Deviation of Total Values for Primary Seven Nuclides from Gross β Values for Water Treated with Multi-nuclide Removal Equipment, etc.

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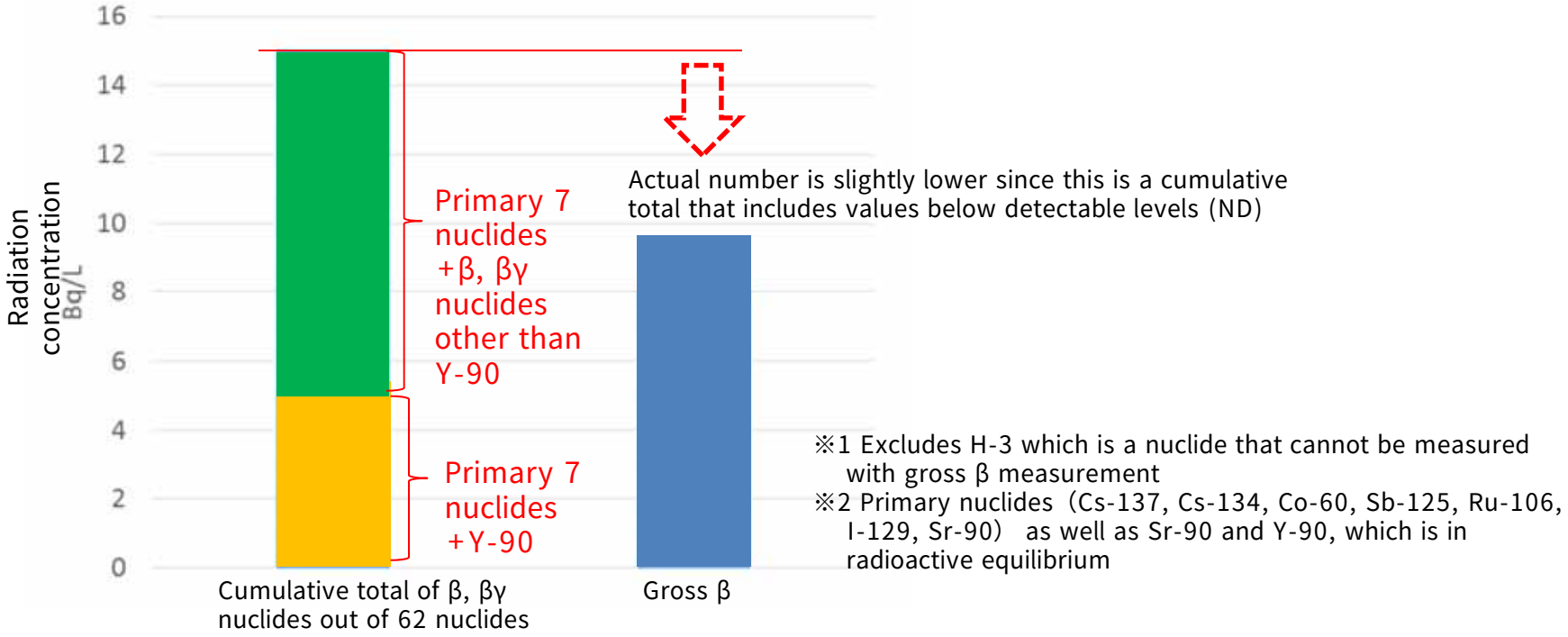
Tokyo Electric Power Company Holdings, Inc.

Foreword



Comparison of cumulative total of β, βγ nuclides (62 nuclides) in K4 tank and gross β

At the meeting of the Subcommittee on the Handling of Water Treated with Multi-Nuclide Removal Equipment, etc. on October 1, 2018, the observation was made in regards to the deviation of gross β values from the total for the primary 7 nuclides that the gap between gross β values could be reduced by stacking on the ND values for the 62 nuclides (refer to the graph above)

- This was just an observation and facts are required to backup this hypothesis
- An investigation was performed to identify any impact from nuclides other than the primary 7 nuclides, and to examine the accuracy of the analysis method

ALPS-treated water examined

- The water in tanks H4N-A6, which shows the largest deviation of gross β values from the total values for the primary 7 nuclides, was selected to be examined during this investigation (refer to the chart below for measurement values).
- Furthermore, although the water from tank H4N-A6 that was used for this investigation was sampled in October 2018, the value obtained for gross β was 44.72Bq/L is within the margin of error (±10%) of the measurement equipment, so it is assumed that there is no large difference in nuclide composition.

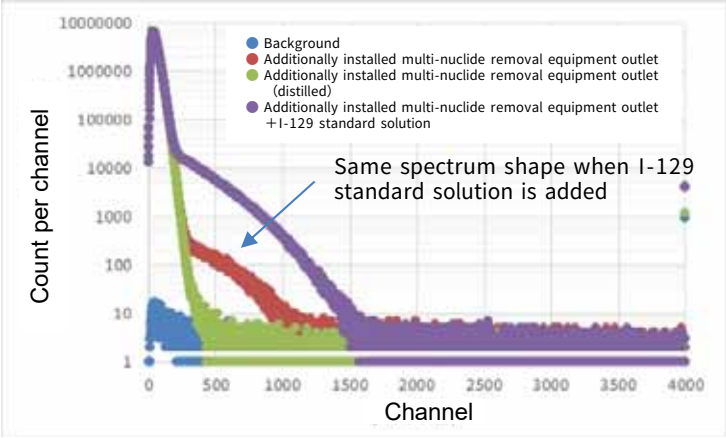
H4N-A6 tank water analysis results
(sampled in April 2018)

Nuclide	Concentration (Bq/L)	Gross β value (Bq/L)
Cs-137	0.3368	
Cs-134	<0.1675	
Sr-90	0.191	
Y-90	0.191	
I-129	1.765	
Ru-106	5.774	
Rh-106	5.774	
Co-60	0.462	
Sb-125	0.6526	
Total	15.31	40.74

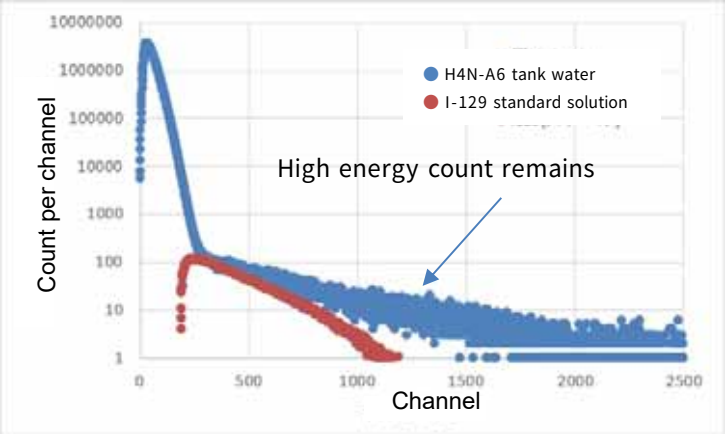
Assessment of impact of nuclides other than the primary 7 nuclides

◆ Pure β nuclide impact assessment

- The energy distribution of water from the outlet of additionally installed multi-nuclide removal equipment and of the water from tank H4N-A6 was examined using measurements taken with a liquid scintillation counter.
- Spectral analysis of the water from the outlet of the additionally installed multi-nuclide removal equipment showed the presence of a nuclide that has approximately the same maximum β ray energy as I-129 (154keV) and the count value exceeded I-129 measurement values (6.6Bq/L), so measurements (refer to the following pages for details on the measurement method) were conducted to look for the presence of C-14, which has approximately the same maximum β ray energy (154keV). As a result, a significant amount of C-14 was detected, and C-14 was also detected in H4N-A6.
- Furthermore, the β ray spectral analysis for water in the H4N-A6 tank showed a remaining count of energy higher than that of I-129, and it was estimated from the shape of the spectrum that the maximum β ray energy is approximately 300keV.
- Out of the primary 7 nuclides, the nuclides with a maximum β ray energy close to 300keV are Co-60 and Sb-125, but this count is much higher than the known concentrations of these nuclides, which suggests the presence of another nuclide.
- Tc-99 (294keV) was selected as a possible candidate for this unknown nuclide, and when the water in tank H4N-A6 was tested for the presence of Tc-99 (ICP-MS method), a significant amount was detected.



β ray spectral analysis for water from the outlet of additionally installed multi-nuclide removal equipment

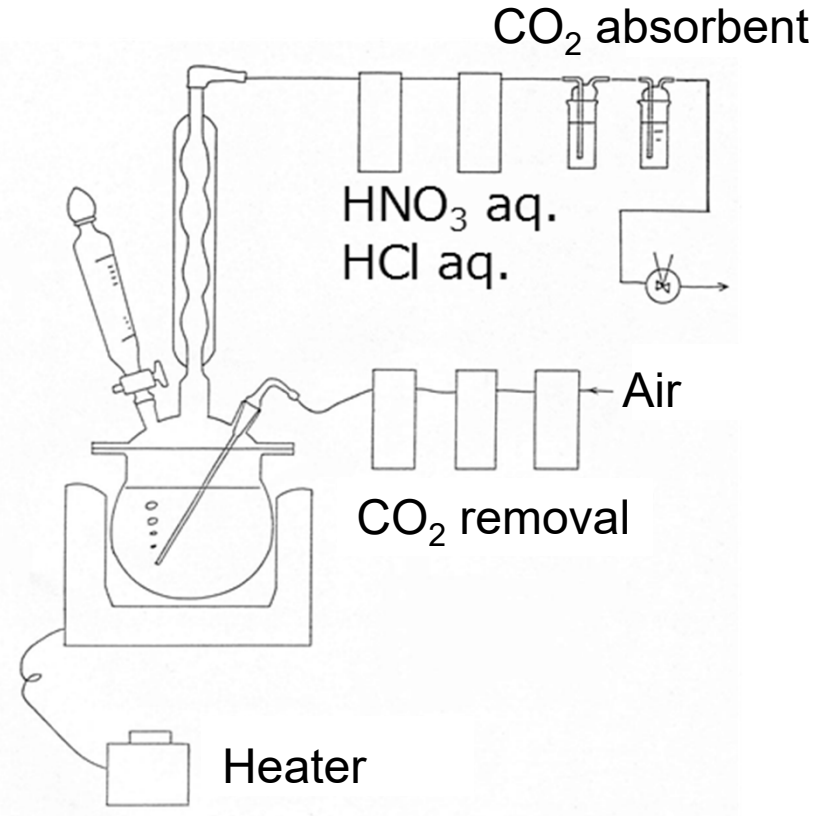


β ray special analysis of water from tank H4N-A6

◆ Pure β nuclide impact assessment

➢ C-14 analysis method

- Oxidized into CO_2 by wet oxidation using concentrated nitric acid and potassium persulfate
- CO_2 absorbent used to absorb the CO_2 and measure LSC



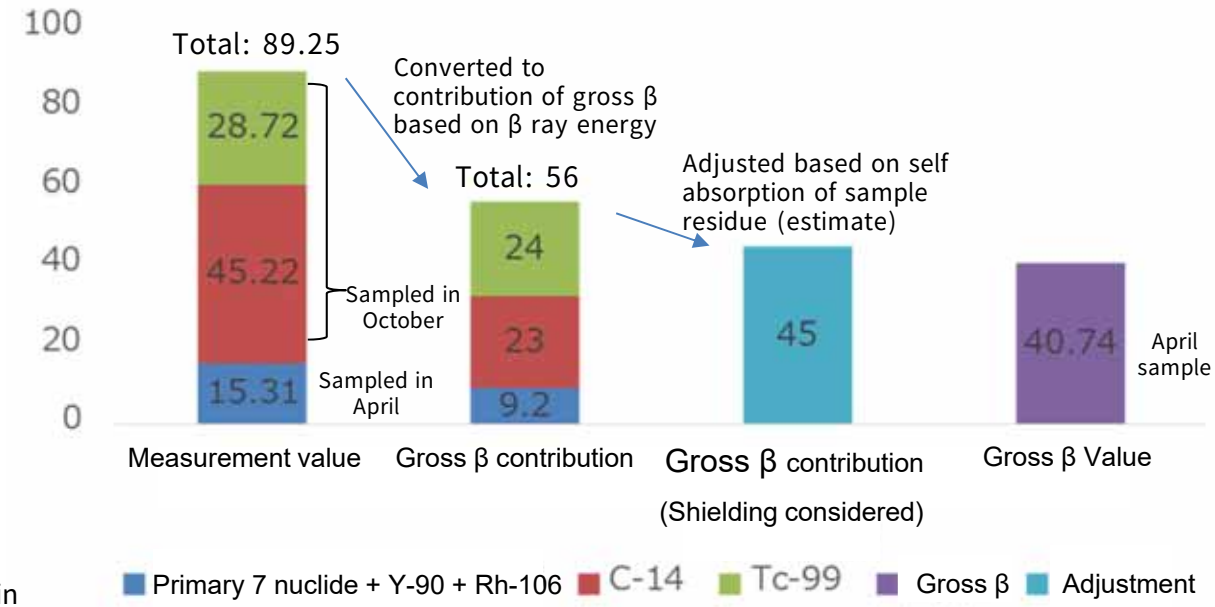
Overview of C-14 analysis pretreatment

C-14 and Tc-99 measurement results

Nuclide	Measurement instrument	Concentration (Bq/L)
C-14	LSC	45.22
Tc-99	ICP-MS	28.72

※1: Gross β contribution conversion performed under the technical guidance of the High Energy Accelerator Research Organization Radiation Science Center

※2: Self-absorption adjustment formula noted in the radioisotope pocket data book used



Results of gross β value assessment that includes C-14 and Tc-99 (Bq/L)

- An assessment of the gross β contribution conversion values for the obtained measurement results, which takes into account the β ray energy for each nuclide, yielded a value of 56.33Bq/L. ※1。
- Furthermore an adjustment performed under the assumption that the self-shielding of the samples lowered the contribution to gross beta values yielded a value of approximately 45Bq/L ※2, which is pretty much within the margin of error of the gross β measurement count (±10%).
- From these results the conclusion was reached that the presence of C-14 and TC-99 in the water in tank H4N-A6 is the primary reason why the gross β values for ALPS-treated water is larger than the total value for the primary 7 nuclides.
- After all tank groups have been analyzed, tank groups other than the H4N tank group that show a deviation between gross β values and the total values for the primary 7 nuclides will be selected for further analysis using the same methods.