Ensuring Safety of ALPS treated water discharged into the sea

July 2023

Ministry of Economy, Trade and Industry

Necessity of Disposal of ALPS treated water for Decommissioning of FDNPS

- Since the accident in March 2011, water has been continuously injected **to cool the fuel debris***. By maintaining the reactor in a stable condition, decommissioning work can proceed.
  * Solidified fused materials composed of fuel, structures, etc.
- However, **groundwater, etc. flows into buildings** and **mixes with water containing radioactive materials in buildings**, and **the volumes of that water increases**.
- The increased water is **reused for cooling** as much as possible, and **the remainder is purified by ALPS**(Advanced Liquid Processing system) **and stored in tanks on FDNPS site**. Efforts are being made to reduce the amount of water flowing into buildings, but **the large volume of tanks is putting pressure** on the site and **may impede decommissioning work**.
- It is necessary to bring the concentration of radioactive materials in the water stored in these tanks to a level well **below regulatory standards** and **dispose** of it **safely** in order to **proceed with decommissioning**, which is **a major prerequisite for reconstruction of Fukushima**.
- In order to safely dispose, the government **announced the Basic Policy** on discharge of ALPS treated water into the sea in April 2021, after studying various methods **for over six years**.

Basic Policy on ALPS treated water (announced in April 2021)

➢ Japanese Government requires that TEPCO will proceed with concrete preparations to start discharge of ALPS treated water into the sea approximately after two years.

⑴ A method of discharge that minimizes adverse impacts on reputation

①Tritium (H-3) :

・Concentration : 1,500Bq/L (1/40 of the regulatory standard value for tritium and around 1/7 of the WHO Guidelines for drinking water quality value)

・Total annual amount : 22 trillion Bq/year (operational target value before the accident)

②Other than Tritium : purify until the level satisfies the regulatory standards for safety

⑵ Thorough monitoring of sea areas

- Strengthen and enhance monitoring before and after the discharge. Having participation and observation by agriculture, forestry, fisheries, local municipalities and other businesses.
- Secure credibility of analytical capacity with the cooperation of IAEA
- Suspend discharges in case unusual values are detected.

Efforts to ensure safety following the announcement of the Basic Policy in Apr. 2021

	Review by Regulatory Agencies, etc.	Review by IAEA
2021	**Apr. The Basic Policy announced**	
		Jul. Signed TOR for the review.
		Sep. IAEA officials visited Japan.
	Dec. TEPCO applied for approval to amend the implementation plan for installation of facility.	Dec. Online meeting between the Minister Hagiuda and Director-General Grossi
2022		Feb. Safety Review Mission (1)
		Mar. Regulatory Review Mission (1)
		Apr. Report on Safety Review Mission was published.
		May Director-General Grossi visited Japan.
		Jun. Report on Regulatory Review Mission was published.
	Jul. NRA **approved the amendment** of the implementation plan for **installation of facility**.	
	Aug. **Prior approval by local governments** (Fukushima Pref., Okuma Town, Futaba Town) (8 requirements)	
	Oct. TEPCO reported progress at **Fukushima Prefecture Decommissioning Safety Monitoring Council***.	
	Nov. TEPCO applied for approval to amend the implementation plan for operational measures.	Nov. Safety Review Mission (2)
		Dec. Report on Status of Sampling, Data Corroboration, and Analysis was published.
2023		Jan. Regulatory Review Mission (2)
		Apr. Report on Safety Review Mission was published. Online meeting between Minister Nishimura and Director-General Grossi.
	May NRA **approved the amendment** of the implementation plan for **operational measures**.	May Report on Regulatory Review Mission was published. Report on First Interlaboratory Comparison was published. Comprehensive Review Mission
	Jul. **NRA issued certificate of completion for pre-service inspections.**	Jul. Comprehensive Report was published.
	Aug. Start discharge	Aug. IAEA office at FDNPS established
		Oct. IAEA Review Mission

*Decommissioning Safety Monitoring Council: The Council, consisting of Fukushima Prefecture, 13 municipalities, and academic experts, reported on the progress of the 8 requirements for ALPS treated water at the time of prior approval by local governments.

Points that are assessed as being consistent with international safety standards in IAEA Comprehensive Report

※The report is compiled under IAEA's authority based on the reviews by Task Force (IAEA staff and eleven international experts).

Radiological impact on humans and the environment

- The discharge of the ALPS treated water will have **a negligible radiological impact on people and the environment.** 【V】
  - A Radiological Environmental Impact Assessment(REIA) has been produced and is compliant with the international safety standards.【p.83】
  - The IAEA has accepted the rationale presented by TEPCO for a sufficiently conservative, yet realistic, source term*. (*characteristic of radioactive materials in the ALPS treated water assessed before discharge)【p.58】
  - Based on the results of the marine dispersion model used by TEPCO, activity concentrations in international waters will not be influenced by the discharge of ALPS treated water into the sea and **the transboundary impacts are therefore negligible.**【p.80】

Safety related aspects of systems and processes for controlling discharges

- The IAEA notes that **the systems and processes in place to control the discharges of ALPS treated water are robust.**【p.53】
- Redundancy was built into the system for some components, such as emergency isolation valves and detectors.【p.29】

Regulatory control and authorization

- NRA serves as the independent regulatory body within Japan, **has promulgated and implemented an appropriate legal and regulatory framework for safety.**【p.42】

Analysis/Source and Environmental Monitoring

- The IAEA has concluded that the monitoring activities and approach taken by TEPCO and GOJ are consistent with the relevant international safety standards.【p.94】
- The results of the first interlaboratory comparison provide confidence in **TEPCO's capability for undertaking accurate and precise measurements** related to the discharge of ALPS treated water. **TEPCO has demonstrated that it has a sustainable and robust analytical system.**【p.108】
- **Neither the IAEA, nor the participating third-party laboratories, detected any additional radionuclides (i.e., radionuclides beyond what is included in the source term) at significant levels.** 【p.107】

The IAEA is committed to engaging with Japan on the discharge of ALPS treated water **not only before, but also during, and after the treated water discharges occur.** Additional review and monitoring activities are envisaged that will continue and which will provide additional transparency and reassurance to the international community. 【V, VI】

Overall Picture of ALPS Treated Water Discharge into the Sea

IAEA Review 1 Safety of ALPS treated water
(Characterization of Treated Water, Safety of the Facilities, Radiological Environmental Impact Assessment)

Characterization of Treated Water

29 nuclides other than tritium were selected for radiation exposure evaluation

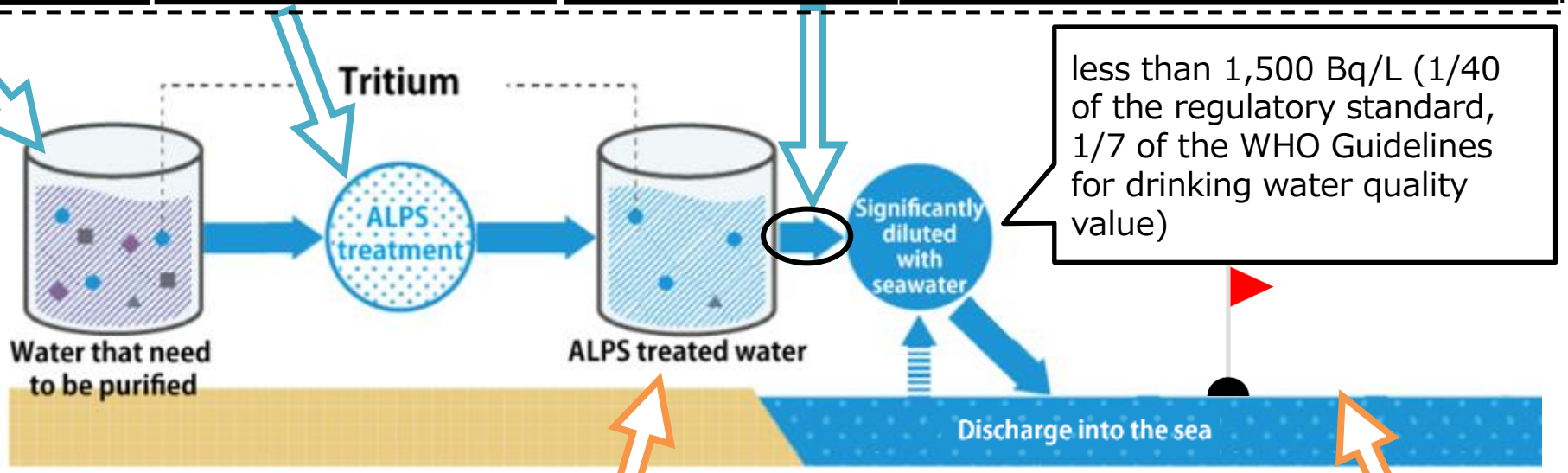
Safety of the Facilities

All nuclides other than tritium are purified until the concentration level is below regulatory standards.

In the event any abnormality etc. is detected, the discharge will be stopped by using two emergency isolation valves.

Radiological Environmental Impact Assessment (International Approach)

Long-term effect including bioaccumulation, etc. is assessed by using the IAEA's approach for all nuclides. Marine dispersion simulation is conducted.



IAEA Review 2
Adequacy of the Regulatory Process

Review by Regulatory Agencies, etc.

Installation of the discharge facilities and operation of the facilities have been authorized by NRA

IAEA Review 3 Independent sampling and data corroboration and analysis

Source (ALPS treated water) monitoring before the discharge

Prior to the discharge, it will be confirmed that nuclides other than tritium are **below regulatory standards**
(Otherwise, the treated water will not be discharged and will be re-purified.)

Sea area monitoring based on CRMP

Monitoring of seawater, sediment and marine biota will be conducted to confirm no significant changes before and after the discharge into the sea

Characteristics of ALPS treated water
(selection of nuclides to be confirmed before discharge, purification performance of ALPS, etc.)

- The ALPS has 62 nuclides to be removed, but **in response to the IAEA's suggestion**, **29 nuclides other than tritium that could realistically exist in the water before treatment were selected for analysis before the discharge**, taking half-lives and other factors into consideration. **(No nuclides other than the 29 nuclides have been detected so far, but measurement continues.)**
- **Only 9 out of 29 nuclides were detected after treatment by ALPS**, and these were also purified to well below the regulatory standard, indicating that ALPS has achieved stable purification with sufficient performance.

Concept of selection of nuclides to be confirmed before discharge

Even taking into account the half-life, could exist in 12 years (2023)

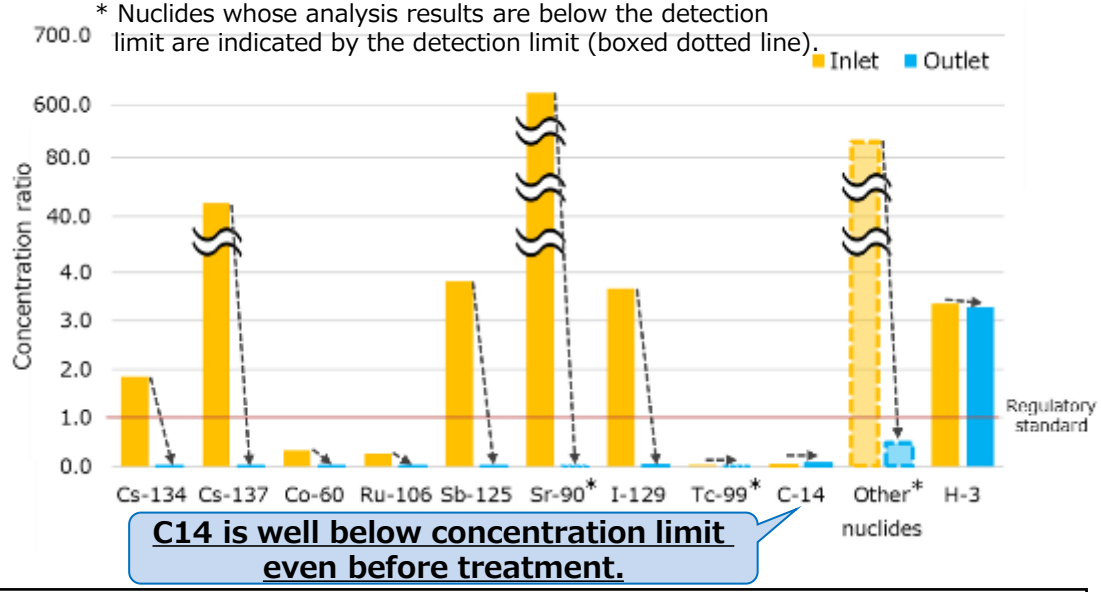
↓ 210 nuclides

Considering its solubility in water, etc. can realistically exist in the water before treatment

↓ 30 nuclides

Selected "29 nuclides" excluding tritium

Example of ALPS treatment results (May 2022)



Assessments by IAEA

- ✓ The concept and results of selecting 29 nuclides are **sufficiently conservative, yet realistic**. 【p.58】
- ✓ **Many radionuclides** included in the source term **will never be detected in ALPS treated water**. 【p.59】

Safety of the Discharge Related Facility

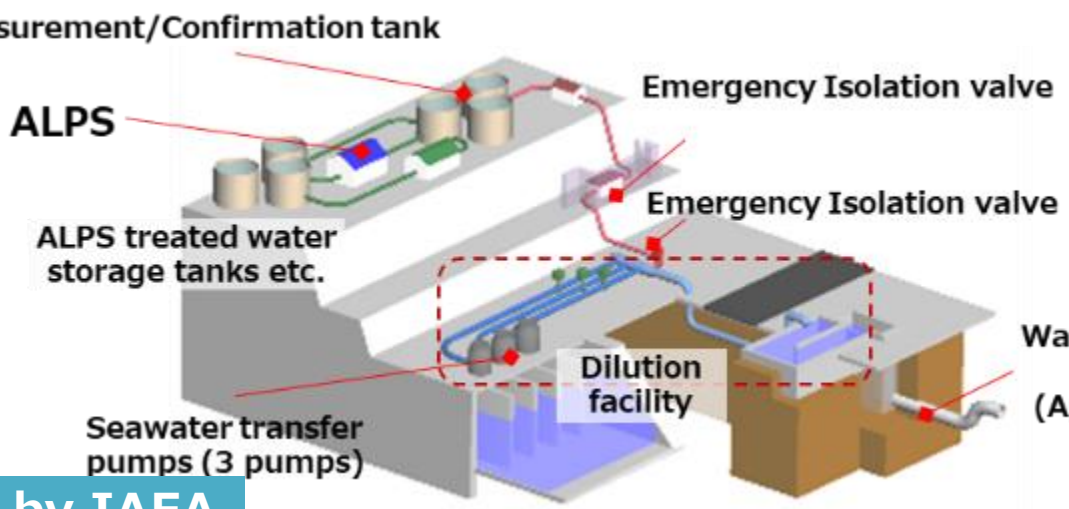
- For the discharge into the sea
  1) The water that needs to be purified will be **purified by ALPS until the concentrations of nuclides other than tritium, fully satisfy the regulatory standards**.
  2) Water after the purification (ALPS treated water) **is agitated and homogenized in the" Measurement/Confirmation Facility** " and **the concentration*1 will be confirmed**.
  3) The treated water will be **diluted more than 100 times*2 at the "Dilution Facility" to meet the regulatory standard for tritium** and **only the water meeting the regulatory standard will be discharged into the sea***3.
- If **an abnormality etc., is detected**, **the discharge will be stopped by closing the two emergency valves**.

*1 The third-party laboratories are also conducting analysis to ensure the objectiveness.

*2 Tritium concentration after the dilution will be less than 1,500 Bq/L (1/40 of the regulatory standard, 1/7 of the WHO Guidelines for drinking water quality value).

*3 Total annual amount of the tritium to be discharged will be less than the operational target of the FDNPS before the accident (22 TBq).

Discharge related facilities for ALPS Treated Water



Assessments by IAEA

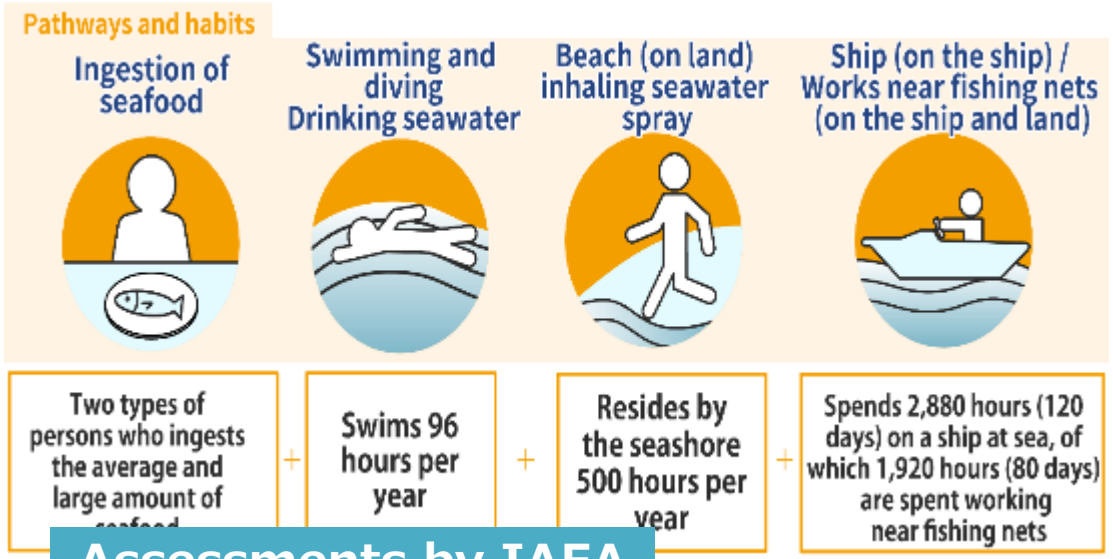
- ✓ **The systems and processes** in place **to control the discharges** of ALPS treated water **are robust and more than adequate for the expected low doses and the low risk arising** from the discharge process.【p.53】
- ✓ **Redundancy was built into the system for some components**, such as emergency isolation valves and detectors.【p.29】
- ✓ The pre-service inspections conducted by the NRA are sufficient to ensure the installation and operation of relevant **facilities and equipment is consistent with the NRA-approved Implementation Plan**.【p.53】

Assessment of Radiation Impacts Using International Methods

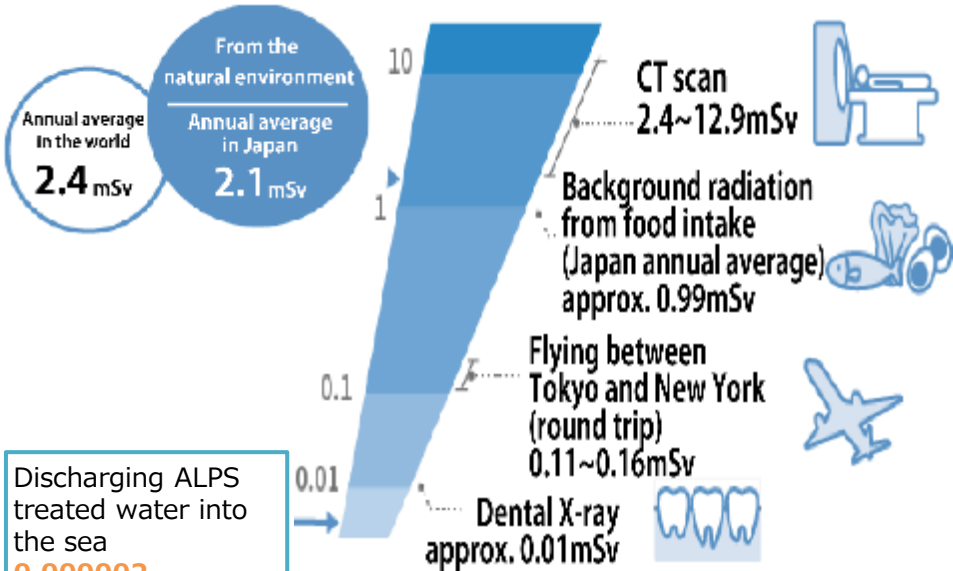
- **"The most affected person" who frequents the sea area around the discharge point (10km×10km) is assessed.**
- **All radionuclides including tritium are assessed based on the IAEA evaluation method which the effect of food chain and bioaccumulation were taken into account.**
- **The exposure dose on the public is approx. 1/1,000,000 to 1/70,000 of natural radiation exposure (average in Japan:2.1mSv/y).**
- **The exposure dose on animals and plants is approx. 1/3,000,000 to 1/1,000,000 of the level defined by ICRP.**

Assume "most affected case" as the target of assessment

Person who frequents the sea area and ingests seafood around the discharge point was assessed.



Comparison with radiation impacts in daily life



Discharging ALPS treated water into the sea
0.000002 – 0.00003 mSv

mSv : mili-sievert

Assessments by IAEA

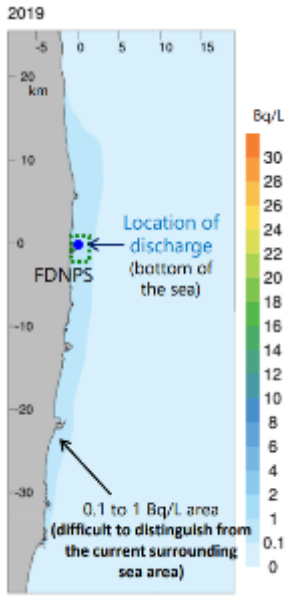
- ✓ The discharge of the ALPS treated water will have **a negligible radiological impact on people and the environment**. 【III, V】
- ✓ **A REIA has been produced and is compliant with the international safety standards**. 【p.83】

The approach taken by TEPCO results in a highly conservative approach.【p.69】

Results of dispersion simulation at sea

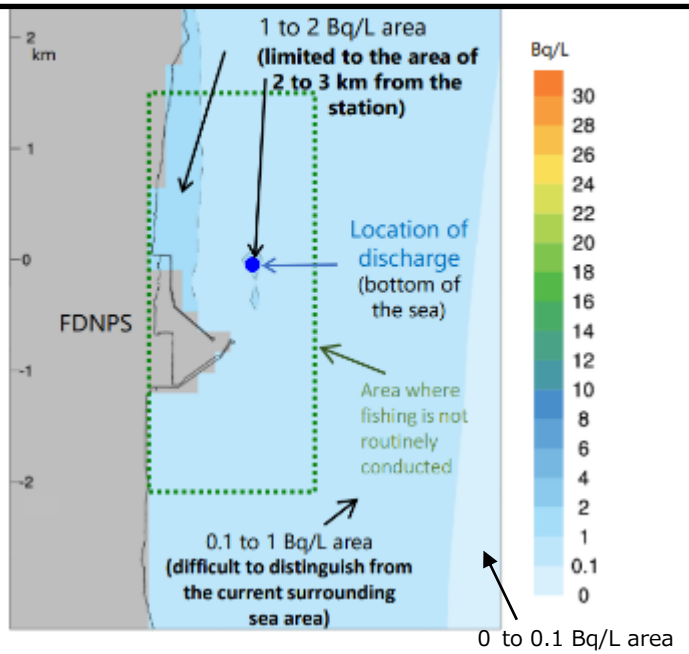
- Results of the simulation by TEPCO shows that increase in the concentration (1 to 2 Bq/L: 1/10,000 to 1/5000 of the WHO drinking water criterion, 10,000 Bq/L) by the discharge will only be detected in **the area of 2 to 3km from the FDNPS**. Beyond that area it will be **indistinguishable from the 'background' values**(0.1 to 1Bq/L).
- **The result of the simulation at several hundred kilometers from the FDNPS shows that the transboundary impact will be negligible because the concentration of nuclides were indistinguishable from the current level.**

Tritium concentrations have changed only slightly, and changes have been observed only in the sea area around the FDNPS.



Off the coast of Fukushima

Enlarged



Assessments by IAEA

✓ Based on the results of the marine dispersion model, activity concentrations in international waters will not be influenced by the discharge of ALPS treated water into the sea and **the transboundary impacts are therefore negligible**. 【p.80】

Authorization by regulatory bodies, etc.

- Nuclear Regulation Authority (NRA) as a highly independent regulatory body authorized the facility and operation regarding the ALPS treated water discharge into the sea.
- In December 2021, TEPCO applied to NRA for approval to amend the implementation plan for facilities. As a result of the examination, it was confirmed that the regulatory requirements based on regulations and the basic policy of the government were satisfied, and NRA approved it in July 2022.
- In August 2022, local municipalities granted TEPCO prior consent confirming the state of the safety measures of the plan for the discharge facilities, etc. are appropriate.
- On the other hand, the Nuclear Power Station Safety Assurance Technical Review Committee, consisting of experts and related municipalities in Fukushima, confirmed 12 major items and compiled 8 requirements for TEPCO, based on the need for additional safety improvements and easy-to-understand information dissemination. (Progress has been reported to the Decommissioning Safety Monitoring Council)
- In November 2022, TEPCO applied an application to NRA for approval to amend the implementation plan regarding the operation, etc. for the discharge. NRA approved it in May 2023 as a result of the examination.

Assessments by IAEA

- ✓ **NRA serves as the independent regulatory body within Japan, has promulgated and implemented an appropriate legal and regulatory framework for safety**. 【p.38, p.42】
- ✓ **An authorization process has been established**. During the authorization process, **both parties play a role in ensuring compliance with requirements listed in Reactor Regulation Act and Basic Policy**. 【p.42】

Source monitoring before discharge

- In addition to TEPCO, **the objectivity of data on radioactive nuclides in the ALPS treated water before discharge is thoroughly ensured by having the third-party laboratory to conduct independent analysis** to confirm that the water meets regulatory standards.
- **IAEA and third-party laboratories* conducted their own analyses of the ALPS treated water to corroborate the TEPCO's source monitoring**.
  (On June 22, TEPCO published the analysis results of the ALPS treated water in the first batch being discharged. **It has been confirmed that the concentration of nuclides other than tritium are below the regulatory standard before the discharge**.)

* In France, the U.S., Switzerland and Republic of Korea

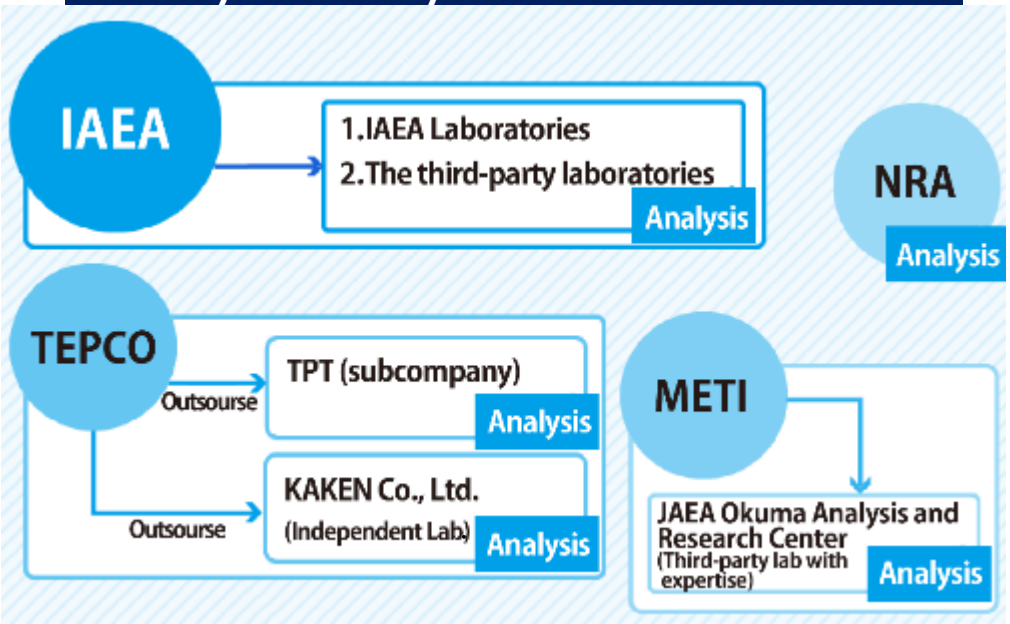
The analysis result for the first discharge (sampled in March 2023)

Percentage of Radiation Impact
(Regulatory Standards: The sum is less than 1)
Detected nuclides*1 : 0.25
Non-detected nuclides*2 : 0.026
⇒ **Sum : 0.28 ＜ 1**

*1: Total of 9 detected nuclides this time
*2: Assessed **with the conservative assumption that the nuclides exist at the detection limit etc.**

At the discharge, the degree of the impact will be further reduced by **diluting the water more than 100 times.**
- **For tritium, less than 0.025**
- **For other nuclides, less than 0.0028**

Analytical entity for ALPS treated water



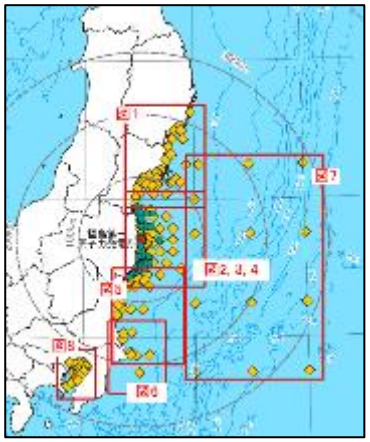
Assessments by IAEA

- ✓ The activities and approach taken by TEPCO and NRA are **consistent with the relevant international safety standards**.【p.94】
- ✓ The results of the first ILC provide confidence in TEPCO's capability for undertaking **accurate and precise measurements**. Based on the observations of the IAEA, TEPCO has demonstrated that it has a **sustainable and robust analytical system**.【V, p.108, p.114】
- ✓ **Neither the IAEA, nor the participating third-party laboratories, detected any additional radionuclides** (i.e., radionuclides beyond what is included in the source term) at significant levels.【p.58, 108】

Sea Area Monitoring

- **Monitoring is conducted by the relevant ministries, agencies, local governments and TEPCO**, etc., based on the "Comprehensive Radiation Monitoring Plan (CRMP)," which was designed to conduct meticulous off-site environmental radiation monitoring pertaining to the accident at TEPCO's Fukushima Daiichi NPS.
- **Sea area monitoring has been enhanced before the start of the discharge to confirm that there is no significant change after the start of the discharge.**
- **Strengthen and expanded monitoring by increasing the frequency of the ordinary precise measurement as well as by introducing the measurements method that provides results rapidly(Rapid analysis measurement).**

<CRMP summary>

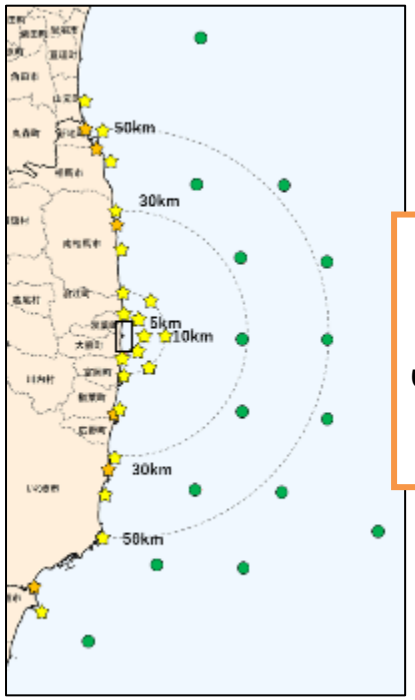


・Tritium in seawater is mainly measured within 10 km radius.
・Tritium is also measured at points several tens of kilometers away.(also at beaches)

・For fishery products, tritium is precisely measured for approx. **200 samples per a year**. The sampling range is the pacific side of eastern Japan (Hokkaido to Chiba)
・Rapid analysis measurements (detection limit is approx. 10Bq/kg) have also been conducted **for 180 samples** (from 2 points, north and south, several kilometers away from the discharge point)of which data are available the **next day or the day after next**.

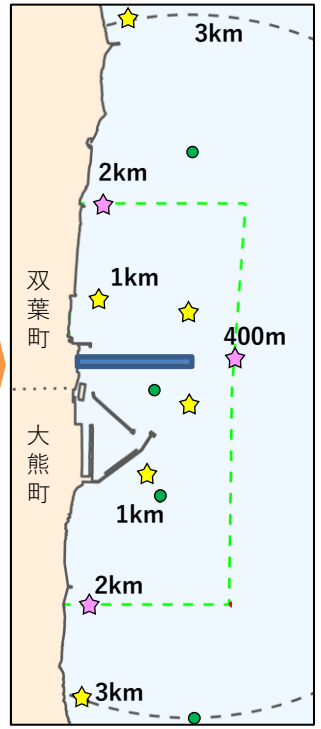
<Overview of the GOJ's enhanced monitoring related to ALPS treated water >

【Broad Map】



Enlarged

【Within 3 km radius】



・**Precise measurements are** conducted 4 times a year, considering seasonal changes
・**After the discharge, measurements are conducted more frequently for the time being.**
- **Rapid analyses** for tritium are conducted **frequently** (ex. Weekly at 11 points)
- **Precise measurements** for tritium are conducted **once a month at** ★

- For the points ★, nuclides other than tritium are measured
  - 7 main nuclides (Cesium etc.): 4 times a year
  - Various range of nuclides: Once a year
- **Marine biota are also measured 4 times a year as below**
  - Tritium in fish (FWT, OBT), Carbon-14
  - Iodine-129 in seaweeds (Ukedo Fishing Port, Tomioka Fishing Port)

Assessments by IAEA

✓ The activities and approach taken by TEPCO and NRA are **consistent with the relevant international safety standards**.【p.94】

✓ A clearly defined plan for **enhanced environmental monitoring** by **TEPCO and the Government of Japan** to address the discharges of ALPS treated water is in place.【p.94】

Future involvement of the IAEA

- The IAEA is **committed to engaging with Japan** on the discharge of ALPS treated water **not only before, but also during, and after the treated water discharges occur**.
- The IAEA will maintain an onsite presence at FDNPS throughout its review and will publish available data for use by the global community, including the provision of real-time and near real-time monitoring data from FDNPS.
- **Additional review and monitoring activities are envisaged** that will continue and which will provide **additional transparency and reassurance to the international community**.

Future Activities

Assessment of Protection and Safety	○**Review TEPCO's implementation plan and supporting documentation** ※Focus on technical considerations such as source characterization, safety related aspects of the approach, occupational radiation exposure, radiological environmental impact assessment.
Regulatory Activities and Process	○**Review NRA actions and processes relevant to the project** ※Focus on safety objectives, regulatory requirements, regulatory assessment, regulatory inspections.
Independent Sampling, Data Corroboration and Analysis	○**Independent sampling and analysis to corroborate data from Japan** ○Perform analysis of source term and environmental samples ○Corroborate monitoring results for occupational exposure.
Additional Activities	○The IAEA has established **an IAEA site office at the FDNPS**. **IAEA experts will maintain** a constant presence on site **for a number of weeks before and after the discharges** of ALPS treated water. Outside of this timeframe, the IAEA experts will be on site for major activities and conducting monitoring as needed. ○The IAEA will **share the status of the ALPS discharge facilities** provided by TEPCO **on a real-time or near real-time for members of the public**.

Reasons for selecting of Discharge into the sea

Selected the safest and most risk-manageable method in accordance with IAEA safety standards.

- The IAEA safety standards require ①safe disposal, and ②continuous monitoring of environmental impact and safety.
- **Based on experts' assessment over 6 years, discharge into the sea was selected, because (1) it has a proven track record in domestic and overseas nuclear facilities and can ensure safe disposals, and (2) it is easiest to monitor and allows continued evaluation of any impact to the environment.** It is not selected due to economic costs.
- Continued storage in tanks will hinder decommissioning work and the room for expansion is limited. In addition, there is a risk of leakage due to deterioration, etc. in long-term storage.

Options Considered	Consideration results
Discharge into the sea	It can be implemented more reliably because it has proven track record in domestic and overseas nuclear facilities, it is easy to forecast the diffusion behavior, and it is the easiest to monitor.
Geosphere injection	There is no monitoring technology to assess the environmental impacts, and there are no regulatory standards for suitable sites.
Vapor release	It is less reliable due to lack of track record and technical challenges in monitoring caused by difficulty in predicting the diffusion behavior.
Hydrogen release	Technologies such as pretreatment and scale expansion have not been established.
Underground burial (Solidification into concrete)	Moisture containing tritium evaporates during solidification, and since it must be managed as radioactive waste, it interferes with decommissioning.
Long-term storage	There is limited room for additional tanks to expand storage capacity on site. There are risks of Leakage due to tank deterioration, etc.
Off-site storage	There are risks of leakage due to tank deterioration, etc.

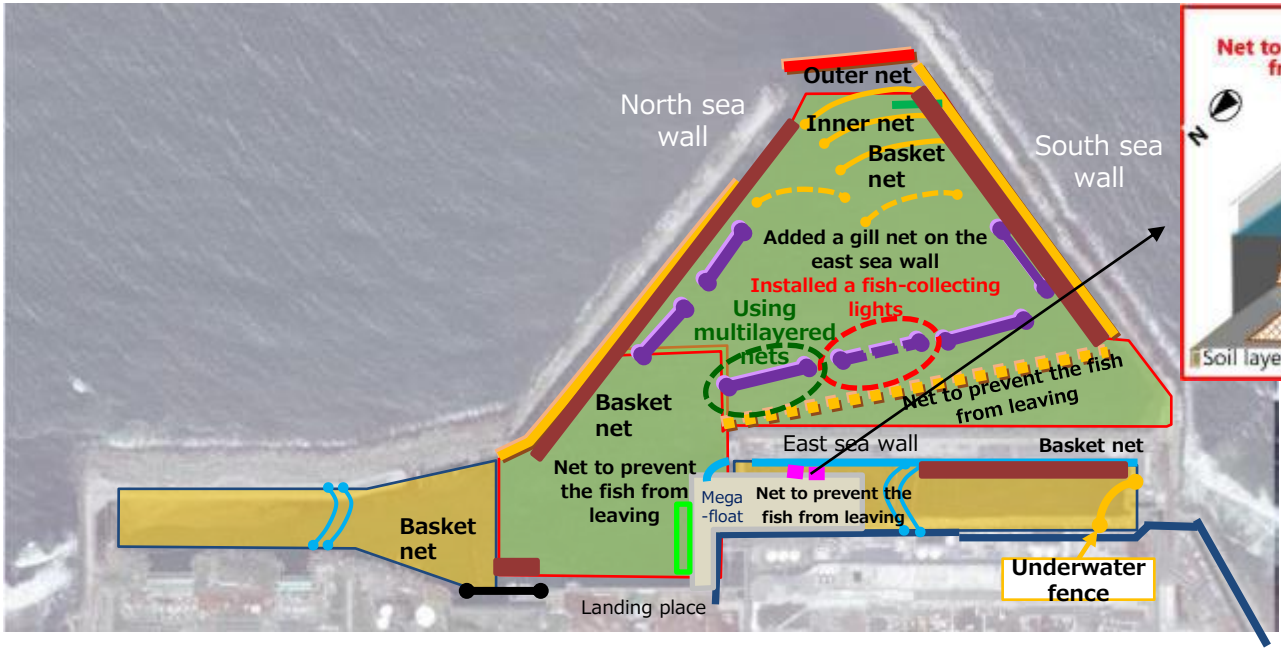
Assessments by IAEA

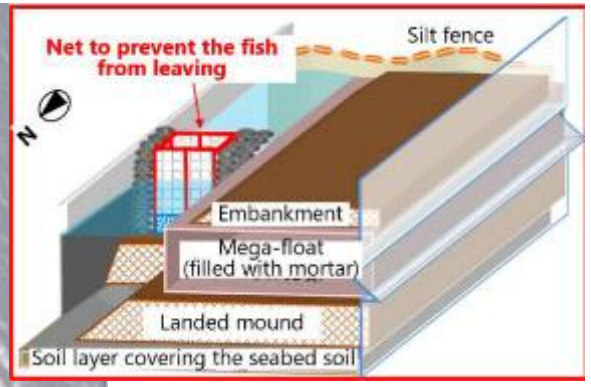
- ✓ **The selection took into account relevant IAEA reviews, and as a result, DG Grossi stated when the Basic Policy was adopted that discharge into the sea is "technically feasible and in line with international practice."**
- ✓ The IAEA notes that **the government of Japan has followed a decision-making process leading to the justification of its approach**. 【p.19】

(Ref) Fish (Black Rockfish) with high cesium concentration found at FDNPS

The fish with high cesium concentration is not caused by the discharge of ALPS treated water into the sea. It was caught at the area of the open channel at the innermost part of the port, where fish cannot escape to the outside of the open channel. No fishing takes place inside this area, and no fish will be shipped out to the market.

- The fish (black rockfish), in which **cesium of 18,000 Bq/kg was detected** on June 5, was collected in the open channel closest to the power plant in the port of the FDNPS. The open channel is fenced off to prevent the fish from escaping to outside of the port. In addition, commercial fishing is prohibited in the port and the fish are not shipped to market.
- **As for safety standards, while Codex's cesium standard is 1,000 Bq/kg, Japan has established a strict standard of 100 Bq/kg and conducts examination, so no fish exceeding the standard is distributed and there is no problem with the safety of Japanese food products.**
- The detection of such fish in the port of FDNPS is **due to the effects of the accident** at that time, and has **nothing to do with the ALPS treated water** that is currently being discharged into the sea.





(Reference) Nuclides that are confirmed to be below regulatory standards before the discharge

C-14 Carbon	Sr-90 Strontium	I-129 Iodine	Eu-154 Europium	Pu-239 Plutonium
Mn-54 Manganese	Y-90 Yttrium	Cs-134 Cesium	Eu-155 Europium	Pu-240 Plutonium
Fe-55 Iron	Tc-99 Technetium	Cs-137 Cesium	U-234 Uranium	Pu-241 Plutonium
Co-60 Cobalt	Ru-106 Ruthenium	Ce-144 Cerium	U-238 Uranium	Am-241 Americium
Ni-63 Nickel	Sb-125 Antimony	Pm-147 Promethium	Np-237 Neptunium	Cm-244 Curium
Se-79 Selenium	Te-125m Tellurium	Sm-151 Samarium	Pu-238 Plutonium	

9 nuclides detected

Detected nuclides	The ratios to regulatory concentrations
C-14	0.0071
Co-60	0.0017
Sr-90	0.014
Tc-99	0.00068
Sb-125	0.00023
I-129	0.22
Cs-137	0.0052

Non-detected nuclides	The ratios to regulatory concentrations
Mn-54	Less than 0.000026
Fe-55	Less than 0.0074
Ni-63	Less than 0.0015
Se-79	Less than 0.0047
Y-90	0.0014
Ru-106	Less than 0.0025
Te-125m	0.000071
Cs-134	Less than 0.00054
Ce-144	Less than 0.0018

Non-detected nuclides	The ratios to regulatory concentrations
Pm-147	Less than 0.00010
Sm-151	Less than 0.0000015
Eu-154	Less than 0.00018
Eu-155	Less than 0.000063
Pu-241	Less than 0.0029

Non-detected nuclides	The ratios to regulatory concentrations
U-234	Less than 0.0053
U-238	
Np-237	
Pu-238	
Pu-239	
Pu-240	
Am-241	
Cm-244	

The analysis result for the first discharge (sampled in March 2023)