

MEMORANDUM

Date: August 8, 2019

To: J. Roy Quinn – Tennessee Valley Authority
Melissa A. Hedgecoth – Tennessee Valley Authority
W. Bryan Wells – Tennessee Valley Authority

From: Amanda J. Cover – Environmental Standards, Inc.
Jennifer N. Gable – Environmental Standards, Inc.
Andrew L. Piasecki – Environmental Standards, Inc.

Copy: Jim Kerr, Jr. M.Sc., PG – Stantec
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Rock J. Vitale, CEAC – Environmental Standards, Inc.
Jacob G. Gruzalski – Environmental Standards, Inc.

Subject: TVA TDEC Order Environmental Investigations Combined Radium-226+228
Uncertainty Calculation Issue in Solid Samples

In compliance with the Tennessee Department of Environment and Conversation (TDEC) Commissioner's Order, No. OGC15-0177 Tennessee Valley Authority (TVA) developed Environmental Investigation Plans (EIPs) describing the investigations needed to characterize the hydrology and geology in an effort to identify the extent of soil, surface water, and groundwater impacts by coal combustion residuals (CCR). The primary chemical and radiological parameters of interest under the EIPs are those listed in Appendices III and IV to the CCR Rule; Appendix IV includes combined radium-226+228 as a target analyte.

Solid samples collected under the EIPs for the analysis for radium have been submitted to Eurofins TestAmerica, in St. Louis, Missouri (Eurofins TestAmerica St. Louis). Combined radium-226+228 is not measured directly; rather, radium-226 and radium-228 are measured separately and the individual results are mathematically combined and reported as radium-226+228. For soil and sediments, samples both radium isotopes are determined using a modified US EPA Method 901.1 (*gamma* spectroscopy).

To assist with the reporting of combined radium-226+228, the following TVA reporting protocols were developed by Environmental Standards, Inc. (Environmental Standards) in early 2017 during the TVA Gallatin EIP with the assistance of Eurofins TestAmerica. The agreed upon reporting protocol is summarized below:

- When one isotope result is less than background (negative activity), the negative activity will be treated as “0” for the purpose of calculating combined radium-226+228. When both isotope results are less than background (negative activities), the combined radium-226+228 result will be reported as “0.”
- When both isotope activities are less than the minimum detectable activity (MDA) (flagged “U”), the combined radium-226+228 result will also be flagged “U.”
- In all cases, the total uncertainty (2σ) for combined radium-226+228 will be calculated and reported as the combined uncertainty of both isotope results, calculated as the square root of the sum of the squared individual uncertainties. The equation to be used for reporting combined radium-226+228 is as follows:

$$\text{Radium-226+228 total uncertainty (2}\sigma\text{)} = \sqrt{(\text{radium-226 uncertainty})^2 + (\text{radium-228 uncertainty})^2}$$

During review of soil radium data from Eurofins TestAmerica St. Louis (Sample Delivery Group [SDG] 180-87481-1), it was observed that the reported total uncertainty (2σ) for combined radium-226+228 for select samples was not calculated in accordance with the reporting protocol as outlined above. For these select samples, the result for an isotope was less than background (negative activity) and Eurofins TestAmerica St. Louis treated the associated uncertainty as “0” when calculating the total uncertainty (2σ) for combined radium-226+228 instead of using the true measured uncertainty for the isotope with negative activity. Table 1 presents an example of incorrectly calculated total uncertainty (2σ) for combined radium-226+228.

Table 1: Sample 180-87481-2 - Reported Uncertainty Results

Isotope	Report Result (pCi/g)	Reported Uncertainty (2σ)
radium-226	0.391	0.173
radium-228	-0.221	0.528
combined radium-226+228	0.391	0.173

As shown on Table 1, the reported uncertainty for radium-228 was incorrectly treated as “0” and a simple summation was used to determine the combined radium-226+228 uncertainty. Under the combined radium reporting protocol, the reported radium-228 uncertainty of 0.528 should have been used to calculate the combined radium-226+228 total uncertainty (2σ). Using the previously agreed-to radium reporting protocol the correct combined radium-226+228 total uncertainty (2σ) for sample 180-87481-2 should have been reported as 0.556.

As part of Environmental Standards’ quality assurance (QA) oversight activities, formal data verification/validation was performed on 61 SDGs of soil and sediment data recently reported by Eurofins TestAmerica St. Louis. During those QA efforts, Environmental Standards identified 12 investigative and 96 field and equipment blank radium-226+228 sample results impacted by this calculation/reporting error. Environmental Standards notified Eurofins TestAmerica St. Louis of the reporting error and provided a listing of the impacted samples (Attachment 1).

Upon review of the issue, Eurofins TestAmerica St. Louis acknowledged that there was a programming issue in the laboratory information management system (LIMS) and confirmed that this issue has since been corrected. In addition, the laboratory reviewed and confirmed the combined radium-226+228 total uncertainty (2σ) calculated by Environmental Standards are correct; the TVA project EQUIS™ database was updated accordingly.

The overall impact to the reported radium-226+228 data due to this issue is minor as it affects only the reported uncertainty for combined radium when one isotope activity was below background (negative activity). This issue does not impact the measured activities for the individual isotopes, the uncertainties calculated for the individual isotopes, or the calculated combined radium-226+228 activities for these samples. The minimal impact of the calculation issue did not warrant the considerable effort to revise, reload, and review 61 laboratory data packages and electronic data deliverables impacted by this issue. Accordingly, this memorandum will serve as documentation of the combined radium-226+228 total uncertainty (2σ) revisions made in lieu of requesting revised data packages and electronic data deliverables from Eurofins TestAmerica St. Louis.

Attachment 1 includes Eurofins TestAmerica St Louis' confirmation of the corrected combined radium-226+228 total uncertainty (2σ) values and the spreadsheet that summarizes the originally reported and recalculated combined radium-226+228 total uncertainty (2σ) values for the impacted investigative and field and equipment blank samples. It is important to note that this issue only impacted samples analyzed by US EPA Method 901.1. Aqueous samples analyzed by US EPA Method 903.0 and US EPA Method 904.0 were not impacted by this issue.

End of memorandum.

ATTACHMENT 1

July 30, 2019

Environmental Standards, Inc.
1140 Valley Forge Road
Valley Forge, PA 19482

RE: EPA 901.1 Radium-226 + Radium-228, Incorrect Uncertainty Calculation

Dear Ms. Gable

It was recently discovered that sample uncertainty was being incorrectly calculated for the summation analyte Radium-226 + Radium-228 by EPA method 901.1. When either of the analyte results was negative, the uncertainty for that analyte was being set to zero.

Environmental Standards provided Eurofins TestAmerica with a spreadsheet of affected data that included the corrected uncertainty. This spreadsheet was then validated by the Quality Assurance Manager on July 26th, 2019. One error was found (sample JOF-SED-BH02-CORRB-0.0/0.5-20190124, lab ID 180-86185-60). This was corrected, and a PDF of the spreadsheet has been included (see attachment "901.1_uncertainties_072619").

The uncertainty calculation for Ra-226 + Ra-228 has been corrected by the Eurofins TestAmerica IT department, and has been verified by Terry Romanko, the Technical Director at the St. Louis facility.

Eurofins TestAmerica St. Louis prides itself on supplying its clients with reliable quality data. We deeply apologize for the calculation error and any difficulties this may have caused.

Regards,



Kristen Ely
Quality Assurance Manager
Kristen.Ely@testamericainc.com

Sample Name	Sample Type	analytic_method	lab_sample_id	Reported Uncertainty for Radium- 226+228	Calculated Uncertainty for Radium- 226+228	unit
BRF-BS-FB08-20181116	Field Blank	EPA 901.1	180-84164-4	19.9	28.6	PCI/L
BRF-BS-EB03-20181116	Equipment Blank	EPA 901.1	180-84164-6	5.96	18.2	PCI/L
CUF-BS-FB-16-20181213	Field Blank	EPA 901.1	180-84956-3	12.5	19.4	PCI/L
CUF-CCR-FB02-20181217	Field Blank	EPA 901.1	180-85059-1	7.90	25.5	PCI/L
CUF-CCR-EB01-20181218	Equipment Blank	EPA 901.1	180-85059-13	0.00000	20.2	PCI/L
CUF-CCR-FB03-20181218	Field Blank	EPA 901.1	180-85059-5	17.9	40.2	PCI/L
JSF-SED-PB03-FB01-20181218	Field Blank	EPA 901.1	180-85168-1	0.00000	24.9	PCI/L
JSF-SED-PB05-FB02-20181219	Field Blank	EPA 901.1	180-85168-19	19.1	23.1	PCI/L
JSF-SED-PB03-EB01-20181218	Equipment Blank	EPA 901.1	180-85168-2	18.1	24.3	PCI/L
CUF-CCR-FB05-20190110	Field Blank	EPA 901.1	180-85699-7	15.1	31.7	PCI/L
BRF-SED-BRC02-FB01-20190107	Field Blank	EPA 901.1	180-85727-1	12.1	25.7	PCI/L
BRF-SED-BRC04-FB02-20190108	Field Blank	EPA 901.1	180-85727-16	14.8	25.3	PCI/L
BRF-SED-BRC04-EB02-20190108	Equipment Blank	EPA 901.1	180-85727-17	14.8	29.8	PCI/L
BRF-SED-CR08-FB03-20190109	Field Blank	EPA 901.1	180-85727-59	9.34	26.9	PCI/L
BRF-SED-CR08-EB03-20190109	Equipment Blank	EPA 901.1	180-85727-60	10.4	23.1	PCI/L
BRF-SED-CR03-FB04-20190110	Field Blank	EPA 901.1	180-85727-62	13.7	20.6	PCI/L
BRF-SED-CR03-EB04-20190110	Equipment Blank	EPA 901.1	180-85727-63	1.58	20.1	PCI/L
JSF AQ EB02 20190124	Equipment Blank	EPA 901.1	180-86105-3	6.20	22.5	PCI/L
CUF-CCR-FB10-20190125	Field Blank	EPA 901.1	180-86107-11	13.2	18.7	PCI/L
CUF-CCR-EB03-20190124	Equipment Blank	EPA 901.1	180-86107-7	16.9	20.1	PCI/L
JSF-BS-EB01-20190124	Equipment Blank	EPA 901.1	180-86110-12	17.2	21.0	PCI/L
KIF-CCR-FB02-20190125	Field Blank	EPA 901.1	180-86125-8	14.2	21.2	PCI/L
JSF-BS-FB05-20190128	Field Blank	EPA 901.1	180-86168-6	11.5	11.9	PCI/L
JOF-SED-CV01-EB01-20190122	Equipment Blank	EPA 901.1	180-86185-1	14.5	25.2	PCI/L
JOF-SED-CV01-FB01-20190122	Field Blank	EPA 901.1	180-86185-2	27.1	32.5	PCI/L
JOF-SED-BH02-FB01-20190124	Field Blank	EPA 901.1	180-86185-50	15.6	25.1	PCI/L
JOF-SED-BH02-EB01-20190124	Equipment Blank	EPA 901.1	180-86185-55	19.5	34.8	PCI/L
JSF BS JSF110 EB03 20190129	Equipment Blank	EPA 901.1	180-86237-2	13.2	15.9	PCI/L
JSF BS JSF110 FB07 20190129	Field Blank	EPA 901.1	180-86237-3	18.3	23.1	PCI/L
JSF-AQ-FB06-20190129	Field Blank	EPA 901.1	180-86238-10	0.00000	28.3	PCI/L
JSF-BS-FB07-20190130	Field Blank	EPA 901.1	180-86263-6	0.00000	46.3	PCI/L
JSF-AQ-FB08-20190131	Field Blank	EPA 901.1	180-86289-5	0.00000	17.4	PCI/L
JSF-AQ-EB05-20190204	Equipment Blank	EPA 901.1	180-86348-7	23.5	28.2	PCI/L
JSF-AQ-FB10-20190204	Field Blank	EPA 901.1	180-86348-8	17.3	19.1	PCI/L
JSF-AQ-FB11-20190205	Field Blank	EPA 901.1	180-86418-5	19.6	31.5	PCI/L
CUF-CCR-EB04-20190206	Equipment Blank	EPA 901.1	180-86561-11	22.4	29.2	PCI/L
CUF-CCR-FB12-20190206	Field Blank	EPA 901.1	180-86561-9	22.4	29.4	PCI/L
KIF-CCR-FB06-20190211	Field Blank	EPA 901.1	180-86707-5	1.95	3.64	PCI/L
KIF-CCR-TW04-FB05-20190208	Field Blank	EPA 901.1	180-86712-3	19.7	39.6	PCI/L
KIF-CCR-FB07-20190213	Field Blank	EPA 901.1	180-86717-3	17.4	24.5	PCI/L
CUF-CCR-FB14-20190214	Field Blank	EPA 901.1	180-86782-1	24.5	28.7	PCI/L
CUF-CCR-FB15-20190219	Field Blank	EPA 901.1	180-86976-1	0.00000	30.9	PCI/L
CUF-CCR-FB16-20190220	Field Blank	EPA 901.1	180-86976-3	12.2	19.0	PCI/L
CUF-CCR-FB17-20190221	Field Blank	EPA 901.1	180-87007-1	21.8	28.1	PCI/L
CUF-CCR-EB06-20190221	Equipment Blank	EPA 901.1	180-87007-8	27.8	38.2	PCI/L
KIF-CCR-FB08-20190225	Field Blank	EPA 901.1	180-87081-1	9.29	22.8	PCI/L
KIF-CCR-FB09-20190226	Field Blank	EPA 901.1	180-87081-6	26.1	32.0	PCI/L
JSF-CCR-FB01-20190306	Field Blank	EPA 901.1	180-87442-2	17.0	22.8	PCI/L
JSF-CCR-FB02-20190307	Field Blank	EPA 901.1	180-87442-5	24.5	34.9	PCI/L
CUF-CCR-FB18-20190305	Field Blank	EPA 901.1	180-87449-1	19.3	25.9	PCI/L
CUF-CCR-FB19-20190306	Field Blank	EPA 901.1	180-87449-4	20.9	26.9	PCI/L
JSF-CCR-EB01-20190312	Equipment Blank	EPA 901.1	180-87622-8	15.7	32.3	PCI/L
KIF-BS-FB01-20190312	Field Blank	EPA 901.1	180-87628-13	5.93	23.3	PCI/L
JSF-CCR-FB05-20190319	Field Blank	EPA 901.1	180-87844-2	31.9	41.8	PCI/L
KIF-BS-EB01-20190318	Equipment Blank	EPA 901.1	180-87847-8	21.9	32.4	PCI/L
JOF-SED-TR08-FB01-20190319	Field Blank	EPA 901.1	180-88021-1	9.17	24.5	PCI/L
JOF-SED-TR02-FB01-20190320	Field Blank	EPA 901.1	180-88021-17	23.8	29.2	PCI/L
JOF-SED-TR08-EB01-20190319	Equipment Blank	EPA 901.1	180-88021-2	3.67	21.3	PCI/L
JSF-CCR-FB07-20190322	Field Blank	EPA 901.1	180-88032-8	18.1	27.6	PCI/L
KIF-BS-LB01-20190320	Equipment Blank	EPA 901.1	180-88035-1	22.9	32.7	PCI/L
KIF-BS-FB06-20190321	Field Blank	EPA 901.1	180-88035-2	23.1	29.0	PCI/L
KIF-BS-FB08-20190325	Field Blank	EPA 901.1	180-88180-4	28.2	34.3	PCI/L
KIF-BS-FB09-20190326	Field Blank	EPA 901.1	180-88180-8	19.3	29.2	PCI/L
KIF-BS-EB02-20190326	Equipment Blank	EPA 901.1	180-88180-9	29.2	34.1	PCI/L
KIF-BS-FB10-20190327	Field Blank	EPA 901.1	180-88268-1	7.20	32.4	PCI/L
KIF-BS-FB11-20190328	Field Blank	EPA 901.1	180-88309-1	14.3	30.7	PCI/L
JSF-SED-HR05-EB01-20190402	Equipment Blank	EPA 901.1	180-88611-20	24.5	33.6	PCI/L
JSF-SED-HR05-EB01-20190404	Equipment Blank	EPA 901.1	180-88611-21	0.03930	21.10	PCI/L
JSF-SED-HR05-FB01-20190402	Field Blank	EPA 901.1	180-88611-22	20.8	28.8	PCI/L
WBF-SED-TR05-FB01-20190401	Field Blank	EPA 901.1	180-88614-11	15.3	25.8	PCI/L
WBF-SED-TR05-EB02-20190401	Equipment Blank	EPA 901.1	180-88614-13	9.13	33.2	PCI/L
JSF-CCR-FB11-20190404	Field Blank	EPA 901.1	180-88621-5	21.9	48.8	PCI/L
CUF-BS-FB01-20190409	Field Blank	EPA 901.1	180-88917-2	20.4	20.8	PCI/L
JSF-CCR-FB13-20190416	Field Blank	EPA 901.1	180-89203-11	12.3	24.4	PCI/L
WBF-SeS-EB01-20190418	Equipment Blank	EPA 901.1	180-89238-3	0.00000	34.1	PCI/L

Sample Name	Sample Type	analytic_method	lab_sample_id	Reported Uncertainty for Radium- 226+228	Calculated Uncertainty for Radium- 226+228	unit
WBF-SeS-FB01-20190418	Field Blank	EPA 901.1	180-89238-4	23.0	31.9	PCI/L
JSF-CCR-EB04-20190423	Equipment Blank	EPA 901.1	180-89448-14	20.6	26.6	PCI/L
JSF-CCR-FB17-20190429	Field Blank	EPA 901.1	180-89567-1	7.16	19.0	PCI/L
BRF-SES-FB01-20190515	Field Blank	EPA 901.1	180-90260-3	18.6	28.5	PCI/L
BRF-SES-EB01-20190515	Equipment Blank	EPA 901.1	180-90260-7	14.8	24.9	PCI/L
JOF-BS-EB01-20190523	Equipment Blank	EPA 901.1	180-90566-16	0.00000	30.9	PCI/L
JOF-BS-FB02-20190523	Field Blank	EPA 901.1	180-90566-17	24.6	33.6	PCI/L
JOF-BS-FB01-20190522	Field Blank	EPA 901.1	180-90566-6	16.6	28.2	PCI/L
JOF-BS-FB03-20190524	Field Blank	EPA 901.1	180-90607-5	19.3	29.6	PCI/L
CUF-BS-FB07-20181129	Field Blank	EPA 901.1	490-164123-1	15.6	25.3	PCI/L
CUF-BS-FB08-20181129	Field Blank	EPA 901.1	490-164124-3	14.1	23.6	PCI/L
CUF-BS-FB10-20181203	Field Blank	EPA 901.1	490-164296-1	21.8	27.5	PCI/L
CUF-BS-FB11-20181204	Field Blank	EPA 901.1	490-164296-5	0.00000	32.8	PCI/L
CUF-BS-FB13-20181206	Field Blank	EPA 901.1	490-164491-1	8.96	17.4	PCI/L
CUF-BS-FB-14-20181206	Field Blank	EPA 901.1	490-164496-3	0.00000	18.3	PCI/L
JSF-CCR-FB16-20190423	Field Blank	EPA 901.1	180-89448-5	19.1	25.3	PCI/L
JSF-CCR-EB03-20190409	Equipment Blank	EPA 901.1	180-88851-4	15.2	21.4	PCI/L
JSF-CCR-EB05-20190501	Equipment Blank	EPA 901.1	180-89668-1	12.2	29.4	PCI/L
JSF-CCR-FB19-20190501	Field Blank	EPA 901.1	180-89668-5	0	35.4	PCI/L
JSF-CCR-FB20-20190513	Field Blank	EPA 901.1	180-90101-1	19.7	25.4	PCI/L
JSF-CCR-FB21-20190514	Field Blank	EPA 901.1	180-90104-1	0	33.3	PCI/L