Meeting Material 1-2 of 109 the Committee on Oversight and Evaluation of Specified Nuclear Facilities, 5 Oct 2023
Tentative Translation by NRA

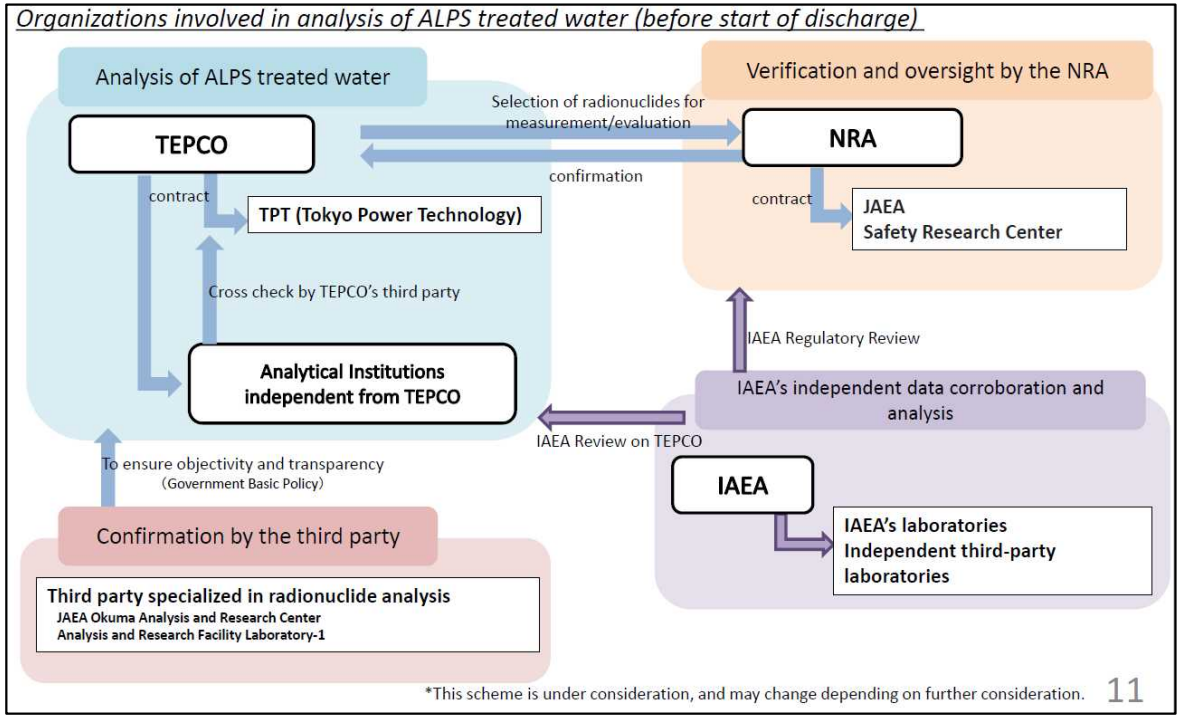
Analysis result of ALPS treated water

5 October 2023

NRA
Office for Accident Measures of
Fukushima-Daiichi Nuclear Power Station

Purpose

- The NRA inspected TEPCO's organizational framework for analyzing "nuclides to be measured and evaluated" and their quality assurance activities, and confirmed that they are following the approved Implementation Plan.
- Also, considering the statement in the Governmental Policy "monitoring with objectivity and transparency", the NRA confirms the validity of TEPCO's analysis by conducting independent monitoring
- At the Committee meeting held in April this year, the NRA explained the NRA/JAEA NSRC's analysis results for the first batch of release. Similar validation analysis was recently conducted for the second batch of release. This is the report on the results.
- JAEA NSRC analyzed radionuclides in ALPS treated water under the contract from the NRA in the same framework as for the first batch.

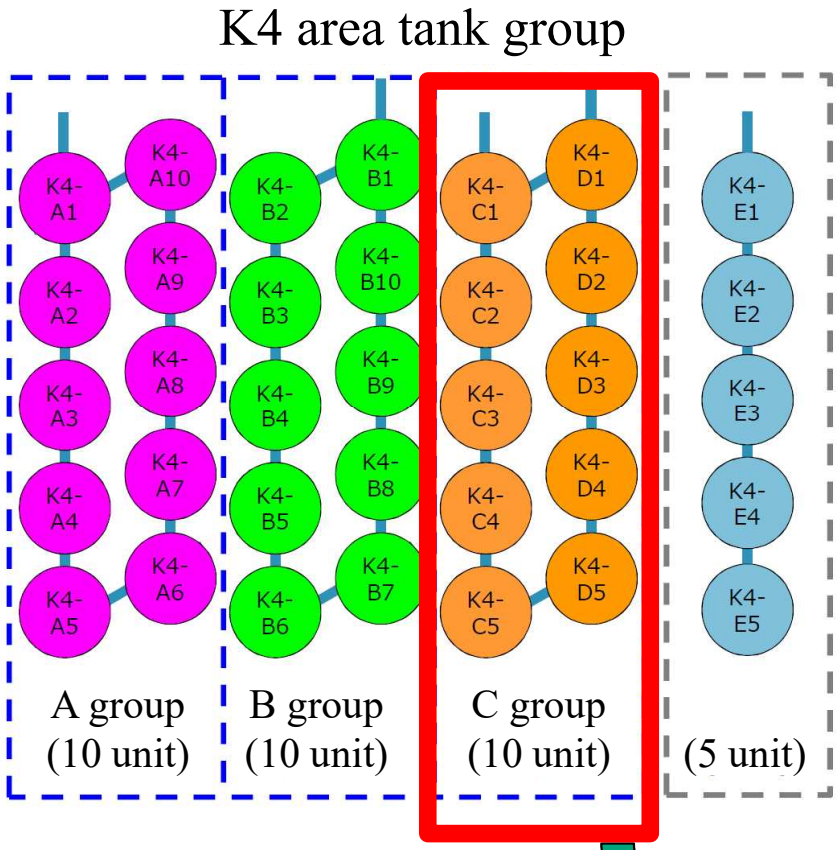


"Update Material" explained in 2nd IAEA review mission for NRA

Compare the analytical results (radionuclide concentration) by JAEA NSRC and TEPCO with consideration of uncertainty ranges, for supporting the overall oversight by the NRA.

Analysis Sample

Sampled on June 26, 2023 at 11:28 AM
“ALPS treated water measurement/confirmation tank water (K4 tank C group)”



JAEA
Received at the Nuclear Science Research Institute
(July 31, 2023)

Excerpt from meeting material 2-2 of 98 the Committee on Oversight and Evaluation of Specified Nuclear Facilities

Target nuclides

- **Analyzed 7 radionuclides (compared with TEPCO's result)**
- Among nuclides mainly detected in ALPS treated water:

  Co-60, Ru-106, Sb-125, I-129, Cs-134, Cs-137, C-14

*Reason for selecting those nuclides

Based on the analysis results from the previous batch, for the purpose of more effectively and efficiently confirming the validity of the analysis, the NRA selected the nuclides with comparatively large detected values (I-129 and C-14) excluding tritium, and gamma-ray emitting nuclides (Ge semiconductor measurement) that can be targeted in one measurement.

1. Overview

TEPCO

- For the 35 nuclides of the nuclides to be measured/assessed and monitored, the analytical results at the ALPS inlet (FY 2021) and ALPS outlet (K4, J1-C, J1-G) are reported based on the results of checking the sum of the ratios to regulatory concentrations limits in the classification in the table below. Note that in the calculation of the regulatory concentration limit ratio of α-nuclides, the total-α value is divided by 4 Bq/L, which is the lowest regulatory concentration limit among the α-nuclides selected.

Classification					Specific nuclides	ALPS inlet	ALPS outlet		
							K-4	J1-C	J1-G
Nuclides mainly detected in ALPS treated water					7 major nuclides including radioactive equilibrium Y-90, Te-125 m), C-14, Tc-99	1.7E+03	2.7E-01	1.6E-01	5.8E-02
Nuclides rarely detected in ALPS treated water	α				U-234, U-238, Np-237, Pu-238, Pu-239, Pu-240, Am-241, Cm-244	5.4E+00 →1.0E+00	8.2E-04 →1.6E-04	4.2E-02 →8.1E-03	3.7E-02 →7.0E-3
	Other than α nuclides	Other than those subject to removal	Subject to removal by ALPS (other than the above)		Mn-54, Ni-63, Cd-113m, Ce-144, Pm-147, Sm-151, Eu-154, Eu-155, Pu-241	2.2E+00	1.4E-03	1.3E-02	1.2E-02
			A large number of measurements		Cl-36, Se-79, Nb-94	5.0E-02	1.2E-02	1.2E-02	1.2E-02
			Small number of measurements	[1] Countable for gross β or Ge	Ba-133	8.7E-03	1.5E-03 →1.8E-05	1.4E-03 →1.4E-04	1.4E-03 →1.3E-04
				[2] Not countable for gross β and Ge	Fe-55, Nb-93m, Mo-93	2.1E-02	9.3E-03	6.8E-03	6.8E-03

*For J1-C and J1-G, the analysis and evaluation results for Cl-36, Se-79, ~~Ba-133,~~ Fe-55, Nb-93 m, and Mo-93 are not available, and the results from the additional ALPS outlet are used.

The Japanese version shall prevail.

Meeting Material 1-1-2 of 3rd Technical Meeting on Specified Nuclear Facility

https://www.tepco.co.jp/en/hd/decommission/information/committee/pdf/2022/technical_22122102-e.pdf

Analytical methods

Nuclides	Principal radiation emitted	Analytical equipment	Analytical method (pretreatment)	Basis for Analytical Method
Co-60	βγ	Ge	without pretreatment	The Series of Environmental Radioactivity Measuring Methods (SERMM) No.7
Ru-106	β	Ge (Measure Rh-106)	without pretreatment	SERMM No.7
Sb-125	βγ	Ge	without pretreatment	SERMM No.7
I-129	βγ	ICP-MS	I was purified with Anion-SR	SERMM No.32
Cs-134	βγ	Ge	without pretreatment	SERMM No.7
Cs-137	βγ	Ge	without pretreatment	SERMM No.7
C-14	β	LSC	1.5 M HNO_3 was added into sample solution and N_2 gas was insufflated to the solution to evaporate CO_2. CO_2 was tapped by absorbent and absorbent was mixed with scintillator.	JAEA-Technology 2009-051

Ge：Ge Semiconductor Detector
LSC：Liquid Scintillation Counter
ICP-MS：Inductively Coupled Plasma Mass Spectrometry

Comparison of analytical result (*E*n score)

Evaluated analytical results by using *E*n score shown in B.3 of ISO/IEC17043: 2010(JIS Q 17043:2011), with consideration of uncertainty in analytical results

→If the absolute value of *E*n score exceed 1 ($|En|>1$), the cause of discrepancy will be investigated.

$$En = \frac{X_{TEPCO} - X_{JAEA}}{\sqrt{U_{TEPCO}^2 + U_{JAEA}^2}}$$

X_{TEPCO} : Measured value (radionuclide concentration) by TEPCO

X_{JAEA} : Measured value (radionuclide concentration) by JAEA NSRC

U_{TEPCO} : Uncertainty of TEPCO's value

U_{JAEA} : Uncertainty of JAEA NSRC's value

Analysis result(1/2)

➢ **Nuclides which were not detected in the analysis of JAEA NSRC**

Nuclides	JAEA NSRC (Bq/L)	TEPCO* (Bq/L)	Concentration limit (Bq/L)
Ru-106	<0.81	<0.21	100
Sb-125	<0.26	<0.088	800
Cs-134	<0.17	<0.03	60

・Any detection limit is lower than 1/100 of regulatory concentration limit

＊：https://www.tepco.co.jp/decommission/data/analysis/pdf_csv/2023/3q/measurement_confirmation_230921-j.pdf

Analysis result(2/2)

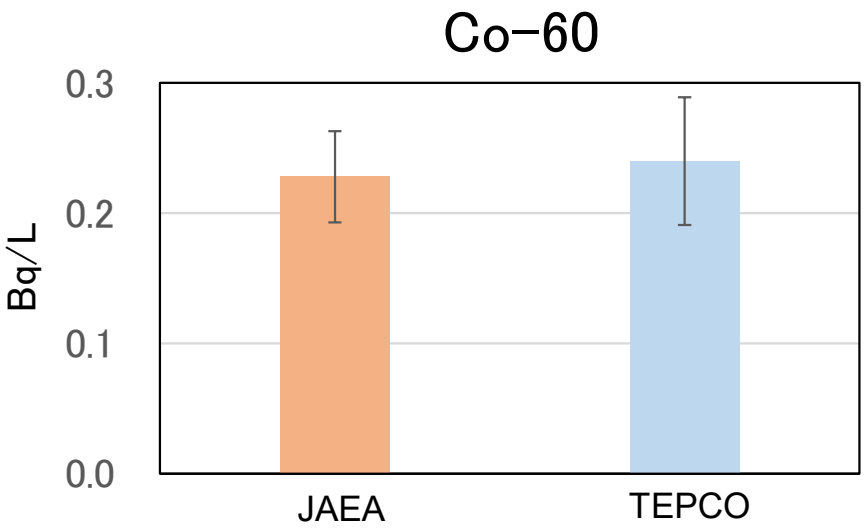
➢ **Nuclides which were detected in the analysis of JAEA NSRC**

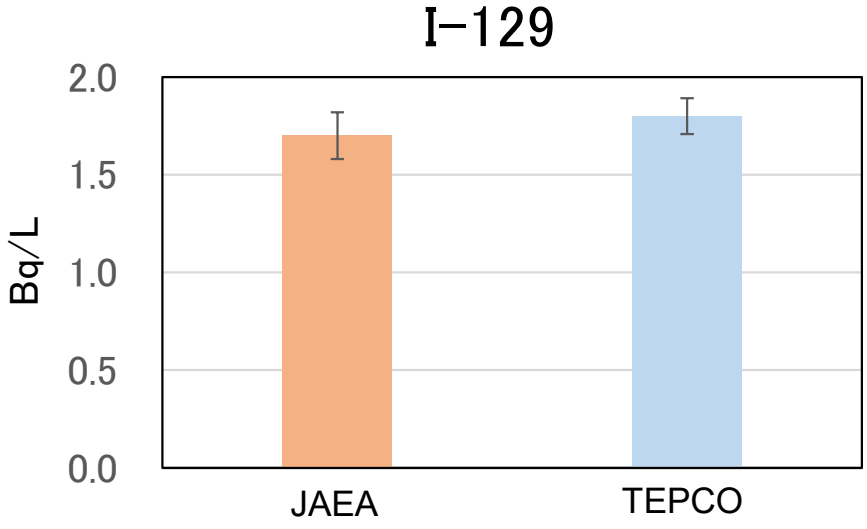
Nuclides	JAEA NSRC (Bq/L)	TEPCO* (Bq/L)	Concentration limit (Bq/L)	|*E*n|
Co-60	0.228±0.035	0.24±0.049	200	0.20
I-129	1.70±0.12	1.8±0.092	9	0.66
Cs-137	0.445±0.064	0.45±0.080	90	0.05
C-14	13.19±0.65	13±2.3	2,000	0.08

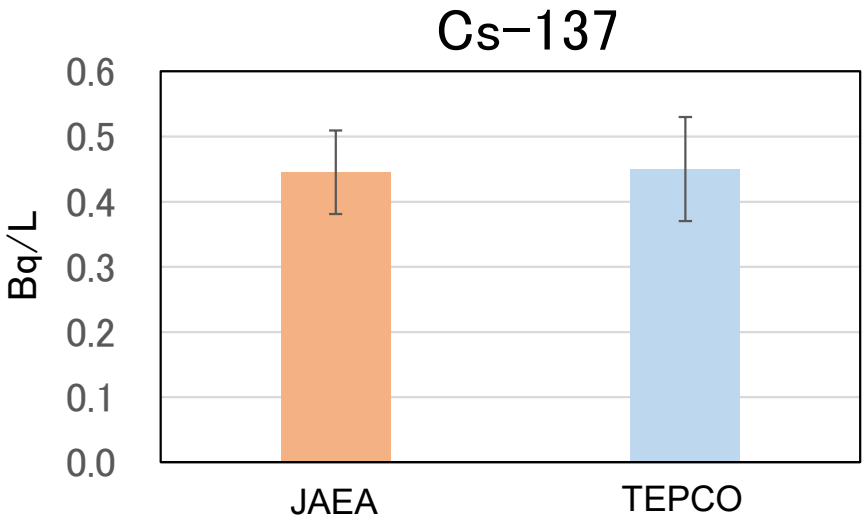
・All of the values of |*E*n| were below 1.

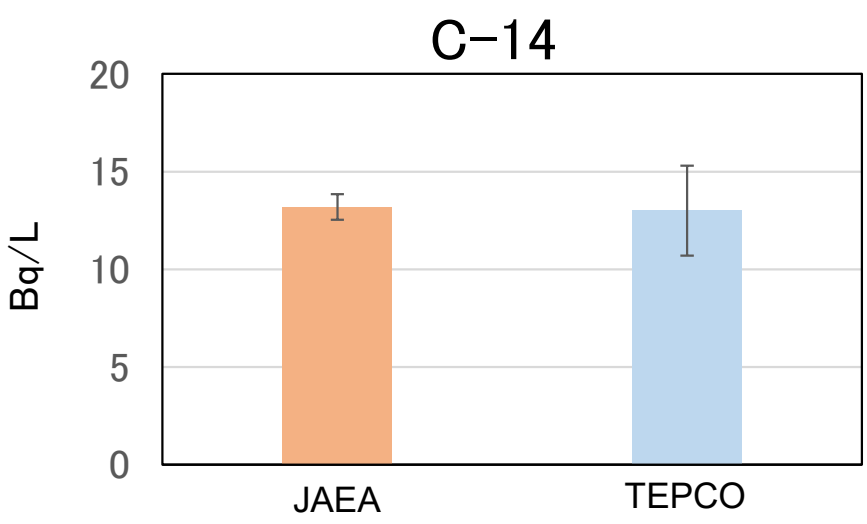
＊：https://www.tepco.co.jp/decommission/data/analysis/pdf_csv/2023/3q/measurement_confirmation_230921-j.pdf

Analysis result(2/2)









Error bar shows relative expanded uncertainty

Example of evaluation of uncertainty (H-3)

Cause of uncertainty	Relative standard uncertainty*1	Value (%)
Uncertainty of sample analysis		
・Uncertainty of sample collection	μ_1	0.618
Uncertainty of equipment calibration		
・Uncertainty of standard source	μ_2	2.550
・Uncertainty of sampling of standard source	μ_3	1.020
・Uncertainty of counting for standard source	μ_4	0.854
・Uncertainty due to fitting using calibration formula	μ_5	0.654
・Uncertainty for decay correction	μ_6	0.004
Uncertainty of sample measurement		
・Fluctuation of background	μ_7	2.438
・Uncertainty of counting	μ_8	0.432
・Uncertainty for decay correction	μ_9	0.007

・Combined standard uncertainty $= \sqrt{\mu_1^2 + \cdots\cdots + \mu_9^2} = 3.9$ (%)

・Relative expanded uncertainty*2 =

(Combined standard uncertainty) × 2 = **7.8 (%)**

Value of uncertainty is different by each analysis. Also, if the concentration is very small, uncertainty becomes large

＊1 : [Relative standard uncertainty (%)] = [standard uncertainty] ÷ [analysis result] × 100

＊2 : It shows about 95% confidence interval, based on "Guide to the expression of uncertainty in Measurement(1995)".