分析実施機関　：　一般財団法人九州環境管理協会

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: H-3

Method:

Distilled seawater sample was electrically enriched about 40 times using electric cell (Ni anode, Fe cathode). After electrical enrichment, the sample was neutlized and distilled. Enriched sample water 10 g was mixed with scintillation cocktail 10 g in a 20 mL low diffusion polyvial, and measured by Low Backgound LSC for 800 min.

Detection system (including type of calibration applied):

Low Background Liquid Scintillation Counter(ALOKA, LB8) calibrated with a set of quenched standards.

Nuclear data used (e.g., half-life):

H-3 half-life: 12.312 ± 0.025 year (BIPM-5 Table of Radionuclides Vol.3)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)				1.30	
Uncertainty (k=1) (Bq/L)				0.05	
Detection limit (Bq/L):				0.02	

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate				1.35	
Uncertainty component associated with detector efficiency				2.63	
Uncertainty component associated with weighing				0.0588	
Uncertainty component associated with reproducibility of electrolytic enrichment				2.97	
Relative combined standard uncertainty (k=1)	0.0	0.0	0.0	4.2	0.0

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Sr-90

Method:

Sr pre-consentration in 40 L of seawater sample was carried out using a cation exchange resin, followed by separation of carbonate precipitation and oxalate precipitation. Sr-Ca separation was carried out using a cation exchange resin. Ba was separated from Sr as the insoluble Ba cromate precipitate. The Sr-Y separation was carried out by co-precipitation of Y with ferric hydroxide. Sr chemical recovery was determined by ICP-AES. After 2weeks, Y-90 was measured immediately after separation from Sr-90 by proportional counter.

Detection system (including type of calibration applied):

Proportional counter(Mirion Technologies Canberra, LB-4200) calibrated with co-precipitation of Y-90 with ferric hydroxide.

Nuclear data used (e.g., half-life):

BIPM-5 Table of Radionuclides Vol.3
Sr-90 half-life(y): 28.80 ± 0.07 , Y-90 half-life(d):2.6684 ± 0.0013

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	0.00099	0.00066	0.00121	0.00087	0.00086
Uncertainty (k=1) (Bq/L)	0.00015	0.00013	0.00017	0.00015	0.00014
Detection limit (Bq/L):	0.00032	0.00033	0.00031	0.00033	0.00029

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate	14.4	19.4	12.3	15.9	15.1
Uncertainty component associated with detector efficiency	1.73	1.48	2.62	1.94	2.27
Uncertainty component associated with chemical yield determination	5.49	5.36	5.38	7.16	6.95
Uncertainty component associated with weighing	0.199	0.199	0.199	0.199	0.199
Any other uncertainty component (please specify)	0	0	0	0	0
Relative combined standard uncertainty (k=1)	15.5	20.2	13.7	17.5	16.8

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Cs-134

Method:

Cs in seawater sample (20 L) was co-precipitated with AMP, and separated AMP was measured for 160,000 sec by Ge detector.

Detection system (including type of calibration applied):

Low-Background Coaxial Ge detector (Mirion Technologies Canberra, GX4018-7915-30ULB) calibrated with multi gamma source.

Nuclear data used (e.g., half-life):

BIPM-5 Table of Radionuclides Vol.7
Cs-134 half-life(y): 2.0644 ± 0.0014 , emission probablities(%) 97.63 ± 0.08 (604.720 keV)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)			<0.00077	<0.00075	
Uncertainty (k=1) (Bq/L)			-	-	
Detection limit (Bq/L):			0.00077	0.00075	

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate			-	-	
Uncertainty component associated with detector efficiency			-	-	
Uncertainty component associated with emission probability			-	-	
Uncertainty component associated with weighing			-	-	
Any other uncertainty component (please specify)			-	-	
Relative combined standard uncertainty (k=1)	0.0	0.0	-	-	0.0

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Cs-137

Method:

Cs in seawater sample (20 L) was co-precipitated with AMP, and separated AMP was measured for 160,000 sec by Ge detector.

Detection system (including type of calibration applied):

Low-Background Coaxial Ge detector (Mirion Technologies Canberra, GX4018-7915-30ULB) calibrated with multi gamma source.

Nuclear data used (e.g., half-life):

BIPM-5 Table of Radionuclides Vol.9
Cs-137 half-life(y): 30.018 ± 0.022 , emission probablities(%) 85.01 ± 0.20 (661.655 keV)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)			0.0243	0.00758	
Uncertainty (k=1) (Bq/L)			0.0010	0.00041	
Detection limit (Bq/L):			0.0005	0.00056	

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate			1.82	3.84	
Uncertainty component associated with detector efficiency			3.51	3.51	
Uncertainty component associated with emission probability			0.235	0.235	
Uncertainty component associated with weighing			0.102	0.102	
Uncertainty component associated with detector stability and sample positioning			1.46	1.46	
Relative combined standard uncertainty (k=1)	0.0	0.0	4.2	5.4	0.0

Nuclide: H-3

Method:

Distilled seawater sample was electrically enriched about 40 times using electric cell (Ni anode, Fe cathode). After electrical enrichment, the sample was neutlized and distilled. Enriched sample water 10 g was mixed with scintillation cocktail 10 g in a 20 mL low diffusion polyvial, and measured by Low Backgound LSC for 800 min.

Detection system (including type of calibration applied):

Low Background Liquid Scintillation Counter(ALOKA, LB7) calibrated with a set of quenched standards.

Nuclear data used (e.g., half-life):

H-3 half-life: 12.312 ± 0.025 year (BIPM-5 Table of Radionuclides Vol.3)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	E-S15	T-0-1A	T-3	M-E1	M-E3
Activity concentration (Bq/L)					0.049
Uncertainty (k=1) (Bq/L)					0.010
Detection limit (Bq/L):					0.029

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate					20.2
Uncertainty component associated with detector efficiency					2.62
Uncertainty component associated with weighing					0.0588
Uncertainty component associated with reproducibility of electrolytic enrichment					2.97
Relative combined standard uncertainty (k=1)	0.0	0.0	0.0	0.0	20.6

IAEA Additional Measures for Independent Sampling and Analysis
H-3, Sr-90 and Cs-137 in seawater

Nuclide: Sr-90

Method:

Sr pre-consentration in 40 L of seawater sample was carried out using a cation exchange resin, followed by separation of carbonate precipitation and oxalate precipitation. Sr-Ca separation was carried out using a cation exchange resin. Ba was separated from Sr as the insoluble Ba cromate precipitate. The Sr-Y separation was carried out by co-precipitation of Y with ferric hydroxide. Sr chemical recovery was determined by ICP-AES. After 2weeks, Y-90 was measured immediately after separation from Sr-90 by proportional counter.

Detection system (including type of calibration applied):

Proportional counter(Mirion Technologies Canberra, LB-4200) calibrated with co-precipitation of Y-90 with ferric hydroxide.

Nuclear data used (e.g., half-life):

BIPM-5 Table of Radionuclides Vol.3
Sr-90 half-life(y): 28.80 ± 0.07 , Y-90 half-life(d):2.6684 ± 0.0013

RESULTS

At reference time 15 October 2024 12:00 UTC

	Bq/L
	M-103
Activity concentration (Bq/L)	0.00083
Uncertainty (k=1) (Bq/L)	0.00015
Detection limit (Bq/L):	0.00036

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**
Uncertainty component associated with net count rate	17.4
Uncertainty component associated with detector efficiency	2.01
Uncertainty component associated with chemical yield determination	4.74
Uncertainty component associated with weighing	0.200
Any other uncertainty component (please specify)	
Relative combined standard uncertainty (k=1)	18.1

IAEA Additional Measures for Independent Sampling and Analysis
H-3, Sr-90 and Cs-137 in seawater

Nuclide: Cs-137

Method:

Cs in seawater sample (20 L) was co-precipitated with AMP, and separated AMP was measured for 160,000 sec by Ge detector.

Detection system (including type of calibration applied):

Low-Background Coaxial Ge detector (Mirion Technologies Canberra, GX4018-7915-30ULB) calibrated with multi gamma source.

Nuclear data used (e.g., half-life):

BIPM-5 Table of Radionuclides Vol.9
Cs-137 half-life(y): 30.018 ± 0.022 , emission probablities(%) 85.01 ± 0.20 (661.655 keV)

RESULTS

At reference time 15 October 2024 12:00 UTC

	Bq/L
	M-103
Activity concentration (Bq/L)	0.0103
Uncertainty (k=1) (Bq/L)	0.0005
Detection limit (Bq/L):	0.0005

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**
Uncertainty component associated with net count rate	3.05
Uncertainty component associated with detector efficiency	3.56
Uncertainty component associated with emission probability	0.235
Uncertainty component associated with weighing	0.102
Uncertainty component associated with detector stability and sample positioning	1.60
Relative combined standard uncertainty (k=1)	5.0

分析実施機関　：　公益財団法人海洋生物環境研究所

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: H-3

Method:

The seawater samples were purified by distillation, and then tritium in the sample was concentrated by an electrolytic enrichment method (500 mL to 50 mL) by Ni-Ni electrodes. Enriched sample was further purified by distillation. The enriched sample (50ml) was mixed with 50 mL of Ultima Gold uLLT scintillation cocktail.

Detection system (including type of calibration applied):

Beta rays from the sample were measured using Hitachi AccuFLEX LSC-LB7 low background liquid scintillation counter. By using 8 standard samples with known concentrations of tritium and variable quenching levels, relationship between counting efficiencies and External Standard Channel Ratios (ESCR) was derived. The relationship was used to estimate counting efficiencies for each sample.

Nuclear data used (e.g., half-life):

The physical parameters used to calculate the radioactivity was referred to ENSDF（2020）.
Half life : 12.32 ± 0.02 years

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	0.46	0.11	0.12	1.2	0.11
Uncertainty (k=1) (Bq/L)	0.025	0.012	0.012	0.050	0.012
Detection limit (Bq/L):	0.036	0.037	0.034	0.035	0.037

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate	4.0%	10.8%	9.4%	1.8%	9.7%
Uncertainty component associated with detector efficiency	2.6%	2.6%	2.6%	2.6%	2.6%
Uncertainty component associated with weighing	0.018%	0.018%	0.018%	0.018%	0.018%
Any other uncertainty component (please specify)	2.6%	2.6%	2.6%	2.6%	2.6%
Relative combined standard uncertainty (k=1)	5.4%	11.4%	10.1%	4.1%	10.3%

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Cs-134

Method:

By adding 0.26 g of CsCl as carrier and 12 g of ammonium phosphomolybdate (AMP) to 18-21 l of seawater, ^{134}Cs was separated by co-precipitation. AMP/Cs precipitate was filtered and, then, its radioactivity was measured by using a gamma-ray spectrometer equipped with a planar-type, high purity Ge detector. The chemical yield was estimated by Comparison of stable cesium concentrations in seawater before and after adding AMP, and it was more than 99.9 %.

Detection system (including type of calibration applied):

Efficiency calibration was carried out using five standard gamma ray sources with different height (0.5 cm, 1.0 cm, 2.0 cm, 3.0 cm, and 5.0 cm) in U-8 containers. The efficiency for the samples were calculated based on the regression curve for the height-efficiency relationship. FWHM was calculated by measuring a Co-60 standard source. The relative efficiency and FWHM of the detector 3 are 41.5 % and 1.83 keV, respectively.

Nuclear data used (e.g., half-life):

We referred Table of Isotopes 7th edition.
Half life : 2.062 ± 0.005 years, Principal gamma ray emission energy :604.66 ± 0.02 keV, Principal gamma ray emission probability : 97.56 ± 0.32 %

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	Not Detect (N.D.)	N.D.	N.D.	N.D.	N.D.
Uncertainty (k=1) (Bq/L)					
Detection limit (Bq/L):	0.00071	0.00088	0.00085	0.00079	0.00087

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate					
Uncertainty component associated with detector efficiency					
Uncertainty component associated with emission probability					
Uncertainty component associated with weighing					
Any other uncertainty component (please specify)					
Relative combined standard uncertainty (k=1)	0.0	0.0	0.0	0.0	0.0

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Cs-137

Method:

By adding 0.26 g of CsCl as carrier and 12 g of ammonium phosphomolybdate (AMP) to 18-21 l of seawater, ^{137}Cs was separated by co-precipitation. AMP/Cs precipitate was filtered and, then, its radioactivity was measured by using a gamma-ray spectrometer equipped with a planar-type, high purity Ge detector. The chemical yield was estimated by Comparison of stable cesium concentrations in seawater before and after adding AMP, and it was more than 99.9 %.

Detection system (including type of calibration applied):

Efficiency calibration was carried out using five standard gamma ray sources with different height (0.5 cm, 1.0 cm, 2.0 cm, 3.0 cm, and 5.0 cm) in U-8 containers. The efficiency for the samples were calculated based on the regression curve for the height-efficiency relationship. FWHM was calculated by measuring a ^{60}Co standard source. The relative efficiency and FWHM of the detector 3 are 41.5 % and 1.83 keV, respectively.

Nuclear data used (e.g., half-life):

We referred Table of Isotopes 7th edition.
Half life : 30.174 ± 0.034 years, Principal gamma ray emission energy : 661.649 ± 0.012 keV, Principal gamma ray emission probability : 85.0 ± 0.5 %

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	0.0082	0.0068	0.026	0.0074	0.0079
Uncertainty (k=1) (Bq/L)	0.00073	0.00062	0.0022	0.00066	0.00070
Detection limit (Bq/L):	0.00072	0.00061	0.00068	0.00068	0.00068

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate	3.5%	3.8%	1.7%	3.6%	3.5%
Uncertainty component associated with detector efficiency	7.9%	7.9%	7.9%	7.9%	7.9%
Uncertainty component associated with emission probability	0.6%	0.6%	0.6%	0.6%	0.6%
Uncertainty component associated with weighing	0.0059%	0.0059%	0.0059%	0.0059%	0.0059%
Any other uncertainty component (please specify)	2.1%	2.1%	2.1%	2.1%	2.1%
Relative combined standard uncertainty (k=1)	8.9%	9.1%	8.4%	8.9%	8.9%

IAEA Additional Measures for Independent Sampling and Analysis
H-3, Sr-90 and Cs-137 in seawater

Nuclide: H-3

Method:

The seawater samples were purified by distillation, and then tritium in the sample was concentrated by an electrolytic enrichment method (500 mL to 50 mL) by Ni-Ni electrodes. Enriched sample was further purified by distillation. The enriched sample (50ml) was mixed with 50 mL of Ultima Gold uLLT scintillation cocktail.

Detection system (including type of calibration applied):

Beta rays from the sample were measured using Hitachi AccuFLEX LSC-LB7 low background liquid scintillation counter. By using 8 standard samples with known concentrations of tritium and variable quenching levels, relationship between counting efficiencies and External Standard Channel Ratios (ESCR) was derived. The relationship was used to estimate counting efficiencies for each sample.

Nuclear data used (e.g., half-life):

The physical parameters used to calculate the radioactivity was referred to ENSDF（2020）.
Half life : 12.32 ± 0.02 years

RESULTS

At reference time 15 October 2024 12:00 UTC

	Bq/L
	M-103
Activity concentration (Bq/L)	0.12
Uncertainty (k=1) (Bq/L)	0.018
Detection limit (Bq/L):	0.042

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**
Uncertainty component associated with net count rate	14%
Uncertainty component associated with detector efficiency	2.6%
Uncertainty component associated with weighing	0.018%
Any other uncertainty component (please specify)	2.6%
Relative combined standard uncertainty (k=1)	14%

IAEA Additional Measures for Independent Sampling and Analysis
H-3, Sr-90 and Cs-137 in seawater

Nuclide: Cs-137

Method:

By adding 0.26 g of CsCl as carrier and 12 g of ammonium phosphomolybdate (AMP) to 18-21 l of seawater, ^{137}Cs was separated by co-precipitation. AMP/Cs precipitate was filtered and, then, its radioactivity was measured by using a gamma-ray spectrometer equipped with a planar-type, high purity Ge detector. The chemical yield was estimated by Comparison of stable cesium concentrations in seawater before and after adding AMP, and it was more than 99.9 %.

Detection system (including type of calibration applied):

Efficiency calibration was carried out using five standard gamma ray sources with different height (0.5 cm, 1.0 cm, 2.0 cm, 3.0 cm, and 5.0 cm) in U-8 containers. The efficiency for the samples were calculated based on the regression curve for the height-efficiency relationship. FWHM was calculated by measuring a ^{60}Co standard source. The relative efficiency and FWHM of the detector 3 are 41.5 % and 1.83 keV, respectively.

Nuclear data used (e.g., half-life):

We referred Table of Isotopes 7th edition.
Half life : 30.174 ± 0.034 years, Principal gamma ray emission energy : 661.649 ± 0.012 keV, Principal gamma ray emission probability : 85.0 ± 0.5 %

RESULTS

At reference time 15 October 2024 12:00 UTC

	Bq/L
	M-103
Activity concentration (Bq/L)	0.011
Uncertainty (k=1) (Bq/L)	0.0010
Detection limit (Bq/L):	0.00069

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**
Uncertainty component associated with net count rate	2.8%
Uncertainty component associated with detector efficiency	7.9%
Uncertainty component associated with emission probability	0.59%
Uncertainty component associated with weighing	0.0059%
Any other uncertainty component (please specify)	2.1%
Relative combined standard uncertainty (k=1)	8.7%

分析実施機関　：　東京パワーテクノロジー株式会社

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: H-3

Method:

The sample solution was purified by vacuum distillation in rotary evaporator with sodium peroxide and potassium permanganate, followed by electrolytic enrichment (500 mL reduced to 60 mL). The enriched sample was further purified by vacuum distillation.
A liquid scintillation counter (ALOKA, LB-7) was used for the counting of an aliquot of the enriched and distilled sample mixed with a scintillation cocktail (Ultima Gold LLT).

Detection system (including type of calibration applied):

The counting efficiency was determined by the external standard channels ratio method (ESCR).

Nuclear data used (e.g., half-life):

half life・・・ 12.32 (year)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	-	-	-	-	0.0474
Uncertainty (k=1) (Bq/L)	-	-	-	-	0.0125
Detection limit (Bq/L):	-	-	-	-	0.0364

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate	-	-	-	-	25.7
Uncertainty component associated with detector efficiency	-	-	-	-	3.77
Uncertainty component associated with weighing	-	-	-	-	0.058
Any other uncertainty component (electrolytic enrichment)	-	-	-	-	4.57
Relative combined standard uncertainty (k=1)	-	-	-	-	26.4

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Sr-90

Method:

A cation-exchange resin column was used for pre-concentration of strontium in analyte, followed by precipitation of carbonates. Moreover Ca is separated by Sr by these column. After ^{90}Y was removed by scarvenging and the sample attained secular equilibrium, ^{90}Y was separated using an iron hydroxide co-precipitation technique and measured by a gas proportional counter. The recovery rate of yttrium was calculated by gravimetric measurement.

Detection system (including type of calibration applied):

Efficiency calibration was carried out using the yttrium oxalate precipitates produced by standard ^{90}Sr solution.

Nuclear data used (e.g., half-life):

half-life of Sr-90 ・・・ 28.74 (year)
half-life of Y-90 ・・・ 64.10 (hr)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	-	-	-	-	0.00178
Uncertainty (k=1) (Bq/L)	-	-	-	-	0.000189
Detection limit (Bq/L):	-	-	-	-	0.000369

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate	-	-	-	-	10.1
Uncertainty component associated with detector efficiency	-	-	-	-	1.63
Uncertainty component associated with chemical yield determination	-	-	-	-	3.06
Uncertainty component associated with weighing	-	-	-	-	0.5
Any other uncertainty component (please specify)	-	-	-	-	0
Relative combined standard uncertainty (k=1)	-	-	-	-	10.7

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Cs-134

Method:

Chemical separation of caesium by ammonium molybdophosphate (AMP), followed by gamma-ray spectrometry with a p-type coaxial HPGe detector.
SEIKO EG&G Gamma Studio was used for the analysis of the obtained spectra.

Detection system (including type of calibration applied):

Efficiency calibration was carried out using mixed-radionuclide sources in Marinelli beaker (Cd-109, Co-57, Ce-139, Cr-51, Sr-85, Cs-137, Mn-54, Y-88 and Co-60) for coincidence losses, self-absorption effects.

Nuclear data used (e.g., half-life):

half-life ・・・ 2.0644 (year)
emission probabilities ・・・ 85.73 (%)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	-	-	-	-	ND
Uncertainty (k=1) (Bq/L)	-	-	-	-	-
Detection limit (Bq/L):	-	-	-	-	0.000547

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate	-	-	-	-	-
Uncertainty component associated with detector efficiency	-	-	-	-	-
Uncertainty component associated with emission probability	-	-	-	-	-
Uncertainty component associated with weighing	-	-	-	-	-
Any other uncertainty component (please specify)	-	-	-	-	-
Relative combined standard uncertainty (k=1)	-	-	-	-	-

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Cs-137

Method:

Chemical separation of caesium by ammonium molybdophosphate (AMP), followed by gamma-ray spectrometry with a p-type coaxial HPGe detector.
SEIKO EG&G Gamma Studio was used for the analysis of the obtained spectra.

Detection system (including type of calibration applied):

Efficiency calibration was carried out using mixed-radionuclide sources in Marinelli beaker (Cd-109, Co-57, Ce-139, Cr-51, Sr-85, Cs-137, Mn-54, Y-88 and Co-60) for coincidence losses, self-absorption effects.

Nuclear data used (e.g., half-life):

half-life ··· 30.018 (year)
emission probabilities ··· 97.57 (%)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	-	-	-	-	0.00737
Uncertainty (k=1) (Bq/L)	-	-	-	-	0.000284
Detection limit (Bq/L):	-	-	-	-	0.000474

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate	-	-	-	-	2.62
Uncertainty component associated with detector efficiency	-	-	-	-	2.77
Uncertainty component associated with emission probability	-	-	-	-	0.275
Uncertainty component associated with weighing	-	-	-	-	0.5
Any other uncertainty component (half-life)	-	-	-	-	0.073
Relative combined standard uncertainty (k=1)	-	-	-	-	3.9

IAEA ILC 2024 (NA3/38)
Cs-134, Cs-137, Pu-238 and Pu-239,240 in sediment

Nuclide: Cs-134

Method:

Sediment samples in polypropylene container were directly counted on a p-type coaxial HPGe detector. The obtained spectra was identified and calculated by commercial software packages (SEIKO EG&G Gamma Studio).

Detection system (including type of calibration applied):

Efficiency calibration was carried out using mixed-radionuclide sources with the same geometry as the test sample for coincidence losses, self-absorption effects. Sources contains Cd-109, Co-57, Ce-139, Cr-51, Sr-85, Cs-137, Mn-54, Y-88 and Co-60.

Nuclear data used (e.g., half-life and emission probabilities):

half-life ・・・ 2.0644 (year)
emission probabilities ・・・ 85.73 (%)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/kg d.w.		
	F-P04	T-S3	T-S8
Massic activity (Bq/kg d.w.)	ND	ND	ND
Uncertainty (k=1) (Bq/kg d.w.)	-	-	-
Detection limit (Bq/kg d.w.)	0.975	0.732	0.865

Uncertainty Budget (optional)	Relative uncertainty (%) (k=1)		
Uncertainty component associated with net count rate	-	-	-
Uncertainty component associated with detector efficiency	-	-	-
Uncertainty component associated with emission probability	-	-	-
Uncertainty component associated with weighing	-	-	-
Any other uncertainty component (please specify)	-	-	-
Relative combined standard uncertainty (k=1)	-	-	-

IAEA ILC 2024 (NA3/38)
Cs-134, Cs-137, Pu-238 and Pu-239,240 in sediment

Nuclide: Cs-137

Method:

Sediment samples in polypropylene container were directly counted on a p-type coaxial HPGe detector. The obtained spectra was identified and calculated by commercial software packages (SEIKO EG&G Gamma Studio).

Detection system (including type of calibration applied):

Efficiency calibration was carried out using mixed-radionuclide sources with the same geometry as the test sample for coincidence losses, self-absorption effects. Sources contains Cd-109, Co-57, Ce-139, Cr-51, Sr-85, Cs-137, Mn-54, Y-88 and Co-60.

Nuclear data used (e.g., half-life and emission probabilities):

half-life ・・・ 30.018 (year)
emission probabilities ・・・ 97.57 (%)

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/kg d.w.		
	F-P04	T-S3	T-S8
Massic activity (Bq/kg d.w.)	46.3	8.77	40.3
Uncertainty (k=1) (Bq/kg d.w.)	1.42	0.394	1.28
Detection limit (Bq/kg d.w.)	0.621	0.59	0.704

Uncertainty Budget (optional)	Relative uncertainty (%) (k=1)		
Uncertainty component associated with net count rate	1.28	3.52	1.52
Uncertainty component associated with detector efficiency	2.77	2.77	2.77
Uncertainty component associated with emission probability	0.275	0.275	0.275
Uncertainty component associated with weighing	0	0	0
Any other uncertainty component (half-life)	0.073	0.073	0.073
Relative combined standard uncertainty (k=1)	3.1	4.5	3.2

分析実施機関　：　東北緑化環境保全株式会社

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Cs-134

Method:

Cesium chemical separation by ammonium phosphomolybdate (AMP)

Detection system (including type of calibration applied):

Germanium semiconductor detector
Calibration with cesium source

Nuclear data used (e.g., half-life):

2.065 years 604.66keV 97.62%

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	ND				ND
Uncertainty (k=1) (Bq/L)	-				-
Detection limit (Bq/L):	0.000931				0.000882

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate	185				18600
Uncertainty component associated with detector efficiency	0				0
Uncertainty component associated with emission probability	11				11
Uncertainty component associated with weighing	0.001				0.001
Any other uncertainty component (please specify)	1.2				1.2
Relative combined standard uncertainty (k=1)	185	0.0	0.0	0.0	18600

IAEA ILC 2024 (NA3/38)
H-3, Sr-90, Cs-134 and Cs-137 in seawater

Nuclide: Cs-137

Method:

Cesium chemical separation by ammonium phosphomolybdate (AMP)

Detection system (including type of calibration applied):

Germanium semiconductor detector
Calibration with cesium source

Nuclear data used (e.g., half-life):

30.07 years 661.64keV 85.10%

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/L				
	M-101	M-102	M-103	M-104	T-D1
Activity concentration (Bq/L)	0.00596				0.00663
Uncertainty (k=1) (Bq/L)	0.00122				0.00135
Detection limit (Bq/L):	0.000406				0.000390

Uncertainty Budget (optional)	**Relative uncertainty (%) (k=1)**				
Uncertainty component associated with net count rate	4.23				3.85
Uncertainty component associated with detector efficiency	0				0
Uncertainty component associated with emission probability	20				20
Uncertainty component associated with weighing	0.001				0.001
Any other uncertainty component (please specify)	1.2				1.2
Relative combined standard uncertainty (k=1)	20.5	0.0	0.0	0.0	20.4

IAEA ILC 2024 (NA3/38)
Cs-134, Cs-137, Pu-238 and Pu-239,240 in sediment

Nuclide: Cs-134

Method:

Fill the sample in a U-8 container and measure with a Ge semiconductor detector.

Detection system (including type of calibration applied):

Germanium semiconductor detector
Calibration with cesium source

Nuclear data used (e.g., half-life and emission probabilities):

2.065年　604.66kev 97.62%

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/kg d.w.		
	F-P04	T-S3	T-S8
Massic activity (Bq/kg d.w.)	ND	ND	0.845
Uncertainty (k=1) (Bq/kg d.w.)	-	-	0.198
Detection limit (Bq/kg d.w.)	0.757	0.652	0.576

Uncertainty Budget (optional)	Relative uncertainty (%) (k=1)		
Uncertainty component associated with net count rate	50.23	1204	23.32
Uncertainty component associated with detector efficiency	0.311	0.311	0.311
Uncertainty component associated with emission probability	0	0	0
Uncertainty component associated with weighing	0	0	0
Any other uncertainty component (please specify)	2.4	2.4	2.4
Relative combined standard uncertainty (k=1)	50.3	1204.0	23.4

IAEA ILC 2024 (NA3/38)
Cs-134, Cs-137, Pu-238 and Pu-239,240 in sediment

Nuclide: Cs-137

Method:

Fill the sample in a U-8 container and measure with a Ge semiconductor detector.

Detection system (including type of calibration applied):

Germanium semiconductor detector
Calibration with cesium source

Nuclear data used (e.g., half-life and emission probabilities):

30.07年 661.64kev 85.10%

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/kg d.w.		
	F-P04	T-S3	T-S8
Massic activity (Bq/kg d.w.)	44.98	10.56	49.54
Uncertainty (k=1) (Bq/kg d.w.)	1.259	0.414	1.387
Detection limit (Bq/kg d.w.)	0.736	0.565	0.691

Uncertainty Budget (optional)	Relative uncertainty (%) (k=1)		
Uncertainty component associated with net count rate	1.41	3.09	1.34
Uncertainty component associated with detector efficiency	0.311	0.311	0.311
Uncertainty component associated with emission probability	0	0	0
Uncertainty component associated with weighing	0	0	0
Any other uncertainty component (please specify)	2.4	2.4	2.4
Relative combined standard uncertainty (k=1)	2.8	3.9	2.8

分析実施機関　：　国立研究開発法人日本原子力研究開発機構

IAEA ILC 2024 (NA3/38)
Cs-134, Cs-137, Pu-238 and Pu-239,240 in sediment

Nuclide: Pu-238

Method:

T-S8: 1. A sample was heated to 450 °C.
2. The sample was spiked with a Pu-242 tracer and immersed in the HNO_3 solution on heating for leaching.
3. Plutonium ions were extracted from the filtered leaching solution by an ion-exchange method.
4. These plutonium ions were fixed on a stainless steel plate by electrodeposition.
5. The massic activity of Pu-238 was measured by alpha-counting for 200000 seconds.

Detection system (including type of calibration applied):

T-S8: High purity silicon semiconductor detector with 25% relative efficiency : SEIKO EG&G ALPHA-ENSEMBLE-8
The detector was calibrated with the radioactivity standard (Am-241) of the same shape as the masurement sample.

Nuclear data used (e.g., half-life and emission probabilities):

T-S8: Half-life: 87.7_{1} years
Energy: 5499.03_{20} keV
Reference: Evaluated Nuclear Structure Data File, NNDC, Brookhaven National Laboratory, 2006

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/kg d.w.		
	F-P04	T-S3	T-S8
Massic activity (Bq/kg d.w.)			0.00833
Uncertainty (k=1) (Bq/kg d.w.)			0.00279
Detection limit (Bq/kg d.w.)			0.00702

Uncertainty Budget (optional)	Relative uncertainty (%) (k=1)		
Uncertainty component associated with net count rate			21.3
Uncertainty component associated with activity of yield tracer (if used)			0.361
Uncertainty component associated with net count rate of yield tracer (if used)			1.89
Uncertainty component associated with weighing			0.00949
Any other uncertainty component (detector efficiency)			2.74
Relative combined standard uncertainty (k=1)			21.6

IAEA ILC 2024 (NA3/38)
Cs-134, Cs-137, Pu-238 and Pu-239,240 in sediment

Nuclide: Pu-239,240

Method:

T-S8: 1. A sample was heated to 450 °C.
2. The sample was spiked with a Pu-242 tracer and immersed in the HNO_3 solution on heating for leaching.
3. Plutonium ions were extracted from the filtered leaching solution by an ion-exchange method.
4. These plutonium ions were fixed on a stainless steel plate by electrodeposition.
5. The massic activity of Pu-239/240 was measured by alpha-counting for 200000 seconds.

Detection system (including type of calibration applied):

T-S8: High purity silicon semiconductor detector with 25% relative efficiency : SEIKO EG&G ALPHA-ENSEMBLE-8
The detector was calibrated with the radioactivity standard (Am-241) of the same shape as the masurement sample.

Nuclear data used (e.g., half-life and emission probabilities):

T-S8: Half-life: 24110_{30} years
Energy: 5156.59_{14} keV
Reference: Evaluated Nuclear Structure Data File, NNDC, Brookhaven National Laboratory, 2014

RESULTS

At reference time 7 October 2024 12:00 UTC

	Bq/kg d.w.		
	F-P04	T-S3	T-S8
Massic activity (Bq/kg d.w.)			0.518
Uncertainty (k=1) (Bq/kg d.w.)			0.00210
Detection limit (Bq/kg d.w.)			0.00563

Uncertainty Budget (optional)	Relative uncertainty (%) (k=1)		
Uncertainty component associated with net count rate			3.15
Uncertainty component associated with activity of yield tracer (if used)			0.361
Uncertainty component associated with net count rate of yield tracer (if used)			1.89
Uncertainty component associated with weighing			0.00949
Any other uncertainty component (detector efficiency)			2.74
Relative combined standard uncertainty (k=1)			4.60