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CCP-TP-103

Revision 9

CCP
Data Reviewing, Validating, and Reporting Procedure for the High Efficiency Neutron Counter and the Super High Efficiency Neutron Counter Using NDA2000

EFFECTIVE DATE: 03/14/2011

Larry Porter

PRINTED NAME

APPROVED FOR USE

RECORD OF REVISION

Revision Number	Date Approved	Description of Revision
0	11/25/2003	Initial Issue.
1	03/22/2004	Incorporated resolutions to CBFO Adequacy Review comments. Updated Section 4.0 and all Attachments to incorporate changes resulting from the LANL MSA / LRA and Dry-runs December 2003 - February 2004.
2	04/21/2004	Incorporated CBFO Adequacy Review comment resolutions into Sections 2.0 and 4.0. Revised Attachment 3 for sequencing.
3	05/14/2004	Incorporated CBFO Audit comment resolution into Section 4.0, step 4.3.
4	10/26/2004	Clarified functions of the Operator, TS, EA, and ITR. Also renumbered the attachments to correspond with sequence lists in document. Changed Attachment 5. Deleted part of step 4.3.1[C] to in answer to CAR-SRS-002-04. Incorporated CBFO comments.
5	07/18/2005	Revised to produce nonconformance report (NCR) for assays > 2 curies.
6	02/08/2006	Modified Appendix 1 to correct application of mass scaling factors for estimating U-234 in weapons grade and heat source materials. Clarification of Revision 5 Record of Revision description should read “Revised to produce nonconformance report (NCR) for assays where the TRU Alpha Activity of the assay exceeds 2 alpha-curies of heat source material.”
7	11/16/2006	Revised to implement the Waste Isolation Pilot Plant Hazardous Waste Facility Permit requirements resulting from the Section 311/Remote-Handled (RH) Permit Modification Request (PMR). Addressed Carlsbad Field Office (CBFO) Document Review Record (DRR) comments.
8	07/12/2010	Revised to delete step 4.1.1 [D.2] (a) per Carlsbad Field Office (CBFO) Corrective Action Report (CAR) # 10-028.
9	03/14/2011	Addition of Super High Efficiency Neutron Counter to the procedure.

TABLE OF CONTENTS

LIST OF ATTACHMENTS

1.0 PURPOSE

This procedure describes the methods and techniques to review, validate, verify, and report data from the High Efficiency Neutron Counter (HENC) with integral gamma-ray spectrometer and the Super High Efficiency Neutron Counter (SuperHENC) with two gamma-ray spectrometers.

1.1 Scope

This procedure provides specific instructions for the review, validation and reporting of measurement data from the HENC and SuperHENC of the radionuclide content in contact-handled (CH) transuranic (TRU) waste. Instructions within this procedure are specific to the Canberra NDA2000 software.

2.0 REQUIREMENTS

2.1 References

Baseline Documents

- Canberra Industries, Inc., Publication, *High Efficiency Neutron Counter Technical Reference Manual*
- Canberra Industries, Inc., Publication No. 9231594F, V3.1, *NDA 2000 Users Manual*
- Canberra Industries, Inc., Publication No. 9231595C, V3.1, *NDA 2000 Technical Reference Manual*
- CCP-PO-001, *CCP Transuranic Waste Characterization Quality Assurance Project Plan*
- CCP-QP-006, *CCP Corrective Action Reporting and Control*
- Document No. 96179, Rev. A, *Model HE-WDAS High Efficiency Waste Drum Assay System w/Add-A-Source Option, Hardware Reference Manual*
- *Methods and Algorithms Used in MGA*, by Ray Gunnink, 1999
- MCS-HENC#1-NDA-1002, *HENC#1 Calibration Report*
- HENC#2-NDA-1002, *HENC #2 Calibration Report*
- LANL-NDA-1003-Lead-Lined, *HENC #2 Lead-Lined Calibration Report*
- MCS-SHENC-NDA-1003, Super High Efficiency Neutron Counter Calibration Report
- PC-FRAM (PC/FRAM-B32), Plutonium and Uranium Isotopic Analysis Software User's Manual, Version 4.3, Manual Revision C.

Referenced Documents

- CCP-PO-002, *CCP Transuranic Waste Certification Plan*
- CCP-QP-002, *CCP Training and Qualification Plan*
- CCP-QP-005, *CCP TRU Nonconforming Item Reporting and Control*

- CCP-QP-008, *CCP Records Management*
- CCP-TP-059, *CCP Operating the Super High Efficiency Neutron Counter (SuperHENC) Using NDA2000*
- CCP-TP-063, *CCP Operating the High Efficiency Neutron Counter Using NDA2000*

2.2 Training Requirements

2.2.1 Personnel performing this procedure will be trained and qualified in accordance with CCP-QP-002, *CCP Training and Qualification Plan,* prior to performing this procedure.

2.3 Equipment List

2.3.1 Software

- NDA2000, Waste Assay
- Genie 2000, Gamma Acquisition and Analysis

2.4 Precautions and Limitations

2.4.1 None.

2.5 Prerequisite Actions

2.5.1 None.

3.0 RESPONSIBILITIES

NOTE

The Nondestructive Assay (NDA) Independent Technical Reviewer (ITR) is an individual, other than the data generator, who is qualified to perform the initial work.

3.1 NDA Operator

3.1.1 Assembles the Batch Data Report (BDR).

3.2 NDA Independent Technical Reviewer (ITR)

3.2.1 Ensures that proper data reduction has been performed and the documentation is complete and accurate.

3.2.2 Ensures the BDR is paginated.

3.2.3 Ensures Attachment 2, NDA Batch Data Report Table of Contents, is complete.

3.3 NDA Expert Analyst (EA)

3.3.1 Reviews the Automated Independent Technical Review List (see Attachment 5, Automated Independent Technical Review List for an example).

3.3.2 Resolves any problem assay results of containers.

3.4 Facility Records Custodian

3.4.1 Receives, processes, and transmits all records generated by this procedure in accordance with CCP-QP-008, *CCP Records Management*.

4.0 PROCEDURE

NOTE

The NDA ITR must be able to manually complete Attachment 4, NDA Independent Technical Reviewer Checklist.

Control charts must cover the period of performance.

4.1 NDA Operator Review

4.1.1 Perform the following:

[A] Forward the data and report files (with Radioassay Data Sheet [RDS] and Automated Independent Technical Review List [AITR]) to the NDA Expert Analyst (EA) for evaluation in accordance with Section 4.2.

[B] After the NDA EA has completed the evaluation of Section 4.2 and returned the data and report files (with RDS and AITR), perform the following:

[B.1] Prepare the BDR to include the following as a minimum.

- Attachment 1, NDA Batch Data Report Cover Sheet
- Attachment 2, NDA Batch Data Report Table of Contents
- Attachment 3, NDA Batch Data Report Narrative Summary
- Copy of Nonconformance Report(s) (NCRs), if applicable
- Attachment 4, NDA Independent Technical Reviewer Checklist
- Waste Container Radioassay Report Files (with RDS and AITR)

- Last Results Reports (Background and Daily Quality Control [QC] Checks) (from CCP-TP-059, *CCP Operating the Super High Efficiency Neutron Counter (SuperHENC) Using NDA2000*, or CCP-TP-063, *CCP Operating the High Efficiency Neutron Counter Using NDA2000)*

- Quality Assurance Control Charts (Background and Daily Quality Control [QC] Checks) (from CCP-TP-059, or CCP-TP-063)

- Weekly Interfering Matrix Drum Measurement Control Charts (from CCP-TP-059, or CCP-TP-063)

[B.2] Sign and date each of the data sheets below (if not previously signed):

(a) Waste Container Radioassay Data Sheet(s)

(b) Last Results Reports

[C] Complete the blocks labeled Site ID, NDA Batch #, NDA Counter ID, NDA Batch Date, and Waste Containers on Attachment 1, and the blocks labeled NDA Batch Number and Testing Facility on Attachment 2.

[D] Forward the BDR to the NDA ITR.

4.2 NDA EA Review

NOTE

All comments on the Automated Independent Technical Review List SHALL be resolved by the NDA EA and documented in the Disposition field.

Certain waste matrices will have specified default isotopic distributions (derived from Acceptable Knowledge [AK]) for determining isotopic activities. Other matrices will **NOT** have specified default isotopic distributions. For the latter, the NDA EA will review the data to ensure that default isotopics are **NOT** used in the analysis.

The NDA EA must maintain expertise in performing waste container assay analysis. The NDA EA must be knowledgeable of the data acquisition process for the type of NDA (e.g., neutron, gamma) reviewed.

The two HENCs and the SuperHENC are equipped with High-Purity Germanium (HPGe) detectors for determining isotopic distributions or quantitative results, and uses passive neutron analysis methods to measure the spontaneous fission neutron signal of nuclides in containers of contact-handled (CH) transuranic (TRU) waste. In all three instruments, gamma-ray spectra are analyzed by Genie 2000 and NDA 2000 to produce the data compiled in Section 4.0.

The ratio of peaks from Americium (Am)-241 is used to determine the presence of Cesium (Cs)-137. If detected, the Cs-137 concentration can be used to calculate the Strontium (Sr)-90 by applying an appropriate scaling factor.

Multi Group Analysis (MGA) is the main analytical software tool for isotopic calculation. Fixed-energy Response function Analysis with Multiple-efficiencies (FRAM) may be used to supplement for assays that MGA CAN **NOT** analyze.

4.2.1 Perform the following:

[A] Review the spectra to determine if self-shielding **OR** other corrections need to be made to the data.

[B] Resolve any problem(s) flagged on the Automated Independent Technical Review List, **AND** document them in the corresponding Disposition field(s) of the Automated Independent Technical Review List.

[C] Evaluate both the Gamma and Neutron Radioassay Data Sheets with the following criteria, **AND** select the best set of results to include in the BDR:

[C.1] Measurement uncertainty.

[C.2] Interfering nuclides.

[C.3] Density and moderation properties of the matrix.

[C.4] Other parameters deemed appropriate by theNDA EA.

[C.5] **IF** the container was counted on HENC#1 or HENC#2 and contains Pu-238 as the predominant radionuclide by mass fraction and the assay was **NOT** counted to precision,
THEN generate an NCR in accordance with CCP-QP-005, *CCP TRU Nonconforming Item Reporting and Control,* with the disposition of the NCR to re-assay the drum using count to precision in accordance with CCP-TP-063.

[D] Ensure Sr-90 and U-234 values have been calculated correctly based upon the information in Appendix 1, Activity/Mass Calculations for Pu-242, Sr-90, and U-234.

[E] Ensure the appropriate use of the default isotopics has been performed for the matrix assayed, when applicable.

[F] Ensure that only measured radionuclides are reported for waste matrices with **NO** default isotopics.

[G] Regenerate the Radioassay Data Sheet, if applicable.

[H] Sign and date the Automated Independent Technical Review List.

[I] Forward the data and Report Files (with RDS and AITR) to the NDA Operator for review in accordance with step 4.1.1[B] through 4.1.1[D].

4.3 NDA ITR Review

NOTE

The NDA ITR is someone, other than the data generator, who is technically qualified to perform the initial work.

The NDA ITR ensures that, at a minimum, the 10 Waste Isolation Pilot Plant (WIPP)-tracked radionuclides (Am-241, Pu-238, Pu-239, Pu-240, Pu-242, U-233, U-234, U-238, Cs-137 and Sr-90), and U-235, for determining FGE, are listed on every Radioassay Data Sheet.

The NDA ITR reviews and completes the Radioassay Data Sheet, Last Results Reports from CCP-TP-059, or CCP-TP-063, Attachment 1, and Attachment 4. Equations used for calculating Sr-90 and U-234 are in Appendix 1.

The Automated Independent Technical Review software performs limit checks on the analysis results and flags for review any data that do **NOT** meet the required limits set by the NDA EA.

4.3.1 Perform the following:

[A] Review the BDRs, **AND** ensure all documentation is complete and accurate as listed in step 4.1.1[B.1].

[B] Complete and print as necessary, sign, and date the following:

[B.1] Radioassay Data Sheets.

[B.2] Last results Reports (Background and Daily Quality Control [QC] Checks) (from CCP-TP-059 or CCP-TP-063).

[B.3] Attachment 4.

[B.4] Attachment 1.

[B.5] Attachment 3.

[C] If applicable, generate an NCR in accordance with CCP-QP-005.

4.3.2 Ensures all required pages are included in the BDR and the BDR is paginated.

4.3.3 Ensures Attachment 2 is completed.

4.3.4 Submit the BDR to the Facility Records Custodian.

4.4 Facility Records Custodian

4.4.1 Receive, process, and transmit all records in accordance with CCP-QP-008.

5.0 RECORDS

5.1 Records generated during the performance of this procedure are maintained as QA records in accordance with CCP-QP-008. The records are the following:

5.1.1 QA/Lifetime Records

[A] BDR to include:

[A.1] Attachment 1, NDA Batch Data Report Cover Sheet

[A.2] Attachment 2, NDA Batch Data Report Table of Contents

[A.3] Attachment 3, NDA Batch Data Report Narrative Summary

[A.4] Attachment 4, NDA Independent Technical Reviewer Checklist

[A.5] Copy of NCRs, if applicable

[A.6] Last Results Report from CCP-TP-059 (Sections 4.3, 4.4, and 4.5) or CCP-TP-063 (Sections 4.3 and 4.4)

[A.7] Radioassay Data Sheets (from CCP-TP-059, or CCP-TP-063)

[A.8] Automated Independent Technical Review List(s)

[A.9] Quality Assurance Control Charts (Background and Daily QC Checks) (from CCP-TP-059, or CCP-TP-063)

[A.10] Weekly Interfering Matrix Drum Measurement Control Chart (from CCP-TP-059, or CCP-TP-063)

Appendix 1 – Activity/Mass Calculations for Pu-242, Sr-90, and U-234

NOTE
Activity and Mass of a particular isotope are related by the following formula:
(Mass)(Specific Activity) = Activity

CCP-PO-002, *CCP Transuranic Waste Certification Plan*, requires the quantification of the 10 WIPP tracked radionuclides, Am-241, Pu-238, Pu-239, Pu-240, Pu-242, U-233, U-234, U-238, Sr-90, and Cs-137, and U-235 for determining FGE.

For the HENC and SuperHENC, these nuclides are either directly measured or estimated through isotopic ratios to direct measurements. Pu-242 content is estimated in accordance with the guidance in Reference 1. Sr-90 and U-234 are estimated from the analysis contained in Reference 2 and incorporated in the NDA/AK memoranda.

Sr-90 Calculations

Ac(Sr-90) = Ac(Cs-137) * SCF(Sr-90).

For all LANL waste streams, a 1:1 activity ratio is used; therefore, the activity scaling factor (SCF) for Sr-90 is 1 and Ac(Sr-90) = Ac(Cs-137).

For Pu-239 Material Types (MTs) (MT-51 through MT-57)--Pu-242 (MT-42)

Pu-242 Calculations

M(Pu-242) = a + b [239] + c[240] + d[241]+ e $[239]^2$ + f$[240]^2$ + g$[241]^2$; where the bracketed quantities are the percentage abundance of the indicated isotopes. However for MT-42 the mass percent of Pu-242 and other Pu mass percents are derived from AK.

The MGA Pu-242 algorithm coefficients (a through g) are calculated during the actual execution of the MGA code. This is due to the fact that the coefficients are dependent on the measured Pu-239 weight fraction for the particular item being assayed and therefore need to be dynamically calculated.

^{234}U Calculations

If U-235 is reported above the lower limit of detection (LLD), then the U-234 activity is derived from the SCF. The SCF is derived from the U-234 mass scaling factor taken from Reference 2 (i.e., 0.014) and the specific activities of U-234 ($U\text{-}234_{SA}$) and U-235 ($U\text{-}235_{SA}$). The following equation defines the SCF for U-234.

$$SCF = 0.014 * \frac{U-234_{SA}}{U-235_{SA}} \qquad \text{Equation A.1}$$

Using Equation A.1, the U-234 SCF is 40.4. The U-234 activity is estimated by multiplying the U-235 activity [Ac (U-235)] by the derived SCF for U-234.

Ac (U-234) = Ac (U-235) * SCF (U-234) Equation A.2

Appendix 1 – Activity/Mass Calculations for Pu-242, Sr-90, and U-234 (Continued)

If U-238 is reported above the LLD and U-235 is not detected, or is reported below the detection limit LLD, then the U-234 SCF is zero

For Pu-238 MT-83

U-234 Calculations

For U-234, the determination of activity is accomplished by assuming a 45-year in-growth from the decay of Pu-238. This will provide a conservative estimate. Accordingly from Reference 2 the mass scaling factor is 0.427. This mass scaling factor is applied to derive a SCF similar to the function shown in Equation A.1. The SCF applied to Pu-238 to estimate U-234 is 1.56×10^{-4}.

References:

1. Methods and Algorithms Used in MGA, Ray Gunnink, 1999
2. *U-234 and Sr-90 Calculations For NDA Reporting*, Los Alamos National Laboratory, TWCP-12684, J. Veilleux, April 2003

Attachment 1 – NDA Batch Data Report Cover Sheet

Site ID:	**NDA Batch #:**
NDA Counter ID:	**NDA Batch Date:**
Waste Containers:	
NDA Independent Technical Reviewer (ITR) Approval	
NDA ITR's Printed Name: _____	
Approval Signature and Date:	
_____	_____

Attachment 2 – NDA Batch Data Report Table of Contents

NDA Batch Number:_____

Testing Facility:_____

Attachment 3 – NDA Batch Data Report Narrative Summary

Batch #: _____

Date: _____

Quality Control Summary:

Nonconformance:

NDA ITR Comments:

NDA ITR:_____Date: _____

Attachment 4 – NDA Independent Technical Reviewer Checklist

Site ID:	**NDA Batch Number:**
Procedure/Rev Number:	**NDA Counter ID:**

Description of Criteria Reviewed	**Criteria Met Yes/No/NA**
NDA Independent Technical Reviewer (ITR) Checklist	
Data generation and reduction were conducted in a technically correct manner in accordance with the standard operating procedures for the NDA methods used, including the following: • NDA Batch Data Report Cover Sheet • NDA Batch Data Report Table of Contents • NDA Batch Data Report Narrative Summary • NDA Independent Technical Reviewer Checklist • NCR (If applicable) • Last Results Reports • Quality Assurance Control Charts (Background and Daily QC Checks) • Weekly Interfering Matrix Drum Measurement Control Chart • Radioassay Data Sheet(s) • Automated Independent Technical Review List Data are reported in the proper units.	☐ Yes ☐ No ☐ Yes ☐ No
Calculations have been validated by a valid calculation program or a spot check of verified calculation programs.	☐ Yes ☐ No
QC documentation is complete and includes: 1. Daily Gamma Background 2. Daily Gamma QC Check 3. Daily Neutron Background 4. Daily Neutron QC Check	 ☐ Yes ☐ No ☐ Yes ☐ No ☐ Yes ☐ No ☐ Yes ☐ No

Attachment 4 –NDA Independent Technical Reviewer Checklist (continued)

NDA Independent Technical Reviewer Checklist	
QC measurement results are within established control limits per standard operating procedures (Reference Table A-3 Range of Applicability, CCP-PO-002). Were QC criteria that were not met documented with an NCR?	☐ Yes ☐ No ☐ Yes ☐ No ☐ N/A
Weekly Interfering Matrix Drum Measurements were properly performed and completed on _____ (Date).	☐ Yes ☐ No
The activities and masses (including Total Measurement Uncertainties (TMU) expressed in one sigma) are reported for the 10 WIPP-tracked radionuclides, as listed in Section 4.3 NOTE plus U-235. **Note**: Less than LLD or zero values shall be reported in accordance with CCP-PO-002, Sections 3.3.1 and A.3.	☐ Yes ☐ No
Are there any additional radionuclides that contribute to 95 percent of the radioactive hazard in any container? If YES, are they reported?	☐ Yes ☐ No ☐ Yes ☐ No ☐ N/A
Was U-235 detected in any waste container? If YES, is it reported?	☐ Yes ☐ No ☐ Yes ☐ No ☐ N/A
NDA Independent Technical Reviewer Approval	
NDA Independent Technical Reviewer Printed Name: _____ Approval Signature and Date: _____ _____	

Attachment 5 – Automated Independent Technical Review List

EXAMPLE

Automated ITR for 86600 10/14/2010 5:36:55 PM Page 4

Automated Independent Technical Review

Count Sequence Number: 17387 Batch Number: 1LANDA1309
Counter ID: MCS HENC #1
Container ID: 86600
Waste Matrix Code: Debris S5000 Count Type:
Sequence Type: Assay Date: 10/14/2010

Comments	Disposition
Section 1 - Add-A-Source Analysis Add-a-Source WARNINGS:	
Section 2 - Passive Neutron Analysis Analysis Status: No errors.	
Section 3 - Data Combiner Analysis Override enabled; Passive Neutron Pu and Gamma U data specified as input. Pu results taken from Passive Neutron data, U from Quantitative Gamma data. Results comparison test passed.	
Section 4 - MGA Analysis	
Section 5 - Gamma Analysis Analysis Status: No errors.	
Miscellaneous	

Expert Review by:_____ Date:_____