Analytical Services Division

Rocky Flats Environmental Technology Site

Statement of Work
For Analytical Measurements

RADIOMETRIC STRONTIUM
BY
GAS PROPORTIONAL
COUNTING (GPC)

MODULE RC05-B.1

May 4, 1998

Approved: _____
Analytical Services

Reviewed For Classification
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Date: May 4, 1998

RADIOMETRIC STRONTIUM BY GAS PROPORTIONAL COUNTING MODULE

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RADIOMETRIC STRONTIUM BY GAS PROPORTIONAL COUNTING MODULE

INTRODUCTION

This module provides the deliverables, technical, quality control (QC) and evidentiary requirements for the identification and quantitation of radiometric strontium by gas proportional counting in support of the Rocky Flats Environmental Technology Site. Sample matrices may consist of, groundwater, surface water, sediment, sludge, waste (i.e., oil and chemicals), soil, and other solids as appropriate for the methods.

The following modules are required for radiometric strontium by gas proportional counting under this statement of work (SOW): the General Laboratory Requirements Module, GR01; the Requirement for Analytical Services Electronic Deliverable Module, GR02; and the Requirements for Radiometric Strontium by Gas Proportional Counting, RC05. The RC05 specifications shall supersede any GR01 specifications in the case of conflicting requirements.

EXHIBIT A

SUMMARY OF REQUIREMENTS

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SUMMARY OF REQUIREMENTS

1. GENERAL REQUIREMENTS

1.1. This module is comprised of eight exhibits. Exhibit A provides an overview of the module and its general requirements. Exhibit B contains all reporting and deliverables requirements for the contract. Exhibit C contains the Target Analyte List (TAL) and the required detection limits (RDL) for all target analytes. Exhibit D contains method specifications and required analyses under this contract. Exhibit E contains general and specific laboratory QA/QC requirements. Exhibit F contains evidentiary requirements, including chain-of-custody and document control requirements. To ensure proper understanding of language utilized in this contract, Exhibit G contains a glossary of terms. When a term is used in the text without definition, the glossary meaning shall be applicable. Exhibit H contains suggested references for analytical method development and quality assurance/quality control.

2. FACILITY, INSTRUMENTATION AND KEY POSITION REQUIREMENTS

2.1. **Capability And Capacity:** The Laboratory shall have sufficient analytical capacity and capability to meet all terms and conditions of the SOW.

2.2. **Key Position Requirements:** The Laboratory shall assign individuals the responsibilities for the technical key positions listed below and in GR01 to perform the minimum functional requirements necessary to meet the terms and conditions of this subcontract. Minimum academic training and experience qualifications for positions specific to RC05 are identified below. All positions listed in GR01 Exhibit A, Section 1, the Sample Custodian and Document Control Officer (DCO) specified in GR01 Exhibit F, Section 4, and all of the positions listed below are considered key positions for this subcontract. A qualifying individual may fill more than one of the key positions.

2.2.1. <u>Gas Proportional Counting Specialist</u> I

- Responsibility: Responsible for all aspects of gas proportional counter operation and counting data interpretation in conjunction with the analysis software.
- Academic Training: A minimum of a bachelor's degree in a science discipline.
- Experience: A minimum of one year of work experience with gas proportional counting data interpretation with formal vendor supported or accredited training, or like experience using the analysis software.

2.2.2. <u>Radiochemist- Sample Preparation</u>

- Responsibility: Responsible for all aspects of radiochemical separation methodology and techniques.
- Academic Training: A minimum of a bachelor's degree in a science discipline.
- Experience: A minimum of two years of work experience with classical chemistry laboratory procedures, including at least one year of experience with radiochemical separation methodology and techniques.

2.3. **Facilities:** Requirements for the facilities are specified in the General Laboratory Requirements Module, GR01.

2.4. **Instrumentation:** At a minimum, the Laboratory shall have operational gas proportional counting instrumentation at the time of the on-site evaluation, that is committed for the full duration of the contract and is able to produce data as described herein.

EXHIBIT B

REPORTING AND DELIVERABLES REQUIREMENTS

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REPORTING AND DELIVERABLES REQUIREMENTS

1. INTRODUCTION

RC05 Exhibit B contains the reporting and deliverables requirements applicable to all Radiometric Strontium by Gas Proportional Counting line item codes defined in RC05, Exhibit C. This exhibit supplements the fundamental deliverable requirements specified in GR01 Exhibit B. Requirements for Sample Data Packages, Supporting Data Packages, and other deliverables specific to Radiometric Strontium by Gas Proportional Counting are detailed. Four tables in RC05, Exhibit B further define some of the required deliverables specified in GR01 Exhibit B.

Table B1. Schedule for Sample Data Package Deliverables
Table B2. Sample Data Package Deliverables
Table B3. Other Deliverables
Table B4. Supporting Documentation Package Deliverables

Tables B2 through B4 define major deliverable components as Deliverable Sections which are each assigned titles. Text accompanying the tables provides structural and content requirements. Tables and text also provide reference lists for Radiometric Strontium by Gas Proportional Counting deliverable requirements found in this module and other modules of this SOW.

Deliverable requirements and schedules specified in the General Laboratory Requirements Module, GR01, and in any of the tables of this module shall be met. However, schedules contained in this document that conflict with Module GR01 shall take precedence.

2. SAMPLE DATA PACKAGE REQUIREMENTS

2.1. **Sample Data Package Deliverable Requirements**: The sample data package deliverable requirements for Radiometric Strontium by Gas Proportional Counting Priority Processing differ from those specified in GR01. The priority processing schedule for Radiometric Strontium by Gas Proportional Counting sample data package delivery is provided in Table B1. Module RC05 does not have a Rush Processing deliverable.

2.1.1. All deliverables contained in Table B1 shall be transmitted to the CTR.

2.1.2. The final report shall be completed and in the Site's possession by the requested turn around time unless otherwise agreed upon in writing by the CTR.

TABLE B1 SCHEDULE FOR SAMPLE DATA PACKAGE DELIVERABLES

Processing	Item	Copies	Schedule	Reference
Priority: Water/Soil/Waste	Quick-turn packet (Narrative, COC copies, and results only)	1	14 days after VTSR for total Sr 21 days after VTSR for 89 and 90 Sr	RC05, Exhibit B/Section 3
	Sample data package	1	31 days after VTSR	RC05, Exhibit B/Section 2
	EDD	1	31 days after VTSR	GR02

2.2. **Sample Data Package Components**: Table B2 lists the required deliverable sections for a Sample Data Package for RC05. Each deliverable section is numbered and assigned a title. These *Deliverable Section Numbers* and *Titles* are referenced in the remainder of the accompanying text in RC05 Exhibit B Section 2. The *Reference* column in Table B2 contains designators which refer to modules, exhibits, and sections where more details may be found. This reference column is intended as an aid in locating additional information, but is not expected to be all-inclusive.

TABLE B2 SAMPLE DATA PACKAGE DELIVERABLES

Deliverable Section Number	Deliverable Section Title	Reference (Module, Exhibit/Section Letter or Title)
1	Cover Page	GR01, Exhibit B/Section 4
2	Table of Contents	GR01, Exhibit B/Section 4
3	Data Review Checklist-RC05 Sample Data Package	GR01, Exhibit B/Section 4 RC05, Exhibit B/Section 2 RC05, Appendix A
4	COC(s)	GR01, Exhibit B/Section 4
5	Narrative	GR01, Exhibit B/Section 4
6	Sample and QC Sample Results Summary	GR01, Exhibit B/Section 4 RC05, Exhibit B/Section 2 RC05, Exhibit C RC05, Exhibit E
7	Preparation Raw Data Summary	GR01, Exhibit B/Section 4 GR01, Exhibit E/Section 5 GR01, Exhibit F/Section 4 RC05, Exhibit B/Section 2 RC05, Exhibit D/Section 4 RC05, Exhibit E
8	Standards Summary	GR01, Exhibit B/Section 4 GR01, Exhibit E/Section 5 GR01, Exhibit E/Section 6 RC05, Exhibit B/Section 2 RC05, Exhibit E
9	Instrument Calibration Summary	GR01, Exhibit B/Section 4 GR01, Exhibit E/Section 6 RC05, Exhibit B/Section 2 RC05, Exhibit E/Section 11
10	Continuing Calibration Data	GR01, Exhibit B/Section 4 RC05, Exhibit B RC05, Exhibit E

TABLE B2 SAMPLE DATA PACKAGE DELIVERABLES (continued)

Deliverable Section Number	Deliverable Section Title	Reference (Module, Exhibit/Section Letter or Title)
11	Counting Raw Data Summary	GR01, Exhibit B/Section 4 GR01, Exhibit F RC05, Exhibit B/Section 5 RC05, Exhibit E
12	Electronic Data Deliverable (EDD)-Hard Copy	GR02 RC05, Exhibit B/Section 2

2.3. **Sample Data Package General Requirements**

2.3.1. All Sample Deliverable Sections shall meet the general and specific requirements listed in GR01 Exhibit B Section 4 which are referenced in RC05 Table B2.

2.3.2. All Sample Deliverable Sections shall appear in the Sample Data Package in numerical order by *Deliverable Section Number*.

2.3.3. Deliverable Section Numbers 6 through 12 shall each be preceded by a Cover Sheet which is titled exactly as given under the *Deliverable Section Title* column of Table B2. These Cover Sheets shall be paginated along with the rest of the Sample Data Package. Each of these Deliverable Section Cover Sheets shall comply with the following structural requirements:

2.3.3.1. The Deliverable Section Title shall appear at the top.

2.3.3.2. If identifiers for required items differ from specified identifiers (denoted in quotation marks), then these discrepancies shall also be mapped in table form on the Cover Sheet of the affected deliverable section. This table shall include mapping information in columns labeled "Specified Identifier" and "Identifier Used." Abbreviations of the delimited identifications are acceptable, where applicable.

2.3.3.3. If the locations of required items differ from the specified location, then these discrepancies shall be mapped in table form on the Cover Sheet of the deliverable section for the specified location. This table shall include mapping information in columns labeled "Required Item," "Specified Location," and "Actual Location."

2.3.3.4. The required items within each Summary Section do <u>NOT</u> need to be in the order specified.

2.3.4. Any undocumented and/or misplaced items shall be considered incomplete.

2.3.5. All raw data from failed analytical batches or from failed individual analyses shall be clearly labeled as "Data Not Used" and shall be included in the appropriate Deliverable Section.

2.3.6. Applicable units shall be reported for all measurements, i.e., weight, volume, temperatures, activity, ect.

2.3.7. Refer to GR01 Exhibit B and RC05 Exhibits D and E for additional requirements for Sample Data Packages.

2.4. **Sample Data Package Cover Page Requirements**
(*Requirements for Sample Data Package Deliverable Section Number 1*)

Sample Data Package Cover Pages shall be included as specified in GR01.

2.5. **Table of Contents**
(*Requirements for Sample Data Package Deliverable Section Number 2*)

A Table of Contents for the Sample Data Package shall be included as specified in GR01.

2.6. **Data Review Checklist Requirements**
(*Requirements for Sample Data Package Deliverable Section Numbers 3*)

Data Review Checklists document the completeness and the quality control status of the Sample Data Package. RC05 Appendix A contains the form that must be used to complete this check for radiometric strontium analyses. A completed Data Review Checklist form shall be submitted with each Sample Data Package and shall be in strict conformance with the formatting and content of the form contained in RC05 Appendix A. Refer to General Laboratory Requirements Module GR01 Exhibit B Section 4 for more details.

2.7. **Chain of Custody (COC)**
(*Requirements for Sample Data Package Deliverable Section Number 4*)

COC documentation shall be included in the Sample Data Package as specified in GR01.

2.8. **Sample Data Package Narrative**
(*Requirements for Sample Data Package Deliverable Section Number 5*)

Sample Data Package Narratives shall be included in the Sample Data Package as specified in GR01.

2.9. **Sample and QC Sample Results Summary**
(Requirements for Sample Data Package Deliverable Section Number 6)

2.9.1. All sample results shall be arranged by Site sample identification number in increasing alphanumeric order.

2.9.2. For each sample and QC sample the results shall include the following:

- analytes (^{90}Sr and/or ^{89}Sr)
- analyte activities (see RC05 Exhibit E/Section 4 for Result Reporting Requirements)
- overall measurement uncertainty (2-sigma) for each analyte (same units as the reported activity)
- "MDA" for each analyte (same units as the reported activity).
- "Analytical Batch ID" (Analytical Batch Identification Number)

2.9.3. The QC sample type shall be clearly identified and designated as follows:

- duplicate is the corresponding sample identification + "D", or "Duplicate"
- laboratory control sample is designated as "LCS"
- preparation blank is designated as "PB"

2.9.4. For each duplicate pair, the following additional information shall be reported:

- result of duplicate result equivalency test as defined in Exhibit E, Section 7, including calculated values for F and E

2.9.5. For the "LCS", the following additional information shall be reported:

- LCS "% Recovery".

2.10. **Preparation Raw Data Summary**
(Requirements for Sample Data Package Deliverable Section Number 7)

2.10.1. The preparation data shall be documented in the form of preparation benchsheets and/or preparation logs, and these shall follow the requirements defined in the General Laboratory Requirements Module GR01, Exhibit F, Document Control Procedures.

2.10.2. The preparation documentation shall include the following information, at a minimum:

- preparation start date
- "Analytical Batch ID"
- sample identifications
- QC sample type and identifications (unique LCS identification traceable as described in the Standards Summary Section)
- sample and QC sample aliquots
- sample dilution, digestion, or dissolution volumes, if applicable
- “Final Sample Aliquot” - calculated net aliquot on planchet, if applicable (required only if dilution, digestion, or dissolution was required for sample preparation)
- "Tare Weight" and “Gross Weight”, for each planchet
- “Net weight” of Sr and/or Y precipitate on counting planchet
- "Pipette ID" and dates of use, if applicable
- amount and concentration of stable Sr, and Y carriers added, if applicable
- measured amount of stable Sr in samples before carrier is added
- analysis technique that was employed to determine the amount of stable Sr present in the sample before the carrier is added, if applicable
- date and time for the start of the Yttrium ingrowth
- date and time for the end of the Yttrium ingrowth
- "Balance ID" and dates of use
- methodology SOP, including revision number or date
- signatures and dates of all analysts and reviewers

2.10.3. For soils, sediments, sludges and solid waste which require homogenizing the sample prior to analysis (refer to Exhibit D, Section 4), the following additional information shall be reported:

- the approximate sample volume of the gross sample (as received)
- the aliquot size homogenized

2.11. **Standards Summary**
(Requirements for Sample Data Package Deliverable Section Number 8)

2.11.1. The following information shall be included in the standards summary:

- “Standard ID” for all LCS standards used
- “SV” and “SV Uncertainty” and certification date for each standard
- expiration date for each standard

2.12. Instrument Calibration Summary

(Requirements for Sample Data Package Deliverable Section Number 9)

2.12.1. The Instrument Calibration Summary deliverable is a summary of the portion of the calibration data from the Instrument Calibration, which is directly used to calculate analyte activities.

2.12.2. Samples from Rocky Flats Environmental Technology Site have many alpha emitting isotopes that could be abundant in some samples. Alpha calibrations and alpha to beta crosstalk corrections are only required if it is believed that the separations chemistry has not eliminated all alpha emitting isotopes from the beta fraction, (Sr or Y).

2.12.3. The Instrument Calibration Package identification, with the syntax of "RC05CAL_Lab ID_Date" shall be reported in the summary (e.g., "RC05CAL_XYZ_01Jan1997"), for the all applicable calibration packages.

2.12.4. The Instrument Calibration Summary shall contain the following information for each GPC detector used to analyze Site samples for the RIN and for the associated Analytical Batch QC samples:

- instrument and detector ID(s)
- date(s) of efficiency calibration
- “Standard IDs” of sources used for efficiency calibrations (alpha and beta)
- “Efficiency” and “Efficiency Uncertainty” (2 sigma) for Sr and Y counting efficiencies
- date(s) of self-absorption/crosstalk curve calibration
- “Standard IDs” of sources used for self-absorption/crosstalk curve calibration
- curve coefficients for alpha and beta self-absorption curves
- curve coefficients for crosstalk curves, or crosstalk factors, as applicable

2.13. Continuing Calibration Summary

(Requirements for Sample Data Package Deliverable Section Number 10)

2.13.1. Continuing calibration data for GPC systems consists of instrument background data and check source data used to document instrument stability. The required information shall be provided for all GPC detectors used to analyze the Site samples for the RIN and for the associated Analytical Batch QC samples.

2.13.2. The following information shall be reported for the detector backgrounds:

- instrument and detector ID(s)
- date of the background analysis
- data filename, if applicable
- individual alpha and beta background counts or count rates
- “Count Time” - background count time
- “Alpha Background” and “Beta Background” - average alpha and beta count rates
- “Alpha Background Error” and “Beta Background Error” and confidence limits for each
- signatures and dates of all analysts and reviewers
- analyst and/or reviewers comments regarding resolution of abnormal background counts
- methodology SOP(s) with revision number or date

2.13.3. The following information shall be reported for the detector check source determinations:

- instrument and detector ID
- date of check source analysis
- data filename, if applicable
- check source ID(s)
- alpha and beta counts, count rates, or calculated efficiencies, as appropriate. If the check source test requires that more than one count is collected but only the averages of the data are evaluated, only the averages are required to be reported.
- control limits
- result of check source data assessment (pass, fail, etc.)
- signatures and dates of all analysts and reviewers
- analyst and/or reviewers comments regarding resolution of "failed" check source data
- methodology SOP(s) with revision number or date

2.14. Counting Raw Data Summary

(Requirements for Sample Data Package Deliverable Section Number 11)

2.14.1. The Counting Raw Data Summary Section includes all of the instrument raw data for each Site sample in the RIN, and the associated Analytical Batch QC samples as follows:

- Site sample ID or respective laboratory ID
- date of analysis
- data filename, if applicable
- instrument and detector ID(s)
- "Analytical Batch ID"
- "Count Time"
- alpha and beta "Gross Counts" (or "Gross count rate")
- methodology SOP(s) with revision number or date
- analyst and reviewer's signature and date

2.14.2. If the planchets were counted more than once, the required information shall be provided for each count. If more than one count was used to calculate the reported results, the worksheet, spreadsheet, etc. used to calculate averages and propagated uncertainties shall also be included. If not all of the counts taken were used, the data which were not used shall be clearly labeled as "Data Not Used"

2.14.3. Counting raw data shall include evidence such as the Instrument Calibration Package ID(s), calibration dates or calibration filenames to definitively show that the appropriate calibration data were used for the calculations.

2.14.4. A copy of the instrument run log shall be included in this Deliverable Section. It shall contain the following information, at a minimum:

- date of analysis
- data filename, if applicable
- Site sample ID or respective laboratory ID
- instrument and detector ID
- analyst and reviewer's signature and date

2.15. **Electronic Data Deliverable (EDD) - Hard Copy**
(*Requirements for Sample Data Package Deliverable Section Number 12)*

The EDD Hard Copy shall be included as specified in GR01, Exhibit B, Section 4.

3. QUICK TURN PACKET REQUIREMENTS

Quick-turn Packets designated in priority processing schedules in RC05 Exhibit B, Table B1 shall include the following items from RC05 Exhibit B, Table B2, Sample Data Package Deliverables:

- Section 4, COC
- Section 5, Narrative
- Section 6, Sample and QC Result Summary

Please note that submittal of the Quick-turn Packet does not affect deliverable requirements for Sample Data Packages, QC Result Summaries, Electronic Data Deliverables, Supporting Documentation Packages, or any other deliverables.

4. REQUIREMENT FOR OTHER DELIVERABLES

The following table defines other required deliverables in addition to the Sample Data Package deliverables for Radiometric Strontium by Gas Proportional Counting

TABLE B3 OTHER DELIVERABLES

Deliverable	Copies	Schedule	Recipient	Reference (Module, Exhibit/Section)
Instrument Calibration Package • Cover Page • Data Review Checklist- RC05 Instrument Calibration Package • Narrative • Instrument Calibration and Raw Data	1	Prior to or with first use for sample analysis, and within 7 days of request by CTR	CTR	GR01, Exhibit B/Section 4 RC05, Exhibit B/Section 4 RC05, Exhibit E/Section 10 RC05, Appendix B
SRM and Calibration Source Certificates	1	With first use and within 7 days of request by CTR	CTR	GR01, Exhibit E/Section 6 RC05, Exhibit E/Sections 8, 9, 10
Standards and Calibration Planchet Preparation Documentation	1	With first use and within 7 days of request by CTR	CTR	GR01, Exhibit E/ Section 6 RC05, Exhibit E/Section 10
Electronic Data Deliverable (EDD)	1	With each Sample Data Package	CTR	GR02, RC05, Exhibit B, Section 4
Control Charts	1	Available during audits or within 7 days of request by the CTR	Maintained at Laboratory	RC05, Exhibit E, Section 11
PE sample results	1	7 days from receipt of results	CTR	GR01, Exhibit E, Section 9 RC05, Exhibit E, Section 15

4.1. **Instrument Calibration Package**

The Instrument Calibration Package consists of 4 parts in the following order: (1) Cover Page, (2) Data Review Checklist- RC05 Instrument Calibration Package, (3) Narrative, and (4) Instrument Calibration and Raw Data.

4.1.1. *Cover Page*: The Cover Page shall be titled with the Laboratory name, Laboratory code, subcontract number, instrument ID, and the Instrument Calibration Package identification with the syntax of "RC05CAL_Lab ID_Date" (e.g., "RC05CAL_XYZ_01Jan1997").

4.1.2. *Data Review Checklist*: The Data Review Checklist- RC05 Instrument Calibration Package, RC05 Appendix B, shall be completed and included according to instructions given in GR01 Exhibit B, Section 4.

4.1.3. *Narrative*: A narrative describing all problems or unusual circumstances encountered during the instrument calibration process.

4.1.4. *Instrument Calibration and Raw Data*

- A Cover Sheet titled "Instrument Calibration and Raw Data Section" shall precede this Section.
- It is absolutely imperative that the required items in this Section are legible and clearly identified. All RC05 specified item identifications (denoted in quotation marks) shall appear exactly as given, or the identification shall be cross-referenced on the Cover Sheet (abbreviations of the delimited identifications are acceptable, where applicable). **ANY UNDISCERNIBLE ITEMS SHALL BE CONSIDERED INCOMPLETE**.
- If there is an item identification discrepancy, then on the Cover Sheet, the RC05 specified item identification shall be listed under a header titled "Specified Item", and the Laboratory's cross-referenced identification shall appear under an adjacent header titled "Identifier Used".

4.2. **Instrument Calibration and Raw Data Section Content** The following information shall be included in the Instrument Calibration and Raw Data Section:

4.2.1. Voltage Plateau Data

- date(s) of plateau determinations
- data filename(s), if applicable
- instrument and detector ID(s)
- “Standard ID” of source(s) used for plateau determination
- counts obtained for each voltage setting
- plot of voltage plateau curve
- length and slope of the plateau
- selected operating voltage.
- analyst’s and reviewer’s signature and date
- methodology SOP with revision number or date
- copy of instrument run log

4.2.2. Discriminator Window Settings

- date(s) of discriminator window determination
- data filename(s), if applicable
- instrument and detector ID(s)

- “Standard ID” of source(s) used for setting discriminator windows
- beta upper level discriminator and alpha lower level discriminator settings
- calculated beta to alpha crosstalk and alpha to beta crosstalk (percent or fraction) for selected discriminator settings
- analyst’s and reviewer’s signature and date
- methodology SOP with revision number or date
- copy of instrument run log

4.2.3. Efficiency Determinations

The following information shall be provided for the gross alpha, Yttrium and Strontium efficiencies:

- date(s) of efficiency calibration
- data filename(s), if applicable
- instrument and detector ID(s)
- “Standard ID” of sources used for efficiency calibration
- “SV”, “SV Uncertainty”, and date of certified activity for efficiency calibration sources
- count time
- alpha, Yttrium and Strontium counts or count rate for each count collected
- calculated "Efficiency", "Efficiency Error" and confidence level
- analyst’s and reviewer’s signature and date
- methodology SOP with revision number or date
- copy of instrument run log

4.2.4. Self-Absorption and Crosstalk Curve Calibration

The following information shall be provided for both alpha and beta self-absorption and crosstalk curve calibrations:

- date(s) of calibration
- data filename(s), if applicable
- instrument and detector ID(s)
- “Standard ID” of sources used for calibration
- “SV”, “SV Uncertainty”, and date of certified activity for calibration sources
- residue weight of each source used for calibration
- identity of salt matrix used to prepare calibration planchets
- alpha and beta counts or count rate for each count collected
- count time
- calculated "Self-Absorption Factor" for each count collected
- calculated “Crosstalk Factor” for each count collected.
- coefficients of best-fit curve for self-absorption curve with goodness of fit test result (correlation coefficient)
- coefficients of best-fit curve for crosstalk curve(s) with goodness of fit test result
- plots of curves
- analyst’s and reviewer’s signature and date
- methodology SOP with revision number or date
- copy of instrument run log

4.3. **SRM/Calibration Source Certificates**

4.3.1. This exhibit section further defines the requirements of Table B3, SRM/Calibration Source Certificates.

4.3.2. For (1)standard reference material (ampules), (2)standards which will be used "as received" and (3)purchased sources, the following information must be provided prior to or with first use. The information shall either be found on the certificate or provided with the certificate.

- a copy of the certificate for the standard or source
- "Standard ID" (ID which will be used by the laboratory to reference the standard or source)
- standard type ("SRM" or "Source")
- standard isotope(s)
- "SV" and "SV Uncertainty" 2 sigma certified activity
- certification date
- receipt date
- expiration date, if applicable
- geometry (sources only)

4.4. **Standards and Calibration Planchet Preparation Documentation:**

4.4.1. The preparation of diluted standards shall be documented according to the following guidelines. The preparation data shall be documented in the form of standard preparation benchsheets and/or standard logs. These shall follow the requirements defined in the General Laboratory Requirements Module GR01, Exhibits E and F. The receipt or preparation documentation, as applicable, of the parent standard used for the dilution must be submitted prior to or with first use of the standard. At a minimum, the following information shall be included

- date of preparation
- "Standard ID" for the parent standard (traceable to the certificate).
- "Standard ID" for the diluted standard (unique identification of the diluted standard)
- standard isotope
- " SV" and "SV Uncertainty" (2 sigma) of the diluted standard (certified activity)
- reference date for certified activity of diluted standard
- expiration date of diluted standard, if applicable
- diluent used for preparation
- dilution data (e.g., 5 mls diluted to 1 liter)
- "Pipette ID" and dates of use
- "Balance ID" and dates of use (if applicable)
- methodology SOP and revision number or date
- signatures and dates of all analysts and reviewers

4.4.2. The following information shall be provided for all in-house prepared sources: The preparation data shall be documented in the form of standard preparation benchsheets and/or standard logs. These shall follow the requirements defined in the General Laboratory Requirements Module GR01, Exhibits E and F.

- standard isotope
- "Standard ID" of SRM used to prepared source
- "SV" and "SV uncertainty" (2 sigma) and certification date of SRM used to prepare source

- expiration date of SRM used to prepare sources
- “Standard ID” for fabricated source (unique identifier for each source)
- aliquot size of SRM used to prepare source
- “Tare Weight” and “Gross Weight” of planchets (self-absorption curve sources only)
- “Net Weight” for residue weight on source (self-absorption curve planchets only)
- “SV" and “SV uncertainty” (2 sigma) and certification date of prepared source
- expiration date of prepared source, if applicable
- geometry
- "Pipette ID" and dates of use (if applicable)
- "Balance ID" and dates of use (if applicable)
- methodology SOP and revision number or date
- signatures and dates of all analysts and reviewers

4.4.3. Results and calculations for standardization of strontium and yttrium carrier solution shall be provided.

4.5. **Electronic Data Deliverable (EDD)**

4.5.1. Requirements for the Electronic Data Deliverable (EDD) are specified in Module, GR02. An EDD is required for all analyses performed under this module, unless otherwise directed in writing by the CTR.

5. SUPPORTING DOCUMENTATION PACKAGE (SUPPORT PACKAGE)

5.1. **Support Package Schedules and Maintenance**: See GR01 Module B Section 5 for delivery schedules and maintenance requirements for Support Packages

5.2. **Support Package Components:** Table B4 lists required components for a RC05 support package. Each section is assigned a title. These titles are referenced in the remainder of the accompanying text in RC05 Section 5. The *Reference* column in Table B4 refers to the module, exhibit, and section number where more details may be found. The information in this column is intended as an aid in locating specifics, but may not be all-inclusive. Refer to Exhibits B, E, and F of the General Laboratory Requirements Module GR01 for details about these requirements.

TABLE B4 SUPPORTING DOCUMENTATION PACKAGE

Deliverable Section Title	Copies	Reference (Module, Exhibit/Section Number)
Document Inventory	1	GR01, Exhibit B/Section 5
Sample receipt, storage, tracking and internal COC records	1	GR01, Exhibit F/Section 2, 3 RC05, Exhibit F/Section 2
Copy of Sample Data Package	1	GR01, Exhibit B/Sections 4, 5 RC05, Exhibit B/Sections 2, 3
Original SRM and Source Certificates	1	GR01, Exhibit E/Section 6 RC05, Exhibit E/Sections 8, 9, 10
Original logs and/or logbooks	1	GR01, Exhibit F/Section 4 RC05, Exhibit B/Section 5 RC05, Exhibit F/Section 3

TABLE B4 SUPPORTING DOCUMENTATION PACKAGE (continued)

Deliverable Section Title	Copies	Reference (Module, Exhibit/Section Number)
Standard Operating Procedures	1	GR01, Exhibit F/Section 6 RC05, Exhibit F/Section 4
QC Control Charts	1	RC05, Exhibit E/Section 12
Software Quality Assurance	1	GR01, Exhibit F/Section 5
Electronic Data Deliverable (EDD)	1	GR02 RC05, Exhibit B/Section 5

5.3. **Document Inventory Requirements:** See GR01 Module B Section 5 for Document Inventory requirements for Support Packages.

5.4. **Sample Receipt, Storage, Tracking and Internal COC Records Requirements**: The Support Package shall include sample receipt, storage, tracking, and internal COC records as required in GR01 Exhibit F Sections 2 and 3.

5.5. **Copy of the Sample Data Package**: The Support Package shall include a photocopy of the Sample Data Package.

5.6. **Instrument Calibration Package:** The Laboratory is not required to maintain a hard copy of the Instrument Calibration Package as part of the Support Package. However, the Laboratory shall maintain the capability to generate a package that is within the five year retention period as described in GR01 Exhibit F, Section 4

5.7. **Original SRM and Source Certificate Requirements**: The Support Package shall include the originals of all standard certificates required for meeting GR01 Exhibit E Section 6. It is expected these originals will be included by referencing their location on the Support Package Document Inventory.

5.8. **Original Logs and/or Logbook Requirements**: Logs and/or logbooks include, but are not limited to, preparation logs, instrument run logs, standard dilution logs, balance calibration logs, pipette calibration logs, instrument maintenance logs, and ASTM type II water logs. All logs must be included in the Support Package. (It is expected that many of these items will be included by referencing their location on the Support Package Document Inventory.)

5.9. **Standard Operating Procedure Requirements**: The Support Package shall include the SOPs required for meeting RC05 Exhibit F Section 4. (It is expected these procedures will be included by referencing their location on the Support Package Document Inventory.)

5.10. **QC Control Charts**: The Support Package shall include QC Control Charts of Preparation Blanks, LCSs, detector Backgrounds, and check sources. Refer to RC05 Exhibit E, Section 12. (It is expected that these items will be included by referencing its location on the Support Package Document Inventory.)

5.11. **Software Quality Assurance**: The Support Package shall include Software Quality Assurance Documentation required by GR01, Exhibit F Section 5. (It is expected that this information will be included by referencing its location on the Support Package Document Inventory.)

5.12. **Support Package Electronic Data Deliverable Requirements**: The copy of the Sample Data Package contained in the Support Package may include the EDD by reference to the physical location and file identifier for a retained copy of the EDD.

EXHIBIT C

RADIONUCLIDE TARGET ANAYLTE LIST AND REQUIRED DETECTION LIMITS

TABLE OF CONTENTS

SECTION **PAGE NO.**

1. RADIONUCLIDE TARGET ANAYLTE LISTS C-2

RADIONUCLIDE TARGET ANAYLTE LIST

1. RADIONUCLIDE TARGET ANAYLTE LISTS AND REQUIRED DETECTION LIMITS (RDL)

TABLE C1 STRONTIUM

	Line Item Code:	**RC05B001**	**RC05B002**	**RC05B003**
	Matrices:	**Water**	**Soil[1]**	**Waste[2, 3]**
	Reporting Units:	**(pCi/l)**	**(pCi/g)**	**(pCi/g)**
CAS No.	**Isotope**	**RDL**	**RDL**	**RDL**
11-10-9	$^{89/90}Sr$	1.0	1.0	1.0
10098-97-2	^{90}Sr	1.0	1.0	1.0

(1) The activity units for soils shall be reported in pCi/g of dried sample.

(2) The activity units for waste shall be reported in pCi/g of sample as received.

(3) Waste includes, but is not limited to, sludge, oil, and chemicals.

EXHIBIT D

RADIOCHEMICAL ANALYTICAL METHOD

TABLE OF CONTENTS

SECTION **PAGE NO.**

1. INTRODUCTION D-2

2. METHOD SELECTION AND APPLICATION D-2

3. SAMPLE HOLDING TIMES AND PRESERVATION REQUIREMENTS D-4

4. SAMPLE PREPARATION REQUIREMENTS D-4

5. COUNTING AND CALCULATION REQUIREMENTS D-6

RADIOCHEMICAL ANALYTICAL METHODS

1. INTRODUCTION

1.1. This Exhibit contains method requirements for analyzing radiometric strontium by gas proportional counting.

1.2. The analytical method selected for this module shall meet the minimum method QA/QC requirements in Exhibit E.

2. METHOD SELECTION AND APPLICATION

2.1. **Minimum Detectable Activity (MDA)**: The method(s) selected for analyses under this subcontract must be able to achieve an MDA that meets the analyte Required Detection Limits (RDLs) specified in RC05, Exhibit C.

2.2. **Method Limitations**: In choosing an analytical method on which to base an SOP, the laboratory should be aware that many analytical methods often have limitations. Some analytical methods assume the presence of only the isotope of interest, and others assume the absence of a specific interfering isotope. Analytical methods involving dissolution or leaching may assume that the element of interest is in a specific chemical form. Careful attention to the conditions and limitations is essential both in the selection of radiometric strontium analysis procedures and in the interpretation of data obtained from those analytical methods. The analytical method(s) selected for this module shall meet the minimum method QA/QC requirements in Exhibit E.

2.3. **Hazardous Additions**: The methods of choice shall not introduce hazardous constituents over and beyond that which may be inherent to the sample, when alternative methods are available.

2.4. **SOP Development**: Presently, there is no universally accepted compilation of required standard methods for the determination of radiometric strontium by gas proportional counting. However the analytical methods provided in RC05, Exhibit H and their updated versions may be referenced by the laboratories in developing their analytical method SOPs for this module, with the above listed stipulations in mind.

2.5. **Strontium 89/90**: This method forms the basis for analyzing radiometric strontium (isotopes 89 and/or 90).

2.5.1. Two of the options for determining chemical recovery, by measuring stable Sr {either by weighing the $Sr(NO_3)_2$ residue or by instrumental analyses of Sr, e.g., by atomic absorption (AA) or inductively coupled plasma (ICP)}, are suggested. Using stable Sr is the preferred way and introduces no counting interferences and is generally appropriate for proportional counting. The basis for this method is covered under this statement of work and involves adding a known amount of stable strontium carrier to each sample and QC sample before the dissolution of the sample is performed. Large samples are reduced in volume by evaporation, cation exchange, or by coprecipitation.

2.5.2. Stable strontium present in the sample will interfere with the yield determination. If the Sr content in the sample is unknown, it should be determined by atomic absorption (AA), inductively coupled plasma (ICP), or by a duplicate sample run with no added Sr carrier so that appropriate adjustments can be made to the amount of Sr carrier recovered.

2.5.3. The weight of the stable Sr blank is subtracted from the residue weight of the sample to get the net residue weight. The chemical recovery is determined by dividing the net residue weight of the sample by the amount of stable Sr carrier added. Samples and QC samples are then counted on a low background gas proportional counter.

2.5.4. A known amount of inactive strontium ions, in the form of strontium nitrate, $Sr(N0_3)_2$, is added as a "carrier". The carrier, alkaline earths, and rare earths are precipitated as the carbonate to concentrate the radiostrontium.

2.5.5. The carrier, along with the radionuclides of strontium, are separated from other radioactive elements according to the laboratories SOP.

2.5.6. The strontium carrier along with the radionuclides of strontium are precipitated, dried, weighed to determine recovery of carrier, and measured for total strontium radioactivity. The activity in the final precipitate is due to radioactive strontium only, because all other radioactive elements have been removed.

2.5.7. A correction is applied to compensate for losses of carrier and activity during the various purification steps. NOTE: A delay in counting will give an increased counting rate due to the ingrowth of ^{90}Y.

2.5.8. Because it is impossible to separate the isotopes of ^{89}Sr and ^{90}Sr by any chemical procedures, the amount of ^{90}Sr is determined by separating and measuring ^{90}Y, its daughter.

2.5.9. After equilibrium is reached, the activity of ^{90}Y is exactly equal to the activity of ^{90}Sr. Yttrium carrier is added and separated by precipitating the yttrium hydroxide and then finally precipitating the yttrium oxalate for counting.

2.6. **Gas Proportional Counting to determine Total Sr or ^{89}Sr and ^{90}Sr individually**.

2.6.1. This type of determination requires a beta count immediately following the Sr purification to determine total strontium. The counting result immediately ascertained, represents the total strontium in the sample, (^{89}Sr and ^{90}Sr), plus an insignificant fraction of the ^{90}Y ingrowth. The determination of ^{89}Sr and ^{90}Sr individually also requires a second count after ^{90}Y ingrowth and separation.

2.6.2. An appropriate aliquot (enough to produce appropriate counting statistics in a reasonable amount of time, <1h) of the eluent is pipeted evenly onto a stainless-steel planchet.

2.6.3. The sample should be counted within 3 h after the Sr is stripped from the column to obtain a total beta count rate and a background count rate. If the 3 h limit is exceeded, more error will be introduced in the final determination due to ^{90}Y ingrowth.

2.6.4. If only ^{90}Sr analysis is required, the Sr fraction can be saved to allow ^{90}Y ingrowth. After sufficient ingrowth time (e.g., at least one week) the fraction is redissolved, and ^{90}Y is purified and counted. This option can give very good detection limits and is independent of the presence of ^{89}Sr.

2.6.5. Apply the appropriate conversion factors and volume or weight factors to calculate quantities of ^{89}Sr, total Sr, and ^{90}Sr per sample aliquot to obtain the desired reporting units decal corrected to the data of sampling.

3. SAMPLE HOLDING TIMES AND PRESERVATION REQUIREMENTS

3.1. **Holding Time:** The maximum sample holding time allowable under this Statement of Work (SOW) is **90 days**. To comply with this SOW, the Laboratory shall analyze samples within this time, even if the time is less than the maximum data submission time allowed.

3.2. **Sample Preservation**

3.2.1. Water samples are typically preserved with nitric acid to pH less than 2 unless the sample is suspected to contain acid incompatible compounds, in which case the appropriate preservation will be refrigeration at $4^{o}C \pm 2^{o}C$.

3.2.2. Water samples which will be analyzed within 24 hours of receipt do not require acid preservation; however, these samples shall be maintained at $4^{o}C \pm 2^{o}C$.

3.2.3. Samples other than water shall not be preserved with acid, unless specified by the CTR; however, these samples shall be maintained at $4^{o}C \pm 2^{o}C$.

3.2.4. The laboratory is required to verify preservation of samples upon receipt as specified in GR01, Exhibit F, Section 3.

3.2.5. If acidification was the proper preservation, as indicated on the COC, and it was found upon pH verification to have not been properly performed, the laboratory shall add concentrated nitric acid to bring the sample to pH < 2. Such action shall be recorded on the COC and the appropriate sample receiving documentation. The sample shall be retained in its original container for a minimum of 16 hours before aliquotting the sample.

4. SAMPLE PREPARATION REQUIREMENTS

4.1. **Water Purity:** Requirements for laboratory ASTM type II water purity are specified in Exhibit D of the General Laboratory Requirements Module, GR01.

4.2. **Analytical Radiological Control:**

4.2.1. The laboratory shall maintain a radiological control program which rigorously addresses analytical radiological control. One important aspect of this program will be the procedures for segregating samples with potentially widely varying levels of radioactivity. The radiological control program must explicitly define how low level and high level samples will be identified and segregated and processed in order to prevent sample cross-contamination. The quality of the program will be evident in evaluation of the method QC.

4.2.2. Rocky Flats Environmental Technology Site samples are not expected to contain high levels of Sr; however, they may contain high levels of other radionuclides

4.2.3. Glassware, sieves, mortars and pestles, grinders and other such laboratory equipment that directly come in contact with high level samples shall be designated as high level, and shall

be segregated from low level. This equipment shall not be used to prepare low level samples.

4.2.4. To reduce the chances of cross-contamination (that would not be detected in an aqueous Preparation Blank), sieves shall be used at a minimum, and only when necessary to remove rocks.

4.2.5. If the sample activity is high enough to warrant use of additional radiological control practices in order to minimize the potential of contaminating the laboratory, a reduced aliquot size can be used if approved by the CTR. In some cases, use of small aliquots will be compensated for by requiring more than one analysis aliquot in order to reduce the effect of sub-sampling errors The laboratory's methodology for aliquotting and processing high level soils, sludges and sediments shall be discussed in applicable procedures.

4.2.6. The laboratory shall have a procedure for glassware and equipment cleaning and decontamination which contains, at a minimum, the following requirements:

- At a minimum, the glassware and applicable equipment shall be fully submersed, soaked and cleaned in a suitable decontaminating/cleaning agent, followed by a thorough acid soaking, and thorough rinsing with ASTM type II water.
- Low level glassware and applicable equipment shall not be cleaned in the same receptacle as high level glassware and equipment.
- The cleaning receptacles and any reused acids shall be segregated by high and low level.
- The cleaning agents shall not be reused.

4.2.7. Ion exchange and extraction resins shall be replaced or regenerated prior to each use. Prior to using newly regenerated resin, the resin shall be tested, proven and documented as having no added radioactivity that would interfere with the analyses.

4.3. Planchet Preparation

4.3.1. Planchets shall be thoroughly cleaned before use to ensure that there are no interfering residues or contamination.

4.3.2. Moisture absorbed by the residue on the counting planchet will affect self-absorption characteristics of the sample, thus prepared planchets should be stored in a desiccator until they are counted.

4.4. Preparation Requirements for Solid Samples

4.4.1. Unless instructed otherwise by the CTR, all samples shall be mixed thoroughly prior to allocating for preparation. The sample aliquot shall be as representative as possible of what is in the original sample container.

4.4.2. For soils, sludges and sediments, the following preparation steps are required, unless specified otherwise by the CTR.

- If there is sufficient sample, the initial aliquot to be dried and homogenized shall be at least 10% of the entire sample by volume (up to approximately 100 grams), and a minimum of 30 grams
- If there are less than 30 grams in the sample container, the entire contents of the container shall be dried and homogenized

- The dried aliquot shall be mechanically reduced in particle size to a fine powder. The assessment of sufficient particle size reduction shall be determined either as a visual or tactile approximation, wearing proper personal protective equipment.

4.4.3. Total digestion/dissolution is required for soils, sediments, sludges, waste, filter socks, and filters, unless specified otherwise by the CTR.

4.5. Preparation Requirements for Aqueous Samples containing Sediment

This section is applicable to aqueous samples which contain, by visual approximation, greater than 10% sediment, soil or other solid material.

4.5.1. The sample shall be mixed thoroughly prior to aliquotting or coprecipitation if applicable. The sample aliquot shall be as representative as possible of what is in the original sample container.

4.5.2. After aliquotting or coprecipitation the aliquot shall be digested with nitric acid or a nitric/hydrochloric acid mixture until the sediment is dissolved or nearly dissolved. Total dissolution is not required; however, any undissolved material should be left in the digestate.

5. COUNTING AND CALCULATION REQUIREMENTS

Refer to Exhibit E of this module for additional QA/QC requirements.

5.1. Counting Requirements

5.1.1. Instrument Background:

- Background count time shall be equal to the sample count time.

5.1.2. Counting Time

- The count time for the analyses shall be sufficiently long to achieve MDAs which meet the RDLs.

5.2. Calculations

The analysis SOP(s) shall include the equations used to calculate sample analyte activities, uncertainties, and MDAs. The laboratory shall provide all necessary information used to calculate these values, even if not explicitly required in this SOW.

5.2.1. The calculation routines for analyte activity <u>and uncertainty</u> shall take into account the following:

- instrument background
- detector efficiency
- self-absorption correction
- alpha to beta crosstalk correction (at a minimum)
- sample dilution
- wet/dry ratios (% moisture), if applicable

5.3. Preparation Blank Correction

5.3.1. Samples that naturally contain significant amounts of stable strontium will cause errors in the recovery of the added strontium carrier. Blank samples to which no strontium carrier is added should be run to determine natural strontium content. The amount of natural strontium contained in the sample aliquot should be used to correct the yield. The residue weight of the preparation blank shall be subtracted from the residue weight of the sample to get the net residue weight. The unknown natural strontium content in the sample can also be determined by atomic absorption (AA), or inductively coupled plasma (ICP), so that appropriate adjustments can be made to the amount of Sr recovered.

5.3.2. Preparation blank correction for analyte activity is not allowed.

EXHIBIT E

QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

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QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

1. INTRODUCTION

The purpose of this Exhibit is to describe the processes by which radiometric strontium by gas proportional counting meets the defined quality objectives. This module requires a variety of activities which represent the minimum QA/QC operations necessary to satisfy the analytical requirements associated with the determination of radiometric strontium by gas proportional counting. These operations and those in the General Laboratory Requirements Module, GR01, are designed to ensure the generation of comparable data from all laboratories. These requirements do not release the Laboratory from maintaining its own QC checks on method and instrument performance.

2. QUALITY ASSURANCE PLAN

Requirements for the quality assurance plan are specified in GR01 Exhibit E.

3. ANALYTICAL BATCH QUALITY CONTROL REQUIREMENTS

3.1. **Sample Control**: All laboratory identifications used for the prepared samples through the entire analysis (identifications of beakers, planchets, filter papers, vials, etc.) shall be documented and traceable to the Site sample identifications and the respective preparation Analytical Batch Identification.

3.2. **QC Sample Identification**: All QC samples in the preparation Analytical Batch shall be designated with the QC type (refer to RC05, Exhibit B for details) and a unique identification that is traceable to the respective preparation Analytical Batch Identification.

3.3. **QC Traceability to Primary SRM Certificate**: All tracer and LCS aliquot identifications shall be traceable to the respective primary SRM certificate, the standard log and the respective preparation Analytical Batch Identification.

3.4. **Traceability of Measuring and Testing Equipment (M&TE)**: All pipette and balance identifications specified on all Analytical Batch preparation benchsheets or logs shall be traceable to the respective calibration log.

3.5. **Reanalysis**: The Analytical Batch ID for reanalysis must be different from that of the original analysis. All reanalyses shall be traceable to the reanalysis Analytical Batch Identification and to the reanalysis Analytical Batch QC samples.

3.6. **QC Sample Preparation**: The LCS shall be spiked at an appropriate activity level, (refer to Section 8 of this exhibit.). All batch QC samples shall be prepared concurrently and in the same manner as the samples.

3.7. **QC Sample Counting**: All QC samples shall be counted, and analyzed in the same manner as the samples in the Analytical Batch, in the same time frame and using the same instrument calibration parameters, instrument analysis algorithms, etc.

4. RESULTS REPORTING REQUIREMENTS

4.1. The sample activities, measurement uncertainties and MDAs shall be rounded and reported as follows, unless specified otherwise by the CTR:

Sample Activity	Reported
<1.0	nearest tenth digit (0.1)
1 to 99	nearest 1's digit (whole number)
>100	two significant figures (scientific notation)

4.2. Negative activities shall be reported as such. Results in which the sum of the activity and the measurement uncertainty at 2-sigma is a negative number are generally unacceptable and shall not be reported without evidence, such as recounting, to show that the data are not in error.

5. MDA DETERMINATION

The MDA, which is the smallest quantity of a radionuclide that can be detected in a sample with a 95% confidence level, shall be calculated for each analyte for each sample and QC sample analyzed.

5.1. **MDA Factors and Conditions:** The MDAs are determined based on the factors and conditions which influence the measurement. These factors include the sample size, planchet residue weight (self-absorption factor), recovery, count duration, detector background, and detector efficiency.

5.2. **MDA Optimization:** The laboratory shall optimize analysis parameters in order to achieve analyte MDAs less than or equal to the RDLs (Exhibit C of this module), except when sample activities are significantly greater than the RDL. Refer to section 10 of this exhibit for guidelines concerning assessment of data where the MDA exceeds the RDL. Samples with elevated activities shall be handled according to the following requirements:

5.2.1. If the sample activity is expected to be greater than or equal to 50 times the RDL, reduced aliquots may be used in order to reduce the potential for laboratory contamination and sample cross-contamination.

5.2.2. The appropriate aliquot size shall be determined based on the activity level in the sample. The aliquot must be large enough to generate data which meet the following criteria:

- The measurement uncertainty shall not be greater than 15% of the sample activity.
- The MDA for the analysis shall be a maximum of 20% of the sample activity.

5.2.3. The following equation shall be used to calculate the MDA (pCi/g or pCi/l):

$$MDA = \frac{\frac{2.71}{T_S} + 3.29\sqrt{\frac{BKG}{T_S} + \frac{BKG}{T_B}}}{2.22 \times EFF \times AMT \times Y \times e^{-lt}}$$

where,

BKG	=	Background count rate (cpm)
T_B	=	Background count time (minutes)
T_S	=	Sample count duration (minutes)
EFF	=	Detector efficiency
AMT	=	Analysis Aliquot (liters or grams)
$e^{\lambda t}$	=	Decay correction (for specific radionuclide)
Y	=	Chemical recovery obtained from gravimetric stable carrier.

6. QC SAMPLES- PREPARATION BLANK (PB)

The purpose of the preparation blank analysis is to assess the extent of contamination introduced through aliquotting, sample preparation, analysis, and for the assessment of samples that contain significant amounts of stable strontium.

6.1. **Frequency:** At least one preparation blank consisting of ASTM Type II water shall be prepared and analyzed with every Analytical Batch of samples prepared, at the frequency specified in GR01. An aqueous Preparation Blank shall be used for soils, sediments, sludges and waste and all non aqueous matrices.

6.2. **Counting**: Preparation blanks shall be counted for at least the same count duration as the samples, unless the samples had to be counted for a longer time than the routine count time in order to meet the RDL (refer to Exhibit D, Section 5). In this case, the preparation blank data from the routine count time, if collected, can be assessed provided that it meets all of the requirements for preparation blank data described in this section..

6.3. **MDA**: The Preparation Blank MDA calculation shall be based on the greatest sample volume or weight for the entire Analytical Batch.

6.4. **Blank Assessment:** The Preparation Blank Data shall be assessed according to following criteria:

6.4.1. If the MDAs for the samples in an Analytical Batch meet the analyte RDLs and the sample activities are less than 5 times the RDL (Exhibit C), the activity of the preparation blank shall be equivalent to zero when the measurement uncertainty is considered and shall be less than or equal to the RDL.

6.4.2. If the MDAs for the samples in an Analytical Batch do not meet the analyte RDLs due to sample matrix effects and the sample activities are less than the MDAs, the Preparation Blank data shall be assessed as follows: The Preparation Blank analyte activity shall be equivalent to zero when the measurement uncertainty is considered and the preparation blank activities shall be less than the MDAs for the measurements.

6.4.3. If the MDAs for the samples in an Analytical Batch do not meet the RDL due to high analyte activity and reduced sample size (as per Step 5.2 of this Exhibit), the Preparation Blank analyte activity shall be less than 1% of the sample analyte activity.

7. QC SAMPLES- DUPLICATES

The purpose of the Duplicate sample analysis is to assess the data precision by providing information on the laboratory's analytical reproducibility, and the homogeneity of the sample.

7.1. **Frequency**: A Duplicate sample analysis shall be performed at the frequencies specified in GR01.

7.2. **Reporting**: The Duplicate activity shall not be averaged with the corresponding sample activity when reporting results.

7.3. **Selection**: If it is not possible to use a sample from the same RIN for the Duplicate, another Site sample may be used. However, both that sample and the Duplicate results shall be reported for the Analytical Batch requirement in the RIN. This shall be explained in the Narrative. Referral to other Data Packages is not allowed.

7.3.1. Samples identified as Field Blanks should not be used for Duplicate sample analysis.

7.3.2. The Site may require that a specific sample be used for Duplicate sample analysis.

7.4. **Counting**: Duplicates shall be counted for the same count duration as the samples.

7.5. **Equivalency**: The following equations shall be used to test the equivalency between the Duplicate and respective sample activities with the measurement uncertainties stated at the 2 sigma confidence level:

$$F = |S - R|$$

$$E = \sqrt{E_S^2 + E_R^2}$$

where,

F	=	The absolute difference of the sample and duplicate activities
S	=	Original sample activity
R	=	Duplicate sample activity
E	=	Propagated measurement uncertainty of the difference at 2-sigma
E_S	=	2-sigma measurement uncertainty of sample activity
E_R	=	2-sigma measurement uncertainty of Duplicate activity

7.5.1. F shall be $\leq$ E*1.5 or F/E $\leq$ 1.5 for acceptable duplicate precision.

8. QC SAMPLES- LABORATORY CONTROL SAMPLE (LCS)

The purpose of the laboratory control sample is to provide information about the degree of accuracy of the analysis, and to assess the overall preparation and measurement processes for any inherent biases or trends.

8.1. **Frequency**: A valid (unexpired) NIST-traceable LCS shall be prepared and analyzed at the frequency specified in GR01.

8.2. **Isotopes**: The isotopes for the LCS shall be $^{90}Sr/^{90}Y$.

8.3. **Matrix**: Aqueous LCSs may be used for soil and all non aqueous matrices.

8.4. **Reporting Units**: The units for reporting the LCS are up to the discretion of the laboratory as long as the units are specified, and are the same for both the observed and certified values.

8.5. **Selection and Level**: The activity level in the LCS shall be at an appropriate level for the samples in the Analytical Batch. The activity in the analysis aliquot should be sufficiently high to produce statistically sound data. However, the activity level should not be so high as to create a potential for sample or laboratory cross-contamination.

8.5.1. The LCS for low level, environmental water samples, low level soil samples and low level waste samples shall be less than 5 pCi/aliquot.

8.5.2. For higher level samples, the activity in the analysis aliquot (not the concentration of the activity in the sample) shall be used to determine the appropriate LCS level.

8.6. **Counting**: The LCS shall be counted for the same count duration as the samples.

8.7. **Acceptance Criteria**: The observed value (OV) of the LCS shall meet both of the following criteria:

8.7.1. The OV of the LCS shall be within plus or minus three standard deviations of the standard value (SV).

8.7.2. The percent recovery (OV/SV * 100) shall be in the range of 75% to 125%.

9. ANALYSIS QC ASSESSMENT

9.1. Chemical Recovery

9.1.1. The purpose of the chemical recovery is to evaluate the effectiveness of the sample preparation process used to isolate the radioisotope(s) of interest. The chemical recovery is used to calculate the quantity of the Sr or Y in the sample aliquot.

9.1.2. In general, the following equations are the <u>basis</u> for calculating the chemical recovery :

The residue weight of the stable Sr blank is subtracted from the residue weight of the sample to get the net residue weight. The chemical recovery is determined by dividing the net residue weight of the sample by the amount of stable Sr or Y carrier added.

$$R_{Sr} = \frac{(\text{ mg Sr })}{(\text{wt Sr carrier})\ (\text{conc. Sr carrier})}$$

$$R_{Y} = \frac{(\text{mg Y})}{(\text{wt Y carrier})\ (\text{conc. Y carrier})}$$

9.1.3. The chemical recovery for Sr or Y analyses shall be > 30% but < 110%.

9.2. **Analytical Batch QC Assessment**: The reviewer shall assess the Analytical Batch QC and determine if the sample results for the Analytical Batch are acceptable. The Data Review Checklist provides documentation of this assessment.

10. CONDITIONS REQUIRING REANALYSIS

10.1. **Sample and Analyte Specific Conditions**: Any one of the following are conditions that require reanalysis for a particular sample and analyte, beginning with the preparation:

10.1.1. If the sample activity is less than twice the analysis MDA and the target analyte RDL was not met due to inadequate sample aliquot size, sample matrix problems, inadequate count duration, low detector efficiencies, or high detector backgrounds, the sample shall be reanalyzed under more optimal conditions, and the reasons for reanalysis shall be reported in the Narrative.

10.1.2. If the target analyte RDL was not met but the sample analyte activity is greater than two times the analysis MDA, reanalysis is not required provided that all other QC assessment criteria are acceptable.

10.1.3. If the sample aliquot is spilled or measured incorrectly, reanalysis is required.

10.1.4. If a prepared planchet is dropped and the residue weight changed, the sample shall be reanalyzed. If the planchet was one of the batch QC samples, the entire batch shall be reanalyzed.

10.1.5. If the salt "crept over" the edge of the planchet during preparation the sample shall be reanalyzed. If the planchet was one of the batch QC samples, the entire batch shall be reanalyzed.

10.2. **Analytical Batch Conditions**: Except where noted otherwise, any one of the following conditions requires reanalysis of the entire Analytical Batch, beginning with the preparation:

10.2.1. If the Preparation Blank data does not meet the acceptance criteria specified in this Exhibit, reanalysis of the entire batch is required.

10.2.2. If the Duplicate does not meet the required precision specified in this Exhibit reanalysis of the entire batch is required. Duplicate data variability which is due to extreme sample heterogeneity should be discussed with the CTR.

10.2.3. If there are any unexplainable sample identification mix-ups (e.g., switched beakers, planchets, etc.), reanalysis is required.

10.2.4. If the LCS observed activity is outside the required limits specified in this Exhibit, reanalysis is required.

10.2.5. If there is any sample spattering during the preparation, reanalysis is required.

10.2.6. If there is any evidence of contaminated glassware or reagents (may or may not be demonstrated in the Preparation Blank), reanalysis is required.

10.2.7. If any standards or standard sources used in the analysis are expired, reanalysis is required.

10.2.8. If there is an unexplainable mix-up between the QC samples, either among themselves or with any samples in the Analytical Batch, reanalysis is required.

11. INSTRUMENT CALIBRATION

11.1. **Calibration Frequency:** The gas proportional counters shall be calibrated every two years at a minimum. The instrument shall also be calibrated whenever instrument maintenance or repair which may effect counting performance was done or when instrument QC data, particularly check source data, indicates that the instrument performance may have changed.

11.2. **Calibration Curve Matrix:** Due to the many different techniques for concentration and separation of radiostrontium, the calibration curves must be of the same matrix as the sample counting planchet residue.

11.3. **Alpha Calibration Requirements:** If the separation scheme is designed to remove all alpha emitters from the strontium and yttrium fractions, then alpha calibration, including alpha to beta crosstalk, requirements can be disregarded.

11.4. **Reporting Requirements** The Instrument Calibration Package shall be completed and submitted as specified in Exhibit B of this module.

11.5. **Calibration Sources and Standards**:

11.5.1. Standardization of strontium and yttrium carriers shall be performed in triplicate.

11.5.2. The instrument calibration sources, used for voltage plateaus, discriminator window setting, shall be NIST traceable, or equivalent; however, source(s) used in calibration verification (check sources) are not required to be NIST-traceable, unless measurements of these sources are directly used in calculation of analytical sample data results.

11.5.3. The calibration sources should provide adequate counting statistics over the period for which the source is to be counted. However, the source shall not be so radioactive as to cause pulse pileups, or dead time that is significantly different from that to be expected from routine analyses.

11.5.4. The geometry of the calibration sources used for efficiency and self-absorption/crosstalk curves must be the same as the that of the prepared sample and QC sample planchets The depth and shape (flat, flanged, ringed, etc.), in addition to the diameter, are important components of geometry.

11.5.5. Commercially prepared sources shall not be used after their stated expiration dates, which are based on radionuclide half-life or physical form of the standard, (e.g., sealed sources or plated planchet).

11.5.6. The standard reference material used to prepare sources for determining detector efficiencies and self-absorption curves shall be NIST traceable.

11.5.7. Standards prepared from certified radioactive standards at the laboratory or those purchased without expiration dates should be recertified against an NIST traceable standard or replaced yearly.

11.6. **Voltage Plateau**

11.6.1. The voltage range used to prepare the counting plateau must be wide enough to fully define the “knee” of the plateau and the end of the plateau.

11.6.2. The source must be counted long enough to obtain 10,000 counts or more for each point on the plateau portion of the curve.

11.6.3. The length and slope of the plateau shall be calculated and verified to meet the instrument manufacturer's specifications.

11.6.4. If the operating voltage setting is common to more than one detector in the system, the optimum operating voltage for all common detectors shall be selected.

11.7. **Discriminator Window Settings**

11.7.1. The discriminator windows shall be set individually for each detector.

11.7.2. The windows shall be set to achieve a beta to alpha crosstalk value of less than 1%.

11.8. **Efficiency Calibration**

11.8.1. Separate counting efficiencies and errors should be determined for ^{89}Sr and ^{90}Sr using known amounts of the respective radioactive standards and strontium carrier.

11.8.2. The efficiency calibration sources must counted long enough to obtain a minimum of 10,000 counts.

11.9. **Self-Absorption and Crosstalk Curves**

11.9.1. Self-absorption curves are required for both alpha and beta counting. A crosstalk curve shall be established from the same data for alpha to beta crosstalk versus residue weight. Beta to alpha crosstalk is not significantly affected by planchet residue weight, and is generally constant over the applicable weight range. Therefore, crosstalk curves are not required for beta to alpha crosstalk.

11.9.2. The self-absorption and crosstalk curves should consist of at least 8 points well distributed throughout the mass range unless instrument specific programs designate otherwise.

11.9.3. Each alpha and beta calibration standard shall be counted to an accumulation of 10,000 counts

11.9.4. The maximum calibration planchet density for beta counting should be $\leq$10 mg/cm^2.

11.9.5. The isotopes used for calibration should be and ^{90}Sr and ^{90}Y.

11.9.6. Standard activity shall be decay corrected (if applicable) prior to calculation of instrument efficiency.

11.9.7. The laboratory SOPs shall define the acceptance criteria for self-absorption and crosstalk curves and goodness of fit statistics for these curves

11.10. **Check Source Requirements**

11.10.1. The alpha and beta calibration of each detector used to count analytical samples or QC samples under this module is required to be checked daily. The only exception to this requirement is when performing analyses with extended count times. In this case, check source measurements may be performed between sample sets.

11.10.2. Check sources shall be analyzed following gas changes, before samples are counted.

11.10.3. Check source data shall be evaluated with tolerance or QC charts. Refer to Section 12 for additional details regarding control charting of check source data.

11.10.4. If the daily check source count results exceeds the tolerance limits or ± 3 sigma control limits, the laboratory should recount the check source to verify the out of control condition. If the recount result again exceeds the control limit, the system is considered out of control, and no samples shall be run on that system until it is brought back into control. If the recount is in control, analytical sample counting may continue. Samples shall not be analyzed on out of control detectors.

11.10.5. Check source data must be submitted with each reporting batch (continuing calibration) and will be evaluated at that frequency. If samples within a reporting batch are from separate counting batches, check source data must be included for all counting batches.

11.11. **Instrument Backgrounds**

11.11.1. Instrument backgrounds for both alpha and beta shall be determined weekly.

11.11.2. The count time for the backgrounds shall be the same as the routine count time for samples unless precluded by extended sample count times as necessary to meet the RDL.

11.11.3. The instrument backgrounds and uncertainties used in calculating sample analyte activities should be based on the averages of at least 5, and preferably 10 to 20, background counts. Alternatively, the instrument background may be based on a single count which is at a minimum of five times as long as the routine sample count time.

11.11.4. The laboratory SOPs shall define the evaluation and acceptance criteria for instrument background data.

11.11.5. Control charts for instrument backgrounds (for beta) must be maintained. Refer to Section 12 for additional details

12. CONTROL CHARTING REQUIREMENTS

The Site requires that control charts of preparation blanks, LCSs, detector backgrounds and check sources be prepared . These charts shall be maintained at the laboratory and be available during on-site audits.

12.1.1. *Instrument Backgrounds*

Instrument background data must be plotted on control charts with the mean and ± 3 sigma limits. Initial control limits, for new instruments or instruments in which the backgrounds may have significantly changed due to repair or modification, can be set empirically based on expected or historical instrument performance. However, once sufficient data have been collected, the control limits should be recalculated based on a minimum of 10 points. Instrument backgrounds of GPC detectors may be expected to very gradually increase with use over time. The purpose of the background control charts is not to take instruments out of service for this expected behavior; therefore, the control limits should be recalculated periodically to account for this. Control charting detector backgrounds is done to monitor for sudden significant increases or decreases in background count rate, which may be indicative of instrument problems.

12.1.2. *Check Sources*

The control limits for check source control charts shall be established using a minimum of 20 data points. No samples, subject to these specifications may be counted until these control limits have been established..

13. MEASURING AND TESTING EQUIPMENT REQUIREMENTS

Requirements for measuring and testing equipment are specified in GR01.

14. DATA MANAGEMENT

Requirements for site data management are specified in GR01.

15. PERFORMANCE EVALUATION SAMPLES

Participation in the following evaluation programs are required under this statement of work. See GR01 Exhibit E, Section 8 for general requirements.

15.1. Las Vegas (CRD-LV)

15.2. DOE Environmental Monitoring Laboratory (EML)

15.3. DOE Mixed Analyte Performance Evaluation Program (MAPEP) semi-annual participation

16. INSTRUMENT MAINTENANCE/REPAIR DOCUMENTATION

16.1. The laboratory shall identify and document the instrument manufacturer, model number, configuration, settings, detector identifications, and any modifications in the instrument maintenance log.

16.2. All repairs and modifications shall be documented.

16.3. Following all repairs and modifications, verification of calibration and/or calibration shall be performed and documented.

17. ON-SITE LABORATORY EVALUATIONS

Requirements for on-site laboratory evaluations are specified in the General Laboratory Requirements Module, GR01.

18. PERFORMANCE CRITERIA

Requirements for performance criteria are specified in the General Laboratory Requirements Module, GR01.

19. CERTIFICATIONS AND APPROVALS

Laboratories are encouraged to provide proof of certifications or approvals for any programs in which the Laboratory is participating. Proof of laboratory certifications (or approvals) delivered to the CTR according to the schedule in GR01 Exhibit B Table B2 may increase the potential sample load for Laboratories providing this proof.

19.1. In particular, proof of the following laboratory certification or approvals to the CTR according to the schedule in GR01 Exhibit B Table B2 will increase a laboratory's potential sample load:

19.1.1. State of Utah certification for the determination of isotopic parameters in samples related to RCRA Treatment, Storage, and Disposal facilities for low-level radioactive waste.

EXHIBIT F

EVIDENTIARY REQUIREMENTS

TABLE OF CONTENTS

SECTION **PAGE NO.**

1. INTRODUCTION F-2

2. SAMPLE CHAIN-OF-CUSTODY F-2

3. DOCUMENT CONTROL PROCEDURES F-2

4. STANDARD OPERATING PROCEDURES F-2

EVIDENTIARY REQUIREMENTS

1. INTRODUCTION

The purpose of this Exhibit is to describe the evidentiary requirements that must be followed for the preparation and analysis of Site samples for radiometric strontium by gas proportional counting under this subcontract.

2. SAMPLE CHAIN OF CUSTODY

2.1. Requirements for the following chain-of-custody procedures are specified in Exhibit F of the General Laboratory Requirements Module, GR01:

- Sample Identification;
- Chain-of-custody Procedures;
- Sample Receiving Procedures; and
- Sample Tracking Procedures.

3. DOCUMENT CONTROL PROCEDURES

3.1. Requirements for the following document control procedures are specified in Exhibit F of the General Laboratory Requirements Module, GR01:

- Preprinted Laboratory Forms and Logbooks;
- Consistency of Documentation;
- Document Numbering and Inventory Procedures;
- Storage of Site Files; and
- Shipping Data Packages and Sample Data Packages.

4. STANDARD OPERATING PROCEDURES

4.1. Requirements for the following SOPs are specified in the General Laboratory Requirements Module, GR01:

- SOP Specifications and Format;
- Required Evidentiary SOPs;
- Required Analytical SOPs;
- Required Quality Management SOPs;
- Handling of Confidential Information; and
- SOP Delivery Requirements.

EXHIBIT G

GLOSSARY OF TERMS AND ACRONYMS

TABLE OF CONTENTS

SECTION **PAGE NO.**

1. INTRODUCTION. G-2

2. GLOSSARY OF TERMS G-2

3. ACRONYMS G-2

GLOSSARY OF TERMS AND ACRONYMS

1. INTRODUCTION

The glossary of terms and acronyms contained in parameter-specific analytical module(s) supplement those found in the General Laboratory Requirements Module, GR01. Any definitions provided in this Exhibit, however, shall supersede the definitions provided in GR01 in cases of conflicting definitions.

2. GLOSSARY OF TERMS

Refer to General Requirements Module GR01, Exhibit G for all applicable terms.

3. ACRONYMS

Refer to General Requirements Module GR01, Exhibit G for all applicable acronyms.

EXHIBIT H

REFERENCES

TABLE OF CONTENTS

SECTION **PAGE NO.**

1. REFERENCES FOR ANALYTICAL METHOD DEVELOPMENT H-2

2. REFERENCES FOR QUALITY ASSURANCE/QUALITY CONTROL H-2

REFERENCES

1. REFERENCES FOR ANALYTICAL METHOD DEVELOPMENT

1.1. U.S. Department of Energy (DOE), Pacific Northwest Laboratory, 1993. DOE Methods for Evaluating Environmental and Waste Management Samples. DOE/EM-0089T, Rev. 1. Richland, WA.

1.2. U.S. DOE, Environmental Measurements Laboratory. 1990. EML Procedures Manual, (most current edition), HASL-300. New York, NY.

1.3. U.S. Environmental Protection Agency (EPA), Environmental Monitoring Systems Laboratory. 1979. Radiochemical Analytical Procedures for Analysis of Environmental Samples, No. EMSL-LV-0539-17. Las Vegas, NV.

1.4. U.S. EPA, Environmental Monitoring Systems Laboratory. 1976. Interim Radiochemical Methodology for Drinking Water, No. EPA-600/4-75-008. Cincinnati, OH.

1.5. U.S. EPA. 1980. Prescribed Procedures for Measurement of Radioactivity in Drinking Water, No. EPA-600/4-80-032. Cincinnati, OH.

1.6. American Public Health Association (APHA). 1992. Standard Methods for the Examination of Water and Wastewater, (18th edition). New York, NY

1.7. U.S. EPA, Office of Radiation Programs. 1984. Eastern Environmental Radiation Facility Radiochemistry Procedures Manual, No. EPA 520/5-84-006. Montgomery, AL.

1.8. U.S. DOE. 1988. The Environmental Survey Manual, Appendix D, part 4 (Radiochemical Analysis Procedures), 2nd Edition. New York, NY.

1.9. U.S. EPA. 1973. Procedures for Radiochemical Analysis of Nuclear Reactor Aqueous Solutions, No. R4-73-014.

2. REFERENCES FOR QUALITY ASSURANCE/QUALITY CONTROL

2.1. Office of Monitoring Systems and Quality Assurance, U.S. Environmental Protection Agency, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans", QAMS-005/80, December 1980.

2.2. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Waste, Third Edition, SW-846, November 1986.

2.3. Laidlaw, R.H., "Document Control and Chain of Custody Considerations for the National Contract Laboratory Program," Quality Control in Remedial Site Investigations: Hazardous and Industrial Solid Waste Testing, Fifth Volume, ASTM STP 925, C.L. Perket, ed., American Society for Testing and Materials, Philadelphia, 1986.

2.4. Environmental Protection Agency, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule", 40 CFR Part 136, Federal Register, Vol. 49, No. 209., pp 43234-43442, October 26, 1984.

2.5. American Chemical Society Committee on Environmental Improvement, and Subcommittee on Environmental Analytical Chemistry, "Guidelines for Data Acquisition and Data Quality Evaluation in Environmental Chemistry", Analytical Chemistry, Volume 52, Number 14, December 1980.

2.6. Moore, J.M. and Pearson, J.G. "Quality Assurance Support for the Superfund Contract Laboratory Program", Quality Control in Remedial Site Investigation: Hazardous and Industrial Solid Waste Testing, Fifth Volume, ASTM STP 925, C.L. Perket, ed., American Society for Testing and Materials, Philadelphia, 1986.

2.7. Environmental Protection Agency, "Handbook for Analytical Quality Control in Radioanalytical Laboratories", EPA-600/7-77-088, USEPA/TVA Interagency Energy Environmental Research and Development Program Report.

2.8. Department of Energy, "Environmental Measurements Laboratory Procedures Manual," 27th Edition, Volume I, HASL-300, November, 1990.

A P P E N D I X A

Data Review Checklist

RC05 SAMPLE DATA PACKAGE

Data Review Checklist
RC05 Sample Data Package

1. COVER PAGE	*Reply*	*Ö*	*C#*
a) The laboratory name, code, subcontract number, RIN, Site sample numbers, analyses, and report dates are accurately recorded.			
b) All Site sample identifications are cross-referenced with all lab identifications.			
c) The verbatim compliance and authorization statement is present with the dated signature of the Laboratory Manager or designee.			
d) Any problems with the receipt are explained.			

2. TABLE OF CONTENTS	*Reply*	*Ö*	*C#*
a) The Table of Contents contains all Full Data Package Deliverable Section Titles and the page numbers.			

3. DATA REVIEW CHECKLIST (DRC) and RC05 SAMPLE DATA PACKAGE (SDP)	*Reply*	*Ö*	*C#*
a) The RC05 DRC is in strict conformance with the formatting and content of the form contained in the current version of the RC05, Appendix A. All discrepancies were identified and documented, accordingly.			
b) All DRC *Reply* blocks are completed with either a "Y", "N" or "N/A".			
c) All DRC *Reply* blocks completed with an "N" are explained in the Narrative.			
d) The DRC footer is completed for each page; the laboratory manager or designee signed and dated the DRC.			
e) All SDP deliverable sections appear in the SDP in order by deliverable section number			
f) Only one SDP is submitted for each RC05 and RIN request.			N/A
g) All components of the SDP deliverables contain original documents where possible.			Φ
h) There is no inclusion of required items in the SDP by reference to another SDP.			Φ
i) Site samples are exclusively used for sample matrix QC			Φ
j) Site and non Site samples are not reported together in any way			Φ
k) The complete sample data package is single sided and consecutively paginated.			

4. CHAIN-OF-CUSTODY, HOLDING TIMES, AND SAMPLE PRESERVATION	*Reply*	*Ö*	*C#*
a) The continuity of each sample's custody is evidenced by the chain of the date, time and signatures of each transaction from sample receipt to final disposition.			
b) If the continuity was corrupted, there is documentation and evidence of correspondence with the CTR.			
c) All samples are identified on the COC with the corresponding analysis.			
d) The pH of each sample and the shipping container temperature are recorded, where applicable.			
e) Any conflicting, incorrect, or missing information are identified and documented, and there is documentation of the resolution.			
f) Holding times were met for all sample analyses.			
g) Samples were properly adjusted to the correct pH and were stored at the appropriate temperature.			

RIN: _____ **Lab Name:** _____ **Initials:** _____

Analytical Batch Identification No.(s): _____

Data Review Checklist
RC05 Sample Data Package

5. NARRATIVE	*Reply*	*Ö*	*C#*
a) Contains a synopsis of the methodology and analysis, including all standard operating procedures used.			
b) Contains a description of the samples.			
c) All anomalies, caveats, deficiencies, interferences, reanalyses, and deviations from approved SOPs related to the analysis are explained.			
d) Samples requiring reanalysis are identified with the reason for reanalysis, the original and reanalysis Analytical Batch Identification Numbers, and a synopsis of the reanalysis Analytical Batch QC assessment.			
e) For any deviations that required CTR approval, the correspondence and approval are documented.			

6. SAMPLE AND QC SAMPLE RESULTS SUMMARY	*Reply*	*Ö*	*C#*
a) Samples			
1. All samples and tests were analyzed per the COC.			
2. Sample results are arranged by Site sample number in increasing alphanumeric order and include the required items as specified in the Sample and QC Sample Results Summary Section of RC05, Exhibit B.			
3. One and only one result is reported for each requested analyte.			
4. For samples requiring reanalysis, Analytical Batch Identification Numbers are reported with the results.			Φ
5. The MDA for each sample is reported and is ≤ the RDL. If the MDA is >RDL, then the deficiency is reported in the Narrative.			
• IF item 6.a)5. above was marked "NO," were samples and duplicates prepared with a reduced aliquot size due to high or significant activity?			
• IF the above question was answered "YES," were the following criteria met: *The aliquot was large enough to generate data in which the measurement uncertainty shall not be greater than 15% of the sample activity and the MDA for the analysis shall be a maximum of 20% of the sample activity* • THEN Reanalysis or reporting in the narrative for MDAs exceeding RDLs is not warranted if the responses to these questions are "YES.".			
b) QC Samples	*Reply*	*Ö*	*C#*
1. For each QC sample (Duplicate, LCS and Preparation Blank), the QC type, QC Sample Identification, and other required items are included as specified in the Sample and QC Sample Results Summary Section of RC05, Exhibit B.			Φ
2. A set of QC samples are run with every Analytical Batch at the frequency specified in GR01 Exhibit A, Section 2.			
3. All QC deficiencies are detailed in the Narrative.			
4. For all sample results, including reanalyses, the corresponding Analytical Batch QC sample results are acceptable according to the criteria defined in RC05 and were reported.			
c) Duplicate Samples	*Reply*	*Ö*	*C#*
1. The results for each duplicate were reported separately from the corresponding sample.			
2. The results for the duplicate and the corresponding sample were equivalent, using the RC05 equivalency test and control criteria (F≤E*1.5, or F/E ≤ 1.5).			Φ

RIN: _____ Lab Name: _____ Initials: _____

Analytical Batch Identification No.(s): _____

Data Review Checklist
RC05 Sample Data Package

(continued)			
d) Laboratory Control Sample	*Reply*	*Ö*	*C#*
1. The LCS certified activity and uncertainty at 2-sigma are reported. The observed activity and percent recovery are within the acceptable control limits according the criteria defined in RC05.			
2. The LCS activity is appropriate for the activity level of the samples in the Analytical Batch according to the guidelines set in RC05.			
e) Preparation Blank	*Reply*	*Ö*	*C#*
1. The PB activity meets the requirements specified in RC05, Exhibit E.			
a) If the MDAs for the samples in the analytical batch meet the analyte RDLs and the sample activities are less than 5 times the RDL, the activity of the preparation blank is equivalent to zero when the measurement uncertainty is considered and is less than or equal to the RDL.			
b) If the MDAs for the samples in an Analytical Batch did not meet the analyte RDLs due to sample matrix effects and the sample activities are less than the MDAs, then the Preparation Blank analyte activity is equivalent to zero when the measurement uncertainty is considered and the preparation blank activities are less than the MDAs for the measurements.			
c) If the MDAs for the samples in an Analytical Batch did not meet the RDL due to high analyte activity and reduced sample size, the Preparation Blank analyte activity is less than 1% of the sample analyte activity			

7. PREPARATION SUMMARY	*Reply*	*Ö*	*C#*
a) The preparation raw data (benchsheets and/or preparation logs) are included and document the required items as specified in the Preparation Summary Section of RC05, Exhibit B.			
b) If stable strontium carrier was used and the stable strontium content of the sample was unknown, was it determined by AA or ICP.			Φ
c) Was the weight of the blank subtracted from the residue weight of the sample to get the net residue weight.			Φ
d) Was the sample counted within three hours after the sample was stripped from the column.			Φ
e) Was the time allowed for Yttrium ingrowth sufficient, (7days or more).			Φ
f) Were all start and stop times for all ingrowths recorded .			Φ
g) The volume or weight used to calculate the Preparation Blank activity and MDA (pCi/l or pCi/g) did not exceed the maximum volume or weight of sample for the entire Analytical Batch.			Φ

8. STANDARDS SUMMARY	Reply	√	C#
a) The Standards Summary Section is present and for primary standards that were diluted and used for the LCS and any in-house prepared instrument calibration sources, the required items as specified in the Standards Summary Section of RC05, Exhibit B are included.			
b) If the standards used for the LCSs were NOT diluted, the required items as specified in the Standards Summary Section of RC05, Exhibit B are included.			Φ
c) All applicable standard certificates were forwarded to the CTR upon first use.			Φ
d) All standard identifications are traceable to the primary certificates, which are traceable to NIST.			Φ
e) All standards and sources traceable to NIST were valid (not expired) at the time of use.			Φ

RIN: _____ Lab Name: _____ Initials: _____

Analytical Batch Identification No.(s): _____

Data Review Checklist
RC05 Sample Data Package

9. INSTRUMENT CALIBRATION SUMMARY	Reply	√	C#
a) The required items as specified in the Instrument Calibration Summary Section of RC05 Exhibit B are included for each GPC detector used to report results for this RIN.			
b) The Instrument Calibration Package, *Id #* _____ is acceptable per the RC05 requirements and has been forwarded to the CTR.			
c) The Instrument Calibration Package identification is included in the Instrument Calibration Summary.			
d) All applicable source certificates used for the instrument calibration are traceable to NIST and were forwarded to the CTR upon first use.			Φ

10. CONTINUING CALIBRATION SUMMARY	Reply	√	C#
a) The required items as specified in the Continuing Calibration Summary Section of RC05 Exhibit B are included for each GPC detector used to report results for this RIN.			
b) The required items as specified in RC05 Exhibit B for detector backgrounds are included.			Φ
c) The required items as specified in RC05 Exhibit B for detector check source determinations are included.			Φ

11. COUNTING RAW DATA SUMMARY	Reply	√	C#
a) The required items as specified in the Counting Raw Data Summary Section of RC05 Exhibit B are included for each Site sample in the RIN and the associated Analytical Batch QC samples.			
b) If the planchets were counted more than once, the required information is provided for each count. If more than one count was used to calculate the reported results, the worksheet, spreadsheet, etc. used to calculate averages and propagated uncertainties is included. If not all of the counts taken were used, is the data which were not used clearly labeled as "Data Not Used"			Φ
c) A copy of the instrument run log is included and contains the required items as specified in the Counting Raw Data Summary Section of RC05 Exhibit B.			Φ

12. ELECTRONIC DATA DELIVERABLE (EDD)-Hard Copy	Reply	√	C#
a) The EDD accurately reflects the data contained in the Sample Data Package and follows the format requirements for the EDD as specified in Module GR02			
b) The hard copy of the EDD as specified in GR01 Exhibit B, Section 4 is included with the Sample Data Package. The hard copy includes data file name and means of transmittal.			
c) An automated EDD verification check has been performed.			*N/A*

Shaded areas are for Site use only.
Respond to each checklist item in the "Reply" column with a Y (yes), N (no), or NA (not applicable).
Insert the monthly Instrument Calibration Package Identification No. in the blank provided within statement 9b.
Complete footer information, including the initials of the laboratory manager or designee on each page.
Refer to Module GR01, Exhibit B, Section 4 for instructions to complete this form.

I certify that all responses to this checklist accurately reflect the completeness and quality aspects of this sample data package as outlined in GR01 and RC05. Furthermore, I understand that inaccuracies in the completion of this checklist will be considered a nonconformance to Subcontract Requirements as evidenced by the following signature of the laboratory manager or designee.

Print/Typed Name: _____ **Title:** _____

RIN: _____ **Lab Name:** _____ **Initials:** _____

Analytical Batch Identification No.(s): _____

Signature _____ **Date** _____

For Data Assessment Use Only

DATA REVIEW CHECKLIST EXAMINATION

Assessment of this Sample Data Package is based on the following documents:

DA-GR01 Version _____ **DA-RC05 Version** _____

This Sample Data Package requires the following assessment level:

❑ **No Further Assessment** ❑ **Partial Verification** ❑ **Complete Verification** ❑ **Validation**

Assessment Level is based on: ❑ **Examination** ❑ **Customer** ❑ **Laboratory Assessment Program**

Notes:

Examiner	Signature	Date

PARTIAL VERIFICATION

❑ **This Sample Data Package requires no further assessment (See attached Data Quality Assessment Report)**

❑ **This Sample Data Package requires further assessment at the following level:**

❑ **Complete Verification** ❑ **Validation**

Notes:

Data Verifier	Signature	Date

RIN: _____ **Lab Name:** _____ **Initials:** _____

Analytical Batch Identification No.(s): _____

COMPLETE VERIFICATION

- ❑ **This Sample Data Package requires no further assessment (See attached Data Quality Assessment Report)**
- ❑ **This Sample Data Package requires validation**

Notes:

Data Verifier	Signature	Date

RIN: _____ **Lab Name:** _____ **Initials:** _____

Analytical Batch Identification No.(s): _____

A P P E N D I X B

Data Review Checklist

RC05 INSTRUMENT CALIBRATION PACKAGE

Data Review Checklist
RC05 Instrument Calibration Package

1. STRUCTURAL REQUIREMENTS	*Reply*	*Ö*	*C#*
a) The Instrument Calibration Package was assigned an identification using the syntax of RC05CAL_Lab ID_Date.			
b) The Instrument Calibration Package contains the following sections in the following order: (1) Cover Page, (2) Data Review Checklist- RC05 Instrument Calibration Package, (3) Narrative, and (4) Instrument Calibration and Raw Data.			
c) The Instrument Calibration Package structural requirements specified in RC05 have been met. All discrepancies were identified and documented, accordingly			

2. GENERAL REQUIRMENTS	*Reply*	*Ö*	*C#*
a) All the required items in Instrument Calibration Package Section of RC05, Exhibit B are legible and clearly identified. All RC05 specified item identifications (denoted in quotation marks) appear exactly as given, or the identification is cross-referenced on the Cover Sheet (abbreviations of the delimited identifications are acceptable, where applicable).			Φ
b) If there was an item identification discrepancy, then on the Cover Sheet, the RC05 specified item identification is listed under a header titled "Specified Item", and the Laboratory's cross-referenced identification appears under an adjacent header titled "Identifier Used"			Φ
c) The instrument calibration sources, used for voltage plateaus, discriminator window setting, efficiency calibration and self-absorption curve are NIST traceable, or equivalent.			Φ
d) The geometry of the calibration sources used for efficiency and self-absorption/crosstalk curves were the same as the that of the prepared sample and QC sample planchets The depth and shape (flat, flanged, ringed, etc.), in addition to the diameter, are important components of geometry.			Φ
e) The matrices of the calibration sources used for efficiency and self-absorption/crosstalk curves were the same as the that of the prepared sample and QC sample planchets			Φ
f) Commercially prepared sources were not used after their stated expiration dates, which are based on radionuclide half-life or physical form of the standard, (e.g., sealed sources or plated planchet).			Φ
g) If alpha calibration requirements were disregarded, were all alpha emitters removed from the strontium and yttrium fraction?			Φ
h) The Instrument Calibration and Raw Data are included and document the required items as specified in the Instrument Calibration Package Section of RC05, Exhibit B.			Φ
i) All data were reviewed and certified as accurate- the date and signatures of all analysts and reviewers of the data are included.			Φ
j) Standardization of strontium and yttrium carriers was performed in triplicate.			Φ

3. VOLTAGE PLATEAU DATA	*Reply*	*Ö*	*C#*
a) The voltage range used to prepare the counting plateau is wide enough to fully define the “knee” of the plateau and the end of the plateau.			Φ
b) The source was counted long enough to obtain 10,000 counts or more for each point on the plateau portion of the curve.			Φ
c) The length and slope of the plateau was calculated and verified to meet the instrument manufacturer’s specifications.			Φ
d) If the operating voltage setting is common to more than one detector in the system, the optimum operating voltage for all common detectors was selected.			Φ

INSTRUMENT CALIBRATION PACKAGE ID: _____ **Initials:** _____

Lab Name : _____

Data Review Checklist
RC05 Instrument Calibration Package

4. DISCRIMINATOR WINDOW SETTING	*Reply*	*Ö*	*C#*
a) The discriminator windows were set individually for each detector.			Φ
b) The windows were set to achieve a beta to alpha crosstalk value of less than 1%.			Φ

5. EFFICIENCY CALIBRATIONS	*Reply*	*Ö*	*C#*
a) Separate counting efficiencies and errors were determined for ^{89}Sr and ^{90}Sr using known amounts of the respective radioactive standards and strontium carrier			Φ
b) The efficiency calibration sources were counted long enough to obtain a minimum of 10,000 counts.			Φ

6. SELF-ABSORPTION AND CROSSTALK CURVES	*Reply*	*Ö*	*C#*
a) Self-absorption curves are required to be prepared for both alpha and beta counting. Was a crosstalk curve established for alpha to beta crosstalk versus residue weight.			Φ
b) The self-absorption and crosstalk curves consisted of at least 8 points well distributed throughout the mass range unless instrument specific programs designate otherwise.			Φ
c) Each alpha and beta calibration standard was counted to an accumulation of 10,000 counts			Φ
d) The sources used for the determination of self-absorption and cross talk were of similar isotope content to that of the analytical samples			Φ
e) Standard activity was decay corrected (if applicable) prior to calculation of instrument efficiency.			Φ
f) The laboratory SOPs define the acceptance criteria for self-absorption and crosstalk curves and goodness of fit statistics for these curves.			Φ

7. CHECK SOURCE REQUIREMENTS	*Reply*	*Ö*	*C#*
a) Check sources were analyzed following gas changes, before samples were counted and/or daily			Φ
b) If the daily check source count results exceeded the tolerance limits or ± 3 sigma control limits did the laboratory recount the check source to verify the out of control condition.			Φ
c) If the recount result again exceeded the control limits, were the detectors taken out of service until the system was brought back into control?			Φ
d) Check source data was submitted with each reporting batch. If samples within a reporting batch are from separate counting batches, was check source data included for all counting batches			Φ

8. INSTRUMENT BACKGROUNDS	*Reply*	*Ö*	*C#*
a) Instrument backgrounds for both alpha and beta were determined weekly			Φ
b) The count time for the backgrounds were the same as the routine count time for samples.			Φ
c) The instrument backgrounds and uncertainties used in calculating sample analyte activities were based on the averages of at least 5 background counts.			Φ
d) Does the laboratory SOPs define the evaluation and acceptance criteria for instrument background data?			Φ

Shaded areas are for Site use only.
Respond to each checklist item in the "Reply" column with a Y (yes), N (no), or NA (not applicable).
Complete footer information, including the initials of the laboratory manager or designee on each page.
Refer to Module GR01, Exhibit B, Section 4 for instructions to complete this form.

INSTRUMENT CALIBRATION PACKAGE ID: _____ **Initials:** _____

Lab Name : _____

I certify that all responses to this checklist accurately reflect the completeness and quality aspects of this calibration package as outlined in GR01 and RC05. Furthermore, I understand that inaccuracies in the completion of this checklist will be considered a nonconformance to Subcontract Requirements as evidenced by the following signature of the laboratory manager or designee.

Print/Typed Name: _____ **Title:** _____

Signature _____ **Date** _____

For Site Use Only

Overall Assessment:		
Comments:		
Data Assessor	**Signature**	**Date**

INSTRUMENT CALIBRATION PACKAGE ID: _____ **Initials:** _____

Lab Name : _____