**FIELD CHANGE REQUEST FORM**

| **Contract No.:**<br>N62473-17-D-0005 | **CTO No.:**<br>N6247317F4332 | **FCR No.:**<br>003 |
|---|---|---|
| **Location:**<br>Hunters Point Naval Shipyard, Parcel E | | **Date:**<br>03/05/2021 |
| **Document Title:**<br>*Final Sampling and Analysis Plan Parcel E Remedial Action, Phase 2, Hunters Point Naval Shipyard, San Francisco, California* (SAP; Gilbane, 2019) | | **NIRIS Doc. No.:**<br>3799 |

**Description** (items involved, submit sketch, if applicable

1. The parent SAP made no provision for differentiating the suite of radionuclides of concern (ROCs) to be analyzed based on the type of sampling. In order to align with the HRA and the ROD, the SAP will be updated as follows:
The complete list of ROCs for Parcel E from the *Record of Decision for Parcel E* (ROD; Navy, 2013) shall be used for imported fill material sampling. Site-specific ROCs as presented in Section 8.3.5.30 of the *Final Historical Radiological Assessment, History of the Use of General Radioactive Materials, 1939-2003, Hunters Point Shipyard* (HRA; NAVSEA, 2004) and Table 1 of the *Final Radiological Addendum to the Feasibility Study Report for Parcel E, Hunters Point Shipyard, San Francisco, California* (FS Addendum; ERRG and RSRS, 2012) as referenced in in Section 2.1 of the ROD, shall be used for waste characterization and post-excavation confirmation radiological sampling.

2. Radiological analyses will be transferred from Eurofins TestAmerica St. Louis to the backup laboratory ARS Aleut Analytical, LLC.

**Reason for Change**

The Navy seeks to spend the public's money wisely. Sampling for every radionuclide makes sense for import soil but not for site characterization or waste samples because the radionuclides of concern (ROCs) have already been established at the site based on sampling for the full suite of possible radionuclides. The ROCs at the site are a subset of the full suite of possible radionuclides as documented in the HRA and the ROD. The parent SAP made no provision for differentiating the suite of radionuclides of concern (ROCs) to be analyzed based on the type of sampling. In order to align with the HRA and the ROD, and to reflect the transfer of radiological analyses to the backup laboratory, the SAP will be updated as follows:

1. Replacement Worksheets #15.2 (confirmation sampling), and #15.11 have been provided to be used in conjunction with the SAP.

2. Replacement Worksheets #17.1 (confirmation sampling) with new text in bold italics for sections 17.4 and 17.5, #18A, #23.3, 24.2, #28.1A. #28.2A, #28.3A. #28.4A, and #30.1, laboratory standard operating procedures, and laboratory certificates have been provided to be used in conjunction with the SAP.



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**FIELD CHANGE REQUEST FORM**

| **Contract No.:** N62473-17-D-0005 | **CTO No.:** N6247317F4332 | **FCR No.:** 003 |
|---|---|---|

**Recommended Disposition** (submit sketch, if applicable):

Not applicable.

**Additional Details:**
Validation will remain as 100% S2AVEM for screening data to be performed by the Gilbane Project Chemist; 80% S2BVEM and 20% randomly chosen S4VEM for definitive data as described on SAP Worksheet #36.

If this change results in a contract cost or schedule change, is the NAVFAC RPM aware of it? □ Yes □ NA X No
If this change does not result in a contract cost or schedule change, is the NAVFAC RPM aware of the FCR content? X Yes □ No

| **Preparer's Signature/Title:** **Program Chemist** | **Date:** | **Technical Lead** (Signature) | **Date:** |
|---|---|---|---|
| Kristen Carlyn Porter | 3/5/2021 | | |

**Disposition:**
□ **Approved**
□ **Not approved (give reason) :** _____

| **Engineer (signature) (if engineering related):** | **Date:** | **Project Manager (signature)** | **Date:** |
|---|---|---|---|
| | | Brett Womack Digitally signed by Brett Womack DN: cn=Brett Womack, o=Gilbane Federal, ou, email=bwomack@gilbaneco.com, c=US Date: 2021.03.08 06:57:23 -08'00' | |
| **Navy ROICC (signature)** | **Date:** | **QC Manager (signature)** | **Date:** |
| | | Henry Ng Digitally signed by Henry Ng Date: 2021.03.08 07:51:30 -08'00' | |
| **Navy RPM (signature)** | **Date:** | **Navy QAO (signature)** | **Date:** |
| RODDY.ELIZABETH.ANN.1548029712 Digitally signed by RODDY.ELIZABETH.ANN.1548029712 Date: 2021.03.15 09:29:47 -07'00' | | BOWERS.KENNETH.A.1230092474 Digitally signed by BOWERS.KENNETH.A.1230092474 Date: 2021.03.11 16:32:12 -05'00' | |



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SAP Worksheets:

| | |
|---|---|
| #15.2 | Reference Limits and Evaluation Tables |
| #15.11 | Reference Limits and Evaluation Tables |
| #17.1 | Sampling Design and Rationale |
| #18A | Sampling Locations and Methods/SOP Requirements Table |
| #23.3 | Analytical SOP References Table |
| #24.2 | Analytical Instrument Calibration Table |
| # 28.1A | Laboratory QC Sample Table |
| # 28.2A | Laboratory QC Sample Table |
| # 28.3A | Laboratory QC Sample Table |
| # 28.4A | Laboratory QC Sample Table |
| #30.1 | Analytical Services Table |

Attachments:

Attachment 1: Laboratory Standard Operating Procedures
Attachment 2: Laboratory Certifications
Attachment 3: Informational Material
Table 1 (Final Radiological Addendum to the Feasibility Study Report for Parcel E, Hunters Point Shipyard, San Francisco, California [ERRG and RSRS, 2012])

Distribution: Project File
Copy to Site

# SAP WORKSHEETS

## SAP Worksheet #15.2 – Reference Limits and Evaluation Table
(UFP-QAPP Manual Section 2.8.1)

**Matrix**: Soil
**Analytical Group**: Radionuclides (confirmation sampling)

| Analyte[1] | CAS Number | Project Screening Limit[3] (pCi/g) | Project Action Limit Reference | Project Quantitation Limit Goal (pCi/g) | Laboratory-specific | |
|---|---|---|---|---|---|---|
| | | | | | MDC (pCi/g) | MDL (pCi/g) |
| Cesium-137 | 10045-97-3 | NA[3] | Not Applicable[3] | 0.07 | 0.07 | NA |
| Radium-226 | 13982-63-3 | NA[3] | Not Applicable[3] | 1.0[2] | 1.0 | NA |
| Strontium-90[4] | 10098-97-2 | NA[3] | Not Applicable[3] | 0.2 | 0.2 | NA |

**Notes:**
[1] For gamma spectrometry, all detected radionuclides will be reported. Sample count time will be based on counting time necessary to achieve Cs-137 project quantitation limit goal. Radium-226 will be reported after 21-day ingrowth, based on the 609 kilo-electron volt (keV) bismuth-214 gamma energy peak.
[2] Objective is 1 pCi/g above background, per agreement with EPA (established in "Final Basewide Radiological Removal Action, Action Memorandum – Revision 2006, Hunters Point Shipyard, San Francisco, California," dated April 21, 2006). The Radium-226 background level for surface soil is 0.633 pCi/g.
[3] Confirmation samples for radionuclides are to be collected for the purposes of documentation of final conditions only. Samples collected from this excavation for ROCs will not be compared to RGs but will be used to evaluate future radiological remediation efforts under another contract task order.
[4] Total strontium analysis will be performed first by the laboratory. If the total strontium result is less than 0.331 pCi/g, a Sr-90 specific analysis is not required. If the total strontium result is above 0.331 pCi/g, then a Sr-90 specific analysis will also be performed.
MDC = minimum detectable concentration
MDL = method detection limit
NA = not applicable
pCi/g = picocuries per gram



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## SAP Worksheet #15.11 – Reference Limits and Evaluation Table

**Matrix**: Soil

**Analytical Group**: Radionuclides (import material testing)

| Analyte[2,5] | CAS Number | Project Screening Limit (pCi/g) | Project Screening Limit Reference | Project Quantitation Limit Goal (pCi/g) | Laboratory-specific | |
|---|---|---|---|---|---|---|
| | | | | | MDC (pCi/g) | MDL (pCi/g) |
| Americium-241 | 14596-10-2 | 1.36 | Residential Remediation Goals (RBC)[1] | 0.7 | 0.7 | NA |
| Cesium-137 | 10045-97-3 | 0.113 | Residential Remediation Goals (RBC)[1] | 0.07 | 0.07 | NA |
| Cobalt-60 | 10198-40-0 | 0.252 | Residential Remediation Goals (RBC)[1] | 0.1 | 0.1 | NA |
| Radium-226 | 13982-63-3 | 1.0 pCi/g above background[3] | Residential Remediation Goals (RBC)[1] | 1.0 | 1.0 | NA |
| Strontium-90[4] | 10098-97-2 | 0.331 | Residential Remediation Goals (RBC)[1] | 0.2 | 0.2 | NA |
| Plutonium-239 | 15117-48-3 | 2.59 | Residential Remediation Goals (RBC)[1] | 0.5 | 0.5 | NA |
| Uranium-235 | 15117-96-1 | 0.195 | Residential Remediation Goals (RBC)[1] | 0.1 | 0.1 | NA |

**Notes:**

[1]Values listed are from Table 8 of the *Design Basis Report Parcel E, Hunters Point Naval Shipyard, San Francisco, California* (CES, 2018).

[2] For gamma spectrometry, all detected radionuclides will be reported and radium-226 will be reported based on the 609 kilo-electron volt (keV) bismuth-214 gamma energy peak. Sample count time will be based on counting time necessary to achieve Cs-137 project quantitation limit goal.

[3]Objective is 1 pCi/g above background per agreement with EPA (established in "Final Basewide Radiological Removal Action, Action Memorandum – Revision 2006, Hunters Point Shipyard, San Francisco, California," dated April 21, 2006). The Radium-226 background level for surface soil is 0.633 pCi/g.

[4] Total strontium analysis will be performed first by the laboratory. If the total strontium result is less than 0.331 pCi/g, a Sr-90 specific analysis is not required. If the total strontium result is above 0.331 pCi/g, then a Sr-90 specific analysis will also be performed.

[5]Analytical decision logic flowchart presented in Worksheet #17.1.

RBC = risk-based criteria

RG = remediation goal



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## SAP Worksheet #17.1 – Sampling Design and Rationale (Continued)

### 17.4 Post-Excavation Radiological Characterization

Post-excavation Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) surveys will not be performed in the shoreline excavation due to the saturated soil conditions; however, ROC analyses will still be performed as part of post-excavation sampling to document the "as-left" conditions of the excavation. **Worksheet #15.2 presents the ROCs specific to IR-03 and the Parcel E Shoreline, Redevelopment Block EOS-3 as presented in Table 1 - Parcel E Impacted Sites, Radionuclides of Concern, Historical Uses, and Planned Reuse from the *Final Radiological Addendum to the Feasibility Study Report for Parcel E, Hunters Point Shipyard, San Francisco, California* (FS Addendum; ERRG and RSRS, 2012) and Section 8.3.5.30 of the *Final Historical Radiological Assessment, History of the Use of General Radioactive Materials, 1939-2003, Hunters Point Shipyard* (NAVSEA, 2004). Samples will be analyzed by gamma spectroscopy for Ra-226 and Cs-137. A minimum of 10 percent of the samples will be randomly selected for analysis by gas proportional counting for total strontium. In addition, samples for which gamma spectroscopy results indicate the presence of Cs-137 above its remediation goal also will be analyzed for total strontium. If the total strontium result does not exceed the remediation goal, then no further analyses will be performed. Otherwise, Sr-90 analysis will be performed to quantify the Sr-90 concentration.**

**Rationale for the sampling strategy presented for Sr-90 is as follows: the presence of Sr-90 primarily would be attributed to fission products associated with OPERATIONS CROSSROADS and the decontamination of ships that participated in atomic weapons testing. Standard procedure is to analyze all samples for Cs-137. Because Sr-90 and Cs-137 are both fission products that are found together, the Sr-90 analysis of a randomly-selected 10 percent of the collected samples serves as a second verification (beyond that for Cs-137) that fission products are not present as contaminants in the material.**

### 17.5 Import Backfill Material

Once excavation and sampling are completed, the excavation areas will be backfilled with certified-clean imported fill materials. The backfill acceptance criteria for Parcel E, which include the required frequency and analysis methods for characterization samples, are included in Specification Section 31 00 00 of the RDP (specification provided as Attachment 2 of the RAWP), and Worksheets #15.3 through #15.11. The backfill will be composed of clean imported fill material that has been analyzed to confirm that the material does not contain site-specific COCs, ROCs, or other contaminants **above the project screening criteria**, based on the nature of the fill source in accordance with the DTSC "Information Advisory, for Clean Imported Fill Material" (DTSC, 2001). **Samples will be analyzed by gamma spectroscopy for site-specific ROCs (Am-241, Ra-226, and Cs-137); by alpha spectroscopy for Pu-239 and U-235; and by gas proportional counting for total strontium. If the total strontium result does not exceed the remediation goal, then no further analyses will be performed. Otherwise, Sr-90 analysis will be performed to quantify the Sr-90 concentration. The concentration of Ra-226 will be inferred from the concentration of its progeny bismuth (Bi)-214 using a progeny in-growth**

**method to allow the Bi-214 to approach secular equilibrium with Ra-226. The method requires the sample to be hermetically sealed with a 21-day (or longer) hold time before counting. The Ra-226 results will be calculated and reported from the 46.1 percent abundant 0.609 MeV gamma spectrum line of Bi-214 after the in-growth period of 21 days.**

## SAP Worksheet #18A – Sampling Locations and Methods/SOP Requirements Table

| Sampling Location/ID Number | Matrix | Depth (feet bgs) | Analytical Group | Approximate Number of Samples | Sampling SOP Reference |
|---|---|---|---|---|---|
| **Characterization Sampling:** | | | | | |
| 4332-EOS3-501-DD → 4332-EOS3-ZZZ-DD (as defined on SAP Worksheet # 27) | Sediment | TBD[2] | TPH-g, TPH-d,mo, Radionuclides[1] | 80 | SAP WS # 14.1.2 |
| **Import Material Sampling:** | | | | | |
| 4332A-IF-XXX-001 →4332A-IF-XXX-YYY (as defined on SAP Worksheet # 27) | Soil | TBD[4] | VOCs, SVOCs, PAHs, PCBs, TPH-g, TPH-d,mo, Metals, Asbestos, pH, Radionuclides[3] | 106 | PR-TC-02-02.01.03 |

**Notes:**

[1] Radionuclides = Gamma Spectroscopy and 10% Total Strontium/Sr-90.

[2] TBD = To be determined. Excavations will be to the Bay Mud layer as determined in the field.

[3] Radionuclides = Gamma Spectroscopy, Total Strontium/Sr-90, Alpha Spectroscopy for Uranium-235 and Plutonium-239.

[4] TBD = To be determined. The depth and final number of import material samples will depend on the source(s) and the amount of import material required.



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## SAP Worksheet #23.3 – Analytical SOP References Table

| Lab SOP Number | Title, Revision Date, and / or Number | Definitive or Screening Data | Matrix and Analytical Group | Instrument | Organization Performing Analysis | Modified for Project Work? (Y/N) |
|---|---|---|---|---|---|---|
| ARS-007 | Modified Gamma Emitting Radionuclides in Soil, Air and Biota Matrices, Rev. 7.5, Effective 5/28/2020 | Definitive | Soil/Radiochemical (gamma spectroscopy) | EG&G Ortec Gamma Spectrometer | ARS | N |
| ARS-032 | Strontium 89, 90 and Total Strontium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation (USEPA 905.0M) Rev. 8.5, Effective 6/1/2020 | Definitive | Soil and Water /Radiochemical (GFPC) | Gas Flow Proportional Counting System | ARS | N |
| ARS-026 | Am, Pu, and U Sequential Separation Using Eichrom Stabilized Chemistry Resin, Rev 15.2, Effective 1/25/2020 | Definitive | Soil and Water /Radiochemical (alpha spectroscopy) | Alpha Spectroscopy | ARS | N |



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## SAP Worksheet #24.2 – Analytical Instrument Calibration Table

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action (CA) | Person Responsible for CA | SOP Reference |
|---|---|---|---|---|---|---|
| Gamma Spectrometer | Initial Calibration Verification (ICAL) for Energy, Efficiency, and FWHM peak resolution | Prior to initial use, following repair or loss of control, and upon incorporation of new or changed instrument settings | The energy difference should be within 0.05% for all calibration points or within 0.2 keV. Peak energy difference is within 0.1 keV of reference energy for all points. Peak Full width at Half Maximum (FWHM) < 3 keV at 1332 keV. The efficiency difference should be within 8% of the true value for each point unless T.C.C calibration is performed. | Correct problem, then repeat ICAL. | Lab Manager / Analyst[1] | ARS-007 |
| Gamma Spectrometer | Initial Calibration Verification (ICV) | After ICAL for energy/efficiency and prior to analysis of samples. | Observed peaks of second source standard fall within ± 10% of initial calibration value relative to the true value. | Verify second source standard and repeat ICV to check for errors. If that fails, identify and correct problem and repeat ICV or ICAL and ICV as appropriate. | Lab Manager / Analyst[1] | ARS-007 |



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**SAP Worksheet #24.2 – Analytical Instrument Calibration Table (Continued)**

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action (CA) | Person Responsible for CA | SOP Reference |
|---|---|---|---|---|---|---|
| Gamma Spectrometer | Continuing Calibration Verification (CCV) (Daily Check) | Daily or prior to use. When working with long count times or batch sequences that run more than a day, CCV is performed at the beginning and end of each analytical batch as long as it not longer than a week. | Energy: ±0.5 keV at 60 keV; ± .75 keV at 1332 keV. FW HM: ±1.2x at 60 keV; ±1.8x at 662 keV; ±2.3x at 1332 keV. Activity Difference: % difference between the source activity and the reported activity ±5% | Correct problem, rerun CCV. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification. | Lab Manager / Analyst[1] | ARS-007 |
| Gamma Spectrometer | Background Subtraction Count Measurement (BSC) (Long count for subtracting background from blanks or test sources) | Immediately after ICAL and then performed on at least a monthly basis. | Background count rate of the entire spectrum with ±3σ of the average. | Recount and check control chart for trends. Determine cause, correct problem, re-establish BSC. If background activity has changed, re-establish BSC and reanalyze or qualify all impacted samples since last acceptable BSC. | Lab Manager / Analyst[1] | ARS-007 |



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**SAP Worksheet #24.2 – Analytical Instrument Calibration Table (Continued)**

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action (CA) | Person Responsible for CA | SOP Reference |
|---|---|---|---|---|---|---|
| Gamma Spectrometer | Instrument Contamination Check (ICC) (Short count for controlling gross contamination) | Daily or when working with long count times before and after each analytical batch. Check after counting high activity samples. | No extraneous peaks identified (i.e., no new peaks in the short background spectrum compared to previous spectra); Background count rate of the entire spectrum with ±3σ of the average. | Recount the background. If still out of control, locate and correct problem; reanalyze or qualify all impacted samples since last acceptable ICC. If background activity has changed, re-establish BSC and reanalyze samples. | Lab Manager / Analyst[1] | ARS-007 |
| Gas Flow Proportional Counter | Initial Calibration - Voltage Plateau (ICALV) (separate plateaus determined for alpha and beta activity) | Prior to initial use and after loss of control. | Slope of the plateau less than 5% over a range of 100V. | Correct problem, then repeat ICALV. | Lab Manager / Analyst[1] | ARS-032 |
| Gas Flow Proportional Counter | Initial Calibration - Efficiency (ICALE) | Prior to initial use, after loss of control, and upon incorporation of new or changed instrument settings. | Verify manufacturer's specifications for detector efficiency for both alpha and beta counting modes using electroplated sources. | Correct problem, then repeat ICALE. | Lab Manager / Analyst[1] | ARS-032 |



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**SAP Worksheet #24.2 – Analytical Instrument Calibration Table (Continued)**

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action (CA) | Person Responsible for CA | SOP Reference |
|---|---|---|---|---|---|---|
| Gas Flow Proportional Counter | Initial Calibration – Cross-talk Factors (ICALCT) | Prior to initial use, after loss of control, and upon incorporation of new or changed instrument settings. | Verify manufacturer's specifications for cross talk in alpha and beta channels. | Correct problem, then repeat ICALCT. | Lab Manager / Analyst[1] | ARS-032 |
| Gas Flow Proportional Counter | Initial Calibration – Self-Absorption Curve (ICALSA) | Prior to initial use, after loss of control, and upon incorporation of new or changed instrument settings. | For each radionuclide of interest (or isotope with similar energy profile), establish mathematical function (curve) of detector efficiency vs. source mass loading. Best fit of data with coefficient of determination (r2) ≥ 0.9. | Correct problem, then repeat ICALSA. | Lab Manager / Analyst[1] | ARS-032 |
| Gas Flow Proportional Counter | Efficiency Calibration Verification (IECV) | After ICALE for alpha and beta and prior to analysis of samples. | Individual points within ±30% of true value, average of points within ±10% of initial calibration value. | Correct problem and verify second source standard. Rerun IECV. If that fails, correct problem and repeat ICALE. | Lab Manager / Analyst[1] | ARS-032 |
| Gas Flow Proportional Counter | Continuing Calibration Verification (CCV) | After a counting gas change and daily for short test-source counting intervals. | Within tolerance or control chart limits ± 3% or 3σ of the mean. | Correct problem, rerun calibration verification. If that fails, then repeat ICALE. Reanalyze all samples since the last successful calibration verification. | Lab Manager / Analyst[1] | ARS-032 |



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**SAP Worksheet #24.2 – Analytical Instrument Calibration Table (Continued)**

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action (CA) | Person Responsible for CA | SOP Reference |
|---|---|---|---|---|---|---|
| Alpha Spectrometer | Initial Calibration (ICAL) (Energy, efficiency and FWHM peak resolution) | Prior to initial use, following repair or loss of control and upon incorporation of new or changed instrument settings. | 3 isotopes within energy range of 3-6 MeV. Energy vs. channel slope equation <15 keV per channel. Full Width – Half Maximum (FWHM) <100 keV for each peak used for calibration. Final peak energy within 20 keV of reference energy Minimum of 3,000 net counts in each peak. | Correct problem, then repeat ICAL. | Lab Manager / Analyst[1] | ARS-026 |
| Alpha Spectrometer | Initial Calibration Verification (ICV) | After initial calibration. | FWHM ≤100 keV ; Each peak within ±20 keV of corresponding calibration peaks in initial energy calibration. Minimum 2000 net counts. Efficiency within 95% - 105% of initial calibration value. | Repeat ICV to check for error. If that fails, identify and correct problem and repeat ICV or ICAL and ICV, as appropriate. | Lab Manager / Analyst[1] | ARS-026 |
| Alpha Spectrometer | Continuing Calibration Verification (CCV) (Pulser check) | Pulser verification daily, prior to analysis of samples. | Gross counts within 5% of the average (20-point minimum). FWHM within 10-20 keV. Energy within ± 40 keV of the average (20-point minimum). | Recount and check control chart for trends. Determine cause, correct problem, and repeat CCV and all associated samples since last successful CCV. | Lab Manager / Analyst[1] | ARS-026 |



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**SAP Worksheet #24.2 – Analytical Instrument Calibration Table (Continued)**

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | Corrective Action (CA) | Person Responsible for CA | SOP Reference |
|---|---|---|---|---|---|---|
| Alpha Spectrometer | Continuing Calibration Verification (CCV) (Check source) | Monthly source check verification prior to analysis of samples. | FWHM ≤100 keV; Each peak within ±30 keV of corresponding calibration peaks in initial energy calibration. Minimum 2000 net counts. Efficiency within 95% - 105% of initial calibration value. | Recount and check control chart for trends. Determine cause, correct problem, and repeat CCV and all associated samples since last successful CCV. | Lab Manager / Analyst[1] | ARS-026 |
| Alpha Spectrometer | Background Subtraction Count (BSC) Measurement | Prior to initial use or after initial calibration and monthly. | Use a statistical test to determine a change in the background count rate value. | Check control chart for trends and recount. Determine cause, correct problem, re-establish BSC. If background activity has changed, re-establish BSC and reanalyze all impacted samples since last acceptable BSC. | Lab Manager / Analyst[1] | ARS-026 |
| Alpha Spectrometer | Instrument Contamination Check (ICC) | Performed weekly, at minimum, and after counting high activity samples. | ZBlank ≤3 for blank subtracted (net) activity in all ROIs. | Check control chart for trends and recount. Determine cause and correct problem. background activity has changed, re-establish BSC and reanalyze all infected samples. | Lab Manager / Analyst[1] | ARS-026 |



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## SAP Worksheet #24.2 – Analytical Instrument Calibration Table (Continued)

**Notes:**

[1]The analyst initiates the corrective action and the lab manager and analyst are responsible for the corrective action.
BSC = background subtraction count
ICC = instrument contamination check
ROI = region of interest
RSD = relative standard deviation
RT = retention time



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## SAP Worksheet #28.1A – Laboratory QC Samples Table

| | |
|---|---|
| **Matrix** | Soil/Sediment |
| **Analytical Group** | Gamma Spectroscopy |
| **Analytical Method / SOP Reference[1]** | EPA 901.1 / ARS-007 |

| QC Sample | Frequency / Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method blank | One per preparation batch | No analytes detected > target detection limit (PQL WS 15) | Correct problem. If required, re-prepare and re-analyze MB and all samples processed with the contaminated blank. | Analyst, Supervisor | Accuracy/Bias/ Contamination | Acceptable results per stated QC Acceptance Limits |
| LCS | One per preparation batch | Recovery limits: 75-125% for Am-241, Cs-137, and Co-60 | Correct problem, then re-prepare and re-analyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. | Analyst, Supervisor | Accuracy/Bias | Acceptable QC Acceptance Limits |
| Duplicate | One per preparation batch | RPD limit of 40% or Relative Error Ratio <1 | Correct problem, then re-prepare and re-analyze all samples in the associated preparatory batch, if the exceedance not caused by sample matrix. | Analyst, Supervisor | Precision/ Accuracy/Bias | Acceptable QC Acceptance Limits |



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## SAP Worksheet #28.2A – Laboratory QC Samples Table

| | |
|---|---|
| **Matrix** | Soil/Sediment |
| **Analytical Group** | Strontium-90 |
| **Analytical Method / SOP Reference[1]** | EPA 905.0 / ARS-032 |

| QC Sample | Frequency / Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method blank | One per preparation batch | No analytes detected > target detection limit (PQL WS 15) | Correct problem. If required, re-prepare and re-analyze MB and all samples processed with the contaminated blank. | Analyst, Supervisor | Accuracy/Bias/ Contamination | Acceptable results per stated QC Acceptance Limits |
| LCS | One per preparation batch | Recovery limits: 75-125% for Sr-90 | Correct problem, then re-prepare and re-analyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. | Analyst, Supervisor | Accuracy/Bias | Acceptable QC Acceptance Limits |
| Duplicate | One per preparation batch | RPD limit of 25% or Relative Error Ratio <1 | Correct problem, then re-prepare and re-analyze all samples in the associated preparatory batch, if not exceedane not caused by sample matrix. | Analyst, Supervisor | Precision/ Accuracy/Bias | Acceptable QC Acceptance Limits |
| Strontium and Barium Carrier | Every Sample | Recovery limits of 40-110% | Truncate carriers above 100% recovery to eliminate low biased results. Re-prep and reanalyze sample if carrier is low (indicating high biased results) if there is activity in the sample above the reporting limit. No reanalysis if matrix interference is noticed during sample preparation. | Analyst, Supervisor | Accuracy/Bias | Acceptable QC Acceptance Limits |



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## SAP Worksheet #28.3A – Laboratory QC Samples Table

| | |
|---|---|
| **Matrix** | Soil/Sediment |
| **Analytical Group** | Isotopic Uranium |
| **Analytical Method / SOP Reference[1]** | HASL 300 / ARS-026 |

| QC Sample | Frequency / Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method blank | One per preparation batch | No analytes detected > target detection limit (PQL WS 15) | Correct problem. If required, re-prepare and re-analyze MB and all samples processed with the contaminated blank. | Analyst, Supervisor | Accuracy/Bias/ Contamination | Acceptable results per stated QC Acceptance Limits |
| LCS | One per preparation batch | Recovery limits: 75-125% | Correct problem, then re-prepare and re-analyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. | Analyst, Supervisor | Accuracy/Bias | Acceptable QC Acceptance Limits |
| Duplicate | One per preparation batch | RPD limit of 40% or Relative Error Ratio <1 | Correct problem, then re-prepare and re-analyze all samples in the associated preparatory batch, if not exceedance not caused by sample matrix. | Analyst, Supervisor | Precision/ Accuracy/Bias | Acceptable QC Acceptance Limits |
| U-232 Tracer | Every Sample | Recovery limits of 30-110% | Truncate tracers above 100% recovery to eliminate low-biased results. Re-prep and re-analyze sample if carrier is low (indicating high-biased results) if there is activity in the sample above the reporting limit. No re-analysis if matrix interference is noticed during sample preparation. | Analyst, Supervisor | Accuracy/Bias | Acceptable QC Acceptance Limits |



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## SAP Worksheet #28.4A – Laboratory QC Samples Table

| | |
|---|---|
| **Matrix** | Soil/Sediment |
| **Analytical Group** | Isotopic Plutonium |
| **Analytical Method / SOP Reference[1]** | HASL 300 / ARS-026 |

| QC Sample | Frequency / Number | Method/SOP QC Acceptance Limits | Corrective Action | Person(s) Responsible for Corrective Action | Data Quality Indicator (DQI) | Measurement Performance Criteria |
|---|---|---|---|---|---|---|
| Method blank | One per preparation batch | No analytes detected > target detection limit (PQL WS 15) | Correct problem. If required, re-prepare and re-analyze MB and all samples processed with the contaminated blank. | Analyst, Supervisor | Accuracy/Bias/ Contamination | Acceptable results per stated QC Acceptance Limits |
| LCS | One per preparation batch | Recovery limits: 75-125% for Pu-239 | Correct problem, then re-prepare and re-analyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. | Analyst, Supervisor | Accuracy/Bias | Acceptable QC Acceptance Limits |
| Duplicate | One per preparation batch | RPD limit of 40% or Relative Error Ratio <1 | Correct problem, then re-prepare and re-analyze all samples in the associated preparatory batch, if not exceedance not caused by sample matrix. | Analyst, Supervisor | Precision/ Accuracy/Bias | Acceptable QC Acceptance Limits |
| Pu-236 or Pu-242 Tracer | Every Sample | Recovery limits of 30-110% | Truncate tracers above 100% recovery to eliminate low-biased results. Re-prep and re-analyze sample if carrier is low (indicating high-biased results) if there is activity in the sample above the reporting limit. No reanalysis if matrix interference is noticed during sample preparation. | Analyst, Supervisor | Accuracy/Bias | Acceptable QC Acceptance Limits |



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## SAP Worksheet #30.1 – Analytical Services Table

| **Matrix** | **Analytical Group** | **Sample Locations/ ID Number** | **Analytical Method** | **Data Package Turnaround Time** | **Laboratory / Organization** (name and address, contact person and telephone number) | **Backup Laboratory / Organization** (name and address, contact person and telephone number) |
|---|---|---|---|---|---|---|
| Soil | Radiochemistry | Samples as listed on SAP Worksheet #18 | EPA 901.1, EPA 905.0, HASL 300 A-01-R | 30 Calendar Days | ARS Aleut Analytical, LLC<br>2609 North River Road<br>Port Allen, LA 70767<br>Danielle Dittrich<br>(225) 381-2991 | TestAmerica St. Louis<br>13715 Rider Trail North<br>Earth City, MO 63045<br>Rhonda Ridenhower<br>(314) 298-8566 |

Selected laboratories will have successfully completed the DoD Environmental Laboratory Accreditation Program (ELAP) certification for the matrices and methods for definitive data listed in SAP Worksheet #19 and will maintain current status throughout the duration of this project. Laboratories also will be certified by the California Water Board under the ELAP for all the analytical methods listed in SAP Worksheet #23. Laboratories will be capable of providing the project QC and data deliverables required by this SAP and the DoD QSM for Environmental Laboratories version 5.3. The status of laboratory certifications/accreditations will be verified prior to fieldwork and before samples are delivered to lab. Updates to lab accreditation to ensure the laboratory is qualified to perform the analysis will be made prior to sample testing.



ED_006787_00025297-00022

# ATTACHMENT 1 – LABORATORY STANDARD OPERATING PROCEDURES

Uncontrolled

ARS Aleut Analytical

# Gamma Emitting Radionuclides in Air Filters, Soil, and Biota Matrices

**(EPA 901.1 Mod, SM 7120B, HASL 300 Ga-01-R)**

## ARS-007

**Revision 7.5**

**Effective Date: 05-28-2020**
**Last Reviewed: 02-09-2020**

Gabe Culberson

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**Keith Greene**

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| REVISION # | DATE OF REVISION | PURPOSE OF REVISION | SECTION AFFECTED |
|---|---|---|---|
| **7.5** | 02-09-2020 | ARS-049 and ARS-062 SOP names updated | Section 2, 11, 24 |
| **7.4** | 02-09-2019 | Annual Review and Formatting | Entire Document |
| **7.3** | 02-09-2018 | Added following to section<br>14.4. Print the gamma raw data, load the raw data into the TRAX system, and store the raw data on the appropriate computer-compatible device.<br>14.5. Review the data and complete the data review checklist defined in ARS-059 Review, Validation, and Reporting of Radiochemistry Data and Results.<br>14.6. Calculate the radioactivity of the gamma emitters present in the sample using the TRAX calculation system.<br>14.7. Deliver the data to the Senior Chemist or designee for secondary data review. After secondary data review, the data is delivered to Project Management for data package generation. | Section 14 |
| **7.3** | 02-09-2018 | Added "Certified Gamma Sources in required geometries with water and solid densities." | Section 10 |
| **7.3** | 02-09-2018 | Added "N Type" | Section 8.1 |
| **7.3** | 02-09-2018 | Added references to HASL 300 and Standard Methods | Section 2 |
| **7.3** | 02-09-2018 | Changed Logo | Entire Document |
| **7.2** | 01-29-2018 | Annual Review | None |
| **7.1** | 02-06-2017 | Annual review | None |
| **7.0** | 04-15-2016 | Added note after Section 14.2. | Section 14 |



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## 1.0 SCOPE AND APPLICATION, APPLICABLE MATRICES AND DETECTION LIMITS

1.1. Scope and Matrices

This procedure establishes the framework and requirements for laboratory analysis of gamma emitting radionuclides in all matrices to include but not limited to air, soil and biota utilizing a modification to the EPA 901.1, SM 7120B, HASL 300 Ga-01-R.

1.2. Application and Detection Limits

1.2.1. This method describes the use of gamma spectroscopy for the measurement of gamma photons from radionuclides without separating them from the sample matrix

1.2.2. Because of its energy resolution advantage, an HPGe detection system is used for measuring gamma emitting radionuclides.

1.2.3. The method is applicable for analyzing samples that contain radionuclides emitting gamma photons with energies ranging from about 20 to 2,000 KeV.

## 2.0 REFERENCES

2.1. *ARS-001 Quality Assurance Manual*

2.2. *ARS-013 Nonconformance Reporting and Corrective Action Program*

2.3. *ARS-014 Operational QA for Radiochemistry*

2.4. *ML-QA-002-SOP Document Control and Records Management*

2.5. *ARS-058 Operation of the Ortec Gamma Spectroscopy System.*

2.6. *ARS-059 Review, Validation, and Reporting*

2.7. *ARS-060 Analytical Calculations for Radiochemistry*

2.8. *PALA-SR-001-SOP Sample Receiving*

2.9. *ARS-064 Pre-Analytical Sample Preparation*

2.10. *ARS-134 Project Management Procedure*

2.11. *ARS-140 Limits of Detection and Quantification*

2.12. *ARS-164 Operational QA for Stable Chemistry*

2.13. *HSE-001 HS&E Manual*

2.14. *HSE-004 Chemical Hygiene Plan*

2.15. *HSE-005 Waste Handling*

2.16. *RSP-001 Radiation Safety Plan*

2.17. TNI Standard-2009 and 2016

2.18. DoD/DOE Quality Systems Manual (QSM), Final Version 5.3

2.19. OSHA Laboratory Standards Chemical Hygiene Plan 29 CFR 1910.1450

2.20. OSHA Workplace Safety Standards 29 CFR 1910.

2.21. Ortec DSPEC Pro Hardware User's Manual, GammaVision V6 User Manual and related documents.

2.22. U.S. Environmental Protection Agency, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Method 901.1, EPA-600/4-80-032, August 1980.

2.23. "Calibration and Use of Germanium Spectrometers for the Measurement of Gamma-Ray Emission Rates of Radionuclides", ANSI N42.14-1999, Institute of Electrical Engineers, Inc., May 12, 1999.

2.24. U.S. Environmental Protection Agency, National Primary Drinking Water Regulations; Radionuclides; Final Rule. 40 CFR Parts 9, 141 and 142. (2000)

2.25. Standard Methods for the Examination of Water and Wastewater, 20th Edition

2.26. HASL 300, EML Procedures Manual, 28th Edition

## 3.0 REQUIREMENTS

3.1. Prior to the performance of this procedure all documents establishing control and handling of the sample must be completed in full. This includes the Chain of Custody Form.

3.2. All preparation procedures must be performed and entered into Trax for proper calculations per *ARS-060 Analytical Calculations for Radiochemistry.*

## 4.0 SUMMARY OF THE TEST METHOD

4.1. A homogeneous sample aliquot is put into a standard geometry for gamma counting. The counting efficiency for this geometry must have been determined with standard (known) radionuclide activity. Sample aliquots are counted long enough to meet the required sensitivity of measurement.

4.2. The gamma spectrum is printed out and/or stored in the appropriate computer-compatible device for data processing (calculation of sample radionuclide concentrations).

## 5.0 DEFINITIONS

Refer to *ARS-001 Quality Assurance Manual.*

## 6.0 INTERFERENCES

6.1. Sample homogeneity is important to gamma count reproducibility and counting efficiency validity.

## 7.0 SAFETY

Safety shall be in accordance with the following:

7.1.1. *HSE-001 HS&E Manual*

7.1.2. *HSE-004 Chemical Hygiene Plan*

7.1.3. *ARS-001 Quality Assurance Manual*

7.1.4. *RSP-001 Radiation Safety Plan*

7.1.5. OSHA Laboratory Standards Chemical Hygiene Plan 29 CFR 1910.1450

7.1.6. OSHA Workplace Safety Standards 29 CFR 1910.1926

## 8.0 EQUIPMENT AND SUPPLIES

8.1. Large volume (> 50 cm3) HPGe "N-Type" detector plus analyzer with at least 2,048 channels

8.2. Standard geometry sample counting containers

## 9.0 GLASSWARE CLEANING

Refer to *ARS-001 Quality Assurance Manual.*

## 10.0 REAGENTS AND STANDARDS

10.1. Certified Gamma Sources in required geometries with water and solid densities.

## 11.0 SAMPLE RECEIPT, STORAGE AND TRANSFER

11.1. Reference *PALA-SR-001-SOP Sample Receiving* for guidance on the sample receiving process.

11.2. Reference *ARS-005 Internal Chain of Custody* for sample storage and transfer requirements

## 12.0 QUALITY CONTROL

Refer to *ARS-014 Operational QA for Radiochemistry.*

## 13.0 CALIBRATION AND STANDARDIZATION

The HPGe *detector system shall be calibrated according to ARS-001 Quality Assurance Manual* and *ARS-058 Operation of the ORTEC Gamma Spectroscopy System.*

## 14.0 PROCEDURE

14.1. Prepare sample as prescribed in *ARS-064 Pre-Analytical Sample Preparation..*

14.2. Measure the weight/volume of the sample in a standard geometry (one that has been calibrated).

**Note: Samples prepared in a 250mL(8 oz.) tuna can should undergo a twenty-one day ingrowth period prior to counting.**

14.3. Place the standard geometry container (with the sample aliquot) on a shielded HPGe and gamma count for a period of time that will meet the required sensitivity of measurement.

14.4. Print the gamma raw data, load the raw data into the TRAX system, and store the raw data on the appropriate computer-compatible device.

14.5. Review the data and complete the data review checklist defined in ARS-059 Review, Validation, and Reporting of Radiochemistry Data and Results.

14.6. Deliver the data to the Senior Chemist or designee for secondary data review. After secondary data review, the data is delivered to Project Management for data package generation.

## 15.0 CALCULATIONS

Refer to *ARS-060 Analytical Calculations for Radiochemistry.*

## 16.0 MDA ASSESSMENT

Refer to *ARS-014 Operational QA for Radiochemistry.*

## 17.0 PRECISION AND ACCURACY

Refer to *ARS-014 Operational QA for Radiochemistry* and *ARS-060 Analytical Calculations for Radiochemistry.*

## 18.0 METHOD PERFORMANCE

Refer to *ARS-001 Quality Assurance Manual.*

## 19.0 POLLUTION PREVENTION

Refer to *ARS-001 Quality Assurance Manual.*

## 20.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QUALITY CONTROL MEASURES

Refer to *ARS-014 Operational QA for Radiochemistry.*

## 21.0 CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

Refer to *ARS-013 Nonconformance Reporting and Corrective Action Program.*

## 22.0 CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

Refer to *ARS-013 Nonconformance Reporting and Corrective Action Program.*

## 23.0 WASTE MANAGEMENT

Refer to *ARS-001 Quality Assurance Manual* and *HSE-005 Waste Handling Procedure.*

## 24.0 RECORDS, REPORTS, AND NOTIFICATIONS

24.1. The Laboratory Chemist performing the analysis shall be responsible for the data entry onto appropriate ARS forms. Refer to *ARS-059 Review, Validation, and Reporting.*

24.2. The Project Manager and Laboratory Management shall ensure that the forms are properly completed.

24.3. Records shall be controlled in accordance with *ML-QA-002-SOP Document Control and Records Management.*

## 25.0 REPORTING RESULTS

Refer to *ARS-059 Review, Validation and Reporting.*

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# Americium, Plutonium and Uranium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation

**Americium: Eichrom ACW03, Eichrom RAW03, HASL 300 Am-01-RC, HASL 300 Am-02-RC, HASL 300 Am-03-RC, HASL 300 Am-05-RC, HASL 300 Am-06-RC, HASL 300 Se-03**

**Plutonium: Eichrom ACW03, HASL 300 Pu-01-RC, HASL 300 Pu-02-RC, HASL 300 Pu-03-RC, HASL 300 Pu-04-RC, HASL 300 Pu-08-RC, HASL 300 Pu-10-RC, HASL 300 Se-03**

**Uranium: Eichrom ACW02, Eichrom ACW03, HASL 300 U-02-RC, HASL 300 U-04-RC, HASL 300 Se-03**

## ARS-026
## Revision 15.2

**Effective Date: 05-29-2020**
**Review Date: 01-25-2020**

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| REVISION # | DATE OF REVISION | PURPOSE OF REVISION | SECTION AFFECTED |
|---|---|---|---|
| **15.2** | 01-25-2020 | Updated SOP names for ARS-049 and ARS-062 | Section 2, 11, 24 |
| **15.2** | 01-25-2020 | Updated methods to show HASL 300 | Cover Page |
| **15.1** | 01-23-2019 | Annual Review and Formatting | Entire Document and Section 14 |
| **15.0** | 02-09-2018 | Add steps for current acid digestion | Section 14.2.2 |
| **15.0** | 02-09-2018 | Changed Logo | Whole Document |
| **15.0** | 02-09-2018 | Added "This method also includes modifications for other matrices including soil, vegetation, and filter material." | Section 1.1 |
| **15.0** | 02-09-2018 | Added references to HASL 300 | Section 2 |
| **15.0** | 02-09-2018 | Deleted "Vacuum Box System" from Reagents, it is listed under Equipment. | Section 10 |
| **15.0** | 02-09-2018 | Added "Ensure original volume is documented." | Section 14.2 |
| | | | |



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## 1.0 SCOPE AND APPLICATION, APPLICABLE MATRICES AND DETECTION LIMITS

1.1. **Scope and Matrices**

This procedure establishes the framework and requirements for a laboratory method for separation and measurement of Americium, Plutonium and Uranium in water as prescribed in the Eichrom Industries Analytical Procedure Eichrom ACW03. This method also includes modifications for other matrices including soil, vegetation, and filter material.

1.2. **Applicable Matrices and Detection Limits**

1.2.1. This method is applicable to all matrices to include but not limited to water, soil, and vegetation.

1.2.2. With the assumption of a 12 hour count time and a 1 liter sample for liquids and 0.5 gram sample for solids the following detection limits can be obtained: For Uranium Liquids = 0.0315 pCi/L and Solids = 0.0629 pCi/g. For Plutonium Liquids = 0.0064 pCi/L and Solids = 0.0129 pCi/g. For Americium Liquids = 0.0659 pCi/L and Solids = 0.1317 pCi/g.

## 2.0 REFERENCES

2.1. *ARS-001 Quality Assurance Manual*

2.2. *ARS-005 Internal Chain of Custody*

2.3. *ARS-013 Nonconformance Reporting and Corrective Action Program*

2.4. *ARS-014 Operational QA for Radiochemistry*

2.5. *ARS-036 Sample Microwave Digestion*

2.6. *ML-QA-002-SOP Document Control and Records Management*

2.7. *ARS-051 Operation of the ORTEC Alpha Spec*

2.8. ARS-053 *Operation of CANBERRA Alpha Spec*

2.9. *ARS-059 Review, Validation, and Reporting*

2.10. *ARS-060 Analytical Calculations for Radiochemistry*

2.11. *ARS-134 Project Management Procedure*

2.12. *HSE-001 HS&E Manual*

2.13. *HSE-004 Chemical Hygiene Plan*

2.14. *HSE-005 Waste Handling*

2.15. *RSP-001 Radiation Safety Plan*



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2.16. TNI Standard-2009 and 2016

2.17. DoD/DOE Quality Systems Manual (QSM), Final version 5.3

2.18. OSHA Laboratory Standards Chemical Hygiene Plan 29 CFR 1910.1450

2.19. OSHA Workplace Safety Standards 29 CFR 1910.1926

## 3.0 REQUIREMENTS

3.1. Prior to the performance of this procedure all documents establishing control and handling of the sample must be completed in full.

3.2. The analyst performing the procedure shall have completed a current Demonstration of Capability (DOC) or shall be under the direct supervision of an analyst with a current DOC.

## 4.0 SUMMARY OF THE TEST METHOD

4.1. This method is a rapid, reliable method for measurement of actinides in water samples that is more cost-effective and efficient than traditional ion exchange, solvent extraction and precipitation techniques.

4.2. Americium, plutonium and uranium are separated by Eichrom resins prior to measurement by alpha spectrometry. A calcium phosphate precipitation technique can be used to concentrate and remove actinides from water samples. Tracers are used to monitor chemical recoveries and correct results to improve precision and accuracy.

## 5.0 DEFINITIONS

Refer to ARS-001 Quality Assurance Manual.

## 6.0 INTERFERENCES

6.1. Actinides with unresolvable alpha energies such as Am-241 and Pu-238 or Np-237 and U-234 must be chemically separated to enable measurement. This method separates these isotopes effectively.

6.2. Very high levels of phosphate in the sample may cause interference. Adjusting the amount of phosphate added to coprecipitate the actinides might be necessary in these cases.

6.3. Po-210 has an alpha energy similar to U-232. This method will achieve adequate decontamination of Po in the U fraction for samples with moderate levels of Po-210. However, for samples containing very high levels of Po-210 (e.g., environmental samples with the natural uranium decay chain intact, or dissolved air filter samples) an additional column rinse is recommended.

## 7.0 SAFETY

Safety shall be in accordance with the following:

1.1.1. *HSE-001 HS&E Manual*

1.1.2. *HSE-004 Chemical Hygiene Plan*

1.1.3. *ARS-001 Quality Assurance Manual*

1.1.4. *RSP-001 Radiation Safety Plan*

1.1.5. OSHA Laboratory Standards Chemical Hygiene Plan 29 CFR 1910.1450

1.1.6. OSHA Workplace Safety Standards 29 CFR 1910.1926

## 8.0 EQUIPMENT AND SUPPLIES

8.1. Analytical balance - 0.0001 g sensitivity

8.2. Centrifuge

8.3. Centrifuge tubes

8.4. Column rack - Eichrom part number AC-103.

8.5. Column reservoirs - 25 mL, Eichrom part number AC-120.

8.6. Electrodeposition cell assembly- consisting of disposable plastic vial, cap assembly containing stainless steel for plating planchet (cathode) and Teflon cover with platinum electrode (anode).

8.7. Engraver to engrave stainless steel discs

8.8. Filter apparatus- Gelman apparatus 0.1 micron with 25 mm filters with polycarbonate base and metal screen, polysulfide funnel and 100 mL polypropylene flask..

8.9. Filter- 0.45 micron

8.10. Fume hood

8.11. Glue stick or double sided tape

8.12. Hotplate

8.13. Low background alpha counter

8.14. Stirring glass rods

8.15. Plastic Millipore Petri dishes, 5-1/2 x 1 cm

8.16. Stainless steel planchets- ¾ inch diameter, flat

8.17. Stainless steel tweezers

8.18. Pump suggested- dry pump with 115 V, 60 Hz Fisher catalog no. 01-094-22 or house vacuum (see 8.5 ordering from outside the USA)

8.19. Tips, white inner, Eichrom part number AC-1000-IT

8.20. Tips, yellow outer, Eichrom part number AC-1000-OT

8.21. Vacuum Box, Eichrom part number AC-24-BOX

8.22. Vortex mixer

## 9.0 GLASSWARE CLEANING

Refer to *ARS-001 Quality Assurance Manual.*

## 10.0 REAGENTS AND STANDARDS

All chemicals should be of "reagent-grade" or equivalent whenever they are commercially available.

10.1. Unless otherwise indicated, all references to water should be understood to mean deionized distilled water.

10.2. Acetone

10.3. Ammonium Hydrogen Oxalate (0.1 M) - Dissolve 6.31 grams of $H_2C_2O_4 \bullet 2H_2O$ (Oxalic Acid) and 7.11 grams of $(NH_4)_2C_2O_4 \bullet H_2O$ (Ammonium Oxalate) in 900 mL of water, and dilute to 1 L with water.

10.4. Ammonium Hydrogen Phosphate (3.2 M) - Dissolve 104 grams of $(NH_4)_2HPO_4$ in 200 mL of water, heat gently to dissolve, and dilute to 250 mL with water

10.5. Ammonium Hydroxide (5 wt %) - Dissolve 50 grams of Ammonium Hydroxide in 950 grams of water.

10.6. Ammonium Hydroxide (15N) - Concentrated (sp grade 0.9).

10.7. Ammonium Oxalate plating solution (20 g/L)- Dissolve 5 grams of Ammonium Oxalate Hydrate in 250 mL of water.

10.8. Ammonium Thiocyanate Indicator (1M) - Dissolve 7.6 grams of Ammonium Thiocyanate in 90 mL of water and dilute to 100 mL with water.

10.9. Appropriate amounts of the correct tracers (Am-243, Pu-242, U-232)

10.10. Ascorbic Acid (1 M)-Dissolve 17.6 grams of Ascorbic Acid in 90 mL of water and dilute to 100 mL with water. Prepare weekly.

10.11. Calcium Nitrate (1.25 M) - Dissolve 51 g of Ca $(NO_3)_2$ in 100 mL of water and dilute to 250 mL with water.

10.12. Ethanol, 80%- Add 80 mL ethanol to 20 mL water.

10.13. Ferrous Sulfamate solution (0.6 M)- Add 57 g of $NH_2SO_3H$ (Sulfamic Acid) to 150 mL of water, heat to 70° C, add 7 g of iron powder (< 100 mesh size) in small increments until dissolved, filter (Whatman #4 suggested), transfer to flask and dilute to 200 mL with water. **Prepare new batch weekly.**

10.14. Hydrochloric Acid (12 M) - concentrated HCl (sp gr 1.19).

10.15. Hydrochloric Acid (4 M) - Add 333 mL of concentrated HCl (sp gr 1.19) to 500 mL of water and dilute to 1 L with water.

10.16. Hydrochloric Acid (4 M) - Hydrofluoric Acid (0.2 M) - Add 333 mL of concentrated HCl (sp gr 1.19) and 7.2 mL of concentrated HF (sp gr 1.2) to 500 mL of water and dilute to 1 L with water.

10.17. Hydrochloric Acid (5 M) - Oxalic Acid (0.05 M) solution- Dissolve 6.3 grams of Oxalic Acid dihydrate in 400 mL water. Add 417 mL concentrated HCl (sp gr 1.19). Cool to room temperature and dilute to 1 L with water.

10.18. Hydrochloric Acid (9 M) - Add 750 mL of concentrated HCl (sp gr 1.19) to 100 mL of water and dilute to 1 L with water.

10.19. Hydrofluoric Acid (28 M) - concentrated Hydrofluoric Acid (sp gr 1.2)

10.20. Hydrogen Peroxide (30%) - $H_2O_2$

10.21. Nitric Acid (15.7 M) - concentrated $HNO_3$ (16N)(sp gr 1.42)

10.22. Nitric Acid (3 M)- sodium nitrite (0.1 M) solution- Add 48 mL of concentrated $HNO_3$ (sp gr 1.42) to 175 mL of water, dissolve 1.72 grams of Sodium Nitrite in the solution and dilute to 250 mL with water. Prepare fresh daily.

10.23. Nitric Acid (3 M)- Aluminum Nitrate (1.0 M) solution- Dissolve 212 grams of Anhydrous Aluminum Nitrate in 700 mL of water, add 191 mL of concentrated $HNO_3$ (sp gr 1.42) and dilute to 1 L with water.

10.24. Nitric Acid solution (3 M) - Add 191 mL of concentrated $HNO_3$ (sp gr 1.42) to 700 mL of water and dilute to 1 L with water.

10.25. Phenolphthalein solutions - dissolve 1 g phenolphthalein in 100 mL 95% Isopropyl Alcohol and dilute with 100 mL of water.

10.26. Potassium Hydroxide (25 wt %) - Dissolve 250 grams of Potassium Hydroxide in 750 grams of water.

10.27. Sodium Hydrogen Sulfate (5 wt %) - Dissolve 50 grams of Sodium Hydrogen Sulfate in 950 g of water.

10.28. Sodium Sulfate (15 wt %) - dissolve 150 g of Sodium Sulfate in 850 grams of water.

10.29. Sulfuric Acid ($H_2SO_4$) (1.8M) – add 10 ml. Conc. $H_2SO_4$ to 75 ml of water. Bring to 10 ml. with water.

10.30. Hydrochloric Acid (0.01 M) - Add 0.8 mL of concentrated HCl (sp gr 1.19) to 900 mL of water and dilute to 1 L with water.

10.31. UTEVA Resin- 2mL cartridge, 50-100µ , part number UT-R50-S and UT-R200-S

10.32. TRU Resin- 2mL cartridge, 50-100µ, part number TR-R50-S and TR-R200-S

## 11.0 SAMPLE RECEIPT, STORAGE AND TRANSFER

11.1. Refer to *PALA-SR-001-SOP Sample Receiving* for guidance on the sample receiving process.

11.2. Refer to *ARS-005 Internal Chain of Custody* for sample storage and transfer requirements.

## 12.0 QUALITY CONTROL

Refer to *ARS-014 Operational QA for Radiochemistry.*

## 13.0 CALIBRATION AND STANDARDIZATION

13.1. Calibration and Standardization can be found in *ARS-051 Operation of the ORTEC Alpha Spectroscopy System* and *ARS-53 Operation of the Canberra Alpha Spectroscopy System.*

## 14.0 PROCEDURE:

14.1. **For matrices other than water, ensure the proper digestion has been performed according to *ARS-064 & ARS-036*. Then proceed with the appropriate steps in this procedure.**

14.2. **Ensure all the required tracers have been added prior to performing the procedure; for soils, prior to digestion and for waters, following Step 14.3.5 or Step 14.3.6 depending on sample size.**

14.3. **Water Sample Preparation:**

14.3.1. If sample has not been previously acidified, acidify the sample to pH 2, with concentrated HNO3 (sp gr 1.42) (0.6 mL per 1000 mL) and wait **at least 16 hours before preparing sample.**

14.3.2. If the client request filter analysis, then filter the sample through a 0.45-micron filter.

14.3.3. Aliquot 500 to 1000 mL of the sample (or enough to meet required detection limit) into an appropriate size beaker.

14.3.4. Add appropriate amount of the correct tracers.

**NOTE: For samples greater than 100 mL use Step 14.3.5 and for samples less than 100 mL use Step 14.3.6.**

14.3.5. Calcium phosphate precipitation option: (greater than 100 ml of sample)

14.3.5.1. Add 0.5 mL of 1.25 M $Ca(NO_3)_2$ to each beaker.

14.3.5.2. Place each beaker on a hot plate.

14.3.5.3. Cover each beaker with a watch glass.

14.3.5.4. Allow the samples to heat until boiling.



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14.3.5.5. Once the samples boil, take the watch glass off the beaker and turn the heat down.

14.3.5.6. Add 2-3 drops of phenolphthalein indicator and 200 µL of 3.2 M $(NH_4)_2HPO_4$ solution.

14.3.5.7. Add enough concentrated $NH_4OH$ with a squeeze bottle to reach the dark pink phenolphthalein end point and form $Ca_3(PO_4)_2$ precipitate. $NH_4OH$ should be added very slowly. Stir the solution with a glass rod. Precipitate should aggregate and settle.

14.3.5.8. If the sample volume is too large to centrifuge the entire sample, allow precipitate to settle until solution can be decanted (30 minutes to 2 hours) and proceed to **Step 14.3.5.10**.

14.3.5.9. If the volume is small enough to centrifuge, then proceed to **Step 14.3.5.11.**

14.3.5.10. Decant supernatant and discard to waste.

14.3.5.11. Transfer the precipitate to a centrifuge tube and centrifuge the precipitate for approximately 10 minutes at 2000 rpm.

14.3.5.12. Decant supernatant and discard to waste. If ammonia odor is present, add 20 mL of DI water, vortex, and centrifuge. Decant this supernatant and discard to waste, then proceed to **Step 14.5.1.**

14.3.6. Evaporation option to reduce volume: (less than 100 ml of sample)

14.3.6.1. Evaporate sample to less than 50 mL and transfer to a 100 mL beaker.

**NOTE: For some water samples, calcium sulfate formation may occur during evaporation. If this occurs, use the calcium phosphate precipitation option in Section 14.3.5.**

14.3.6.2. Gently evaporate the sample to dryness and redissolve in approximately 5 mL of concentrated $HNO_3$ (sp gr 1.42).

14.3.6.3. **Repeat Step 14.3.6.2 two more times**, and evaporate to near dryness, then proceed to **Step 14.5.1.**

## 14.4. Soil Sample Preparation

14.4.1. Microwave Digestion

14.4.1.1. Weigh 1 gram or put enough in the weigh boat, medicine cup, or appropriate container to meet the required detection limit.

14.4.1.2. Blank: Use acid washed sand and aliquot mass matching largest aliquot in the batch.

14.4.1.3. Add appropriate amount of the correct tracers.

14.4.1.4. Add 9 mL 16N (conc.) HNO3, 3 mL of 28M (conc.) HF, and 2 mL of 12M (conc.) HCl.

**NOTE: Samples that are high in organic content or other reactive materials can cause vessel to blow up if samples are not given time to react.**



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14.4.1.5. Microwave samples or perform hot plate digestion according to procedure *ARS-036 Sample Digestion*.

14.4.1.6. Allow samples to cool upon completion of digestion.

14.4.1.7. Filter samples into a clean centrifuge tube using a Whatman 42 filter. Rinse beaker with concentrated nitric acid and filter as well.

14.4.1.8. Pour filtered samples into clean beakers

14.4.1.9. Place the samples on a hot plate and evaporated to dryness.

14.4.1.10. Convert samples by adding 5 mL of 16N (conc.) HNO3 to dried material. **Repeat this step three (3) times, then proceed to Step 14.5.2 for Soils.**

14.4.2. Hotplate Acid Digestion

14.4.2.1. Weigh 1 gram of sample into weight boat, medicine cup, or appropriate container.

14.4.2.2. Record sample aliquot in Trax.

14.4.2.3. Transfer sample to Teflon beaker.

14.4.2.4. Add appropriate amount of the correct tracers.

14.4.2.5. Add 10 mL of 16N $HNO_3$(conc.), 3 mL of 28M HF(conc.), and 2 mL of 12M HCL (conc.).

14.4.2.6. Place beaker on hotplate for two hours set at 200C and cover with a Teflon watch glass.

14.4.2.7. After two hours, remove sample from hotplate and allow to cool. Filter samples through Whatman 42 air filter

14.4.2.8. Rinse empty beaker and filter with 16N $HNO_3$.

14.4.2.9. Transfer filtrate to clean Teflon beaker and evaporate to dryness.

14.4.2.10. Once dry, add 5mL of 16N $HNO_3$ and evaporate to dryness. **Repeat this Step two more times,** then proceed to **Step 14.5.2 for Soils.**

## 14.5. Actinide Separations using Eichrom Resins

14.5.1. Re-dissolve calcium phosphate residue or evaporated **water** sample **(14.5.1 Step is only for Waters and for Soils proceed to Step 14.5.2)**

14.5.2. Dissolve precipitate or residue from evaporation in 10 mL 3 M $HNO_3$-1.0 M $Al(NO_3)_3$.

14.5.3. If full dissolution is **not** achieved, then add 5 additional mL of 3M $HNO_3$-1.0 M $Al(NO_3)_3$.

14.5.4. Add 2 mL of 0.6 M Ferrous Sulfamate to each solution. Swirl to mix.

**NOTE: If the additional 5 mL was used to dissolve the sample in Step 14.5.3, add a total of 3 mL of Ferrous Sulfamate solution.**

14.5.5. Add 1 drop of 1 M Ammonium Thiocyanate indicator to each sample and mix.

**NOTE: The color of the solution turns deep red, due to the presence of iron in $Fe^{+3}$ state.**

14.5.6. Add 1 mL of 1 M ascorbic acid to each solution, swirling to mix. Wait for at least 2-3 minutes before proceeding to the next step.

**NOTE: The red color should disappear which indicates reduction of $Fe^{+3}$ to $Fe^{+2}$. If the red color still persists, then additional ascorbic acid solution should be added drop-wise with mixing until the red color disappears.**

**NOTE: If particles are observed suspended in the solution, centrifuge the sample. The supernatant will be transferred to the column in Step 14.5.8.1. The precipitates will be discarded.**

14.5.7. Set up of UTEVA and TRU cartridges in tandem on the vacuum box system

14.5.7.1. Place the inner tube rack (supplied with vacuum box) into the vacuum box with the centrifuge tubes in the rack. Fit the lid to the vacuum system box.

14.5.7.2. Place the yellow outer tips into all 24 openings of the lid of the vacuum box. Fit in the inner white tip into each yellow tip.

14.5.7.3. For each sample solution, fit in the TRU cartridge on to the inner white tip. Luer lock the UTEVA cartridge to the top end of the TRU cartridge.

14.5.7.4. Luer lock syringe barrels (funnels/reservoirs) to the top end of the UTEVA cartridge.

14.5.7.5. Connect the vacuum pump to the box. Turn the vacuum pump on and ensure proper fitting of the lid.

**IMPORTANT: The unused openings on the vacuum box should be sealed. Yellow caps (included with the vacuum box) can be used to plug unused white tips to achieve good seal during the separation.**

14.5.7.6. Add 5 mL of 3M $HNO_3$ to the funnel to precondition the UTEVA and TRU cartridges

14.5.7.7. Adjust the vacuum pressure to achieve a flow-rate of at most 3 drops/sec.

**IMPORTANT: Unless otherwise specified in the procedure, use a flow rate of 1 mL/min for load and strip solutions and 3 mL/min for rinse solutions.**

14.5.8. U separation from Pu, Am using UTEVA and TRU Resin

14.5.8.1. Transfer each sample into the appropriate funnel by pouring or by using a plastic transfer pipette. Allow solution to pass through both the cartridges at a flow rate of about 1 drop/sec.

14.5.8.2. Add 5 mL of 3 M $HNO_3$ to rinse to each beaker and transfer each solution into the appropriate funnel (the flow rate can be adjusted to at most 3 drops/sec)

14.5.8.3. Add 10 mL of 3 M $HNO_3$ into each funnel and discard eluent. Flow rate should be at most 3 drops/sec.

14.5.8.4. Separate UTEVA cartridge from TRU cartridge. Place new funnel on the TRU cartridge. For uranium separation with UTEVA cartridge, continue with steps 14.5.8.5 through 14.5.8.10. For Americium and Plutonium proceed to **Step 14.5.9**.

14.5.8.5. Place UTEVA cartridge along with the funnel on a new opening on the vacuum box lid.

**NOTE: If a high level of Po-210 is present in the sample then an additional 3M $HNO_3$ rinse is necessary to eliminate Po-210. Add 30 mL of 3 M $HNO_3$ rinse to each UTEVA cartridge in increments of 10 mL, then continue to step 14.5.8.6**

14.5.8.6. Pipette 5 mL of 9 M HCl into each UTEVA cartridge and allow to drain. Flow rate should be at most 3 drops/sec. Discard this rinse.

**NOTE: This rinse converts the resin to the chloride system. Some Np may be removed here.**

14.5.8.7. Pipette 20 mL of 5 M HCl- 0.05 M oxalic acid into each UTEVA cartridge and allow it to drain. Flow rate should be at most 3 drops/sec. Discard this rinse.

**NOTE: This rinse removes neptunium and thorium from the cartridge. The 9 M HCl and 5 M HCl- 0.05 M oxalic acid rinses also remove any residual ferrous iron that might interfere with electro-deposition.**

14.5.8.8. Ensure that clean, labeled tubes are placed in the tube rack.

14.5.8.9. Pipette 15 mL of 0.01 M HCl into each cartridge to strip the Uranium. Elute Uranium at about 1 drop/sec.

14.5.8.10. Transfer to clean beaker.

14.5.8.11. Evaporate to dryness for electro-deposition.

14.5.9. Pu, Am Separation Using TRU cartridge

14.5.9.1. Pipette 5 mL of 3 M $HNO_3$ into each TRU cartridge.

14.5.9.2. Pipette 10 mL of 3 M $HNO_3$- 0.1 M $NaNO_2$ directly into each cartridge, rinsing each cartridge reservoir while adding the 3 M $HNO_3$- 0.1 M $NaNO_2$. IMPORTANT: The flow rate for the cartridge should be adjusted to at most 3 drops/sec.

**NOTE: Sodium nitrite is used to oxidize $Pu^{+3}$ to $Pu^{+4}$ and enhance the Pu/Am separation.**



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14.5.9.3. Allow the rinse solution to drain through each cartridge.

14.5.9.4. Discard the load and rinse solutions to waste.

14.5.9.5. Ensure that clean, labeled tubes are placed in the tube rack.

14.5.9.6. Americium Elution

14.5.9.6.1. Add 20 mL of 4 M HCl to elute americium. Collect eluate in same tube. Elute at rate of about 1 drop/sec.

14.5.9.6.2. Transfer eluate to a beaker.

14.5.9.6.3. Evaporate samples to near dryness. **DO NOT BAKE THE RESIDUE.**

14.5.9.6.4. For electrodeposition proceed to **Section 14.6**.

14.5.9.7. Plutonium Elution

14.5.9.7.1. Rinse the cartridge with 12 mL of 4 M HCl- 0.2 M HF. Flow rate should be at most 3 drops/sec. Discard eluate.

**NOTE: 4 M HCl- 0.2 M HF is used to selectively remove any residual Th that may be present on the TRU cartridge and leave the Pu.**

14.5.9.7.2. Ensure that clean, labeled tubes are placed in the tube rack under each cartridge.

14.5.9.7.3. Add 10 mL of 0.1 M $NH_4HC_2O_4$ (Ammonium Hydrogen Oxalate) to elute plutonium from each cartridge. Elute at rate of about 1 drop/sec.

14.5.9.7.4. Transfer eluate to clean beaker

14.5.9.7.5. Evaporate to near dryness for electrodeposition.

## 14.6. Electrodeposition

**NOTE: Electrodeposition using a sulfate system is described below.**

14.6.1. Inscribe a ¾ inch stainless steel planchet with sample number, radionuclide, and plating date. Wipe clean with acetone.

14.6.2. Assemble the planchet in the cell as the cathode and rinse the cell several times with water.

14.6.3. Test cell for leaks:

14.6.3.1. Wipe the outside of the assembled cell dry, add water to each cell and allow to stand 30 minutes to check for leaks.

14.6.3.2. If a leak is found, retighten the cap assembly and observe.

14.6.3.3. If the leak is still present, disassemble the cell, clean all surfaces with acetone and then water, reassemble cell and test again.

14.6.3.4. If the cell continues to leak, replace the plastic vial and cap, and test again.

14.6.4. Add 2.5 mL of 5 wt % $NaHSO_4$, 2 mL of water and 5 mL 15 wt % $Na_2SO_4$ to each evaporated actinide solution and heat each solution using a hotplate.

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14.6.5. Transfer each electrolyte solution from **Step 14.6.4** to a cell using 3 rinses of 1 mL water, adding the rinses to the cell.

14.6.6. Add 1 mL of ammonium oxalate plating solution to each cell.

14.6.7. Insert the platinum anode into the solution and connect the electrodes to the current source.

14.6.8. Turn on the power, adjust current to 0.5 A and electrodeposit for 5 minutes.

14.6.9. Adjust current to 0.75 A and electrodeposit for at least 90 minutes. For Americium samples, keep the current at 0.5 A and electrodeposit for at least 150 minutes (2.5 hours).

14.6.10. Add 2 mL of 25 wt % KOH drop wise to stop the reaction, continuing deposition for 1 minute after the KOH addition.

14.6.11. Turn off power, remove electrodes and decant electrolyte to waste.

14.6.12. Wash each cell three times with 2 mL of 5 wt % $NH_4OH$.

14.6.13. Remove each planchet and rinse with a small volume of 5 wt % $NH_4OH$, then with ethanol and finally acetone.

14.6.14. Dry each planchet on a hot plate for 5 minutes and allow to cool.

14.6.15. Store each planchet in a covered, labeled Petri dish.

14.6.16. Measure planchet using alpha spectrometry.

## 15.0 CALCULATIONS

Refer to *ARS-060 Analytical Calculations for Radiochemistry.*

## 16.0 MDA ASSESSMENT

Refer to *ARS-060 Analytical Calculations for Radiochemistry*

## 17.0 PRECISION AND ACCURACY

17.1. Precision- A relative standard deviation of 9% at the 12.7 dpm level has been reported for uranium. A relative standard deviation of 4% at the 9.4 dpm level has been reported for plutonium. A relative standard deviation of 7% at 6.52 dpm level has been reported for americium.

17.2. Bias- Mean chemical recoveries of 81% for americium, 76% for plutonium and 81% for uranium have been reported. Since results are corrected based on spike recovery, no significant bias exists for the method.

17.3. Refer to *ARS-014 Operational QA for Radiochemistry* and *ARS-060 Analytical Calculations for Radiochemistry.*

## 18.0 METHOD PERFORMANCE

Refer to *ARS-001 Quality Assurance Manual.*



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## 19.0 POLLUTION PREVENTION

Refer to *ARS-001 Quality Assurance Manual.*

## 20.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QUALITY CONTROL MEASURES

Refer to *ARS-014 Operational QA for Radiochemistry.*

## 21.0 CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

Refer to *ARS-013 Nonconformance Reporting and Corrective Action Program.*

## 22.0 CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

Refer to *ARS-013 Nonconformance Reporting and Corrective Action Program.*

## 23.0 WASTE MANAGEMENT

Refer to *ARS-001 Quality Assurance Manual* and *HSE-005 Waste Handling.*

## 24.0 RECORDS, REPORTS, AND NOTIFICATIONS

24.1. The Laboratory Technician performing the analysis shall be responsible for the data entry onto appropriate ARS forms. Refer to *ARS-059 Review, Validation and Reporting.*

24.2. The Project Manager, Quality Assurance Manager and Laboratory Director shall ensure that the forms are properly completed.

24.3. Records shall be controlled in accordance with *ML-QA-002-SOP Document Control and Records Management.*

## 25.0 REPORTING RESULTS

Refer to *ARS-059 Review, Validation and Reporting.*

## 26.0 BIBLIOGRAPHY

26.1. HASL 300, EML Procedures Manual, 28th Edition

26.2. Eichrom Technologies LLC, Method ACW03, May 2014

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ARS Aleut Analytical

# Strontium 89, 90 and Total Strontium in Water, Soil and Vegetation Matrices by Eichrom Resin Separation

**(Eichrom SRW01, EPA 905.0, EPA 905.0 Mod, HASL 300 Sr-01-RC/Sr-02-RC/Sr-03-RC)**

## ARS-032

**Revision 8.5**

**Effective Date: 06-01-2020**
**Last Reviewed: 02-03-2020**

Gabe Culberson

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| REVISION # | DATE OF REVISION | PURPOSE OF REVISION | SECTION AFFECTED |
|---|---|---|---|
| **8.5** | 02-03-2020 | Updated SOP names | Section 2, 11, 24 |
| **8.4** | 10-30-2018 | Update Format | Entire Document |
| **8.3** | 09-06-2018 | Update Reference Method | Cover Sheet, Section 1 |
| **8.2** | 01-29-2018 | Annual Review | None |
| **8.0** | 04-01-2016 | Replace "beaker" with "centrifuge tube." | Section 14.3.2 |

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## 1.0 SCOPE AND APPLICATION, APPLICABLE MATRICES AND DETECTION LIMITS

### 1.1. Scope and Matrices

This procedure establishes the framework and requirements for a laboratory method for separation and measurement of Strontium-89/90 using Sr Resin as prescribed in the Eichrom Technologies Analytical Procedure SRW-01, EPA 905.0. 905.0 Mod & HASL 300 Sr-01-RC..

### 1.2. Application and Detection Limits

1.2.1. This procedure is applicable to all matrices to include but not limited to water, soil, and vegetation

1.2.2. With the assumption of a 12 hour count time and a 1 liter sample for liquids and 0.5 gram sample for solids the following detection limits can be obtained: Liquids = 0.1993 pCi/L and Solids = 0.3985 pCi/g. However, typical counting times are 2 hours or dependent on client specific required detection limits.

## 2.0 REFERENCES

2.1. *ARS-001 Quality Assurance* Manual

2.2. *ARS-013 Nonconformance Reporting and Corrective Action Program*

2.3. *ARS-014 Operational Quality Assurance for Radiochemistry*

2.4. *ML-QA-002-SOP Document Control and Records Management*

2.5 *ARS-059 Review, Validation, and Reporting*

2.5. *ARS-060 Analytical Calculations for Radiochemistry*

2.6. *ARS-134 Project Management Procedure*

2.7. PALA-SR-001-SOP Sample Receiving

2.8. *HSE-001 HS&E Manual*

2.9. *HSE-004 Chemical Hygiene Plan*

2.10. *HSE-005 Waste Handling*

2.11. *RSP-001 Radiation Safety Plan*

2.12. TNI Standard- 2009 and 2016

2.13. DoD/DOE Quality Systems Manual (QSM), Final version 5.3

2.14. OSHA Laboratory Standards Chemical Hygiene Plan 29 CFR 1910.1450

2.15. OSHA Workplace Safety Standards 29 CFR 1910.1926

2.16. U.S. Environmental Protection Agency, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, Method 900.0, EPA-600/4-80-032, August 1980. (see pp 1-10)

2.17. American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 21st Edition, Method 7110B.

2.18. US. Environmental Protection Agency, Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, SW-846, Method 9310, Third Edition.

2.19. Code of Federal Regulations, 40 CFR Section 141.25 "*Analytical methods for radioactivity*".

## 3.0 REQUIREMENTS

### 3.1. Prerequisites

Prior to the performance of this procedure all documents establishing control and handling of the sample must be completed in full. This includes the ARS Chain of Custody Form.

The analyst performing the procedure shall have completed a current Demonstration of Capability (DOC) or shall be under the direct supervision of an analyst with a current DOC.

## 4.0 SUMMARY OF THE TEST METHOD

4.1. Radioactive strontium is separated using Sr Resin prior to gas proportional counting. Cation exchange resin is used to concentrate strontium and other cationic species from samples. Stable strontium is used to monitor method yields and correct results to improve precision and accuracy.

## 5.0 DEFINITIONS

See *ARS-001 Quality Assurance Manual.*

## 6.0 INTERFERENCES

6.1. The presence of more than approximately 0.1mg of elemental strontium in the sample will lead to positive bias in the gravimetric yield determination. This procedure addresses the determination of indigenous strontium, if there are indications that a significant amount of natural strontium is present in the sample.

6.2. Strontium must be separated from interfering isotopes of other elements to enable measurement by beta counting.

6.3. Sr Resin with an 8M $HNO_3$ load solution is used to effectively remove barium-140 and potassium-40 isotopes as well as other matrix interference's.

6.4. Tetravalent plutonium, neptunium, cerium and ruthenium are not removed using nitric acid. When appropriate, these isotopes are effectively removed by including an additional rinse of approximately four free column volumes of 3M HNO3-0.05M oxalic acid.

## 7.0 SAFETY

Safety shall be in accordance with the following:

7.1. *HSE-001 ARS Safety Plan*

7.2. *HSE-004 Chemical Hygiene Plan*

7.3. *RSP-001 ARS Radiation Safety Plan*

7.4. OSHA Laboratory Standards Chemical Hygiene Plan 29 CFR 1910.1450

7.5. OSHA Workplace Safety Standards 29 CFR 1910.R1926

## 8.0 EQUIPMENT AND SUPPLIES

8.1. Gas flow proportional low beta counter

8.2. Column rack – Eichrom part number AC-103 or equivalent or vacuum box assembly

8.3. Column reservoirs - 250 mL to 1 liter volume.

8.4. Column reservoirs - 25 mL, Eichrom part number AC-120 or equivalent.

8.5. Counting dishes - 50.8 mm diameter, 6.4 mm deep, flat bottom, cupped planchet

8.6. Planchets, stainless steel - 2" diameter

8.7. Heat lamp

8.8. Hot plate

8.9. Ion exchange columns - 1 to 1.5 cm diameter, 10 ml resin volume

8.10. Liquid scintillation vials, glass, 20 mL

8.11. Plastic bottle - 1 liter

8.12. Volumetric flask - 1 liter

## 9.0 GLASSWARE CLEANING

See *ARS-001 Quality Assurance Manual.*

## 10.0 REAGENTS AND STANDARDS

All chemicals should be of "reagent-grade" or equivalent whenever they are commercially available.

10.1. Cation exchange resin - C8-B500-M-H, hydrogen form or equivalent, 100 to 200 mesh - available from Eichrom.

10.2. Ethyl alcohol - USP, 100%

10.3. Nitric acid (15.7M) - concentrated nitric acid (sp gr 1.42)

10.4. Nitric acid (3M) - Add 191 mL of concentrated $HNO_3$ (sp gr 1.42) to 800 mL of water and dilute to 1 liter with water.

10.5. Nitric acid (3M) - oxalic acid solution (0.05M) - Add 191 mL of concentrated $HNO_3$ (sp gr 1.42) and add 6.3 grams of oxalic acid dihydrate to 800 mL of water and dilute to 1 liter with water.

10.6. Nitric acid solution (0.05M) - Add 3.2 mL of concentrated nitric acid (sp gr 1.42) to 900 mL of water and dilute to 1 liter with water.

10.7. Nitric acid solution (0.1M) - Add 6.4 mL of concentrated nitric acid (sp gr 1.42) to 900 mL of water and dilute to 1 liter with water.

10.8. Nitric acid solution (8M) - Add 510 mL of concentrated nitric acid (sp gr 1.42) to 400 mL of water and dilute to 1 liter with water.

10.9. Sr Resin – 0.7 grams resin in prepacked columns, or small particle size (50-100 µm) in appropriate size column. Pre-packed cartridges may also be used.

10.10. Strontium (Sr) carrier (5 mg/mL), gravimetric - Dissolve 12.1 grams $Sr(NO_3)_2$ in water and dilute to 1 liter with water.

## 11.0 SAMPLING COLLECTION, PRESERVATION, SHIPMENT AND STORAGE

11.1. A representative sample must be collected from a free-flowing source of drinking water, and should be large enough so that adequate aliquots can be taken to obtain the required sensitivity.

11.2. It is recommended that samples be preserved at the time of collection by adding enough 1N $HNO_3$ to the sample to bring it to pH $\leq 2$ (15 ml 1N $HNO_3$ per liter of sample is usually sufficient). If samples are to be collected without preservation, they should be brought to the laboratory within 5 days, then preserved and held in the original container for a minimum of 16 hours before analysis or transfer of the sample.

11.3. The container choice should be plastic over glass to prevent loss due to breakage during transportation and handling.

11.4. Reference the *PALA-SR-001-SOP Sample Receiving* for further guidance on collection, preservation, shipment and storage.

## 12.0 QUALITY CONTROL

See *ARS-001 Quality Assurance Manual.*

## 13.0 CALIBRATION AND STANDARDIZATION

Counting instrumentation calibration and standardization can be found in *ARS-050 Operation of the Tennelec LB-4100 Alpha/Beta Counting System.*

## 14.0 PROCEDURE

**NOTE 1**: If other matrices other than water are to be analyzed, ensure the proper digestion has been performed and proceed on with the appropriate steps in the procedure.

**NOTE 2**: Ensure the required tracers have been added prior to performing the procedure.

### 14.1. Water Sample Precipitation

14.1.1. If samples larger than 1 liter are analyzed, evaporate the sample to approximately 1 liter.

14.1.2. Measure the sample volume using a standard graduated cylinder (or equivalent) and transfer volume to an appropriate size plastic bottle or volumetric flask.

14.1.3. Verify the samples have been acidified to pH $\leq 2$.

14.1.4. Add 1 ml of 5 mg/ml strontium carrier (for gravimetric yield option) or strontium-85 tracer (for gamma yield determination option) into each sample aliquot.

**NOTE 3:** If client has indicated suspected indigenous strontium, split sample and run 1 sample with carrier and the other without carrier to determine quantity of indigenous strontium present.

**NOTE 4:** Alternatively, evaporation to dryness (when insoluble residues such as calcium sulfate do not form) and calcium carbonate precipitation can be used to concentrate strontium.

### 14.2. Cation Exchange to Concentrate Strontium from Water Samples

14.2.1. Prepare a cation exchange column containing 10 ml of C8-B500-M-H, 100-200 mesh for each sample analyzed.

14.2.2. Place columns on rack with large volume reservoirs (250 ml to 1 liter).

14.2.3. Ensure that a suitable container is below each column.

14.2.4. Add 20 ml of 0.1 M $HNO_3$ to each column to condition columns.

14.2.5. Load each sample onto the appropriate column and allow to drain.

14.2.6. Add 25 ml of 0.1 M $HNO_3$ to each column to rinse.

14.2.7. Discard the feed and rinse the solution collected.

14.2.8. Ensure that a labeled 150 ml beaker is below each column.



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14.2.9. Add 50 ml of 8 M $HNO_3$ to each column to elute strontium.

14.2.10. Place each beaker on a hot plate in a fume hood and evaporate to dryness.

14.3. **Sr Resin Column Preparation**

14.3.1. For each sample, place a Sr Resin column in the column rack.

14.3.2. Place a centrifuge tube below each column.

14.3.3. Attach column reservoirs to each column.

14.3.4. Pipette 5 mL of 8M $HNO_3$ into each column and allow to drain.

14.4. **Sr Resin Column Separation**

14.4.1. Dissolve residue from step 14.2.10 in 10 ml of 8M $HNO_3$.

14.4.2. Transfer each redissolved sample into the appropriate Sr Resin column by pouring or by using a plastic transfer pipette and allow to drain.

14.4.3. Add 5 mL of 8M $HNO_3$ to rinse to each tube/beaker and transfer each solution into the appropriate Sr Resin column and allow to drain.

14.4.4. If $Pu^{+4}$, $Np^{+4}$ or $Ce^{+4}$ may be present, add 5 mL of 3M $HNO_3$ - 0.05M oxalic acid into each column and allow to drain.

**NOTE 5:** The 3M HNO3 - 0.05M oxalic acid removes Pu+4, Np+4 or Ce+4, which are retained by Sr Resin.

14.4.5. Add 5 mL of 8M $HNO_3$ to each column and allow the rinse solution to drain through each column.

**NOTE 6:** This additional 8M $HNO_3$ rinse removes any residual oxalic acid and ensures full removal of $K^+$ and $Ba^{+2}$ that may be present.

14.4.6. Record the time when the last rinse completely drains through each column as the start of yttrium ingrowth. Discard waste solution.

14.4.7. Ensure that labeled plastic vials are below each column.

14.4.8. Pipette 10 mL of 0.05M $HNO_3$ into each column and allow to drain to elute the strontium. Set elute aside.

14.5. **Preparation of Pure Sr-90 and Pure Y-90 for Counter Calibration Sources:**

14.5.1. Add an appropriate volume of calibrated Sr-90 standard solution (in equilibrium with Y-90) to a small beaker, add 1 ml of Sr. Carrier and evaporated the solution to dryness.

14.5.2. Redissolve the residue in 5 mL of 8M $HNO_3$.

14.5.3. Place a beaker below each column.

14.5.4. Pipette 5 ml of 8M $HNO_3$ into each column to condition resin and allow to drain.

14.5.5. Ensure that a clean beaker or vial is below the column.

14.5.6. Transfer the redissolved residue into the appropriate Sr resin column by pouring or by using a plastic transfer pipette and allow to drain.

14.5.7. Add 5 mL of 8M $HNO_3$ to rinse the beaker and transfer the solutions into the appropriate Sr resin column and allow to drain.

14.5.8. Repeat step 14.5.7.

14.5.9. Add 5mL of 8M $HNO_3$ to the Sr resin column and allow to drain. Record separation date and time for start of Y-90 ingrowth.

14.5.10. Place clean beaker under the column.

14.5.11. Add 10 mL of 0.05M $HNO_3$ to the column to elute the Sr-90. Allow to drain.

14.5.12. Prepare Sr-90 from step 14.5.11 for use as a calibration standard by evaporation on a planchet.

**NOTE 7:** Count Sr-90 as soon as possible after separation to minimize Y-90 ingrowth.

14.5.13. Prepare Y-90 from Step 14.5.9 for use as a calibration standard by evaporation on a planchet.

**NOTE 8:** Y-90 must be counted within 24 hours of separation.

14.6. **Gas Proportional Counting Preparation**

14.6.1. For each sample analyzed, clean a counting dish by moistening a paper towel with ethanol, wiping the dish and letting it dry.

14.6.2. Weigh the counting dish(s) on an analytical balance and record the weight.

14.6.3. Place each counting dish on a hot plate under a heat lamp in a hood.

14.6.4. Evaporate the column strip solution from step 14.4.8 onto each dish in successive 3 mL volumes.

14.6.5. Allow each 3 mL volume to evaporate to near dryness between additions.

14.6.6. Rinse the vial containing the column strip solution with 2 mL of 0.05M $HNO_3$ and transfer to the counting dish.

14.6.7. After all the solution has evaporated to dryness, cool each dish.

14.6.8. Reweigh each counting dish, and record the weight.

14.6.9. Transfer to Count Room and count samples sufficient time to achieve the desired counting statistics and minimum detectable concentration.

14.6.10. After total strontium has been counted, set the planchets aside in a safe place during the Y-90 ingrowth period.

14.7. **Y-90 Isolation after Ingrowth**

**NOTE 9**: If Sr-89 is known to be absent, Sr-90 can be measured with a single count. However, if Sr-89 is present, Sr-90 is measured by isolating Y-90 using this section and counting the Y-90.

14.7.1. Add 5 mL of 8M $HNO_3$ and allow to drain to condition a new column. Discard waste.

14.7.2. Ensure that a clean beaker or vial is below the column.

14.7.3. After yttrium ingrowth of approximately 1 week, redissolve the evaporated Sr residue in up to 15 mL of 8M $HNO_3$. Transfer the solution into the appropriate Sr Resin column and allow to drain.

**NOTE 10**: This dissolution may be performed as follows: Place the planchet in a clean, dry 150 mL glass beaker. Add 5 mL of 8M $HNO_3$ to redissolve the residue, warm gently, and swirl. Remove the planchet with a pair of tweezers and rinse any remaining residue.

14.7.4. Add 5 ml of 8M $HNO_3$ to rinse the beaker and transfer each solution into the Sr Resin column and allow to drain.

14.7.5. Record the date and time of the completion of last rinse as the start time for yttrium decay.

14.7.6. Prepare the Y-90 solution for counting as appropriate depending on the counting method used (section 14.5) and assume a 100% yield of Y-90.

## 15.0 CALCULATIONS

See *ARS-060 Analytical Calculations.*

## 16.0 MDA/MDC ASSESSMENT

See *ARS-060 Analytical Calculations.*

## 17.0 PRECISION AND ACCURACY

See *ARS-014 Operational Quality Assurance for Radiochemistry* and *ARS-060 Analytical Calculations.*

## 18.0 METHOD PERFORMANCE

See *ARS-001 Quality Assurance Manual.*

## 19.0 POLLUTION PREVENTION

See *ARS-001 Quality Assurance Manual.*

## 20.0 DATA ASSESSMENT AND ACCEPTANCE CRITERIA FOR QUALITY CONTROL MEASURES

See ARS-014 *Operational Quality Assurance for Radiochemistry.*

## 21.0 CORRECTIVE ACTIONS FOR OUT-OF-CONTROL DATA

See *ARS-013 Nonconformance Reporting and Corrective Action Program.*

## 22.0 CONTINGENCIES FOR HANDLING OUT-OF-CONTROL OR UNACCEPTABLE DATA

See *ARS-013 Nonconformance Reporting and Corrective Action Program.*

## 23.0 WASTE MANAGEMENT

See *ARS-001 Quality Assurance Manual* and *HSE-005 Waste Handling Procedures.*

## 24.0 RECORDS, REPORTS, AND NOTIFICATIONS

24.1. The Laboratory Technician performing the analysis shall be responsible for the data entry and completion of the appropriate checklist, see *ARS-059 Review, Validation, and Reporting.*

24.2. The Project Manager, Quality Assurance Manager and Laboratory Director shall ensure that the forms are properly completed.

24.3. Records shall be controlled in accordance with *ML-QA-002-SOP Document Control and Records Management.*

## 25.0 REPORTING RESULTS

See *ARS-059 Review, Validation, and Reporting.*

## 26.0 BIBLIOGRAPHY

N/A

# ATTACHMENT 2 – LABORATORY CERTIFICATIONS

ANSI National Accreditation Board

# CERTIFICATE OF ACCREDITATION

## The ANSI National Accreditation Board

Hereby attests that

## ARS Aleut Analytical, LLC

**2609 North River Road**
**Port Allen, Louisiana 70767**

Fulfills the requirements of

## ISO/IEC 17025:2017

and the

**U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V5.3)**

In the field of

## TESTING

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 12 October 2022
Certificate Number: ADE-1489

ANSI National Accreditation Board

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

ANSI National Accreditation Board

# SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017 AND U.S. DEPARTMENT OF DEFENSE (DOD) QUALITY SYSTEMS MANUAL FOR ENVIRONMENTAL LABORATORIES (DOD QSM V 5.3)


**ARS Aleut Analytical, LLC**
2609 North River Road
Port Allen, Louisiana 70767
Gabe Culberson
225-381-2991


## TESTING

Valid to: **October 12, 2022** Certificate Number: **ADE-1489**

**Environmental**

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Actinium-228 |
| Gamma Spectroscopy | EPA 901.1 | Americium-241 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-122 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-124 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-125 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-126 |
| Gamma Spectroscopy | EPA 901.1 | Arsenic-73 |
| Gamma Spectroscopy | EPA 901.1 | Arsenic-74 |
| Gamma Spectroscopy | EPA 901.1 | Arsenic-76 |
| Gamma Spectroscopy | EPA 901.1 | Barium-133 |
| Gamma Spectroscopy | EPA 901.1 | Barium-140 |
| Gamma Spectroscopy | EPA 901.1 | Beryllium-7 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-207 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-211 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-212 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-214 |
| Gamma Spectroscopy | EPA 901.1 | Cadmium-109 |
| Gamma Spectroscopy | EPA 901.1 | Cerium-139 |
| Gamma Spectroscopy | EPA 901.1 | Cerium-141 |

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| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Cerium-144 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-129 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-134 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-136 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-137 |
| Gamma Spectroscopy | EPA 901.1 | Chromium-51 |
| Gamma Spectroscopy | EPA 901.1 | Cobalt-57 |
| Gamma Spectroscopy | EPA 901.1 | Cobalt-58 |
| Gamma Spectroscopy | EPA 901.1 | Cobalt-60 |
| Gamma Spectroscopy | EPA 901.1 | Europium-152 |
| Gamma Spectroscopy | EPA 901.1 | Europium-154 |
| Gamma Spectroscopy | EPA 901.1 | Europium-155 |
| Gamma Spectroscopy | EPA 901.1 | Gadolinium-153 |
| Gamma Spectroscopy | EPA 901.1 | Gallium-67 |
| Gamma Spectroscopy | EPA 901.1 | Gold-196 |
| Gamma Spectroscopy | EPA 901.1 | Gold-198 |
| Gamma Spectroscopy | EPA 901.1 | Hafnium-181 |
| Gamma Spectroscopy | EPA 901.1 | Indium-113m |
| Gamma Spectroscopy | EPA 901.1 | Iodine-123 |
| Gamma Spectroscopy | EPA 901.1 | Iodine-125 |
| Gamma Spectroscopy | EPA 901.1 | Iodine-129 |
| Gamma Spectroscopy | EPA 901.1 | Iodine-131 |
| Gamma Spectroscopy | EPA 901.1 | Iridium-192 |
| Gamma Spectroscopy | EPA 901.1 | Iron-59 |
| Gamma Spectroscopy | EPA 901.1 | Lanthanum-140 |
| Gamma Spectroscopy | EPA 901.1 | Lead-210 |
| Gamma Spectroscopy | EPA 901.1 | Lead-212 |
| Gamma Spectroscopy | EPA 901.1 | Lead-214 |
| Gamma Spectroscopy | EPA 901.1 | Lutetium-177 |
| Gamma Spectroscopy | EPA 901.1 | Manganese-54 |
| Gamma Spectroscopy | EPA 901.1 | Mercury-197 |
| Gamma Spectroscopy | EPA 901.1 | Mercury-203 |
| Gamma Spectroscopy | EPA 901.1 | Molybdenum-99 |
| Gamma Spectroscopy | EPA 901.1 | Neodymium-147 |
| Gamma Spectroscopy | EPA 901.1 | Neptunium-237 |

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ANSI National Accreditation Board

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Niobium-94 |
| Gamma Spectroscopy | EPA 901.1 | Niobium-95 |
| Gamma Spectroscopy | EPA 901.1 | Polonium-210 |
| Gamma Spectroscopy | EPA 901.1 | Potassium-40 |
| Gamma Spectroscopy | EPA 901.1 | Promethium-144 |
| Gamma Spectroscopy | EPA 901.1 | Promethium-146 |
| Gamma Spectroscopy | EPA 901.1 | Protactinium-234 |
| Gamma Spectroscopy | EPA 901.1 | Radium-223 |
| Gamma Spectroscopy | EPA 901.1 | Radium-224 |
| Gamma Spectroscopy | EPA 901.1 | Radium-226 |
| Gamma Spectroscopy | EPA 901.1 | Radium-228 |
| Gamma Spectroscopy | EPA 901.1 | Rubidium-83 |
| Gamma Spectroscopy | EPA 901.1 | Rubidium-86 |
| Gamma Spectroscopy | EPA 901.1 | Ruthenium-103 |
| Gamma Spectroscopy | EPA 901.1 | Ruthenium-106 |
| Gamma Spectroscopy | EPA 901.1 | Scandium-46 |
| Gamma Spectroscopy | EPA 901.1 | Selenium-72 |
| Gamma Spectroscopy | EPA 901.1 | Selenium-75 |
| Gamma Spectroscopy | EPA 901.1 | Silver-108m |
| Gamma Spectroscopy | EPA 901.1 | Silver-110m |
| Gamma Spectroscopy | EPA 901.1 | Sodium-22 |
| Gamma Spectroscopy | EPA 901.1 | Strontium-85 |
| Gamma Spectroscopy | EPA 901.1 | Tantalum-182 |
| Gamma Spectroscopy | EPA 901.1 | Tellurium-132 |
| Gamma Spectroscopy | EPA 901.1 | Terbium-160 |
| Gamma Spectroscopy | EPA 901.1 | Thallium-208 |
| Gamma Spectroscopy | EPA 901.1 | Thallium-210 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-227 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-228 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-231 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-234 |
| Gamma Spectroscopy | EPA 901.1 | Tin-113 |
| Gamma Spectroscopy | EPA 901.1 | Total NORM Activity |
| Gamma Spectroscopy | EPA 901.1 | Total NORM GAMMA |
| Gamma Spectroscopy | EPA 901.1 | Uranium-235 |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Uranium-238 |
| Gamma Spectroscopy | EPA 901.1 | Xenon-131m |
| Gamma Spectroscopy | EPA 901.1 | Xenon-133m |
| Gamma Spectroscopy | EPA 901.1 | Ytterbium-169 |
| Gamma Spectroscopy | EPA 901.1 | Ytterbium-175 |
| Gamma Spectroscopy | EPA 901.1 | Yttrium-88 |
| Gamma Spectroscopy | EPA 901.1 | Yttrium-91 |
| Gamma Spectroscopy | EPA 901.1 | Zinc-65 |
| Gamma Spectroscopy | EPA 901.1 | Zirconium-95 |
| Gamma Spectroscopy | SM 7120B | Actinium-228 |
| Gamma Spectroscopy | SM 7120B | Americium-241 |
| Gamma Spectroscopy | SM 7120B | Antimony-122 |
| Gamma Spectroscopy | SM 7120B | Antimony-124 |
| Gamma Spectroscopy | SM 7120B | Antimony-125 |
| Gamma Spectroscopy | SM 7120B | Antimony-126 |
| Gamma Spectroscopy | SM 7120B | Arsenic-73 |
| Gamma Spectroscopy | SM 7120B | Arsenic-74 |
| Gamma Spectroscopy | SM 7120B | Arsenic-76 |
| Gamma Spectroscopy | SM 7120B | Barium-133 |
| Gamma Spectroscopy | SM 7120B | Barium-140 |
| Gamma Spectroscopy | SM 7120B | Beryllium-7 |
| Gamma Spectroscopy | SM 7120B | Bismuth-207 |
| Gamma Spectroscopy | SM 7120B | Bismuth-211 |
| Gamma Spectroscopy | SM 7120B | Bismuth-212 |
| Gamma Spectroscopy | SM 7120B | Bismuth-214 |
| Gamma Spectroscopy | SM 7120B | Cadmium-109 |
| Gamma Spectroscopy | SM 7120B | Cerium-139 |
| Gamma Spectroscopy | SM 7120B | Cerium-141 |
| Gamma Spectroscopy | SM 7120B | Cerium-144 |
| Gamma Spectroscopy | SM 7120B | Cesium-129 |
| Gamma Spectroscopy | SM 7120B | Cesium-134 |
| Gamma Spectroscopy | SM 7120B | Cesium-136 |
| Gamma Spectroscopy | SM 7120B | Cesium-137 |
| Gamma Spectroscopy | SM 7120B | Chromium-51 |
| Gamma Spectroscopy | SM 7120B | Cobalt-57 |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | SM 7120B | Cobalt-58 |
| Gamma Spectroscopy | SM 7120B | Cobalt-60 |
| Gamma Spectroscopy | SM 7120B | Europium-152 |
| Gamma Spectroscopy | SM 7120B | Europium-154 |
| Gamma Spectroscopy | SM 7120B | Europium-155 |
| Gamma Spectroscopy | SM 7120B | Gadolinium-153 |
| Gamma Spectroscopy | SM 7120B | Gallium-67 |
| Gamma Spectroscopy | SM 7120B | Gold-196 |
| Gamma Spectroscopy | SM 7120B | Gold-198 |
| Gamma Spectroscopy | SM 7120B | Hafnium-181 |
| Gamma Spectroscopy | SM 7120B | Indium-113m |
| Gamma Spectroscopy | SM 7120B | Iodine-123 |
| Gamma Spectroscopy | SM 7120B | Iodine-125 |
| Gamma Spectroscopy | SM 7120B | Iodine-129 |
| Gamma Spectroscopy | SM 7120B | Iodine-131 |
| Gamma Spectroscopy | SM 7120B | Iridium-192 |
| Gamma Spectroscopy | SM 7120B | Iron-59 |
| Gamma Spectroscopy | SM 7120B | Lanthanum-140 |
| Gamma Spectroscopy | SM 7120B | Lead-210 |
| Gamma Spectroscopy | SM 7120B | Lead-212 |
| Gamma Spectroscopy | SM 7120B | Lead-214 |
| Gamma Spectroscopy | SM 7120B | Lutetium-177 |
| Gamma Spectroscopy | SM 7120B | Manganese-54 |
| Gamma Spectroscopy | SM 7120B | Mercury-197 |
| Gamma Spectroscopy | SM 7120B | Mercury-203 |
| Gamma Spectroscopy | SM 7120B | Molybdenum-99 |
| Gamma Spectroscopy | SM 7120B | Neodymium-147 |
| Gamma Spectroscopy | SM 7120B | Neptunium-237 |
| Gamma Spectroscopy | SM 7120B | Niobium-94 |
| Gamma Spectroscopy | SM 7120B | Niobium-95 |
| Gamma Spectroscopy | SM 7120B | Polonium-210 |
| Gamma Spectroscopy | SM 7120B | Potassium-40 |
| Gamma Spectroscopy | SM 7120B | Promethium-144 |
| Gamma Spectroscopy | SM 7120B | Promethium-146 |
| Gamma Spectroscopy | SM 7120B | Protactinium-234 |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | SM 7120B | Radium-223 |
| Gamma Spectroscopy | SM 7120B | Radium-224 |
| Gamma Spectroscopy | SM 7120B | Radium-226 |
| Gamma Spectroscopy | SM 7120B | Radium-228 |
| Gamma Spectroscopy | SM 7120B | Rubidium-83 |
| Gamma Spectroscopy | SM 7120B | Rubidium-86 |
| Gamma Spectroscopy | SM 7120B | Ruthenium-103 |
| Gamma Spectroscopy | SM 7120B | Ruthenium-106 |
| Gamma Spectroscopy | SM 7120B | Scandium-46 |
| Gamma Spectroscopy | SM 7120B | Selenium-72 |
| Gamma Spectroscopy | SM 7120B | Selenium-75 |
| Gamma Spectroscopy | SM 7120B | Silver-108m |
| Gamma Spectroscopy | SM 7120B | Silver-110m |
| Gamma Spectroscopy | SM 7120B | Sodium-22 |
| Gamma Spectroscopy | SM 7120B | Strontium-85 |
| Gamma Spectroscopy | SM 7120B | Tantalum-182 |
| Gamma Spectroscopy | SM 7120B | Tellurium-132 |
| Gamma Spectroscopy | SM 7120B | Terbium-160 |
| Gamma Spectroscopy | SM 7120B | Thallium-208 |
| Gamma Spectroscopy | SM 7120B | Thallium-210 |
| Gamma Spectroscopy | SM 7120B | Thorium-227 |
| Gamma Spectroscopy | SM 7120B | Thorium-228 |
| Gamma Spectroscopy | SM 7120B | Thorium-231 |
| Gamma Spectroscopy | SM 7120B | Thorium-234 |
| Gamma Spectroscopy | SM 7120B | Tin-113 |
| Gamma Spectroscopy | SM 7120B | Total NORM Activity |
| Gamma Spectroscopy | SM 7120B | Total NORM GAMMA |
| Gamma Spectroscopy | SM 7120B | Uranium-235 |
| Gamma Spectroscopy | SM 7120B | Uranium-238 |
| Gamma Spectroscopy | SM 7120B | Xenon-131m |
| Gamma Spectroscopy | SM 7120B | Xenon-133m |
| Gamma Spectroscopy | SM 7120B | Ytterbium-169 |
| Gamma Spectroscopy | SM 7120B | Ytterbium-175 |
| Gamma Spectroscopy | SM 7120B | Yttrium-88 |
| Gamma Spectroscopy | SM 7120B | Yttrium-91 |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | SM 7120B | Zinc-65 |
| Gamma Spectroscopy | SM 7120B | Zirconium-95 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Actinium-228 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Americium-241 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony 122 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-124 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-125 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-126 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Arsenic-73 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Arsenic-74 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Arsenic-76 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Barium-133 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Barium-140 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Beryllium-7 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-207 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-211 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-212 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-214 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cadmium-109 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cerium-139 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cerium-141 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cerium-144 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-129 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-134 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-136 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-137 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Chromium-51 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cobalt-57 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cobalt-58 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cobalt-60 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Europium-152 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Europium-154 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Europium-155 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gadolinium-153 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gallium-67 |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gold-196 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gold-198 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Hafnium-181 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Indium-113m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-123 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-125 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-129 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-131 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iridium-192 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iron-59 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lanthanum-140 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lead-210 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lead-212 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lead-214 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lutetium-177 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Manganese-54 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Mercury-197 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Mercury-203 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Molybdenum-99 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Neodymium-147 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Neptunium-237 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Niobium-94 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Niobium-95 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Polonium-210 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Potassium-40 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Promethium-144 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Promethium-146 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Protactinium-234 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-223 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-224 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-226 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-228 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Rubidium-83 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Rubidium-86 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ruthenium-103 |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ruthenium-106 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Scandium-46 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Selenium-72 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Selenium-75 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Silver-108m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Silver-110m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Sodium-22 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Strontium-85 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Tantalum-182 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Tellurium-132 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Terbium-160 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thallium-208 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thallium-210 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-227 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-228 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-231 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-234 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Tin-113 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Total NORM Activity |
| Gamma Spectroscopy | HASL 300 GA-01-R | Total NORM GAMMA |
| Gamma Spectroscopy | HASL 300 GA-01-R | Uranium-235 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Uranium-238 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Xenon-131m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Xenon-133m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ytterbium-169 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ytterbium-175 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Yttrium-88 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Yttrium-91 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Zinc-65 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Zirconium-95 |
| Gas Flow Proportional Counter | ARS 019 – Carbon-14 in Water | Carbon-14 |
| Gas Flow Proportional Counter | EPA 900.0 | Gross-alpha |
| Gas Flow Proportional Counter | EPA 9310 | Gross-alpha |
| Gas Flow Proportional Counter | EPA 900.0 | Gross-beta |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gas Flow Proportional Counter | EPA 9310 | Gross-beta |
| Gas Flow Proportional Counter | EPA 903.0 | Radium-226 |
| Gas Flow Proportional Counter | EPA 9315 | Radium-226 |
| Gas Flow Proportional Counter | EPA 904.0 | Radium-228 |
| Gas Flow Proportional Counter | EPA 9320 | Radium-228 |
| Gas Flow Proportional Counter | Eichrom OTW01 | Lead-210 |
| Gas Flow Proportional Counter | EPA 905 Mod | Strontium-89 |
| Gas Flow Proportional Counter | Eichrom SRW01 | Strontium-89 |
| Gas Flow Proportional Counter | HASL 300 SR-01-RC | Strontium-89 |
| Gas Flow Proportional Counter | EPA 905 | Strontium-90 |
| Gas Flow Proportional Counter | Eichrom SRW01 | Strontium-90 |
| Gas Flow Proportional Counter | HASL 300 Sr-02-RC | Strontium-90 |
| Liquid Scintillation | ARS-040 Tritium in Water by Electrolytic Enrichment | Low Level Tritium |
| Liquid Scintillation | EPA 906.0 | Tritium |
| Liquid Scintillation | ARS 151 – Use of Pyrolyser for H-3, C-14 | Tritium |
| Liquid Scintillation | ARS 151 – Use of Pyrolyser for H-3, C-14 | Carbon-14 |
| Liquid Scintillation | Eichrom TCW02 | Technetium 99 |
| Alpha Scintillation | EPA 903.1 | Radium-226 |
| Alpha Spectroscopy | Eichrom ACW03 | Americium 241 |
| Alpha Spectroscopy | HASL 300 Se-03 | Americium-241 |
| Alpha Spectroscopy | HASL 300 Am-03-RC | Americium-241 |
| Alpha Spectroscopy | Eichrom ACW03 | Plutonium 238 |
| Alpha Spectroscopy | HASL 300 Se-03 | Plutonium-238 |
| Alpha Spectroscopy | HASL 300 Pu-10-RC | Plutonium-238 |
| Alpha Spectroscopy | Eichrom ACW03 | Plutonium-239/240 |
| Alpha Spectroscopy | HASL 300 Se-03 | Plutonium-239/240 |
| Alpha Spectroscopy | HASL 300 Pu-10-RC | Plutonium-239/240 |
| Alpha Spectroscopy | Eichrom ACW03 | Plutonium-241 |
| Alpha Spectroscopy | HASL 300 Se-03 | Plutonium-241 |
| Alpha Spectroscopy | HASL 300 Pu-10-RC | Plutonium-241 |
| Alpha Spectroscopy | Eichrom ACW03 | Uranium-234 |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Alpha Spectroscopy | HASL 300 Se-03 | Uranium-234 |
| Alpha Spectroscopy | Eichrom ACW03 | Uranium-235 |
| Alpha Spectroscopy | HASL 300 Se-03 | Uranium-235 |
| Alpha Spectroscopy | Eichrom ACW03 | Uranium-238 |
| Alpha Spectroscopy | HASL 300 Se-03 | Uranium-238 |
| Alpha Spectroscopy | Eichrom ACW10 | Thorium-228 |
| Alpha Spectroscopy | Eichrom ACW10 | Thorium-230 |
| Alpha Spectroscopy | Eichrom ACW10 | Thorium-232 |
| ICP-OES | EPA 6010D | Aluminum |
| ICP-OES | EPA 6010D | Boron |
| ICP-OES | EPA 6010D | Calcium |
| ICP-OES | EPA 6010D | Iron |
| ICP-OES | EPA 6010D | Magnesium |
| ICP-OES | EPA 6010D | Potassium |
| ICP-OES | EPA 6010D | Silicon |
| ICP-OES | EPA 6010D | Sodium |
| ICP-OES | EPA 6010D | Strontium |
| ICP-OES | EPA 6010D | Titanium |
| ICP/MS | EPA 6020B | Antimony |
| ICP/MS | EPA 6020B | Arsenic |
| ICP/MS | EPA 6020B | Barium |
| ICP/MS | EPA 6020B | Beryllium |
| ICP/MS | EPA 6020B | Cadmium |
| ICP/MS | EPA 6020B | Chromium |
| ICP/MS | EPA 6020B | Cobalt |
| ICP/MS | EPA 6020B | Copper |
| ICP/MS | EPA 6020B | Lead |
| ICP/MS | EPA 6020B | Manganese |
| ICP/MS | EPA 6020B | Molybdenum |
| ICP/MS | EPA 6020B | Nickel |
| ICP/MS | EPA 6020B | Selenium |
| ICP/MS | EPA 6020B | Silver |
| ICP/MS | EPA 6020B | Thallium |
| ICP/MS | EPA 6020B | Total Uranium |
| ICP/MS | EPA 6020B | Uranium |

| Non-Potable Water | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| ICP/MS | EPA 6020B | Vanadium |
| ICP/MS | EPA 6020B | Zinc |
| Mercury CVAA | EPA 7470A | Mercury |
| GC/ECD | EPA 8082A | Aroclor-1016 (PCB-1016) |
| GC/ECD | EPA 8082A | Aroclor-1260 (PCB-1260) |
| **Preparation** | **Method** | **Type** |
| SVOA/PCB Prep | SW846-3510C | Separatory Funnel Liquid-Liquid extraction |
| Metals Prep | EPA 200.2 | Extraction |
| Metals Prep | EPA 3010A | Acid Digestion |
| Metals Prep | EPA 3050B | Acid Digestion |
| RAD Prep | HASL 300 G-02 | Electrodeposition of the Actinides |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Actinium-228 |
| Gamma Spectroscopy | EPA 901.1 | Americium-241 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-122 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-124 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-125 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-126 |
| Gamma Spectroscopy | EPA 901.1 | Arsenic-73 |
| Gamma Spectroscopy | EPA 901.1 | Arsenic-74 |
| Gamma Spectroscopy | EPA 901.1 | Arsenic-76 |
| Gamma Spectroscopy | EPA 901.1 | Barium-133 |
| Gamma Spectroscopy | EPA 901.1 | Barium-140 |
| Gamma Spectroscopy | EPA 901.1 | Beryllium-7 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-207 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-211 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-212 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-214 |
| Gamma Spectroscopy | EPA 901.1 | Cadmium-109 |
| Gamma Spectroscopy | EPA 901.1 | Cerium-139 |
| Gamma Spectroscopy | EPA 901.1 | Cerium-141 |
| Gamma Spectroscopy | EPA 901.1 | Cerium-144 |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Cesium-129 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-134 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-136 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-137 |
| Gamma Spectroscopy | EPA 901.1 | Chromium-51 |
| Gamma Spectroscopy | EPA 901.1 | Cobalt-57 |
| Gamma Spectroscopy | EPA 901.1 | Cobalt-58 |
| Gamma Spectroscopy | EPA 901.1 | Cobalt-60 |
| Gamma Spectroscopy | EPA 901.1 | Europium-152 |
| Gamma Spectroscopy | EPA 901.1 | Europium-154 |
| Gamma Spectroscopy | EPA 901.1 | Europium-155 |
| Gamma Spectroscopy | EPA 901.1 | Gadolinium-153 |
| Gamma Spectroscopy | EPA 901.1 | Gallium-67 |
| Gamma Spectroscopy | EPA 901.1 | Gold-196 |
| Gamma Spectroscopy | EPA 901.1 | Gold-198 |
| Gamma Spectroscopy | EPA 901.1 | Hafnium-181 |
| Gamma Spectroscopy | EPA 901.1 | Indium-113m |
| Gamma Spectroscopy | EPA 901.1 | Iodine-123 |
| Gamma Spectroscopy | EPA 901.1 | Iodine-125 |
| Gamma Spectroscopy | EPA 901.1 | Iodine-129 |
| Gamma Spectroscopy | EPA 901.1 | Iodine-131 |
| Gamma Spectroscopy | EPA 901.1 | Iridium-192 |
| Gamma Spectroscopy | EPA 901.1 | Iron-59 |
| Gamma Spectroscopy | EPA 901.1 | Lanthanum-140 |
| Gamma Spectroscopy | EPA 901.1 | Lead-210 |
| Gamma Spectroscopy | EPA 901.1 | Lead-212 |
| Gamma Spectroscopy | EPA 901.1 | Lead-214 |
| Gamma Spectroscopy | EPA 901.1 | Lutetium-177 |
| Gamma Spectroscopy | EPA 901.1 | Manganese-54 |
| Gamma Spectroscopy | EPA 901.1 | Mercury-197 |
| Gamma Spectroscopy | EPA 901.1 | Mercury-203 |
| Gamma Spectroscopy | EPA 901.1 | Molybdenum-99 |
| Gamma Spectroscopy | EPA 901.1 | Neodymium-147 |
| Gamma Spectroscopy | EPA 901.1 | Neptunium-237 |
| Gamma Spectroscopy | EPA 901.1 | Niobium-94 |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Niobium-95 |
| Gamma Spectroscopy | EPA 901.1 | Polonium-210 |
| Gamma Spectroscopy | EPA 901.1 | Potassium-40 |
| Gamma Spectroscopy | EPA 901.1 | Promethium-144 |
| Gamma Spectroscopy | EPA 901.1 | Promethium-146 |
| Gamma Spectroscopy | EPA 901.1 | Protactinium-234 |
| Gamma Spectroscopy | EPA 901.1 | Radium-223 |
| Gamma Spectroscopy | EPA 901.1 | Radium-224 |
| Gamma Spectroscopy | EPA 901.1 | Radium-226 |
| Gamma Spectroscopy | EPA 901.1 | Radium-228 |
| Gamma Spectroscopy | EPA 901.1 | Rubidium-83 |
| Gamma Spectroscopy | EPA 901.1 | Rubidium-86 |
| Gamma Spectroscopy | EPA 901.1 | Ruthenium-103 |
| Gamma Spectroscopy | EPA 901.1 | Ruthenium-106 |
| Gamma Spectroscopy | EPA 901.1 | Scandium-46 |
| Gamma Spectroscopy | EPA 901.1 | Selenium-72 |
| Gamma Spectroscopy | EPA 901.1 | Selenium-75 |
| Gamma Spectroscopy | EPA 901.1 | Silver-108m |
| Gamma Spectroscopy | EPA 901.1 | Silver-110m |
| Gamma Spectroscopy | EPA 901.1 | Sodium-22 |
| Gamma Spectroscopy | EPA 901.1 | Strontium-85 |
| Gamma Spectroscopy | EPA 901.1 | Tantalum-182 |
| Gamma Spectroscopy | EPA 901.1 | Tellurium-132 |
| Gamma Spectroscopy | EPA 901.1 | Terbium-160 |
| Gamma Spectroscopy | EPA 901.1 | Thallium-208 |
| Gamma Spectroscopy | EPA 901.1 | Thallium-210 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-227 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-228 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-231 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-234 |
| Gamma Spectroscopy | EPA 901.1 | Tin-113 |
| Gamma Spectroscopy | EPA 901.1 | Total NORM Activity |
| Gamma Spectroscopy | EPA 901.1 | Total NORM GAMMA |
| Gamma Spectroscopy | EPA 901.1 | Uranium-235 |
| Gamma Spectroscopy | EPA 901.1 | Uranium-238 |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Xenon-131m |
| Gamma Spectroscopy | EPA 901.1 | Xenon-133m |
| Gamma Spectroscopy | EPA 901.1 | Ytterbium-169 |
| Gamma Spectroscopy | EPA 901.1 | Ytterbium-175 |
| Gamma Spectroscopy | EPA 901.1 | Yttrium-88 |
| Gamma Spectroscopy | EPA 901.1 | Yttrium-91 |
| Gamma Spectroscopy | EPA 901.1 | Zinc-65 |
| Gamma Spectroscopy | EPA 901.1 | Zirconium-95 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Actinium-228 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Americium-241 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-122 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-124 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-125 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-126 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Arsenic-73 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Arsenic-74 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Arsenic-76 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Barium-133 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Barium-140 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Beryllium-7 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-207 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-211 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-212 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-214 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cadmium-109 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cerium-139 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cerium-141 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cerium-144 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-129 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-134 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-136 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-137 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Chromium-51 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cobalt-57 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cobalt-58 |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cobalt-60 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Europium-152 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Europium-154 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Europium-155 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gadolinium-153 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gallium-67 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gold-196 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gold-198 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Hafnium-181 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Indium-113m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-123 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-125 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-129 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-131 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iridium-192 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iron-59 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lanthanum-140 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lead-210 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lead-212 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lead-214 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lutetium-177 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Manganese-54 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Mercury-197 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Mercury-203 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Molybdenum-99 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Neodymium-147 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Neptunium-237 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Niobium-94 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Niobium-95 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Polonium-210 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Potassium-40 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Promethium-144 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Promethium-146 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Protactinium-234 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-223 |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-224 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-226 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-228 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Rubidium-83 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Rubidium-86 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ruthenium-103 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ruthenium-106 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Scandium-46 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Selenium-72 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Selenium-75 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Silver-108m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Silver-110m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Sodium-22 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Strontium-85 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Tantalum-182 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Tellurium-132 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Terbium-160 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thallium-208 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thallium-210 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-227 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-228 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-231 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-234 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Tin-113 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Total NORM Activity |
| Gamma Spectroscopy | HASL 300 GA-01-R | Total NORM GAMMA |
| Gamma Spectroscopy | HASL 300 GA-01-R | Uranium-235 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Uranium-238 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Xenon-131m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Xenon-133m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ytterbium-169 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ytterbium-175 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Yttrium-88 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Yttrium-91 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Zinc-65 |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | HASL 300 GA-01-R | Zirconium-95 |
| Gas Flow Proportional Counter | EPA 900.0 Mod | Gross-alpha |
| Gas Flow Proportional Counter | EPA 9310 | Gross-alpha |
| Gas Flow Proportional Counter | EPA 900.0 Mod | Gross-beta |
| Gas Flow Proportional Counter | EPA 9310 | Gross-beta |
| Gas Flow Proportional Counter | Eichrom SRW01 | Strontium-89 |
| Gas Flow Proportional Counter | EPA 905.0 Mod | Strontium-89 |
| Gas Flow Proportional Counter | HASL 300 SR-01-RC | Strontium-89 |
| Gas Flow Proportional Counter | Eichrom SRW01 | Strontium-90 |
| Gas Flow Proportional Counter | EPA 905.0 Mod | Strontium-90 |
| Gas Flow Proportional Counter | HASL 300 SR-02-RC | Strontium-90 |
| Liquid Scintillation | EPA 906.0 Mod | Tritium |
| Liquid Scintillation/Pyrolysis | ARS 151 – Use of Pyrolyser for H-3, C-14 | Tritium |
| Liquid Scintillation | Eichrom TCS01 | Technetium-99 |
| Liquid Scintillation/Pyrolysis | ARS 151 – Use of Pyrolyser for H-3 | Carbon-14 |
| Alpha Spectroscopy | Eichrom ACW03 | Americium-241 |
| Alpha Spectroscopy | HASL 300 Se-03 | Americium-241 |
| Alpha Spectroscopy | HASL 300 Am-01-RC | Americium-241 |
| Alpha Spectroscopy | Eichrom ACW03 | Plutonium-238 |
| Alpha Spectroscopy | HASL 300 Se-03 | Plutonium-238 |
| Alpha Spectroscopy | HASL 300 Pu-02-RC | Plutonium-238 |
| Alpha Spectroscopy | HASL 300 Pu-03-RC | Plutonium-238 |
| Alpha Spectroscopy | Eichrom ACW03 | Plutonium-239/240 |
| Alpha Spectroscopy | HASL 300 Se-03 | Plutonium-239/240 |
| Alpha Spectroscopy | HASL 300 Pu-02-RC | Plutonium-239/240 |
| Alpha Spectroscopy | HASL 300 Pu-03-RC | Plutonium-239/240 |
| Alpha Spectroscopy | Eichrom ACW03 | Plutonium-241 |
| Alpha Spectroscopy | HASL 300 Se-03 | Plutonium-241 |
| Alpha Spectroscopy | HASL 300 Pu-02-RC | Plutonium-241 |
| Alpha Spectroscopy | HASL 300 Pu-03-RC | Plutonium-241 |
| Alpha Spectroscopy | Eichrom ACW03 | Uranium-234 |



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| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Alpha Spectroscopy | HASL 300 Se-03 | Uranium-234 |
| Alpha Spectroscopy | HASL 300 U-02-RC | Uranium-234 |
| Alpha Spectroscopy | HASL 300 U-04-RC | Uranium-234 |
| Alpha Spectroscopy | Eichrom ACW03 | Uranium-235 |
| Alpha Spectroscopy | HASL 300 Se-03 | Uranium-235 |
| Alpha Spectroscopy | HASL 300 U-02-RC | Uranium-235 |
| Alpha Spectroscopy | HASL 300 U-04-RC | Uranium-235 |
| Alpha Spectroscopy | Eichrom ACW03 VBS<br>HASL 300 Se-03<br>HASL 300 U-02<br>HASL 300 U-04 | Uranium-238 |
| Alpha Spectroscopy | HASL 300 Se-03 | Uranium-238 |
| Alpha Spectroscopy | HASL 300 U-02-RC | Uranium-238 |
| Alpha Spectroscopy | HASL 300 U-04-RC | Uranium-238 |
| Alpha Spectroscopy | Eichrom ACW10 | Thorium-228 |
| Alpha Spectroscopy | Eichrom ACW10 | Thorium-230 |
| Alpha Spectroscopy | Eichrom ACW10 | Thorium-232 |
| ICP-OES | EPA 6010D | Aluminum |
| ICP-OES | EPA 6010D | Boron |
| ICP-OES | EPA 6010D | Calcium |
| ICP-OES | EPA 6010D | Iron |
| ICP-OES | EPA 6010D | Magnesium |
| ICP-OES | EPA 6010D | Potassium |
| ICP-OES | EPA 6010D | Sodium |
| ICP-OES | EPA 6010D | Strontium |
| ICP-OES | EPA 6010D | Tin |
| ICP-OES | EPA 6010D | Titanium |
| ICP-MS | EPA 6020B | Antimony |
| ICP/MS | EPA 6020B | Arsenic |
| ICP/MS | EPA 6020B | Barium |
| ICP/MS | EPA 6020B | Beryllium |
| ICP/MS | EPA 6020B | Cadmium |
| ICP/MS | EPA 6020B | Chromium |
| ICP/MS | EPA 6020B | Cobalt |
| ICP/MS | EPA 6020B | Copper |
| ICP/MS | EPA 6020B | Lead |

| Solid and Chemical Materials | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| ICP/MS | EPA 6020B | Molybdenum |
| ICP/MS | EPA 6020B | Nickel |
| ICP/MS | EPA 6020B | Selenium |
| ICP/MS | EPA 6020B | Silver |
| ICP/MS | EPA 6020B | Thallium |
| ICP/MS | EPA 6020B | Total Uranium |
| ICP/MS | EPA 6020B | Uranium |
| ICP/MS | EPA 6020B | Vanadium |
| ICP/MS | EPA 6020B | Zinc |
| Mercury CVAA | EPA 7471B | Mercury |
| GC/ECD | EPA 8082A | Aroclor-1016 (PCB-1016) |
| GC/ECD | EPA 8082A | Aroclor-1260 (PCB-1260) |
| **Preparation** | **Method** | **Type** |
| SVOA/PCB Prep | SW846-3550C | Ultrasonic Extraction |
| Metals Prep | EPA 3050B | Acid Digestion of Sediments, Sludges, and soils |

| Air and Emissions | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Actinium-228 |
| Gamma Spectroscopy | EPA 901.1 | Americium-241 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-122 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-124 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-125 |
| Gamma Spectroscopy | EPA 901.1 | Antimony-126 |
| Gamma Spectroscopy | EPA 901.1 | Arsenic-73 |
| Gamma Spectroscopy | EPA 901.1 | Arsenic-74 |
| Gamma Spectroscopy | EPA 901.1 | Arsenic-76 |
| Gamma Spectroscopy | EPA 901.1 | Barium-133 |
| Gamma Spectroscopy | EPA 901.1 | Barium-140 |
| Gamma Spectroscopy | EPA 901.1 | Beryllium-7 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-207 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-211 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-212 |
| Gamma Spectroscopy | EPA 901.1 | Bismuth-214 |

| Air and Emissions | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Cadmium-109 |
| Gamma Spectroscopy | EPA 901.1 | Cerium-139 |
| Gamma Spectroscopy | EPA 901.1 | Cerium-141 |
| Gamma Spectroscopy | EPA 901.1 | Cerium-144 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-129 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-134 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-136 |
| Gamma Spectroscopy | EPA 901.1 | Cesium-137 |
| Gamma Spectroscopy | EPA 901.1 | Chromium-51 |
| Gamma Spectroscopy | EPA 901.1 | Cobalt-57 |
| Gamma Spectroscopy | EPA 901.1 | Cobalt-58 |
| Gamma Spectroscopy | EPA 901.1 | Cobalt-60 |
| Gamma Spectroscopy | EPA 901.1 | Europium-152 |
| Gamma Spectroscopy | EPA 901.1 | Europium-154 |
| Gamma Spectroscopy | EPA 901.1 | Europium-155 |
| Gamma Spectroscopy | EPA 901.1 | Gadolinium-153 |
| Gamma Spectroscopy | EPA 901.1 | Gallium-67 |
| Gamma Spectroscopy | EPA 901.1 | Gold-196 |
| Gamma Spectroscopy | EPA 901.1 | Gold-198 |
| Gamma Spectroscopy | EPA 901.1 | Hafnium-181 |
| Gamma Spectroscopy | EPA 901.1 | Indium-113m |
| Gamma Spectroscopy | EPA 901.1 | Iodine-123 |
| Gamma Spectroscopy | EPA 901.1 | Iodine-125 |
| Gamma Spectroscopy | EPA 901.1 | Iodine-129 |
| Gamma Spectroscopy | EPA 901.1 | Iodine-131 |
| Gamma Spectroscopy | EPA 901.1 | Iridium-192 |
| Gamma Spectroscopy | EPA 901.1 | Iron-59 |
| Gamma Spectroscopy | EPA 901.1 | Lanthanum-140 |
| Gamma Spectroscopy | EPA 901.1 | Lead-210 |
| Gamma Spectroscopy | EPA 901.1 | Lead-212 |
| Gamma Spectroscopy | EPA 901.1 | Lead-214 |
| Gamma Spectroscopy | EPA 901.1 | Lutetium-177 |
| Gamma Spectroscopy | EPA 901.1 | Manganese-54 |
| Gamma Spectroscopy | EPA 901.1 | Mercury-197 |
| Gamma Spectroscopy | EPA 901.1 | Mercury-203 |

| Air and Emissions | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Molybdenum-99 |
| Gamma Spectroscopy | EPA 901.1 | Neodymium-147 |
| Gamma Spectroscopy | EPA 901.1 | Neptunium-237 |
| Gamma Spectroscopy | EPA 901.1 | Niobium-94 |
| Gamma Spectroscopy | EPA 901.1 | Niobium-95 |
| Gamma Spectroscopy | EPA 901.1 | Polonium-210 |
| Gamma Spectroscopy | EPA 901.1 | Potassium-40 |
| Gamma Spectroscopy | EPA 901.1 | Promethium-144 |
| Gamma Spectroscopy | EPA 901.1 | Promethium-146 |
| Gamma Spectroscopy | EPA 901.1 | Protactinium-234 |
| Gamma Spectroscopy | EPA 901.1 | Radium-223 |
| Gamma Spectroscopy | EPA 901.1 | Radium-224 |
| Gamma Spectroscopy | EPA 901.1 | Radium-226 |
| Gamma Spectroscopy | EPA 901.1 | Radium-228 |
| Gamma Spectroscopy | EPA 901.1 | Rubidium-83 |
| Gamma Spectroscopy | EPA 901.1 | Rubidium-86 |
| Gamma Spectroscopy | EPA 901.1 | Ruthenium-103 |
| Gamma Spectroscopy | EPA 901.1 | Ruthenium-106 |
| Gamma Spectroscopy | EPA 901.1 | Scandium-46 |
| Gamma Spectroscopy | EPA 901.1 | Selenium-72 |
| Gamma Spectroscopy | EPA 901.1 | Selenium-75 |
| Gamma Spectroscopy | EPA 901.1 | Silver-108m |
| Gamma Spectroscopy | EPA 901.1 | Silver-110m |
| Gamma Spectroscopy | EPA 901.1 | Sodium-22 |
| Gamma Spectroscopy | EPA 901.1 | Strontium-85 |
| Gamma Spectroscopy | EPA 901.1 | Tantalum-182 |
| Gamma Spectroscopy | EPA 901.1 | Tellurium-132 |
| Gamma Spectroscopy | EPA 901.1 | Terbium-160 |
| Gamma Spectroscopy | EPA 901.1 | Thallium-208 |
| Gamma Spectroscopy | EPA 901.1 | Thallium-210 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-227 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-228 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-231 |
| Gamma Spectroscopy | EPA 901.1 | Thorium-234 |
| Gamma Spectroscopy | EPA 901.1 | Tin-113 |

| Air and Emissions | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | EPA 901.1 | Total NORM Activity |
| Gamma Spectroscopy | EPA 901.1 | Total NORM GAMMA |
| Gamma Spectroscopy | EPA 901.1 | Uranium-235 |
| Gamma Spectroscopy | EPA 901.1 | Uranium-238 |
| Gamma Spectroscopy | EPA 901.1 | Xenon-131m |
| Gamma Spectroscopy | EPA 901.1 | Xenon-133m |
| Gamma Spectroscopy | EPA 901.1 | Ytterbium-169 |
| Gamma Spectroscopy | EPA 901.1 | Ytterbium-175 |
| Gamma Spectroscopy | EPA 901.1 | Yttrium-88 |
| Gamma Spectroscopy | EPA 901.1 | Yttrium-91 |
| Gamma Spectroscopy | EPA 901.1 | Zinc-65 |
| Gamma Spectroscopy | EPA 901.1 | Zirconium-95 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Actinium-228 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Americium-241 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-122 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-124 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-125 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Antimony-126 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Arsenic-73 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Arsenic-74 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Arsenic-76 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Barium-133 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Barium-140 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Beryllium-7 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-207 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-211 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-212 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Bismuth-214 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cadmium-109 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cerium-139 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cerium-141 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cerium-144 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-129 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-134 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-136 |

| Air and Emissions | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cesium-137 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Chromium-51 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cobalt-57 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cobalt-58 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Cobalt-60 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Europium-152 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Europium-154 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Europium-155 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gadolinium-153 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gallium-67 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gold-196 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Gold-198 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Hafnium-181 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Indium-113m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-123 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-125 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-129 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iodine-131 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iridium-192 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Iron-59 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lanthanum-140 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lead-210 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lead-212 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lead-214 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Lutetium-177 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Manganese-54 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Mercury-197 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Mercury-203 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Molybdenum-99 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Neodymium-147 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Neptunium-237 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Niobium-94 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Niobium-95 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Polonium-210 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Potassium-40 |

| Air and Emissions | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | HASL 300 GA-01-R | Promethium-144 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Promethium-146 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Protactinium-234 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-223 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-224 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-226 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Radium-228 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Rubidium-83 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Rubidium-86 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ruthenium-103 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ruthenium-106 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Scandium-46 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Selenium-72 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Selenium-75 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Silver-108m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Silver-110m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Sodium-22 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Strontium-85 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Tantalum-182 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Tellurium-132 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Terbium-160 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thallium-208 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thallium-210 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-227 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-228 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-231 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Thorium-234 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Tin-113 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Total NORM Activity |
| Gamma Spectroscopy | HASL 300 GA-01-R | Total NORM GAMMA |
| Gamma Spectroscopy | HASL 300 GA-01-R | Uranium-235 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Uranium-238 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Xenon-131m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Xenon-133m |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ytterbium-169 |

| Air and Emissions | | |
|---|---|---|
| **Technology** | **Method** | **Analyte** |
| Gamma Spectroscopy | HASL 300 GA-01-R | Ytterbium-175 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Yttrium-88 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Yttrium-91 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Zinc-65 |
| Gamma Spectroscopy | HASL 300 GA-01-R | Zirconium-95 |
| Gas Flow Proportional Counter | EPA 900.0 Mod | Gross-alpha |
| Gas Flow Proportional Counter | EPA 9310 | Gross-alpha |
| Gas Flow Proportional Counter | EPA 900.0 Mod | Gross-beta |
| Gas Flow Proportional Counter | EPA 9310 | Gross-beta |
| Gas Flow Proportional Counter | Eichrom SRW01 | Strontium-89 |
| Gas Flow Proportional Counter | HASL 300 Sr-01-RC | Strontium-89 |
| Gas Flow Proportional Counter | Eichrom SRW01 | Strontium-90 |
| Gas Flow Proportional Counter | HASL 300 Sr-02-RC | Strontium-90 |
| Liquid Scintillation | Eichrom TCW02 | Technetium-99 |
| Liquid Scintillation | Eichrom TCS01 | Technetium-99 |
| Alpha Spectroscopy | Eichrom ACW03 VBS | Americium-241 |
| Alpha Spectroscopy | HASL 300 Se-03 | Americium-241 |
| Alpha Spectroscopy | Eichrom ACW03 VBS | Plutonium-238 |
| Alpha Spectroscopy | HASL 300 Se-03 | Plutonium-238 |
| Alpha Spectroscopy | Eichrom ACW03 VBS | Plutonium-239/240 |
| Alpha Spectroscopy | HASL 300 Se-03 | Plutonium-239/240 |
| Alpha Spectroscopy | Eichrom ACW03 VBS | Plutonium-241 |
| Alpha Spectroscopy | HASL 300 Se-03 | Plutonium-241 |
| Alpha Spectroscopy | Eichrom ACW03 VBS<br>HASL 300 Se-03 | Uranium-234 |
| Alpha Spectroscopy | HASL 300 Se-03 | Uranium-234 |
| Alpha Spectroscopy | Eichrom ACW03 VBS | Uranium-235 |
| Alpha Spectroscopy | HASL 300 Se-03 | Uranium-235 |
| Alpha Spectroscopy | Eichrom ACW03 VBS | Uranium-238 |
| Alpha Spectroscopy | HASL 300 Se-03 | Uranium-238 |
| Alpha Spectroscopy | Eichrom ACW10 | Thorium-228 |
| Alpha Spectroscopy | Eichrom ACW10 | Thorium-230 |
| Alpha Spectroscopy | Eichrom ACW10 | Thorium-232 |

ANSI National Accreditation Board

Note:

1. This scope is formatted as part of a single document including Certificate of Accreditation No. ADE-1489.

R. Douglas Leonard Jr., VP, PILR SBU



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CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

CALIFORNIA STATE

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

# CERTIFICATE OF ENVIRONMENTAL ACCREDITATION

Is hereby granted to

**ARS Aleut International, LLC**

2609 North River Road

Port Allen, LA 70767

Scope of the certificate is limited to the
"Fields of Testing"
which accompany this Certificate.

Continued accredited status depends on successful completion of on-site inspection, proficiency testing studies, and payment of applicable fees.

This Certificate is granted in accordance with provisions of
Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **2785**

Expiration Date: **6/30/2021**

Effective Date: **7/1/2020**

Sacramento, California
subject to forfeiture or revocation

Christine Sotelo, Chief
Environmental Laboratory Accreditation Program

# CALIFORNIA STATE
# ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM
## Accredited Fields of Testing

**ARS Aleut International, LLC**

2609 North River Road
Port Allen, LA 70767
Phone: 2253812991

**Certificate No.** 2785
**Expiration Date** 6/30/2021

| | | | | Primary Accreditation Body |
|---|---|---|---|---|
| **Field of Testing:** 108 - Inorganic Constituents in Non-Potable Water | | | | |
| 108.013 | 001 | Calcium | EPA 200.7 (1994 Rev. 4.4) | LA |
| 108.013 | 002 | Magnesium | EPA 200.7 (1994 Rev. 4.4) | LA |
| 108.013 | 004 | Potassium | EPA 200.7 (1994 Rev. 4.4) | LA |
| 108.013 | 006 | Sodium | EPA 200.7 (1994 Rev. 4.4) | LA |
| **Field of Testing:** 109 - Metals and Trace Elements in Non-Potable Water | | | | |
| 109.623 | 001 | Aluminum | EPA 200.7 (1994 Rev. 4.4) | LA |
| 109.623 | 006 | Boron | EPA 200.7 (1994 Rev. 4.4) | LA |
| 109.623 | 011 | Iron | EPA 200.7 (1994 Rev. 4.4) | LA |
| 109.623 | 019 | Tin | EPA 200.7 (1994 Rev. 4.4) | LA |
| 109.623 | 020 | Titanium | EPA 200.7 (1994 Rev. 4.4) | LA |
| 109.625 | 002 | Antimony | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 003 | Arsenic | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 004 | Barium | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 005 | Beryllium | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 007 | Cadmium | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 008 | Chromium | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 009 | Cobalt | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 010 | Copper | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 013 | Lead | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 014 | Manganese | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 015 | Molybdenum | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 016 | Nickel | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 017 | Selenium | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 018 | Silver | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 019 | Thallium | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 022 | Vanadium | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.625 | 023 | Zinc | EPA 200.8 (1994 Rev. 5.4) | LA |
| 109.637 | 001 | Mercury | EPA 245.2 (1974) | LA |
| **Field of Testing:** 110 - Volatile Organic Constituents in Non-Potable Water | | | | |
| 110.040 | 001 | Acetone | EPA 624.1 | LA |
| 110.040 | 002 | Acetonitrile | EPA 624.1 | LA |
| 110.040 | 003 | Acrolein | EPA 624.1 | LA |
| 110.040 | 004 | Acrylonitrile | EPA 624.1 | LA |

As of 7/1/2020 , this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.



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| | | | | | |
|---|---|---|---|---|---|
| 110.040 | 005 | Benzene | EPA 624.1 | | LA |
| 110.040 | 006 | Bromodichloromethane | EPA 624.1 | | LA |
| 110.040 | 007 | Bromoform | EPA 624.1 | | LA |
| 110.040 | 008 | Bromomethane (Methyl Bromide) | EPA 624.1 | | LA |
| 110.040 | 010 | Carbon Tetrachloride | EPA 624.1 | | LA |
| 110.040 | 011 | Chlorobenzene | EPA 624.1 | | LA |
| 110.040 | 012 | Chloroethane | EPA 624.1 | | LA |
| 110.040 | 013 | 2-Chloroethylvinyl Ether | EPA 624.1 | | LA |
| 110.040 | 014 | Chloroform | EPA 624.1 | | LA |
| 110.040 | 015 | Chloromethane (Methyl Chloride) | EPA 624.1 | | LA |
| 110.040 | 016 | Dibromochloromethane (Chlorodibromomethane) | EPA 624.1 | | LA |
| 110.040 | 017 | 1,2-Dichlorobenzene | EPA 624.1 | | LA |
| 110.040 | 018 | 1,3-Dichlorobenzene | EPA 624.1 | | LA |
| 110.040 | 019 | 1,4-Dichlorobenzene | EPA 624.1 | | LA |
| 110.040 | 020 | 1,1-Dichloroethane | EPA 624.1 | | LA |
| 110.040 | 021 | 1,2-Dichloroethane | EPA 624.1 | | LA |
| 110.040 | 022 | 1,1-Dichloroethylene (1,1-Dichloroethene) | EPA 624.1 | | LA |
| 110.040 | 023 | trans-1,2-Dichloroethylene (trans- 1,2 Dichloroethene) | EPA 624.1 | | LA |
| 110.040 | 024 | 1,2-Dichloropropane | EPA 624.1 | | LA |
| 110.040 | 025 | cis-1,3-Dichloropropylene (cis 1,3 Dichloropropene) | EPA 624.1 | | LA |
| 110.040 | 026 | trans-1,3-Dichloropropylene (trans-1,3 Dichloroprope | EPA 624.1 | | LA |
| 110.040 | 029 | Ethylbenzene | EPA 624.1 | | LA |
| 110.040 | 031 | Methylene Chloride (Dichloromethane) | EPA 624.1 | | LA |
| 110.040 | 032 | 4-Methyl-2-pentanone (MIBK) | EPA 624.1 | | LA |
| 110.040 | 034 | 1,1,2,2-Tetrachloroethane | EPA 624.1 | | LA |
| 110.040 | 035 | Tetrachloroethylene (Tetrachloroethene) | EPA 624.1 | | LA |
| 110.040 | 037 | Toluene | EPA 624.1 | | LA |
| 110.040 | 038 | 1,1,1-Trichloroethane | EPA 624.1 | | LA |
| 110.040 | 039 | 1,1,2-Trichloroethane | EPA 624.1 | | LA |
| 110.040 | 040 | Trichloroethylene (Trichloroethene) | EPA 624.1 | | LA |
| 110.040 | 041 | Vinyl Chloride | EPA 624.1 | | LA |
| 110.040 | 043 | o-Xylene | EPA 624.1 | | LA |
| 110.040 | 045 | Trichlorofluoromethane | EPA 624.1 | | LA |
| 110.040 | 046 | m+p-Xylene | EPA 624.1 | | LA |
| 110.040 | 047 | 2-Butanone (MEK) | EPA 624.1 | | LA |

**Field of Testing:** 112 - Radionuclides in Non-Potable Water

| | | | | | |
|---|---|---|---|---|---|
| 112.001 | 001 | Gross Alpha | EPA 900.0 | | LA |
| 112.001 | 002 | Gross Beta | EPA 900.0 | | LA |
| 112.003 | 001 | Total Alpha Radium | EPA 903.0 | | LA |
| 112.005 | 001 | Radium-226 | EPA 903.1 | | LA |

**Field of Testing:** 114 - Inorganic Chemistry of Hazardous Waste

| | | | | | |
|---|---|---|---|---|---|
| 114.140 | 001 | Mercury | EPA 7470 A | Aqueous Only | LA |

**Field of Testing:** 116 - Volatile Organic Chemistry of Hazardous Waste

| | | | | | |
|---|---|---|---|---|---|
| 116.080 | 000 | Volatile Organic Compounds | EPA 8260 B | | LA |
| 116.080 | 120 | Oxygenates | EPA 8260 B | | LA |

**Field of Testing:** 118 - Radionuclides in Hazardous Waste

| | | | | | |
|---|---|---|---|---|---|
| 118.010 | 001 | Gross Alpha | EPA 9310 | Aqueous Only | LA |
| 118.010 | 002 | Gross Beta | EPA 9310 | Aqueous Only | LA |
| 118.030 | 001 | Radium-228 | EPA 9320 | Aqueous Only | LA |

# ATTACHMENT 3 – INFORMATIONAL MATERIAL

## Table 1. Parcel E Impacted Sites, Radionuclides of Concern, Historical Uses, and Planned Reuse

| Building/ Site Number | Impacted Redevelopment Block | Radionuclides of Interest | Historic Use | Redevelopment Block Planned Reuse |
|---|---|---|---|---|
| 406 | MU-2 | $^{137}Cs$, $^{226}Ra$ | Shipping, packing, and preserving | Mixed Use |
| 414 | MU-2 | $^{226}Ra$ | LLRW storage area for RI IDW, Public Works/Supply storehouse | Mixed Use |
| 500 | MU-2 | $^{137}Cs$, $^{226}Ra$ | NRDL storage, barracks, bachelor officers' quarters, and NRDL administrative offices | Mixed Use |
| 500 Building Series | Various | $^{241}Am$, $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Original RADLAB/NRDL administrative and laboratory facilities and outdoor storage | Various |
| 503 Site (Demolished) | MU-2 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Ships Galley and Military Support Services and NRDL contaminated laundry facility | Mixed Use |
| 506 Site (Demolished) | MU-2 / EOS-4 | $^{241}Am$, $^{137}Cs$, $^{3}H$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Radioactive waste containers stored on pad behind building; NRDL biology and health physics laboratories; animal, nuclear, and physical chemistry laboratories; radioactive waste storage tank located behind building; NRDL chemistry laboratories; radiochemistry laboratory; NRDL instrument repair, darkroom, and densitometer for film badges; counting rooms; electro-physical and surface chemistry laboratories; administrative offices; storerooms; duty watch berthing; personnel decontamination; and RADLAB/NRDL Headquarters and main facility prior to move to Building 815 in 1955 | Mixed Use / Open Space |
| 507 Site (Demolished) | MU-2 / EOS-4 | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | NRDL biology laboratories, NRDL change house and animal quarters; Radiological Decontamination Center, Biochemistry Branch, Physiology-Psychology Branch, and Experimental Pathology Branch | Mixed Use / Open Space |



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**Table 1. Parcel E Impacted Sites, Radionuclides of Concern Historical Uses, and Planned Reuse** *(continued)*

| Building/ Site Number | Impacted Redevelopment Block | Radionuclides of Interest | Historic Use | Redevelopment Block Planned Reuse |
|---|---|---|---|---|
| 508 Site (Demolished) | MU-2 / EOS-4 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | NRDL chemistry branch, library, personnel branch, photographic section of publications branch, radiological safety branch, barracks, health services division, chemical technology and nucleonics division, security division, health physics division, employee relations branch, and pathology laboratory | Mixed Use |
| 509 Site (Demolished) | EOS-4 | $^{137}Cs$, $^{90}Sr$ | Library | Open Space |
| 510 Site (Demolished) | EOS-4 | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Weapons test sample storage, non-NRDL training facility, NRDL radiation facility, glassblowing, woodworking, and machine shops; physics branch; nuclear radiation branch; and research engineering section physics branch | Open Space |
| 510A Site (Demolished) | EOS-4 | $^{137}Cs$, $^{90}Sr$ | NRDL kevatron facility, NRDL x-ray facility, SUPSHIPS record storage, and fire research facility | Open Space |
| 517 Site (Demolished) | EOS-4 | $^{137}Cs$, $^{60}Co$, $^{90}Sr$ | Former brig and NRDL cobalt animal irradiation facility | Open Space |
| 520 Site (Demolished) | MU-2 / EOS-3 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Shipyard dental clinic and NRDL administrative offices | Mixed Use / Open Space |
| 521 Site | EOS-4 | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Power plant; also one of two suspected sites of fuel oil burning from three OPERATION CROSSROADS target ships | Open Space |
| 527 | N/A | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Motor generator building (located on offshore pier that is not planned to be reused) | N/A |



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**Table 1. Parcel E Impacted Sites, Radionuclides of Concern Historical Uses, and Planned Reuse** *(continued)*

| Building/ Site Number | Impacted Redevelopment Block | Radionuclides of Interest | Historic Use | Redevelopment Block Planned Reuse |
|---|---|---|---|---|
| 529 Site (Demolished) | MU-2 | $^{137}Cs$, $^{3}H$, $^{226}Ra$, $^{90}Sr$ | NRDL isotope storage facility (vault) and neutron generator | Mixed Use |
| 701 Site | MU-3 | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Storage building that NRDL requested for "temporary" (120 days) storage of samples in 1947 | Mixed Use |
| 704 Area Animal Pens | MU-1 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Animal pens for NRDL | Mixed Use |
| 704 Radioactive Material Storage Area | MU-1 | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Radioactive material storage area | Mixed Use |
| 707 and Kennels | MU-1 | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Research animal facility used by NRDL for animal breeding and housing; waste processing and storage facility, formerly leased to Pet Express as an animal clinic | Mixed Use |
| 707B Site (Demolished) | MU-1 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | NRDL animal colony | Mixed Use |
| 707C Site (Demolished) | MU-1 | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Nuclear weapons test support and experimentation and equipment issue and receiving area | Mixed Use |
| 707 Triangle Area | MU-1 | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$, $^{235}U$ | NRDL radioactive waste receiving, packaging, and storage area and suspected septic tank and leach field from early operations | Mixed Use |
| 708 | MU-1 | $^{137}Cs$, $^{90}Sr$ | Research animal facility, bio-medical facility and animal psychology facility | Mixed Use |
| 807 Site (Demolished) | MU-13 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Scrap yard processing shed | Mixed Use |

**Table 1. Parcel E Impacted Sites, Radionuclides of Concern Historical Uses, and Planned Reuse** *(continued)*

| Building/ Site Number | Impacted Redevelopment Block | Radionuclides of Interest | Historic Use | Redevelopment Block Planned Reuse |
|---|---|---|---|---|
| 810 | MU-3 / EOS-5B | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | LLRW and IDW storage location; storehouse, paint shop, and paint and oil storage | Mixed Use / Open Space |
| S-719 Site (Demolished) | EOS-1 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Incinerator; potentially used by NRDL animal facility at Building 707 | Open Space |
| Shack 79 Site (Demolished) | MU-2 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | NRDL support for radioactive material | Mixed Use |
| Shack 80 Site (Demolished) | MU-2 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | NRDL support; shack reported to have been moved from behind Building 506 to Building 704 area for "lab operations" | Mixed Use |
| IR-02 (Bay Fill Area) | EOS-1 / EOS-2 / EOS-3 / EOS-4 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Bay Fill Area was used for disposal of assorted shipyard wastes, which included $^{90}Sr$ and $^{226}Ra$ devices. The area known as IR-02 Northwest and Central contains a suspected concentration of these devices. Potentially used for disposal of wastes from decontamination of OPERATION CROSSROADS ships. | Open Space |
| IR-03 (Former Oil Reclamation Ponds Area) | EOS-3 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | HPS fuel oil reclaiming plant; possible area for disposal of assorted shipyard wastes, which may have included $^{90}Sr$ and $^{226}Ra$ devices and oil | Open Space |
| IR-04 (Former Scrap Yard) | MU-3 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Post-disassembly area for metals, equipment, and other unusable items from the salvage yard that could have contained $^{226}Ra$ devices and other contaminants | Mixed Use |
| Former Salvage Yard | MU-3 / MU-1 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Predisposal disassembly area for metals, equipment, and other reusable items that could have contained $^{226}Ra$ devices and other contaminants | Mixed Use |



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**Table 1. Parcel E Impacted Sites, Radionuclides of Concern Historical Uses, and Planned Reuse** *(continued)*

| Building/ Site Number | Impacted Redevelopment Block | Radionuclides of Interest | Historic Use | Redevelopment Block Planned Reuse |
|---|---|---|---|---|
| Parcel E Shoreline | EOS-1 / EOS-2 / EOS-3 / EOS-4 | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Debris disposal | Open Space |
| Piers and Berths | N/A | $^{137}Cs$, $^{239}Pu$, $^{226}Ra$, $^{90}Sr$ | Berthing of OPERATION CROSSROADS ships, berthing of the YGN-73 (radioactive waste disposal barge), and NRDL usage (berthing of experimental barges YAG-39 and YAG-40) | N/A |
| Sanitary Sewer System | Various | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Sanitary sewer system | Various |
| Storm Drain Lines | Various | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Combined storm and sanitary sewer drains | Various |
| Septic Sewer Lines | Various | $^{137}Cs$, $^{226}Ra$, $^{90}Sr$ | Septic sewage system (predating sanitary sewer system; potentially associated with impacted Building 810) | Various |

Notes:

$^{241}Am$ = americium-241

$^{60}Co$ = cobalt-60

$^{137}Cs$ = cesium-137

$^{3}H$ = hydrogen-3

IDW = investigation-derived waste

IR = Installation Restoration

LLRW = low-level radioactive waste

N/A = not applicable (offshore piers and berths are considered part of the offshore Parcel F but are included in this document for completeness; these structures are not planned for reuse)

NRDL = Naval Radiological Defense Laboratory

$^{239}Pu$ = plutonium-239

$^{226}Ra$ = radium-226

RADLAB = radiation laboratory

RI = remedial investigation

$^{90}Sr$ = strontium-90

SUPSHIPS = Superintendent of Shipbuilding

$^{235}U$ = uranium-235



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