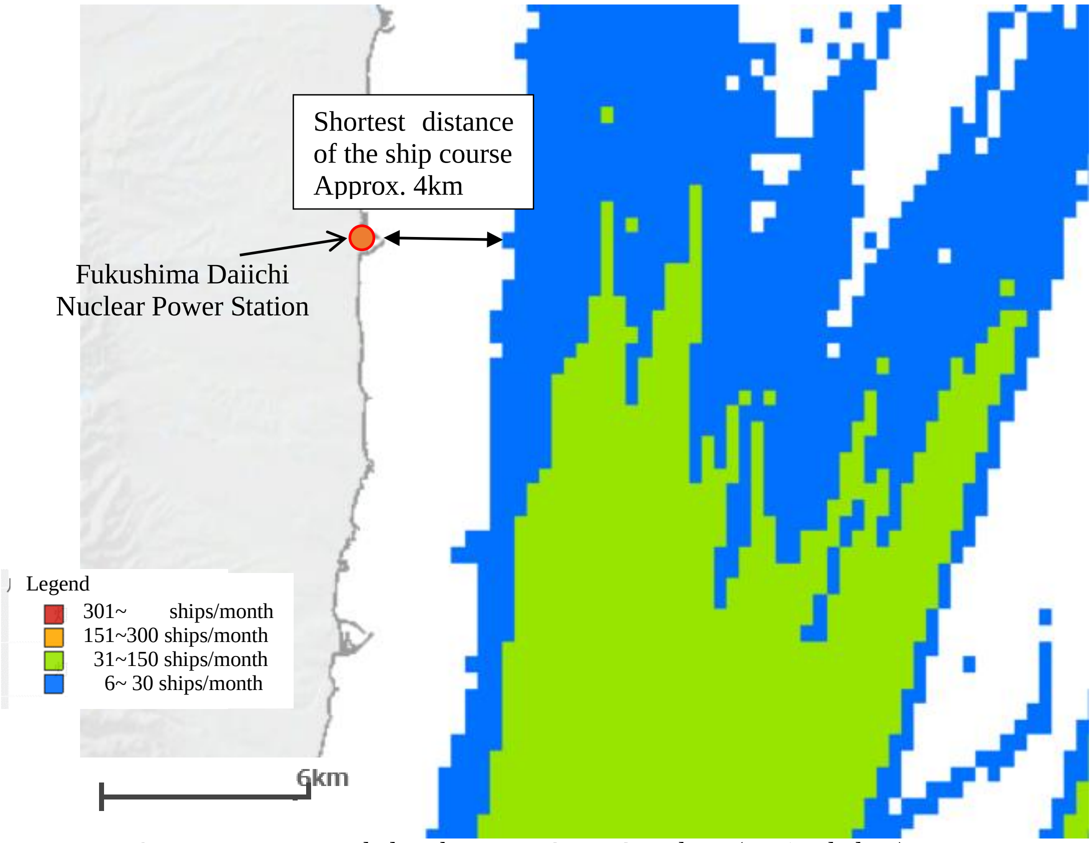
1. Overview

Since the nearest ship course has an isolation distance of approximately 4km or more offshore from the Fukushima Daiichi Nuclear Power Station, thus the collision of ships passing through the ship course will not impair the safety function of the specified nuclear facilities. As a result of investigating the current direction in the sea area around the power station, since there is main flow in the north-south direction almost along the shoreline in the sea area in front of the power station, it is unlikely that a collided ship will enter the water intake point even if they drift. Even if a small ship drifts in the vicinity of the power plant, it stops by collision with the north breakwater in the front of the site or the partition ridge in the harbor and will not affect the water intake.

In preparation for the occurrence of a heavy oil spill accident due to the grounding of a vessel, an oil fence will be installed at the front of the water intake canal of Units 5 and 6 so as not to affect the water intake function.

2. About the ship course in front of the premises

As for ships in the vicinity of the Fukushima Daiichi Nuclear Power Station in addition to having an isolation distance of approx. 4 km from the Fukushima Daiichi Nuclear Power Station even though the closest ship course showed in Figure-1, as a result of investigating the direction of currents in the vicinity of the power station as shown in Figure-2, there is a large amount of north-south current almost along the shoreline in the sea area in front of the power station. Therefore, even if drifted ships passing through the course, it is unlikely that the ship will reach the site and the safety function of the specified nuclear facility will not be impaired.



Source: Partially added to the Japan Coast Guard HP (marine ledger)

Current distribution map

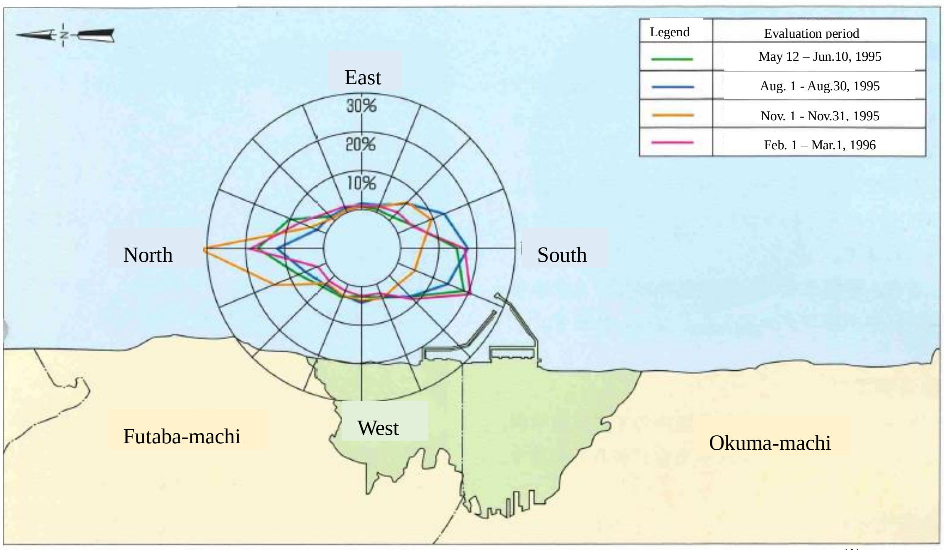


Figure-2 Current distribution map of the sea area around the power station※

※From the outline of the plan for the expansion and the environmental impact survey for Units 7 and 8 at the Fukushima Daiichi Nuclear Power Station

The Japanese version shall prevail.

3.Impact of collisions of small ships, etc.

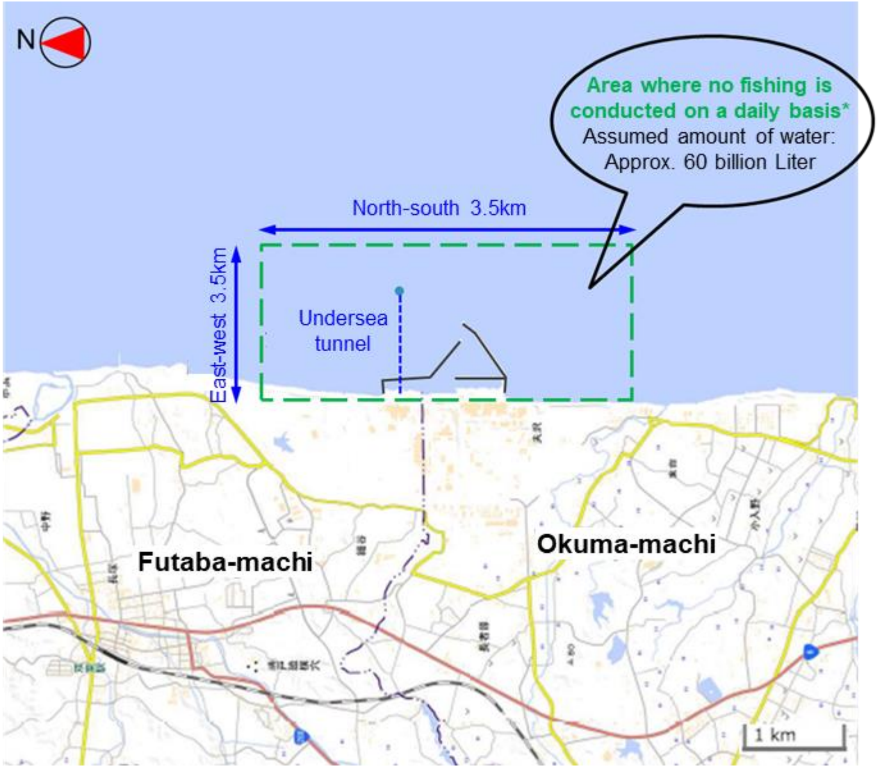
Impact assessment of ships around the power station will be carried out as ships outside the ship course. As the ships to be evaluated are: transportation ships such as fuel, earth carriers as ships on the premises (inside the plant harbor), and fishing ships, pleasure boats, and patrol ships as ships outside the premises (outside the plant harbor).

Regarding patrol ships among ships on the premises and ships outside the premises, if abnormal weather, oceanographic phenomena, or stormy weather is predicted, measures such as stopping port entry and leaving shore are to be taken as necessary. Therefore, it is evaluated that they will not be drifting ships.

Of the ships outside the premises, fishing ships and pleasure boards are separated using breakwaters all over the port and harbors, and there is a lighthouse they can use as a mark. Even if they drift due to stormy weather, it is possible to take measures such as anchoring. As for fishing ships, fishing is not carried out on a daily basis in the sea area around the power station (see Figure-3.) Therefore, it is extremely unlike that they will enter the harbor.

Even if a small ship approaches the port, Units 5 and 6, which are taking in cooling water, as well as ALPS treated water dilution/discharge facilities and the related facility are taking in water from north side and outside of the port. Therefore, the entry of small ship is inhibited by the breakwaters on the north side and the installation of partition dike on the south side, the side for Units 1 to 4 (see Figure-4.)

In addition, even if a small ship arrives at the northern breakwater, the intake will not be blocked because of the wide entrance (approx. 40m in width) of the breakwater.



Source: the Geographical Survey Institute map (national land electronic website) revised by Tokyo Electric Power Company Holdings, Inc.
https://maps.gsi.go.jp/#13/37.422730/141.044970/&base=std&ls=std&disp=1&vs=c1j0h0k0l0u0t0z0r0s0m0f1

*Areas where common fishery rights are not established

Figure-3 Area where no fishing is conducted on a daily basis

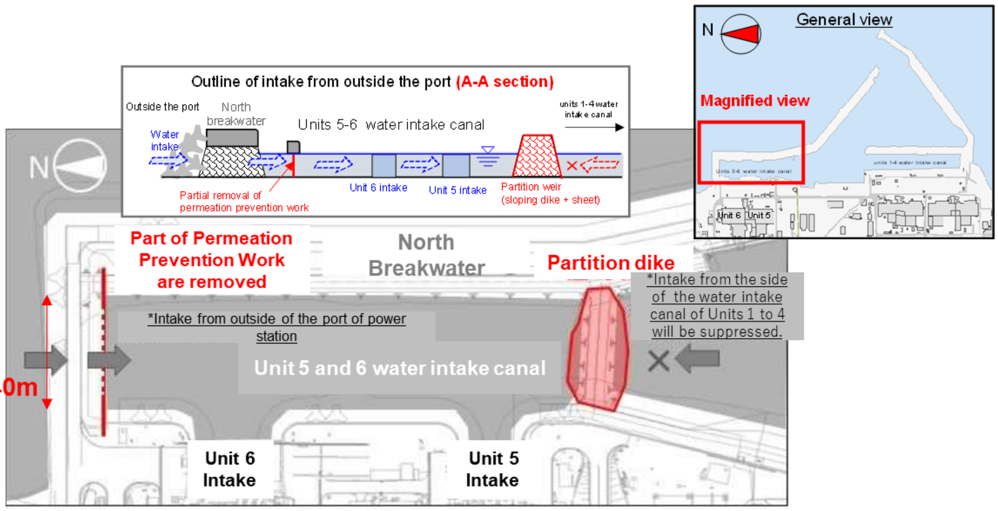


Figure-4 Intake method of Units 5 and 6

4.Impact of heavy oil spills

In addition to chapter 1 to 3, measures will be taken to install oil fences in front of the water intake canal of Units 5 and 6 so as not to affect the intake function in case of the inflow of heavy oil into the water intake canal, assuming an accident involving a fuel oil spill caused by a ship running aground. And, the structure of the north breakwater is a structure which penetrates the sea water, and the impact on the intake by the inflow of heavy oil is small.

End

2.5 Contaminated Water Treatment Facilities, etc.

(Refer to comparison table for any amendments)

Policy on Design and Confirmation of Medium-and Low-Concentration Tanks

(Refer to comparison table for any amendments)

2.16 Radioactive Liquid Waste Treatment Facilities and Related Facilities

2.16.1 Advance Liquid Processing System

(Refer to comparison table for any amendments)

Assessment Result of Structural Strength and Seismic Resistance of Radioactive Liquid Waste Treatment Facilities, etc.

(Refer to comparison table for any amendments)

Confirmation Items of Advance Liquid Processing System

(Refer to comparison table for any amendments)

2.16.2 Additional Advance Liquid Processing System

(Refer to comparison table for any amendments)

Strength Calculation Sheet of Aditional Advance Liquid Processing System

(Refer to comparison table for any amendments)

Confirmation Items of Additional Advance Liquid Processing System

(Refer to comparison table for any amendments)

2.16.3 High-Performance Advance Liquid Processing System

(Refer to comparison table for any amendments)

The Japanese version shall prevail.

Strength Calculation Sheet of High-Performance Advance Liquid Processing System

(Refer to comparison table for any amendments)

Confirmation Items of High-Performance Advance Liquid Processing System

(Refer to comparison table for any amendments)

2.50 ALPS Treated Water Dilution/Discharge Facilities and the Related Facility

2.50.1 Basic Design

2.50.1.1 ALPS Treated Water Dilution/Discharge Facilities

2.50.1.1.1 Purpose of Installation

The tanks* on the premises of the Fukushima Daiichi NPS store the water, which radionuclides other than tritium has been removed to a sufficiently low concentration by ALPS (hereinafter “ALPS treated water, etc.”).

The purpose of this facility shall be to dilute ALPS treated water, etc. with seawater and discharge into the sea after confirming that the water satisfies the concentration where sum of the ratios of regulatory required concentration of radionuclides, excluding tritium is less than 1 (hereinafter “ALPS treated water.”).

*: The Reverse Osmosis membrane (hereinafter “RO”) concentrated water storage tanks, the ALPS treated water, etc. storage tanks, and Sr treated water storage tanks.

RO concentrated water storage tanks initially stored the concentrated salt water transferred from the RO device, but after the completion of the treatment of the concentrated water, RO concentrated water storage tanks store ALPS treated water, Sr treated storage tanks initially stored water treated by RO concentrated salt water treatment facility (already closed down), but after the completion of the treatment of the water treated by RO concentrated salt water treatment facility, Sr treated storage tanks store ALPS treated water, etc.

2.50.1.1.2 Required function

(1) The amount of discharge into the sea shall be capable of exceeding the amount of contaminated water generated (the amount increased by the inflow of groundwater and rainwater).

(2) In order to confirm that the water to be diluted/discharged is ALPS treated water, it shall be capable of homogenous the radionuclides concentration in each tank in a tank group in the status of measurement/confirmation.

(3) ALPS treated water can be diluted with seawater and drained to discharge facility.

(4) The facilities have a function to immediately halt the discharge of the ALPS treated water into the sea in case an abnormal matter happens.

(5) The facilities have a function to dilute the ALPS treated water 100 times or more so that the level of tritium concentration in diluted ALPS treated water after diluting with seawater is below 1,500Bq/L.

2.50.1.1.3 Design Policy

(1) Processing of radioactive liquid waste

ALPS treated water dilution/discharge facilities mainly consist of measurement/confirmation facility, transfer facility, and dilution facility.

At the measurement/confirmation facility, the radioactive material concentration in each tank and between the tanks in a tank group is made homogeneous, and then sample collection and analysis are performed to confirm that the sum of the ratios to regulatory concentrations limits of radionuclides other than tritium contained in ALPS treated water is less than 1 and the tritium concentration.

Thereafter, ALPS treated water is transferred to the dilution facility by the transfer facility, diluted with seawater, and then drained to the discharge facility.

a. Homogenization of Radioactivity Concentrations of In-Tank ALPS Treated Water Prior to Discharge into the Sea

In the measurement confirmation facility, the concentration of radioactive materials in the tank group is made almost homogenous by circulating water in the tank group using circulation pumps before sampling so that representative samples can be obtained. In addition, agitation equipment shall be installed in each tank to promote homogenization.

b. Adjusting and monitoring the mixing and dilution rate of ALPS treated water to seawater

In order to reduce the effective dose at the site boundary as much as achievable, dilution shall be designed so that the tritium concentration in the water discharged after diluting the ALPS treated water with seawater (the "discharge water") is less than 1,500Bq/L, which is the upper limit of operation, and the dilution ratio by seawater is 100 times or more. The mixing and diluting conditions in ALPS treated water dilution/discharge facilities is evaluated using the analysis code.

In addition, the mixing and diluting ratio shall be adjusted and monitored so that the tritium concentration in the released water is less than 1, 500Bq/L, the upper limit of operation.

c. Detecting Abnormalities and Halting the Discharge of ALPS Treated Water into the Ocean

In preparation for the occurrence of an event that may lead to ocean release of ALPS treated water in an unintentional manner due to a failure along with other abnormalities during the service period, emergency isolation valves shall be installed in the transfer facility, and when it is judged that the operational condition deviates from the normal operating state, they shall be closed by an interlock, and the discharge into the sea of ALPS treated water shall be designed to manually be halted by the operator as required.

d. Prevention of leakage and uncontrolled release of radioactive materials

Since ALPS treated water dilution/discharge facility handles ALPS treated water as radioactive liquid waste, the following items shall be considered in order to prevent both of the occurrence of the leakage and the spread of contamination. However, among the those facilities, the discharge vertical shaft (upper-stream storage) shall be designed to ensure water tightness so that no significant outflow to other than the discharge facility will occur, since only the discharge water is handled at normal times.

(a) In order to prevent the occurrence of leakage, appropriate materials to the environment installed and the properties of internal fluids shall be used for equipment, etc.

(b) In the event of a leak of liquid radioactive material, early detection of the leak shall be enabled, and the leak liquid shall be easily removed.

(c) Alarms such as detection of a leakage should be displayed in the Seismic Isolation Building Central Monitoring Room to ensure that the abnormality is communicated to the operators and appropriate measures can be taken.

e. Dose reduction

The ALPS treated water dilution/discharge facilities shall be designed considering the shielding function in designing the equipment, etc., according to the nature of the radioactive liquid waste to be handled.

(2) Applicable Codes and Standards

Regarding the design, selection of materials, manufacture, and test/inspection of structures, systems, and components constituting ALPS treated water dilution/discharge facilities, reliability shall be ensured by applying the Rules on Design/Construction for Nuclear Power Plants (JSME) for Power Generation, the technical standards of the Society of Civil Engineers along with others, and the Japanese Industrial Standards (JIS), etc.

(3) Design considerations against natural phenomena

a. Design considerations against earthquakes

Structures, systems and components constituting ALPS treated water dilution/discharge facilities shall be classified in terms of seismic design, referring to the seismic class classification of fuel fabrication facilities, and use facilities that handle unsealed nuclear fuel materials, while considering the importance of their safety functions, influences on safety (influences on public exposure) in the event of loss of a function due to an earthquake, and influences on decommissioning activities, and shall be designed to withstand the seismic force for design that is considered appropriate.

In evaluating the seismic resistance of major components, it is basic to comply with the Technical Codes for Seismic Design of Nuclear Power Stations (JEAC4601), etc., however the evaluation methods and evaluation standards shall be adopted according to the actual conditions.
Polyethylene pipes and pressure resistant hoses shall ensure seismic resistance by the flexibility of the materials.

b. Design considerations against natural phenomena other than earthquakes (tsunamis, heavy rainfall, typhoons, tornadoes, etc.)
The ALPS treated water dilution/discharge facilities shall be designed so that the safety of the facility will not be impaired by natural phenomena (tsunami, heavy rainfall, typhoon, tornado, etc.) that are assumed to be other than earthquakes.

(4) Design considerations for external anthropogenic events
The ALPS treated water dilution/discharge facilities shall be designed so that the safety of the facility will not be compromised by any postulated external anthropogenic events. In addition, appropriate measures shall be taken to protect against unauthorized access by third parties.

(5) Design considerations against fires
The ALPS treated water dilution/discharge facility shall be designed so that the safety of the facility will not be compromised by fire with appropriate combination of measures to prevent the occurrence of fire, to detect and extinguish the fire, and to mitigate the consequences of the fire.

(6) Design considerations for environmental conditions
Structures, systems and components for ALPS treated water dilution/discharge facilities shall be designed to be compatible with all assumed environmental conditions, including ageing events.

(7) Design considerations for operations
The ALPS treated water dilution/discharge facilities shall be designed to prevent misoperation by operators, and shall be designed so that operators can easily operate the facilities required to cope with these events even in situations where abnormal events or natural phenomena that could affect the operation of the facility have occurred.

(8) Design considerations for reliability
The ALPS treated water dilution/discharge facility shall be designed to ensure high reliability so that "unintentional ocean release of ALPS treated water" will not occur due to human error and/or equipment failure. In addition, even if "unintentional ocean release of ALPS treated water" occurs,

the quantity shall be designed to be extremely small.

(9) Design considerations for testability

Structures, systems and components constituting ALPS treated water dilution/discharge facilities shall be designed so that each function can be tested/inspected by appropriate methods to confirm the integrity and capability.

(10) Other Design considerations

a. Consideration for soundness

The ALPS treated water dilution/discharge facilities shall be designed to enable efficient maintenance according to the degree of importance of each component.

b. Consider for monitoring and operation

The ALPS treated water dilution/discharge facility shall be designed to enable remote control and monitoring of operation status by monitoring and control equipment in the central monitoring room of the Seismic Isolation Building.

c. Consideration for long-term shutdowns

Among the ALPS treated water dilution/discharge facilities, either which are dynamic components or have functions for the components that immediately shuts down in the event of an abnormality shall be installed two series in parallel so that the facilities will not be shut down for a long time due to events such as a failure. In addition, power shall be designed to be receivable from two different in-house high-voltage bus lines.

2.50.1.1.4 Major Components

ALPS treated water dilution/discharge facilities consists of measurement/confirmation facility, transfer facility, and dilution facility.

(1) Measurement/confirmation facility

Measurement/confirmation facility consists of measurement/confirmation tanks, agitation equipment, circulation pumps, circulation pipes, and receiving pipes, for the purpose of homogenizing the radioactive material concentration of ALPS treated water and sampling prior to discharge.

Since the measurement/confirmation tanks require at least about 10,000 m^3 of capacity to discharge ALPS treated water into the sea in view of the current amount of contaminated water generated and the time required to measure and evaluate the amount of radioactive materials contained in ALPS treated water, 10 of the K4 area tanks shown in the multi-nuclide process water storage tanks of "II 2.5 Contaminated Water Treatment Facilities, etc." will be used as a single tank group in three tank groups (30 tanks), and each tank group will be distributed to the receiving, measurement/confirmation, and discharge processes of ALPS treated water.

Agitation equipment is installed one by one in the tank for measurement and confirmation, and agitation in the tank is performed.

Two circulation pumps are installed to circulate and agitate water inside one group of tanks (10 tanks). Incidentally, both circulation pumps and agitators shall ensure sufficient processing capacity for homogenization of the concentration of radioactive materials in the K4 area tank.

(2) Transfer facility

The transfer facility consists of ALPS treated water transfer pump and pipes to transfer the water, which has been verified as ALPS treated water in the measurement/confirmation facility, to the dilution facility.

ALPS treated water transfer pumps shall consist of two units, the operational unit and the stand-by unit, and transfer ALPS treated water to the dilution facility.

Also, emergency isolation valves-2 shall be provided at one location behind the seawall and emergency isolation valves-1 shall be provided in front of seawater pipe header as a countermeasure against tsunamis so that the transfer can be halted immediately in the event of an abnormality.

(3) Dilution facility

The dilution facility consists of seawater transfer pumps, seawater pipes (including seawater pipe header), discharge vertical shaft (upper-stream storage) for the purpose of diluting the ALPS treated water with seawater, transferring it to the discharge vertical shaft (upper-stream storage), and drained away to the discharge facility.

The seawater transfer pumps transfer seawater from the water intake canal of Unit 5 to the discharge vertical shaft. Furthermore, the dilution facility shall ensure a capacity to dilute the ALPS treated water 100 times or more so that tritium concentration of the ALPS treated water transferred by transfer facility shall be sufficiently below 1,500Bq/L.

2.50.1.1.5 Items to be checked during service period

The ALPS treated water dilution/discharge facilities shall be capable of transferring the ALPS treated water through the transfer facility to the dilution facility and dilute it with seawater before draining away to discharge facility.

In addition, in the case of abnormality occurrence, the facility shall immediately halt the discharge of ALPS treated water into the sea.

2.50.1.2 Discharge Facility

2.50.1.2.1 Purpose of Installation

The purpose of this facility shall be to discharge the drained water from ALPS treated water dilution/discharge facilities (water satisfies the concentration where sum of the ratios to regulatory concentration limit of all radionuclides including tritium is below one by dilution with seawater) into the sea which is about 1km away from the shore by the water head difference between discharge vertical shaft (down-stream storage) and sea level.

2.50.1.2.2 Required Function

The drained water from ALPS treated water dilution/discharge facilities (the water satisfies the concentration where sum of the ratios to regulatory concentration limit of all radionuclides including tritium is below one by dilution with seawater) can be discharged into the sea which is about 1km offshore.

2.50.1.2.3 Design Policy

Design shall be as follows in accordance with the “items to be taken”

(1) Applicable codes and standards

Reliability shall be ensured by applying domestic and overseas private standards such as technical standards and Japanese Industrial Standards (JIS) of the Society of Civil Engineers, etc. for the design, selection of materials and manufacture for each facility constituting the water discharge facility.

(2) Design considerations against natural phenomena

a. Design considerations against earthquakes

The facilities constituting the water discharge facility shall be classified in terms of seismic design and shall be designed to withstand the seismic capacity for design that is considered appropriate, in consideration of the handling of the wastewater from the diluted ALPS treatment water discharge facility (water diluted with seawater and having the sum of ratio to regulatory concentration limit including tritium falling below one).

b. Design considerations against natural phenomena (tsunamis, heavy rainfall, typhoons, tornadoes, etc.) that are assumed other than earthquakes

The discharge facilities shall be designed so that safety of the facilities will not be impaired by assumed natural phenomena (tsunamis, typhoons) other than earthquakes.

(3) Design Considerations against Fires

Water spraying equipment shall use non-flammable or flame-retardant materials as practically possible to prevent the occurrence of fire.

Incidentally, the risk of fire is very low because seawater is filled inside the facility.

(4) Design Considerations for Environmental Condition

The equipment constituting the discharge facility shall be designed to be compatible with all envisaged environmental conditions including ageing events.

(5) Design Considerations for Testability

The discharge facility shall be designed so that the required functions can be verified.

(6) Other Design Considerations

a. Hydraulic Design

The design shall be such that water in the discharge vertical shaft (down-stream storage) is transferred to the outlet at a distance of about 1km using the difference in water head between the discharge vertical shaft (down-stream storage) and the sea surface. In addition, the wall height of the discharge vertical shaft (down-stream storage) shall be designed in consideration of hydraulic loss in the discharge facility and water level rise due to surging, etc.

b. Structure

The structure shall be so constructed that it is less susceptible to earthquakes by installing water discharge facilities on the bedrock. In addition, the water discharge tunnel shall be installed inside the bedrock, and the shield method shall be adopted in consideration of safety during construction in excavation of the sea bottom and durability during service. In addition, the water-tightness is ensured by providing sealing material on the lining plate made of reinforced concrete which constitutes the water discharge tunnel.

c. Consideration for Soundness

The structure is established after confirming that both the long-term load and the short-term load are within the allowable stresses. And, it is confirmed that the floating of the structure does not occur. In addition, crack width and salt damage on the reinforced concrete skeleton is checked, and appropriate reinforcement covering is set, and thus it is confirmed that the durability during the service period is ensured. In addition, as with general civil engineering structures, maintenance and management shall be carried out based on the inspection long-term plan.

In addition, as with general civil engineering structures, maintenance and management shall be carried out based on the inspection long-term plan.

2.50.1.2.4 Major Facility

Discharge facility shall be composed of discharge vertical shaft (down-stream storage), discharge tunnel and discharge outlet for the purpose of discharge of the water overflowed over the weir in the discharge vertical shaft, flowing from discharge vertical shaft (upper-stream storage) to discharge vertical shaft (down-stream storage) into the sea which is about 1km offshore.

2.50.1.2.5 Items to be Checked during the Service Period

By activating sea water transfer pumps, the treated water shall be released into the sea through the discharge tunnel and discharge outlet by the difference in water head between the discharge shaft (down-stream storage) and the sea level.

2.50.2 Basic Specifications

2.50.2.1 Main Specifications of ALPS Treated Water Dilution/Discharge Facility

2.50.2.1.1 Measurement/confirmation facility

(1) Circulation pump (finished product)

Number of units	2
Capacity	160 m^3/h (per unit)

(2) Agitating facility (finished product)

Number of units	30

(3) Measurement/confirmation tank※

Total Volume (Nominal)	30, 000 m^3
Number of units	30
Volume (single unit)	1, 000m^3 per unit
Material	SS400
Thickness (side plate)	15mm

※: A portion of the K4 area tanks, which are out of storage tanks for ALPS treated water, etc. in "II 2.5 Contaminated water treatment facilities, etc.", shall be used for diversion. Note that the nominal capacity is the upper limit of the operating water level.

(4) Pipe

Main pipe specifications (1/3)

Name	Specification	
From measurement/confirmation tank outlet to circulation pump inlet (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	200A／Sch.20S SUS316LTP 0.49MPa 40°C
(Polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 200A Polyethylene 0.49MPa 40°C
(Pressure resistant hose)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	Equivalent to 200A Synthetic rubber 0.49MPa 40°C
(Expansion joint)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 200A Synthetic rubber 0.49MPa 40°C
From circulation pump outlet to measurement/confirmation tank inlet (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	125A／Sch.20S 150A／Sch.20S 200A／Sch.20S SUS316LTP 0.98MPa 40°C
(Polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 150A Polyethylene 0.98MPa 40°C
(Expansion joint)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 125A Synthetic rubber 0.98MPa 40°C

Main pipe specifications (2/3)

Name	Specification	
From the outlet of ALPS to treated water storage tanks*1 and other tanks*2 (Polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
(Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch. 20S SUS316LTP 0.98MPa 40°C
(Pressure resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Synthetic rubber 0.98MPa 40°C
From outlet of sampling tanks to storage tank of ALPS treated water, and RO concentrated water storage tanks or Sr treated water storage tanks*2 (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch. 20S SUS316LTP 0.98MPa 40°C
(Polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
(Pressure resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Synthetic rubber 0.98MPa 40°C

*1: Multi-nuclide treated water storage tank, RO concentrated water storage tank or Sr treated water storage tank.

*2: Among the pipes to measurement/confirmation tanks (also used as multi-nuclide treated water storage tanks), the pipes specified above shall also be used as "II 2 16.1 Multi-nuclide removal facility" and "II 2 16.2 Extended Multi-nuclide removal facility".

The Japanese version shall prevail.

Main pipe specifications (3/3)

Name	Specification	
From outlet of sampling tanks to ALPS, and RO concentrated water storage tanks or Sr treated water storage tanks*3 (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A/Sch. 20S SUS316LTP 0.98MPa 40°C
(Polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
(Pressure resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Synthetic rubber 0.98MPa 40°C

*3: Among the pipes to measurement/confirmation tanks (also used as multi-nuclide treated water storage tanks), the pipes specified above shall also be used as "II 2 16.3 Multi-nuclide removal facility".

2.50.2.1.2 Transfer facility

(1) ALPS treated water transfer pump (finished product)

Number of units	2 (1 for stand-by)
Capacity	30 m^3/h (per unit)

(2) ALPS treated water flowmeter

Number of units	4 (2 for stand-by) ※
Method for measurement	Differential pressure type
Range for measurement	0 ~ 40 m^3/h

(3) Radiation monitor

Number of units	2 (1 for stand-by)
Type	Scintillation detector
Measuring range	10^{-1} ~ 10^5 s^{-1}

(4) Emergency isolation valve-1 (finished product)

Number of Units	2 (1 for stand-by)

(5) Emergency isolation valve-2 (finished product)

Number of Units	2 (1 for stand-by)

(6) ALPS treated water Flow Control Valve (finished product)

Number of Units	2 (1 for stand-by)

※: Number of differential pressure transmitter is shown. Number of orifice plates and pipes for pressure sensing are 2 each (1 for stand-by.)

(6) Pipe

Main pipe specifications (1/2)

Name	Specification	
Between measurement/confirmation tanks (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	200A／Sch.20S SUS316LTP 0.49MPa 40°C
(Polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 200A Polyethylene 0.49MPa 40°C
(Pressure resistant hose)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 200A Synthetic rubber 0.49MPa 40°C
From the measurement/confirmation tank outlet to the ALPS treated water transfer pump inlet (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	80A／Sch.20S 150A／Sch.20S SUS316LTP 0.49MPa 40°C
(Polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Equivalent to 150A Polyethylene 0.49MPa 40°C
(Expansion joint)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Equivalent to 80A Synthetic rubber 0.49MPa 40°C

Main piping specifications (2/2)

Name	Specifications	
From the ALPS treated water transfer pump outlet to emergency isolation velve-1 (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	40A／Sch.20S 100A／Sch.20S 150A／Sch.20S SUS316LTP 0.98MPa 40°C
(Polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.98MPa 40°C
(Expansion joint)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 40A Synthetic rubber 0.98MPa 40°C
From the emergency isolation velve-1 to the seawater pipe header inlet connection (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	100A／Sch.20S SUS316LTP 0.60MPa 40°C
(Polyethylene pipe)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Polyethylene 0.60MPa 40°C
(Expansion joint)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 100A Synthetic rubber 0.60MPa 40°C

2.50.2.1.3 Dilution facility

(1) Seawater transfer pump (finished product)

Number of units	3 (1 for stand-by)
Capacity	7,086 m^3/h (per unit)

(2) Sea water flowmeter

Number of units	3 (1 for stand-by)
Method for measurement	Differential pressure type
Range for measurement	0 ~ 10,000m^3/h

(3) Discharge vertical shaft (upper-stream storage)

Number of units	1
Main dimensions	Length 34,500mm x Width 16,900mm × Height 6,000mm (Inner space)
Structure	Reinforced concrete (Concrete: 40N/mm^2, Rebar: SD345)

(4) Pipe

Main pipe specifications

Name	Specification	
From seawater transfer pump outlet to seawater pipe header inlet connection (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	800A／12.7mm 900A／12.7mm STPY400 0.60MPa 40°C
(Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	900A/13mm SUS329J4L 0.60MPa 40°C
(Expansion joint)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 800A Equivalent to 900A Synthetic rubber 0.60MPa 40°C
Seawater pipe header (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	1800A／16mm 2200A／16mm SM400B 0.60MPa 40°C
From seawater pipe header outlet to discharge vertical shaft (upper-stream storage) (Steel pipe)	Nominal diameter/thickness Material Max. working pressure Max. working temperature	1800A／16mm SM400B 0.60MPa 40°C
(Expansion joint)	Nominal diameter Material Max. working pressure Max. working temperature	Equivalent to 1800A Synthetic rubber 0.60MPa 40°C

2.50.2.2 Major Specifications of Discharge Facilities

(1) Discharge vertical shaft (Down-stream storage)

Number of units	1
Main dimensions	Length 4,600mm × Width 10,000mm × Height 17,200mm (Inner space)
Structure	Reinforced concrete construction (Concrete: 24N/mm^2, Rebar: SD345)

(2) Discharge tunnel

Number of units	1
Main dimensions	Length: 1,034m Inner diameter: 2,590mm
Structure	Reinforced concrete (Concrete: 42N/mm^2, Rebar: SD345)

(3) Discharge outlet

Number of units	1
Main dimensions	Length 8,000mm × Width 11,000mm × Height 8,300mm (Inner space)
Structure	Reinforced concrete construction (Concrete: 30N/mm^2, Rebar: SD345)

2.50.3 Attachments

Attachment-1: System overview and schematic diagram

Attachment-2: Specific measures to ensure safety of ALPS Treated Water Dilution/Discharge Facilities and Related Facility

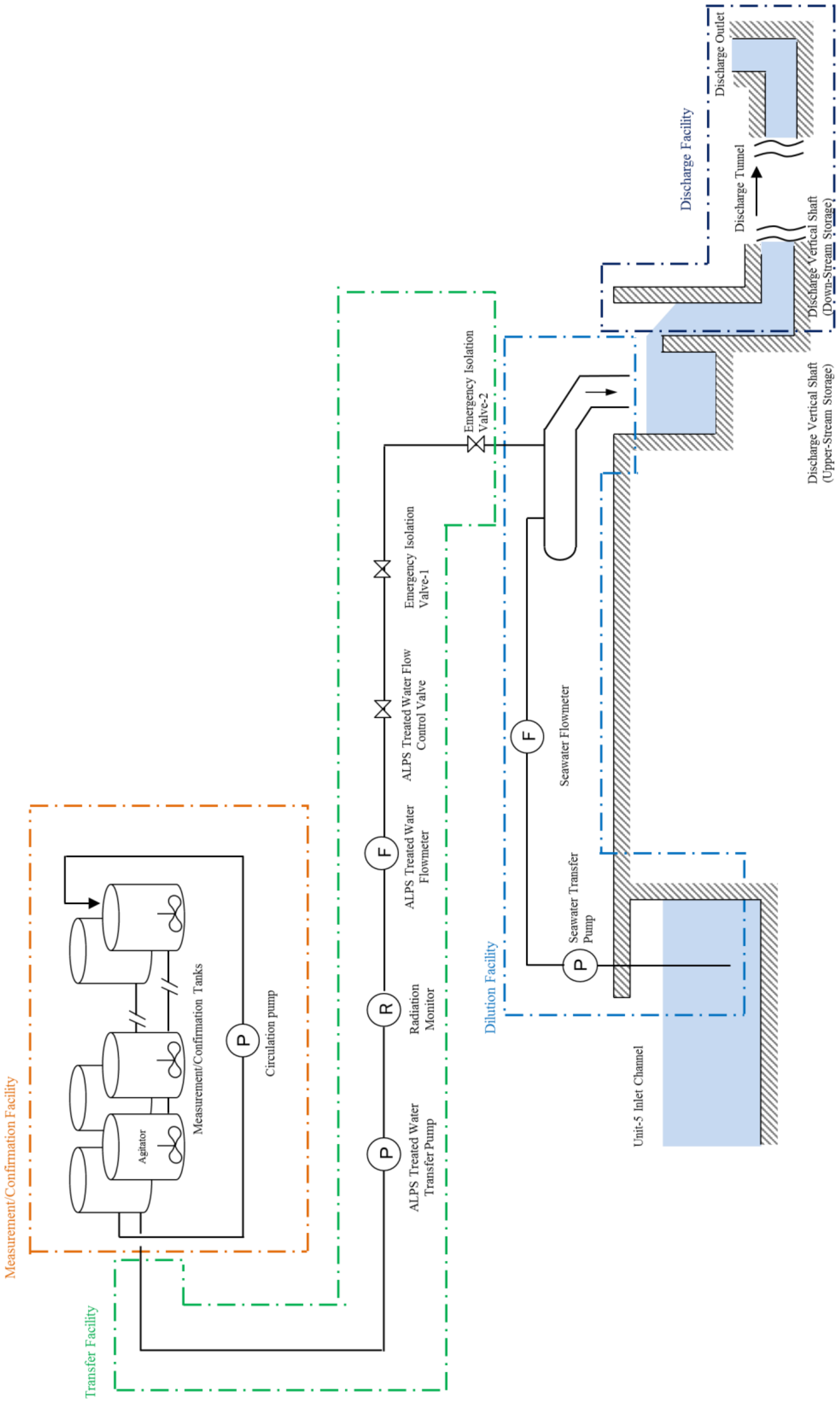
Attachment-3: Description on structural strength and seismic resistance of ALPS Treated Water Dilution/Discharge Facilities

Attachment-4: Items to be checked for ALPS Treated Water Dilution/Discharge Facilities and Related Facility

Attachment-5: Description on Design of Discharge Vertical Shaft (upper-stream storage) and Discharge Facility

Attachment-6: Construction schedule

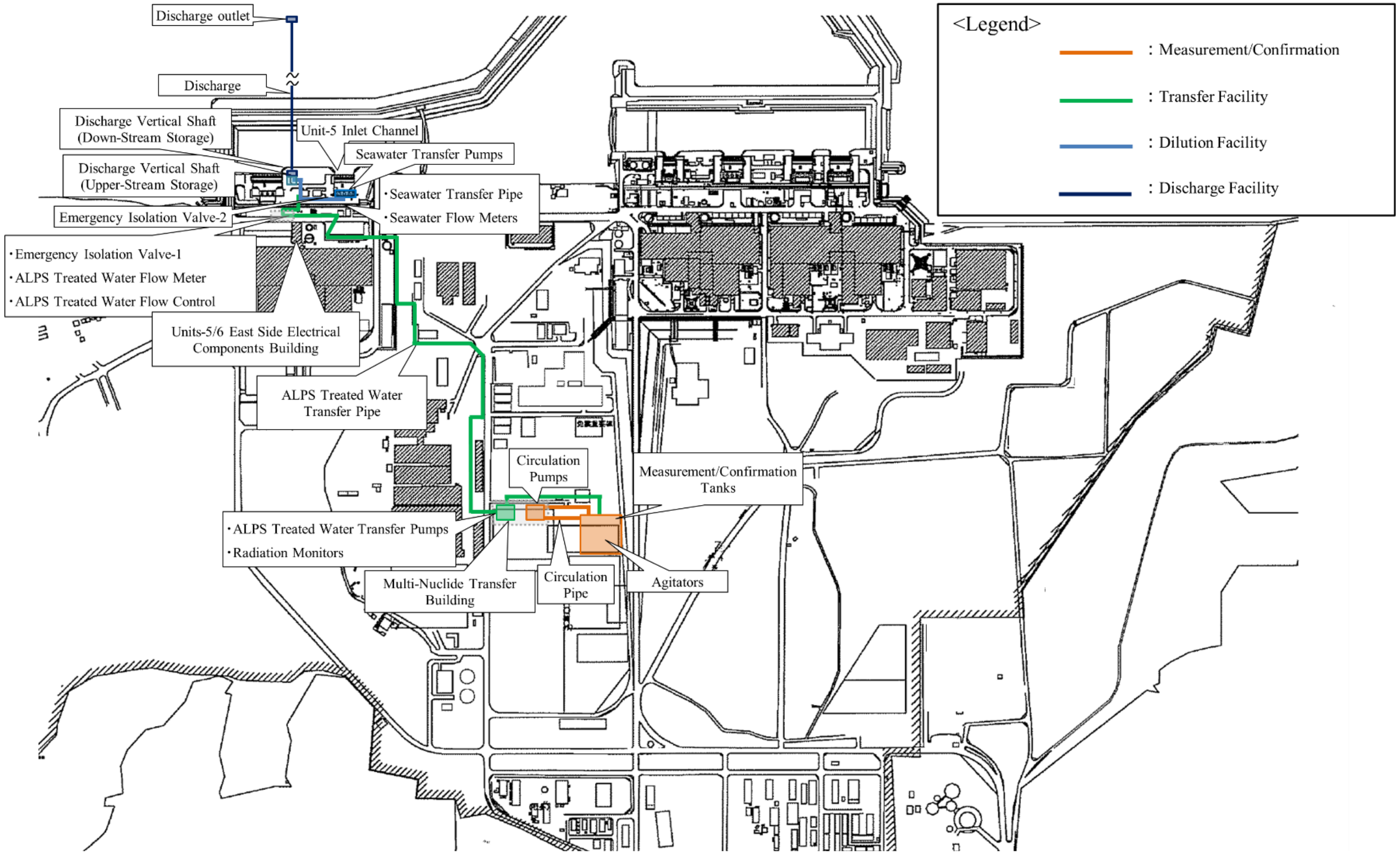
Attachment-7: Items for consideration on testability



(a) System Overview

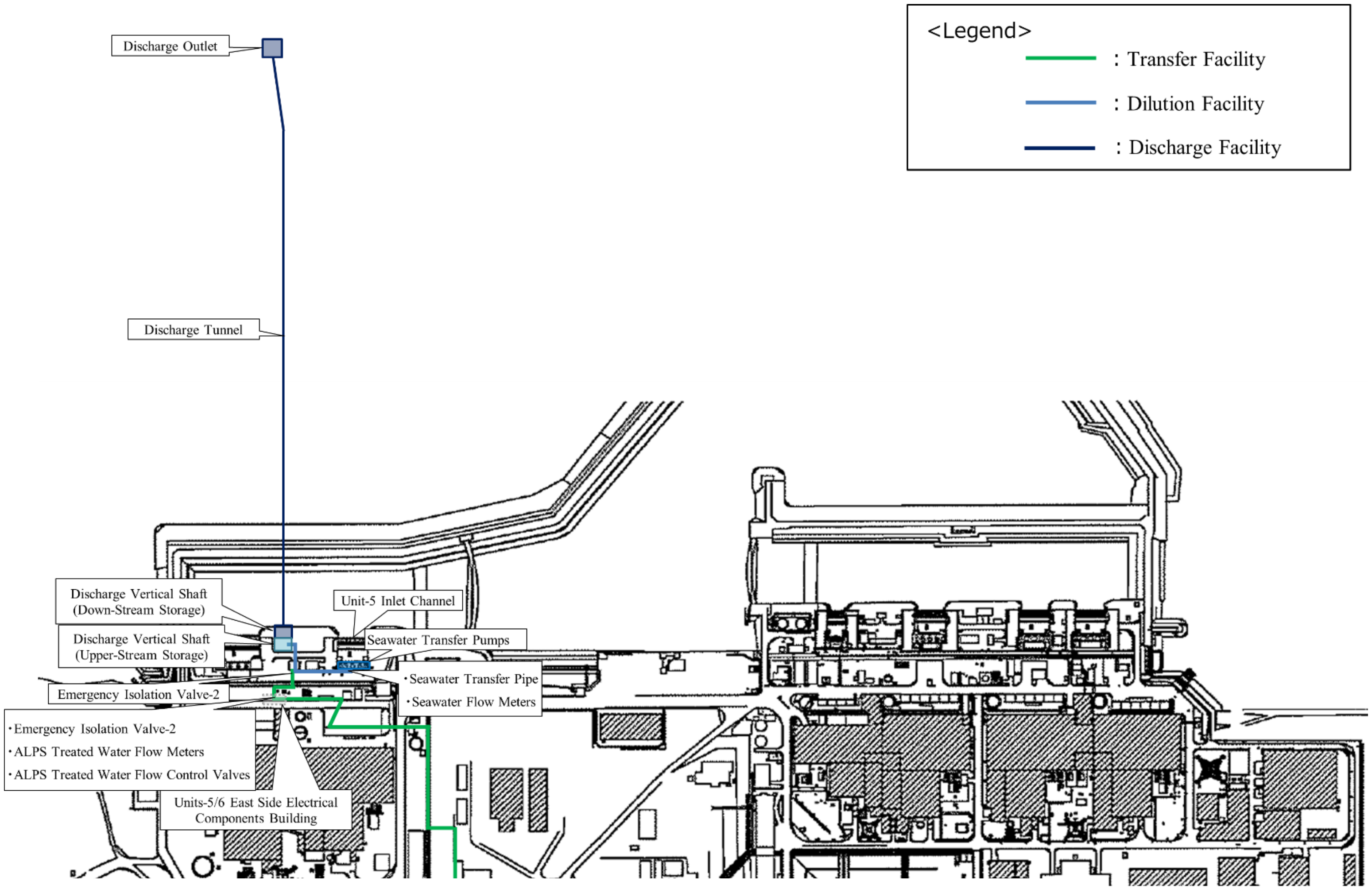
Figure-1 Overview of ALPS Treated Water Dilution/Discharge Facilities and Related Facility (1/3)

The Japanese version shall prevail.



(b) Layout overview (overall)

Figure-1 Overview of ALPS Treated Water Dilution/Discharge Facilities and Related Facility (2/3)

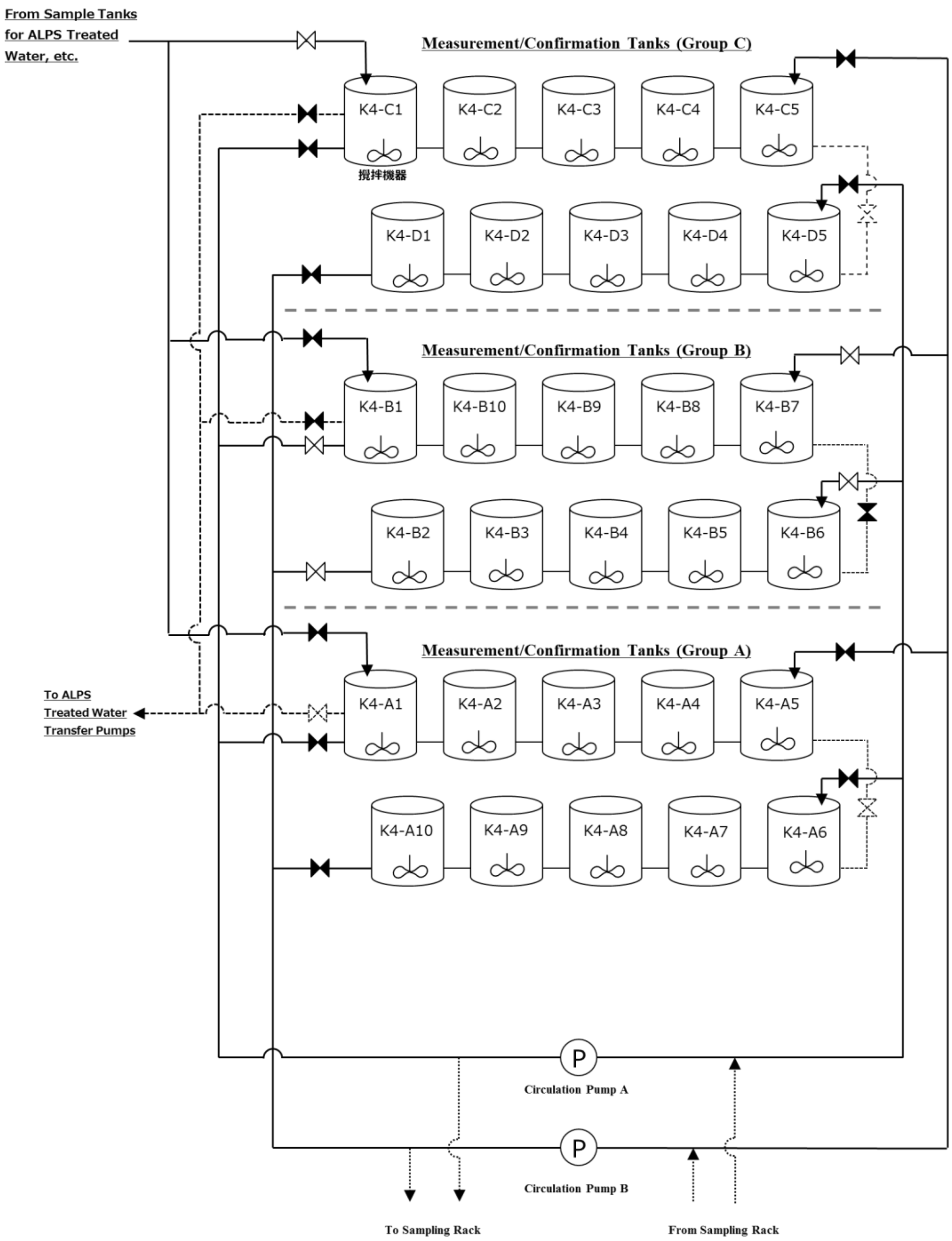


(c) Layout overview (sea side)

Figure-1 Overview of ALPS Treated Water Dilution/Discharge Facilities and Related Facility (3/3)

The tanks for measurement and confirmation are divided into group A, group B, and group C, and each tank group repeats ① the receiving process, ② the measurement and confirmation process, and ③ the discharge process. The situation in the figure shows group A (discharge step), group B (measurement and confirmation step), and group C (receiving step).

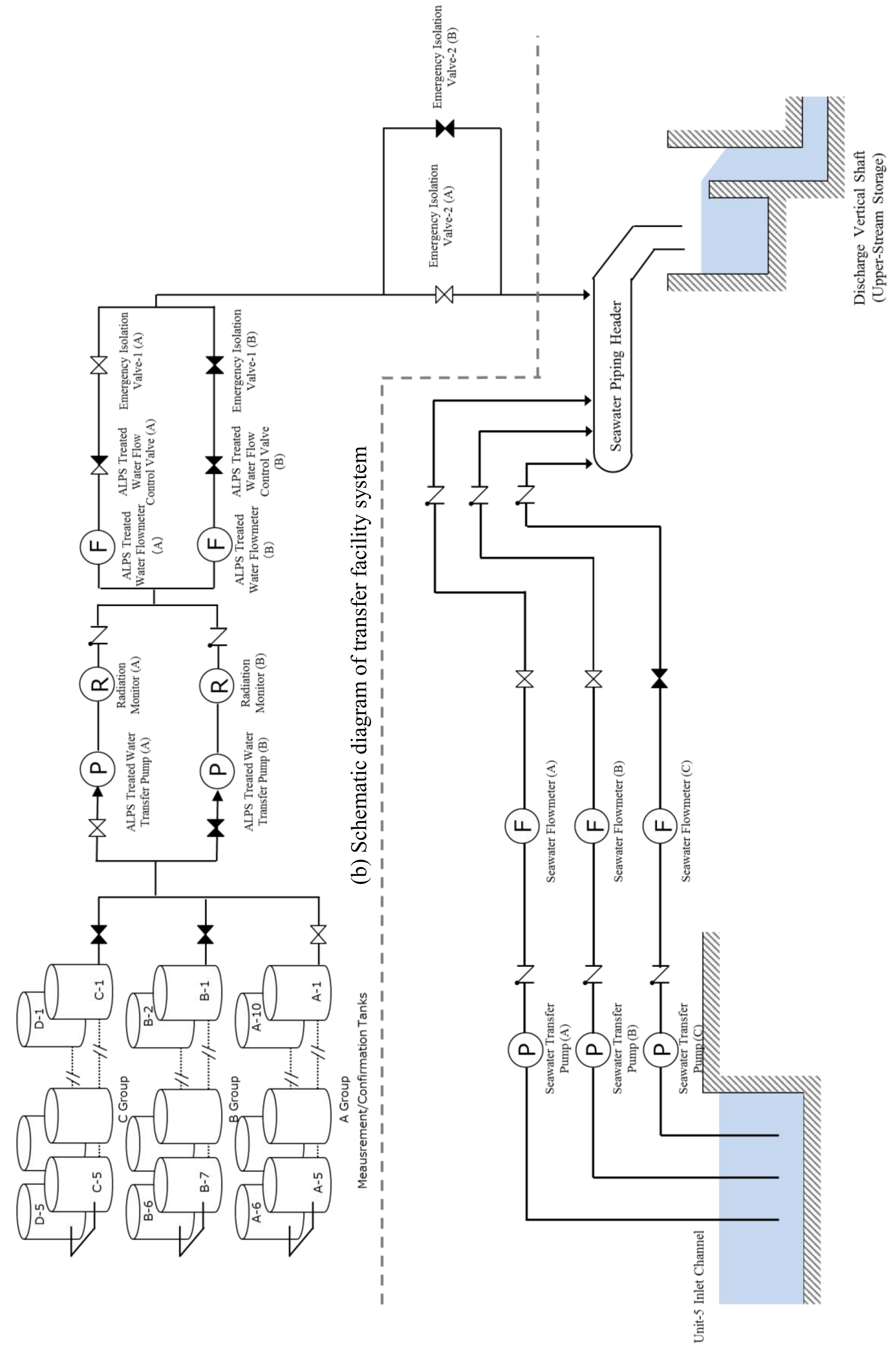
For the receiving and discharge processes, open the connection valve of the measurement/confirmation tanks (between five tanks) to receive and transfer.



(a) Schematic diagram of measurement/confirmation facility system

Figure-2 Schematic diagram ALPS Treated Water Dilution/Discharge Facilities (1/2)

The Japanese version shall prevail.



(c) Schematic diagram of dilution facility system

Figure-2 Schematic diagram of ALPS Treated Water Dilution/Discharge Facilities

(2/2)

The Japanese version shall prevail.

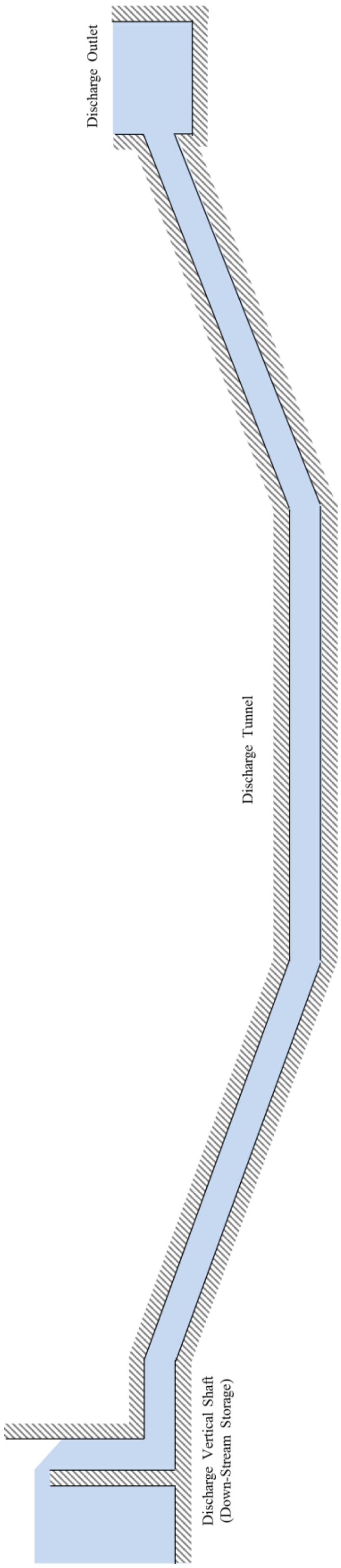


Figure-3 Schematic diagram of discharge facility system

Attachment-2

Specific measures to ensure safety of ALPS Treated Water Dilution/Discharge Facilities and Related Facility

Although the liquid handled by ALPS treated water dilution/discharge facilities is ALPS treated water, it contains radioactive materials. Therefore, for this facility, measures required to satisfy the regulatory standards, such as the matters to be taken related measures, shall be taken. In particular, specific safety measures shall be established and implemented for homogenization of radioactive material concentration by measurement/confirmation facility, mixing and dilution of ALPS treated water by seawater, prevention of “unintentional discharge of ALPS treated water into the sea,” prevention of leakage occurrence, prevention and detection of leakage and expansion of the leakage, and considerations in design for operation by operators.

1. Processing, storage and management of radioactive solid waste

For the handling of solid waste generated as a result of the installation of ALPS treated water dilution/discharge facilities and related facility, the responses for treatment, storage and management of radioactive solid waste for the entire power plant shall be followed. (Refer to "II 1.8 Processing, Storage and Management of Radioactive Solid Waste.")

2. Treatment, storage and management of radioactive liquid waste

2.1 Homogenization of Radioactivity Concentrations of In-Tank ALPS Treated Water Prior to Ocean Discharge

In the receiving process, the concentration of radioactive materials contained in ALPS treated water received in the measurement/confirmation tanks varies according to the storage tanks of the transfer source. Therefore, in the measuring/confirming process prior to discharge of ALPS treated water into the sea, all ten tanks of a tank group in the process are connected and the water in the tanks is homogenized by facilities including circulating pumps and agitators before sampling, and the concentration of radioactive materials contained in ALPS treated water in the tank group is analyzed and evaluated.

In addition, the circulation/agitation time required for homogenization will be appropriately set through a circulation/agitation verification test using sodium tertiary phosphate as a reagent.

Furthermore, in the analysis after homogenizing ALPS treated water, tritium and radionuclides other than tritium are analyzed and evaluated, and the tritium concentration in the treated water is confirmed, and after confirming that the sum of ratios to regulatory concentration limit of nuclides other than tritium is less than 1, the permissibility of discharge of the ALPS treated water is judged.

2.2 Adjusting and monitoring the mixing/dilution ratio of ALPS treated water to seawater

The dilution of ALPS treated water is carried out by injecting ALPS treated water into the seawater pipe headers through which seawater for dilution flows.

The injected ALPS treated water is mixed with the surrounding seawater while flowing down in the seawater pipe to reduce the radioactive material concentration.

(1) Adjustment of mixing/dilution ratio

To reduce the effective dose at the site boundary as much as possible, the following dilution and evaluations shall be conducted so that the concentration of tritium contained in the released water is less than 1,500Bq/L, which is the upper limit of operation, and the dilution ratio by seawater is 100 times or more.

(2) Volume of seawater for dilution of ALPS treated water

Depending on the tritium concentration measured in the measurement/confirmation process, set the flow rate of ALPS treated water up to 500 m^3/day using ALPS treated water transfer pumps, ALPS treated water flow control valves, ALPS treated water flow meters, etc.

In addition, in order to make the concentration of tritium contained in discharged water less than 1,500 Bq/L, which is the upper limit of operation, and to make the diluting ratio 100 times or more, three seawater transfer pumps with a capacity of 170,000 m^3/day will be installed, and two or more seawater transfer pumps will be operated constantly in accordance with the flow rate of ALPS treated water, thereby securing the necessary amount of seawater. In addition, under normal operation, when ALPS treated water flow rate is set at 500 m^3/day and the number of operating seawater transfer pumps is set at two, the maximum tritium concentration of ALPS treated water released into the sea is set at 1 million Bq/L in order to reduce the tritium concentration in the discharged water to less than 1,500 Bq/L, which is the upper limit of operation, because it is the most severe operating condition in terms of the dilution ratio.

(3) Assessment of Mixing/Dilution Condition of ALPS Treated Water by Analysis Code

ALPS treated water and seawater for dilution are mixed and diluted in seawater pipe header and seawater pipes, and then released into the sea as diluted seawater.

To confirm the mixed dilution condition of ALPS treated water in seawater pipe header and seawater pipes, the mixing/dilution effectiveness is evaluated by numerical simulations using an analytical code. (Refer to the attached sheet for details of the analysis code.)

a. Evaluation Method

(a) Evaluation Concept

To confirm that ALPS treated water is sufficiently mixed and diluted in the seawater pipe headers and seawater pipes, the distribution of the mass fraction of ALPS treated water advected and diffused into the seawater for dilution shall be evaluated.

(b) Analytical Code

In evaluating mixing/dilution conditions, the basic equations (mass conservation equation, momentum conservation equation, energy conservation equation) for fluid behavior can be solved to analyze and evaluate fluid motion (flow velocity, pressure) and temperature in three-dimensional space, and STAR-CCM+ code verified by turbulence experiments along with others is used.

In addition to the function of obtaining the fluid flow (flow velocity, pressure, and temperature) by three-dimensional numerical fluid calculation, the analytical code has an advection and diffusion analysis function of the fluid. Therefore, it is possible to analyze and evaluate the situation in which ALPS treated water injected into the diluting seawater is mixed and diffused.

(c) Evaluation conditions

Among the operating conditions assumed during normal operation, ALPS treated water flow rate shall be 500 m^3/day, the planned maximum flow rate, and the seawater flow rate shall be 340,000 m^3/day, the minimum flow rate.

Regarding diffusion of ALPS treated water in seawater pipe header and seawater pipes, diffusion by turbulence is considered. In the analysis, to decrease the influence of turbulent diffusion behavior dominated by the turbulent diffusion coefficient (turbulent Schmidt number), which is determined experimentally, the density and viscosity of ALPS treated water are regarded as the numbers equivalent to pure water.

(d) Criterion for Judgment

Maximum mass fraction of ALPS treated water at outlet of seawater pipe shall be 1.0 % or less (dilution ratio shall be 100 times or more).

(e) Evaluation Results

Since the largest mass fraction of ALPS treated water at the end of the rising part of seawater pipe is 0.28% from the injection position of ALPS treated water, and the dilution ratio of 100 times or more in the seawater pipe is feasible, the judgement criterion at the outlet of seawater pipe is satisfied.

On the other hand, in the seawater pipes, there are some areas where the dilution ratio is about 1/2 of the assumed dilution ratio. Therefore, to satisfy the upper operational limit of tritium concentration of less than 1,500Bq/L including such areas, the mixing dilution ratio, which will be described later, shall be adjusted and monitored.

(4) Adjustment and monitoring of mixing/dilution rate

Adjustment and monitoring of the mixing and diluting ratio are conducted in the following manner so that the concentration of tritium contained in the released water is less than 1,500Bq/L, the upper limit of operation.

a. Adjustment of mixing dilution rate

Adjusting the mixing dilution rate of ALPS treated water to seawater shall be designed to control ALPS treated water flow rate because the seawater transfer pumps operate at the rated capacity. Specifically, the tritium concentration of the measured and confirmed ALPS treated water is registered in advance in the monitoring and control device at the operation for discharge, and the opening of ALPS treated water flow rate control valve is automatically adjusted so that the specified mixing/dilution rate is obtained based on the operational values of the tritium concentration and the tritium concentration after dilution.

・Formula for calculating the flow rate of ALPS treated water (operational)

$$\underset{\text{(operational value)}}{\text{ALPS treated water flow rate}} = \frac{\text{seawater flow rate} \times \text{tritium concentration after dilution of seawater (operational value)}}{\text{tritium concentration of ALPS treated water} - \text{tritium concentration after dilution of seawater (operational value))}}$$

b. Monitoring of mixing/dilution rate

The tritium concentration after dilution by seawater shall be designed by monitoring ALPS treated water flow rate and seawater flow rate.

・Tritium concentration evaluation formula

$$\text{Tritium concentration after diluting seawater} = \frac{\text{ALPS treated water tritium concentration} \times \text{ALPS treated water flow rate)}}{\text{ALPS treated water flow rate} + \text{seawater flow rate}}$$

It is designed to prevent discharge of water into the sea with the tritium concentration exceeds 1,500Bq/L, by setting the condition where the tritium concentration after dilution by seawater is 1,500Bq/L as the upper limit of the flow rate of ALPS treated water, and activating an alarm and closing the emergency isolation valve when it reaches the upper limit.

・Formula for calculating the flow rate of ALPS treated water (upper limit)

$$\underset{\text{(upper limit)}}{\text{ALPS treated water flow rate}} = \frac{\text{seawater flow rate} \times \text{tritium concentration after dilution of seawater (1, 500Bq/L)}}{\text{tritium concentration of ALPS treated water} - \text{tritium concentration after dilution of seawater (1, 500Bq/L)}}$$

2.3 Detecting Abnormalities and Halting the Discharge of ALPS Treated Water into the Sea

In preparation for an event that may lead to "Unintentional discharge of ALPS treated water into the sea," emergency isolation valves are installed in the transfer facility, and when it is judged that the facility will deviate from the normal operating state, the valves are closed by interlock, and the discharge of ALPS treated water into the sea is halted by the operator as required.

(1) Interlocks

When the following conditions are met, the emergency isolation valves are operated to halt the discharge of ALPS treated water into the sea.

a. Discharge of ALPS treated water shall be done after setting the flow rate of seawater and the transfer rate of ALPS treated water in the dilution facility, but an interlock for closing the emergency isolation valves shall be provided in case the prescribed flow rate of seawater cannot be secured or exceeds the prescribed ALPS treated water transfer rate.

b. Provide an interlock for closing the emergency isolation valve in case an abnormality is detected by the radiation monitor※ installed in ALPS treated water transfer line.

※: In the measurement/confirmation facility, the sum of ratios to regulatory concentration limit of radionuclides (other than tritium) shall be confirmed to be less than 1. However, a radiation monitor shall be installed in the transfer facility for case of an abnormality.

(2) Shutdown by operator operation

When an event such as a natural phenomenon that may affect the ALPS treated water dilution/discharge facilities and related facilities occurs, when an abnormal value is detected in the sea area monitoring, or when the shift supervisor confirms it necessary, the discharge of ALPS treated water to the sea is manually halted.

(3) Configuration of the Components

To ensure reliable operation of the emergency isolation valves, two valves shall be arranged in series to the transfer path of ALPS treated water. The emergency isolation valves arranged in series are provided with a stand-by system arranged in parallel each so that the components will not be inoperable for a long time due to a failure.

(4) Arrangement

Emergency isolation valves shall be located so that ALPS treated water can be stopped discharging promptly when the abovementioned interlocks are activated. Namely, among the emergency isolation valves arranged in series with two emergency isolation valves, the downstream emergency isolation valves-2 shall be provided in front of the seawater pipe headers to minimize ALPS treated water release during valve operation. In addition, the upstream emergency isolation valve-1 shall be provided in the seawall in consideration of the possibility of components damage caused by tsunami.

2.4 Prevention of leakage and spread of radioactive materials.

(1) Leakage prevention

a. The circulation pumps and ALPS treated water transfer pumps shall use materials with excellent corrosion resistance such as duplex stainless steel, and the shaft seal shall adopt a mechanical seal that is resistant to leakage.

b. Transfer pipes for ALPS treated water are manufactured by corrosion resistant polyethylene pipes, pressure resistant hoses, carbon steel pipes with sufficient thickness or stainless steel pipes are used. The inner surfaces of the carbon steel pipes for main lines are coated with the corrosion resistance. In addition, the parts requiring flexibility shall be rubber expansion joints having corrosion resistance.

c. Of the transfer pipes laid outdoors, the joints of polyethylene pipes and polyethylene pipes shall be fusion-spliced to prevent leakage.

(2) Leakage detection and prevention of leakage expansion

a. For circulation pumps, ALPS treated water transfer pumps, and emergency isolation valves, etc., the following measures shall be taken.

- To detect leaks as soon as possible and prevent the spread of leaks, weirs shall be provided around the components, and leak detectors shall be installed inside the weirs. In addition, during facility operation, operator walk-down inspections will be conducted to detect leaks at an early stage.
- Alarms for leak detection shall be displayed in the Seismic Isolation Building Centralized Monitoring Room so that operators can monitor the status of operational monitoring parameters such as flow rate and take appropriate measures such as pump operation or shutdown.

b. ALPS treated water transfer pipes, etc., shall take the following measures.

- Regarding transfer pipes laid outdoors, weirs or steel covers are installed at locations where flange connections such as interconnection between steel pipes or between polyethylene pipes and steel pipes to prevent leakage from spreading.
- Even in a leak event to avoid release of radioactive materials into the environment through drainage channels, isolate the transfer pipe from the channels as much as possible. In addition, the polyethylene pipes used for the transfer pipe shall be constructed to prevent the leak from spreading by attaching an exterior pipe (joints are with waterproof covers) on the outside of the pipes.
- Early detection of leakage from transfer pipe shall be secured by operator walk-down inspection during operation.
- A steel cover shall be installed around a vent valve installed in the transfer pipe, and a leak detector

shall be installed at each flange. Alarms for leak detection shall be displayed in the Seismic Isolation Building Centralized Monitoring Room, and the status of operational monitoring parameters such as flow rate shall be monitored by operators so that appropriate measures such as pump operation and shutdown can be taken.

2.5 Exposure reduction

As ALPS treated water contains radionuclides other than tritium as less than 1 of the sum of ratios to regulatory concentration limit, even if it is stored in a tank with a capacity of 1,000 m^3 each, the air dose equivalent rate of the tank area by this as a radiation source is evaluated to be 1μSv/h or less at most, so that the shielding function need not be considered in designing the components, etc.

3. Radiation protection, etc., around the premises by controlling the release of radioactive materials, etc.

The dose assessment of radioactive liquid waste by ALPS treated water dilution/discharge facilities by the drainage is as described in "III Part 3, 2.2.3 Dose assessment by radioactive liquid waste etc."

4. Control of Exposure Doses of Workers, etc.

The control of the exposure dose of workers to the ALPS treated water dilution/discharge facilities and the related facility, shall be in accordance with the management of the exposure dose of workers entire the power plant (See "II 1.12 Control of Exposure Doses of Workers, etc.") along with others.

5. Emergency measures

Emergency measures for ALPS treated water dilution/discharge facilities and the related facility shall be in accordance with the emergency measures for the entire power plant. (See "II 1.13 Emergency Measures.")

6. Design consideration

6.1 Compliant Criteria and Standards

Since the structures, systems and components constituting ALPS treated water dilution/discharge facilities and the related facility are regarded as equivalent to waste processing facilities, etc. in the "NRA Ordinance Prescribing Technical Standards for Commercial Power Reactors and their Auxiliary Facilities," in consideration of the importance of safety functions that they should perform, the provisions of Class 3 components of the Nuclear Facility Standard Design and Construction Standard (JSME S NC1) shall apply to containers and steel pipes containing ALPS treated water in their design, selection, manufacture and inspection of materials, and domestic and overseas private standards such as Japanese Industrial Standards (JIS), (Public Corporation) Civil Engineering Society, etc. shall also apply to components, etc. other than these, as required. In addition, the Japanese Industrial Standard (JIS) fiscal year designation of materials specified in JSME Standard may not be considered from the viewpoint of material procurability in the scope of technical validity.

Specific specifications and standards are as follows.

- JIS G 3454 Carbon steel pipes and tubes for pressurized pipes
- JIS G 3457 Arc-welded carbon steel pipes for pipes
- JIS G 3459 Stainless steel pipes for pipes
- JIS G 3468 Welded large diameter stainless steel pipes for pipes
- JWWA K 144 Polyethylene pipes for water distribution
- Concrete Standard Specification (Design Edition; established in 2017) (PIIA) Japan Society of Civil Engineers
- Concrete Standard Specification (Design Edition; established in 2012) (PIIA) Japan Society of Civil Engineers
- Concrete Standard Specification (Structural Performance Check Edition; established in 2002) (PIIA) Japan Society of Civil Engineers
- Road Bridge Specifications/Explanation I Common Edition 2012 (PIIA) Japan Road Association
- Road Bridge Specification/Explanation IV Substructure Edition 2012 (PIIA) Japan Road Association
- Road Bridge Specification and Explanation V Seismic Design Edition 2012 (PIIA) Japan Road Association
- Utility Conduit Design Guidelines 1986 (PIIA) Japan Road Association
- Hydraulic Formula Collection 2018 (PIIA) Japan Society of Civil Engineers
- Precast Rainwater Underground Storage Facility Technical Manual (revised edition; 2020) (PIIF) Japan Institute of Wastewater Engineering and Technology
- Design and Construction Guidelines for Reinforced Concrete Using Epoxy Resin Painted Reinforcement (Revised Edition; 2013) (PIIA) Japan Society of Civil Engineers
- Design of Civil Engineering Structures at Thermal and Nuclear Power Stations (Additional and Revised Edition) (Foundation) Electric Power Civil Engineering Society
- Tunnel Standard Specification [Common Edition] • Explanation/ [Shield Method Edition] • Explanation (established in 2016) (PIIA) Japan Society of Civil Engineers
- Tunnel Standard Specification [Open Cutting Method]/Explanation (established in 2016) (PIIA) Society of Civil Engineers
- Technical Standards and Explanations of Port Facilities 2018 (PIIA) Japan Port and Harbor Association
- Handbook for design of tunnel lining structure with internal water pressure (established in 1999) (PIIF) Advanced Construction Technology Center

- Standard Segment for Shield Method, jointly edited by Japan Society of Civil Engineers and Japan Institute of Wastewater Engineering and Technology (established in 2001)
- Documents of Public Works Research Institute, Method/Guideline for Seismic Design of Large-scale Underground Structures (Draft) – March, 1992, Seismic Research Institute, Aseismatic and Disaster Prevention Department, Public Works Research Institute, Construction Ministry
- Guideline and Exposition of Aseismatic Measures for Wastewater Facilities – 2014 Edition, (PIIA) Japan Institute for Wastewater Engineering and Technology
- Examples of Aseismatic Calculation for Wastewater Facilities Treatment Facility and Pump Yard Edition – 2015 Edition, (PIIA) Japan Institute for Wastewater Engineering and Technology
- Examples of Aseismatic Calculation for Wastewater Facilities Piping Facility Edition – 2015 Edition, (PIIA) Japan Institute for Wastewater Engineering and Technology

6.2 Design considerations against natural phenomena

(1) Design considerations against earthquakes

Design considerations against the seismic behavior of ALPS treated water dilution/discharge facilities and related facility are described in “Attachment-3 Description on structural strength and seismic resistance of ALPS Treated Water Dilution/Discharge Facilities” and “Attachment-5 Description on Design of Discharge Vertical Shaft (upper-stream storage) and Discharge Facility.”

(2) Design considerations against natural phenomena (tsunamis, heavy rainfall, typhoons, tornadoes, etc.) that are assumed other than earthquakes

Design considerations against non-seismic natural phenomena for ALPS treated water dilution/discharge facilities and associated facility are as follows.

a. Tsunami

Of the ALPS treated water dilution/discharge facilities, the facility for measurement/ confirmation and a part of the transfer facility, excluding the dilution facility, shall be installed at locations higher than approximately T.P. 33.5m or more where tsunamis are considered not to reach.

In addition, when warning such as tsunami warnings is issued, the transfer facility and dilution facility shall be designed so that operators can manually shut down from the seismic isolation building centralized monitoring room in consideration of possible damage of components by tsunami. Incidentally, the emergency isolation valve-1 will be installed inside the Japan Trench Tsunami Breakwater, which will be installed in the area of T.P. about 11.5m, from the viewpoint of mitigating the impact of tsunamis.

As flooding against tsunamis is unavoidable, the water discharge facility shall be designed to have wave pressure resistance according to the restorability.

b. Heavy rainfall

Among ALPS treated water dilution/discharge facilities, electric components such as circulation pumps, ALPS treated water transfer pumps and control panels shall be installed indoors that are less susceptible to heavy rains.

c. Deposited Snow

The multi-nuclide transfer facility building and the electrical component building east side of Units 5 and 6 shall be designed against snow load based on the Building Standards Act Enforcement Order and the Building Standards Act Enforcement Rules of Fukushima Prefecture to prevent damage to the components due to snow cover.

d. Lightning Strike

Among the ALPS treated water dilution/discharge facilities, the multi-nuclide transfer facility buildings and the electric facilities installed in the electrical component buildings east side of Units 5 and 6 shall be designed to prevent damage from lightning strikes by grounding.

e. Typhoons (strong winds, storm surges)

Among the ALPS treated water dilution/discharge facilities, circulation pumps and ALPS treated water transfer pumps will be installed in the multi-nuclide transfer facility building, which is less possible to be damaged by typhoons (strong winds). In addition, in the case of components such as transfer pipes installed outdoors, a design shall be made so that they will not fall over by fixation measures such as foundation bolts.

For the design of the discharge shaft (upper-stream storage) and the discharge facility the effects of rising sea levels due to typhoons (storm surges) shall be considered, and the design allows the operator to manually halt the discharge into the sea from the seismic isolation building central monitoring room because there is a risk that it cannot be released to the sea 1km away from the coast if a storm surge warning is issued.

f. Tornado

The ALPS treated water dilution/discharge facilities shall be designed so that the operator can manually shut down the facility remotely from the central monitoring room of the Seismic Isolation Building, considering the possibility of damage to the facility due to the tornado in the event of a tornado warning.

g. Freezing

For the ALPS treated water dilution/discharge facilities, when the transfer of water is stopped, there

is a concern that the outdoor polyethylene pipe is broken by freezing. Therefore, heat insulating material is placed to the polyethylene pipe laid outdoors to prevent freezing.
Incidentally, the heat insulating material shall be hard polyurethane or others with high air tightness and heat insulation, and enough thickness that does not freeze be ensured.

h. Ultraviolet ray

Polyethylene tubes laid at outdoor among ALPS treated water dilution/discharge facilities are fitted with a heat insulating material to which carbon black, which is effective in preventing ultraviolet rays, is added to prevent degradation due to ultraviolet rays. Alternatively, when a heat insulating material without carbon black added is used, a coating material to which carbon black is added or a material which is hardly deteriorated by ultraviolet rays (such as a steel plate) is attached.

i. High temperature

Polyethylene used as a material for ALPS treated water dilution/discharge facilities is sufficiently unlikely to degrade the material due to heat because the temperature of ALPS treated water is at almost ordinary temperature.

j. Biological events

For the ALPS treated water dilution/discharge facilities, intrusion of marine organisms (e.g. jelly fish) as well as intrusion of small animals through penetrations of the building and so on are assumed. However, the former is designed to prevent intrusion by the breakwaters in the northern side and the partition dike installed in the southern side of water intake canal of units 5 and 6, and the latter is designed to prevent intrusion by applying sealing materials to the penetrations of the building and the openings of the electric channel, etc.

k. Others

The ALPS treated water dilution/discharge facilities shall be designed so that the operator can manually shut down the facilities remotely from the central monitoring room of the Seismic Isolation Building if there is a risk of damage to the facilities due to volcanoes, forest fires, etc. in addition to the natural phenomena mentioned above.

6.3 Design considerations against external anthropogenic events

As for consideration on major external anthropogenic events against ALPS treated water dilution/discharge facilities, the design considerations for external anthropogenic events throughout the plant shall be followed. (Refer to “II 1.14 Design Considerations”).
The following external anthropogenic events are also considered in the design, since the operation of

the discharge into the sea is carried out through telecommunication line.

(1) Electromagnetic interferences

The ALPS treated water dilution/discharge facilities shall be designed to be unaffected by disturbances due to electromagnetic interferences by installing line filters and insulation circuits in the power supply receiving section that enters the control panel, installing line filters and insulated circuits in the signal input/output section from outside, and applying optical cables in the communication line.

(2) Unauthorized access (including cyberterrorism)

To prevent unauthorized access (including cyberterrorism) acts, the system shall be designed to block all the unauthorized access from outside so that oversight and control devices related to the operation of the ALPS treated water dilution/discharge facilities will not be subject to unauthorized access (including cyberterrorism) through telecommunications lines.

6.4 Design considerations against fires

ALPS treated water dilution/discharge facilities and the related facility shall be designed to prevent the occurrence of fires, to detect and extinguish fires, and to reduce the consequences of fires without compromising the safety of the facilities by taking the after-mentioned measures. Incidentally, the vertical discharge shaft (upper-stream storage) and the discharge facility are made of reinforced concrete structure, and the risk of fire is very low.

・To prevent the occurrence of fires and to reduce the consequences of fires, not only using non-flammable or flame-retardant materials as much as possible※, but combustibles shall be eliminated as much as possible around the facilities. And components always required two series of operations at the time of ocean discharge shall be installed distant as much as possible between the components for ensuring that the functions of each component will not be impaired at the same time by the fire.

・For this facility, operator walk-down inspections shall be conducted for the earlier detection of fires. Also, the components installed indoors, like circulation pumps, ALPS treated water transfer pumps and areas around electric appliances, are designed to detect fires with fire detectors. In addition, fire extinguishers will be installed near each facility to enable initial fire extinguishing and to facilitate fire extinguishing activities. Furthermore, guidance signs for evacuation will be installed in the multi-nuclide transfer facility building and the east electrical component building of Units 5 and 6.

※: Including wrapping of flammable materials used in parts of pipe with non-flammable or flame-retardant materials.

6.5 Design considerations for environmental conditions

Design considerations on the materials used in the ALPS treated water dilution/discharge facilities and the related facility for environmental conditions are as follows:

(1) Pressure and temperature

Components with appropriate maximum allowable working pressure and maximum allowable working temperature based on the pressure and temperature assumed in normal operation and in the event of an abnormal event shall be selected for the ALPS treated water dilution/discharge facilities.

(2) Considerations against Corrosion

Among ALPS treated water dilution/discharge facilities, for components used to store or to pass ALPS treated water, duplex stainless steel with excellent corrosion resistance, stainless steel with corrosion resistance, polyethylene, synthetic rubber or carbon steel with sufficient wall thickness along with others shall be used. In addition, for components used to store or to pass seawater, duplex stainless steel with excellent corrosion resistance, carbon steel with corrosion-resistant paint along with others shall be used.

(3) Radiation

For polyethylene, etc., used as a material for the ALPS treated water dilution/discharge facilities, after evaluating a period in which there is no significant change in material properties due to radiation, replacement, etc. shall be performed beforehand when it is used beyond the said period.

(4) Cracks and salt damage

The discharge vertical shaft (upper-stream storage) and the water discharge facility are inspected for crack width and salt damage occurring in the reinforced concrete structure, and appropriate reinforcement covering is set to confirm that durability during the service period is ensured.

6.6 Design considerations for operator operation

Design considerations for operation by operators of the ALPS treated water dilution/discharge facilities are as follows:

(1) Monitoring and operating terminals, etc. that aggregate the information required for the discharge of ALPS treated water into the sea shall be designed to prevent operator’s misoperation and be easily operated by providing indications uniformity (identification by visual elements such as color and shape) in the status indication and operating methods of components.

(2) To prevent misoperation and misjudgment, double action for important operations such as discharge/transfer and process shutdown shall be required by design. Incidentally, the operation related to the release permission shall be designed to require operation with a key switch in addition to the double action.

(3) When the results of tritium analysis confirmed in the measurement/confirmation process are registered in the monitoring/control device, a design shall be made to prevent manual calculation and transcription errors by conducting mechanical readings such as scanners. In addition, if the tritium concentration after dilution of seawater fails to satisfy 1,500Bq/L according to the tritium concentration registered in the monitoring/control device and the flow rate of the seawater transfer pumps during operation, the drainage concentration less than 1,500Bq/L shall be designed to satisfy by providing an interlock that does not proceed to the next process.

(4) For the case that an appropriate tank group is not selected from the three tank groups for measurement/confirmation in the process of receiving, measuring, confirming, and discharging ALPS treated water, an interlock will not be provided for the next process so that ALPS treated water prior to measurement and confirming will not be released.

(5) In ALPS treated water dilution/discharge facilities, emergency isolation valves with a function to shut off discharge into the sea shall be installed for the event that an abnormality that deviates from normal operation is detected, and an interlock for closing the valves shall be provided to enable immediate shutdown of discharge into the sea without manual operation by operators.

6.7 Design considerations for reliability

Design considerations for the reliability of the ALPS treated water dilution/discharge facilities are as follows:

・The measurement/confirmation tanks are composed of three tank groups, and valves which serve as a boundary between the tank groups are made to be a series duplex in order to prevent mixing water between tank groups.

・For ALPS treated water flowmeter, the differential pressure transmitter and transmission system shall be duplicated so that it enables to confirm whether or not the mixed dilution of ALPS treated water into seawater is carried out within the set value.

・Motor driven emergency isolation valve-1 and an air-actuated emergency isolation valve-2 shall be equipped, which enable to provide multiplicity with respect to the shut-off mechanism and diversity with respect to the driving power source, as well as a fail-closed design is in place to ensure that discharge can be halted in case a loss of external power supply or the like.

6.8 Design considerations for testability

Design considerations for the testability of ALPS treated water dilution/discharge facilities and the associated facility are given in “Attachment-7 Items for consideration on testability.”

7. Appendix

Appendix-1 Description for Mixing/Dilution Ratio of ALPS Treated Water

End

Appendix-1

Description for Mixing/Dilution Ratio of ALPS Treated Water

Regarding mixing/dilution of ALPS treated water, ALPS treated water at the flow rate of 500 m^3 per day at maximum will be diluted 100 times or more with seawater, and the result of confirming this mixing/dilution behavior is described.

1. Analytical codes and conditions

For the mixing/dilution behavior, the dilution effect assumed in the analytical model shown in Figure-1 was evaluated using the analytical codes and conditions in Table-1.

Table-1 List of analytical codes and conditions

Condition		Contents
1. Analytical code and analytical model		
(1)	Analytical code	STAR-CCM+ (ver.11)
(2)	Basic formula	Incompressible mass conservation formula, momentum conservation formula (The Reynolds-averaged Navier–Stokes equations (RANS equations)
(3)	Turbulent flow model	Relizable k-ε Model
(4)	Handling of the vicinity of the wall surface	Wall function model
(5)	Discretization method	Finite volume method
(6)	Mass advection and diffusion model	Chemical species advection diffusion model
2. Boundary conditions		
(1)	Dilution seawater inlet	170,000 m^3/day, the number of seawater piping inlets in operation: 2
(2)	ALPS treated water inlet	500 m^3/day
(3)	Seawater pipe outlet	Pressure boundary (atmospheric pressure)
3.Fluid property		
(1)	Temperature	20ºC
(2)	Seawater	Density: 1025 kg/m^3, Viscosity: 1.080 x 10^{-3} Pa · s
(3)	ALPS treated water	Density: 998.2 kg/m^3, Viscosity: 1.002 x 10^{-3} Pa · s

In the mixing/dilution analysis of ALPS treated water, a turbulent flow model needs to be applied, and the Reynolds-averaged Navier–Stokes equations (RANS equations), which is general in Computational Fluid Dynamics (CFD), was adopted as a basic formula.

For a turbulent flow model in the RANS equations, eddy viscosity model that has been used in many CFD analyses is used, among which, the turbulent flow model of the k-ε system, which has been used in many cases, was adopted.

In the analysis, the turbulent diffusion behavior governed by the experimentally determined turbulent diffusion coefficient (turbulent Schmidt number) has a large effect on the concentration of injected pure water.

For this reason, the turbulent Schmidt number, which is close to the upper limit, was set based on the literature[*1, *2 and *3] surveys so that the turbulent diffusion becomes small (the local concentration of injected pure water becomes high) to implement analysis.

Density and viscosity of ALPS treated water (pure water) and seawater were set based on the following:

(Density): Pure water, Japan Society of Mechanical Engineers, vapor table (1999) CD-ROM version
Seawater, equation of state of seawater UNESCO (1981)

(Viscosity): Pure water, Japan Society of Mechanical Engineers, Vapor table (1999) CD-ROM version
Seawater: Nakamura, Standard Symbols for Ship Hydrodynamics and Water Density, Kinematic Viscosity Coefficient, Shipbuilding Association Journal No. 429 (1965).

*1: Gualtieri, G., et al., Fluids, 2, 17 (2017)
*2: Tominaga, Y., et al, Atmospheric Environment, 42, 37 (2007)
*3: Flesch, T, K., et al., Agricultural and Forest Meteorology, 111 (2002)

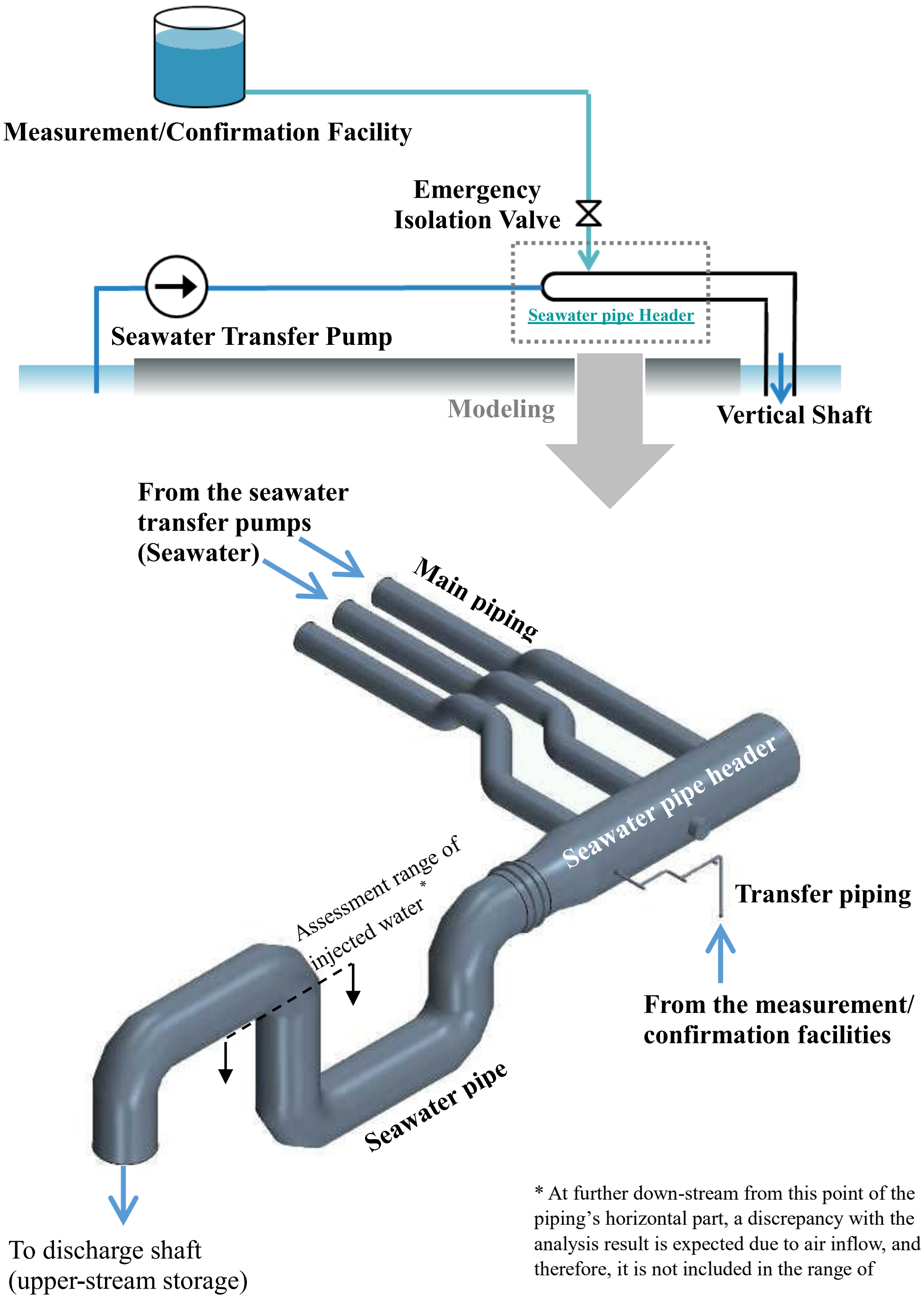


Figure-1 Analytical shape model (1/2)

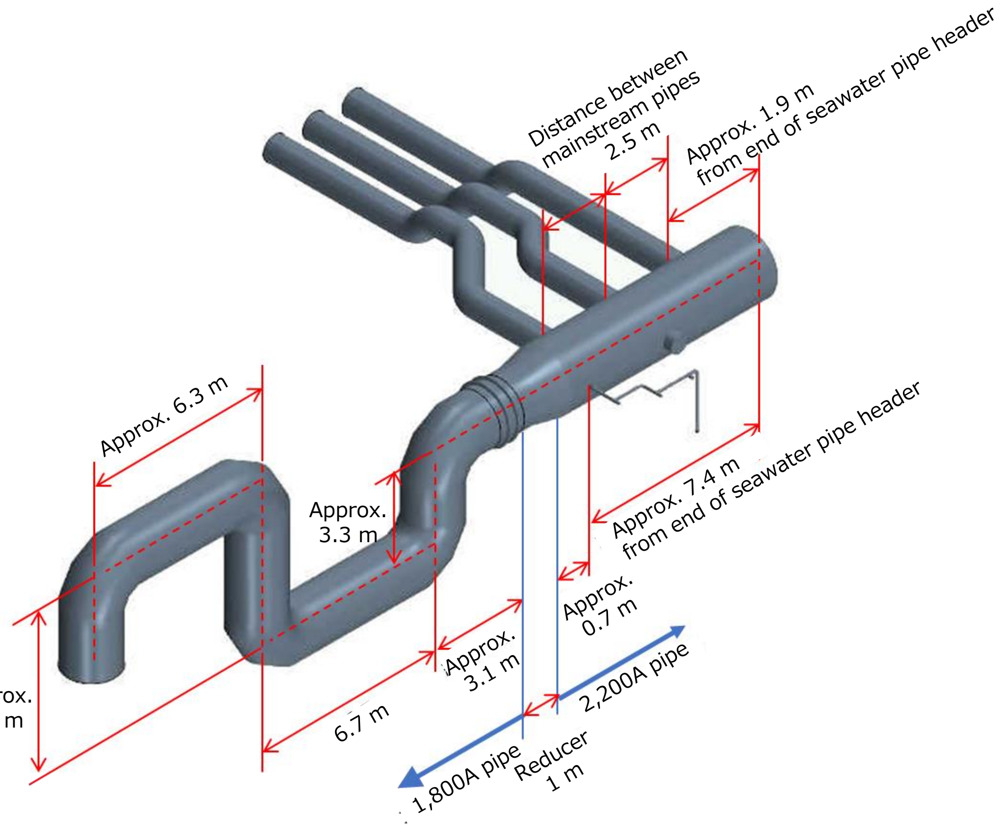


Figure-1 Analytical shape model (2/2)

2. Results of mixing/dilution in the seawater piping

The analytical results for mixing/dilution in the seawater piping are shown in Figures-2 to 6 and Table-2.

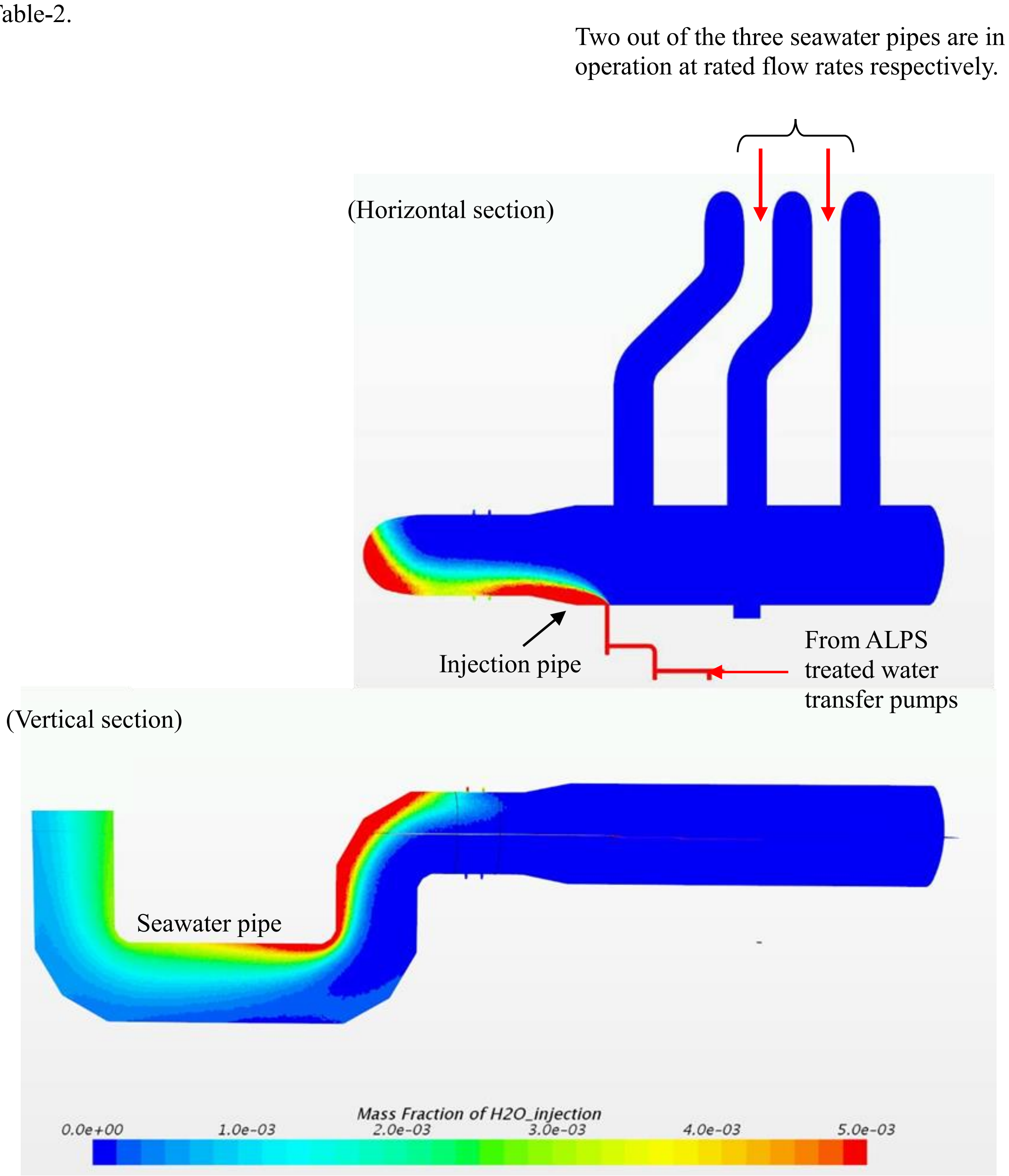


Figure-2 Calculation results of mixing/dilution in the seawater pipe

In Figure-2, it was confirmed that the injected water (ALPS treated water) put into the seawater piping header from the ALPS treated water transfer piping was mixed with surrounding seawater while flowing down in the seawater piping.

To see the analysis results in more detail, the section to be evaluated was set in the transverse direction of seawater pipe as shown in Figure-3, and the mass concentration of injected water (ALPS treated water) in each section to be assessed was evaluated (see Figure-4 and 5.)

The Japanese version shall prevail.

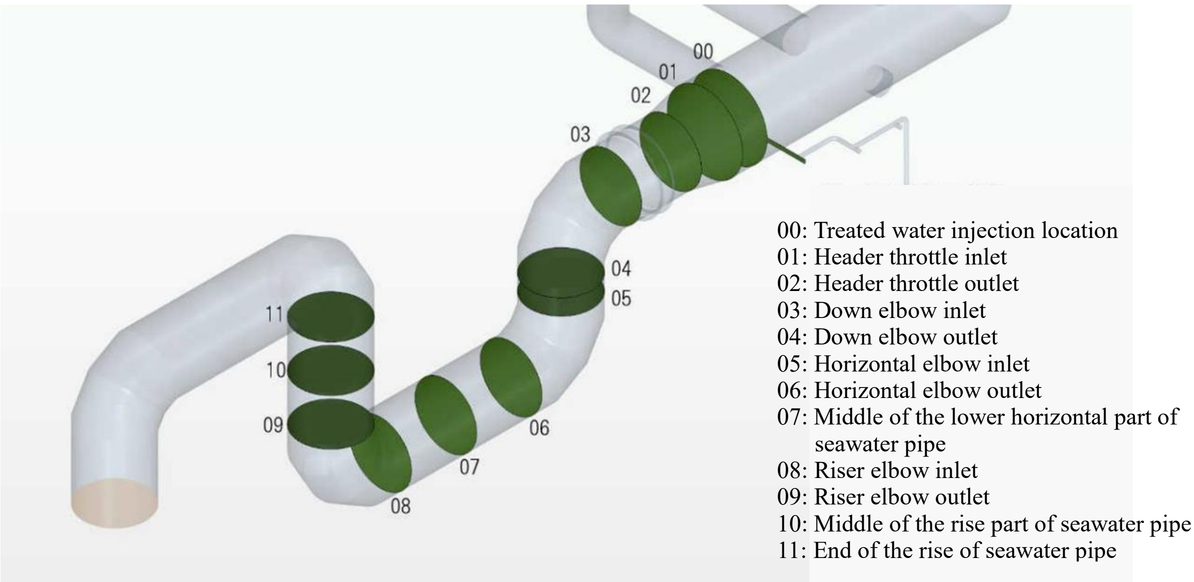


Figure-3 Location and name of sections to be evaluated

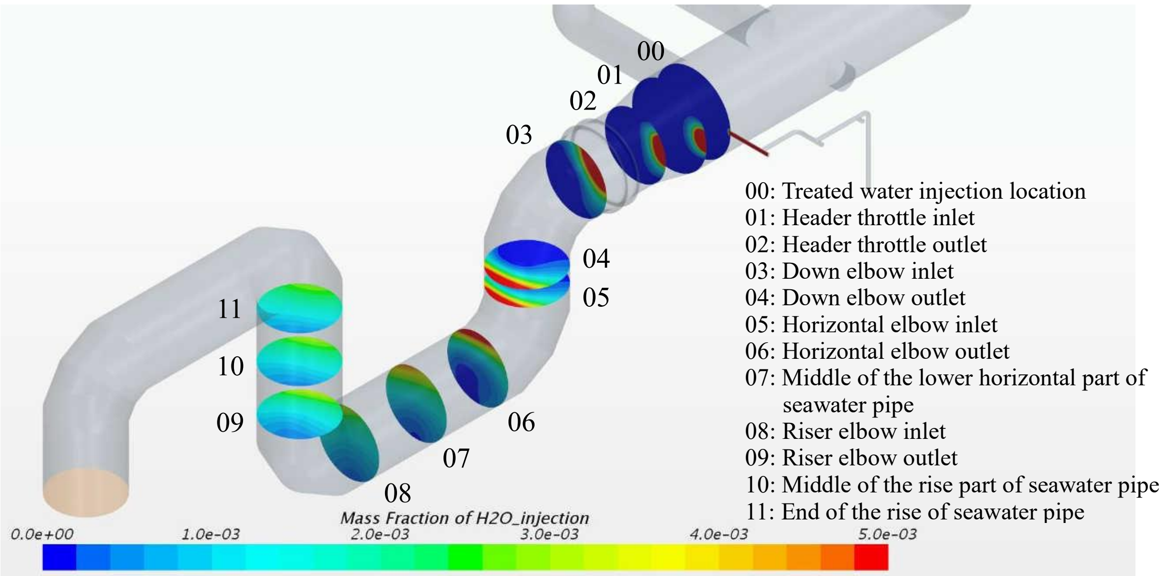


Figure-4 Mass distribution of sections to be evaluated

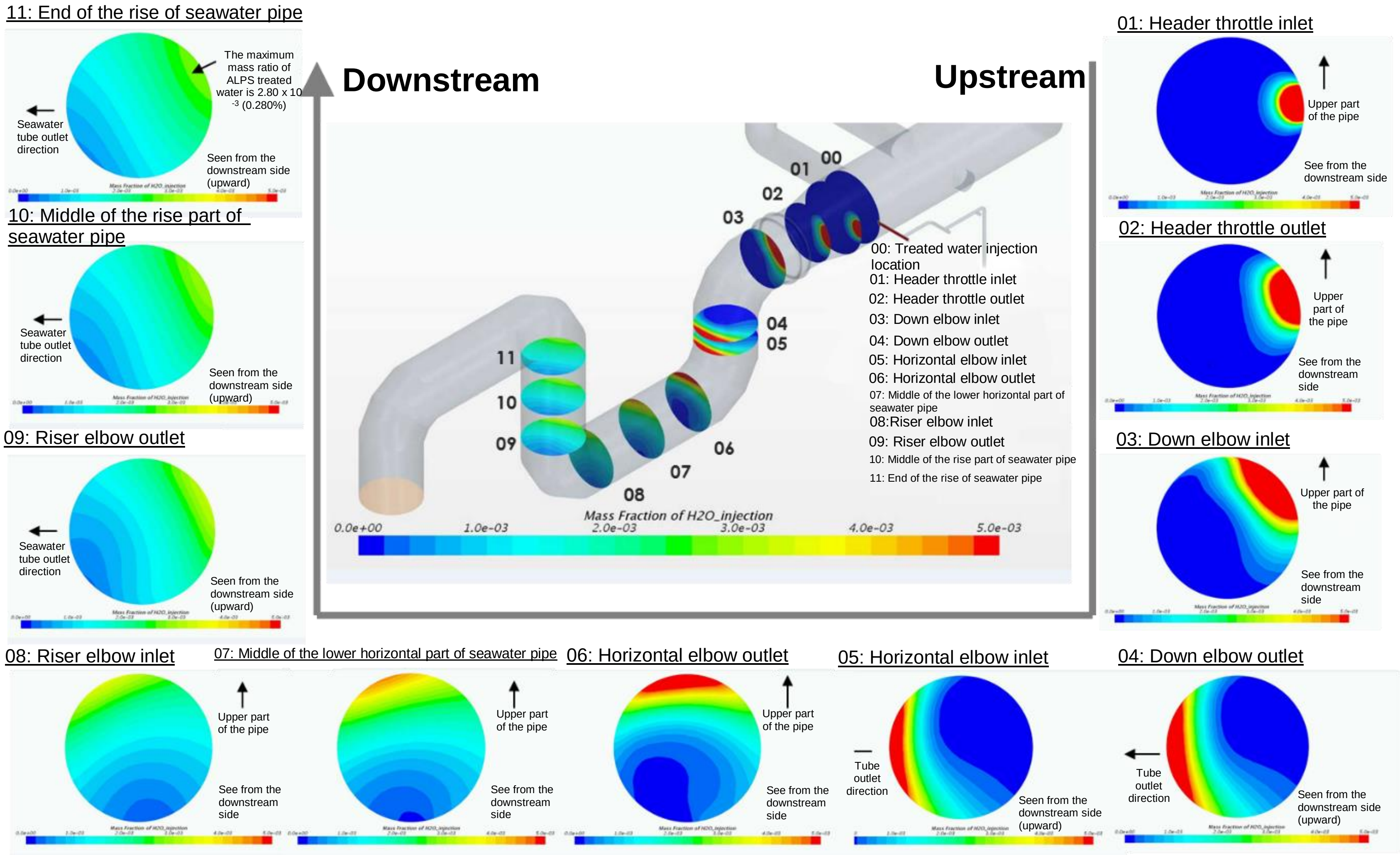


Figure-5 Calculation results of mixed dilution in seawater pipe

The maximum values of mass concentration in each section to be assessed in the Figure-5 are shown in Table-2, and the shift in each value is shown in Figure-6.

Table-2 Maximum concentration of injected water at the section

Name	Maximum concentration value at the section (%)
00: Treated water injection location	100
01: Header throttle inlet	14.26
02: Header throttle outlet	4.16
03: Down elbow inlet	1.79
04: Down elbow outlet	0.90
05: Horizontal elbow inlet	0.84
06: Horizontal elbow outlet	0.71
07: Middle of the lower horizontal part of seawater pipe	0.46
08:Riser elbow inlet	0.37
09: Riser elbow outlet	0.33
10: Middle of the rise part of seawater pipe	0.30
11: End of the rise of seawater pipe	0.28

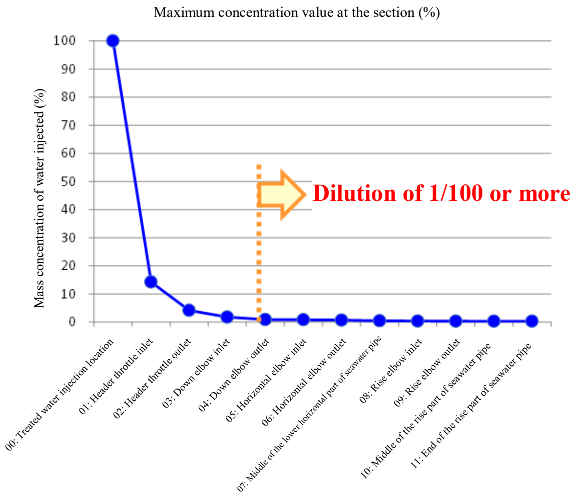


Figure-6 Transition in mass concentration of injected water

Based on this result, it was concluded that the injected water was diluted by 100/0.280 ≒ 357 times even in the maximum concentration part of the seawater piping heading to the discharge shaft (upper-stream storage), and it was confirmed that the dilution effect of over 100 times that is the target of this facility was obtained at the 04: Down elbow outlet.

It was also confirmed that the maximum concentration at the furthest down-stream of the section to be assessed, 11: end of the rise of seawater pipe, was 0.28%, which was 2 times of the theoretical average value of 0.14%.

3. Summary

The behavior of mixing/dilution of ALPS treated water inside the seawater piping was checked using CFD analysis. As the result, even in the maximum value of 500 m^3/day of the ALPS treated water flow rate, though it remained at about 2 times of the average value at the maximum concentration part of the piping terminal part, it was confirmed that the dilution effect over 100 times could be obtained in the seawater piping.

End

Attachment-3

Description on structural strength and seismic resistance of
ALPS Treated Water Dilution/Discharge Facilities

Structural strength and seismic resistance shall be assessed for components constituting ALPS Treated Water Dilution/Discharge Facilities in accordance with the basic policy for assessment on structural strength and seismic resistance.

1. Basic Policy

1.1 Basic policy for structural strength assessment

Since the structures, systems and components constituting ALPS Treated Water Dilution/Discharge Facilities are positioned as equivalent to waste treatment facilities, etc. in the “Ordinance on Technical Standards for Commercial Power Reactors and their auxiliary facilities”, the containers and steel pipes containing ALPS treated water shall be evaluated by applying the provisions of Class 3 component of the Nuclear Facility Standard Design and Construction Standard (JSME S NC1) for Power Generation, considering the importance of safety functions that they should fulfil in their design, selection, manufacture and inspection. Incidentally, steel pipes containing only seawater are also evaluated according to Class 3 component.

Polyethylene pipes conforming to ISO standards or JWWA standards shall be evaluated as having structural strength by the use under the applicable conditions. In addition, pressure-resistant hoses and expansion joints are evaluated to have structural strength at pressure and temperature when used within the manufacturer's specifications. The environmental conditions (maximum working temperature and maximum working pressure) of polyethylene pipes, pressure-resistant hoses, and expansion joints in ALPS treated water dilution/discharge facilities are as follows, and pipes shall be selected that satisfy these conditions.

Table-1 Environment condition of polyethylene pipes, pressure resistant hoses and expansion joints

Type of pipes	Sections used	Max. working pressure (MPa)	Max. working temperature (ºC)
Polyethylene pipes	Receiving pipes	0.98	40
	Circulation pipes	0.49/0.98	40
	Transfer pipes	0.49/0.60/0.98	40
Pressure resistant hoses	Receiving pipes	0.98	40
	Circulation pipes	0.49	40
	Transfer pipes	0.49	40
Expansion joints	Receiving pipes	0.49/0.98	40
	Circulation pipes	0.49/0.60/0.98	40
	Transfer pipes	0.60	40

1.2 Basic policy for seismic resistance

ALPS treated water dilution/discharge facilities are positioned as seismic class C, based on the concept of seismic design presented by the Nuclear Regulatory Authority on September 8, 2021, because the effective dose in case its safety function is lost is evaluated to be less than 1μSv, even if the external exposure dose from direct and skyshine radiation is combined with the internal exposure dose when the leaked ALPS treated water partially evaporates and transfers into the atmosphere.

The ALPS treated water dilution/discharge facilities and the related facility shall ensure the required strength against the seismic motion required for the seismic class C facilities. In evaluating seismic resistance, as shown in Table-2, in principle, 1.0Ci for structures (including indirect supporting structures) and 1.2Ci horizontally designed seismic intensity for components shall be applied. In addition, in evaluating the seismic resistance of major components and steel pipes, structural strength assessment shall be conducted in accordance with the Technical Codes for Seismic Design of Nuclear Power Stations (JEAC4601) along with others, but evaluation methods and evaluation standards shall be adopted in accordance with the actual conditions. Pressure-resistant hoses, polyethylene pipes, etc., used in ALPS treatment water dilution/discharge facilities shall be seismic-resistant by the flexibility of materials.

Table-2 Seismic Class Classification by Component Criticality

Component \ Seismic class	C
(1) Measurement/Confirmation Facility	Measurement/Confirmation tanks Peripheral weir ※1 of the base Circulation pump Main Pipe ※2
(2) Transfer Facility	ALPS treated water transfer pumps Main Pipe ※2
(3) Dilution Facility	Sea water transfer pump Seawater pipe header Main Pipe ※2 Discharge Vertical Shaft (upper-stream storage) ※3
(4) Discharge Facility※3	Discharge Vertical Shaft (downs-stream storage) Discharge tunnel Discharge outlet

※1: Assessment on horizontal design seismic intensity required for class B structures

※2: Support intervals evaluated by the constant pitch span method for steel pipes (including valves)

※3: For details, refer to Attachment-5 Description on Design of Discharge Vertical Shaft (upper-stream storage) and Discharge Facility

2. Method and result of structural strength assessment

2.1 Main pipe (steel pipe excluding seawater pipe headers)

The structural assessment points are shown in Figures-1 to 5.

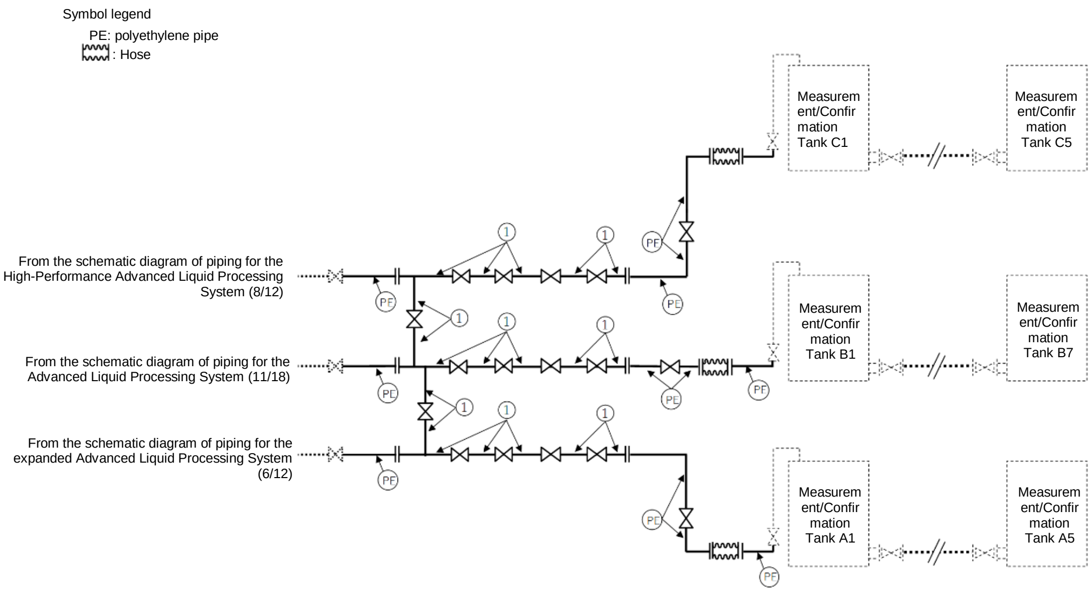


Figure-1 Schematic diagram of pipe (1/5)

(Measurement/Confirmation Facility)

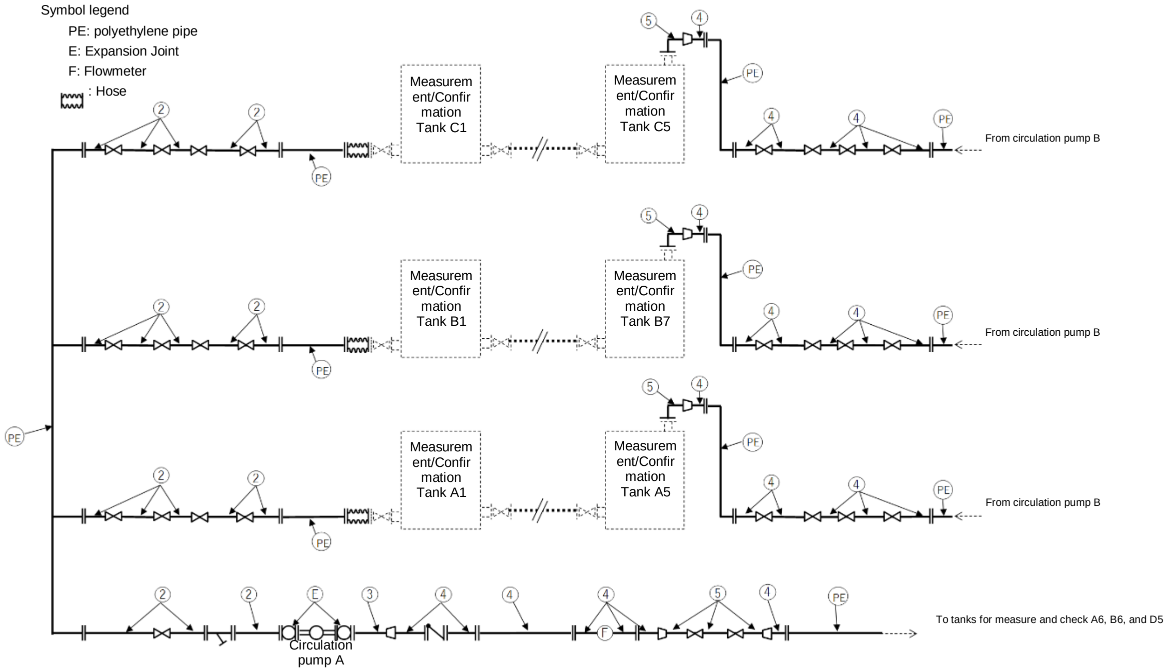


Figure-2 Schematic diagram of pipe (2/5)

(Measurement/Confirmation Facility)

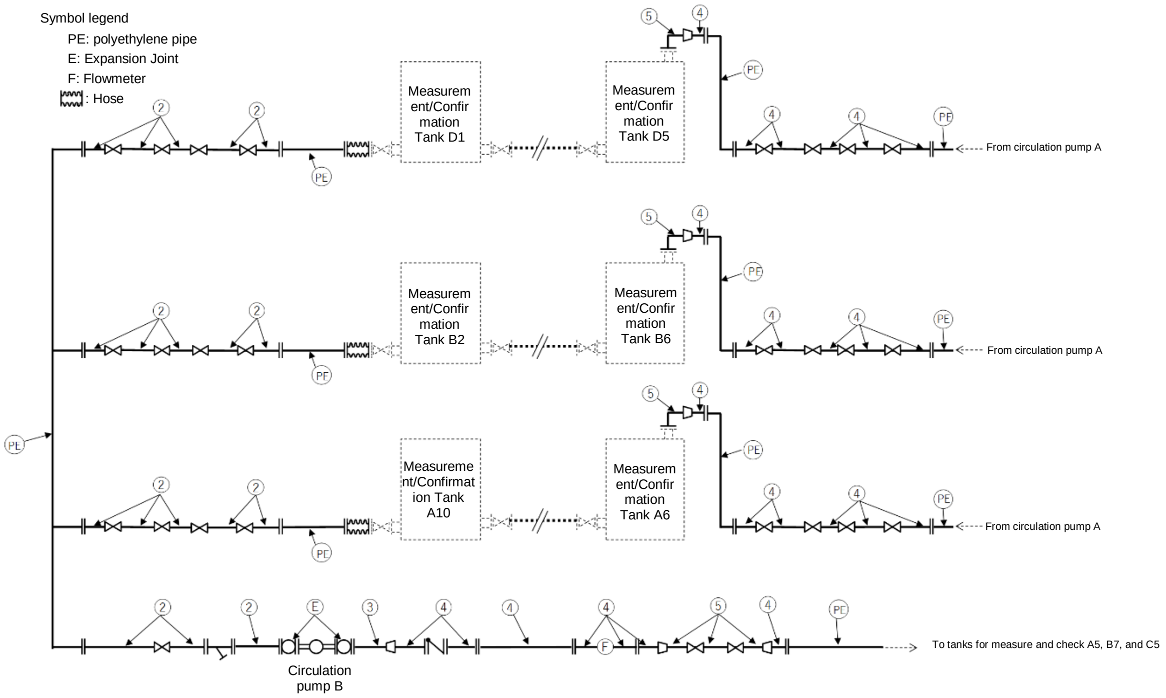


Figure-3 Schematic diagram of pipe (3/5)

(Measurement/Confirmation Facility)

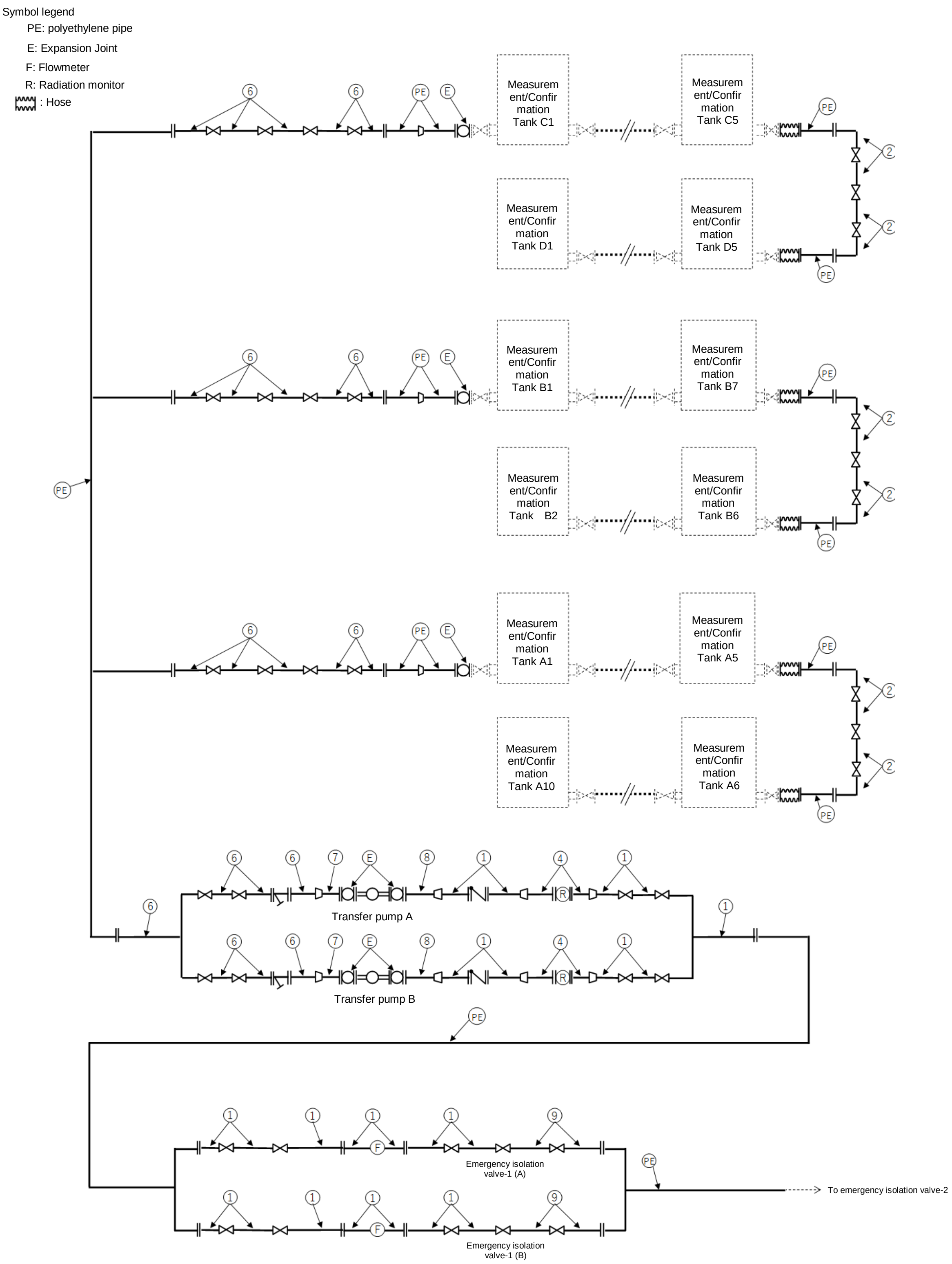


Figure-4 Schematic diagram of piping (4/5)

(Transfer Facility)

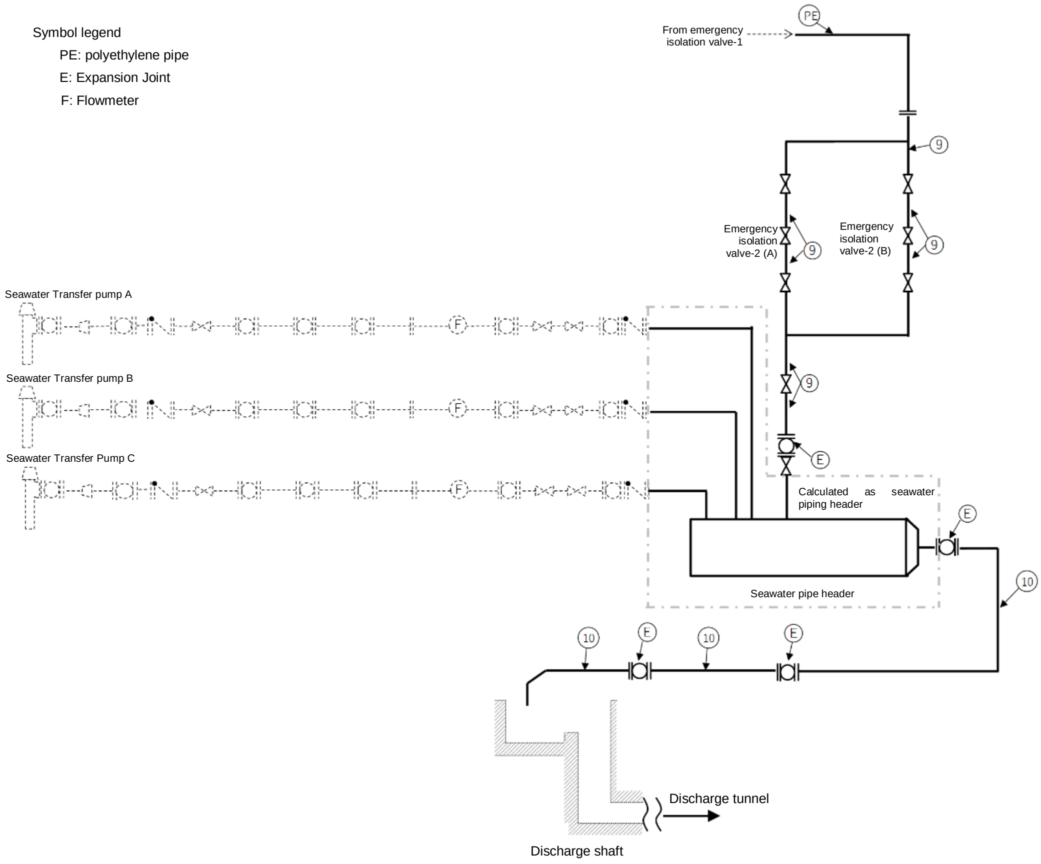


Figure-5 Schematic diagram of piping (5/5)
(Transfer Facility, Dilution Facility)

2.2 Evaluation method

It is ensured that the minimum thickness of the steel pipe satisfies the required thickness determined by Formula (PPD-1.3) of the Design and Construction Standard PPD-3411 or Table PPD-3411-1 of the Design and Construction Standard PPD-3411 (3).

The required thickness of the pipe shall be a larger one in the values listed below.

a. A pipe under pressure on its inner surface

Pipe thickness required for calculation: $t = \frac{PD_0}{2S\eta + 0.8P}$

P : Maximum working pressure (MPa)

D_0 : Outer diameter of the pipe (mm)

S : Allowable tensile stress of the material at maximum working temperature (MPa)

η : Efficiency of the longitudinal joint

b. Minimum thickness required by design and construction standards for carbon steel pipes: t_r

Values obtained from Table PPD-3411-1 of Design and Construction Standard PPD-3411 (3).

2.3 Evaluation results

Evaluation results are given in Table-3. It is assessed that these satisfy the required thickness and have sufficient structural strength.

Table-3 Assessment results of structural strength of main pipe
(steel pipes excluding seawater piping header)

Evaluated components	Outer diameter (mm)	Material	Maximum working pressure (MPa)	Maximum working temperature (°C)	Required thickness (mm)	Minimum thickness (mm)
Pipe (1)	114.3	SUS316LTP	0.98	40	0.48	3.50
Pipe (2)	216.3	SUS316LTP	0.49	40	0.46	5.68
Pipe (3)	139.8	SUS316LTP	0.98	40	0.59	4.37
Pipe (4)	165.2	SUS316LTP	0.98	40	0.69	4.37
Pipe (5)	216.3	SUS316LTP	0.98	40	0.91	5.68
Pipe (6)	165.2	SUS316LTP	0.49	40	0.35	4.37
Pipe (7)	89.1	SUS316LTP	0.49	40	0.19	3.50
Pipe (8)	48.6	SUS316LTP	0.98	40	0.21	2.50
Pipe (9)	114.3	SUS316LTP	0.60	40	0.30	3.50
Pipe (10)	1828.8	SM400B	0.60	40	9.11	14.20

3. Main pipe (seawater piping header)

The structural strength evaluation locations are shown in Figure-6.

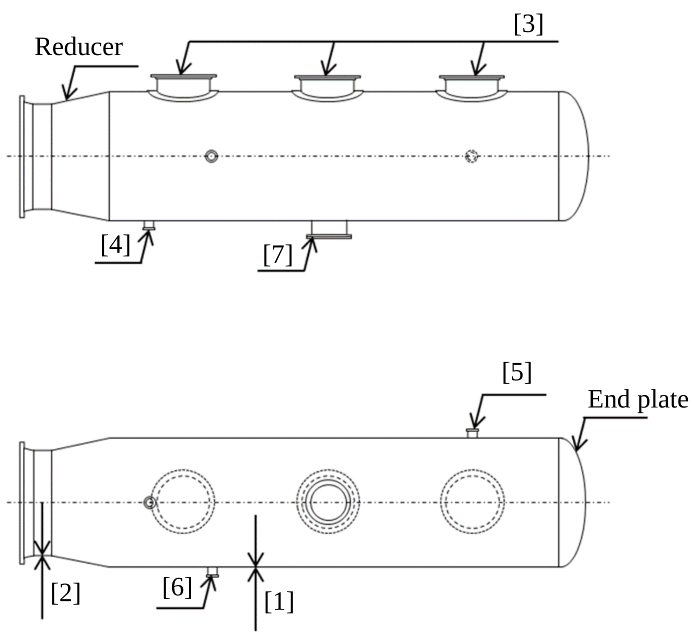


Figure-6 Structural strength evaluation locations for seawater piping header

The Japanese version shall prevail.

3.1 Straight pipes

3.1.1 Structural strength evaluation method

It is ensured that the minimum thickness of the steel pipe satisfies the required thickness determined by formula (PPD-1.3) of the Design and Construction Standard PPD-3411 or the Table PPD-3411-1 of Design and Construction Standard PPD-3411 (3).

The required thickness of the pipe shall be a larger one in the values listed below.

a. A pipe under pressure on its inner surface

The thickness required for the pipe calculation: $t = \frac{PD_0}{2S\eta + 0.8P}$

P : Maximum working pressure (MPa)

D_0 : Pipe outer diameter (mm)

S : Allowable tensile stress of materials at the maximum working temperature (MPa)

η : Efficiency of longitudinal joint

b. Minimum required thickness by design and construction standards for carbon steel pipes: t_r

Values determined from Table PPD-3411-1 of the design and construction standard PPD-3411 (3)

3.1.2 Structural strength evaluation result

The evaluation result is shown in Table-4. It is evaluated that the pipe satisfies the required thickness and has sufficient structural strength.

Table-4 Structural strength evaluation result for the straight pipe of the seawater piping header

Evaluated part	Outer diameter (mm)	Material	Maximum working pressure (MPa)	Maximum working temperature (°C)	Required thickness (mm)	Minimum thickness (mm)
(1) Main pipe	2235.2	SM400B	0.60	40	6.69	14.20
(2) Outlet pipe	1828.8	SM400B	0.60	40	5.48	14.20
(3) Seawater nozzle pipe	914.4	SM400B	0.60	40	2.74	14.20
(4) ALPS treated water injection pipe	114.3	STPG370	0.60	40	0.37	5.25
(5) Vent pipe	114.3	STPG370	0.60	40	0.37	5.25
(6) Drain tube	114.3	STPG370	0.60	40	0.37	5.25
(7) Maintenance hole for inspection	609.6	SM400B	0.60	40	1.83	14.20

3.2 Reducer

3.2.1 Structural evaluation method

It is ensured that the minimum thickness of the reducer satisfies the required thickness as determined by formulas (PPD-1.8 and PPD-1.9) of Design and Construction Standard PPD-3415.1.

The required thickness of the pipe shall be a larger one in the values listed below.

a. Cone part

$$\text{The thickness required for calculation:} t = \frac{PD_i}{2cos\theta(S\eta - 0.6P)}$$

P : Maximum working pressure (MPa)

D_i : The inner diameter of the section perpendicular to the shaft of the conical part connecting to the rounded part of the hem (mm)

θ : 1/2 of the apex angle of the cone (degrees)

S : Allowable tensile stress of the materials at the maximum working temperature (MPa)

η : Efficiency of longitudinal joint

b. The rounded part of its roundness

$$\text{The thickness required for calculation:} t = \frac{PD_iW}{4cos\theta(S\eta - 0.1P)}$$

$$\text{Where, } W = \frac{1}{4}\left(3 + \sqrt{\frac{D_i}{2rcos\theta}}\right)$$

D_i : The inner diameter of the section perpendicular to the shaft of the conical part connecting to the rounded part of the hem (mm)

θ : 1/2 of the apex angle of the cone (degrees)

S : Allowable tensile stress of the materials at the maximum working temperature (MPa)

η : Efficiency of longitudinal joint

r : The inner radius of the bottom part of its roundedness (mm)

3.2.2 Structural strength evaluation result

The evaluation result is shown in Table-5. It is evaluated that the pipe satisfies the required thickness and has sufficient structural strength.

Table-5 Structural strength evaluation result for reducers

Evaluated component	Evaluation part	Material	Maximum working pressure (MPa)	Maximum working temperature (°C)	Required thickness (mm)	Minimum thickness (mm)
Seawater pipe header	Reducer	SM400B	0.60	40	6.77	14.20

3.3 End plate

The end plate of the seawater piping header is saucer-shaped based on the condition of Design and Construction Standard PPD-3415.2 (1).

3.3.1 Structural strength evaluation

It is ensured that the minimum thickness of the end plate of the seawater piping header satisfies the required thickness determined by formula (PPD-1.12) of Design and Construction Standard PPD-3415.2.

The thickness required for the end plate shall be as follows.

The thickness required for calculation: $t = \frac{PRW}{2S\eta - 0.2P}$

Where, $W = \frac{1}{4}\left(3 + \sqrt{\frac{R}{r}}\right)$

P : Maximum working pressure (MPa)

R : Inner radius of the center of the end plate (mm)

S : Allowable tensile stress of the materials at the maximum working temperature (MPa)

η : Efficiency of longitudinal joint

r : Inner radius of the rounded part at the corner of the saucer-shaped end plate (mm)

3.3.2 Structural strength evaluation result

The evaluation result is shown in Table-6. It is evaluated that the pipe satisfies the required thickness and has sufficient structural strength.

Table-6 Structural strength evaluation result for end plate

Evaluated component	Evaluation Part	Material	Maximum working pressure (MPa)	Maximum working temperature (°C)	Required thickness (mm)	Minimum thickness (mm)
Seawater pipe header	End plate	SM400B	0.60	40	10.19	13.40

3.4 Hole reinforcement

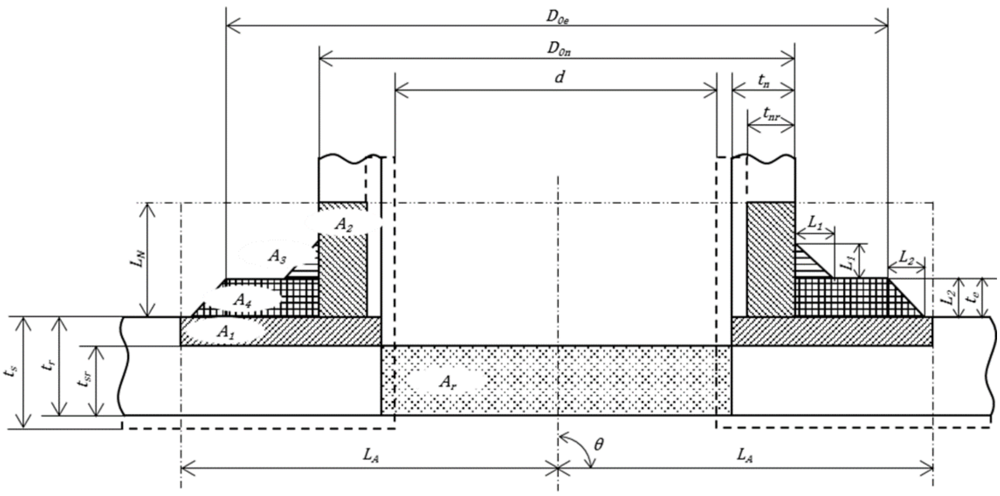
3.4.1 Structural evaluation method

The necessity of the hole reinforcement provided in the seawater piping header shall be evaluated by the Design and Construction Standard PPD-3422. When the hole reinforcement is required, it is ensured that the necessary area determined by the Design and construction standards PPD-3424 (1) shall be satisfied.

The hole reinforcement of the seawater piping header is not required if either of the hole diameters determined by the Design and Construction Standard PPD-3422 is satisfied.

(1) Hole diameter 64 mm or less and hole diameter of 1/4 or less of pipe inner diameter
(2) Excluding what is listed in item (1), hole diameter is 200 mm or less, and hole diameter is equal to or less than d as determined in Figures PPD-3422-1 and PPD-3422-2

It shall be ensured that the total area effective for reinforcement satisfies the area required for the hole requiring reinforcement.



: Area effective for hole reinforcement (main pipe) A_1

: Area effective for hole reinforcement (branch pipe) A_2

: Area effective for hole reinforcement (weld) A_3

: Area effective for hole reinforcement (stiffener) A_4

: Area required for hole reinforcement A_r

Figure-7 Nozzle mounting type

Area required for hole reinforcement: $A_r = 1.07 \bullet d \bullet t_{r^3} \bullet (2 - sin\theta)$

d : Hole diameter (mm)

t_{r^3} : Thickness required by the provisions of PPD-3411 (mm)

θ : Intersection angle between branch pipe and main pipe centerlines (degrees)

Total area required for hole reinforcement: $\mathrm{A}_0 = A_1 + A_2 + A_3 + A_4$

Effective area of the main pipe for hole reinforcement: $A_1 = (\eta \bullet t_s - F \bullet t_{sr}) \bullet (2 \bullet L_A - d)$

Effective area of the nozzle for hole reinforcement: $A_2 = 2 \bullet (t_n - t_{nr}) \bullet cosec\theta \bullet L_N \bullet \frac{S_b}{S_r}$

Effective area of the fillet for hole reinforcement: $A_3 = (L_1)^2 \bullet sin\theta \bullet \frac{S_e}{S_r}$

Effective area of the stiffener for hole reinforcement: $A_4 = (D_{0e} - D_{0b} \bullet cosec\theta) \bullet t_e \bullet \frac{S_e}{S_r} + (L_2)^2 \bullet \frac{S_e}{S_r}$

η : Efficiency of the joint

t_s : Thickness required by the provisions of PPD-3411 (mm)

t_{sr} : Thickness of main pipe required by calculation (mm)

t_n : Pipe thickness

t_{nr} : Thickness of nozzle required by calculation

t_e : Minimum thickness of the stiffener

L_A : Range effective for reinforcement separated by a straight line parallel to the hole centerline

L_N : Range effective for reinforcement separated by a line parallel to the main pipe surface

S_b : Allowable tensile stress of the nozzle material at the maximum working temperature

S_r : Allowable tensile stress of the main pipe material at the maximum working temperature

S_e : Allowable tensile stress of the stiffener material at the maximum working temperature

L_1 : The leg length of the fillet part of the nozzle or the narrow-side length of the reinforced nozzle

L_2 : Leg length of the fillet of the stiffener

D_{0b} : Outer diameter of nozzle

D_{0e} : Outer diameter of the stiffener

d : Diameter of the hole appearing in the cross section

θ : Intersection angle between branch pipe and main pipe centerlines (degrees)

F : Values obtained by figure PPD-3424-1

3.4.2 Structural strength evaluation result

The evaluation result is shown in Table-6.

It is evaluated that the total area effective for reinforcement satisfies the necessary area and has sufficient structural strength.

Table-6 Structural strength evaluation result for hole reinforcement

Evaluated component	Evaluation part	Nozzle diameter	Evaluated point	Ar mm²)	A_0 mm²)
Seawater pipe header	(3) Seawater nozzle pipe	900A	Nozzle stub	6.35×10^3	1.67×10^4
	(4) ALPS treated water injection pipe	100A	Nozzle stub	7.43×10^2	2.52×10^3
	(5) Vent pipe	100A	Nozzle stub	7.43×10^2	2.52×10^3
	(6) Drain pipe	100A	Nozzle stub	7.43×10^2	2.52×10^3
	(7) Maintenance hole for inspection	600A	Nozzle stub	4.16×10^3	1.19×10^4

3.5 Mounting strength of the stiffener

3.5.1 Structural evaluation method

The load to be borne by the welded zone determined by the Design and Construction Standard PPD-3424 (8) shall be evaluated, and it shall be confirmed that the strength of the welded zone is sufficient.

Load to be borne by the weld: $W = d \bullet t_{sr} \bullet S_s - (\eta \bullet t_s - F \bullet t_{sr}) \bullet (2 \bullet L_A - d) \bullet S_s$

d : Diameter of the hole appearing in the cross section (mm)

t_s : Thickness of main pipe (mm)

t_{sr} : The thickness of main pipe required by calculation (mm)

S_s : Allowable tensile stress of the main pipe material at the maximum working temperature

η : Efficiency of the joint

F : Value obtained based on the figure PPD-3424-1

L_A : Range effective for reinforcement separated by a straight line parallel to the hole centerline

2.5.2 Structural strength evaluation result

The evaluation result is shown in Table-8. It is evaluated that the strength of the welded zone is sufficient because the load to be borne by the welded part is zero or less.

Table-8 Structural strength evaluation result for stiffener mounting strength

Evaluated component	Evaluation part	Nozzle diameter	Evaluated locations	W (N)
Seawater pipe header	(3) Seawater nozzle tube	900A	Nozzle stub	-3.69×10^{5}
	(4) ALPS treated water injection pipe	100A	Nozzle stub	-4.32×10^{4}
	(5) Vent pipe	100A	Nozzle stub	-4.32×10^{4}
	(6) Drain pipe	100A	Nozzle stub	-4.32×10^{4}
	(7) Maintenance hole for inspection	600A	Nozzle stub	-2.42×10^{5}

4. Concept to classify the seismic resistance classes

The ALPS Treated Water Dilution/Discharge Facilities are classified as seismic class C, because its effective dose as a result of evaluating the radiation impact on the public in the event of the loss of its safety function is less than 1μSv, even if the external exposure dose by direct and skyshine ray is combined with the internal exposure dose when the leaked ALPS treated water partially evaporates and transfers into the atmosphere.

4.1 Degree of Radiation Impact on the Public Due to Function Loss

For the tanks for measuring/confirming the diluted release facility of ALPS treated water, a dose assessment was carried out to confirm the radiation impact on the public due to the loss of function. The evaluation conditions, in accordance with the evaluation conditions described in Appendix-12 of Attachment-7 of "II 2.5 Contaminated Water Treatment Facilities, etc.", ※ are to set the analytical results (July 2013) of the ALPS treated water as the radioactive concentration of the water in the tanks.

※: In order to prevent not to receive water, of which the sum of ratios to regulatory concentration limit of radionuclides other than tritium is 1 or more, in the measurement/confirmation tanks, the following design and operational measures shall be taken.

- The pipes used for transfer to the measurement/confirmation tanks is a transfer pipes for ALPS, etc., and there is no possibility that Sr treated water, etc. mixes due to the piping configuration.
- It has been confirmed that the radioactivity concentration in the G1 area tank, which was transferred closest to the facility using transfer pipes for ALPS, etc., has the sum of ratios to regulatory concentration limit of radionuclides* other than tritium of less than 1.
- For the measurement/confirmation tanks of ALPS treated water dilution/discharge facilities, transfer of water that has been confirmed or evaluated to be less than 1 in the sum of ratios to regulatory concentration limit of radionuclides* other than tritium in a sample tank of ALPS or in a storage tank for ALPS treated water.

*: Seven radionuclides of Cs-134, Cs-137, Sr-90, Co-60, Sb-125, Ru-106, I-129

4.1.1 Exposure assessment due to direct ray/skyshine ray in the leaked water

Assuming that the sliding of the tanks due to the earthquake damaged the connecting pipes or other component(s) and all the storage water in the measurement/confirmation tanks leaked out, in addition to that, the water continued to exist on one large cylinder that has the same volume and height as the tank group, the exposure dose from the direct ray and skyshine ray at the nearest dose assessment point (No. 70) would be less than 1 μSv / year. Therefore, there would be almost no radiation impact on the public.

4.1.2 Exposure assessment due to vapor transfer of leaked water

It is assumed that the sliding of the tanks due to the earthquake damaged the connecting pipes or other components and the leaked water spread over the entire storable area of the foundation outer barrier of the measurement/confirmation tank, and the vaporized water diffused from the leaked water containing tritium. On the above condition, assuming that it took two weeks to recover the leaked water, the internal exposure dose of tritium ingested by breathing by the residents living at the nearest dose evaluation point (No. 70) would be sufficiently lower than 1 μSv. Therefore, there would be almost no radiation impact on the public.

4.2 Mitigation measure such as immediate responses

The measurement/confirmation tanks of the ALPS treated water dilution/discharge facilities shall be connected between the tanks by flexible connecting pipes, and the connecting valves shall be normally operated as open. The following measures shall be taken to prevent or mitigate the impacts of the expansion of leaks outside the premises, assuming that there is a risk of ALPS treated water leaking from the ALPS treated water dilution/discharge facilities or a leak due to an earthquake.

- In the event of an earthquake with a seismic intensity of 5-lower or higher, discharge into the sea will be halted by remote control from the seismic isolation building centralized monitoring room. At the same time, the outlet-side motor-operated valves of the measurement/confirmation facility will be closed to check for leaks based on the tank water level. In addition, priority patrols will be made on all facilities, including outdoor ALPS treated water transfer pipes, to check for any abnormalities in the facilities.
- Foundation perimeter weirs shall be installed to prevent the seismic class C tanks along with the other components from being damaged by the earthquake and the stored water from significantly leaking out of the premises. For such weirs, the required strength shall be ensured for the horizontal design seismic intensity required for the class B structures.
- If the storage water leaks and retains inside the foundation perimeter weirs, the leaked water shall be recovered by temporary pump, high-pressure suction vehicles, etc. The recovered leaked water is transferred to a sound tank and building.
- As far as possible, ALPS treated water transfer pipes shall be isolated from the drain channel, and the polyethylene pipes used for the transfer pipes shall be constructed to prevent leakage from spreading by attaching the exterior pipes (joints are waterproof covers) to the exterior of the polyethylene pipes.

Attachment-4

Items to be checked for ALPS Treated Water Dilution/Discharge Facilities and Related Facility

Major items to be checked for ALPS treated water dilution/discharge facilities and related facility are shown in Tables-1 to 7.

Table-1 Items to be checked (circulation pumps, ALPS treated water transfer pumps, agitation equipment, seawater transfer pumps)

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength/ seismic resistance	Appearance check	Check the appearance of each part.	No significant defects.
	Installation check	Check the installation conditions of the components.	Carried out construction and installation in accordance with the Implementation Plan.
	Leakage check※1	Check no leakage from the pressure resistant parts under the working pressure.	No significant leakage from the pressure resistant parts.

※1: Not applicable to the agitation equipment because it is the rotation machinery with propeller wings installed in the water of the measurement/confirmation tanks and there is no leakage point to be confirmed.

Table-2-1 Items to be checked (main pipes (steel pipes))

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength/ seismic resistance	Materials check	Confirm the record of main materials described in the Implementation Plan.	In accordance with the Implementation Plan.
	Dimensions check	Confirm the record of outer diameter and thickness described in the Implementation Plan.	In accordance with the Implementation Plan.
	Appearance check※1	Check the appearance of each part.	No significant defects.
	Installation check※1	Check the installation conditions of the pipes.	Carrying out construction and installation in accordance with the Implementation Plan.
	Pressure resistance/leakage check※1	After holding for a certain period of time at 1.25 times the maximum working pressure, confirm that the components withstand the pressure and that there is no leakage from the pressure resistant parts.	Withstanding 1.25 times the maximum working pressure with no abnormalities. In addition, no leakage from the pressure resistant parts.

※1: It shall be within the scope that can be implemented on site, and the quality records shall be checked as necessary.

Table-2-2 Items to be checked (main pipes (polyethylene pipes))

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength/ seismic resistance	Materials check	Confirm the record of main materials described in the Implementation Plan.	In accordance with the Implementation Plan.
	Dimensions check	Confirm the record of outer diameter described in the Implementation Plan.	In accordance with the Implementation Plan.
	Appearance check※1	Check the appearance of each part.	No significant defects.
	Installation check※1	Check the installation conditions of the pipes.	Carrying out construction and installation in accordance with the Implementation Plan.
	Pressure resistance/leakage check※1	After holding for a certain period of time at the maximum working pressure, confirm that the components withstand the pressure and that there is no leakage from the pressure resistant parts.	Withstanding the maximum working pressure with no abnormalities. In addition, no leakage from the pressure resistant parts.

※1: It shall be within the scope that can be implemented on site, and the quality records shall be checked as necessary.

Table-2-3 Items to be checked (main pipes (pressure resistant hose))

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength/ seismic resistance	Materials check	Confirm the record of main materials described in the Implementation Plan.	In accordance with the Implementation Plan.
	Dimensions check	Confirm the record of outer diameter described in the Implementation Plan.	In accordance with the Implementation Plan.
	Appearance check※1	Check the appearance of each part.	No significant defects.
	Installation check※1	Check the installation conditions of the pipes.	Carrying out construction and installation in accordance with the Implementation Plan.
	Pressure resistance/leakage check※1	After holding for a certain period of time at 1.25 times the maximum working pressure, confirm that the components withstand the pressure. Additionally, confirm that there is no leakage from the pressure resistant parts.	Withstanding 1.25 times the maximum working pressure with no abnormalities. In addition, no leakage from the pressure resistant parts.

※1: It shall be within the scope that can be implemented on site, and the quality records shall be checked as necessary.

Table-2-4 Items to be checked (main pipes (expansion joint))

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength/ seismic resistance	Materials check	Confirm the record of main materials described in the Implementation Plan.	In accordance with the Implementation Plan.
	Dimensions check	Confirm the record of outer diameter described in the Implementation Plan.	In accordance with the Implementation Plan.
	Appearance check※1	Check the appearance of each part.	No significant defects.
	Installation check※1	Check the installation conditions of the pipes.	Carrying out construction and installation in accordance with the Implementation Plan.
	Pressure resistance/leakage check※1	After holding for a certain period of time at 1.25 times the maximum working pressure, confirm that the components withstand the pressure and that there is no leakage from the pressure resistant parts.	Withstanding 1.25 times the maximum working pressure with no abnormalities. In addition, no leakage from the pressure resistant parts.

※1: It shall be within the scope that can be implemented on site, and the quality records shall be checked as necessary.

Table-3-1 Items to be checked (leakage detectors and alarms)

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength	Appearance check	Check the appearance of each part.	No significant defects.
	Installation check	Check the installation positions and conditions of the components.	Carrying out construction and installation in accordance with the Implementation Plan.
Function	Leakage alarm check	Check the alarm activation by a leakage signal.	Alarm activation by a leakage signal.

Table-3-2 Items to be checked (ALPS treated water flow meter, seawater flow meter)

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength	Appearance check	Check the appearance of each part.	No significant defects.
	Installation check	Check the installation positions and conditions of the components.	Carrying out construction and installation in accordance with the Implementation Plan.
Performance	Performance calibration check	Check that the flow meter indication is correct for the reference input.	The flow meter indication is within the allowable range.

Table-3-3 Items to be checked (radiation monitor)

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength	Appearance check	Check the appearance of each part.	No significant defects.
	Installation check	Check the installation positions and conditions of the components.	Carrying out construction and installation in accordance with the Implementation Plan.
Function	Alarm check	Check that the alarm is activated by signal "High"※1.	Alarm activation by signal "High"※1.
Performance	Source calibration check	Measure the dose equivalent rate using a standard source and confirm that the calibration of each detector is correct.	The net dose equivalent rate to the reference dose equivalent rate is within the allowable range.
	Calibration check	Check that the radiation monitor indication is correct for the reference input.	The radiation monitor indication is within the allowable range.

※1: Signal names differ depending on the radiation monitor.

Table-4-1 Items to be checked (measurement/confirmation tanks)※1

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength/ seismic resistance	Materials check	Confirm the materials to be used with a certificate of material. Check the delivery documents and product specifications for the connecting pipe and connecting valve.	Using the materials described in the Implementation Plan. The product specifications (maximum working pressure) of the connecting pipes and connecting valves shall be equal to or higher than the water head pressure of the tanks.
	Dimensions check	Check the main dimensions (plate thickness, inner diameter, and height).	In accordance with the Implementation Plan.
	Appearance check	Check the appearance of the tank body (including paint conditions), connecting pipes and connecting valves.	No significant defects.
	Installation check	Check the assembly and installation.	No abnormality in the assembly condition and installation condition.
		Check the unevenness of the tank foundation.	No abnormal unevenness.
	Pressure resistance/leakage check	Perform pressure resistance and leakage tests based on design and construction standards.	No significant leakage from any part and no drawdown in water level.
	Ground bearing force check	Check the bearing force of the foundation of the tanks in the bearing force tests.	Satisfying the necessary bearing force.
Functions and performance	Alarm check	Check that that alarm is activated by the signal "High-High"※2 associated with tank's water level.	Alarm activation by the signal "High-High"※2 associated with tank's water level.
	Dimensions check※3	Check the inner capacity of the weir around the foundation.	Satisfying the capacity inside weir equivalent to the required capacity.
	Appearance check	Check the appearance of the weir around the foundation.	No significant defects.
	Storage function	Confirm tanks can store water without leakage.	No leakage from the tanks and attached components (connecting pipes, connecting valves, manholes, drain valves).

※1: Check the historical records to be used in conjunction with "II 2 5 Contaminated Water Treatment Facility, etc." (pre-use inspection completed).

※2: The signal name varies depending on tank.

※3: This item is confirmed with the inner capacity of the weir at K4 tank area in "II 2.5 Attachment-12, Appendix-6, Table-2".

Table-4-2 Items to be checked (Measurement/Confirmation Tank inlet pipes (steel pipes)) ※1

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength/ seismic resistance	Materials check	Confirm the main materials described in the Implementation Plan with a certificate of material or delivery document.	In accordance with the Implementation Plan.
	Dimensions check	Confirm the main dimensions described in the Implementation Plan with a certificate of material or delivery document.	In accordance with the Implementation Plan.
	Appearance check	Check the appearance of each part by witness or with records.	No abnormalities in appearance.
	Installation check	Check the installation of components in accordance with drawing by witness or with records.	Carrying out the construction and installation based on drawing.
	Pressure resistance/leakage check Remark1	(1) After holding for a certain period of time at 1.25 times the maximum working pressure, confirm that the components withstand the pressure and that there is no leakage from the pressure resistant parts by witness or with records.	Withstanding 1.25 times the maximum working pressure with no deformation of structures. In addition, no leakage from the pressure resistant parts.
		(2) Confirm no leakage from the pressure resistant parts under working pressure by witness or with records.	No leakage from pressure resistant parts.
Functions and performance	Check of water flow	Check that water flow is possible.	Possible to flow water.

※1: Check the historical records to be used in conjunction with "II 2 5 Contaminated Water Treatment Facility, etc." (pre-use inspection completed).

※2: Alternative inspection such as torque check is carried out for flange part of pipes where leakage inspection at pressure resistant parts cannot be conducted under the working pressure.

Remark 1: Pressure resistance/Leakage check shall be confirmed by either (1) or (2).

Table-5 Items to be checked (Water discharge vertical shaft (upper-stream storage)

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength/ seismic resistance	Materials check	Confirm the materials described in the Implementation Plan with a certificate of material or delivery document.	In accordance with the Implementation Plan.
	Dimensions check	Check the main dimensions (inner space) described in the Implementation Plan to ensure the required volume.	In accordance with the Implementation Plan.
	Appearance check※1	Check the appearance	No significant defects.
	Installation and assembly check	Check the installation and assembly of components in accordance with drawing by witness or with records.	Carrying out the construction and installation based on drawing.
	Pressure resistance check	After holding the water level in the storage for a certain period of time, confirm that the components withstand the pressure and that there is no leakage from the pressure resistant parts by witness or with records.	Withstanding water pressure with no deformation of structures. In addition, no leakage from the pressure resistant parts.

※1: It shall be within the scope that can be implemented on site, and the quality records shall be checked as necessary.

Table-6 Items to be checked (discharge vertical shaft (down-stream storage), discharge tunnel, discharge outlet)

Items to be checked	Checking point	Contents of check	Acceptance criteria
Structural strength/ seismic resistance	Material check	Confirm the materials described in the Implementation Plan with a certificate of material or delivery document.	In accordance with the Implementation Plan.
	Dimension check	Check the dimensions of components and main dimensions (inner space) described in the Implementation Plan.	In accordance with the Implementation Plan.
	Appearance check ※1	Check the appearance.	No significant defects.
	Installation and assembly check※2	Check the installation and assembly of components in accordance with drawing by witness or with records.	Carrying out the construction and installation based on drawing.

※1: It shall be within the scope that can be implemented on site, and the quality records shall be checked as necessary.
In addition, it shall be within the scope that can be implemented on site, since seawater will be filled in the discharge tunnel in the middle of construction.

※2: Confirm that the discharge outlet is installed at a point 1km from the coast by the record (location information).

Table-7-1 Items to be checked (measurement/confirmation facility)

Items to be checked	Checking point	Contents of check	Acceptance criteria
Function/ performance	Agitation operation check	Start the agitation equipment and check that the inside of the tank is agitated.	Water flow is occurring on the tank water surface during operation of agitation equipment. The current value is within the proper range.
Function/ performance	Water flow and flow rate check※1	Start the circulation pump and check that water can flow.	For pumps, flow rate is no less than 140m^3/h※2. In addition, there shall be no abnormal noise, odor, vibration, etc. For piping, possible to water flow.

※1: For receiving pipe, check the water flow as a single piece, check for foreign matter in the pipe prior to installation, and check the torque at the fastening section for any abnormal condition.

※2: Set based on actual results of circulation agitation demonstration tests.

Table-7-2 Items to be checked (transfer facility)

Items to be checked	Checking point	Contents of check	Acceptance criteria
Function/ performance	Emergency isolation check	Check that the emergency isolation valve actuates according to the input signal.	The emergency isolation valve shall actuate according to the operation signal.
Function/ performance	Water flow and flow rate check※1	Start ALPS treated water transfer pump and control the flow control valve to confirm that water can flow.	The flow rate can be controlled by the set flow rate ※2. For pumps, there shall be no abnormal noise, odor, abnormal vibration, etc. For piping, possible to water flow.

※1: For pipes for which water flow cannot be confirmed during operation of ALPS treated water transfer pump, heck the water flow as a single piece, check for foreign matter in the pipe prior to installation, and check the torque at the fastening section for any abnormal condition.

※2: Since the flow rate of ALPS processed water is variable, it should be set within the max. 19m^3/h.

Table-7.3 Items to be checked (dilution facility, discharge Facility)

Items to be checked	Checking point	Contents of check	Acceptance criteria
Function/ performance	Water flow and flow rate check※1	Start the sea water transfer pump and check that water can flow.	For pumps, the capacity shall be equal to or greater than the capacity specified in the implementation plan. In addition, there shall be no abnormal noise, odor, vibration, etc. For piping, water discharge shaft (upstream water tank), and water discharge facility, possible to water flow.

Appendix 1: Basic Specifications of Measurement/Confirmation Tanks

Appendix 2: Installation Location of Leakage Detector of ALPS Treated Water Dilution/Discharge Facilities

End

Appendix-1

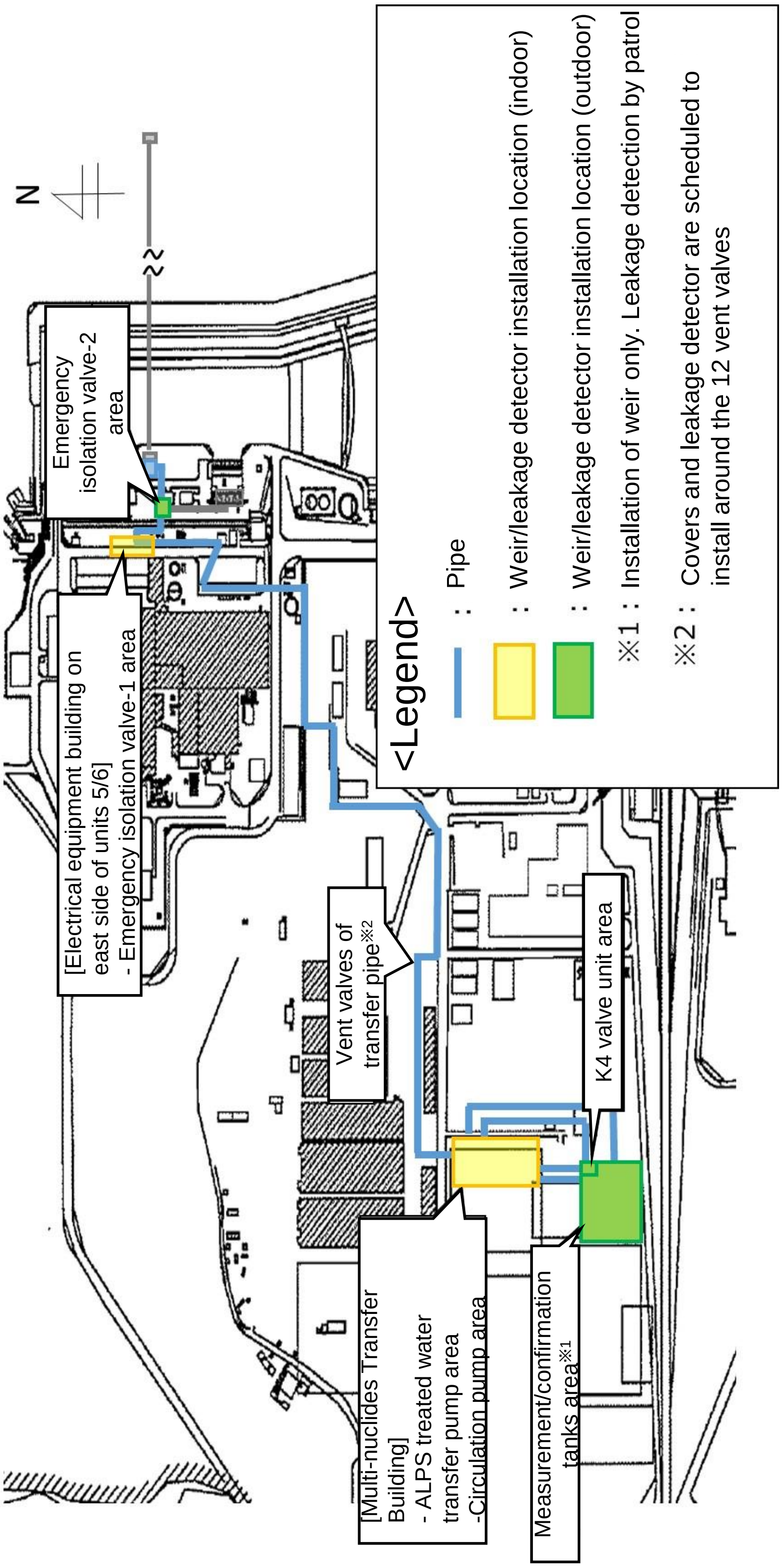
Basic Specifications of Measurement/Confirmation Tanks

Measurement/confirmation tanks

Tank capacity		m^3	1,000
Main dimensions	Inner diameter	mm	10,000
	Shell plate thickness	mm	15
	Bottom plate thickness	mm	25
	Height	mm	14,565
Nozzle stub thickness	100A	mm	8.6
	200A	mm	12.7
	600A	mm	16.0
Material	Shell plate/bottom plate	—	SS400
	Nozzle stub	—	STPT410, SS400

	Connecting pipe (pressure resistant hose (finished product))	Connecting valve (finished product)
Nominal diameter	Equivalent to 200 A	Equivalent to 200 A
Material	EPDM synthetic rubber	FCD450-10
Max. working pressure	1.0 MPa	1.0 MPa
Max. working temp.	50°C	50°C

	Inlet pipe (steel pipe)
Thickness	8.6 mm (100 A)
Material	STPT410
Max. working pressure	1.0 MPa
Max. working temp.	50°C



Installation Location of Leakage Detector of ALPS Treated Water Dilution/Discharge Facility

The Japanese version shall prevail.

Attachment-5

Description on Design of Discharge Vertical Shaft (upper-stream storage) and Discharge Facility

Evaluation shall be conducted on the discharge vertical shaft (upper-stream storage) and the discharge facility (discharge vertical shaft (down-stream storage), discharge tunnel and discharge outlet).

1. Design contents

1.1 Basic policy on design

The discharge vertical shaft (upper-stream storage) and the discharge facility shall be evaluated in accordance with the following:

- Concrete Standard Specification (Design Edition; established in 2017) (PIIA) Japan Society of Civil Engineers
- Concrete Standard Specification (Design Edition; established in 2012) (PIIA) Japan Society of Civil Engineers
- Concrete Standard Specification (Structural Performance Check Edition; established in 2002) (PIIA) Japan Society of Civil Engineers
- Road Bridge Specifications/Explanation I Common Edition 2012 (PIIA) Japan Road Association
- Road Bridge Specification/Explanation IV Substructure Edition 2012 (PIIA) Japan Road Association
- Road Bridge Specification and Explanation V Seismic Design Edition 2012 (PIIA) Japan Road Association
- Utility Conduit Design Guidelines 1986 (PIIA) Japan Road Association
- Hydraulic Formula Collection 2018 (PIIA) Japan Society of Civil Engineers
- Precast Rainwater Underground Storage Facility Technical Manual (revised edition; 2020) (PIIF) Japan Institute of Wastewater Engineering and Technology
- Design and Construction Guidelines for Reinforced Concrete Using Epoxy Resin Painted Reinforcement (Revised Edition; 2013) (PIIA) Japan Society of Civil Engineers
- Design of Civil Engineering Structures at Thermal and Nuclear Power Stations (Additional and Revised Edition) (Foundation) Electric Power Civil Engineering Society
- Tunnel Standard Specification [Common Edition] • Explanation/ [Shield Method Edition] • Explanation (established in 2016) (PIIA) Japan Society of Civil Engineers
- Tunnel Standard Specification [Open Cutting Method]/Explanation (established in 2016) (PIIA) Society of Civil Engineers
- Technical Standards and Explanations of Port Facilities 2018 (PIIA) Japan Port and Harbor Association

The Japanese version shall prevail.

- Handbook for design of tunnel lining structure with internal water pressure (established in 1999) (PIIF) Advanced Construction Technology Center
- Standard Segment for Shield Method, jointly edited by Japan Society of Civil Engineers and Japan Institute of Wastewater Engineering and Technology (established in 2001)
- Documents of Public Works Research Institute, Method/Guideline for Seismic Design of Large-scale Underground Structures (Draft) – March, 1992, Seismic Research Institute, Aseismatic and Disaster Prevention Department, Public Works Research Institute, Construction Ministry
- Guideline and Exposition of Aseismatic Measures for Wastewater Facilities – 2014 Edition, (PIIA) Japan Institute for Wastewater Engineering and Technology
- Examples of Aseismatic Calculation for Wastewater Facilities Treatment Facility and Pump Yard Edition – 2015 Edition, (PIIA) Japan Institute for Wastewater Engineering and Technology
- Examples of Aseismatic Calculation for Wastewater Facilities Piping Facility Edition – 2015 Edition, (PIIA) Japan Institute for Wastewater Engineering and Technology

1.2 Basic Policy on Seismic Resistance

In view of handling the drainage water from ALPS Treated Water Dilution/Discharge Facility (water satisfies the concentration value 1 where the sum of the ratios to regulatory concentration limit of all radionuclides including tritium diluted with seawater), discharge facility is classified as seismic class C according to the degree of radiological impact on the public due to the loss of function of the facility, etc. Therefore, the facilities shall be designed to withstand the seismic force required for facilities of the seismic class C.

2. Design method

2.1 Evaluation conditions

2.1.1 Tolerant stress intensity of the materials used

Among the materials used in the discharge facility, concrete shall be ordinary concrete, and the design strength is $24N/mm^2$, $30N/mm^2$, $r0N/mm^2$, $42N/mm^2$. Reinforcing bar shall be SD345.

The tolerant stress intensity for each material used are shown in Table-1 to 2.

Table-1 Tolerant stress intensity of concrete

Design strength	Long term		Short term	
	Compressive (N/mm^2)	Shearing (N/mm^2)	Compressive (N/mm^2)	Shearing (N/mm^2)
24	9.0	0.45	13.5	0.675
30	11.0	0.50	16.5	0.750
40	14.0	0.55	21.0	0.825
42	16.0	0.73	24.0	1.095

Table-2 Tolerant stress intensity of reinforcing bar

Material used	Long term	Short term
	Compressive/tensile (N/mm^2)	Compressive/tensile (N/mm^2)
SD345	200	300

2.1.2 Soil Constants

The soil constants used in the design are shown in Table-3.

Table-3 Soil constants

Number of layers	Soil	Unit volume weight γ (kN/m^2)	Adhesive force C (kN/m^2)	Internal frictional angle φ (°)	Modulus of deformation E0 (kN/m^2)
1	Embankment	18.0	0	30.0	17,700
2	Sandstone	18.4	0	38.6	94,400
3	Mudstone	17.1	1,500	0	506,000

2.1.3 Groundwater level

T.P. +2.5m

2.1.4 Unit volume weight

The unit volume weight of the materials used in the design is shown in Table-4.

Table-4 Unit volume weight

Material	Unit volume weight (kN/m^3)
Reinforced concrete	24.5
Steel	77.0
Ground	See Table-3

2.1.5 Environmental conditions of the structures

The environmental conditions of the structures shall be corrosive environmental conditions, and the limit value of the crack width shall be from 0.035c to 0.05c (mm). However, c is the distance from concrete surface to the reinforcement surface.

2.1.6 Load

Long and short-term loads are considered in the design.

The seismic force acting on the skeleton is calculated by the seismic intensity method in principle.

$$P=K \cdot W$$

P: Seismic force

K: Designed horizontal seismic intensity

W: Skeleton weight

2.2 Evaluation method

By checking Table-5, it is confirmed that the soundness during the service period is ensured. The checking items are set based on the required performance to meet the intended use of the structure.

Table 5 Items to be checked for the discharge vertical shaft (upper-stream storage) and the discharge facility

Items to be checked		Discharge vertical shaft (upper-stream storage)	Discharge vertical shaft (down-stream storage)	Discharge tunnel	Discharge outlet	Checking item
Long-term	Structure	○	○	○	○	Within tolerant stress intensity
	Structure (Waves)	-	-	○	○	Within tolerant stress intensity
	Crack	○	○	○	○	The crack width shall not exceed the tolerant crack width.
	Salt damage	○	○	○	○	The chloride ion concentration at the steel position does not reach the generation limit of steel corrosion.
	Floating	○	○	-	○	No floating shall occur.
Short-term		○	○	○	○	Within Tolerant stress intensity to earthquake

2.3 Evaluation results

2.3.1 Discharge vertical shaft (upper-stream storage)

The applied stress of discharge vertical shaft (upper-stream storage) is compared with the tolerant stress of it, and the checking results of part where the ratio of the applied stress to the tolerant stress is the maximum are shown in Table-6.

The structure is designed after confirming that the load is within the tolerant stress intensity for long-term load and short-term load. And, it is confirmed that the floating of the structure does not occur. In addition, the crack width and salt damage on the skeleton made of reinforced concrete are checked to confirm that the durability during the service period is ensured.

Furthermore, as with general civil engineering structures, maintenance and management shall be carried out based on the long-term inspection plan.

Table-6 Checking results of discharge vertical shaft (upper-stream storage)

Target part	Load case	Target materials	Stress	Applied stress (N/mm^2)	Tolerant stress (N/mm^2)	Applied stress/ tolerant stress
Bottom plate	Short-term	Reinforcing bar	Bending moment	108	300	0.36
Side wall	Short-term	Reinforcing bar	Bending moment	117	300	0.39
Partition wall	Short-term	Reinforcing bar	Bending moment	177	300	0.59
Top plate	Long-term	Concrete	Shearing force	0.14	0.55	0.26

2.3.2 Discharge vertical shaft (down-stream storage)

The applied stress of the discharge vertical shaft (down-stream storage) is compared with the tolerant stress, and the checking results of part where the ratio of the applied stress to the tolerant stress is the maximum are shown in Table-7.

The structure is designed after confirming that the load is within the tolerant stress intensity for long-term load and short-term load. And, it is confirmed that the floating of the structure does not occur. In addition, the crack width and salt damage on the skeleton made of reinforced concrete are checked to confirm that the durability during the service period is ensured.

Furthermore, as with general civil engineering structures, maintenance and management shall be carried out based on the long-term inspection plan.

Table-7 Checking results of discharge vertical shaft (down-stream storage)

Target part	Load case	Target materials	Stress	Applied stress (N/mm^2)	Tolerant stress (N/mm^2)	Applied stress/ tolerant stress
Bottom plate	Long-term	Reinforcing bar	Bending moment	98	200	0.49
Side wall	Long-term	Reinforcing bar	Bending moment	148	200	0.74

2.3.3 Discharge tunnel

The applied stress of the discharge tunnel is compared with the tolerant stress, and the checking results of part where the ratio of the applied stress to the tolerant stress is the maximum are shown in Table-8.

The structure is designed after confirming that the load is within the tolerant stress intensity for long-term load and short-term load. And, the crack width and salt damage on the lining board made of reinforced concrete are checked to confirm that the durability during the service period is ensured.

In addition, as with general civil engineering structures, maintenance and management shall be carried out based on the long-term inspection plan.

Table-8 Checking results of discharge tunnel

Target part	Load case	Target materials	Stress	Applied stress (N/mm^2)	Tolerant stress (N/mm^2)	Applied stress/ tolerant stress
Lining board (starting section)	Long-term	Reinforcing bar	Bending moment	78	200	0.39
Lining board (deepest section)	Long-term	Reinforcing bar	Bending moment	91	200	0.46

2.3.4 Discharge outlet

The applied stress of the discharge outlet is compared with the tolerant stress, and the checking results of part where the ratio of the applied stress to the tolerant stress is the maximum are shown in Table-9.

The structure is designed after confirming that the load is within the tolerant stress intensity for long-term load and short-term load. And, it is confirmed that the floating of the structure does not occur. In addition, the crack width and salt damage on the skeleton made of reinforced concrete are checked to confirm that the durability during the service period is ensured.

Furthermore, as with general civil engineering structures, maintenance and management shall be carried out based on the long-term inspection plan.

Table-9 Checking results of discharge outlet

Target part	Load Case	Target materials	Stress	Working stress (N/mm^2)	Allowable stress (N/mm^2)	Working stress/allowable stress
Bottom plate	Long-term	Concrete	Shearing force	0.23	0.50	0.46
Side wall	Long-term	Concrete	Shearing force	0.24	0.50	0.48

Appendix 1: Description for checking durability

Appendix 2: Description for checking floating

Appendix 3: Schematic diagram of discharge vertical shaft (upper-stream storage) and discharge facility (discharge vertical shaft (down-stream storage), discharge tunnel and discharge outlet)

End

Appendix 1

Description for checking durability

Methods and results of checking for durability of discharge vertical shaft (upper-stream storage) and the discharge facility (discharge vertical shaft (down-stream storage), discharge tunnel and discharge outlet) are shown as follows:

1. Checking Method

1.1 Crack width

Checking for cracks shall confirm that the generated bending crack width w is not more than the allowable bending crack width wa. The checking formula is shown below.

$$w / wa \leqq 1.0$$

The calculation formula is shown below.

$$w = 1.1 k_1 k_2 k_3 \{4c + 0.7(c_s - \phi)\} \left[\frac{\sigma_{se}}{E_s} \left(\text{ or } \frac{\sigma_{pe}}{E_p} \right) + \varepsilon'_{csd} \right]$$

w: Bending crack width (mm)

k1: Coefficient representing the effect of surface shape of reinforcing bar on crack width (= 1.0)

Epoxy-coated reinforcing bar is used in the discharge shaft (upper-stream storage). 1.1

k2: Coefficient representing the effect of quality of concrete on crack width

k2 = 15 / (f'c + 20) + 0.7

f'c: Concrete compressive strength (N/mm^2)

k3: Coefficient representing the effect of the number of stages of tension reinforcing bar

k3 = 5(n+2)/ (7n+8)

n: Number of stages of tension reinforcing bar

c: Covering depth for reinforcing bar (mm). Here, depth to main reinforcing bar

Cs: Distance between the centers of reinforcing bar (mm)

φ: Diameter of tension reinforcing bar and nominal diameter of reinforcing bar (mm)

ε' csd: Value to consider the increase of crack width due to shrinkage and creep, etc. of concrete.

(Approx. 150×10^{-6} is used for the ε'_{csd} when checking for corrosion of reinforcing bar.)

σ se: Value of increase in stress intensity of reinforcing rod near the surface (N/mm^2)

Es: Young's modulus of reinforcing rod (N/mm^2)

The Japanese version shall prevail.

1.2 Salt damage

The durability shall be checked using a simple design method. The basic concept of the checking is shown below.

- Under a given environmental condition, the combination of design value Cd of covering depth and design diffusion coefficient Dd for chloride ion is appropriately set to satisfy the checking of salt damage.
- In order to satisfy the set design diffusion coefficient Dd, the combination of bending crack width w and water-cement ratio W/C of concrete shall be appropriately set.

The conformity standards shall be as shown in Table-1.

Table-1 Conformity standard for each component

Component	Conformity standards	Remarks
Discharge shaft (upper-stream storage)	Concrete Standard Specification (Structural Performance Check Edition; established in 2002)	Because of the use of epoxy-coated reinforcing rod
Discharge shaft (Down-stream storage)	Concrete Standard Specification (Design Edition; established in 2017)	
Discharge tunnel	Concrete Standard Specification (Design Edition; established in 2017)	
Discharge Outlet	Technical Standards and Explanations of Port Facilities 2018	

Calculate the design value Cd of chloride ion concentration at the reinforcing rod position and confirm that it does not reach the limit concentration Clim of generation of steel corrosion. The checking formula is shown below.

$$\gamma i \cdot Cd / Clim \leqq 1.0$$

γi: Structure coefficient (= 1.0)

Cd: Design value of the chrome ion concentration at the reinforcing bar position (kg/m^3)

Clim: Limit concentration of generation of corrosion in reinforcing bar (kg/m^3)

The chloride ion concentration Cd is calculated by the following formula.

・Discharge vertical shaft (upper-stream storage)

$$C_d = \gamma_{cl} \cdot \left\{1 - erf\left(0.1 / 2\sqrt{t} \left(c / \sqrt{D_d} + c_{ep} / \sqrt{D_{epd}} \right)\right)\right\}$$

γ_{cl}: Safety factor considering Cd variations

Dd: Design diffusion coefficient

C_{ep}: Expected epoxy film thickness (mm)

D_{epd}: Designed values of apparent diffusion coefficients for chloride ions (cm^2/year) when infiltration of chloride ions into the epoxy-resin coating is regarded as diffusion phenomena. Typically 2.0×10^{-6} cm^2/year.

・Discharge vertical shaft (down-stream storage), discharge tunnel and discharge outlet

$$C_d = \gamma_{cl} \cdot C_0 \cdot \left\{1 - \mathrm{erf}\left(0.1 \cdot C_d \Big/ 2 \cdot \sqrt{D_d \cdot t}\right)\right\} + C_i$$

γ_{cl}: Safety factor considering Cd variations

C_0: Chloride ion concentration on concrete surface (kg/m^3)

Dd: Design diffusion coefficient

Design diffusion coefficient Dd is calculated by the following formula.

・Discharge vertical shaft (upper-stream storage)

$$D_d = \gamma_c \cdot D_k + \left(\frac{w}{l}\right) \cdot \left(\frac{w}{w_a}\right)^2 \cdot D_0$$

γ_c: Material factor of concrete (= 1.0)

D_k: Characteristic value of diffusion factor for chloride ion in concrete (cm^2/year)

D_0: Factor that represents the effect of cracking on the transfer of saline in concretes (cm^2/year) (= 200 cm^2/ year)

w/l: Ratio of crack width to crack interval

w: Crack width (mm)

wa: Limit value of crack width against corrosion of steel material (mm)

・Discharge vertical shaft (down-stream storage), discharge tunnel and discharge outlet

$$D_d = \gamma_c \cdot D_k + \lambda \cdot \left(\frac{w}{l}\right) \cdot D_0$$

γ_c: Material factor of concrete (= 1.0)

D_k: Characteristic value of diffusion factor for chloride ion in concrete (cm^2/year)

D_0: Factor that represents the effect of cracking on the transfer of saline in concretes (cm^2/year) (= 400 cm^2/year)

w/l: Ratio of crack width to crack interval

λ: Coefficient representing the impact of cracking on the diffusion coefficient due to the presence of cracking

The Japanese version shall prevail.

The designed value cd of the covering depth is obtained by the following equation taking the construction error Δc_e into account in advance.

$$cd= c-\Delta c_e$$

c: Covering depth on the design drawing

The chloride ion concentration C_0 on the concrete surface shall be based on the regional classification in the "Concrete Standard Specification" shown in Table-2 and the distance from the coast.

Table-2 C_0 of Chloride ionic density on concrete surfaces

		Splash zone	Distance from the shore (km)				
			Shore line	0.1	0.25	0.5	1.0
Areas with high levels of airborne salt	Hokkaido, Tohoku, Hokuriku, Okinawa	13.0	9.0	4.5	3.0	2.0	1.5
Areas with low levels of airborne salt	Kanto, Tokai, Kinki, Chugoku, Shikoku, Kyushu		4.5	2.5	2.0	1.5	1.0

At the discharge outlet, it shall be established based on the following equation in "Technical Standards and Explanations of Port Facilities".

$$C_0=-6.0x + 15.1$$

C_0: chloride ion concentration in surface (kg/m^3) not to be less than 6.0 kg/m^3

x: Distance from sea level (H.W.L) to bottom surface of member (m)

C_0=15.1 kg/m^3 is to be applied at the discharge outlet installed below the surface.

The limit concentration Clim of generation of steel corrosion shall be set according to the water-cement ratio and the type of cement. Ordinary portland cement and blast furnace cement class B are applied, and Clim is determined by the following equation.

・Ordinary portland cement

Discharge vertical shaft (upper-stream storage) Clim= 1.2

Discharge vertical shaft (down-stream storage) Clim =-3.0 (W/C) + 3.4

・Blast furnace cement class B (discharge tunnel)

$$Clim= -2.6(W/C)+3.1$$

Clim=2.0kg/m^3 of the discharge outlet shall be set based on "the technical standards of the port facility and the explanation."

The diffusion coefficient Dk for chloride ions in concrete is obtained from the prediction equation with the apparent diffusion coefficient according to the water-cement ratio and the type of cement. Ordinary portland cement and blast furnace cement class B are applied, and Dk is determined by the following equation.

・Ordinary portland cement

Discharge vertical shaft (upper-stream-storage) $\log 10Dk = -3.9\,(W/C)^2 + 7.2\,(W/C) - 2.5$

Discharge vertical shaft (down-stream storage) $\log 10Dk = 3.0\,(W/C) - 1.8$

・B-category blast furnace cement

$$\log 10D_k = 2.5(W/C) - 1.8$$

The values in Table-3 shall be used for the design conditions to be used for the durability check.

Table-3 Design conditions used for durability checking

		Discharge shaft (upper-stream storage)	Discharge shaft (down-stream storage)	Discharge Tunnel	Discharge Outlet
Durable years	Years	30			
Cement type	-	Ordinary portland cement	Ordinary portland cement	Blast furnace cement class B	Blast furnace cement class B
Chloride ion on surface	C_0 (kg/m^3)	13.0	13.0	9.0	15.1
Limit concentration of generation of corrosion	C_{lim} (kg/m^3)	1.20	1.84	2.19	2.00
Diffusion coefficient	D_k (cm^2/year)	0.69	0.58	0.05	0.28
Water-cement ratio	W/C	0.42	0.52	0.35	0.50

2. Checking Results

2.1 Crack width

2.1.1 Discharge vertical shaft (upper-stream storage)

Comparing the generated bending crack width of the discharge vertical shaft (upper-stream storage) with the allowable bending crack width, Table-4 shows the results of checking the part where the ratio of the generated bending crack width to the allowable bending crack width is the maximum.

Table-4 Checking results of discharge vertical shaft (upper-stream storage)

Target part	Generated bending crack width (mm)	Allowable bending crack width (mm)	Generated bending crack width/allowable bending crack width
Bottom plate	0.19	0.27	0.70
Side wall	0.20	0.27	0.74
Partition wall	0.06	0.27	0.22
Top plate	0.04	0.15	0.27

The Japanese version shall prevail.

2.1.2 Discharge vertical shaft (down-stream storage)

Comparing the generated bending crack width of the discharge vertical shaft (upper-stream storage) with the allowable bending crack width, Table-5 shows the results of checking the part where the ratio of the generated bending crack width to the allowable bending crack width is the maximum.

Table-5 Checking results of discharge vertical shaft (down-stream storage)

Target part	Generated bending crack width (mm)	Allowable bending crack width (mm)	Generated bending crack width/allowable bending crack width
Bottom plate	0.34	0.50	0.68
Side wall	0.39	0.50	0.78

2.1.3 Discharge tunnel

Comparing the generated bending crack width of the discharge tunnel with the allowable bending crack width, Table-6 shows the results of checking the part where the ratio of the generated bending crack width to the allowable bending crack width is the maximum.

Table 6 Checking results of discharge tunnel

Target part	Generated bending crack width (mm)	Allowable bending crack width (mm)	Generated bending crack width/allowable bending crack width
Lining board (starting section)	0.14	0.18	0.76
Lining board (deepest section)	0.15	0.18	0.84

2.1.4 Discharge outlet

Comparing the generated bending crack width of the discharge outlet with the allowable bending crack width, Table-7 shows the results of checking the part where the ratio of the generated bending crack width to the allowable bending crack width is the maximum.

Table-7 Checking results of discharge outlet

Target part	Generated bending crack width (mm)	Allowable bending crack width (mm)	Generated bending crack width/allowable bending crack width
Bottom plate	0.26	0.40	0.66
Side wall	0.30	0.40	0.76

2.2 Salt damage

2.2.1 Discharge vertical shaft (upper-stream storage)

Comparing the chloride ion concentration at the reinforcing rod position of the discharge vertical shaft (upper-stream storage) with the limit concentration of generation of corrosion of reinforcing rod, Table-8 shows the results of checking the part where the ratio of the chloride ion concentration to the limit concentration of generation of corrosion of reinforcing rod reaches the maximum at the position of reinforcing rod.

Table-8 Checking results of discharge vertical shaft (upper-stream storage)

Target part	Chloride ion concentration at the reinforcing rod position (kg/m^3)	Limit concentration of generation of corrosion of reinforcing rod (kg/m^3)	Chloride ion concentration at the reinforcing rod position/ limit concentration of generation of corrosion of reinforcing rod
Bottom plate	0.06	1.20	0.05
Side wall	0.06	1.20	0.05
Partition wall	0.04	1.20	0.03
Top plate	0.16	1.20	0.13

2.2.2 Discharge vertical shaft (down-stream storage)

Comparing the chloride ion concentration at the reinforcing rod position of the discharge vertical shaft (down-stream storage) with the limit concentration of generation of corrosion of reinforcing rod, Table-9 shows the results of checking the part where the ratio of the chloride ion concentration to the limit concentration of generation of corrosion of reinforcing rod reaches the maximum at the position of reinforcing rod.

Table-9 Checking results of discharge vertical shaft (down-stream storage)

Target part	Chloride ion concentration at the reinforcing rod position (kg/m^3)	Limit concentration of generation of corrosion of reinforcing rod (kg/m^3)	Chloride ion concentration at the reinforcing rod position/ limit concentration of generation of corrosion of reinforcing rod
Bottom plate	0.94	1.84	0.51
Side wall	1.66	1.84	0.90

2.2.3 Discharge tunnel

Comparing the chloride ion concentration at the reinforcing rod position of the discharge tunnel with the limit concentration of generation of corrosion of reinforcing rod, Table-10 shows the results of checking the part where the ratio of the chloride ion concentration to the limit concentration of generation of corrosion of reinforcing rod reaches the maximum at the position of reinforcing rod.

Table-10 Checking results of discharge tunnel

Target part	Chloride ion concentration at the reinforcing rod position (kg/m^3)	Limit concentration of generation of corrosion of reinforcing rod (kg/m^3)	Chloride ion concentration at the reinforcing rod position/ limit concentration of generation of corrosion of reinforcing rod
Lining board (starting section)	1.81	2.19	0.83
Lining board (deepest section)	2.02	2.19	0.92

2.2.4 Discharge outlet

Comparing the chloride ion concentration at the reinforcing rod position of the discharge outlet with the limit concentration of generation of corrosion of reinforcing rod, Table-11 shows the results of checking the part where the ratio of the chloride ion concentration to the limit concentration of generation of corrosion of reinforcing rod reaches the maximum at the position of reinforcing rod.

Table-11 Checking results of discharge outlet

Target part	Chloride ion concentration at the reinforcing rod position (kg/m^3)	Limit concentration of generation of corrosion of reinforcing rod (kg/m^3)	Chloride ion concentration at the reinforcing rod position/ limit concentration of generation of corrosion of reinforcing rod
Bottom plate	1.93	2.00	0.97
Side wall	1.95	2.00	0.98

End

Appendix 2

Description for checking floating

Methods and results of checking for floating of discharge vertical shaft (upper-stream storage) and discharge facility (discharge vertical shaft (down-stream storage) and discharge outlet) are shown.

1. Checking method

1.1 Calculation formula

Consideration of floating shall be carried out by the following equation.

$$Fs = W/U$$

$$U = Vw \cdot \gamma w$$

U: Buoyancy (kN)

W: Vertical load (kN)

Vw: Volume below ground water level (m^3)

γw: Unit volume weight of water (seawater) (kN/m^3)

1.2 Consideration Conditions

Table-1 shows the safety factor against the floating.

Table-1 Safety factor against floating

Load condition in storage (seawater load)	In service
Safety factor against the floating	1.20

2. Checking Results

2.1 Discharge vertical shaft (upper-stream storage)

Table-2 shows the checking results of floating of discharge vertical shaft (upper-stream storage) under conditions where the calculated values are stricter.

Table-2 Checking results of floating of discharge vertical shaft (upper-stream storage)

	At all times
Calculated value	1.48
Safety factor for the floating	1.20

2.2 Discharge vertical shaft (down-stream storage)

Table-3 shows the checking results of floating of discharge vertical shaft (down-stream storage) under conditions where the calculated values are stricter.

Table-3 Checking results of floating of the discharge vertical shaft (down-stream storage)

	At all times
Calculated value	1.68
Safety factor for the floating	1.20

2.3 Discharge outlet

Table-4 shows the checking results of floating of discharge outlet under conditions where the calculated values are stricter.

Table-4 Checking results of floating of discharge outlet

	In waves
Calculated value	1.99
Ascent safety factor	1.20

End

Appendix 3

Schematic diagram of discharge vertical shaft (upper-stream storage) and discharge facility (discharge vertical shaft (down-stream storage), discharge tunnel and discharge outlet)

A schematic diagram of the discharge vertical shaft (upper-stream storage) and discharge facility (discharge vertical shaft (down-stream storage), discharge tunnel and discharge outlet) is shown.

1. Discharge vertical shaft (upper-stream storage)

Schematic diagrams of the dimensions, installation and assembly of the discharge vertical shaft (upper-stream storage) are shown in Figures-1 to 3.

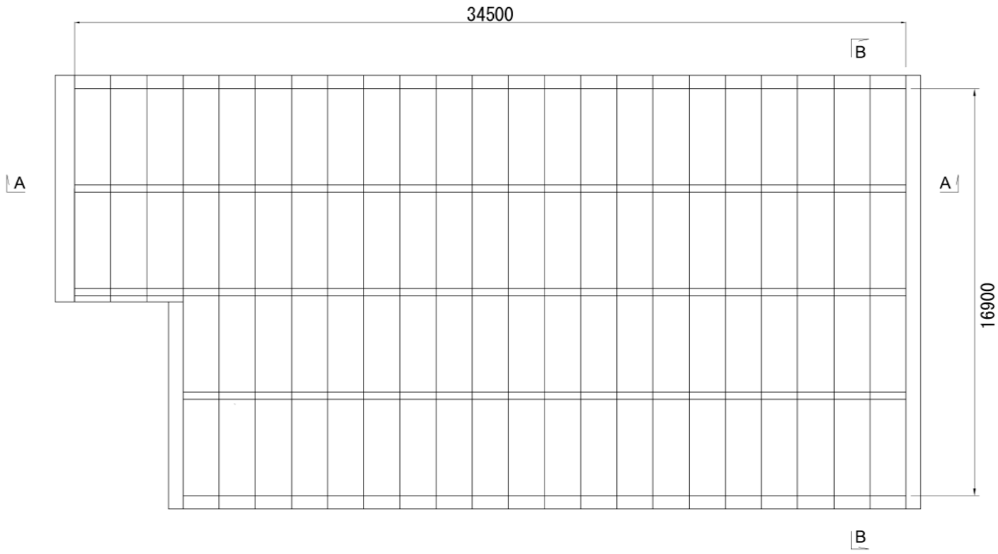


Figure-1 Top view of the discharge vertical shaft (upper-stream storage)

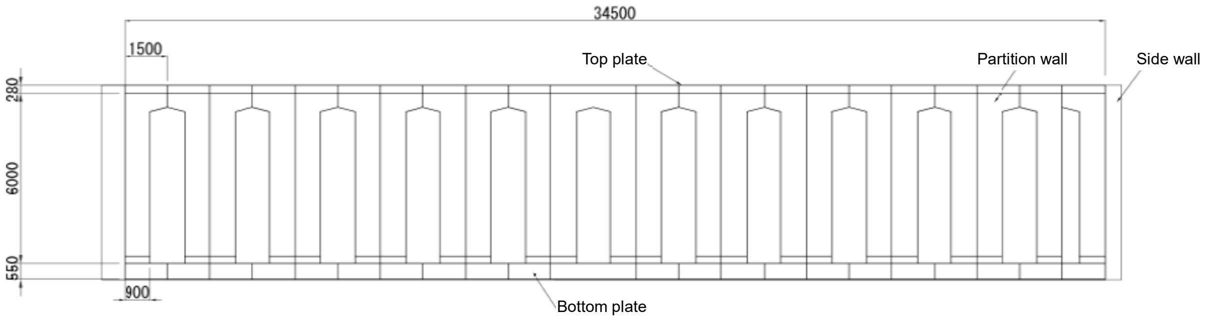


Figure-2 A-A cross-sectional view

The Japanese version shall prevail.

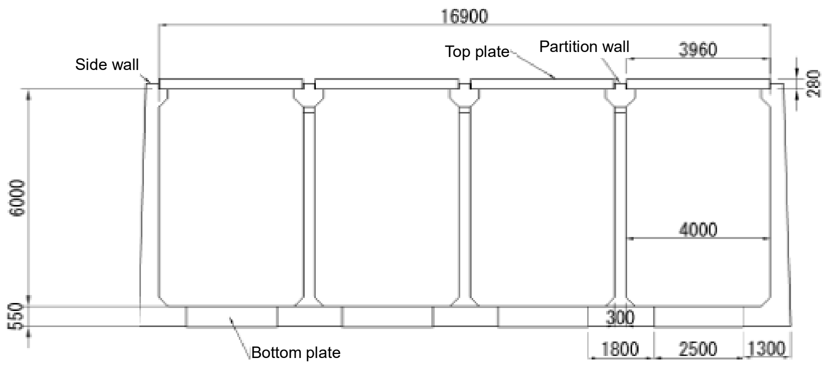


Figure-3 B-B cross-sectional view

2. Discharge facility

2.1 Discharge vertical shaft (down-stream storage)

Schematic diagrams with the dimensions of the discharge vertical shaft (down-stream storage) are shown in Figures-4 to 6.

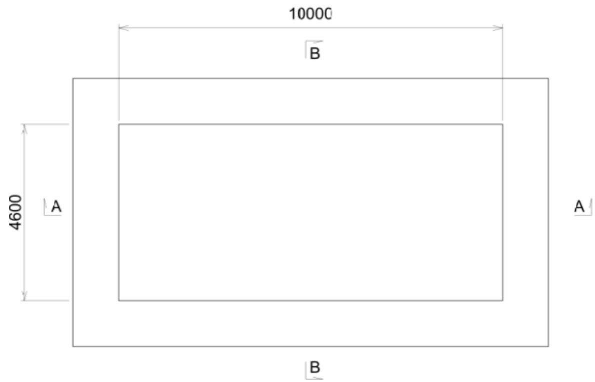


Figure-4 Top view of the discharge vertical shaft (down-stream storage)

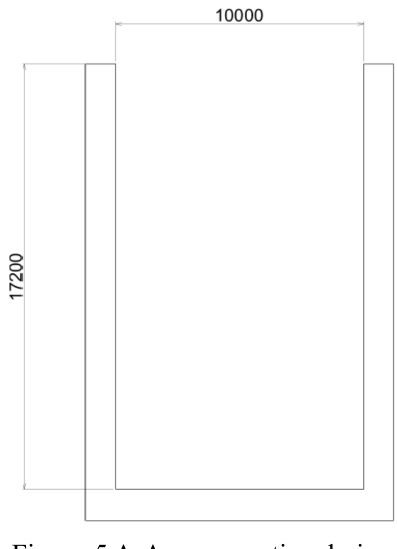


Figure-5 A-A cross-sectional view

The Japanese version shall prevail.

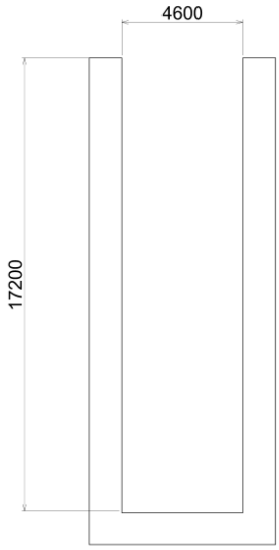


Figure-6 B-B cross-sectional view

2.2 Discharge tunnel

Schematic diagrams of the dimensions, installation and assembly of the discharge tunnel are shown in Figures-7 to 9.

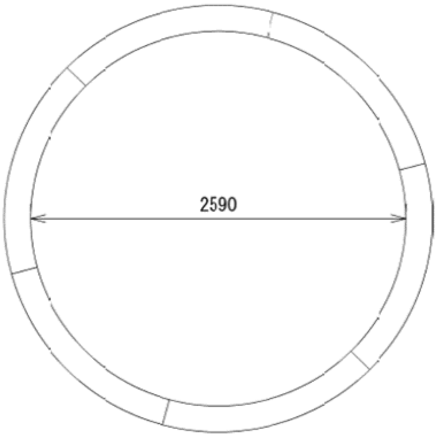


Figure-7 Cross-sectional view of discharge tunnel

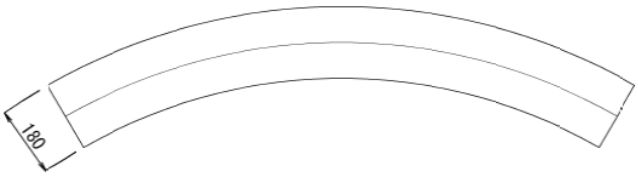


Figure-8 Typical cross-sectional view of segment (circumferential direction)

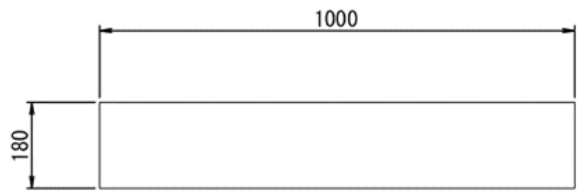


Figure-9 Typical cross-sectional view of segment (axial direction)

2.3 Discharge outlet

A schematic diagram of the dimensions of the discharge outlet is shown in Figures-10 to 12.

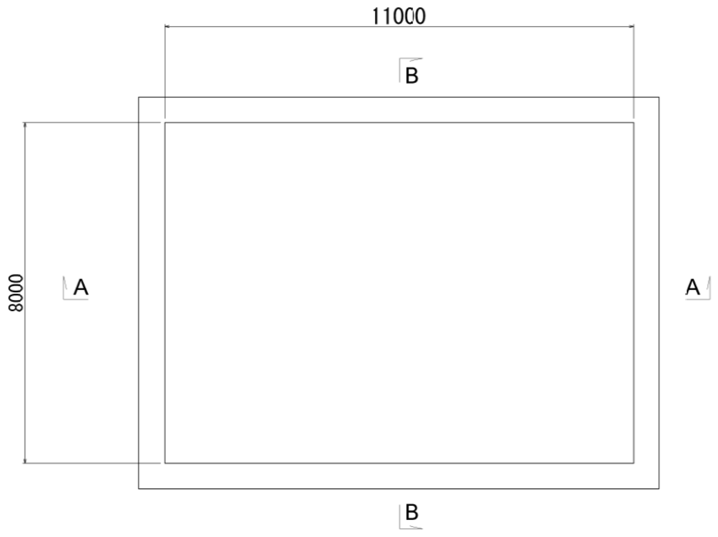


Figure-10 Top view of discharge outlet

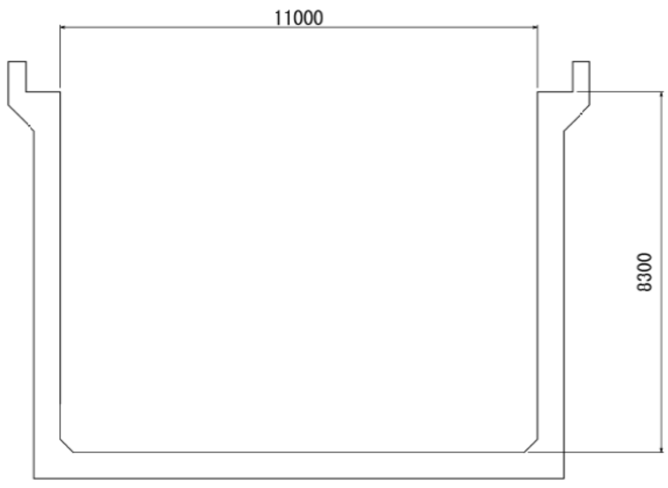


Figure-11 A-A cross-sectional view

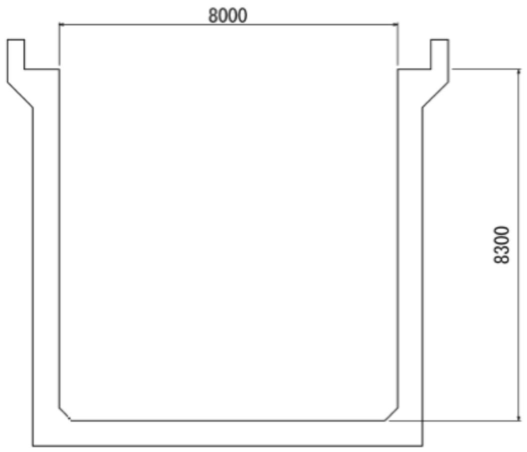
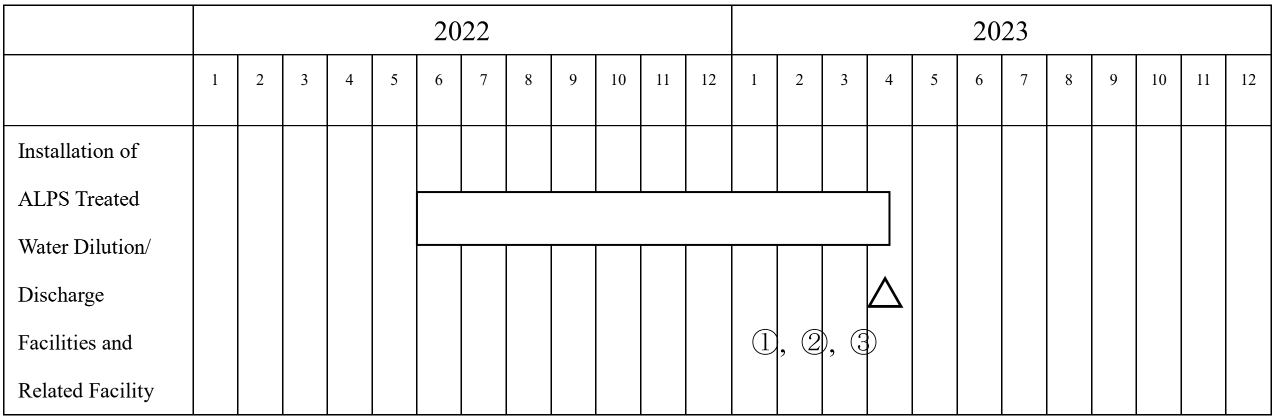


Figure-12 B-B cross sectional view

End

The Japanese version shall prevail.

Construction schedule



: On-site installation and assembly

①: When tests related to structure, strength, or leakage are ready to be conducted

②: When the equipment assembly is completed.

③: When the construction work related to the construction plan is completed

Items for consideration on testability

The components installation is designed considering future maintenance. For facility maintenance management, a long-term inspection plan is prepared, and the inspection is carried out based on the inspection plan.
The components to be installed this time is adjusted to the pre-use inspection item, and the following is considered for the inspection of the representative components:

(1) ALPS treated water dilution/discharge facilities

a. Tank

· External and internal inspections

It shall be designed to enable internal inspection with installing an access port for inspection in the top plate and side part of the tank.

b. Pipe

· External and flange inspection

It shall be designed to enable inspection of replacement such as gasket at a flange (seal) part.

c. Flowmeter

· Performance correction check

It shall be designed to enable checking an output value for a reference input value, and calibration within an instrument error.

d. Emergency isolation valve (including logic circuit)

· Emergency isolation check

It shall be designed to enable confirming an activation signal of an emergency isolation valve occur by an input signal.

· Replacement and operation inspections

It shall be designed to make the valve body replaceable.

e. Seawater pipe header

· It shall be designed to enable internal inspection by installing a maintenance hole for inspection.

f. Pump and valve

· External/disassembly inspections, replacement, and function check

It shall be designed to enable disassembly inspection and replacement.

g. Discharge vertical shaft (upper-stream storage)

· External and internal inspections

It shall be designed to enable internal inspection by installing an inspection port for inspection in the discharge vertical shaft (upper-stream storage).

Furthermore, spare parts are secured for components, such as seawater transfer pump and orifice type flowmeter, that meets the following conditions:

· Components flooded by Japan Trench Tsunami excluding pipe

· Components, which is essential for operation of facilities, without back-up series/components

· Components that takes more than half a year

(2) Discharge facility

a. Discharge vertical shaft (down-stream storage), discharge tunnel, and discharge port

· External and internal inspections

It shall be designed to enable internal inspection from the discharge vertical shaft (down-stream storage) or discharge port.

· Request function check

The discharge vertical shaft (down-stream storage), discharge tunnel, and discharge port are filled with seawater as an integrated structure, and the structure that is connected with the tide level of the open sea is adopted. Based on these, it shall be designed to enable confirming that there is no significant water level fluctuation in the discharge vertical shaft (upper-stream storage) and that the required functions are satisfied.

End

Part 2

(Security Measures regarding Units 5 and 6)

(Refer to comparison table for any amendments)

The Japanese version shall prevail.

1.9 Operation Management of the ALPS Treatment Water Dilution/Discharge Facilities

1.9.1 Overview

When discharging ALPS treated water, which satisfies criteria of less than 1 for sum of the ratios to regulatory concentrations limits of radioactive nuclide except tritium, out of the radioactive liquid waste treated in the radioactive liquid waste treatment facility, concentration of radioactive materials shall be lowered by diluting it with large amount of sea water in order to lower the effective dose as low as achievable at the premise boundary. Therefore, operation management of the ALPS treated water dilution/discharge facility shall satisfy following items.

- To enable collection of representative samples, operation duration of the circulation and agitation is appropriately set based on the circulation agitation demonstration test using sodium triphosphate as a reagent. And, in order to reduce inhomogeneous concentration of tritium in the tank before the circulation and agitation, ALPS treated water to be received in the measurement/confirmation facility shall be planned not to have large difference in tritium concentration.
- To dilute the ALPS treated water 100 times or more by seawater, operation shall be controlled to keep flow rate of the ALPS treated water 500 m^3/day at a maximum (minimum flow rate (annual average) shall be equal or more than generated volume of the contaminated water) based on the tritium concentration measured and confirmed in the measurement/confirmation process, using ALPS treated water transfer pumps, ALPS treated water flow rate control valves, ALPS treated water flowmeter, etc.; and two or more seawater transfer pumps (170 thousand m^3/day/unit) shall always be kept in operation. Further, to confirm the expected dilution in discharge vertical shaft (upper-stream storage) and the secure operation under the operation procedure, discharge shall be carried out cautiously with small volume in the early stage.
- To make mixing/diluting effect large enough to lower the tritium concentration in the seawater after the dilution to less than 1,500 Bq/L, upper limit of the tritium concentration in the ALPS treated water to be discharged into the sea shall be 1 million Bq/L, the tritium concentration (operational value) of discharged water is set based on uncertainty throughout the sea discharging process and results of numerical simulations.
- To keep annual discharge amount of tritium, stay within the range of 22 trillion Bq, annual discharge plan of the ALPS treated water shall be prepared each fiscal year and the discharge shall follow the plan. Further, annual discharge plan shall be reviewed periodically with consideration of whole risk for decommissioning.

To satisfy these items, specific operation management of the ALPS treatment water dilution/discharge facility shall be carried out as follows.

1.9.2 Operation management of ALPS treated water dilution/discharge facility

In the ALPS treated water dilution/discharge facility, three processes of (1) receiving, (2) measurement/confirmation, and (3) discharge of ALPS treated water are carried out. (see Figure-1).

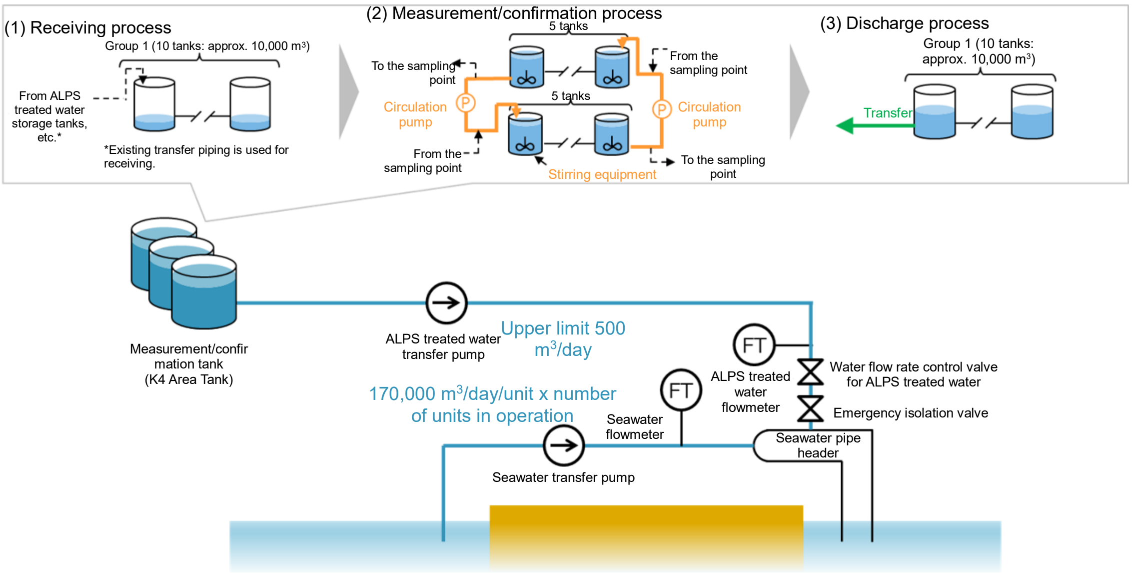


Figure-1 Process overview of ALPS treated water dilution/discharge facility

1.9.2.1 Operation process of ALPS treated water dilution/discharge facility

Process overview of (1) Receiving, (2) Measurement/confirmation, and (3) Discharge is as follows.

(1) Receiving process

Execution of "Receiving Process" of the monitoring/control device make the valve lining-up for the measurement/confirmation facility, and the ALPS treated water is received in the tank for measurement/confirmation.

(2) Measurement/confirmation process

Execution of “Measurement/confirmation Process” of the monitoring/control device make the valve lining-up of the measurement/confirmation facility, and starts up agitation equipment and circulation pumps, making water quality of tanks homogenized. Water is sampled for analysis after the predetermined operation period is elapsed for the circulation and agitation.

(3) Discharge process

Execution of “ALPS treated water Transfer Process” after starting up seawater transfer pumps by monitoring/control device and after registration of tritium concentration measurement results of ALPS treated water in (2) measurement/confirmation process, make the valve lining-up of the measurement/confirmation facility and the transfer facility, and the ALPS treated water is discharged.

Discharge operation is by a key switch so that any erroneous operation is prevented.

1.9.2.2 Operation of tank groups for the measurement/confirmation facilities

For measurement/confirmation facility, the operation is carried out in 3 tank groups with 10 tanks as 1 group. Each of 3 tank groups in turn goes through processes of (1) Receiving, (2) Measurement/confirmation, and (3) Discharge as mentioned above rotationally. (See Figure-2)

	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

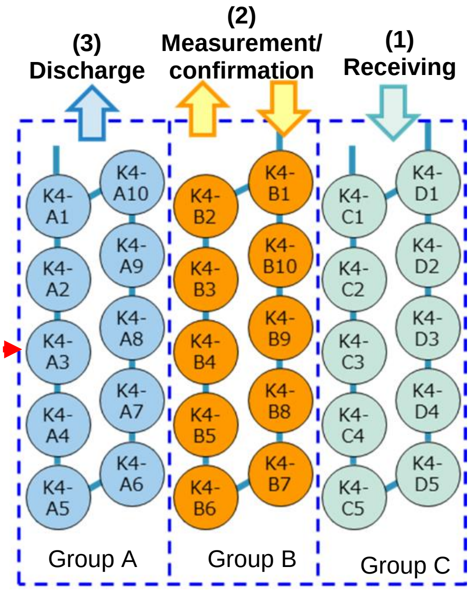


Figure-2 Example of receiving, measurement/confirmation, and discharge process rotation

1.9.2.3 Basic procedures in receiving, measurement/confirmation, and discharge processes

(1) Receiving, (2) measurement/confirmation, and (3) discharge processes mentioned in 1.9.2.2 shall be operated according to the procedure shown in Figure-3. An interlock is embedded to block proceeding to the next process without completing the prior process, by checking the completion by monitoring/control device.

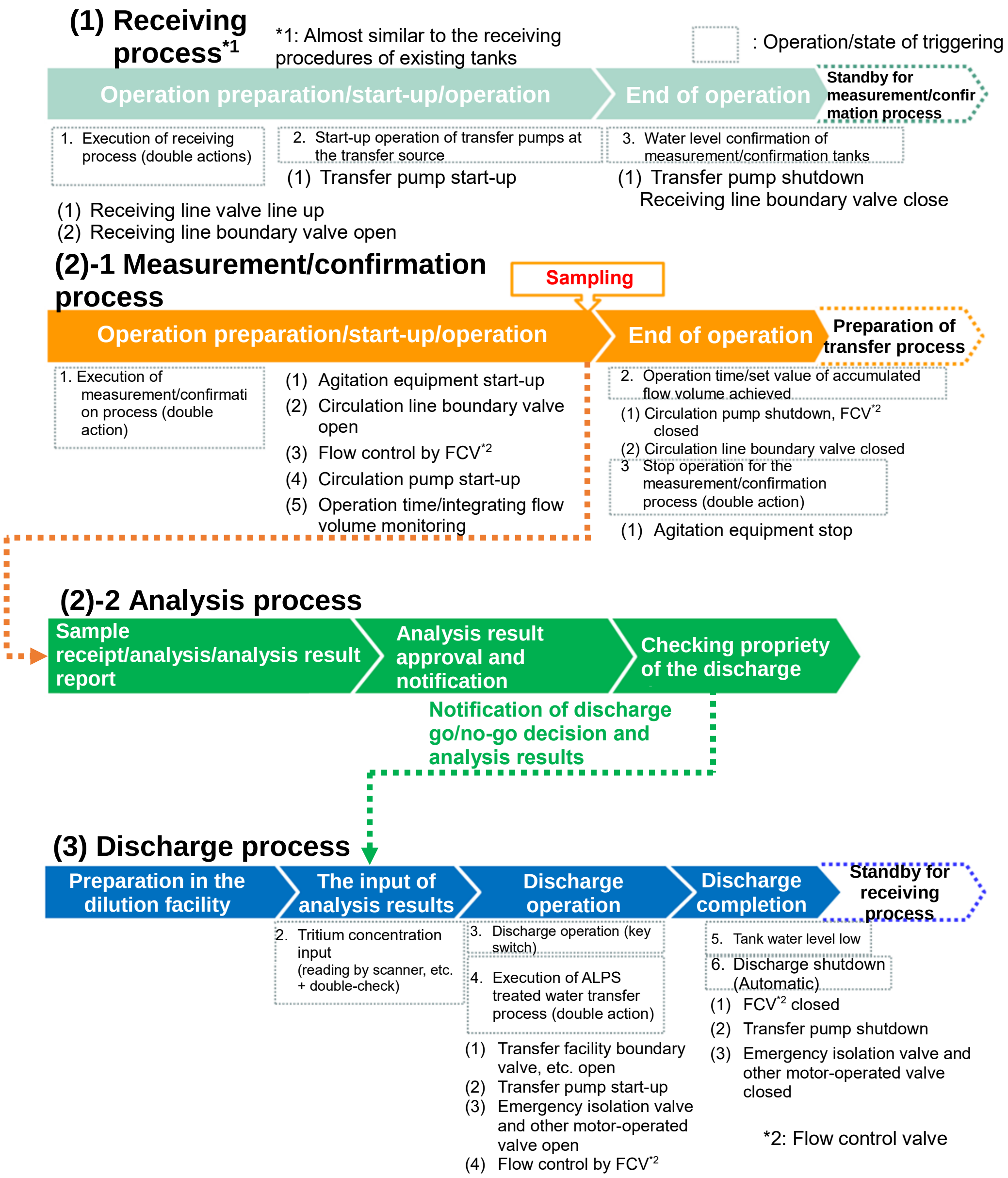


Figure-3 Procedures of receiving, measurement/confirmation, and discharge process

The Japanese version shall prevail.

1.9.2.4 Operation procedures of measurement/confirmation process

In the measurement/confirmation process, once a target tank group is selected using the monitoring/control device and the process is executed, the rest will move on automatically based on the measurement/confirmation process flow (see Figure-4). Figures-5 to 7 show status of facility in the measurement/confirmation process.

In this process, to enable collection of representative samples, based on the prior demonstration test results, operation duration of circulation/agitation for measurement/confirmation tanks shall be in principle two rounds or more of tank water volume. However, validations shall be made as appropriate after the start of the actual service, and if the circulation and agitation can be confirmed to be enough, this will not always be the case.

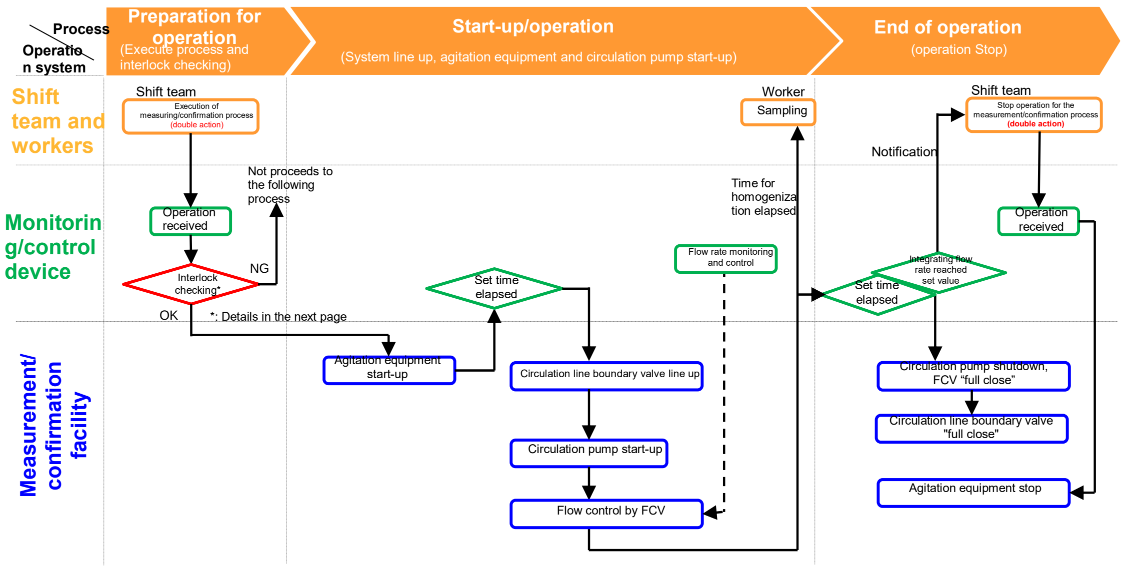


Figure-4 Flow of measurement/confirmation process

The Japanese version shall prevail.

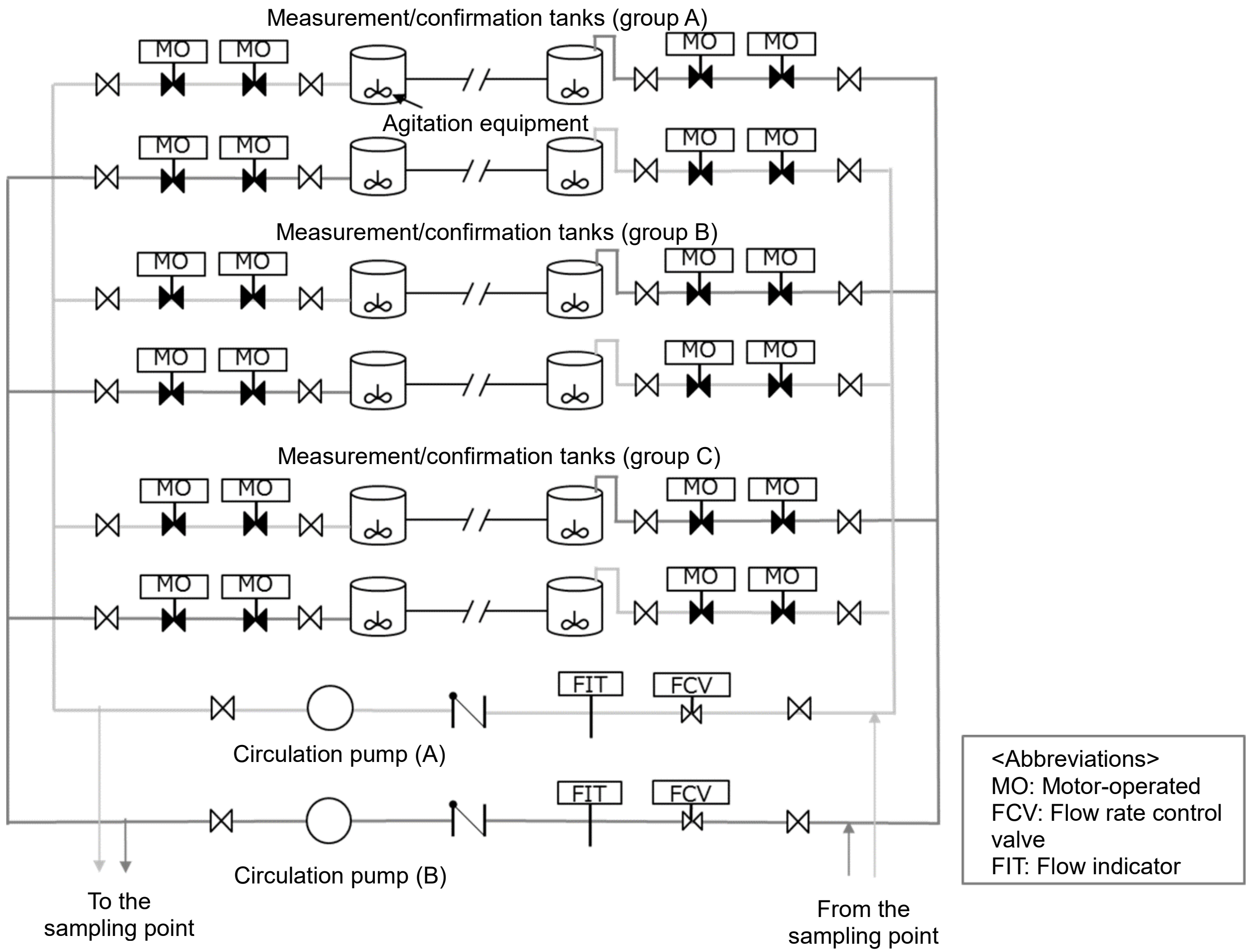


Figure-5 Status of facility in the measurement/confirmation process (before start-up)

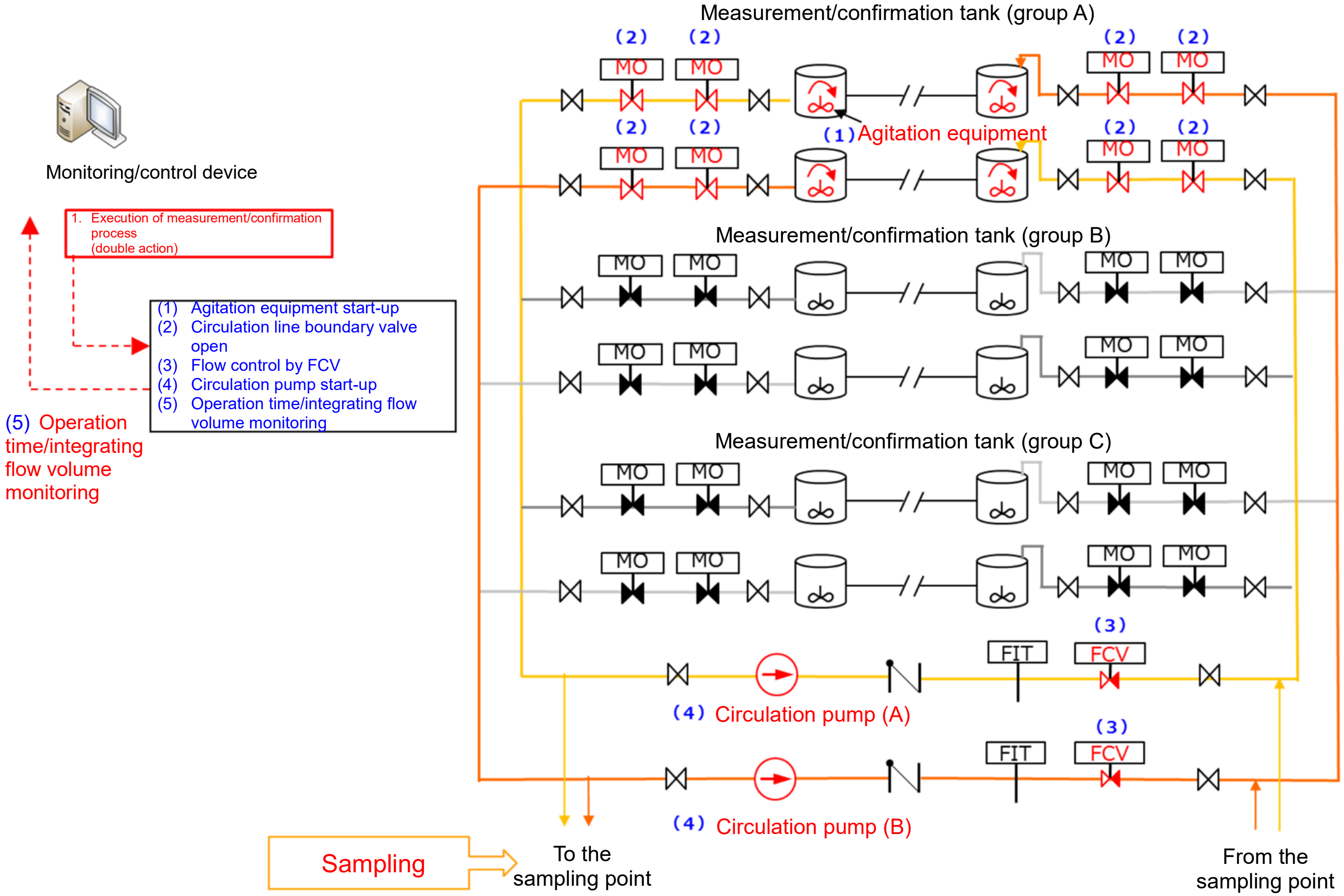


Figure-6 Status of facility in the measurement/confirmation process (from start-up to operation)

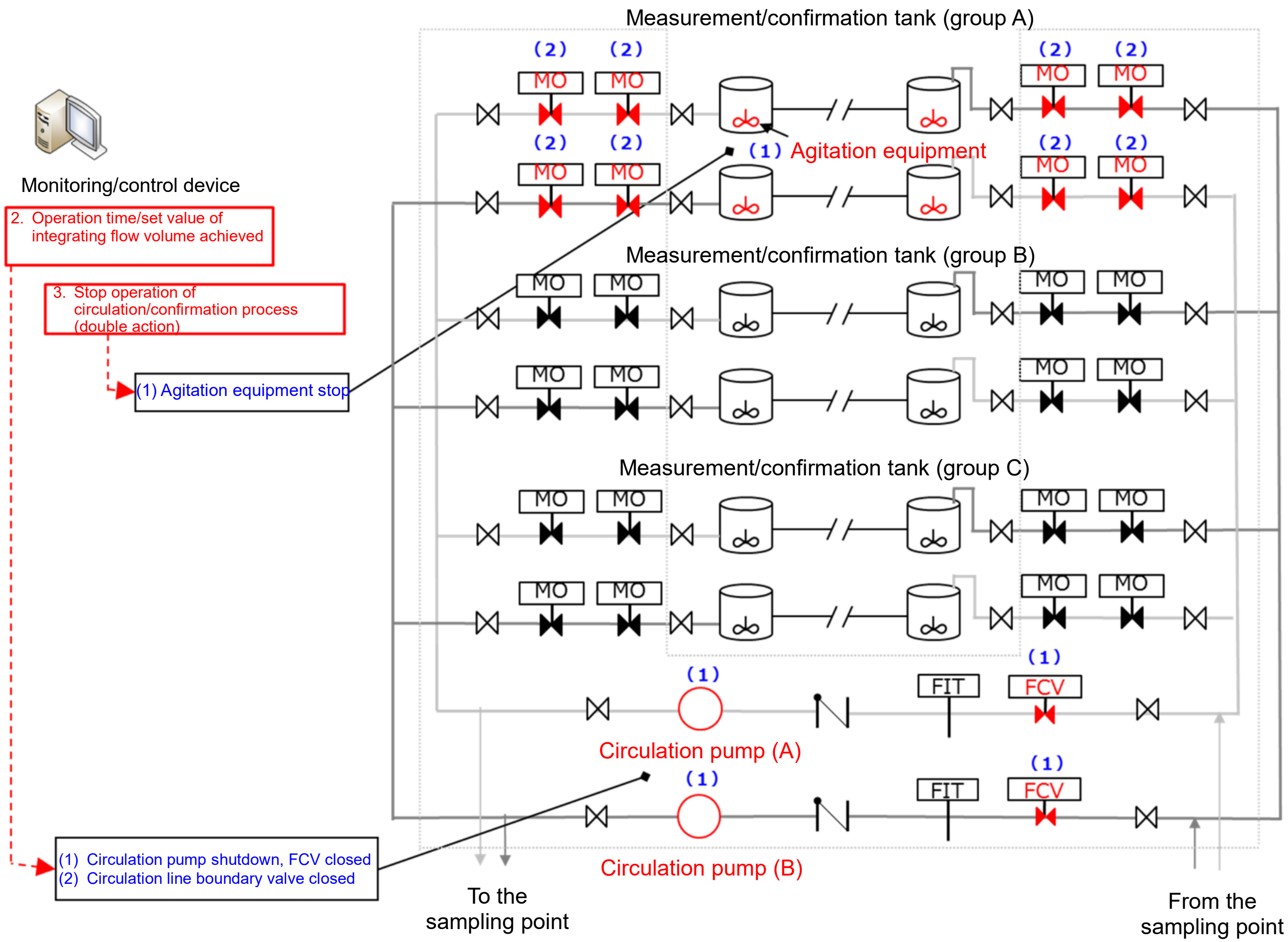


Figure-7 Status of facility in the measurement/confirmation process (from operation to shutdown)

1.9.2.5 Operation procedures of the discharge process

In the discharge process, tritium concentration of the ALPS treated water is registered in the monitoring/control device, and the ALPS treated water transfer flow rate is set within the range of maximum 500 m^3/day (minimum flow rate (annual average) is equal to or more than generated volume of the contaminated water) so that the tritium concentration contained in the seawater after the dilution becomes less than the operation limit of 1,500 Bq/L.

The tritium concentration confirmed in the analysis of measurement/confirmation process is read mechanically by a scanner, etc., in order to prevent human errors, and is registered in monitoring/control device. The monitoring/control device automatically calculates the ALPS treated water transfer flow rate from the registered tritium concentration and sea water flow rate.

From the preparation of the dilution facility to the start of the ALPS treated water discharge, the discharge process flow (see Figure-8) shall be followed.

The monitoring/control device determines go/no-go of the discharge from the viewpoint of whether the tritium concentration after the dilution against seawater dilution volume satisfies the operation limit. The operation shift team proceeds to discharge operation using the key switch after confirming by the monitoring/control device the subject ALPS treated water is OK to discharge and discharge operation is ready.

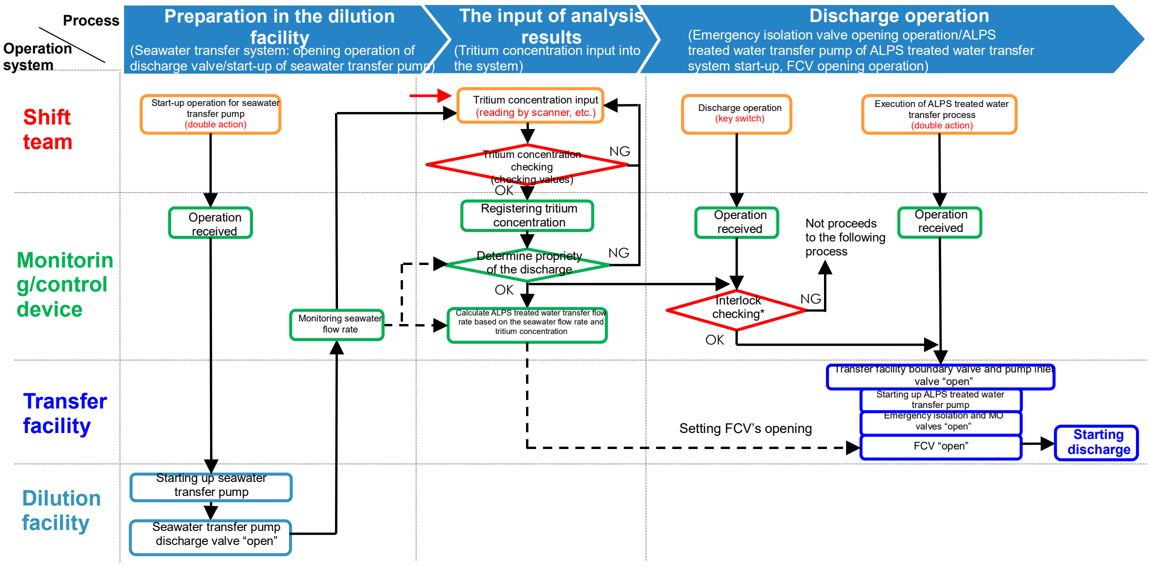


Figure-8 Flow of discharge process

Because tritium concentration of ALPS treated water stored in the storage tanks of ALPS treated water, etc. varies from 150 thousand to 2,160 thousand Bq/L (as of April 2021), exceeding the operation limit of 1,500 Bq/L, dilution by seawater is required.

As the seawater transfer pumps are to be operated with steady flow rate, dilution ratio adjustment shall be carried out using equipment such as ALPS treated water transfer pumps, ALPS treated water flow rate control valves and ALPS treated water flowmeters. Here, to secure enough mixing and dilution effect as obtained from the numerical simulation, two or more seawater transfer pumps shall be planned to be operated.

Tritium concentration after the dilution by seawater shall be assessed from ALPS treated water tritium concentration measured and confirmed by the measurement/confirmation facility, ALPS treated water flow rate, and seawater flow rate as shown in Figure-9. On the other hand, in the actual operations, predetermined dilution rate shall be realized by adjusting opening of ALPS treated water flow rate control valves based on assessment of tritium concentration after the seawater dilution for which a target value (operational value) is determined in advance, as shown in Figure-10.

○ **Assessment formula for tritium concentration**

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

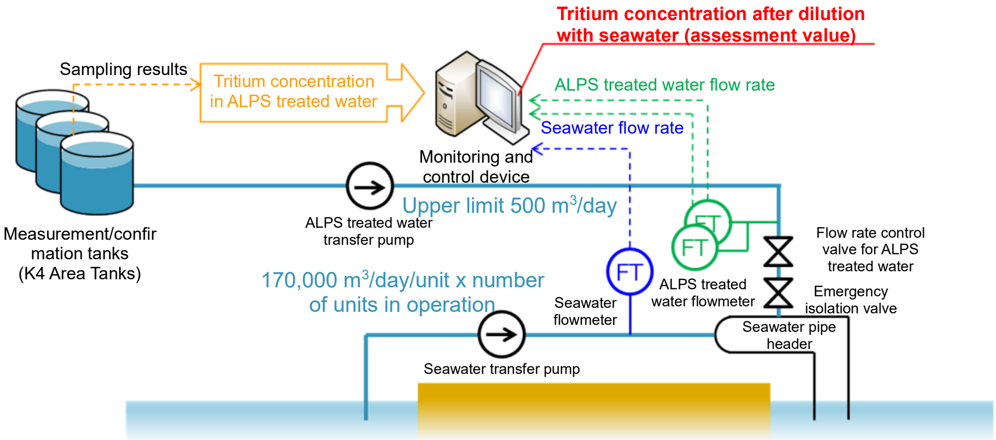


Figure-9 Assessment formula for tritium concentration after the seawater dilution

○ **Calculation formula of ALPS treated water flow rate**

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

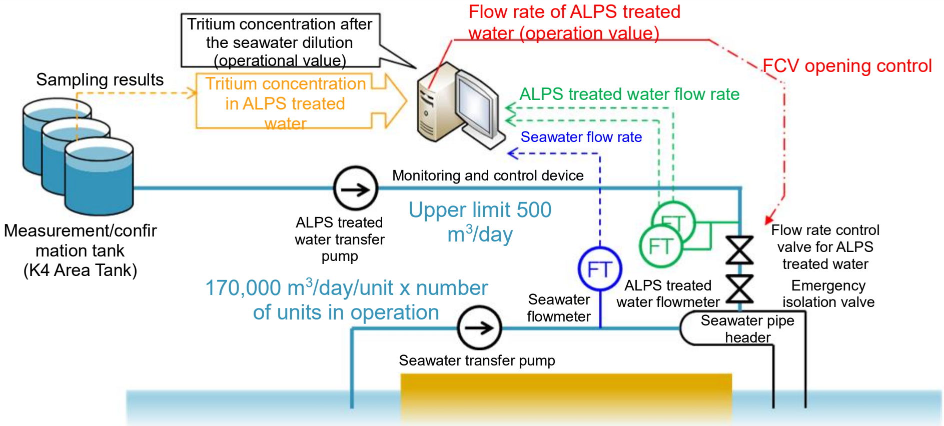
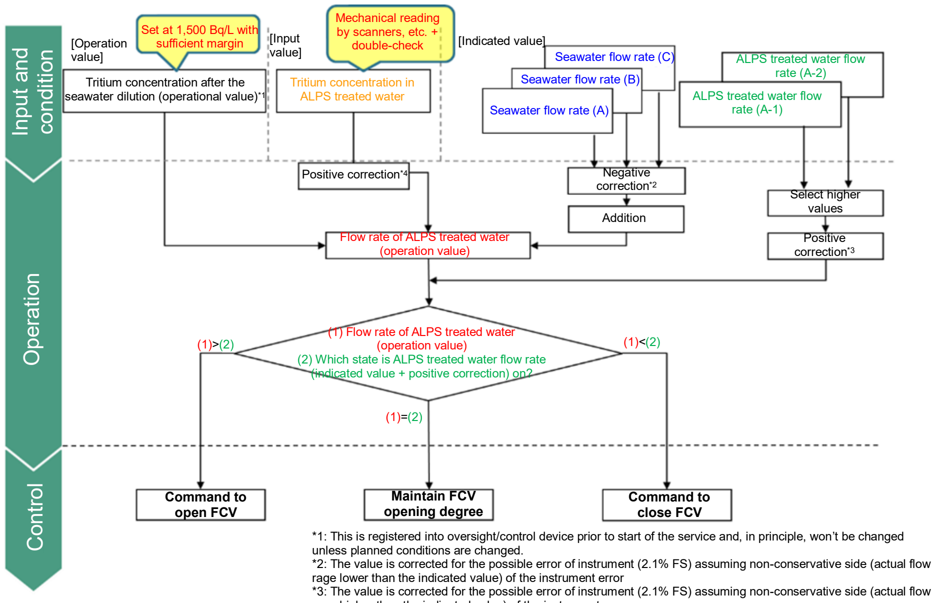


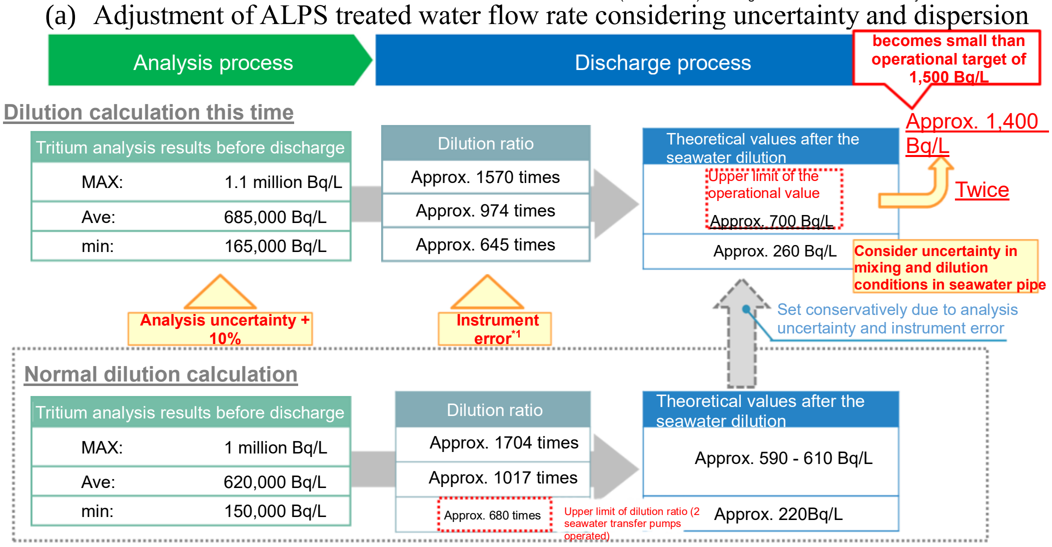
Figure-10 Adjustment of dilution ratio (ALPS treated water flow rate)

As certain uncertainties and dispersion have been identified in the study for discharge of ALPS treated water into the sea, tritium concentration after the seawater dilution (operational value) shall be set so that tritium concentration at the time of discharge will not exceed 1,500 Bq/L even if all the uncertainties and dispersion work for the higher side of the tritium concentration, as shown in Figure-11.



*1: This is registered into oversight/control device prior to start of the service and, in principle, won't be changed unless planned conditions are changed.
*2: The value is corrected for the possible error of instrument (2.1% FS) assuming non-conservative side (actual flow rage lower than the indicated value) of the instrument error
*3: The value is corrected for the possible error of instrument (2.1% FS) assuming non-conservative side (actual flow rage higher than the indicated value) of the instrument error
*4: The value is corrected for uncertainties (tentative 10%) assuming non-conservative side of analysis uncertainties.

(a) Adjustment of ALPS treated water flow rate considering uncertainty and dispersion



*1: ALPS treated water flow meter and seawater flow meter are conservatively considered when calculating the dilution.

(b) Calculation example of tritium concentration considering uncertainty and dispersion

Figure-11 Dilution ratio adjustment considering uncertainties and dispersion

Figures-12 to 16 show facilities status in the discharge process.

The Japanese version shall prevail.

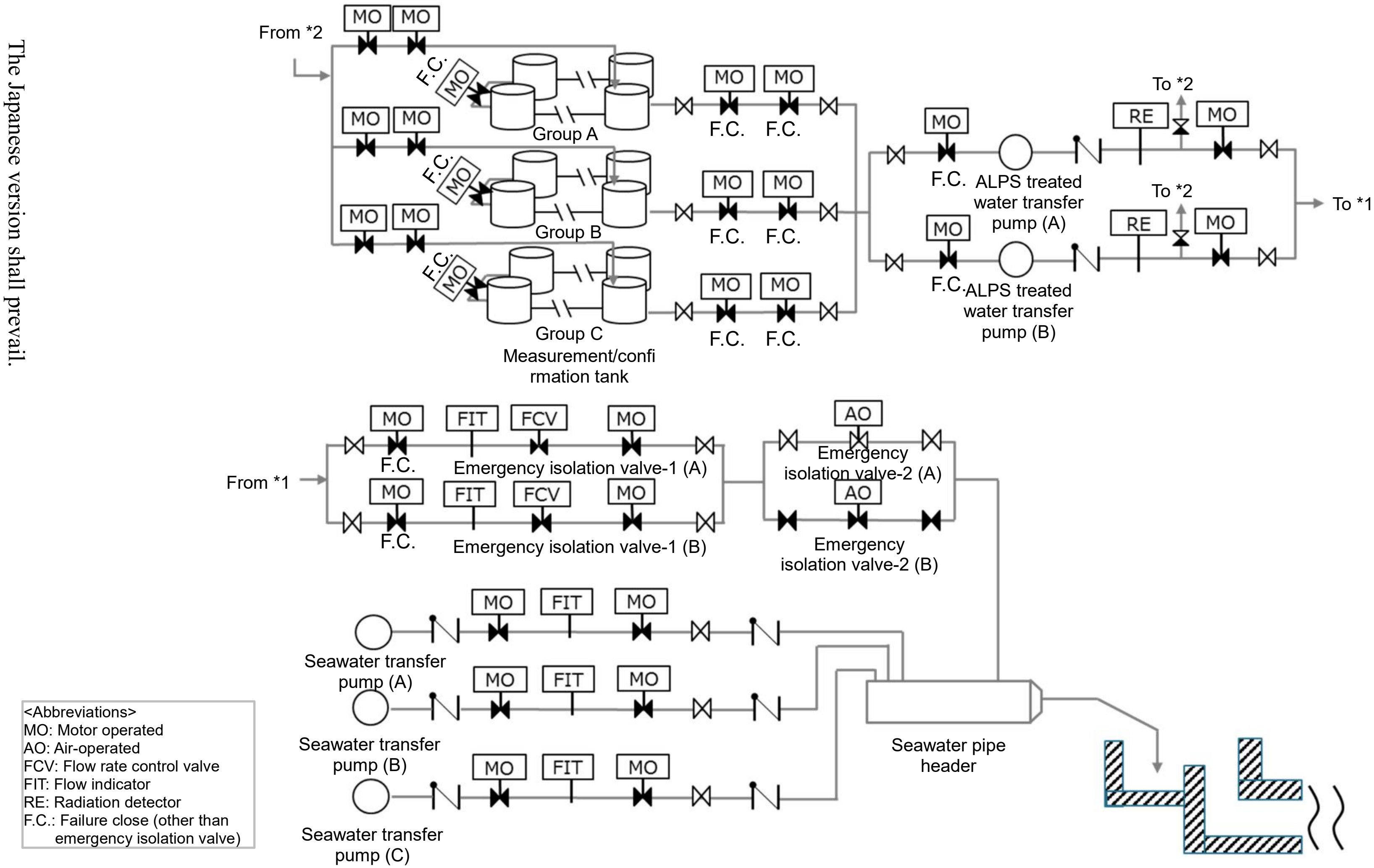


Figure-12 Facilities status in the discharge process (before start-up)

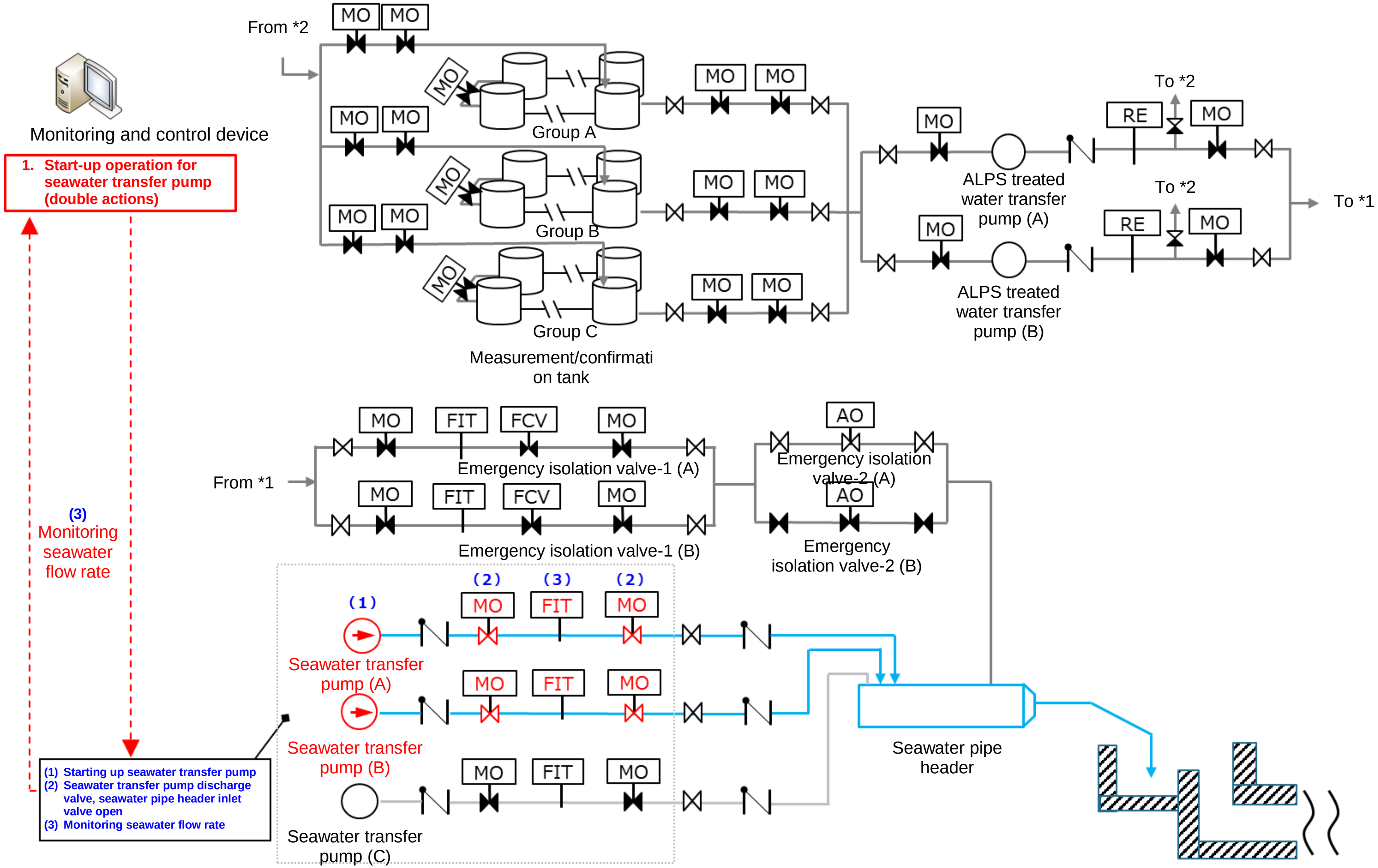


Figure-13 Facilities status of the discharge process (start-up dilution facility)

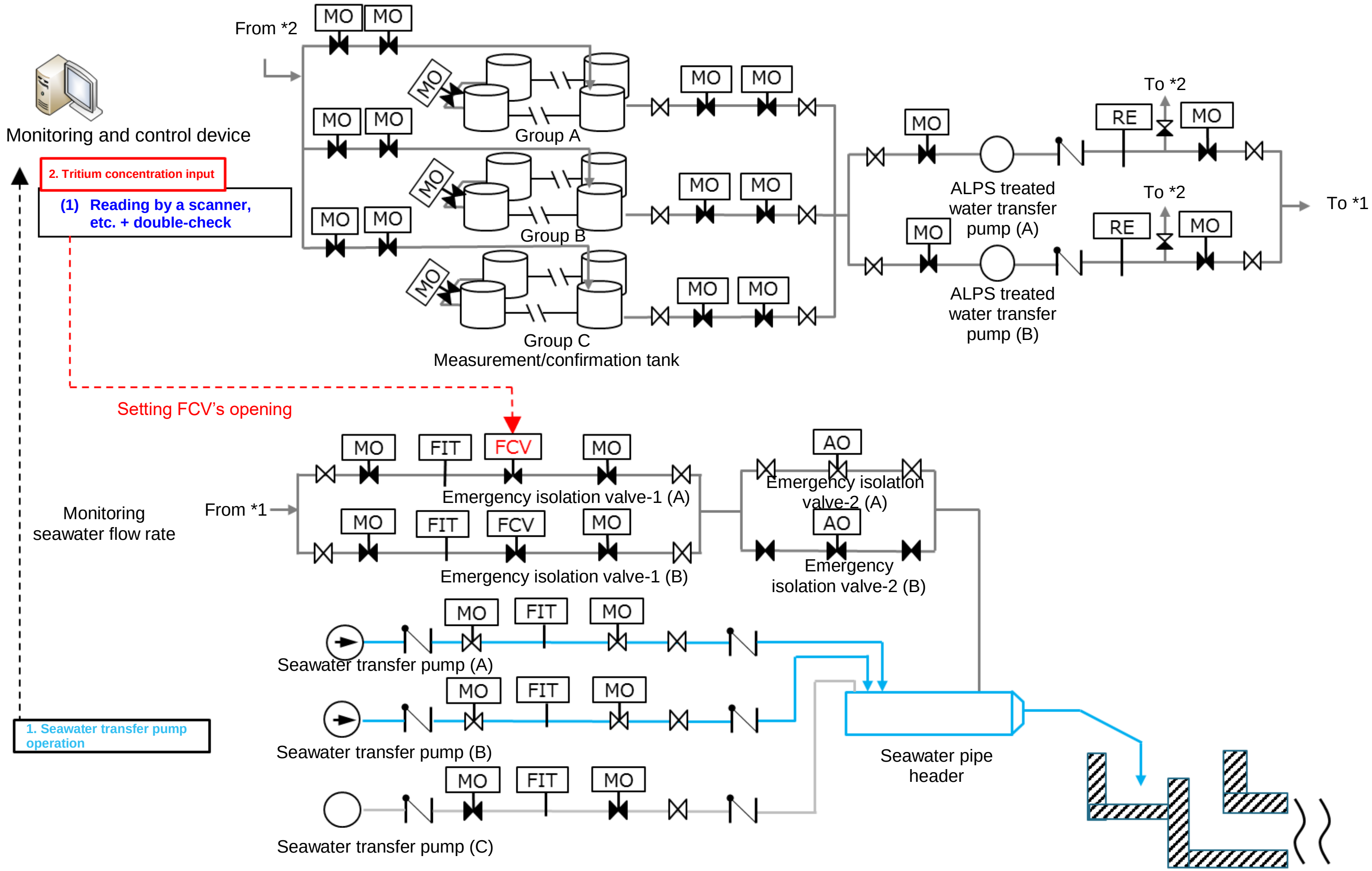


Figure-14 Facilities status of the discharge process (from tritium concentration input to FCV opening set)

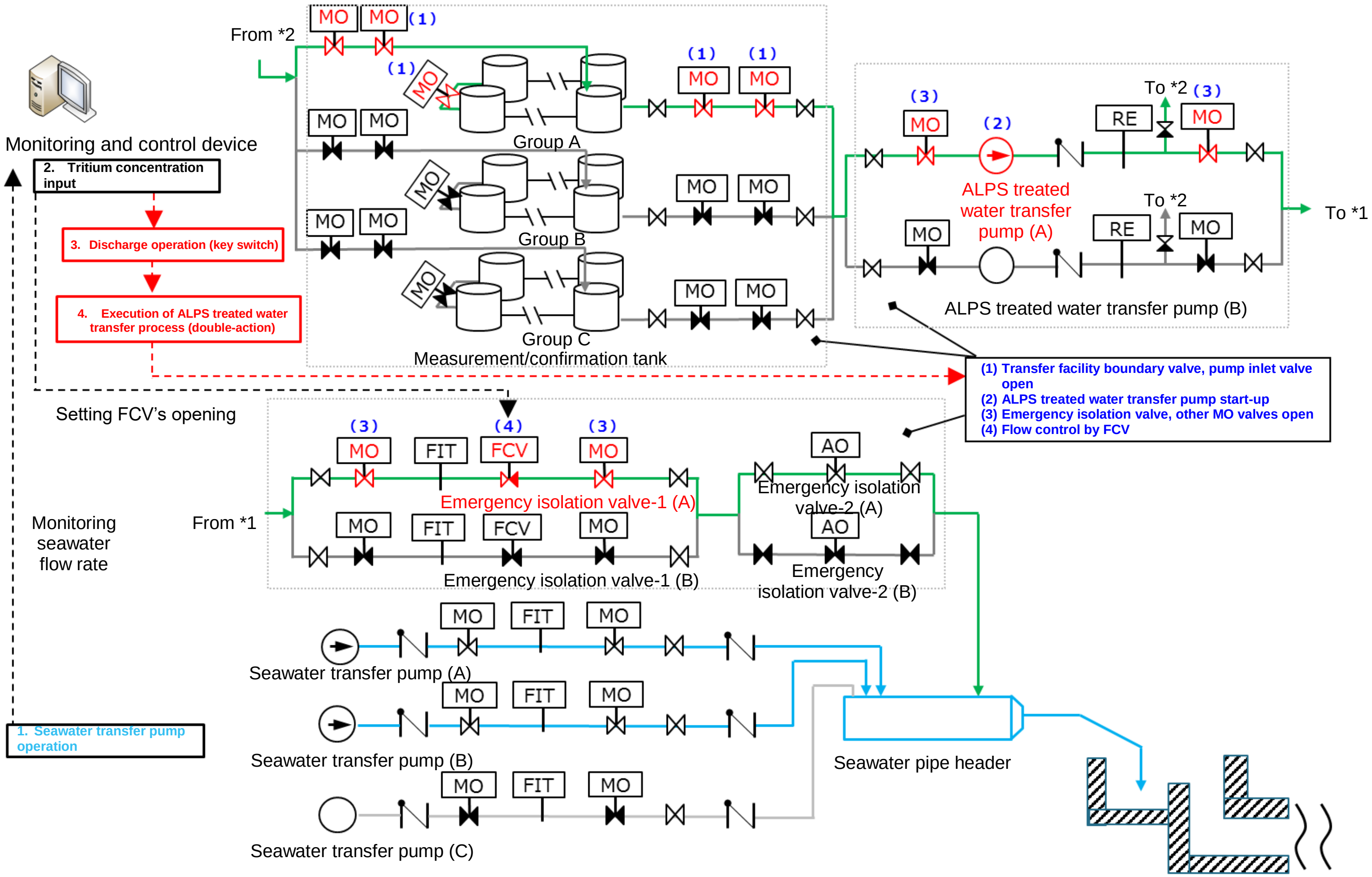


Figure-15 Facilities status of the discharge process (from discharge operation to ALPS treated water transfer start)

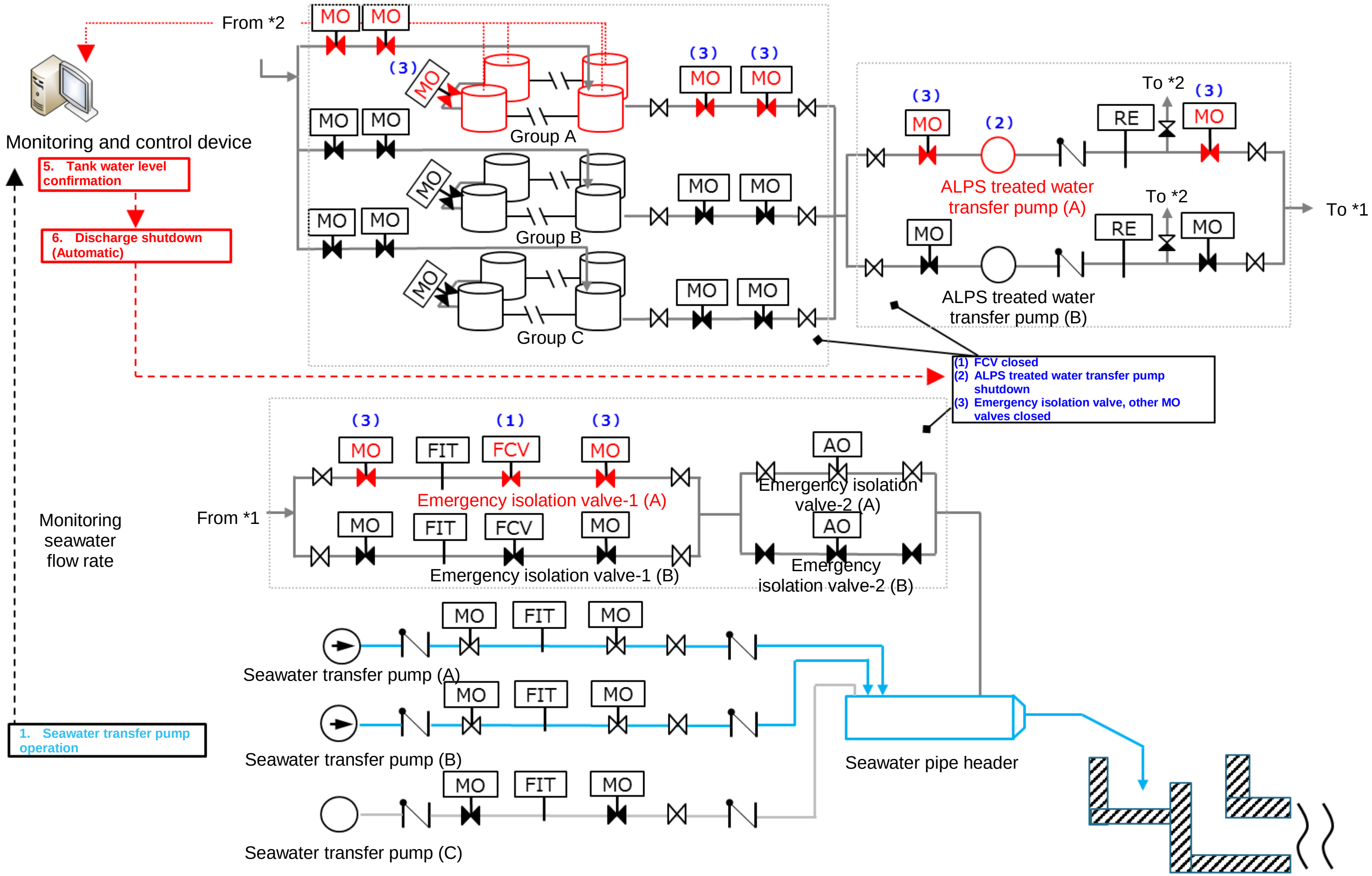


Figure-16 Facilities status of the discharge process (from discharge completion to facility shutdown)

1.9.3 Measures to abnormal occurrence, etc.

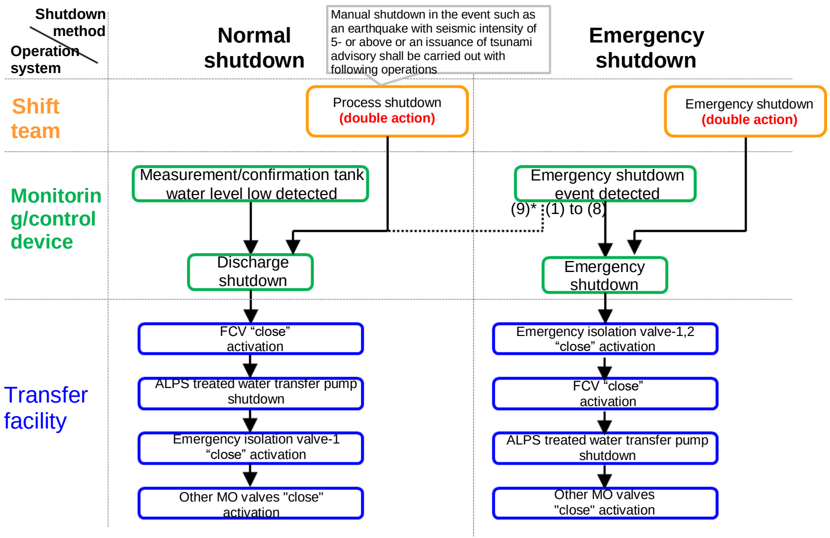
Other than shutdown after normal operations, ALPS treated water dilution/discharge facility shall make an emergency shutdown of the discharge into the sea by automatic activation of the emergency isolation valves or by manual operation by operators when such an event occurs that can lead to "unintentional discharge of ALPS treated water into the sea."

In addition to the above, discharge of ALPS treated water into the sea shall be shut down as required when performance of facilities required to prevent or end "unintentional discharge of ALPS treated water into the sea" cannot be confirmed through inspections, etc., and its immediate recovery is determined to be difficult.

Two types exist in the shutdown of the discharge into the sea, which are normal shutdown and emergency shutdown, and as Figure-17 shows, these types differ only in order of activation of the emergency isolation valves and have design of almost similar facilities with shutdown/operation instructions (see Figure-18 for detailed status of the facilities of emergency shutdown).

Following events are assumed for the normal shutdown operations.

- When a natural phenomenon etc., occurs which can impact ALPS treated water dilution/discharge facilities and its related facility
- When abnormal values are detected in sea area monitoring
- When the Shift Supervisor determines necessary



Emergency shutdown event

[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] Both series of emergency isolation valve panel communication abnormalities

* Since "[9] Both series of emergency isolation valve panel communication abnormalities" is supposed that communication abnormality of control panel for emergency isolation valve and operation of system is expected no failure, we plan the same suspending process as normal shutdown operation

Figure-17 Normal and emergency shutdown flows during the discharge process

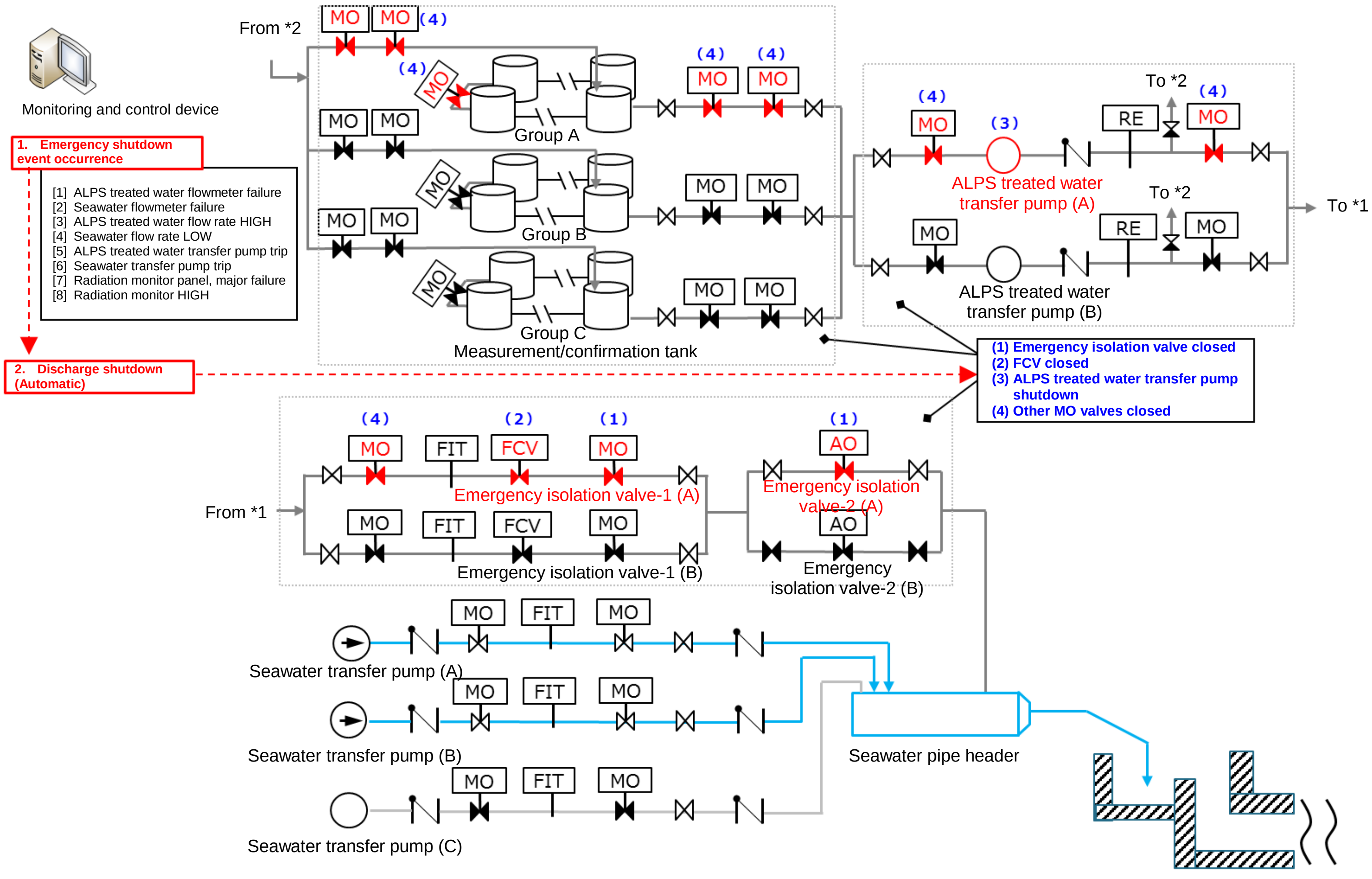


Figure-18 Facilities status of the discharge process (emergency shutdown)

Natural phenomena which may impact ALPS treated water dilution/discharge facilities and related facility mentioned before are assumed as Table-1.
In order to detect these natural phenomena, operators check information of earthquakes and tsunamis through the internet, FAX from the central power feed command center, commercial television, etc., and shutdown the ALPS treated water discharge by following normal shutdown procedures of the ALPS treated water dilution/discharge facilities.
When the Shift supervisor determines the facility needs to be shut down in situations such that other natural phenomenon damages the facility, leading to possible “unintentional discharge of ALPS treated water into the sea,” ALPS treated water discharge shall be shut down.

Table-1 Natural phenomena which lead to shutdown of the discharge into the sea

No.	Events that lead to manual shutdown	Reason for shutdown
1	Earthquakes with a seismic intensity of 5- or above	To minimize the impact of functional loss of the facility caused by an earthquake
2	Tsunami advisory	Because of the risk of getting the facility on T.P. 2.5m damaged by tsunamis
3	Tornado advisory	Because of the risk of each facility getting damaged by tornadoes
4	High tide warning	Because of the risk of the discharge into the sea by water head as designed blocked
5	Other	Other than 1 to 4 above, to shut down the discharge into the sea when there is symptom of anomaly and the Shift supervisor determines necessary

1.9.4 Management of annual discharge amount of tritium

In the ALPS treated water discharge into the sea, to keep the tritium discharge amount stay within the range of 22 TBq per year, management method at the time of planning and operations shall be as follows.

Annual discharge amount of tritium is to be reviewed periodically in the Government Policy. On the other hand, in the ALPS treated water discharge into the sea, with the intent of contributing to lowering overall risk of Fukushima Daiichi nuclear power plant, the annual volume of the tritium discharge is to be reviewed considering the overall risk of the decommissioning.

1.9.4.1 Management of annual discharge amount of tritium at the time of planning

In each fiscal year, at the same timing of disclosing total discharge amount of actual tritium for the fiscal year, discharge of the next fiscal year shall be planned after detailed study about contaminated water generation status (historical change), tritium concentration (historical change) at the inlet of the desalination equipment (RO), utilization plan of the premise going forward, etc. In the planning, the basic policy shall be that ALPS treated water of the lowest tritium concentration is discharged first, followed by the next lower one and so on. Based on the numerical simulation conditions of ALPS treated water mixing and dilution (see “II 2.50 ALPS Treated Water Dilution/Discharge Facilities and Related Facility”), upper limit of the tritium concentration in the ALPS treated water discharged into the sea shall be 1 million Bq/L.

ALPS treated water to be discharged is “A. ALPS treated water generated daily” and “B. ALPS treated water stored in the tanks.”

Since the volume of B of which tritium concentration is lower than that of A is limited, ALPS treated water of B shall be discharged in order at the pace of less than 22 TBq/year while discharging ALPS treated water of A. When discharging B, to reduce dispersion of tritium concentration inside the tanks before the circulation and agitation, tank groups with not much difference in tritium concentration shall be planned to be received.

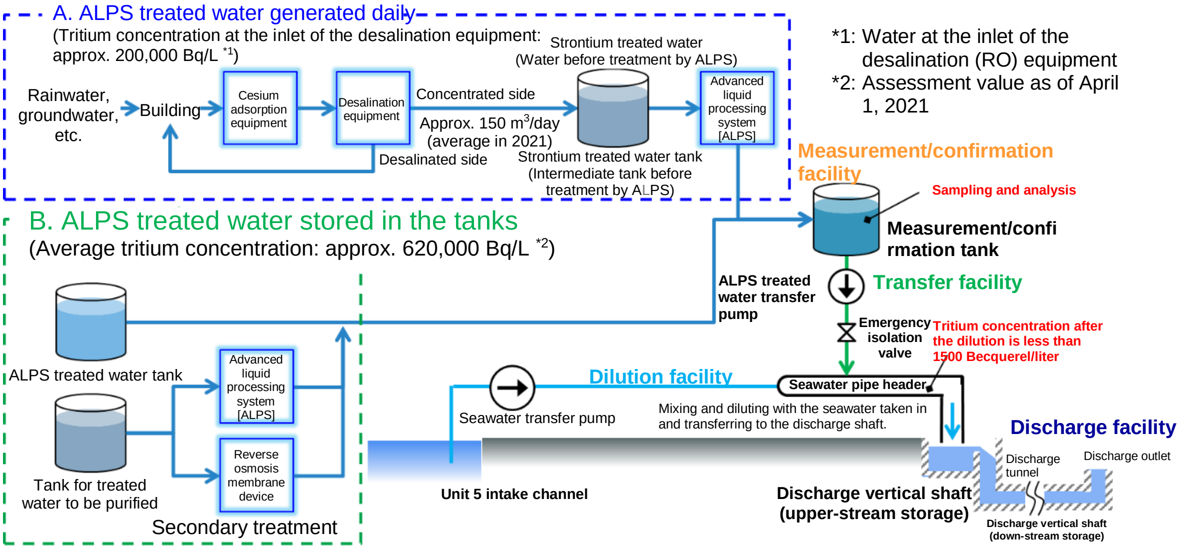


Figure-19 ALPS treated water to be discharge

The Japanese version shall prevail.

In the discharge planning, to make the total annual discharge amount of tritium including the other discharge in accordance with Implementation Plan III (Article 41 of Part 1 and Article 88 of Part 2) stay within the range of 22 trillion Bq. Annual discharge volume (6) and average tritium concentration (7) of ALPS treated water, etc. stored in the tanks shall be calculated as follows. Based on that, to satisfy (6) and (7), discharge sequence of the tank groups is planned with ALPS treated water of lower tritium concentration having higher priority and with operations in mind.

A. ALPS treated water generated daily

(1) Concentration of tritium at the inlet of the desalination (RO) equipment
× (2) Generated volume of contaminated water
= (3) Annual discharge amount of tritium regarding A

B. ALPS treated water stored in the tanks

(4) Annual discharge amount of tritium - (3) = (5) Annual discharge amount of tritium regarding B
(6) Annual discharge volume of B: Based on "Mid-and-Long-Term Decommissioning Action Plan," water volume is determined from area where the tank dismantling needs to be started.
(5) /(6) = (7) Average tritium concentration of B

Table-2 Discharge planning procedures

Type of water	Average tritium concentration [Bq/L]	Annual discharge volume [m^3/year]	Annual discharge amount of tritium [Bq/year]
A	(1) Concentration of tritium at the inlet of the desalination (RO) equipment	(2) Generated volume of contaminated water x 365 [days/year]	(3): (1) x 1000 [L/m^3] x (2) x 365 [days/year]
B	(7):(5)÷(6)÷1000[L/m^3]	(6) From the premise utilization plan	(5): (4) - (3)
Total	—	—	(4): Annual discharge amount of tritium

1.9.4.2 Management of annual discharge amount of tritium during operations

During operations, annual volume of tritium discharge is controlled to stay within the range of 22 TBq by implementing following measures to facilities (see Figure 20.)

(1) Tritium concentration of ALPS treated water to be discharged is registered into the monitoring/control device for each discharge, and the flow rate of ALPS treated water during the discharge is monitored by the monitoring/control device and the integrating flow volume is counted/recorded. By this, tritium discharge amount of each discharge is calculated.

(2) Upper limit for the annual discharge amount of tritium can be set in the monitoring/control device, and if annual integrating amount of tritium discharge calculated by (1) threatens to exceed the set value, an interlock shall be embedded to prevent proceeding to the discharge operations so that the operations won't let the annual discharge amount of tritium exceed the range of 22 TBq.

The design allows confirmation of the data above anytime through the monitoring/control device.

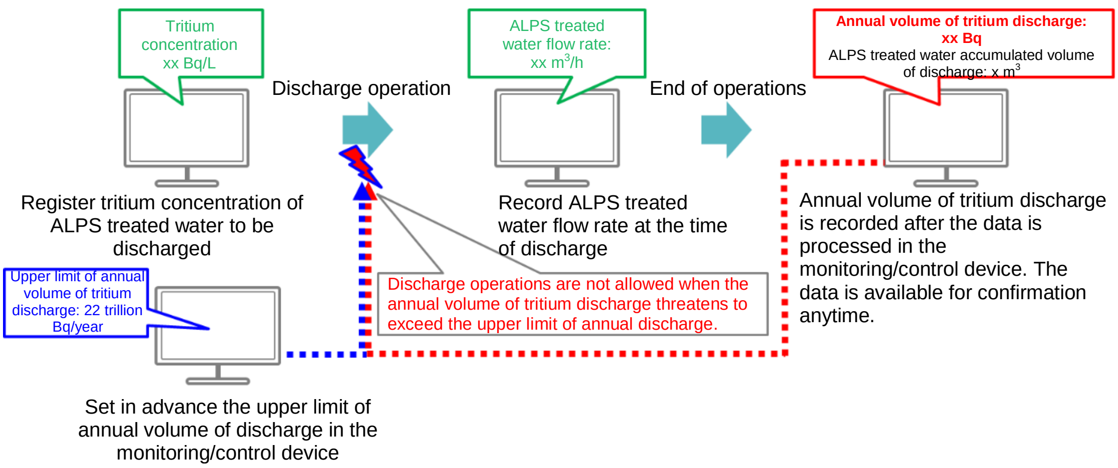


Figure-20 Control method by the monitoring/control device for annual volume of discharge

1.9.5 Adequacy of facility design and operation on ALPS treated water dilution/discharge facilities and related facility

As the discharge of the ALPS treated water into the sea needs to be stable for long term, design and operation of the ALPS treated water dilution/discharge facilities and related facility shall take into account anomalies such as components failures assumed during its service life. Provided above, for a case of such anomalies leading to "unintentional discharge of ALPS treated water into the sea," adequacy shall be confirmed about measures to end the event immediately.
Meanwhile, the discharge vertical shaft (upper-stream storage) and the discharge facility are taken out from the subjects in which abnormal events are to be identified because their internal water is ALPS treated water diluted with seawater and their structure has superior seismic resistance characteristics (see "II 2.50 ALPS Treated Water Dilution/Discharge Facilities and Related Facility.")

1.9.5.1. Analysis of failure events

1.9.5.1.1 Definition of the top event and the abnormal event

(1) Definition of the top event

In the analysis of failure events in the ALPS treated water dilution and discharge facility, the top event is defined as "unintended discharge of ALPS treated water into the sea." The definition assumes, at the time of discharging ALPS treated water into the sea, an event of ALPS treated water discharged into the sea without satisfying conditions stipulated in the plan.

(1) Definition of the abnormal event

Specific details (the abnormal events) of "unintended discharge of ALPS treated water into the sea," which is defined as the top event, is defined.
Here, planned conditions for the ALPS treated water discharge into the sea are organized as shown in Table-3, and discharge without satisfying these conditions by components failures etc. (initiating events) assumable during its service period are defined as the abnormal events (see Table-4.)

Table-3 Plan for discharging ALPS treated water into the sea

No.	Planned details		Remarks
1	Water to be discharged	ALPS treated water	Sum of the ratios to regulatory concentrations limits of radioactive materials other than tritium is less than 1.
2	Discharge method	Concentration of tritium, which is difficult to remove, in the water diluted by seawater shall be less than 1,500 Bq/L.	Operation of determining ALPS treated water flow rate based on tritium concentration, which has been identified in advance, in the ALPS treated water and seawater flow rate.
		At the discharge, ALPS treated water shall be greatly diluted (100 times or more).	Based on the maximum flow rate of ALPS treated water of 500 m^3/day and the seawater transfer pump of 170,000 m^3/day per unit, even if only a single seawater transfer pump is in operation, dilution with 340 times is achievable.
3	Transfer by the transfer facility and discharge through the dilution facility		

Table-4 Definition of the abnormal event

Abnormal events	
[Definition (1)]	An event of discharging with defective measurement/confirmation of radioactive material (defective measurement/confirmation)
[Definition (2)]	An event of discharging with tritium concentration in the water diluted by seawater being 1,500 Bq/L or more, or with dilution ratio being less than 100 times (insufficient seawater dilution)
[Definition (3)]	An event of discharging without seawater dilution due to leakage out to the system (lack of seawater dilution)

1.9.5.1.2 Identifying initiating events and causes which lead to the abnormal events

In identifying initiating events and causes which lead to the abnormal events as defined in 1.9.5.1.1, the master logic diagram* (hereinafter "MLD,") which is simplified fault tree analysis, shall be used for analysis.

In the MLD analysis, considerations shall be made at each of 5 levels as shown in Table-5, and occurrence of the abnormal events is deemed prevented if measures (in design and operations) in 5 levels have been adequately implemented (see Figure-21 for an image of analysis procedures).

*: This is a top down analysis method to identify initiating events from the top event, exposing initiating events and causes which lead to the abnormal events.

Table-5 Details of the MLD analysis at each level

	Analysis details
Level 1	Place “unintentional discharge of ALPS treated water into the sea” which is the top events
Level 2	Place 3 abnormal events which are the definition of the top events (see Figure-21)
Level 3	For the abnormal events defined in the level 2, specific events with potential of leading to the abnormal events are identified from structures, systems and components of ALPS treated water dilution/discharge facilities (including power source and instrumentation/control systems) which belong to ALPS treated water dilution/discharge facilities and related facility, and which handle ALPS treated water before and during seawater dilution with focus on expected functions in each process while referring to facility specs, piping and instrumentation diagrams, interlock block diagrams, components layout and operations procedures.
Level 4	Identify a single failure of components or malfunction of it, or a single erroneous operation of an operator or an external disturbance which is expected to occur with similar frequency, all of which are expected during the service period the facility and are leading to the level 3.
Level 5	Confirm adequacy of measures in facility design and operations against the initiating events at the level 4

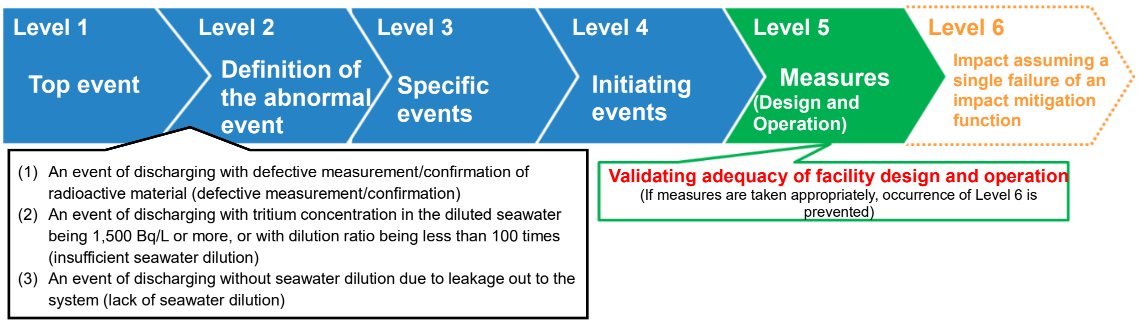


Figure-21 Assessment method using the master logic diagram (MLD)

1.9.5.1.3 Analysis results of the abnormal events using MLD

Table-6 shows results of analysis using MLD

The analysis has found out the abnormal event (1) “an event of discharging with defective measurement/confirmation of radioactive material (defective measurement/confirmation)” and the abnormal event (3) “an event of discharging without seawater dilution due to leakage out to the system” won’t occur as appropriate measures (such as embedding interlock checks in measurement/confirmation process and discharge process, operations in place to close valves upstream through inspection patrols and leakage detectors, etc., at the time of leakage from components, etc.) are implemented.

On the other hand, as following events has been identified for the abnormal event (2) “an event of discharging with tritium concentration in the diluted seawater being 1,500 Bq/L or more, or with dilution ratio being less than 100 times (insufficient seawater dilution),” impact assessment shall be implemented.

- Initiating event (1) “Loss of off-site power supply”
- Initiating event (2) “Seawater transfer pump trip while two or three units of them under operation”

Table-6 Results of analysis using MLD (1/5)

Level 1	Level 2	Level 3	Level 4			Level 5	Level 6
Top event	Definition of the abnormal event (OR condition)	Specific events (OR condition)	Initiating events Timing of occurrence	Abnormality category	Contents	Measures (AND condition)	Impact
"Unintentional discharge of ALPS treated water into the sea"	(1) An event of discharging radioactive materials with defective measurement/confirmation	Inadequate sampling	Measurement/ confirmation process	Human error	Selection error when selecting a tank group for water sampling (Double action input failed)	• Set up an interlock check • Check open/close status of the valves at the time of water sampling	(Prevention)
				Facility (static)	Water from tank groups other than the target tank group is mixed into the water sampling point.	• Make tank inlet valves and outlet valves dual-redundant respectively. • Check open/close status of the valves at the time of water sampling • Perform time-based maintenance for the circulation line switching valves at appropriate timings	(Prevention)
				Human error	Wrong sample for which analysis is requested	• Workers and analysts check together by matching the analysis instructions with sample bottles	(Prevention)
		Inadequate analysis	Measurement/ confirmation process	Human error	Incorrect analysis procedures	• Check by matching internal analysis results with third-party analysis results	(Prevention)
				Human error	Analytical results of wrong samples are notified to the Group Manager who is responsible for management of discharge of liquid waste, etc.	• Notify data through the core system without transcription • Analysts, etc., check trends of results	(Prevention)
				Human error	Abnormal values in the analysis results are overlooked	• Analyst detect abnormal values from the latest trends • Group Manager who is responsible for analysis and data evaluation detect abnormal values from past analysis results, etc.	(Prevention)
				Human error	Analysis results of wrong samples are notified to the Shift supervisor	• Notify data through the core system without transcription • Analysts, etc., to check trends of results	(Prevention)
		Sample homogenization insufficient	Measurement/ confirmation process	Facility (static)	Insufficient agitation and circulation due to shutdown (failure) of agitation equipment or circulating pump	• Circulation operation shutdown due to agitation equipment shutdown • Regularly check the operation status with the monitoring/control device	(Prevention)
				Facility (static)	Insufficient circulation due to lowered circulating pump flow rate	• An interlock to shut down the circulation pump is activated with the circulation pump's low flow rate signal • Regularly check the flow rate with the monitoring/control device	(Prevention)
		Wrong discharge tank	Discharge process	Human error	Selection error when selecting a tank group from which water is to be discharged (Double action input failed)	• Set up an interlock check • Compare analysis results with the target tank before the discharge operation	(Prevention)

Countermeasures → Blue: Design, Green: Operation

The Japanese version shall prevail.

Table-6 Results of analysis using MLD (2/5)

Level 1	Level 2	Level 3	Level 4			Level 5	Level 6
Top event	Definition of the abnormal event (OR condition)	Specific events (OR condition)	Initiating events			Measures (AND condition)	Impact
			Timing of occurrence	Abnormality category	Contents		
"Unintentional discharge of ALPS treated water into the sea"	(2) An event of discharging with tritium concentration in the diluted seawater being 1,500 Bq/L or more, or with dilution ratio being less than 100 times	Defective dilution	Measurement/ confirmation process	Human error	When the tritium concentration is registered to the oversight/control system, a value lower than the actual value is input incorrectly (-> Making the FCV opening larger)	• Mechanically input tritium concentrations to the monitoring/control device using a scanner, etc. • More than one person to check the values mechanically imported to the oversight/control system	(Prevention)
			Discharge process	Facility (static)	Loss of off-site power supply	• In the event of loss of the power, the emergency isolation valve-1 (MO) closes automatically • In the event of loss of the power, the emergency isolation valve-2 (AO) closes automatically • Installation of tank inlet/outlet manual valves enables closing	(1) Discharge assuming a single failure of the emergency isolation valve
				Facility (static)	Failure of the power source panel (M/C) while two or three seawater transfer pumps operating	• In the event of seawater transfer pump failure, the emergency isolation valve-1 (MO) closes automatically • In the event of seawater transfer pump failure, the emergency isolation valve-2 (AO) closes automatically • When lowering of flow rate detected by a seawater flow meter exceeds a certain value, the emergency isolation valve-1 (MO) closes automatically • When lowering of flow rate detected by a seawater flow meter exceeds a certain value, the emergency isolation valve-2 (AO) closes automatically • Tank inlet/outlet manual valves enable closing • *Make arithmetic units dual-redundant*	(1) Discharge assuming a single failure of the emergency isolation valve
				Facility (dynamic)	Pump failure while 2 or 3 seawater transfer pumps operating	(Same as the above)	(1) Discharge assuming a single failure of the emergency isolation valve

Countermeasures → Blue: Design, Green: Operation

Table-6 Results of analysis using MLD (3/5)

Level 1	Level 2	Level 3	Level 4			Level 5	Level 6
Top event	Definition of the abnormal event (OR condition)	Specific events (OR condition)	Initiating events			Measures (AND condition)	Impact
			Timing of occurrence	Abnormality category	Contents		
"Unintentional discharge of ALPS treated water into the sea"	(2) An event of discharging with tritium concentration in the diluted seawater being 1,500 Bq/L or more, or with dilution ratio being less than 100 times	Defective dilution	Discharge process	Facility (static)	An error occurs in the indicated value of the seawater flow meter, but the interlock fails to activate	• Perform time-based maintenance for the seawater flow meter at appropriate timings • Activate an alarm if an instrument fails • Monitor the deviation of flow rate indication values of two or three seawater transfer pumps, and when the deviation exceeding the instrument error margin is observed, activate an alarm	(Prevention)
				Facility (static)	An abnormality occurs in the indication value of the ALPS treated water flow meter (-> Leading to an inadequate opening of the FCV), but an interlock fails to activate	• Perform time-based maintenance for the ALPS treated water flow meters at appropriate timings • Make ALPS treated water flow meters dual-redundant • Activate an alarm if an instrument fails • Set the upper limit on the flow rate according to the set dilution ratio, and activate an alarm when the upper limit is reached	(Prevention)
				Facility (static)	FCV failure (mechanical failure such as valving element failure)	• Embedding an interlock of activating the emergency isolation valves when the indicated value of the ALPS treated water flow meter does not get close to the calculated value of the monitoring/control device • [Addition] Make ALPS treated water flow meter dual-redundant • Installation of the emergency isolation valve-1 (MO) enables closing • Installation of the emergency isolation valve-2 (AO) enables closing • Tank inlet/outlet manual valves enable closing • Make arithmetic units dual-redundant	(Prevention)
				Facility (static)	Leakage occurs at the down-stream flange of the seawater flow meter	• Adopt seawater transfer pumps with sufficient capacity margin for the required functions • Execution of periodic patrol inspections	(Prevention)

Countermeasures → Blue: Design, Green: Operation

Table-6 Results of analysis using MLD (4/5)

Level 1	Level 2	Level 3	Level 4			Level 5	Level 6
			Initiating events				
Top event	Definition of the abnormal event (OR condition)	Specific events (OR condition)	Timing of occurrence	Abnormality category	Contents	Measures (AND condition)	Impact
"Unintentional discharge of ALPS treated water into the sea"	(3) An event of discharging without seawater dilution due to leakage out to the system	Leakage	Always (including inspection period)	Facility (static)	[Reference] Complete destruction of 3 tank groups*	• If a natural phenomenon shown in Table-1 occurs, the system shall be shut down.	Impact assessment from the loss of functions is carried out (see "II 2.50 ALPS Treated Water Dilution/Discharge Facilities and Related Facility")
				Facility (static)	[Reference] Rupture of the transfer pipe*	• Execution of periodic patrol inspections • Connection between the PE pipes shall be a fusion structure. • Surrounding weirs outside of the foundation are installed around tanks with flanges • Weirs and leakage detectors are installed around circulation pumps with flanges	(Prevention)
					Leakage from a circulation pipe flange		
			Always (including inspection period)	Facility (static)	Leakage from a transfer piping flange between a tank outlet and a MO shut-off valve	• Execution of periodic patrol inspections • Connection between the PE pipes shall be a fusion structure. • Surrounding weirs outside of the foundation are installed around tanks with flanges • Weirs and leakage detectors are installed around ALPS treated water transfer pumps with flanges • A vent valve cover and a leak detector are installed on the vent valve with flange. [Additional] Make the leak detector dual-redundant	(Prevention)

*: Assuming the occurrence of an earthquake exceeding the seismic category (C class) of this facility

Countermeasures → Blue: Design, Green: Operation

Table-6 Results of analysis using MLD (5/5)

Level 1	Level 2	Level 3	Level 4			Level 5	Level 6
Top event	Definition of the abnormal event (OR condition)	Specific events (OR condition)	Initiating events: Timing of occurrence	Initiating events: Abnormality category	Initiating events: Contents	Measures (AND condition)	Impact
Unintentional discharge of ALPS treated water into the sea	(3) An event of discharging without seawater dilution due to leakage out to the system	Leakage	Always (including inspection period)	Facility (static)	Leakage from the transfer pipe flange between the MO isolation valve and the AO isolation valve	• Execution of periodic patrol inspections • Connection between the PE pipes shall be a fusion structure. • Weirs around MO/AO valves with flanges are installed	(Prevention)
			Always (including inspection period)	Facility (static)	Leakage from the transfer pipe flange between the AO isolation valve and the seawater piping header	• Execution of periodic patrol inspections • Connection between the PE pipes shall be a fusion structure. • Weirs around AO valves with flanges are installed	(Prevention)
			Discharge process	Facility (static)	Receiving tank overflow caused by events such as loss of driver (compression air) for the emergency isolation valve-2 (AO valve)	• Execution of periodic patrol inspections • Switching of discharge directions can be detected by the limit switch of the AO valve • Operation of the AO valve can be detected from the pressure gauge of the compression air (an interlock to shut down discharge exists) • Water level meter (electrode type) is installed in the receiving tanks	(Prevention)
			Discharge process	Facility (dynamic)	Receiving tank overflow by the prior valve sheet pass of the emergency isolation valve-2 (AO valve) on shutdown side during discharge	• Execution of periodic patrol inspections • Water level meter (electrode type) is installed in the receiving tanks • Weirs are installed around the receiving tank (a leak detector exists)	(Prevention)

Countermeasures → Blue: Design, Green: Operation

1.9.5.2 Impact assessment at the time of failure

Based on the MLD analysis in 1.9.5.1, impact is assessed for the following events which have been identified as (2) “An event of discharging with tritium concentration in the diluted seawater being 1,500 Bq/L or more, or with dilution ratio being less than 100 times (insufficient seawater dilution),” considering functional loss status of components, etc. which consist the ALPS treated water dilution/discharge facilities.

- Initiating event (1) “Loss of off-site power supply”
- Initiating event (2) “Seawater transfer pump trip while two or three units of them under operation*”

*: A power source panel failure and a pump failure are identified as the cause of the trip.

1.9.5.2.1 Setting of initial conditions for abnormal events

For the identified initiating events, the toughest initial conditions and components conditions from the view point of discharge volume of ALPS treated water are set as follows.

Initial conditions
As (2) “an event of discharging with tritium concentration in the diluted seawater being 1,500 Bq/L or more, or with dilution ratio being less than 100 times (insufficient seawater dilution)” occurs during discharge of ALPS treated water into the sea, situation of normal operations is assumed.
Components conditions
As it is normal operations, the plan is to control ALPS treated water flow rate by FCV to be 500 m^3/day (an interlock is embedded to shut down the discharge into the sea when the 500m^3/day is exceeded), but 720m^3/day is assumed conservatively which is the components spec of a single ALPS treated water transfer pump. 2 seawater transfer pumps are assumed to be operating (340 thousand m^3/day), and even though driving power to the pumps are terminated because of the initiating events (1) or (2), continuation of the seawater dilution is expected because of the inertial force, but, conservatively, it is not assumed.

1.9.5.2.2 Components to address abnormal events and their activation conditions

Emergency isolation valves for immediate shut-off the ALPS treated water discharge into the sea and the logic circuit required for its operation shall be provided with the components required to address with abnormal events.

Response time of the signal for activate the emergency isolation valves and the time for the emergency isolation valves are fully closed, set the time so that the assessment result becomes severe.

Installation locations and activation method of the emergency isolation valves are as shown in Table -7 and Figure-22.

Table-7 Design of emergency isolation valve

Design	Emergency isolation valve-1	Emergency isolation valve-2
Location of installation	Location not subject to damage by tsunami	Placed at the furthest down-stream of ALPS treated water transfer piping to minimize the volume of discharge during activation of valve.
Operating system	MO system (Open to Close Time: 10 seconds)	AO system (Open to Close Time: 2 seconds)
Concept of design	Two series are provided and, in the event of failure and maintenance, the series can be switched by manual valve at the front and rear valves to keep the facility operation rate.	(Same as on the left)

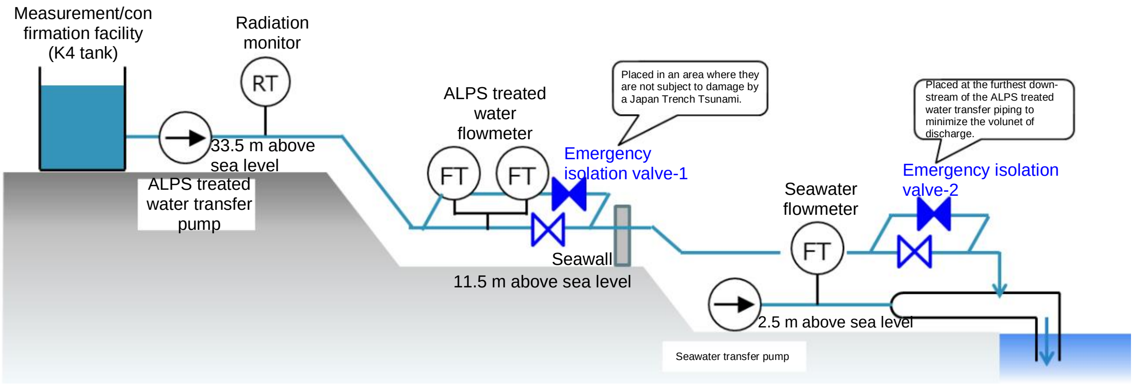


Figure-22 Image of installation location of emergency isolation valves

The Japanese version shall prevail.

1.9.5.2.3. Assumption of a single failure, etc. in abnormal events

A single failure, etc., for which assessment results of dynamic components become the severest, are assumed for facilities required to address abnormal events. For static components, which will be used for long hours (24 hours or more) after an abnormal event occurs, its single failure, etc., are assumed.

Specifically, for both initiating events identified in the MLD analysis of 1.9.5.1, which are (1) "loss of off-site power supply" and (2) "Seawater transfer pump trip while two or three units of them under operation," shutdown of the discharge into the sea by the emergency isolation valves is being a countermeasure for "unintentional discharge of the ALPS treated water," and the emergency isolation valves with a function of shutting down the discharge into the sea are being the required facilities to address abnormal events. Therefore, a single failure, etc., which leads to the severest assessment results for the emergency isolation valves is assumed.

Assumption of a single failure, etc.

A single failure of the emergency isolation valve-2, which is located the furthest down-stream of the ALPS treated water transfer piping to minimize discharge volume at the time of the valve activation, and which is the AO type with the shortest time of 2 seconds from open to close, is assumed in the ALPS treated water dilution and discharge facility.

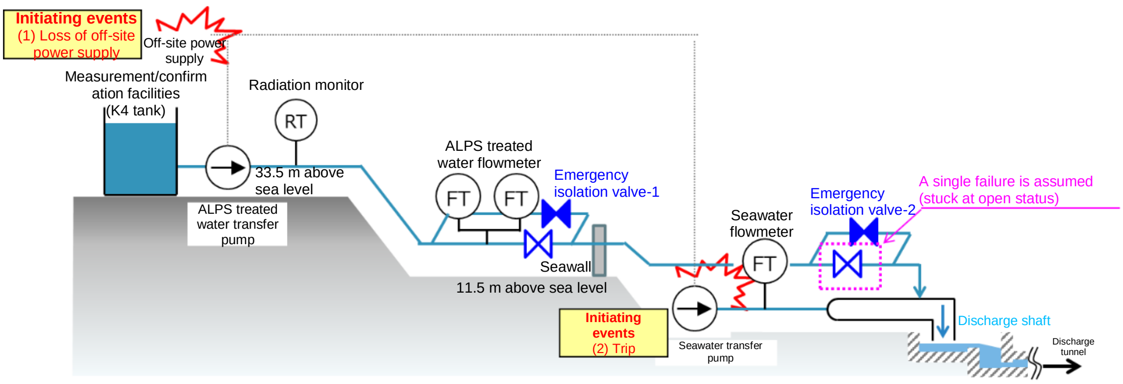


Figure-23 Image of facilities status at the time of an abnormal event and a single failure, etc.

1.9.5.2.4 Assessment at the time of abnormal event

Here, discharge volume of ALPS treated water is assessed based on the conditions set in 1.9.5.2.1 to 1.9.5.2.3.

(1) Discharge volume of ALPS treated water caused by the initiating event (1) "Loss of off-site power supply"

An event is assumed of discharging ALPS treated water into the sea without sufficient dilution when “loss of off-site power supply” occurs due to power transmission system failure, etc. during the ALPS treated water discharge into the sea and the discharge continues by reasons such as tank water head pressure and elevation differences even though the seawater transfer pumps and ALPS treated water transfer pumps are shut down.

Should this event occur, the discharge into the sea will be terminated in 10 seconds or earlier after the loss of off-site power supply because the event will also cut the power supply to the emergency isolation valve and the emergency isolation valve-1 will be fully closed due to the fail-close function of the valve.

Assessment result

In 10 seconds until the emergency isolation valve-1 closes, approximately 1.1m^3 of ALPS treated water is discharged without sufficient dilution, calculated by adding internal water volume (approx. 1.02m^3), which is contained between the emergency isolation valve-1 and the seawater pipe header (about 130m), and the ALPS treated water volume (approx. 0.08m^3), which is conservatively postulated to be transferred by the inertial force of ALPS treated water transfer pump. (See Figure-24)

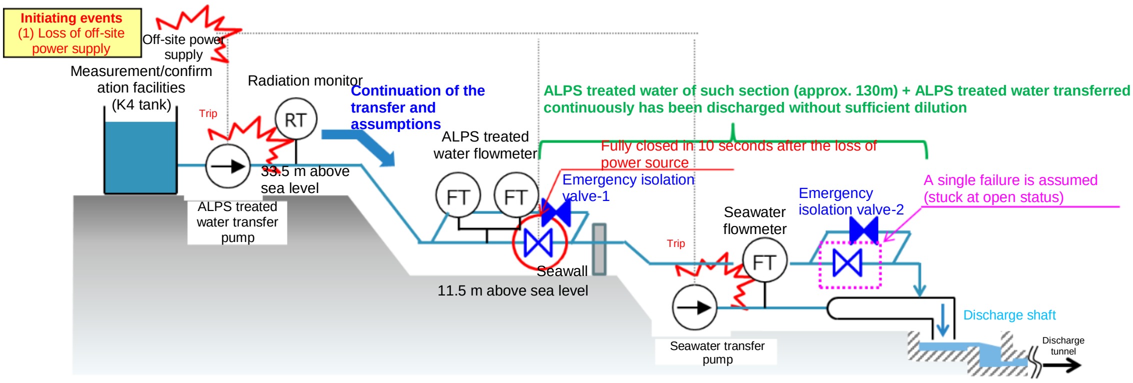


Figure-24 Image of abnormal event (1) "Loss of off-site power supply"

(2) Discharge volume of ALPS treated water caused by the initiating event (2) “Seawater transfer pump trip when two or three units of them under operation”

Assume an event in which the seawater flow rate for diluting ALPS treated water is reduced due to the occurrence of "sea water transfer pump trip during operations of 2 or 3 units of them" etc. during the discharge of ALPS treated water.

This event is a condition in which the emergency isolation valve activates according to a signal of “seawater flow rate low” or “sea water transfer pump trip.” While the seawater transfer pump trip is activated by the power source relay and no time constant exists, seawater flow rate low has a time constant in measurement of the flow rate (4 seconds). Here, and with this time constant, “seawater flow rate low” is more conservative. Therefore, 5 seconds are assumed for the process starting from the occurrence of a pump trip due to a failure of seawater transfer pump or power source panel, then to the measurement of flow rate by the seawater flow meter and its communication to the monitoring/control device, and finally to issuance of activation signal from the monitoring/control device to the emergency isolation valve. As the assumed 5 seconds are added to the 10 seconds required to fully close the valve, the discharge into the sea will be terminated in 15 seconds or less.

Assessment result

Approximately 1.2m^3 of ALPS treated water, which is addition of internal water (approx. 1.02m^3) between the emergency isolation valve-1 and the seawater piping header (approx. 130m) and the volume to ALPS treated water (approx. 0.12m^3) transferred from the ALPS treated water transfer pump during 15 seconds of the emergency isolation valve closure motion, will be discharged without sufficient dilution. (see Figure-25)

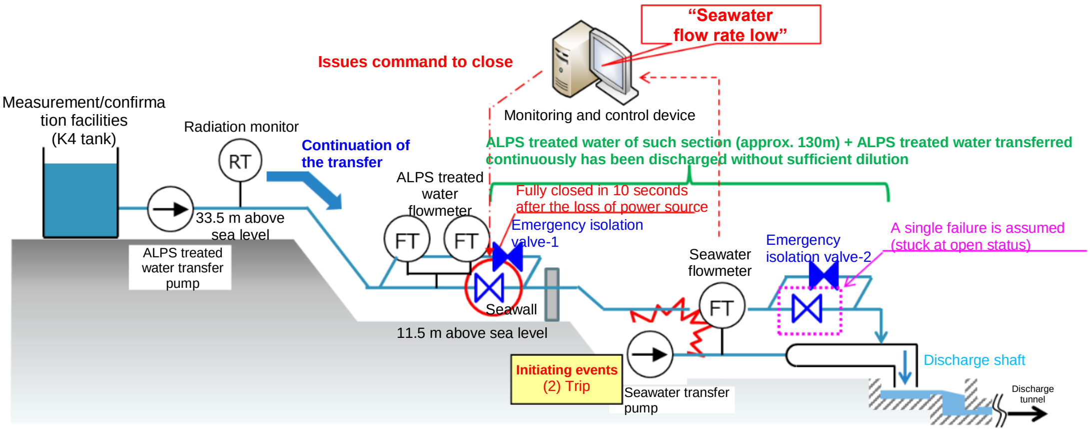


Figure-25 Image of an abnormal event at the time of the initiating event (2) “Seawater transfer pump trip while two or three units of them under operation”

2.5 Summary

The abnormal events identified here is settled by the emergency isolation valve-1 within 15 seconds or less after the occurrence. And, as the discharge volume assessed here (approx. 1.2m^3 at a maximum) is sufficiently low compared to the currently planned ALPS treated water discharge volume (500m^3/day at a maximum), the design and operations of the ALPS treated water dilution and discharge facilities are sufficient for safety.

End

The Japanese version shall prevail.

2.1.2 Management of Radioactive Liquid Waste, etc.

(Refer to comparison table for any amendments)

2.2.3 Dose Assessment by Radioactive Liquid Waste, etc.

(Refer to comparison table for any amendments)

3.1.4 Reduction of Radioactive Materials in Seawater, Seabed Sediment, Groundwater and Drainage Channels in Ports and Harbors

(Refer to comparison table for any amendments)

VI Enhancing Public Acceptance on the Implementation of the Plan

(Refer to comparison table for any amendments)

Annexes of the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility

These documents are supplementary information on "the Implementation Plan for Fukushima Daiichi Nuclear Power Station as Specified Nuclear Facility".

Tokyo Electric Power Company Holdings Inc.

The Japanese version shall prevail.

Table of Contents

(Refer to comparison table for any amendments)

The Japanese version shall prevail.

Annex 27

Supplementary information on the ALPS Treated Water Dilution/Discharge Facilities

The Japanese version shall prevail.

I Structural Strength of ALPS Treated Water Dilution/Discharge Facilities

1. Methods and results of structural strength assessment

1.1 Main pipe (steel pipes other than seawater pipe headers)

Figures-1 to 5 show the evaluation points of structural strength.

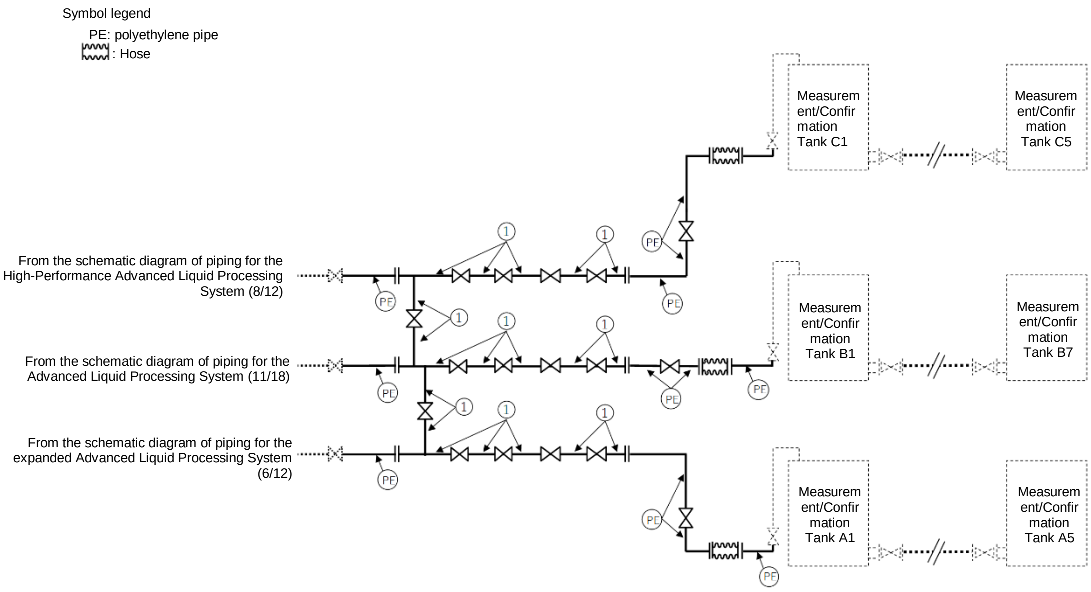


Figure-1 Schematic diagram of pipe (1/5)

(Measurement/Confirmation Facility)

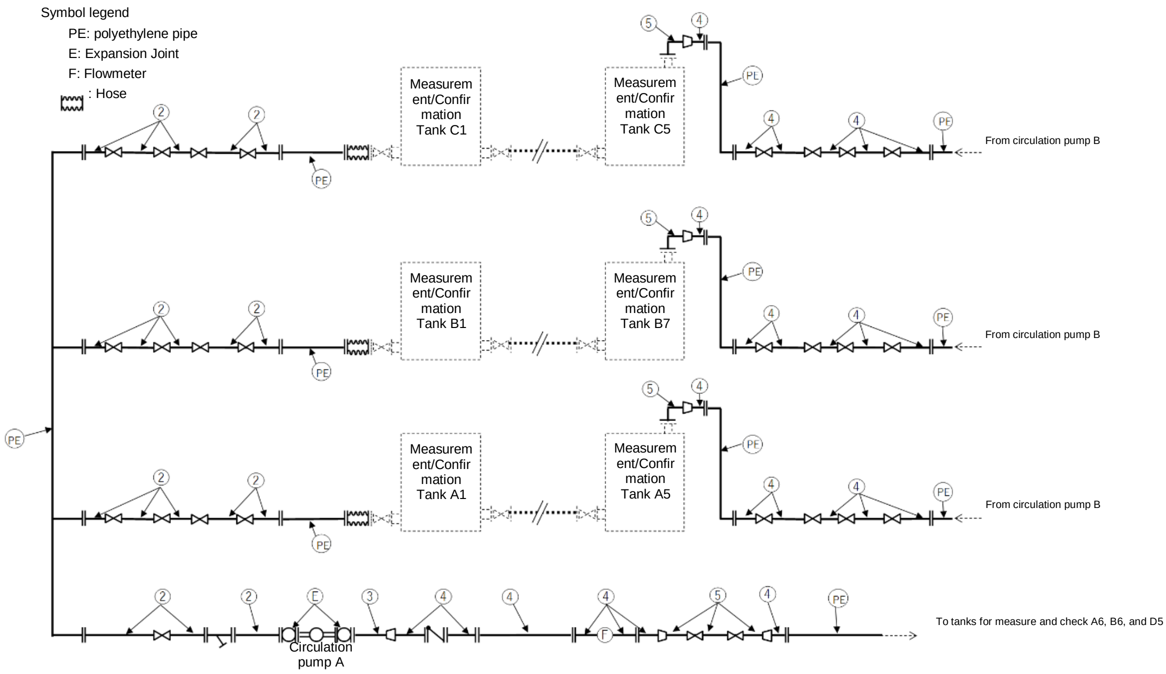


Figure-2 Schematic diagram of pipe (2/5)

(Measurement/Confirmation Facility)

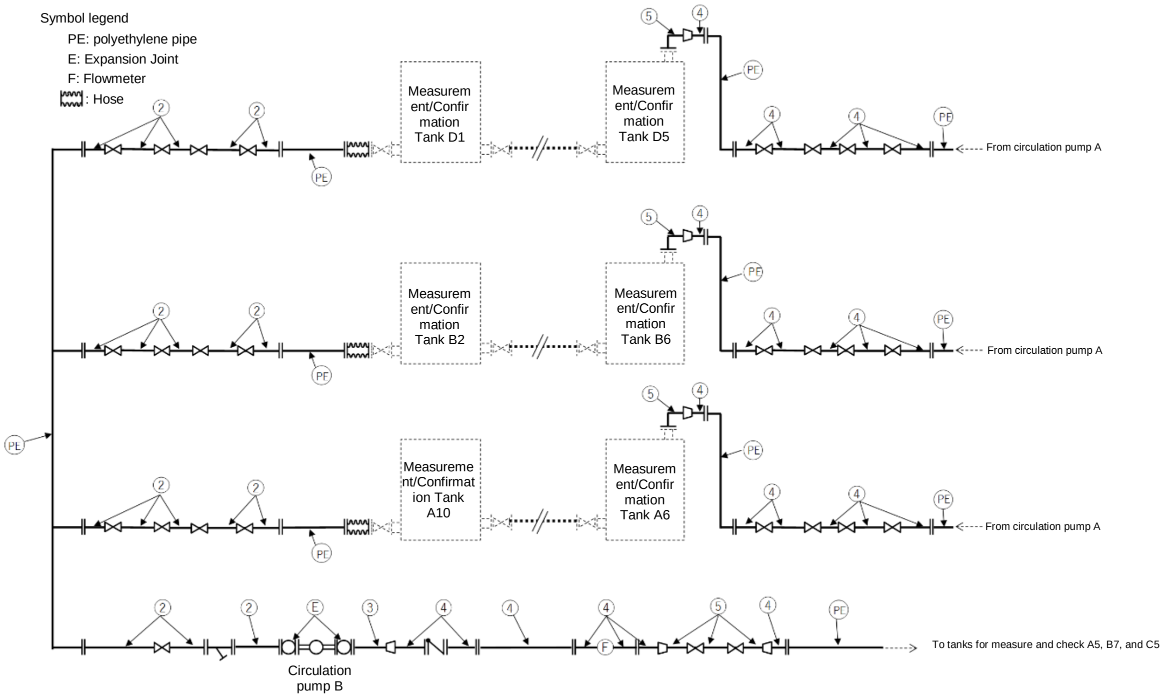


Figure-3 Schematic diagram of pipe (3/5)

(Measurement/Confirmation Facility)

The Japanese version shall prevail.

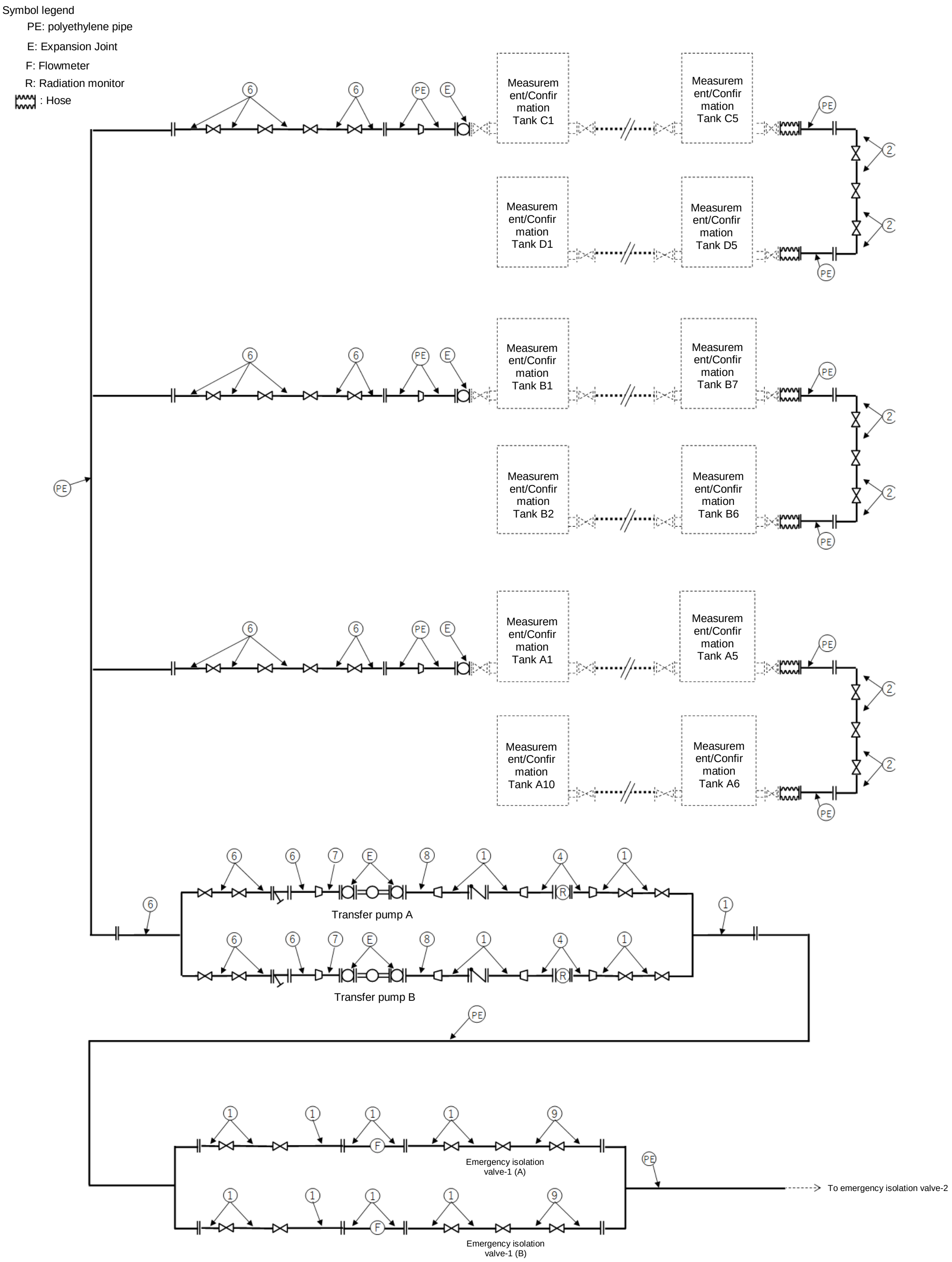


Figure-4 Schematic diagram of pipe (4/5)

(Transfer Facility)

The Japanese version shall prevail.

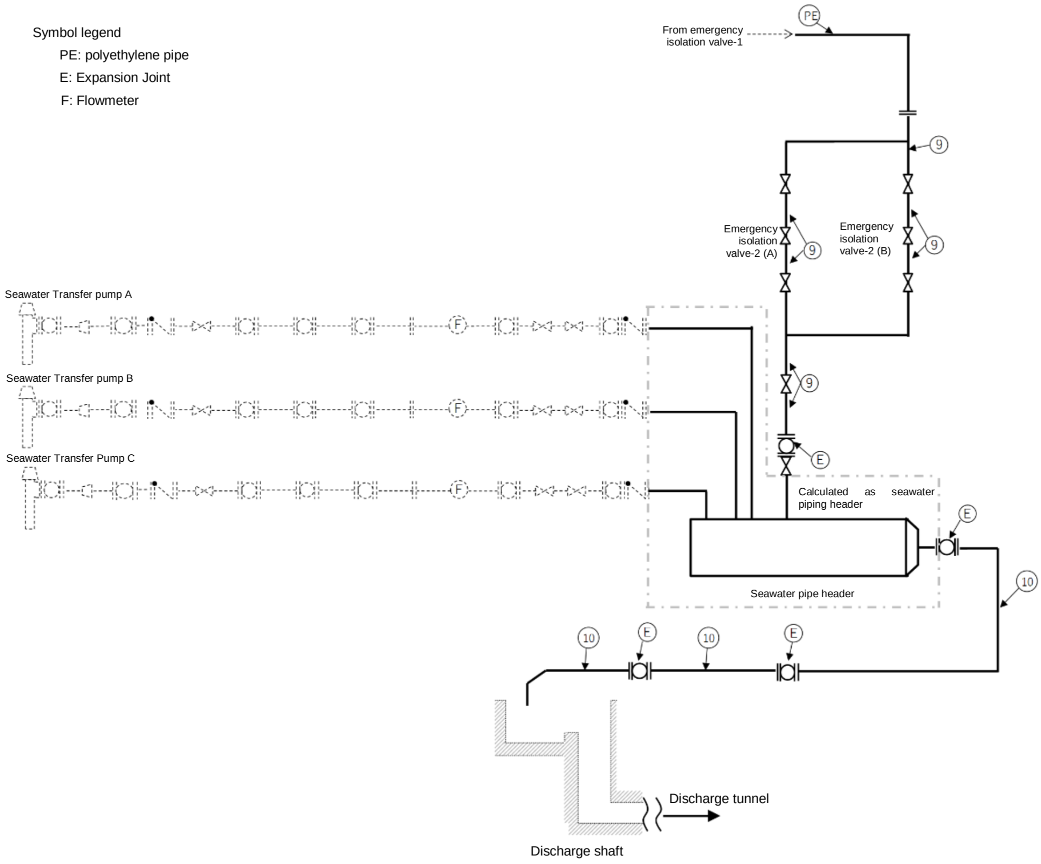


Figure-5 Schematic diagram of pipe (5/5)
(Transfer Facility, Dilution Facility)

The Japanese version shall prevail.

1.2 Evaluation Method of Structural Strength

The required thickness of the pipe shall be the larger of the values listed below.

a. A pipe under pressure on its inner surface

Pipe thickness required for calculation: $t = \frac{PD_0}{2S\eta + 0.8P}$

P : Max. working pressure (MPa)

D_0 : Outer diameter of pipe (mm)

S : Allowable tensile stress of material at maximum working temperature (MPa)

η : Efficiency of the longitudinal joint

b. Minimum required thickness for design and construction code for carbon steel pipes: t_r

Values prescribed in the table PPD-3411-1 of Design and Construction Standard PPD-3411 (3)

1.3 Evaluation Results of Structural Strength

Table-1 Evaluation Results of Structural Strength of Main Pipe (Steel Pipes other than Seawater Pipe Header)

Evaluated components	D_0 (mm)	Material	P (MPa)	S (MPa)	η	Maximum working temperature (℃)	Tolerance	Nominal thickness (mm)	Required thickness (mm)	Minimum thickness (mm)
Pipe ①	114.3	SUS316LTP	0.98	[redacted]	[redacted]	40	[redacted]	4.0	0.48	3.50
Pipe ②	216.3	SUS316LTP	0.49	[redacted]	[redacted]	40	[redacted]	6.5	0.46	5.68
Pipe ③	139.8	SUS316LTP	0.98	[redacted]	[redacted]	40	[redacted]	5.0	0.59	4.37
Pipe ④	165.2	SUS316LTP	0.98	[redacted]	[redacted]	40	[redacted]	5.0	0.69	4.37
Pipe ⑤	216.3	SUS316LTP	0.98	[redacted]	[redacted]	40	[redacted]	6.5	0.91	5.68
Pipe ⑥	165.2	SUS316LTP	0.49	[redacted]	[redacted]	40	[redacted]	5.0	0.35	4.37
Pipe ⑦	89.1	SUS316LTP	0.49	[redacted]	[redacted]	40	[redacted]	4.0	0.19	3.50
Pipe ⑧	48.6	SUS316LTP	0.98	[redacted]	[redacted]	40	[redacted]	3.0	0.21	2.50
Pipe ⑨	114.3	SUS316LTP	0.60	[redacted]	[redacted]	40	[redacted]	4.0	0.30	3.50
Pipe ⑩	1828.8	SM400B	0.60	[redacted]	[redacted]	40	[redacted]	16.0	9.11	14.20

2. Main Pipe (seawater Pipe header)

Figure-6 shows the evaluation points of structural strength.

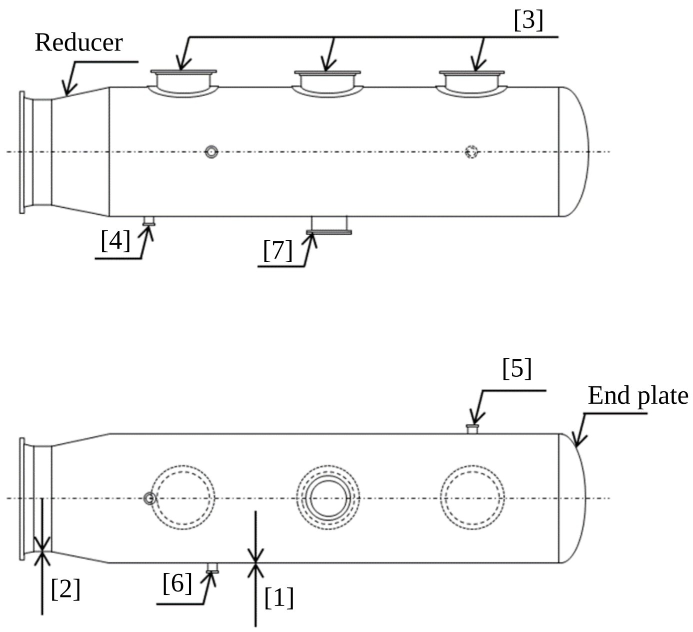


Figure 6: Structural strength evaluation locations for seawater piping header

The Japanese version shall prevail.

2.1 Straight Pipe Part

2.1.1 Evaluation Method of Structural Strength

Confirm that the minimum thickness of the steel pipe satisfies the required thickness prescribed in the "Design and Construction Standard PPD-3411: Equation (PPD-1.3)" or "Design and Construction Standard PPD-3411 (3): Table PPD-3411-1".

The required thickness of the pipe shall be the larger of the following values.

a. A pipe under pressure on its inner surface

The thickness required for the pipe calculation: $t = \frac{PD_0}{2S\eta + 0.8P}$

P	: Max. working pressure (MPa)
D_0	: Outer diameter of pipe (mm)
S	: Allowable tensile stress of material at maximum working temperature (MPa)
η	: Efficiency of the longitudinal joint

b. Minimum required thickness for designing and constructing carbon steel pipes: t_r
Values obtained from the table PPD-3411-1 of Design and Construction Standard PPD-3411 (3)

2.1.2 Evaluation Results of Structural Strength

Evaluation results are given in Table-2. It evaluates the pipe satisfies the required thickness and sufficient structural strength.

Table-2 Evaluation Results of Structural Strength at Straight Pipe Part of Seawater Pipe Headers

Evaluated part	D_0 (mm)	Material	P (MPa)	S (MPa)	η	Maximum working temperature (℃)	Tolerance	Nominal thickness (mm)	Required thickness (mm)	Minimum thickness (mm)
①Main pipe	2235.2	SM400B	0.60	[redacted]	[redacted]	40	[redacted]	16.0	11.14	14.20
②Outlet pipe	1828.8	SM400B	0.60	[redacted]	[redacted]	40	[redacted]	16.0	9.11	14.20
③Sea water Nozzle pipe	914.4	SM400B	0.60	[redacted]	[redacted]	40	[redacted]	16.0	4.56	14.20
④ALPS Treated water Injection pipe	114.3	STPG370	0.60	[redacted]	[redacted]	40	[redacted]	6.0	0.37	5.25
⑤Vent pipe	114.3	STPG370	0.60	[redacted]	[redacted]	40	[redacted]	6.0	0.37	5.25
⑥Drain pipe	114.3	STPG370	0.60	[redacted]	[redacted]	40	[redacted]	6.0	0.37	5.25
⑦Inspection manhole	609.6	SM400B	0.60	[redacted]	[redacted]	40	[redacted]	16.0	3.04	14.20

2.2 Reducer

2.2.1 Evaluation Method of Structural Strength

Confirm that the minimum thickness of the reducer satisfies the required thickness prescribed in "Design and Construction Standard PPD-3415.1: Equation (PPD-1.8 and PPD-1.9)".

The required thickness of the reducer shall be the larger of the following values.

a. Cone part

The thickness required for calculation: $t = \frac{PD_i}{2cos\theta(S\eta - 0.6P)}$

P : Max. working pressure (MPa)

D_i : The inside diameter of the section perpendicular to the axis of the part where the conic part connects to the bottom part of its roundness (mm)

θ : 1/2 of the apex angle of the cone (degrees)

S : Allowable tensile stress of material at maximum working temperature (MPa)

η : Efficiency of the longitudinal joint

b. The bottom part of its roundness

The thickness required for calculation: $t = \frac{PD_iW}{4cos\theta(S\eta - 0.1P)}$

Where, $W = \frac{1}{4}\left(3 + \sqrt{\frac{D_i}{2rcos\theta}}\right)$

D_i : The inside diameter of the section perpendicular to the axis of the part where the conic part connects to the bottom part of its roundness (mm)

θ : 1/2 of the apex angle of the cone (degrees)

S : Allowable tensile stress of material at maximum working temperature (MPa)

η : Efficiency of the longitudinal joint

r : The inner radius of the bottom part of its roundedness (mm)

2.2.2 Evaluation Results of Structural Strength

Evaluation results are given in Table-3. It is evaluated to satisfy the required thickness and structural strength.

Table-3 Result of structural strength evaluation of reducer

Evaluated component	Evaluation part	Material	P (MPa)	S (MPa)	D_i (mm)	θ (degree)	η	Maximum working temperature (°C)	Tolerance	Nominal thickness (mm)	Required thickness (mm)	Minimum thickness (mm)
Seawater pipe header	Reducer	SM400B	0.60	[redacted]	2203.2	11.5	[redacted]	40	[redacted]	16.0	11.31	14.20

2.3 End plate

The end plate of seawater pipe headers is saucer-shaped in accordance with the conditions of "Design and Construction Standard PPD-3415.2(1)".

2.3.1 Evaluation method Structural strength

Confirm that the minimum thickness of the head plate of seawater pipe headers satisfies the required thickness prescribed in "Design and Construction Standard PPD-3415: Equation 2 (PPD-1.12)."

The required thickness of the head plate shall be the following values.

$$\text{The thickness required for calculation: } t = \frac{PRW}{2S\eta - 0.2P}$$

$$\text{However,} W = \frac{1}{4}\left(3 + \sqrt{\frac{R}{r}}\right)$$

P : Max. working pressure (MPa)

R : Inner radius of the center of the end plate (mm)

S : Allowable tensile stress of material at maximum working temperature (MPa)

η : Efficiency of the longitudinal joint

r : Inner radius of fillet radius of saucer-shaped end plate(mm)

2.3.2 Evaluation Results of Structural Strength

The evaluation of the saucer-shaped plate is shown in Table-4-1. In addition, the evaluation results of structural strength are shown in table-4-2. It is evaluated to satisfy the required thickness and to have sufficient structural strength.

Table-4-1 Evaluation of flat head plate

Evaluated component	Evaluation Part	Material	Outer Diameter: D_{oc} (mm)	Radius of the inner surface in the central portion: R (mm)	Inner radius of roundness: r (mm)	Three times the thickness: $3t_{co}$ (mm)	$0.06D_{co}$ (mm)
Seawater pipe header	End plate	SM400B	[redacted]	[redacted]	[redacted]	48.0	[redacted]

Assessment: Since $D_{oc} \geqq R$, $r \geqq 3t_{co}$, $r \geqq 0.06D_{oc}$ and $r \geqq 50$mm, the mirror plate is a flat mirror plate.

Table-4-2: Evaluation results of structural strength of head plate

Evaluated component	Evaluation Part	Material	P (MPa)	S (MPa)	R (mm)	R (mm)	η	Maximum working temperature (℃)	Tolerance	Nominal thickness (mm)	Required thickness (mm)	Minimum thickness (mm)
Seawater pipe header	End plate	SM400B	0.60	[redacted]	[redacted]	[redacted]	[redacted]	40	[redacted]	16.0	10.19	13.40

2.4 Reinforcement of holes

2.4.1 Evaluation Method of Structural Strength

Evaluate the necessity of reinforcement of holes provided in seawater pipe headers by "Design and Construction Standard PPD-3422", and if reinforcement of holes is required, confirm that the required area is satisfied with prescribed in "Design and Construction Standards PPD-3424 (1)."

Reinforcement of holes in seawater pipe headers is not required if either of the hole diameters required by "Design and Construction Standard PPD-3422" is satisfied.

(1) Hole diameter 64 mm or less and hole diameter of 1/4 or less of pipe inner diameter

(2) Excluding what is listed in item (1), hole diameter is 200 mm or less, and hole diameter is equal to or less than d as determined in Figures PPD-3422-1 and PPD-3422-2

Confirm that the total area effective for reinforcement satisfies the area required for reinforcement for the hole that required reinforcement.

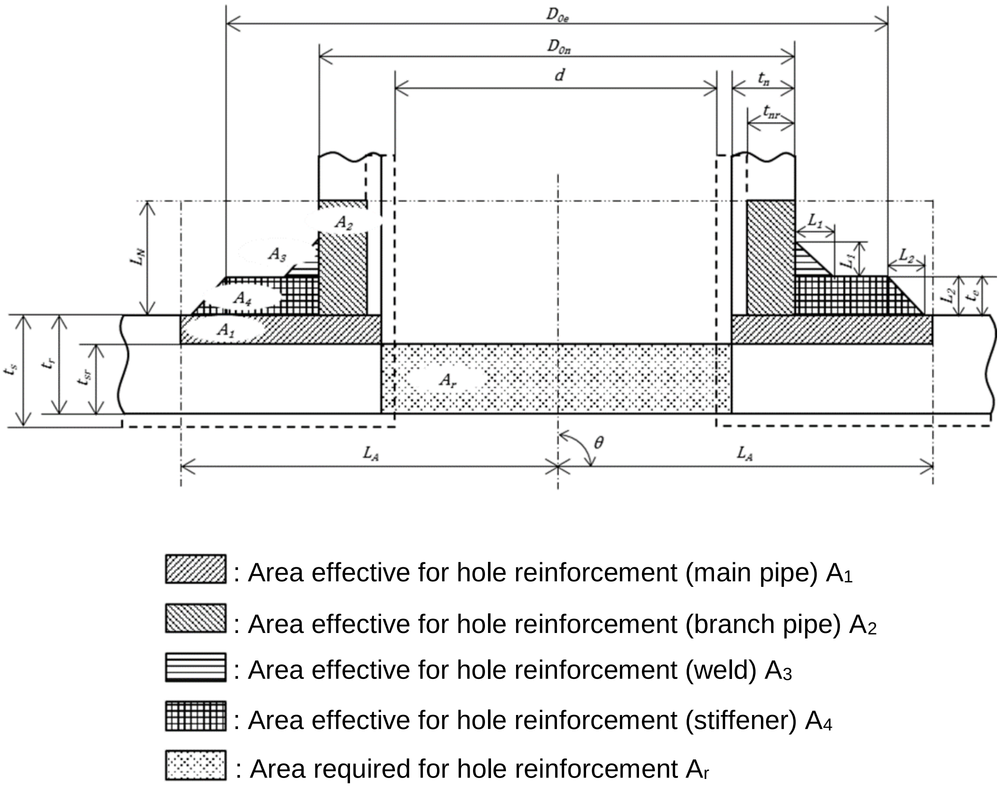


Fig. 7: Mounting type of nozzle stub

The Japanese version shall prevail.

Area required for hole reinforcement: $A_r = 1.07 \cdot \mathrm{d} \cdot t_{r^3} \cdot (2 - sin\theta)$

d	: Diameter of hole (mm)
t_{r^3}	: Thickness prescribed in PPD-3411 provisions (mm)
θ	: Crossing angle (degree) between the center line of the branch pipe and the center line of the main pipe

Total area effective for hole reinforcement: $\mathrm{A}_0 = A_1 + A_2 + A_3 + A_4$

Area of main pipe section effective for hole reinforcement:

$A_1 = (\eta \cdot t_s - F \cdot t_{sr}) \cdot (2 \cdot L_A - d)$

Area of the nozzle stub effective for reinforcing the hole:

$A_2 = 2 \cdot (t_n - t_{nr}) \cdot cosec\theta \cdot L_N \cdot \frac{S_b}{S_r}$

Area of fillet effective for hole reinforcement: $A_3 = (L_1)^2 \cdot sin\theta \cdot \frac{S_e}{S_r}$

Area of reinforcement effective for hole reinforcement:

$$A_4 = (D_{0e} - D_{0b} \cdot cosec\theta) \cdot t_e \cdot \frac{S_e}{S_r} + (L_2)^2 \cdot \frac{S_e}{S_r}$$

η	: Joint efficiency
t_s	: Thickness prescribed in PPD-3411 provisions (mm)
t_{sr}	: Required thickness for calculation of the main pipe (mm)
t_n	: Thickness of pipe
t_{nr}	: Calculated required thickness of the nozzle stub
t_e	: Minimum thickness of reinforcement
L_A	: Effective range for reinforcement delimited by straight lines parallel to the center line of the hole
L_N	: Range effective for reinforcement delimited into lines parallel to the face of the main pipe
S_b	: Allowable tensile stress at maximum working temperature of the material of the nozzle stub
S_r	: Allowable tensile stress at the maximum working temperature of the material of the main pipe
S_e	: Allowable tensile stress at the maximum working temperature of the material of the reinforcement
L_1	: Leg length of fillet part of nozzle stub or shorter side length of nozzle stub reinforcing portion
L_2	: Leg length of fillet part of strength member
D_{0b}	: Outer diameter of the nozzle stub
D_{0e}	: Outside diameter of the reinforcement
d	: Diameter of the hole appearing in the cross section
θ	: Crossing angle (degree) between the center line of the branch pipe and the center line of the main pipe
F	: Values obtained from PPD-3424-1 in Figures

2.4.2 Evaluation Results of Structural Strength

Evaluation results are shown in Table-5 to 9.

The total area effective for reinforcement satisfies the required area, and it has sufficient structural strength.

Table-5 Evaluation Results of Structural Strength on Hole Reinforcement

Evaluated component	Evaluation part	Evaluation point	η	t_s (mm)	t_{sr} (mm)	L_A (mm)	D (mm)	A_1 (mm^2)
Seawater pipe header	③Seawater nozzle pipe	Nozzle stub	1.0	14.2	[redacted]	[redacted]	[redacted]	[redacted]
	④ALPS Treated Water Injection Pipe	Nozzle stub	1.0	14.2	[redacted]	[redacted]	[redacted]	[redacted]
	⑤Vent pipe	Nozzle stub	1.0	14.2	[redacted]	[redacted]	[redacted]	[redacted]
	⑥Drain pipe	Nozzle stub	1.0	14.2	[redacted]	[redacted]	[redacted]	[redacted]
	⑦Manhole	Nozzle stub	1.0	14.2	[redacted]	[redacted]	[redacted]	[redacted]

Table-6 Evaluation Results of Structural Strength of Hole Reinforcement

Evaluated component	Evaluation part	Evaluation point	S_b (MPa)	S_r (MPa)	t_{nr} (mm)	t_n (mm)	L_n (mm)	θ (degree)	A_2 (mm^2)
Seawater pipe header	③Seawater nozzle pipe	Nozzle stub	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	90	[redacted]
	④ALPS Treated Water Injection Pipe	Nozzle stub	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	90	[redacted]
	⑤Vent pipe	Nozzle stub	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	90	[redacted]
	⑥Drain pipe	Nozzle stub	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	90	[redacted]
	⑦Inspection manhole	Nozzle stub	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	90	[redacted]

Table-7 Evaluation Results of Structural Strength of Hole Reinforcement

Evaluated component	Evaluation part	Evaluation point	S_r (MPa)	S_e (MPa)	L_1 (mm)	θ (degree)	A_3 (mm^2)
Seawater pipe header	③Seawater nozzle pipe	Nozzle stub	[redacted]	[redacted]	[redacted]	90	[redacted]
	④ALPS Treated Water Injection Pipe	Nozzle stub	[redacted]	[redacted]	[redacted]	90	[redacted]
	⑤Vent pipe	Nozzle stub	[redacted]	[redacted]	[redacted]	90	[redacted]
	⑥Drain pipe	Nozzle stub	[redacted]	[redacted]	[redacted]	90	[redacted]
	⑦Inspection Manhole	Nozzle stub	[redacted]	[redacted]	[redacted]	90	[redacted]

Table-8 Evaluation Results of Structural Strength of Hole Reinforcement

Evaluated component	Evaluation part	Evaluation point	S_r (MPa)	S_e (MPa)	D_{0e} (mm)	D_{0b} (mm)	t_e (mm)	L_2 (mm)	θ (degree)	A_4 (mm^2)
Seawater pipe header	③Seawater nozzle pipe	Nozzle stub	[redacted]	[redacted]	1300	914.4	[redacted]	[redacted]	90	[redacted]
	④ALPS Treated Water Injection Pipe	Nozzle stub	[redacted]	[redacted]	900	609.6	[redacted]	[redacted]	90	[redacted]
	⑤Vent pipe	Nozzle stub	[redacted]	[redacted]	900	609.6	[redacted]	[redacted]	90	[redacted]
	⑥Drain pipe	Nozzle stub	[redacted]	[redacted]	900	609.6	[redacted]	[redacted]	90	[redacted]
	⑦Inspection manhole	Nozzle stub	[redacted]	[redacted]	180	114.3	[redacted]	[redacted]	90	[redacted]

Table-9 Evaluation Results of Structural Strength of Hole Reinforcement

Evaluated component	Evaluation part	Evaluation point	d (mm)	θ (degree)	t_r[3] (mm)	A_r (mm^2)	A_0 (mm^2)
Seawater pipe header	③Seawater nozzle pipe	Nozzle stub	[redacted]	90	[redacted]	6.35×10^3	1.67×10^4
	④ALPS Treated Water Injection Pipe	Nozzle stub	[redacted]	90	[redacted]	7.43×10^2	2.52×10^3
	⑤Vent pipe	Nozzle stub	[redacted]	90	[redacted]	7.43×10^2	2.52×10^3
	⑥Drain pipe	Nozzle stub	[redacted]	90	[redacted]	7.43×10^2	2.52×10^3
	⑦Inspection manhole	Nozzle stub	[redacted]	90	[redacted]	4.16×10^3	1.19×10^4

2.5 Mounting strength of reinforcement

2.5.1 Evaluation Method of Structural Strength

Evaluate the load to be incurred by the welds prescribed in the "Design and Construction Standards PPD-3424 (8)" and confirm that the welds strength is sufficient.

Loads to be incurred by welds: $W = d \cdot t_{sr} \cdot S_s - (\eta \cdot t_s - F \cdot t_{sr}) \cdot (2 \cdot L_A - d) \cdot S_s$

d : Diameter of hole appearing in cross section (mm)

t_s : Minimum thickness of main pipe (mm)

t_{sr} : Required thickness for calculation of the main pipe (mm)

S_s : Allowable tensile stress at the maximum working temperature of the material of the main pipe

η : Joint efficiency

F : Values obtained from Figures of PPD-3424-1

L_A : Effective range for reinforcement delimited by straight lines parallel to the center line of the hole

2.5.2 Evaluation Results of Structural Strength

Table-10 shows evaluation results. Since the load that the weld should bear is 0 or less, the strength of the weld is evaluated to be sufficient.

The Japanese version shall prevail.

Table-10 Evaluation Results of Structural Strength to Mounting Strength of Reinforcement

Evaluation component	Evaluation Part	Evaluation point	d (mm)	t_{sr} (mm)	S_S (MPa)	t_s (mm)	η	L_A (mm)	F	W(N)
Seawater pipe header	③Seawater nozzle pipe	Nozzle stub	[redacted]	[redacted]	100	14.2	0.6	[redacted]	0.5	-3.69×10^{5}
	④ALPS Treated Water Injection Pipe	Nozzle stub	[redacted]	[redacted]	100	14.2	1.0	[redacted]	0.5	-4.32×10^{4}
	⑤Vent pipe	Nozzle stub	[redacted]	[redacted]	100	14.2	1.0	[redacted]	0.5	-4.32×10^{4}
	⑥Drain pipe	Nozzle stub	[redacted]	[redacted]	100	14.2	1.0	[redacted]	0.5	-4.32×10^{4}
	⑦Inspection manhole	Nozzle stub	[redacted]	[redacted]	100	14.2	0.6	[redacted]	0.5	-2.42×10^{5}

II Tolerance of nominal values for ALPS Treated Water Dilution/Discharge Facilities

Table-1 Tolerance of seawater pipe

[Seawater pipe header]

Major dimensions (mm)			Tolerance	Basis
Main pipe	Outer diameter	2235.2	[redacted]	Production capacity, manufacturer's standards considering production result
	Thickness	16.0	[redacted]	Production capacity, manufacturer's standards considering production result
Outlet pipe	Outer diameter	1828.8	[redacted]	Production capacity, manufacturer's standards considering production result
	Thickness	16.0	[redacted]	Production capacity, manufacturer's standards considering production result
Seawater nozzle pipe	Outer diameter	914.4	[redacted]	Production capacity, manufacturer's standards considering production result
	Thickness	16.0	[redacted]	Production capacity, manufacturer's standards considering production result
ALPS Treated Water Injection Pipe	Outer diameter	114.3	[redacted]	Material tolerance according to JIS
	Thickness	6.0	[redacted]	Material tolerance according to JIS
Vent pipe	Outer diameter	114.3	[redacted]	Material tolerance according to JIS
	Thickness	6.0	[redacted]	Material tolerance according to JIS
Drain pipe	Outer diameter	114.3	[redacted]	Material tolerance according to JIS
	Thickness	6.0	[redacted]	Material tolerance according to JIS
Inspection manhole	Outer diameter	609.6	[redacted]	Production capacity, manufacturer's standards considering production result
	Thickness	16.0	[redacted]	Production capacity, manufacturer's standards considering production result
Reducer	Thickness	16.0	[redacted]	Production capacity, manufacturer's standards considering production result
End plate	Thickness	16.0	[redacted]	Production capacity, manufacturer's standards considering production result

[Seawater transfer Pipe]

Major dimensions (mm)		Tolerance	Basis
Outer diameter	914.4	[redacted]	Production capacity, manufacturer's standards considering production result
Thickness	13.0	[redacted]	Production capacity, manufacturer's standards considering production result

Reference

Action in response to "Basic Policy on handling of ALPS treated water at the Tokyo Electric Power Company Holdings' Fukushima Daiichi Nuclear Power Station"

On April 13, 2021, "The 5th the Ministerial Conference of Contaminated Water, Treated Water and Decommissioning," was held and established the " Basic Policy on handling of ALPS treated water at the Tokyo Electric Power Company Holdings' Fukushima Daiichi Nuclear Power Station (hereinafter "Basic Policy")".

Following the Basic Policy, TEPCO established "TEPCO Holdings' Action in Response to the Government's Policy on the Handling of ALPS Treated Water" on April 16, 2021, which shows measures shall be taken in response to the government policy, and, some part of the implementation plan explicitly mentioned for reference as items below, which are the items related to the discharge method of ALPS treated water into the sea, design and operations of the required facilities, and radiological impact of discharge into the sea.

(1) Required administrative works and facility development, etc. are pushed forward to enable the discharge of ALPS treated water into the sea in around the spring of 2023, which is about 2 years after the release of the Basic Policy.
(2) Prior to the discharge, with a commitment from a third party with expertise in analysis of radioactive materials, tritium concentration of the ALPS treated water shall be confirmed while the purification of the water shall be confirmed to ensure that radioactive materials other than tritium is below the regulatory limit, and the confirmation result shall be disclosed.
(3) Tritium concentration of the discharge water after dilution with seawater shall be less than 1,500 Bq/L. To achieve this criteria, ALPS treated water shall be hugely diluted with seawater (100 times or more).
(4) Annual discharge volume of tritium shall be within 22 TBq per year.
(5) At the beginning of the discharge into the sea, it shall begin with smaller volume while impact on surrounding environment is confirmed through the sea area monitoring. Operation procedures are set to shut down the ocean discharge without fail in case the ALPS treated water dilution and discharge facility fails to discharge into the sea as designed, or any abnormal value is detected by the monitoring.
(6) Safety assessment regarding radiological impact to human and environment shall be done when ALPS treated water is discharged into the sea.

Attachment-1 Action in Response to the Basic Policy of the Government
Attachment-2 Radiological Impact Assessment Report Regarding the Discharge of ALPS Treated Water into the Sea (Design stage / Revised version)

The Japanese version shall prevail.

Attachment-1

Action in Response to the Basic Policy of the Government

Among the address in response to the Basic Policy, each action to 6 items, which are related to the discharge method of ALPS treated water into the sea, design and operations of the required facilities, and radiological impact from discharge into the sea, are described from the next page.

The Basic Policy

3. Specific method of the ALPS treated water discharge into the sea

(1) Basic directions

5) The Government requires that TEPCO will proceed with concrete preparations such as the construction of facilities for discharge and other works, to start discharge of ALPS treated water into the sea approximately after two years.

○Action in response to the Basic Policy

Required administrative works and facility development, etc., including tests about equipment structure, strength, and leakage as well as tests to verify functions and performance of the whole facility, shall be pushed forward to enable discharge the ALPS treated water into the sea in around the spring of 2023, which is about 2 years after the release of the Basic Policy.
(See "II.2.50 ALPS Treated Water Dilution/Discharge Facilities and the Related Facility")

3. Specific method of the ALPS treated water discharge into the sea

(2) A method of discharge that minimizes adverse impacts on reputation

1) Discharge of the ALPS treated water into the sea is conducted after sufficiently diluting the ALPS treated water. Prior to the discharge, i) the concentration of tritium of the ALPS treated water and ii) the water is purified until the level of radioactive materials other than tritium satisfies the regulatory standards for safety, will be confirmed and disclosed, engaging with third-party experts who have expertise in analysis of the radioactive materials.

○Action in response to the Basic Policy

Prior to the ALPS treated water discharge into the sea, while tritium concentration of the water is confirmed, to confirm that purification has made its sum of the ratios to regulatory concentrations limits of radioactive material other than tritium less than 1, radioactive materials other than tritium shall be confirmed to be purified to the level below the safety criteria without fail by conducting analysis by a third party analysis organization with expertise in the analysis in addition to the analysis by our company's analysis facility, and the results are compared. These results are disclosed at every timing of the ALPS treated water discharge.
(See "III 3.2.1 Supplementary Explanations in Relation to the Management of Radioactive Wastes, etc." and Appendix-1)

3. Specific method of the ALPS treated water discharge into the sea

(2) A method of discharge that minimizes adverse impacts on reputation

2) To allay the concerns of the consumers, the target concentration of tritium should be the same as the operational target (less than 1,500Bq/Liter-water7) for the currently implemented discharge of water pumped up via sub-drains, at Fukushima Daiichi NPS. 3) To achieve this target concentration of tritium, prior to the discharge into the sea, the ALPS treated water needs to be sufficiently diluted (more than 100 times8) by sea water. Radioactive materials other than tritium will also be significantly diluted with this dilution.

○Action in response to the Basic Policy

Operations target of less than 1,500 Bq/L of tritium concentration in the seawater after dilution of ALPS treated water shall be achieved by securing required flow rate of seawater for the seawater dilution by operating 2 units or more of seawater transfer pump constantly after installing 3 units of seawater transfer pump with capacity of 170 thousand m^3/day each while setting flow rate of ALPS treated water at the range of 500 m^3/day at maximum.
(See “III 3.1.9 Operation Management of the ALPS Treatment Water Dilution/Discharge Facilities”)

The Japanese version shall prevail.

3. Specific method of the ALPS treated water discharge into the sea

(2) A method of discharge that minimizes adverse impacts on reputation

4) The total annual amount of tritium to be discharged will be at a level below the operational target value10 for tritium discharge of the Fukushima Daiichi NPS before the accident (22 trillion Bq/year). The amount will be reviewed periodically. This operational value for tritium discharge is within the range of the amount of discharge from each nuclear power station inside and outside the county.

○Action in response to the Basic Policy

In the near term, amount of tritium of the ALPS treated water discharge into the sea shall have the upper limit of 22 TBq per year, which was the discharge control value of Fukushima Daiichi Nuclear Power Station before the accident, and shall be lower than that.

The discharge amount of the tritium shall be reviewed every fiscal year based on the trend of generation volume of the contaminated water and the trend of tritium concentration at the entrance of desalination device as well as utilization plan of the premise which influences the progress of the decommissioning.

Regarding the control of annual discharge, a discharge plan for the fiscal year is decided at the beginning of the fiscal year, and actual operation of the ocean discharge of ALPS treated water is carried out according to the plan. In addition, the control shall also be conducted from the facility side by embedding an interlock in the oversight/ control device to keep the annual discharge amount below 22 TBq.

However, when the generation volume of the contaminated water and the tritium concentration at the entrance of the desalination device, which are assumptions of the annual discharge planning, have changed to a large extent, adjustment shall be made flexibly within the range of 22 TBq of annual discharge.

(See “III 3.1.9 Operation Management of the ALPS Treatment Water Dilution/Discharge Facilities”)

3. Specific method of the ALPS treated water discharge into the sea

(2) A method of discharge that minimizes adverse impacts on reputation

6) The discharge into the sea will be conducted in small amount at the initial phase, while confirming the impacts on the surrounding environment. Discharge will be securely stopped until the safety of the discharge is confirmed, if there is any malfunction of dilution facilities and other equipment due to a power or other failure, or if a radiation monitor detects an irregular value.

○Action in response to the Basic Policy

At the beginning of the discharge into the sea, it shall start with smaller volume while impact on surrounding environment is confirmed through sea area monitoring. For the case the ALPS treated water dilution and discharge facility fails to discharge to the ocean as designed by any chance due to reasons such as a failure or power outage of the ALPS treated water dilution and discharge facility, or for the case any abnormal value is detected by the monitoring, operation procedures are set so as to shut down the ocean discharge without fail until the situation is confirmed to be ready for the safe discharge.

(See “III 3.1.9 Operation Management of the ALPS Treatment Water Dilution/Discharge Facilities” and Appendix-2 and 3)

3. Specific method of the ALPS treated water discharge into the sea

(2) A method of discharge that minimizes adverse impacts on reputation

7) Taking into account domestic and international concerns about the potential impact on the environment of discharge into the sea, the Government and TEPCO have been conducting analysis11 from various perspectives on the environmental impact of the discharge. In the actual discharge, TEPCO strictly complies with the national regulatory standards set based on recommendations of ICRP. Furthermore, considering relevant international law and international practice, measures shall be taken to assess the potential impact on the marine environment, and to ascertain the environmental situation through continuous monitoring stated above after discharge. The Government will seek to foster understanding both the general public and international community through ensuring a high degree of transparency by availing the information regarding the impact on the environment to the public in a timely manner.

○Action in response to the Basic Policy

Regarding the discharge of ALPS treated water into the sea, regulatory standards stipulated according to ICRP recommendations shall be strictly followed, and assessment for radiological impacts are carried out about the impact on the marine environment, and are reviewed by IAEA experts, etc., to check that they meet relevant international laws and practices. In addition, sea area monitoring shall be continued after the discharge to grasp the environmental situation.
Information on the environmental impact of the ALPS treated water into the sea shall be communicated accurately and promptly inside and outside Japan, and efforts shall be made to foster understanding inside and outside Japan.

Supplementary explanation on the analyses of ALPS treated water prior to discharge into the sea

In order to confirm the tritium concentration of ALPS treated water as well as that the sum of ratios to regulatory concentration limit other than tritium of ALPS treated water is treated to less than 1 including the accuracy objectively, the ALPS treated water will be analyzed by not only TEPCO but also third-party analysis institute.

1.Operation method

Comparison of analytical results with a third-party analysis institute is conducted as a measure to show that the intended analysis is carried out from the pretreatment method to the acquisition of analytical results for our measurements, and that the obtained analytical values are appropriate. Comparison should include analytical precision, and if there is a steady discrepancy, we investigate the factors and improve the analytical environment or equipment as necessary.

2.View of selection for third-party analysis institute

TEPCO will select a third-party analysis institute, which has obtained certification for the analysis of radionuclides such as ISO/IEC-17025, which is a standard for ability to obtain analytical results of characteristics, properties, etc. for liquid with properties equivalent to those of ALPS treated water based on determined methods, and from domestic companies that do not have any interest with TEPCO.

End

Supplemental explanation on the small volume discharge at the early stage of discharge into the sea

In the ALPS treated water discharge into the sea, dilution and discharge is to be carried out each tank group for ALPS treated water (approx. 10 thousand m^3/tank group) measured/confirmed in the measurement/confirmation facility. In doing so, in accordance with the Basic Policy, discharge shall be carried out cautiously with small volume in the early stage in following 2 steps, and required validation shall be made.

Step 1: To confirm the expected dilution in ALPS treated water dilution/discharge facilities, using the discharge vertical shaft (upper-stream storage), tritium concentration is confirmed directly after the small volume of the ALPS treated water is diluted, and then it is discharged into the sea. (Refer to 1. operation method of the step 1)

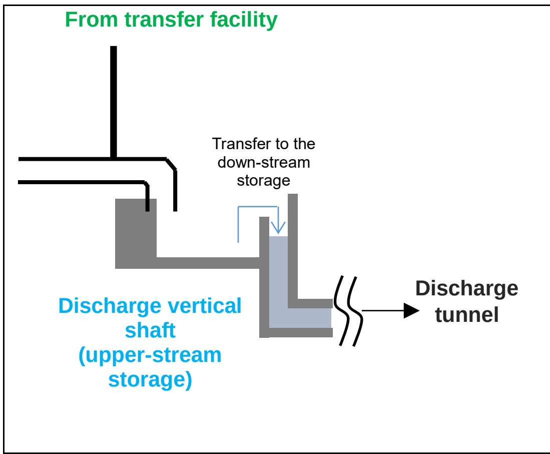
Step 2: To confirm the secure operation under the operation procedure of ALPS treated water dilution/discharge facilities and the related facility, and no significant change of tritium concentration in the sea due to discharge into the sea, the ALPS treated water is discharged into the sea with adjustment of discharge volume and intervals. Discharge method of the step 2 will be determined in the discharge plan of the first fiscal year of the discharge.

After the step 2, ALPS treated water in a tank group of approximately 10 thousand m^3, measured in the measurement/confirmation facility, will be discharged continuously, followed by another tank group with no interval between tank groups.

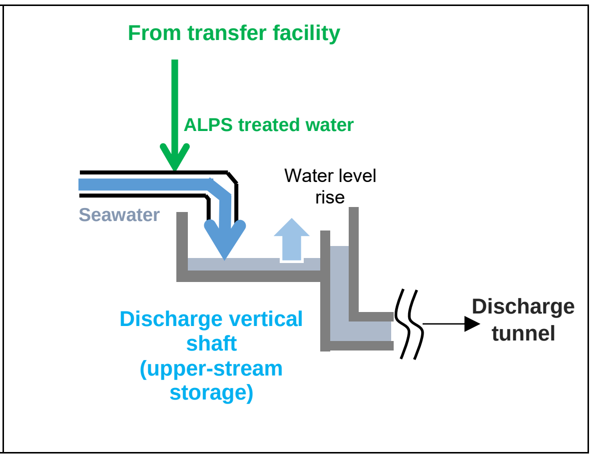
1. Operation method of the step 1

After the discharge vertical shaft (upper-stream storage) with the capacity of approx. 2,000 m^3 is emptied, one seawater transfer pump is started, small volume of ALPS treated water (20 m^3 or less) is transferred to the discharge vertical shaft (upper-stream storage).

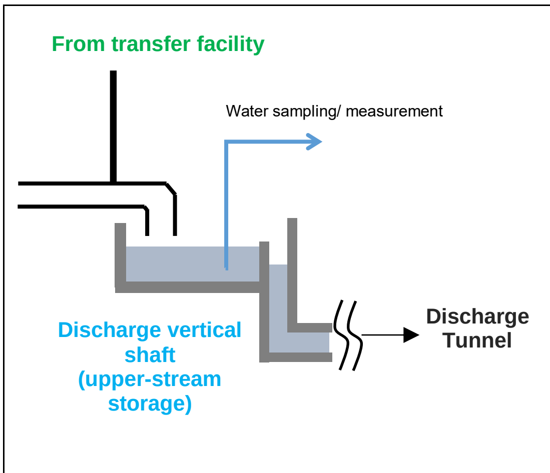
Thus, sample water is collected from the discharge vertical shaft (upper-stream storage) to measure its tritium concentration. The measured tritium concentration of this sample is compared with the calculated tritium concentration, which determined from the volume of the transferred ALPS treated water and the volume of the seawater used for dilution, to check the two values are at similar level and the measured tritium concentration is less than 1,500Bq/L. After confirming that, the seawater for dilution is transferred again to discharge into the sea.



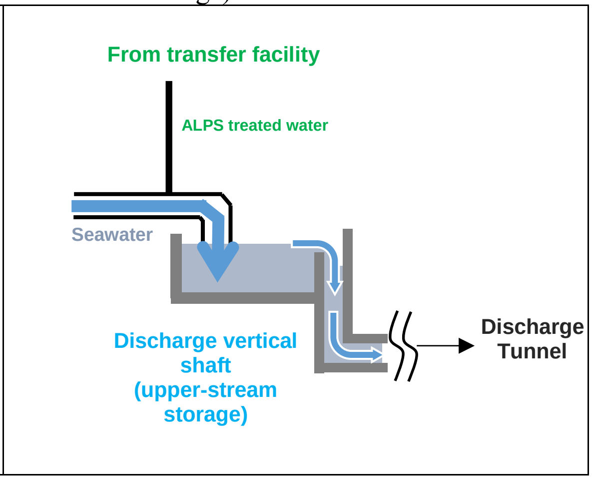
(1) Empty the discharge vertical shaft (upper-stream storage).



(2) Store ALPS treated water transferred by the transfer facility and diluted by the dilution facility, in the discharge vertical shaft (upper-stream storage).



(3) Stop the pump before the discharge vertical shaft (upper-stream storage) is fully filled with water, and collect and measure sample water in the discharge vertical shaft (upper-stream storage) (suspend the discharge until the result is given).



(4) Verify that the actual concentration is close to the calculated tritium concentration and less than 1,500 Bq/L, before flowing seawater and discharging the water in the discharge vertical shaft (upper-stream storage) into the sea.

Figure-1 Image of operation in the step 1

End

Supplemental explanation on the response when facility failure is detected or an abnormal value is monitored in the sea area monitoring

1. Suspension of discharge into the sea due to facility failure

When facility failure is identified, operation procedures to shut down the discharge to the ocean shall be as follows.

1.1 Suspension of discharge into the sea due to facility failure

ALPS treated water dilution/discharge facilities have emergency isolation valves which function is 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.

Here, 9 types of deviation from normal operations which make the emergency isolation valves "closed" are assumed. In addition, emergency shutdown is available manually by design by the monitoring/control system (see Table2).

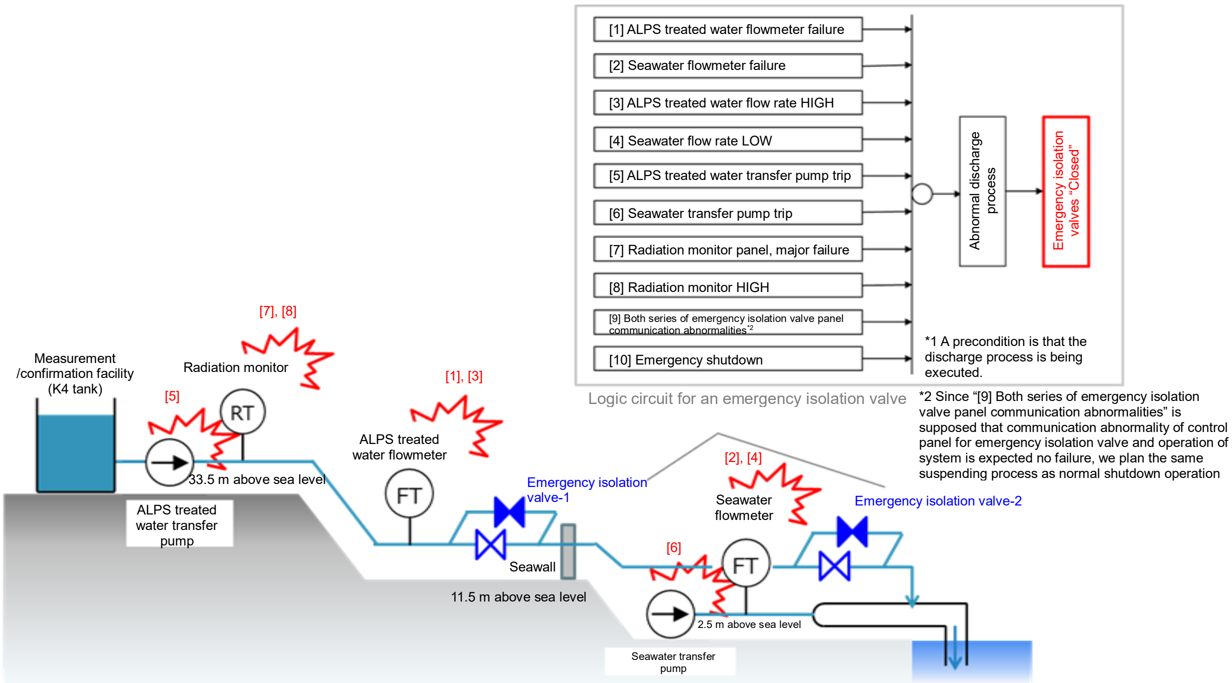


Figure-2 Logic circuit of the emergency isolation valve

The Japanese version shall prevail.

Table 1 Details of operation signal for the emergency isolation valve

Element	Signal	Objectives
ALPS treated water flowmeter failure	Transfer line (A) (B) flowmeter overscale	The flow rate cannot be monitored due to instrument failure.
	Transfer line (A) (B) flowmeter downscale	The flow rate cannot be monitored due to instrument failure or cable disconnection.
Seawater flowmeter failure	Seawater transfer pump (A) (B) (C) flowmeter overscale	The flow rate cannot be monitored due to instrument failure.
	Seawater transfer pump (A) (B) (C) flowmeter downscale	The flow rate cannot be monitored due to instrument failure or cable disconnection.
ALPS treated water flow rate HIGH	Transfer line (A) (B) flow rate signal	To maintain tritium concentration after dilution below 1,500 Bq/L due to increased transfer line flow rate
Seawater flow rate LOW	Seawater transfer pump (A) (B) (C) Flow signal	To prevent an increase in tritium concentration after dilution due to insufficient supply of seawater for dilution. Due to possible abnormalities in the seawater transfer system.
ALPS treated water transfer pump trip	Circuit breaker trip signal	Due to possible abnormalities in the transfer process.
Seawater transfer pump trip	M/C trip signal	To prevent an increase in tritium concentration after dilution due to stopping of supply of seawater for dilution Due to possible abnormalities in the seawater transfer system.
Radiation monitor panel, major failure	Radiation monitor (A) (B) lower limit	Monitoring by radiation monitors is not available
	Radiation monitor (A) (B) circuit breaker trip	
Radiation monitor HIGH	Radiation monitor (A) (B) High	Abnormalities were detected by radiation monitor
Both series of emergency isolation valve panel communication abnormalities	Communication abnormal signal in both series	When communication abnormalities occur in the emergency isolation valve panel in both series, an abnormal signal cannot be received, and the automatic closure of the emergency isolation valve is disabled.
Emergency shutdown	Emergency shutdown signal	To stop immediately when an abnormality is detected by an operator

2. Suspension of discharge into the sea due to the sea area monitoring

Based on the results of sea area monitoring, assessment shall be carried out as follows.

2.1 Operation method

Confirmation shall be made that it stays within the assumed range through comparison with such as simulation results of diffusion in the sea, and concentration used for the radiological impact assessment. The abnormal value in the sea area monitoring will be set appropriately after ascertaining variation range of result of the sea area monitoring before and after discharge ALPS treated water into the sea. When the result exceeds the normal range of variation, results of other monitoring organizations shall also be confirmed and investigation shall be made about the causes. When an event is identified in which it hugely exceeds the normal range of variation, the discharge into the sea shall be suspended temporarily, and measurement shall be made again for the area, together with confirmation of no failure in the surrounding sea area while expanding the area and frequency temporarily.

Measurement results of the sea area monitoring have been stocked from April 2022, and normal values before the discharge shall be held such as changes in seawater concentration by tritium contained in treated water of subdrain/underground drain water and water of underground water bypass system, premise drainage.

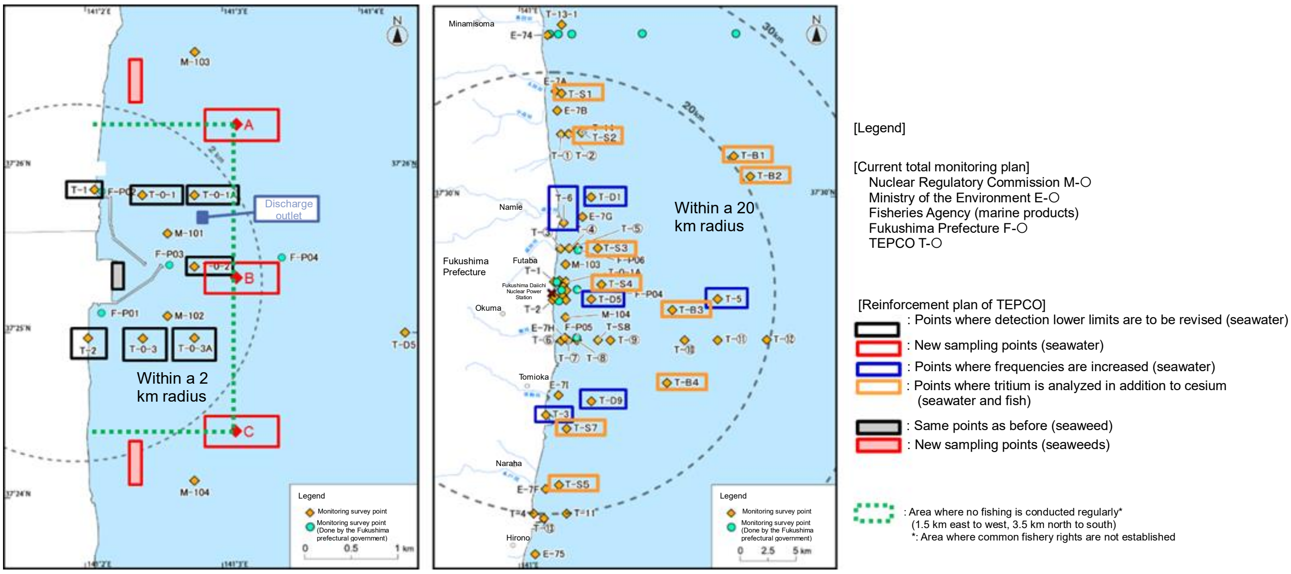


Figure-3 Monitoring chart of the sea area within a 20 km radius from the power station

The Japanese version shall prevail.

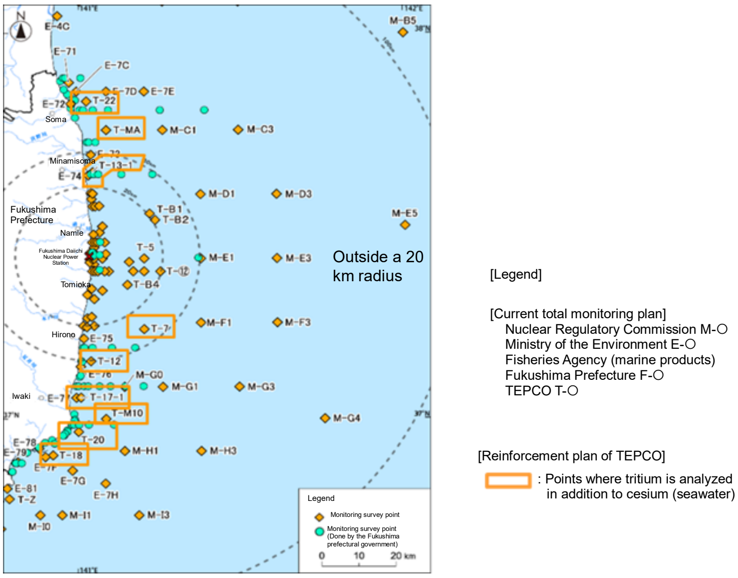


Figure-4 Monitoring chart of the sea area outside a 20 km radius from the power station

End

The Japanese version shall prevail.