

Changes in operation structure for discharge of ALPS treated water into sea and selection of nuclides to be measured and assessed [Outline]

November 21, 2022



Tokyo Electric Power Company Holdings, Inc.

1. Explanation on main items to be confirmed* in the review based on the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Nuclear Reactors

- [1] Establishment of a organizational structure for operation and maintenance of facilities after the start of discharge**
 - Organizational structure for the discharge of ALPS treated water into the sea**

- [2] Establishment of procedures for selecting nuclides to be measured and assessed at the time of the discharge of ALPS treated water into the sea**
 - Procedures for identifying nuclides in ALPS treated water and rationale behind the selection of nuclides to be measured and assessed**

*Source: Material 2 for the 51st Nuclear Regulatory Authority Meeting

1. Explanation on main items to be confirmed* in the review based on the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Nuclear Reactors

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Item to be confirmed [1]

- Establishment of a organizational structure for operation and maintenance of facilities after the start of discharge
 - Organizational structure for the discharge of ALPS treated water into the sea

1-[1] Organizational structure for the discharge of ALPS treated water into the sea **TEPCO**

- For organization of discharge ALPS treated water into the sea, the ALPS Treated Water Program Department will continue to be in charge of planning and managing the project of facilities related to the discharge into the sea. The Implementation Plan was updated to clarify the specific departments that would be in charge of maintenance management and operation management of equipment.

Organization	Operations related to security (Updated)	Red letters : Updated areas
ALPS Treated Water Program Department	Development of plans, management and operation methods for facilities related to sea discharge and the <u>operation plans of ALPS treated water dilution/discharge facilities</u>	
Water Treatment Team, Operation Dept., Construction, Operation, and Maintenance Center	Operation management of contaminated water treatment facilities, buildings for storing stagnant water, ALPS, subdrain and other water treatment facilities, and the <u>ALPS treated water dilution/discharge facilities</u>	
Storage Facilities G, Mechanical Engineering Dept., Construction, Operation, and Maintenance Center	Maintenance management of civil engineering equipment in contaminated water treatment facilities (storage facilities) and <u>mechanical equipment in ALPS treated water dilution/discharge facilities</u> Construction, installation, and maintenance management of contaminated water treatment facilities (ancillary facilities to storage facilities), and rainwater treatment facilities	
Water Treatment Instrumentation G, Electrical, Instrumentation and Control Dept., Center for Construction, Operation, and Maintenance	Construction, installation, and maintenance management of instrumentation for contaminated water treatment facilities, buildings storing stagnant water, ALPS, subdrain and other water treatment facilities, oil treatment facilities, facilities to intake water inside the Unit 3 primary containment vessel, <u>ALPS treated water dilution/ discharge facilities</u>	

The department in charge of works other than the above is as described in the current, approved version of the Implementation Plan. The following Groups will work on each of the tasks as appropriate.

- E.g.)
- Maintenance management of electrical equipment: Electrical Equipment Maintenance G, Electrical, Instrumentation and Control Dept., Construction, Operation, and Maintenance Center
 - Maintenance management of civil engineering equipment: Civil Engineering Equipment G, Civil Engineering Dept., Construction, Operation, and Maintenance Center
 - Maintenance management of construction equipment: Construction Equipment Maintenance G, Construction Dept., Construction, Operation, and Maintenance Center
 - ALPS treated water analysis: Analysis and Assessment G, Radiation/Environment Dept., Emergency Preparedness/Radiation Control Center

1. Explanation on main items to be confirmed* in the review based on the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Nuclear Reactors

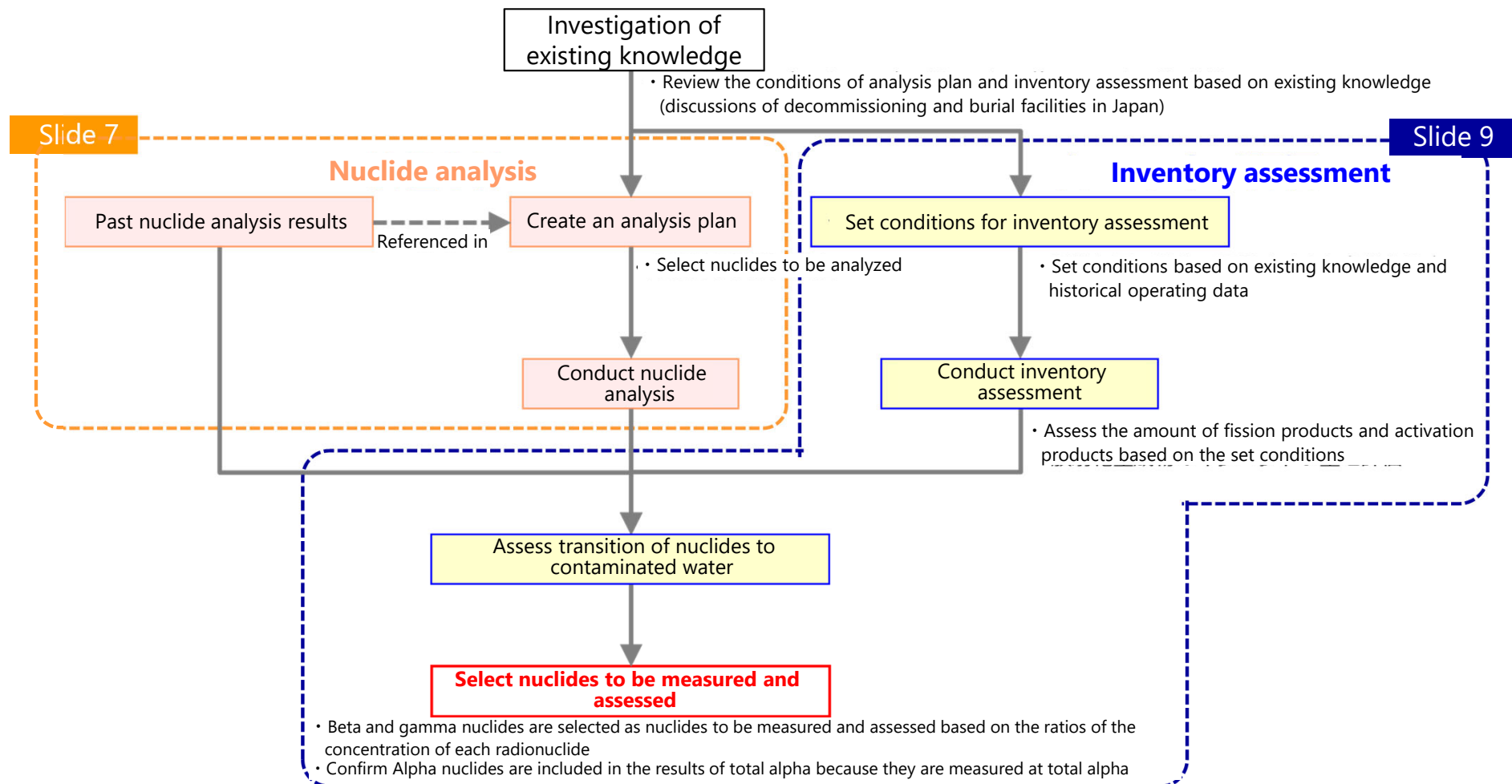
*Source: Material 2 for the 51st Nuclear Regulatory Authority Meeting

Item to be confirmed [2]

- Establishment of procedures for selecting nuclides to be measured and assessed at the time of the discharge of ALPS treated water into the sea
 - Procedures for identifying nuclides in ALPS treated water and rationale behind the selection of nuclides to be measured and assessed

1-[2] Procedures for identifying nuclides in ALPS treated water (1/3)

- The Implementation Plan approved on July 22, 2022 stated "the policy for selecting nuclides subject to measurement and assessment with rigorous verification to ensure that the ALPS treated water meets the discharge criteria after it has been diluted before discharge (sum of the ratios of the concentration of each radionuclide to the regulatory concentration of each, excluding tritium, in the ALPS treated water is less than 1) based on the knowledge in Japan on decommissioning and disposal facilities". We have described our approach to the selection of nuclides based on the results of the verification this time.
- Specifically, as explained at the 9th Review Meeting on the Implementation Plan Regarding the Handling of ALPS Treated Water, the results of actual nuclide analysis are used together with the results of the tabletop inventory assessment to identify the nuclides.



1-[2] Procedures for identifying nuclides in ALPS treated water (2/3)

- In the nuclides analysis, analysis results in the past were assessed and additional analysis was conducted to see if the nuclides garnering attention in the research on decommissioning and burial facilities exist in significant quantities in the stagnant water, Sr removed water, ALPS treated water, etc.
- Results of additional analysis showed that **the nuclides (including α nuclides) garnering attention in the research on decommissioning and burial facilities were not detected in the ALPS treated water.***

*: Below or equal to the 1/100 of the regulatory concentration and below the detection limit ; Uranium was detected in very small amounts of natural uranium in the environment

Nuclides measured in the past

Fission products: 56 nuclides

Rb-86 Rubidium	Sr-89 Strontium	Sr-90 Strontium	Y-90 Yttrium	Y-91 Yttrium	Nb-95 Niobium	Tc-99 Technetium
Ru-103 Ruthenium	Ru-106 Ruthenium	Rh-103m Ruthenium	Rh-106 Rhodium	Ag-110m Silver	Cd-113m Cadmium	Cd-115m Cadmium
Sn-119m Tin	Sn-123 Tin	Sn-126 Tin	Sb-124 Antimony	Sb-125 Antimony	Te-123m Tellurium	Te-125m Tellurium
Te-127 Tellurium	Te-127m Tellurium	Te-129 Tellurium	Te-129m Tellurium	I-129 Iodine	Cs-134 Cesium	Cs-135 Cesium
Cs-136 Cesium	Cs-137 Cesium	Ba-137m Barium	Ba-140 Barium	Ce-141 Cerium	Ce-144 Cerium	Pr-144 Praseodymium
Pr-144m Praseodymium	Pm-146 Promethium	Pm-147 Promethium	Pm-148 Promethium	Pm-148m Promethium	Sm-151 Samarium	Eu-152 Europium
Eu-154 Europium	Eu-155 Europium	Gd-153 Gadolinium	Tb-160 Terbium	Pu-238 Plutonium	Pu-239 Plutonium	Pu-240 Plutonium
Pu-241 Plutonium	Am-241 Americium	Am-242m Americium	Am-243 Americium	Cm-242 Curium	Cm-243 Curium	Cm-244 Curium

Source : the 9th ALPS Treated Water Review Meeting materials

Corrosion products: 6 nuclides

Mn-54 Manganese
Fe-59 Iron
Co-58 Cobalt
Co-60 Cobalt
Ni-63 Nickel
Zn-65 Zinc

Nuclides other than those on the left: 2 nuclides

H-3 Tritium	C-14 Carbon
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Nuclides other than the 64 nuclides: 20 nuclides

Cl-36 Chlorine	Ca-41 Calcium	Ni-59 Nickel
Se-79 Selenium	Nb-94 Niobium	Mo-99 Molybdenum
Tc-99m Technetium	Te-132 Tellurium	I-131 Iodine
I-132 Iodine	La-140 Lanthanum	U-233 Uranium
U-234 Uranium	U-235 Uranium	U-236 Uranium
U-238 Uranium	Np-237 Neptunium	Pu-242 Plutonium
Cm-245 Curium	Cm-246 Curium	

Nuclides selected based on the existing knowledge and additionally analyzed in this study this time (in addition to the nuclides below, alpha nuclides that could exist in significant quantities in stagnant water, Sr removed water, and ALPS treated water, etc. were also analyzed).

Fe-55 Iron	Ni-59 Nickel	Nb-93m Niobium	Mo-93 Molybdenum	Sn-121m Tin	Cl-36 Chlorine	Ca-41 Calcium	Zr-93 Zirconium	Ba-133 Barium	Se-79 Selenium	Pd-107 Palladium
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1-[2] Procedures for identifying nuclides in ALPS treated water (3/3)



- In the inventory assessment, activation products have been evaluated in the safety evaluation of nuclear power plants (also used for the study of nuclides to be removed with ALPS). Additionally, the research on decommissioning and burial facilities conducted the activation calculation of equipment in nuclear power plants.
- Referring to the above two evaluations, the study follows as per the below table. The code to be used is ORIGEN * as in the previous evaluation.

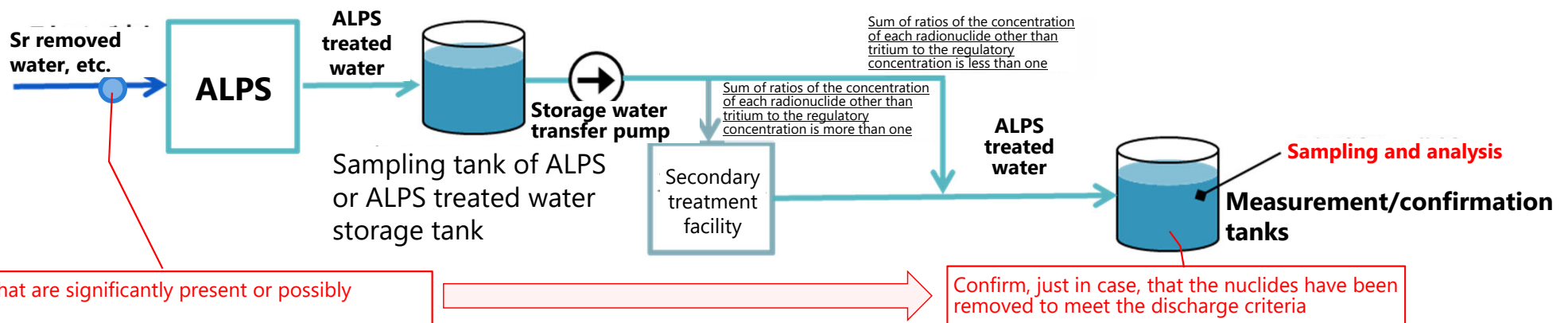
*: ORNL Isotope Generation and Depletion Code. A code system for calculating generation, disintegration, depletion of radioactive materials.

No.	Evaluation	Description
1	Assessment of fission products	Referring to the safety evaluation of conventional nuclear power plants (the same as at the time of studying the nuclides to be removed with ALPS), the inventory volume as of March 2011 was evaluated based on the condition of the fuel loaded in the reactor pressure vessels of 1F-Units 1 to 3, as well as the condition of the burnup assumed from the loading period of each fuel. From March 2011 onwards, a decrease in the 12-year inventory volume due to attenuation was calculated.
2	Assessment of activation products	<p>With reference to the research of decommissioning and burial facilities, about the following 4 types of equipment and structures existing inside the reactor pressure vessel and the lower part thereof, the inventory volume as of March 2011 was assessed based on the irradiation period from the reactor core.</p> <ul style="list-style-type: none"> • Reactor internals • Fuel assembly (excluding nuclear fuel materials) • Pressure vessel • Pedestals <p>In addition, about the corrosion products to be generated due to the corrosion and activation of components of equipment comprising the reactor cooling system, the inventory volume as of March 2011 was assessed with the data of feedwater metal at the time of operation.</p> <p>In both assessments, from March 2011 onwards, a reduction in the inventory volume over 12 years due to attenuation was calculated.</p>

1-[2] Rationale behind the selection of nuclides to be measured and assessed (1/4) **TEPCO**

- In the ALPS treated water etc., there is no discrepancy that would suggest the presence of radionuclides other than the current 64 nuclides between total beta measurements and the sum of analysis results for radioactive concentration of 7 major nuclides* plus carbon-14 and technetium-99. Gross alpha also remained undetectable.
 - ※ Major 7 nuclides : Cesium-134, Cesium-137, Strontium-90, Iodine-129, Cobalt-60, Antimony-125, Ruthenium-106 that were found in significant concentrations compared to the regulatory concentration limits in the analysis of the 62 nuclides in treated water conducted in the past.
- In addition to the above, as shown in the previous slide, results of individual analyses on nuclides other than the current 64 nuclides, that are garnering attention in decommissioning and burial facilities research, demonstrate that these nuclides did not exist in significant concentrations in ALPS treated water.
- Through these efforts, we were able to verify again that the ALPS nuclide removal function was performing as expected, and the nuclides that could exist in significant concentrations were the major 7 nuclides, Carbon-14, and Technetium-99.

■ Nevertheless, based on the discussions at previous review meetings related ALPS treated water and comments from the NRA and the IAEA, **nuclides to be measured and assessed are selected with a perspective of confirming, just in case, that nuclides that are significantly present or possibly present in significant concentrations in stagnant water, Sr removed water, etc. have been removed to meet the discharge criteria in the ALPS treated water to be discharged into the sea.**

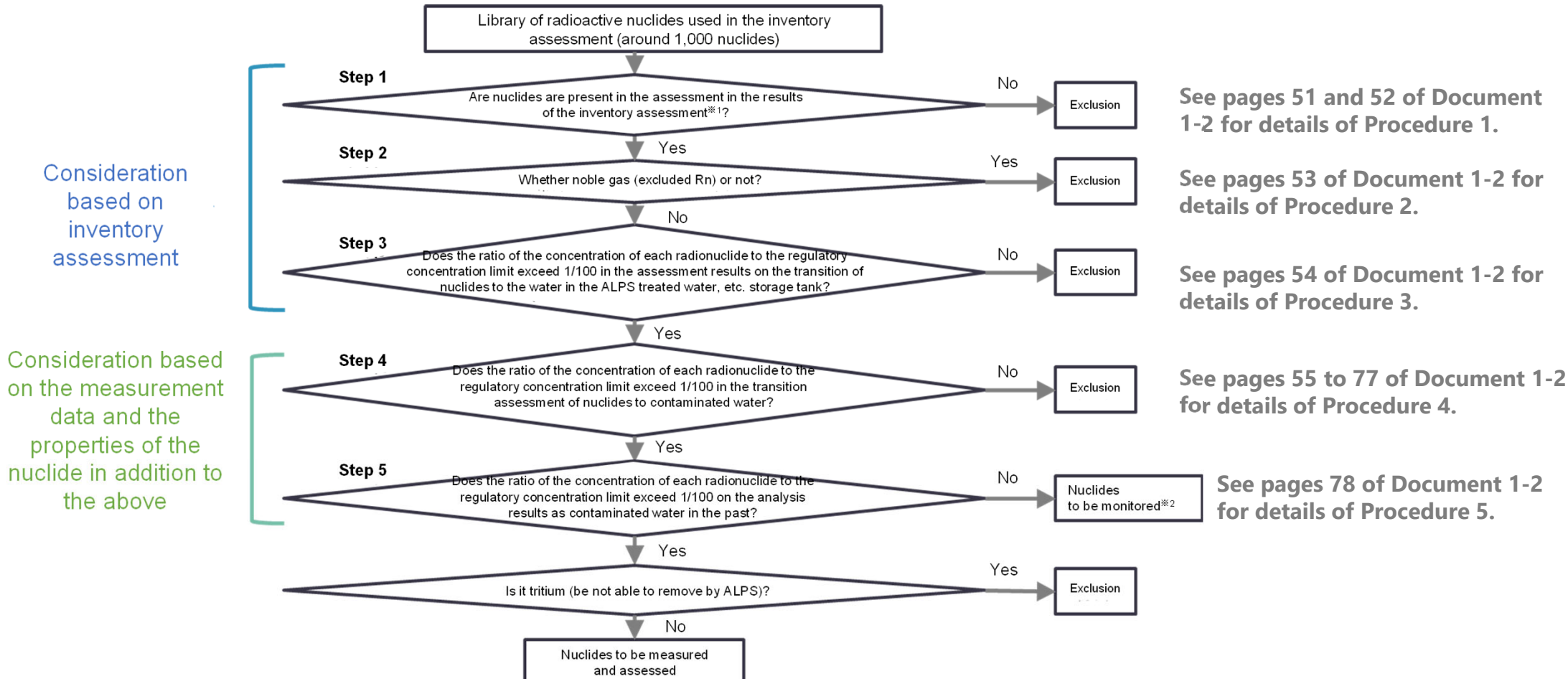


1-[2] Rationale behind the selection of nuclides to be measured and assessed (2/4)



- Following the previous slide, the nuclides to be measured and assessed were selected using the following process.
- Regarding the following process, first, the nuclides that can realistically exist are selected considering the half-life of the nuclides based on the findings pointed by the IAEA and the NRA. Next, we conduct another desk study assuming* that all of the radioactive materials have been transferred to the ALPS treated water storage tanks. Furthermore, the assessment is based on the actual measured data of contaminated water and the properties of nuclides that we have accumulated over the past 12 years.

* Assumption based on the fact that contaminated water has been continuously treated and stored in the tanks over the 12 years since the earthquake.



*1: The attenuation period for the inventory assessment will be set appropriately according to the time when the selection results are used (For the first assessment, it was set to 2023 (12 years after the earthquake)).

*2: Nuclides to be continuously checked to make sure that they do not exist in contaminated water at significant concentrations

1-[2] Rationale behind the selection of nuclides to be measured and assessed (3/4)

- **30 nuclides in the table below and tritium are the nuclides to be measured and assessed in discharging the ALPS treated water into the sea**, selected using the selection flow on the previous slide.
- Before discharging ALPS treated water into the sea, 30 nuclides will be confirmed to make sure that the water meets the discharge criteria (the sum of the ratios to regulatory concentration limits of radionuclides other than tritium must be less than 1). The concentration of tritium will be measured as well, and the dilution ratio at the time of discharge into the sea will be set so that the tritium concentration in the water to be discharged is less than 1,500 Bq/L.
- Among the nuclides subject to be removed by ALPS, there is no possibility that the 37 nuclides that were not selected are present in the contaminated water. However, we will voluntarily measure them and confirm that their concentrations are below the detection limit prior to the discharge.

【Nuclides to be measured and assessed (30 nuclides)】

C-14 Carbon	Y-90 Yttrium	I-129 Iodine	Eu-154 Europium	Pu-239 Plutonium
Mn-54 Manganese	Tc-99 Technetium	Cs-134 Cesium	Eu-155 Europium	Pu-240 Plutonium
Co-60 Cobalt	Ru-106 Ruthenium	Cs-137 Cesium	U-234 Uranium	Pu-241 Plutonium
Ni-63 Nickel	Cd-113m Cadmium	Ce-144 Cerium	U-238 Uranium	Am-241 Americium
Se-79 Selenium	Sb-125 Antimony	Pm-147 Promethium	Np-237 Neptunium	Cm-243 Curium
Sr-90 Strontium	Te-125m Tellurium	Sm-151 Samarium	Pu-238 Plutonium	Cm-244 Curium

1-[2] Rationale behind the selection of nuclides to be measured and assessed (4/4)

- Although the nuclides to be measured and assessed on the previous page were selected after confirming the past analysis results, there is a possibility that the situation may change depending on the progress of future decommissioning work.
- If significant quantities of nuclides other than those to be measured and assessed (hereinafter referred to as "other nuclides") are found, the nuclides to be measured and assessed will be re-evaluated. Decay of radionuclides will be also reflected in the selection following process.

【 Confirmation at each release 】

Confirm that other nuclides in significant quantities are not found by measuring γ -rays with Ge semiconductor detectors, total alpha, and total beta.

【 Confirmation of trend of radioactive concentration in contaminated water 】

【 Research and analysis 】

In the research and analysis, if an event of concern is found in the above confirmation, we will research the presence of other nuclides. Even if there is no concern, we will research the presence of other nuclides by confirming that nuclides to be monitored in significant quantities are not found once a year in Sr removed water.

○ Nuclides to be monitored (6 nuclides)

Nuclides not detected in significant quantities in past analysis of contaminated and treated water but to be continuously confirmed.

Cl-36 Chlorine	Fe-55 Iron	Nb-93m Niobium	Nb-94 Niobium	Mo-93 Molybdenum	Ba-133 Barium
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