

Results of Secondary Treatment Performance Tests for ALPS Treated Water (Third-Party Assessment)

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Tokyo Electric Power Company Holdings, Inc.

Fukushima Daiichi Nuclear Power Station

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【Background】

- Since September 15, 2020, we have treated approximately 1,000m³ of water stored in the J1-C and J1-G tank groups (Total: Approx. 2,000m³), which are two of the tank groups for which sum of ratios of legally required concentrations, excluding tritium, is more than 100.
- [Analysis results from TEPCO analysis facilities](#) have confirmed that secondary treatment using ALPS can reduce the sum of ratios of legally required concentrations, excluding tritium (62 nuclides + C-14), to below 1.
(Reported on December 24, 2020)

Sum of the ratios of legally required concentrations for the nuclides subject to removal (62 nuclides) + Carbon-14:

J1-C Group ; 【Before】 2,406 → 【After】 0.35

J1-G Group ; 【Before】 387 → 【After】 0.22

- We reported that going forward, a third-party agency will analyze the samples using the same analysis procedure as TEPCO and identify issues with the analysis, and that TEPCO will make improvements to the nuclide analysis procedures and process.

【Information reported herein】

- ALPS treated water that has been subjected to secondary treatment with ALPS (J1-C group) has been analyzed by a [third-party agency](#).
- The analysis results obtained by the third-party agency were similar to the analysis results from TEPCO. Going forward issues related to analysis shall be identified and improvements made to the nuclide analysis procedures and process.

Sum of the ratios of legally required concentrations for the nuclides subject to removal (62 nuclides) + Carbon-14:

J1-C Group ; 【After】 0.28

1. Challenges encountered during the analysis by a third-party and countermeasures

【Third-party agency】

<Challenges>

- I. Since the analysis by the third-party was performed using equipment that differs from that of TEPCO, it took approximately two months from the time the samples were handed over until the analysis results were made official.
- II. The analysis performed by the third-party agency was limited to one sample for this time. In consideration of the fact that continual analysis will be required, an analysis system that has countermeasures in place to handle analysis delay risks caused by, for example, analytical equipment malfunction, etc., is necessary.

<Countermeasures>

- I. By employing new analysis equipment the amount of time until analysis results are made official can be shortened.
- II. By increasing the number of analysis personnel and the analytical equipment, we will create an analysis system through which analysis can continue in a stable manner even in the event of analytical equipment malfunction.

2. Challenges with analysis conducted at TEPCO analysis facilities and countermeasures

【TEPCO analysis facilities】

<Challenges>

- I. During the analysis at TEPCO analytical facilities, six samples from before and after treatment were analyzed for the 64 nuclides, and it took approximately two months from the time the samples were taken until the analysis results were made official.
In particular, analysis results for nuclides except for Ni-63 and Cd-113m were obtained in approximately one month, but it took approximately two months to make all the analysis results official because analysis of Ni-63 and Cd-113m needed to be performed again for two samples which were taken prior to secondary treatment.

<Countermeasures>

- I. By ensuring that skilled personnel are performing the analyses, the amount of time required until analysis results for one sample can be made official shall be shortened even if analysis of Ni-63 and Cd-113m, which require the most time, need to be conducted again.
Furthermore, the lessons learned during this analysis shall be reflected in analysis procedures so as to minimize delays if reanalysis is required again in the future.
 - ※Cd recovery rate decrease: Procedures shall be revised so that the pH adjustment of sampled water is done carefully in order to prevent a decrease in the amount of Cd in the chelate disk cartridges.
 - ※Check for nuclides that interfere Ni analysis: Procedures shall be revised to include countermeasures if an nuclide that interfere Ni analysis is detected, such as reducing the sample amount, or increasing the number of water passes through anion exchange resins.

【Reference】 Secondary treatment performance confirmation test result details (J1-C Group)

	Nuclide (half-life)	Legally required concentration [Bq/L]	Third-party agency		TEPCO analysis facility		Notes
			Analysis results※1 [Bq/L]	Legally required concentration ratio※3	Analysis results※2 [Bq/L]	Legally required concentration ratio※3	
1	Rb-86 (Approx. 19 days)	3E+02	< 2.30E-01	7.7E-04	< 4.97E-01	1.7E-03	
2	Sr-89 (Approx. 51 days)	3E+02	< 1.50E-02	5.0E-05	< 5.37E-02	1.8E-04	
3	Sr-90 (Approx. 29 years)	3E+01	4.54E-02	1.5E-03	3.57E-02	1.2E-03	
4	Y-90 (Approx. 64 hours)	3E+02	4.54E-02	1.5E-04	3.57E-02	1.2E-04	Radioactive equilibrium with Sr-90
5	Y-91 (Approx. 59 days)	3E+02	< 1.20E+01	4.0E-02	< 1.65E+01	5.5E-02	
6	Nb-95 (Approx. 35 days)	1E+03	< 2.80E-02	2.8E-05	< 4.96E-02	5.0E-05	
7	Tc-99 (Approx. 210,000 years)	1E+03	< 2.70E-01	2.7E-04	< 1.23E+00	1.2E-03	
8	Ru-103 (Approx. 40 days)	1E+03	< 3.80E-02	3.8E-05	< 5.27E-02	5.3E-05	
9	Ru-106 (Approx. 370 days)	1E+02	9.78E-01	9.8E-03	1.43E+00	1.4E-02	
10	Rh-103m (Approx. 56 min.)	2E+05	< 3.80E-02	1.9E-07	< 5.27E-02	2.6E-07	Radioactive equilibrium with Ru-103
11	Rh-106 (Approx. 30 sec.)	3E+05	9.78E-01	3.3E-06	1.43E+00	4.8E-06	Radioactive equilibrium with Ru-106
12	Ag-110m (Approx. 250 days)	3E+02	< 2.70E-02	9.0E-05	< 4.26E-02	1.4E-04	
13	Cd-113m (Approx. 15 years)	4E+01	< 4.80E-02	1.2E-03	< 8.52E-02	2.1E-03	

※1: Decay correction based on concentration at time of sampling not implemented.

※2: Decay correction based on concentration at time of sampling implemented

※3: The lower detection limit is used in calculations for those nuclides for which the analysis result was below the lower detection limit.

The notation $\bigcirc.\bigcirc\bigcirc E \pm \Delta\Delta$ indicates $\bigcirc.\bigcirc\bigcirc \times 10 \pm \Delta\Delta$

【Reference】 Secondary treatment performance confirmation test result details (J1-C Group)

	Nuclide (half-life)	Legally required concentration [Bq/L]	Third-party agency		TEPCO analysis facility		Notes
			Analysis results※1 [Bq/L]	Legally required concentration ratio※	Analysis results※2 [Bq/L]	Legally required concentration ratio※	
14	Cd-115m (Approx. 45 days)	3E+02	< 1.40E+00	4.7E-03	< 2.70E+00	9.0E-03	
15	Sn-119m (Approx. 290 days)	2E+03	< 2.19E+01	1.1E-02	< 4.24E+01	2.1E-02	Assessed using radiation concentration of Sn-123
16	Sn-123 (Approx. 130 days)	4E+02	< 3.40E+00	8.5E-03	< 6.59E+00	1.6E-02	
17	Sn-126 (Approx. 100,00 years)	2E+02	< 9.80E-02	4.9E-04	< 2.92E-01	1.5E-03	
18	Sb-124 (Approx. 60 days)	3E+02	< 2.80E-02	9.3E-05	< 9.67E-02	3.2E-04	
19	Sb-125 (Approx. 3 years)	8E+02	2.05E-01	2.6E-04	2.26E-01	2.8E-04	
20	Te-123m (Approx. 120 days)	6E+02	< 2.30E-02	3.8E-05	< 9.19E-02	1.5E-04	
21	Te-125m (Approx. 58 days)	9E+02	2.05E-01	2.3E-04	2.26E-01	2.5E-04	Radioactive equilibrium with Sb-125
22	Te-127 (Approx. 9 hours)	5E+03	< 1.90E+00	3.8E-04	< 4.69E+00	9.4E-04	
23	Te-127m (Approx. 110 days)	3E+02	< 1.97E+00	6.6E-03	< 4.87E+00	1.6E-02	Assessed using radiation concentration of Te-127
24	Te-129 (Approx. 70 min.)	1E+04	< 4.40E-01	4.4E-05	< 6.15E-01	6.1E-05	
25	Te-129m (Approx. 34 days)	3E+02	< 6.80E-01	2.3E-03	< 1.37E+00	4.6E-03	
26	I-129 (Approx. 16 million years)	9E+00	1.24E+00	1.4E-01	1.16E+00	1.3E-01	

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【Reference】 Secondary treatment performance confirmation test result details (J1-C Group)

	Nuclide (half-life)	Legally required concentration [Bq/L]	Third-party agency		TEPCO analysis facility		Notes
			Analysis results※1 [Bq/L]	Legally required concentration ratio※	Analysis results※2 [Bq/L]	Legally required concentration ratio※	
27	Cs-134 (Approx. 2 years)	6E+01	< 1.90E-02	3.2E-04	< 7.60E-02	1.3E-03	
28	Cs-135 (Approx. 3 million years)	6E+02	7.51E-07	1.3E-09	1.18E-06	2.0E-09	Assessed using radiation concentration of Cs-137
29	Cs-136 (Approx. 13 days)	3E+02	< 2.00E-02	6.7E-05	< 4.68E-02	1.6E-04	
30	Cs-137 (Approx. 30 years)	9E+01	1.18E-01	1.3E-03	1.85E-01	2.1E-03	
31	Ba-137m (Approx. 3 min.)	8E+05	1.18E-01	1.5E-07	1.85E-01	2.3E-07	Radioactive equilibrium with Cs-137
32	Ba-140 (Approx. 13 days)	3E+02	< 8.10E-02	2.7E-04	< 2.02E-01	6.7E-04	
33	Ce-141 (Approx. 32 days)	1E+03	< 7.00E-02	7.0E-05	< 2.62E-01	2.6E-04	
34	Ce-144 (Approx. 280 days)	2E+02	< 2.00E-01	1.0E-03	< 5.69E-01	2.8E-03	
35	Pr-144 (Approx. 17 min.)	2E+04	< 2.00E-01	1.0E-05	< 5.69E-01	2.8E-05	Radioactive equilibrium with Ce-144
36	Pr-144m (Approx. 7 min.)	4E+04	< 2.00E-01	5.0E-06	< 5.69E-01	1.4E-05	Radioactive equilibrium with Ce-144
37	Pm-146 (Approx. 6 years)	9E+02	< 2.90E-02	3.2E-05	< 6.66E-02	7.4E-05	
38	Pm-147 (Approx. 3 years)	3E+03	< 4.03E-01	1.3E-04	< 8.04E-01	2.7E-04	Assessed using radiation concentration of Eu-154
39	Pm-148 (Approx. 5 days)	3E+02	< 8.10E-02	2.7E-04	< 2.33E-01	7.8E-04	

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【Reference】 Secondary treatment performance confirmation test result details (J1-C Group)

	Nuclide (half-life)	Legally required concentration [Bq/L]	Third-party agency		TEPCO analysis facility		Notes
			Analysis results※1 [Bq/L]	Legally required concentration ratio※3	Analysis results※2 [Bq/L]	Legally required concentration ratio※3	
40	Pm-148m (Approx. 41 days)	5E+02	< 2.00E-02	4.0E-05	< 4.84E-02	9.7E-05	
41	Sm-151 (Approx. 87 years)	8E+03	< 5.70E-03	7.1E-07	< 1.14E-02	1.4E-06	Assessed using radiation concentration of Eu-154
42	Eu-152 (Approx. 13 years)	6E+02	< 9.80E-02	1.6E-04	< 2.84E-01	4.7E-04	
43	Eu-154 (Approx. 9 years)	4E+02	< 5.70E-02	1.4E-04	< 1.14E-01	2.8E-04	
44	Eu-155 (Approx. 5 years)	3E+03	< 1.20E-01	4.0E-05	< 3.36E-01	1.1E-04	
45	Gd-153 (Approx. 240 days)	3E+03	< 9.50E-02	3.2E-05	< 2.64E-01	8.8E-05	
46	Tb-160 (Approx. 72 days)	5E+02	< 6.60E-02	1.3E-04	< 1.43E-01	2.9E-04	
47	Pu-238 (Approx. 88 years)	4E+00	< 2.40E-02	6.0E-03	< 3.25E-02	8.1E-03	Assessed as is included in Gross α radiation measurements
48	Pu-239 (Approx. 24000 years)	4E+00	< 2.40E-02	6.0E-03	< 3.25E-02	8.1E-03	Assessed as is included in Gross α radiation measurements
49	Pu-240 (Approx. 6600 years)	4E+00	< 2.40E-02	6.0E-03	< 3.25E-02	8.1E-03	Assessed as is included in Gross α radiation measurements
50	Pu-241 (Approx. 14 years)	2E+02	< 8.73E-01	4.4E-03	< 1.18E+00	5.9E-03	Assessed using radiation concentration of Pu-238
51	Am-241 (Approx. 430 years)	5E+00	< 2.40E-02	4.8E-03	< 3.25E-02	6.5E-03	Assessed as is included in Gross α radiation measurements
52	Am-242m (Approx. 150 years)	5E+00	< 4.34E-04	8.7E-05	< 5.87E-04	1.2E-04	Assessed using radiation concentration of Am-241

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The notation $0.00E\pm\Delta\Delta$ indicates $0.00 \times 10^{\pm\Delta\Delta}$

【Reference】 Secondary treatment performance confirmation test result details (J1-C Group)

	Nuclide (half-life)	Legally required concentration [Bq/L]	Third-party agency		TEPCO analysis facility		Notes
			Analysis results※1 [Bq/L]	Legally required concentration ratio※3	Analysis results※2 [Bq/L]	Legally required concentration ratio※3	
53	Am-243 (Approx. 7,400 years)	5E+00	< 2.40E-02	4.8E-03	< 3.25E-02	6.5E-03	Assessed as is included in Gross α radiation measurements
54	Cm-242 (Approx. 160 days)	6E+01	< 2.40E-02	4.0E-04	< 3.25E-02	5.4E-04	Assessed as is included in Gross α radiation measurements
55	Cm-243 (Approx. 29 years)	6E+00	< 2.40E-02	4.0E-03	< 3.25E-02	5.4E-03	Assessed as is included in Gross α radiation measurements
56	Cm-244 (Approx. 18 years)	7E+00	< 2.40E-02	3.4E-03	< 3.25E-02	4.6E-03	Assessed as is included in Gross α radiation measurements
57	Mn-54 (Approx. 310 days)	1E+03	< 2.10E-02	2.1E-05	< 3.83E-02	3.8E-05	
58	Fe-59 (Approx. 45 days)	4E+02	< 3.60E-02	9.0E-05	< 8.66E-02	2.2E-04	
59	Co-58 (Approx. 71 days)	1E+03	< 2.10E-02	2.1E-05	< 4.11E-02	4.1E-05	
60	Co-60 (Approx. 5 years)	2E+02	2.90E-01	1.5E-03	3.33E-01	1.7E-03	
61	Ni-63 (Approx. 100 years)	6E+03	< 2.10E+00	3.5E-04	< 8.45E+00	1.4E-03	
62	Zn-65 (Approx. 240 days)	2E+02	< 7.20E-02	3.6E-04	< 9.41E-02	4.7E-04	
63	C-14 (Approx. 5700 years)	2E+03	1.54E+01	7.7E-03	1.76E+01	8.8E-03	
Total			-	2.8E-01	-	3.5E-01	
H-3 (Approx. 12 years)		6E+04	7.91E+05	1.3E+01	8.22E+05	1.4E+01	

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