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2	1	Cog. Mgr. FW Curfman		2/15/01	T5-11						
2	1	QA DR Groth		02-09-01	T4-15	2	1	SPO: P.J. CRANE		For	T4-04
		Safety		per telcon for Don Groth	2/15/01						
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Calibration Report for the Plutonium Finishing Plant Segmented Gamma Scan Assay System

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Fluor Hanford
P.O. Box 1000
Richland, Washington

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Calibration Report for the Plutonium Finishing Plant Segmented Gamma Scan Assay System

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NUMBER WAS
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**Calibration Report
For the Plutonium Finishing Plant
Segmented Gamma Scan Assay System**

Performed by: Bruce Gillespie

1.0 Introduction

This document presents the results of the calibration of the Segmented Gamma Scan Assay System (SGSAS) at the Plutonium Finishing Plant (PFP). The calibration was performed in July, 2000 to qualify the system for assay of residues cans from PFP which will be packaged into pipe overpack containers for shipment to WIPP. The system was calibrated using NIST traceable fission product sources and initial calibration verification runs were performed using the same sources. Validation measurements for WIPP QAOs and the safeguards organization also were performed using NIST traceable plutonium standards.

Initial validation results showed a bias that varied with the overall gram loading of the can. The safeguards organization developed a data correction equation for the results based on the system performance using a number of plutonium standards initially with gram loadings ranging from 9.6 g up to approximately 88 g of weapons grade plutonium.

Later validation work prompted configuration changes to turn on a reference pulser, which was implemented once ground loop problems were resolved. At this point the safeguards organization developed a second set of data correction factors to apply to the assay results based on updated validation measurements.

This initial calibration applies to analysis results from the initial configuration that was used up to September 21 and a second configuration that turned on the reference pulser and an updated transmission calibration performed on September 21. This is valid since the same energy and efficiency calibration was used for both analysis configurations.

2.0 System Description

The SGSAS is designed to accurately quantify gamma emitting nuclides. The system at PFP is configured particularly to assay plutonium waste as a part of the characterization requirements for shipment to WIPP. The system is configured to assay billet cans with dimensions of 5.5 in dia. and a height of 7.0 in. The system assays the container in 15 vertical segments of 0.5 in each.

The SGSAS system uses a 30% relative efficiency coaxial germanium detector. The detector is mounted in a shield and collimator with a 0.5 in high by 8.0 in wide aperture. The detector is collimated to assay the container in 0.5 in high segments. The segments are individually corrected for matrix attenuation using a collimated transmission source located opposite the germanium detector. The detector is oriented perpendicular to the axis of a billet can that is positioned on a vertical drive platform and turntable. The detector collimator arrangement is mounted onto an adjustable trolley. The position of the trolley for the calibration was at 6.75 in as indicated on the trolley positioning ruler

mounted to the frame in front of the detector trolley. A single tin absorber was mounted over the collimator to reduce the count rate from the 59.5 keV Am-241 peak and some of the low energy gammas. This absorber should be used for all measurements to provide the correct efficiency response.

The transmission source used for matrix correction is a Se-75 source. The gamma lines from the transmission source that will be used for matrix correction are the 264 and 400 keV lines.

A second Broad Energy Germanium (BeGe) detector is mounted at an angle relative to the transmission source to minimize its response to the transmission gamma radiation. This detector is used to measure the plutonium isotopic ratios using the Multi Group Analysis software. The detector has a shield and collimator that is used to minimize its response to external radiation sources. It also has tin shields that permit the detector to be optimized for varying levels of Am-241 that may be present in the waste.

The spectra from the two germanium detectors are processed by the ICB **N N** electronics. The electronics consist of a preamplifier integral with the detector, and ICB high power supply, amplifier, ADC and AIM (Acquisition Interface Module).

The mechanical control of the system and the spectral data collection and analysis are through the Genie PC Waste Assay Software package, S480. The calibration was performed using a Pentium class PC, running under the OS/2 WARP operating system

3.0 Energy and FWHM Calibration Method

Energy and FWHM calibrations were performed by inserting a set of calibrated point sources into the empty calibration can. The sources were dispersed in the can as shown in Figure 1 of Appendix I.

The gain and zero of the coaxial detector was adjusted for approximately a 0.5 keV per channel slope and a 0.0 keV intercept. The gain and zero of the BeGe detector was adjusted for approximately a 0.075 keV per channel slope and a 0.0 keV intercept. Calibrations were then performed on the individual detectors and on the summed spectra from the sum of the individual segment data.

Appendix II contains the energy calibration reports and graphs for the individual detector and summed spectrum Energy and FWHM Calibrations.

4.0 Efficiency Calibration Method

The efficiency calibration was performed using the same calibration canister as described in section 2.0. The point source calibration certificates are included in Appendix I. The

line sources were placed in the source locations shown in Figure 2 and Table 1 of Appendix I. Calibration spectra were accumulated while the can was rotated and moved through all 15 vertical segments. The resulting spectra approximate a sample with uniformly distributed activity in the billet can configuration.

The vertical distribution of the sources did not provide for a uniform vertical response for all of the segments. Therefore a representative segment was used for the efficiency calibration of all 15 vertical segments. The choice of the segment was based on the use of a segment away from either the top or bottom end of the can and one which had a count rate which was approximately 1/15 of the overall count rate from all segments. The Efficiency calibration was performed using a calibration certificate that was scaled to represent 1/15 of the total source activity. The calibration certificate values are in Appendix I. Verification counts were performed with a plutonium standard using the new efficiency to demonstrate the validity of the calibration and to establish a baseline for the measurement control and QC checks which will be used to demonstrate that the system is in control. A plot of the efficiency calibration is included in Appendix III.

The GWAS calibration software permits a variety of curve fitting techniques to be used to fit to the various efficiency points on the curve. Although a DUAL fit curve is more commonly used for efficiency curves, the LINEAR fit for the calibration curve was selected for use since it provided somewhat better results for the 129 keV gamma line and equivalent results for the 414 keV line. Parameters for both fits are found in the efficiency report in Appendix III.

5.0 Transmission Source Calibration

To perform the matrix correction using the transmission source an initial transmission measurement in an empty container is required. The matrix correction using a transmission source is a relative measurement based on the ratio of the transmission count rate through the can being assayed over the transmission through an empty can. Therefore it does not need to be tied to a calibration certificate. A 300 second count was performed on the transmission source. Appendix IV provides a copy of the initial transmission calibration report.

The *Se-75* calibration source used in this system has a relatively short half life. The decay of the source is accounted for in the software analysis. However updated transmission calibrations are routinely performed to ensure that the most accurate determination of the empty container transmission rates are used. The routine updates are not included in the calibration document.

6.0 Reference Peak Calibration

In the initial system calibration, the reference peak correction was not implemented due to noise problems related to ground loops with the reference pulser integrated into the

system. This was resolved on September 21. At this time a second phase of the validated results was developed.

The rate loss reference peak used for the measurements is a reference pulser. This was adjusted for an energy of approximately 2000 keV. The response of the reference peak is calibrated by measuring the count rate from the reference peak for a period of 300 seconds with no other sources present. Appendix IV shows the response of the reference peak calibration developed on September 21.

7.0 Verification Counts

A nominal 25 g Pu standard was selected to be used for verifying the calibration and to become the measurement control (QC Check) source. The standard is in a "sealed 7 in can" which has a smaller diameter than the billet can which was used for the calibration. The following table shows the precision and accuracy of the system for this data. The data to the right shows the data corrected results. The % variation is based on the $(Pu(meas) - Pu(act)) / Pu(act)$.

	Pu Mass	Pu Mass	Variation		Pu Mass	Variation
Run #	Actual	Measured	%		Data Cor	%
1	24.53	26.61	8.49%		24.59	0.24%
2	24.53	25.60	4.35%		23.60	-3.79%
3	24.53	25.60	4.35%		23.60	-3.79%
4	24.53	25.43	3.65%		23.44	-4.46%
5	24.53	26.44	7.80%		24.42	-0.43%
6	24.53	26.44	7.80%		24.42	-0.43%
	Average	26.02	6.07%	Average	24.01	-2.11%
	Std Dev	0.533348		Std Dev	0.518337	
	% Std Dev	2.05%		% Std Dev	2.16%	

Table I Initial Calibration Verification Data

This data has been used to establish the baseline for the control charts to ensure that the accuracy of the initial calibration is maintained. The QAO document provides additional data to demonstrate the precision and accuracy of the system.

A copy of the initial QC plots for the system are included in Appendix V.

After the initial configuration change on Sept 21, the measurement control standard data is shown with the new data correction values applied.

Run	Pu Mass	Pu Mass	Variation		Data	Variation
#	Actual	Measured	%		Corrected	%
1	24.53	26.88172	9.59%		24.46	-0.29%
2	24.53	26.98925	10.03%		24.56	0.14%
3	24.53	26.12903	6.52%		23.73	-3.27%
4	24.53	25.05376	2.14%		22.68	-7.54%
5	24.53	25.80645	5.20%		23.41	-4.55%
6	24.53	25.69892	4.77%		23.31	-4.98%
	Avg	26.09319	6.37%	Avg	23.69193	-3.42%
	Std Dev	0.676271		Std Dev	0.657877	
	% Std Dev	2.59%		% Std Dev	2.78%	

Table 2 Verification runs for the second configuration

8.0 Calibration Sources

The source set used for the calibration is a set of 20 small rods, which are NIST-traceable. Each source represents a point source geometry. The sources are dispersed in the billet can approximate a uniform distribution of activity.

The calibration line sources contain Eu-152 and Am-241. These sources provide calibration lines at 59.5, 122, 245, 344, 779, 965, 1112, and 1408 keV. The certificates for these sources are included in Appendix I.

9.0 Bias Correction

The initial runs for the WIPP QAOs were based on the initial calibration configuration. This data showed a positive bias of 108 % for the 9.6 g standard and a low bias of 91.3% for the 142 g standard. Additional standards run for a safeguards validation showed the bias to have a decreasing trend with increasing gram loadings. To minimize this effect a data correction was applied to all data. The data corrected results were only considered valid for safeguards measurements up to a maximum mass of 88 g due to the non linearity problems. The equation used for the bias correction was:

$$Pu_{corr} = (Pu_{meas} - 1.311906)/1.028962$$

On September 21, 2000 the reference pulser was turned on. Standards data evaluated after had a much flatter response over the gram range but a more significant overall bias. The data correction applied to this data used the following equation:

$$Pu_{corr} = (Pu_{meas} - 1.7838829)/1.027964$$

APPENDIX I

CALIBRATION CAN AND SOURCE DOCUMENTATION

1. INTRODUCTION

This appendix contains construction and configuration information for setting up the calibration canisters for the PFP Segmented Gamma Scan Assay system (SGSAS) which was calibrated for use in the TRU waste program.

2. CONSTRUCTION

The canisters that are used for the calibration are standard billet cans that have been selected from the same supply of canisters which will be used for the packaging of the ash residues. The approximate dimensions of the cans are

Diameter: 13.8 cm

Height: 17.75 cm

The canisters have been filled with normal drinking soda straws to provide a fixed very low density configuration for the reliable and reproducible positioning of sources in the canister. Clear straws have been used to pack the can and colored straws have been used to define source locations.

Each source to be used for the calibration is a combination of Eu-152 and Am-241 in a point source configuration. The point source is mounted in a small rod with a diameter of 6.4 mm and a length of 50 mm. The activity is located 6 mm from the end of the rod.

3. CONFIGURATION

In order to simulate a uniform distribution of activity in the billet can the can was divided into 3 equal volume elements as shown in the drawing below. Three colored straws are positioned approximately $\frac{2}{3}$ of the distance out from the inner surface of each volume element. This closely approximates the center of the volume element. Although the drawing shows all of the straws in alignment along one radius from the center of the can, the three sets of straws were positioned in different angular positions to distribute the activity more throughout the canister.

In order to provide a reasonably uniform distribution of activity vertically the sources were positioned as follows:

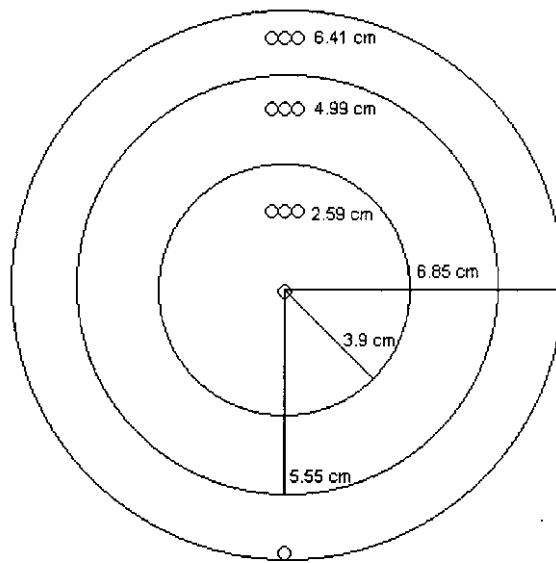


Figure 1

For each set of three straws representing an radial distance from the center of the can:

Straw 1: Place **3** sources with the active end to the bottom of the can.

Straw 2: Place **2** sources with the active end to the bottom of the can spaced up 1 inch from the bottom

Straw 3: Place **1** source with the active end to the top of the can spaced 4 inches up from the bottom.

The above arrangement is shown graphically below in Figure 2.



Figure 2

The sources are loaded into the can as follows:
Source arrangement in Calibration Can

Tube	Serial #		
#	bottom	Center	top
1	6258	6255	6245
2	6256	6252	
3			6247
4			6263
5	6269	6254	6250
6	6272	6262	
7	6268	6251	6253
8	6265	6244	
9			6273

	Activities		
	kBq		
Source	Am-241	Eu-152	
6258	198	220.5	
6255	192.6	217	
6245	170.8	209.2	
6256	188.5	212.5	
6252	198.6	225.6	
6247	190.1	226	
6263	155.9	216.5	
6269	159	224	
6254	204.1	214.2	
6250	199.2	221.2	
6272	202.6	178.6	
6262	172.6	206.4	
6268	188.7	230.6	
6251	199.7	213.7	
6253	194.9	227.8	
6265	150.5	221.3	
6244	196.9	215.2	
6273	193.4	218	
	3356.1	3898.9	kBa
% uncertainty	3.56	3.3	

Calibration Source Certificate File

The **GWAS** efficiency calibration requires the generation of a certificate file containing the total activity of the line sources, expressed as the number of gammas per second for each gamma line to be used. This is just the sum of the activities, multiplied by the abundance (branching ratio) for each of the gamma lines.

The current gamma rates are calculated from the current date and time and the reference date and time.

The total uncertainty for the line sources is calculated from the square root of the sum of the squares of the individual line sources uncertainties.

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97-4 3 pcs

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6244

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	Total <u>Uncertainty (±)</u>	<u>Half Life⁽¹⁾</u>
Am-241	196.9 kBq (5.322 µCi)	3 56%	432.7 ± 0.5 years
Eu-152	215.2 kBq (5.817 µCi)	3 30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

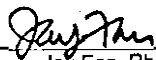
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.



Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986.

• LEAK TEST CERTIFICATION ON REVERSE •

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6245

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life"</u>
Am-241	170.8 kBq (4617 µCi)	3.58%	432.7 ± 0.5 years
Eu-152	209.2 kBq (5654 µCi)	3.31%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS⁽¹⁾

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

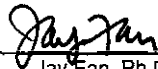
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

o LEAK TEST CERTIFICATION ON REVERSE o

97-4

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6246

Reference Date January 1, 1997

<u>Radioisotope</u>		Total <u>Uncertainty (%)</u>	<u>Half Life⁽¹⁾</u>
Am-241	198.4 kBq (5.363 μ Ci)	3.54%	432.7 \pm 0.5 years
Eu-152	232.3 kBq (6.277 μ Ci)	3.28%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS¹

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

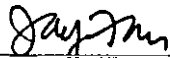
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986.

• LEAK TEST CERTIFICATION ON REVERSE •

97-4

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6247

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life"</u>
Am-241	190 kBq (5 137 µCi)	3.57%	432.7 ± 0.5 years
Eu-152	226.0 kBq (6 109 µCi)	3.30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS"

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112075	13.6
		1408.002	20.8

SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy—efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Pan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

• LEAK TEST CERTIFICATION ON REVERSE •

97-4

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6249

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life"</u>
Am-241	195.3 kBq (5.278 μ Ci)	3.56%	432.7 \pm 0.5 years
Eu-152	221.3 kBq (5.980 μ Ci)	3.30%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS"

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

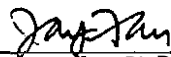
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.



Jay Fan, Ph D
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition. 1986

o LEAK TEST CERTIFICATION ON REVERSE o

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6250

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (\pm)</u>	<u>Half Life'''</u>
Am-241	199.2 kBq (5.385 μ Ci)	3.56%	432.7 \pm 0.5 years
Eu-152	221.2 kBq (5.979 μ Ci)	3.30%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS'''

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

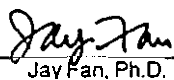
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.

Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes. 7th edition, 1986

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CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6251

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	Total <u>Uncertainty (±)</u>	<u>Half Life⁽¹⁾</u>
Am-241	199.7 kBq (5.397 µCi)	3.56%	432.7 ± 0.5 years
Eu-152	213.7 kBq (5.776 µCi)	3.31%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NiST traceable standard in a Similar geometry. The activity of the standard was determined using an ~~energy vs. efficiency curve~~ established through ongoing ~~intercomparisons~~ with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jav Fan, Ph.D.
Calibration Laboratory Manager,

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6252

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty</u>	<u>Half Life⁽¹⁾</u>
An-241	198.6 kBq (5.366 μ Ci)	3.56%	432.7 \pm 0.5 years
Eu-152	225.6 kBq (6.097 μ Ci)	3.30%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS⁽¹⁾

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

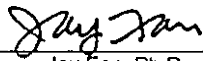
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

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REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CUSTOM POINT SOURCE

SERIAL NUMBER A6253

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life⁽¹⁾</u>
Am-241	194.9 kBq (5.267 µCi)	3.56%	432.7 ± 0.5 years
Eu-152	227.8 kBq (6.157 µCi)	3.30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS⁽¹⁾

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

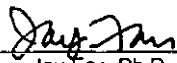
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6254

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life⁽¹⁾</u>
Am-241	204 1 kBq (5.517 µCi)	3.56%	432.7 ± 0.5 years
Eu-152	214 2 kBq (5 789 µCi)	3 30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS⁽¹⁾

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

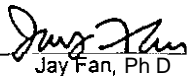
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph D
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CUSTOM POINT SOURCE

SERIAL NUMBER A6255

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life"</u>
Am-241	1926 kBq (5 207 µCi)	3.57%	432.7 ± 0.5 years
Eu-152	217.0 kBq (5 865 µCi)	3.30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS⁽¹⁾

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

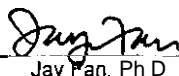
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This Standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6256

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life</u>
Am-241	188.5 kBq (5.096 µCi)	3.57%	432.7 ± 0.5 years
Eu-152	212.5 kBq (5.743 µCi)	3.31%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

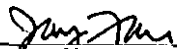
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source **was** calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard **was** determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.


Jay Fan, Ph.D.

Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CUSTOM POINT SOURCE

SERIAL NUMBER A6257

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life⁽¹⁾</u>
Am-241	195.0 kBq (5.271 µCi)	3.56%	432.7 ± 0.5 years
Eu-152	221.0 kBq (5.973 µCi)	3.30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

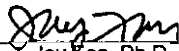
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy — efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.


Jay Fan, Ph.D.

Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6258

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (%)</u>	<u>Half Life"</u>
Am-241	198.0 kBq (5.352 μ Ci)	3.56%	432.7 \pm 0.5 years
Eu-152	220.5 kBq (5.960 μ Ci)	3.30%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS"

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

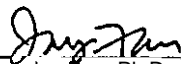
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.



Jay Fan, Ph D
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6260

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life⁽¹⁾</u>
Am-241	165.3 kBq (4.467 µCi)	3.59%	432.7 ± 0.5 years
Eu-152	215.5 kBq (5.823 µCi)	3.30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS⁽¹⁾

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

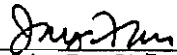
SOURCE DESCRIPTION

Active Diameter: mm Nature of Active Deposit: activity in ion exchange beads in resin matrix
 Overall Diameter: 6.4 mm Position of Active Bead: 6 mm from the end of rod
 Overall Length: 50 mm

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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 Jay Fan, Ph.D.

Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6261

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life'''</u>
Am-241	173.1 kBq (4.678 µCi)	3.58%	432.7 ± 0.5 years
Eu-152	230.4 kBq (6.226 µCi)	3.30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS'''

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8


SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

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CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6262

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (%)</u>	<u>Half Life⁽¹⁾</u>
Am-241	172.6 kBq (4.666 μ Ci)	3.58%	432.7 \pm 0.5 years
Eu-152	206.4 kBq (5.579 μ Ci)	3.31%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

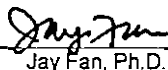
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986.

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CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6263

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (%)</u>	<u>Half Life"</u>
Am-241	155.9 kBq (4.213 μ Ci)	3.60%	432.7 \pm 0.5 years
Eu-152	216.5 kBq (5.851 μ Ci)	3.30%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS"

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

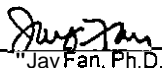
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of *the* Standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.


Jay Fan, Ph.D.

Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986.

• LEAK TEST CERTIFICATION ON REVERSE •

97-4

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6264

Reference Date January 1, 1997

<u>Radionuclide</u>		Total <u>Uncertainty (%)</u>	<u>Half Life"</u>
Am-241	213.7 kBq (5.776 μ Ci)	3.55%	432.7 \pm 0.5 years
Eu-152	214.2 kBq (5.790 μ Ci)	3.30%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS"

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

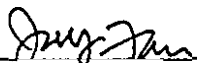
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy — efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.

Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986.

o LEAK TEST CERTIFICATION ON REVERSE •

97-4

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6265

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty</u>	<u>Half Life"</u>
Am-241	150.5 kBq (4.069 μ Ci)	3.60%	432.7 \pm 0.5 years
Eu-152	221.3 kBq (5.981 μ Ci)	3.30%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS"

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5354	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8


SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NiST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.



Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986.

• LEAK TEST CERTIFICATION ON REVERSE •

97-4

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6267

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life⁽¹⁾</u>
Am-241	157.4 kBq (4 255 µCi)	3.60%	432.7 ± 0.5 years
Eu-152	190.6 kBq (5 152 µCi)	3.32%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute,



Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes 7th edition. 1986

● LEAK TEST CERTIFICATION ON REVERSE ●

97-4

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6268

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life⁽¹⁾</u>
Am-241	188.7 kBq (5.100 µCi)	3.42%	432.7 ± 0.5 years
Eu-152	230.6 kBq (6.233 µCi)	3.30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

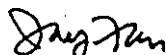
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.



Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes 7th edition 1986

• LEAK TEST CERTIFICATION ON REVERSE •

97

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6269

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life"</u>
Am-241	159.0 kBq (4.298 µCi)	3.59%	432.7 ± 0.5 years
Eu-152	224.0 kBq (6.054 µCi)	3.30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS"

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.



Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

● LEAK TEST CERTIFICATION ON REVERSE ●

97-

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6270

Reference Date January 1, 1997

Radionuclide	Activity	Total Uncertainty (%)	Half Life ⁽¹⁾
Am-241	171.5 kBq (4.634 µCi)	3.58%	432.7 ± 0.5 years
Eu-152	187.7 kBq (5.072 µCi)	3.32%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS⁽¹⁾

	Type	Energy (keV)	Intensity (%)
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.

Jay Fin. Ph D
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition. 1986

• LEAK TEST CERTIFICATION ON REVERSE •

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6271

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life"</u>
Am-241	177.1 kBq (4 787 µCi)	3 58%	432.7 ± 0.5 years
Eu-152	221 6 kBq (5 990 µCi)	3 30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS"

	<u>Type</u>	<u>Energ (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

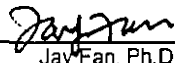
SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan, Ph.D.

Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

• LEAK TEST CERTIFICATION ON REVERSE •

97.1

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6272

Reference Date Januaw 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life⁽¹⁾</u>
Am-241	202.6 kBq (5.474 µCi)	3.56%	432.7 ± 0.5 years
Eu-152	178.6 kBq (4.826 µCi)	3.33%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS⁽¹⁾

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensity (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy—efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

North American Scientific, Inc. actively participates in the Radioactivity Measurements Assurance Program conducted by the National Institute of Standards and Technology in cooperation with the Nuclear Energy Institute.



Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1986

• LEAK TEST CERTIFICATION ON REVERSE •

CERTIFICATE OF CALIBRATION

CUSTOM POINT SOURCE

SERIAL NUMBER A6273

Reference Date January 1, 1997

Radionuclide	Activity	Total Uncertainty (%)	Half Life ⁽¹⁾
Am-241	193.4 kBq (5.227 μ Ci)	3.58%	432.7 \pm 0.5 years
Eu-152	218.0 kBq (5.892 μ Ci)	3.30%	13.33 \pm 0.04 years

PRINCIPLE EMISSIONS⁽¹⁾

	Type	Energy (keV)	Intensity (%)
Am-241	gamma	59.5384	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.286	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active Deposit:	activity in ion-exchange beads in resin matrix
Overall Diameter:	6.4 mm	Position of Active Bead:	6 mm from the end of rod
Overall Length:	50 mm		

METHOD OF CALIBRATION

The source was calibrated on a high purity Germanium detector against an NIST traceable standard in a similar geometry. The activity of the standard was determined using an energy vs. efficiency curve established through ongoing intercomparisons with the National Institute of Standards and Technology. This standard is indirectly (implicitly) traceable to the National Institute of Standards and Technology.

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Jay Fan
Jay Fan, Ph.D.
Calibration Laboratory Manager

January 20, 1997

Date

REFERENCES

- (1) Table of Radioactive Isotopes, 7th edition, 1993

• LEAK TEST CERTIFICATION ON REVERSE •

APPENDIX II

ENERGY AND SHAPE CALIBRATIONS

Energy Calibration Report

8-29-00 3:04:39 PM

Page 1

 ***** ENERGY CALIBRATION REPORT *****

Identification Number : CALCOUNT
 Description/Title : Calibration Count
 Counter : SGS & MGA Detectors
 Arrangement : Scanning System
 Calibration for : DETOL
 Acquisition Started : 7-28-00 5:42:01 PM
 Live Time : 198.1 seconds
 Real Time : 200.0 seconds

***** ENERGY CALIBRATION COEFFICIENTS *****

Energy Calibrate Performed on: 7-28-00 5:53:30 PM
 by: System Manager
 Energy Calibrate Type: POLY

$$\text{Energy(keV)} = -0.223 + 0.504 \cdot \text{ch} + -3.95\text{E-}07 \cdot \text{ch}^2 + 0.00\text{E+}00 \cdot \text{ch}^3$$

***** SHAPE CALIBRATION COEFFICIENTS *****

Shape Calibrate Performed on: 7-28-00 5:53:30 PM
 by: System Manager

$$\text{FWHM} = 1.392 + 0.019 \cdot E^{1/2}$$

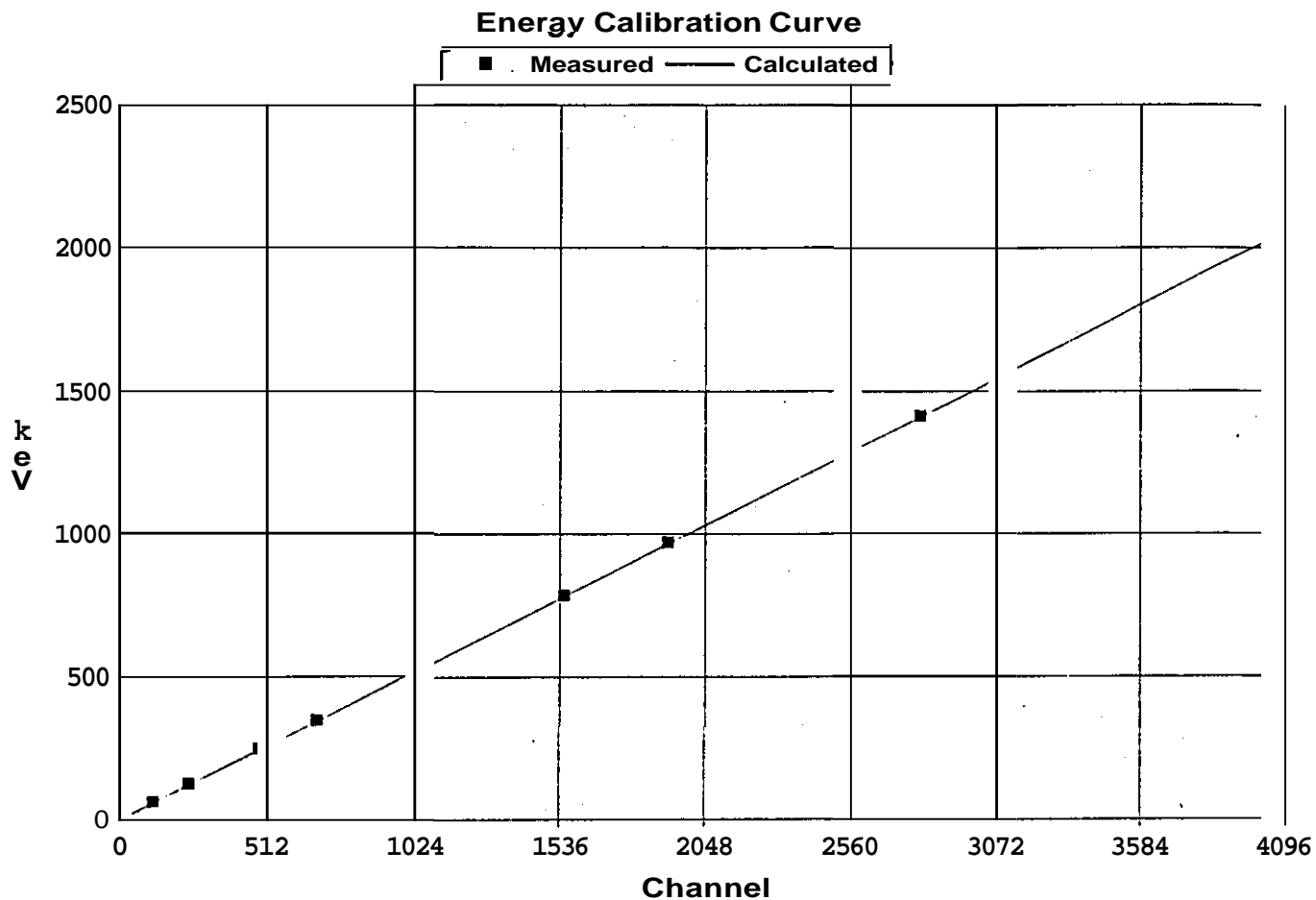
$$\text{LOW TAIL} = 0.0\text{E+}00 + 0.0\text{E+}00 \cdot E$$

***** ENERGY CALIBRATION RESULTS TABLE *****

Centroid Channel	Centroid error	Energy (keV)
118.56	0.02	59.50
242.24	0.01	121.80
486.33	0.04	244.69
684.06	0.02	344.29
1548.39	0.05	778.90
1916.93	0.05	964.10
2801.25	0.05	1408.10

***** SHAPE CALIBRATION RESULTS TABLE *****

Energy (keV)	FWHM channels	FWHM error	TAIL channels	TAIL error
59.50	3.17	0.04	0.00	0.00
121.80	3.14	0.03	0.00	0.00
244.69	3.24	0.07	0.00	0.00
344.29	3.36	0.04	0.00	0.00
778.90	3.76	0.09	0.00	0.00
964.10	3.95	0.10	0.00	0.00
1408.10	4.42	0.09	0.00	0.00



Datasource: C:\WAS\CTRS\CTR1\DET01.DEN

Energy = $-2.233\text{e-}01 \text{ keV}$ $+5.038\text{e-}01 \cdot \text{Ch}$ $-3.947\text{e-}07 \cdot \text{Ch}^2$

FWHM = $1.392\text{e+}00 \text{ keV}$ $+1.861\text{e-}02 \cdot \text{E}^{1/2}$

Energy Calibration Report

8-29-00 3:04:29 PM

Page 1

 ***** ENERGY CALIBRATION REPORT *****

Identification Number : CALCOUNT
 Description/Title : Calibration Count
 Counter : SGS & MGA Detectors
 Arrangement : Scanning System
 Calibration for : DET02
 Acquisition Started : 7-28-00 5:42:00 PM
 Live Time : 189.2 seconds
 Real Time : 203.2 seconds

***** ENERGY CALIBRATION COEFFICIENTS *****

Energy Calibrate Performed on: 7-28-00 5:49:33 PM
 by: System Manager
 Energy Calibrate Type: POLY

$$\text{Energy(keV)} = -0.003 + 0.075 \cdot \text{ch} + 0.00\text{E}+00 \cdot \text{ch}^2 + 0.00\text{E}+00 \cdot \text{ch}^3$$

***** SHAPE CALIBRATION COEFFICIENTS *****

Shape Calibrate Performed on: 7-28-00 5:49:33 PM
 by: System Manager

$$\text{FWHM} = 0.186 + 0.041 \cdot E^{1/2}$$

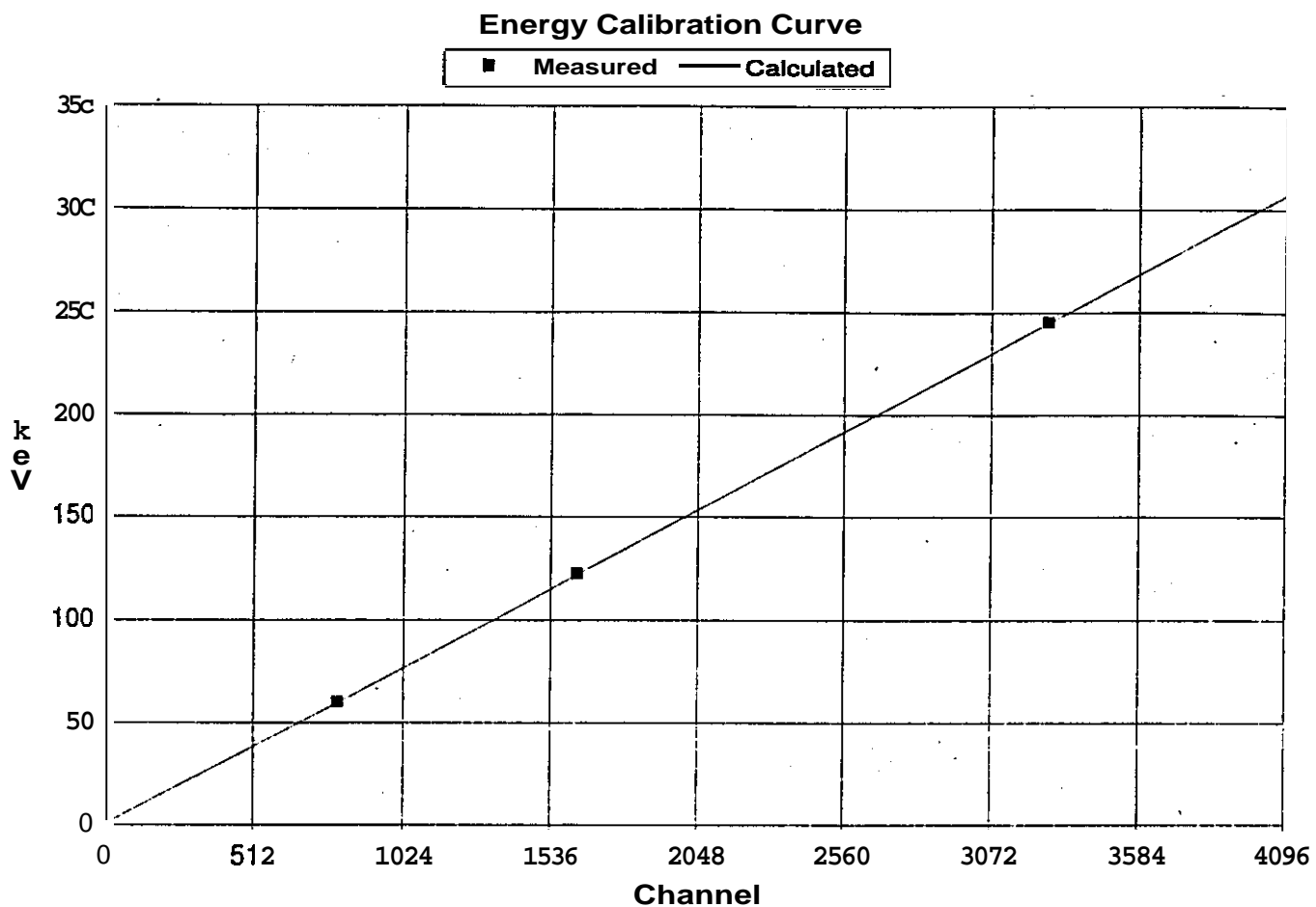
$$\text{LOW TAIL} = 0.0\text{E}+00 + 0.0\text{E}+00 \cdot E$$

***** ENERGY CALIBRATION RESULTS TABLE *****

Centroid Channel	Centroid error	Energy (keV)
794.58	0.01	59.50
1625.89	0.02	121.80
3269.03	0.06	244.69

***** SHAPE CALIBRATION RESULTS TABLE *****

Energy (keV)	FWHM channels	FWHM error	TAIL channels	TAIL error
59.50	6.73	0.02	0.00	0.00
121.80	8.44	0.03	0.00	0.00
244.69	11.67	0.13	0.00	0.00



Datasource: C:\WAS\CTRS\CTR1\DET02.DEN
Energy = $-3.409\text{e-}03$ keV $+7.490\text{e-}02 \cdot \text{Ch}$
FWHM = $1.861\text{e-}01$ keV $+4.095\text{e-}02 \cdot \text{E}^{1/2}$

APPENDIX III
EFFICIENCY CALIBRATIONS

Default Efficiency Calibration Report

8-29-00 3:06:07 PM

Page 2

 ***** EFFICIENCY CALIBRATION REPORT *****

=====
 Calibration Record No. : 1
 =====

Identification Number : EFF CAL
 Description/Title : Eu std with tin filter over collimator

Location
 Container : SLIP LID
 Weight, %Full 0.50 (kg), 100.00 (%),
 Volume, Density 1.00 (l), 0.50 (kg/l)

Comment :

Reference Date : 8-16-00 10:11:09 AM
 Acquisition Started : 8-16-00 10:20:03 AM
 Live Time 118.9 seconds
 Real Time 120.0 seconds

Detector Group : SEGE
 Detector : DET01
 Scan Platform Position : 5
 Geometry/Collimator Position : 0

Geometry Description : Distributed
 Spectrum File Name : C:\WAS\CALIB\CR1AR1\ES1401.D01
 Energy Calibration Performed on : 7-28-00 5:53:30 PM
 Efficiency Calibration Performed on: 8-16-00 10:46:50 AM
 by: System Manager
 Efficiency Calibration Approved on : 8-16-00 10:49:10 AM
 by: System Manager

Efficiency Triplets =====

Energy	Efficiency	Error
59.50	1.10E-04	5.28E-06
121.80	4.40E-04	1.55E-05
244.69	4.09E-04	2.01E-05
344.29	3.16E-04	1.15E-05
778.90	1.59E-04	8.31E-06
964.10	1.49E-04	7.65E-06

DUAL Efficiency Calibration Equation

=====

Single Equation Terms -> Offset: -98.081
 Slope: 49.824
 Quadratic: -9.465
 Cubic: 0.693
 4th Order: -0.014
 5th Order: 0.000
 6th Order: 0.000
 7th Order: 0.000
 8th Order: 0.000
 9th Order: 0.000

EMPIRICAL Efficiency Calibration Equation

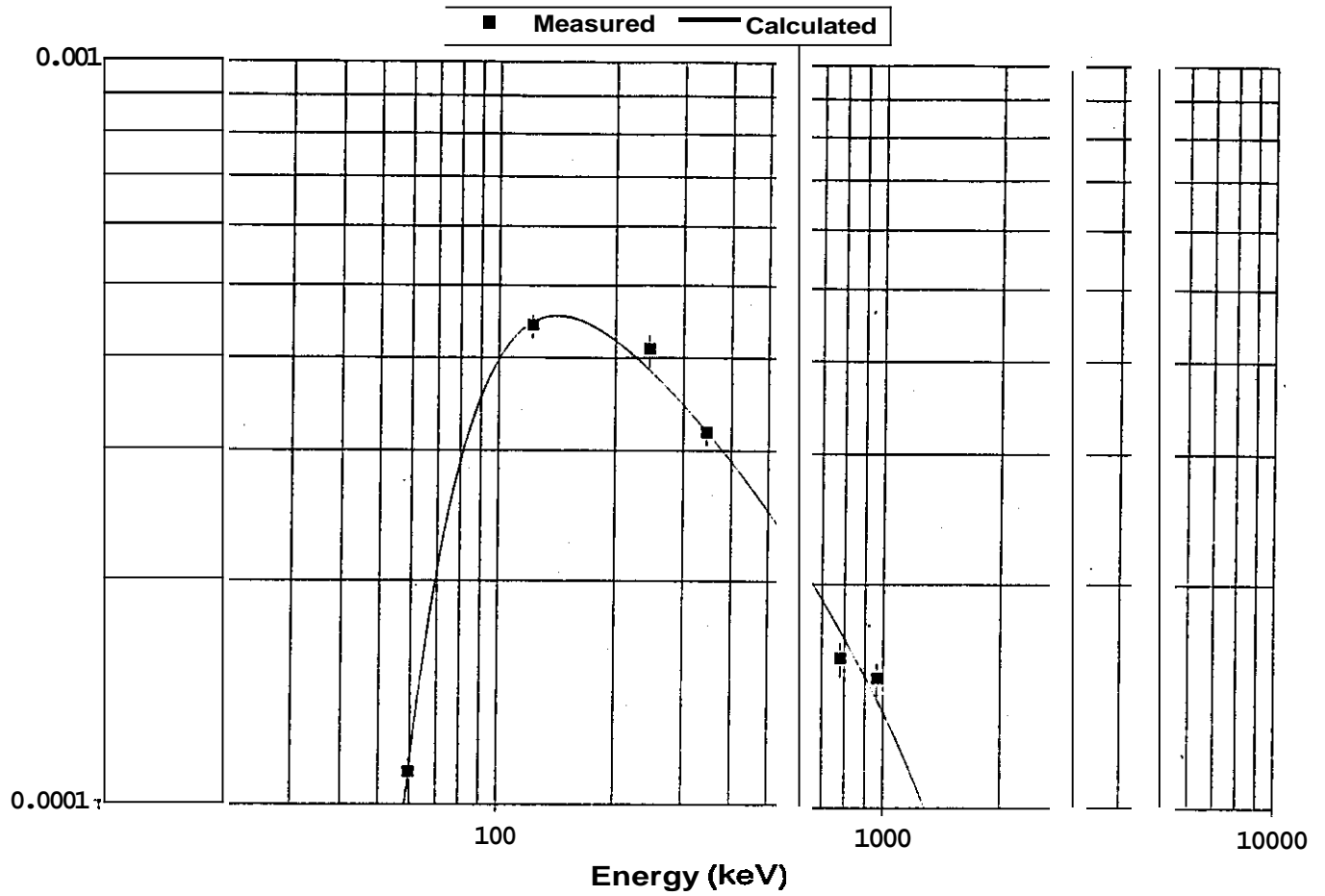
=====

Empirical Equation Terms -> Scaling: 511.800
 Offset: -8.445
 Slope: 0.907
 Quadratic: 0.274
 Cubic: -0.390
 4th Order: 0.000
 5th Order: 0.000

LINEAR Efficiency Calibration Equation

=====

Linear Equation Terms -> Offset: -0.000
 Slope: -3.527
 Quadratic: 77.287
 Cubic: -6042.311
 4th Order: 0.000
 5th Order: 0.000
 6th Order: 0.000
 7th Order: 0.000
 8th Order: 0.000
 9th Order: 0.000

Linear Efficiency Calibration Curve

Datasource: C:\WAS\CALIB\CR1AR1\ES1401.D01

 $\log(\text{Eff}) = -4.149\text{e-}04 \cdot E - 3.527\text{e}+00 + 7.729\text{e}+01/E - 6.042\text{e}+03/E^2$

APPENDIX IV TRANSMISSION CALIBRATION

Transmission Calibration Report

8-29-00 3:06:35 PM

Page 1

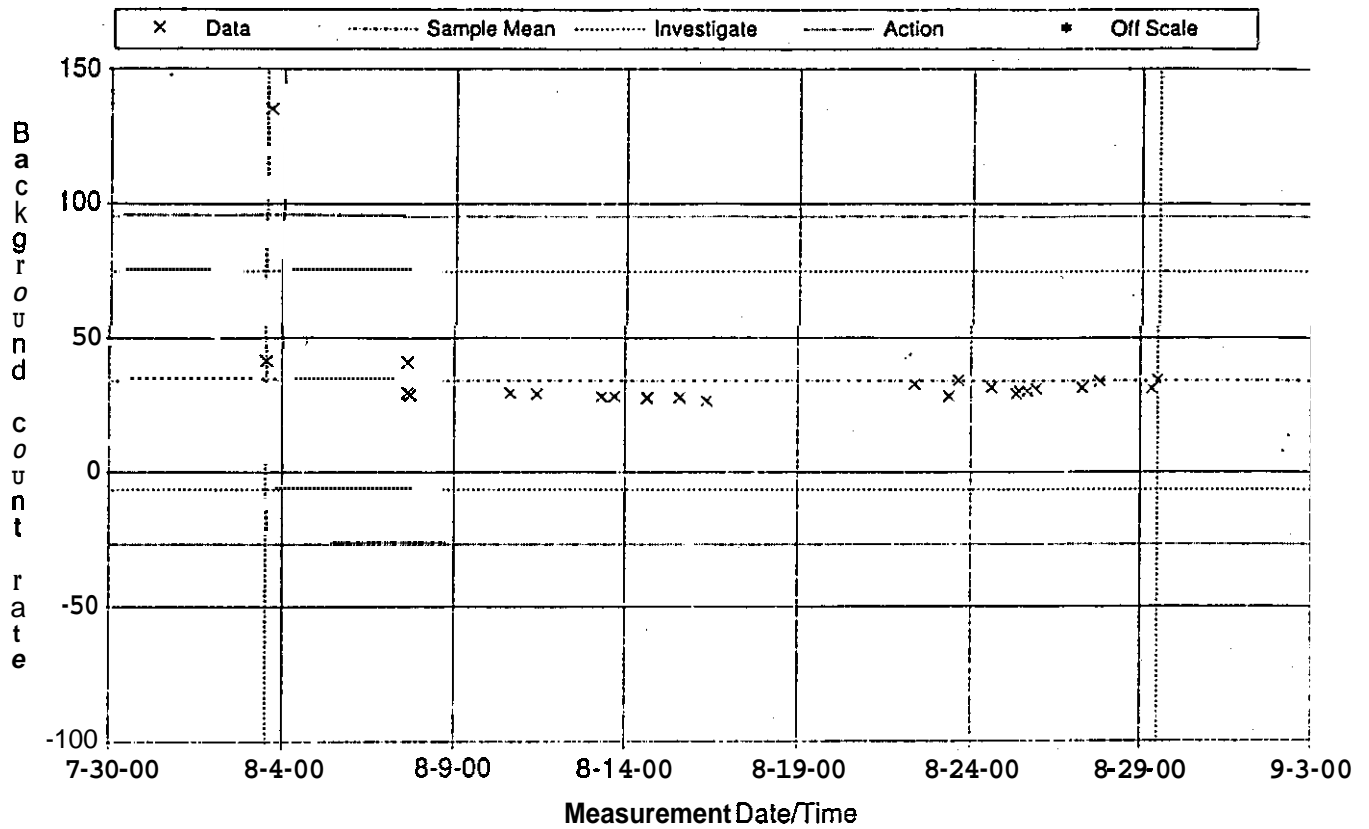
*** T R A N S M I S S I O N C A L I B R A T I O N R E P O R T ***

Detector Name: DET01
Container Type: SLIP LID
Collimator: 0

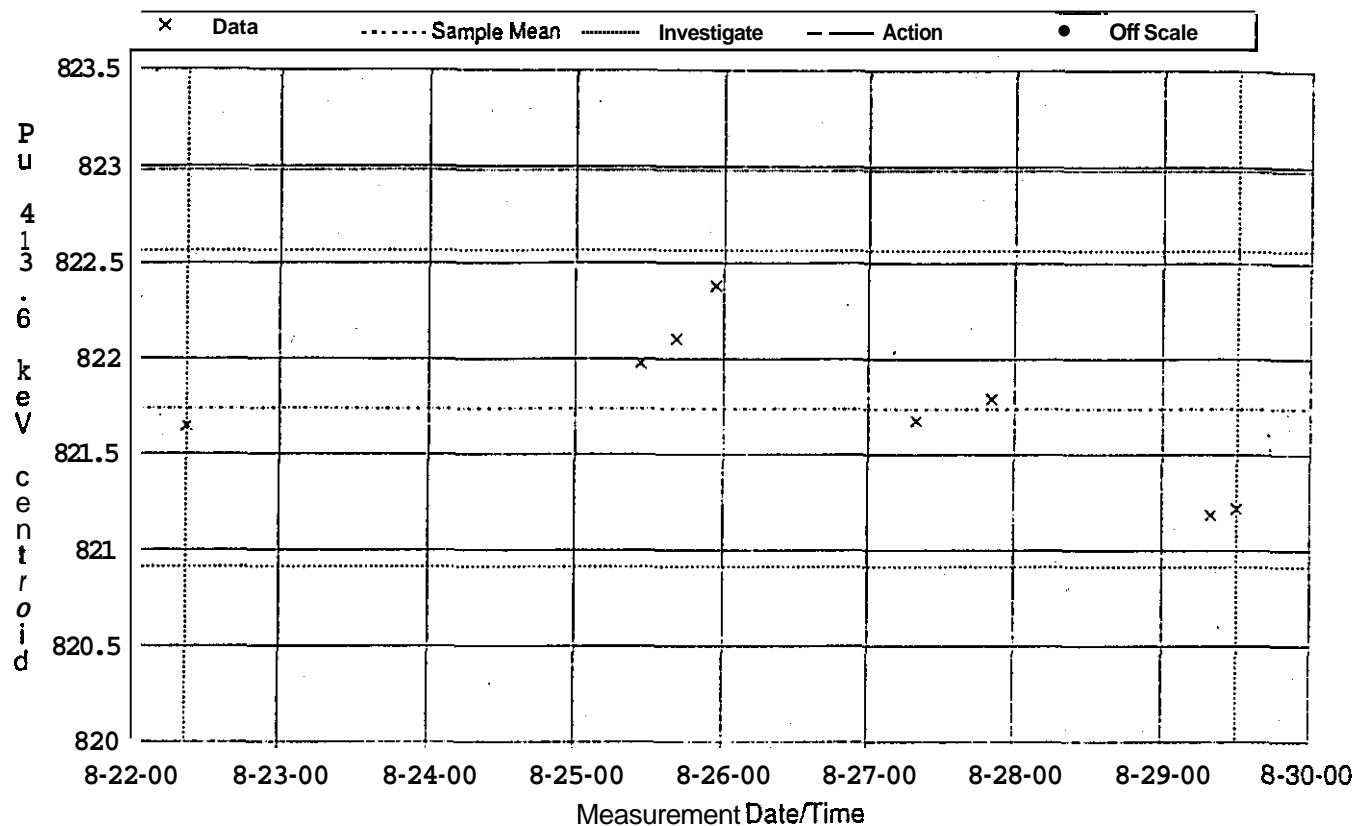
Calibration time: 8-16-00 11:15:27 AM
Calibrated by: System Manager
Calibration Live Time: 23.9 seconds
Energy Tolerance: 1.0 keV

Record	Nuclide	Energy (keV)	Peak Area (Cnts)	Peak Area Error (Cnts)	Half-Life (sec)
1	SE-75	264.70	4.66E+04	2.47E+02	1.03E+07
2	SE-75	400.70	3.55E+04	1.93E+02	1.03E+07

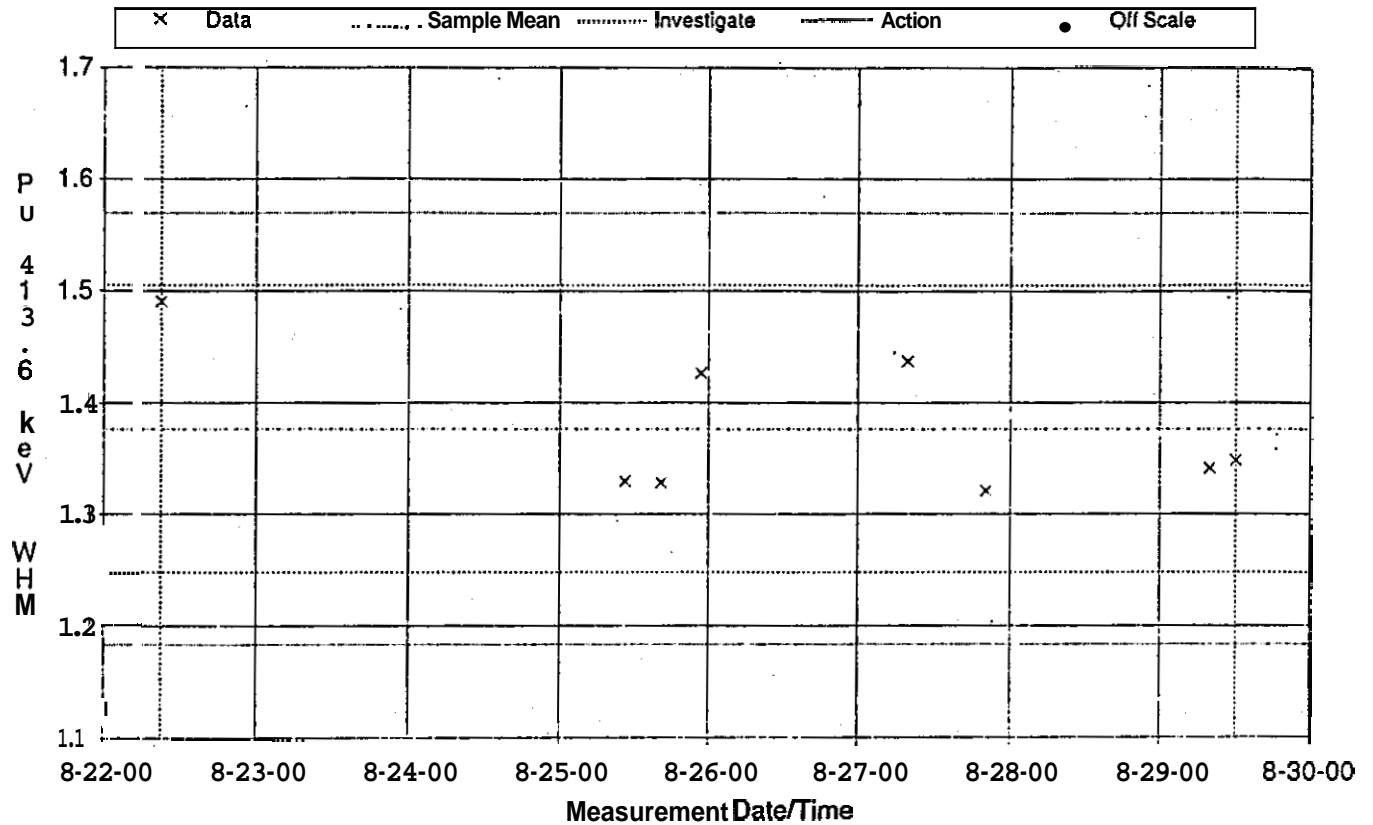
APPENDIX V
QA COUNT PLOTS AND REPORTS



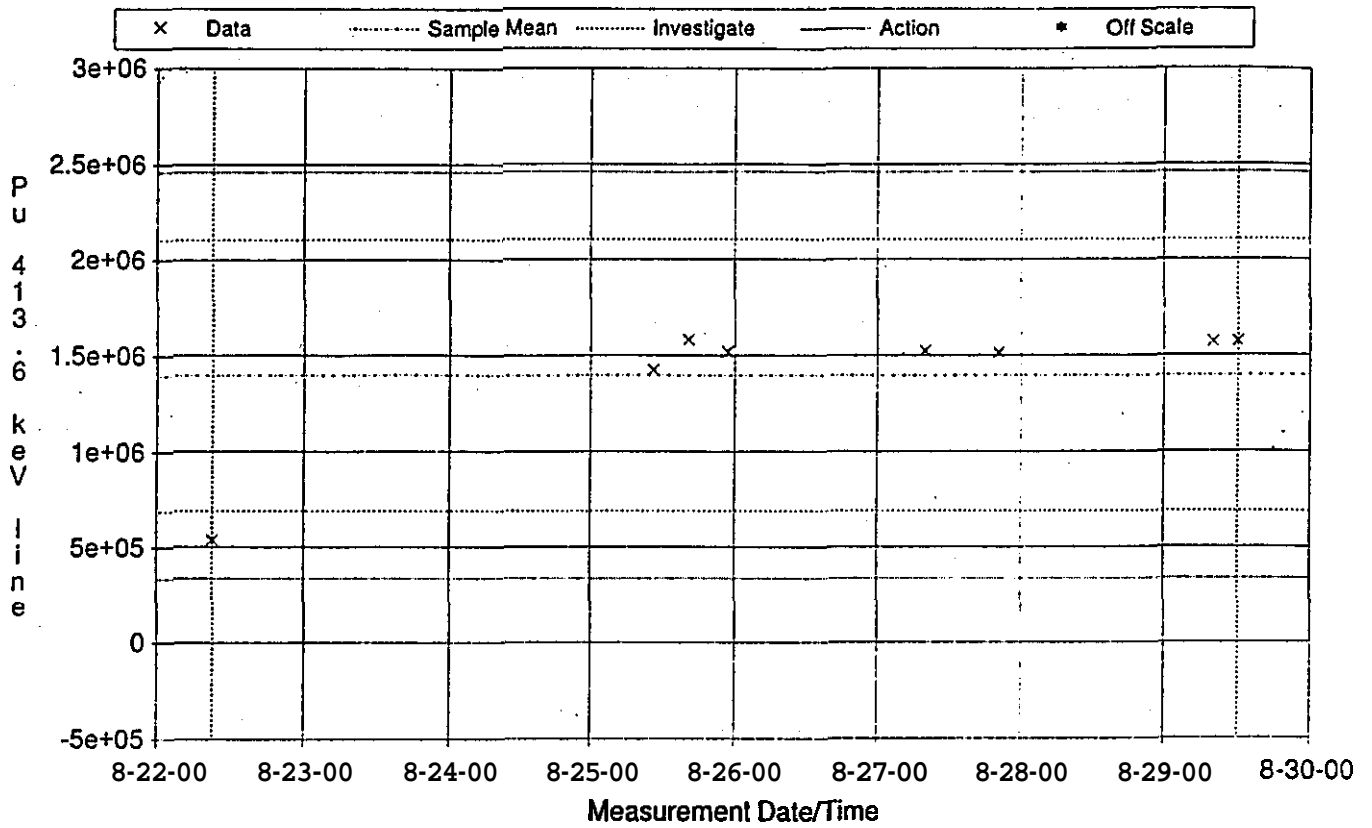
QA Filename : C:\WAS\CTRS\CTR1\ARR1\S11_BCK.QAF
Parameter Description : Background count rate (cps)
Selection Dates : 8-03-0012:18:51 PM - 8-29-0012:01:15 PM
Sample Mean +-Std Dev : 34.025 +-20.356



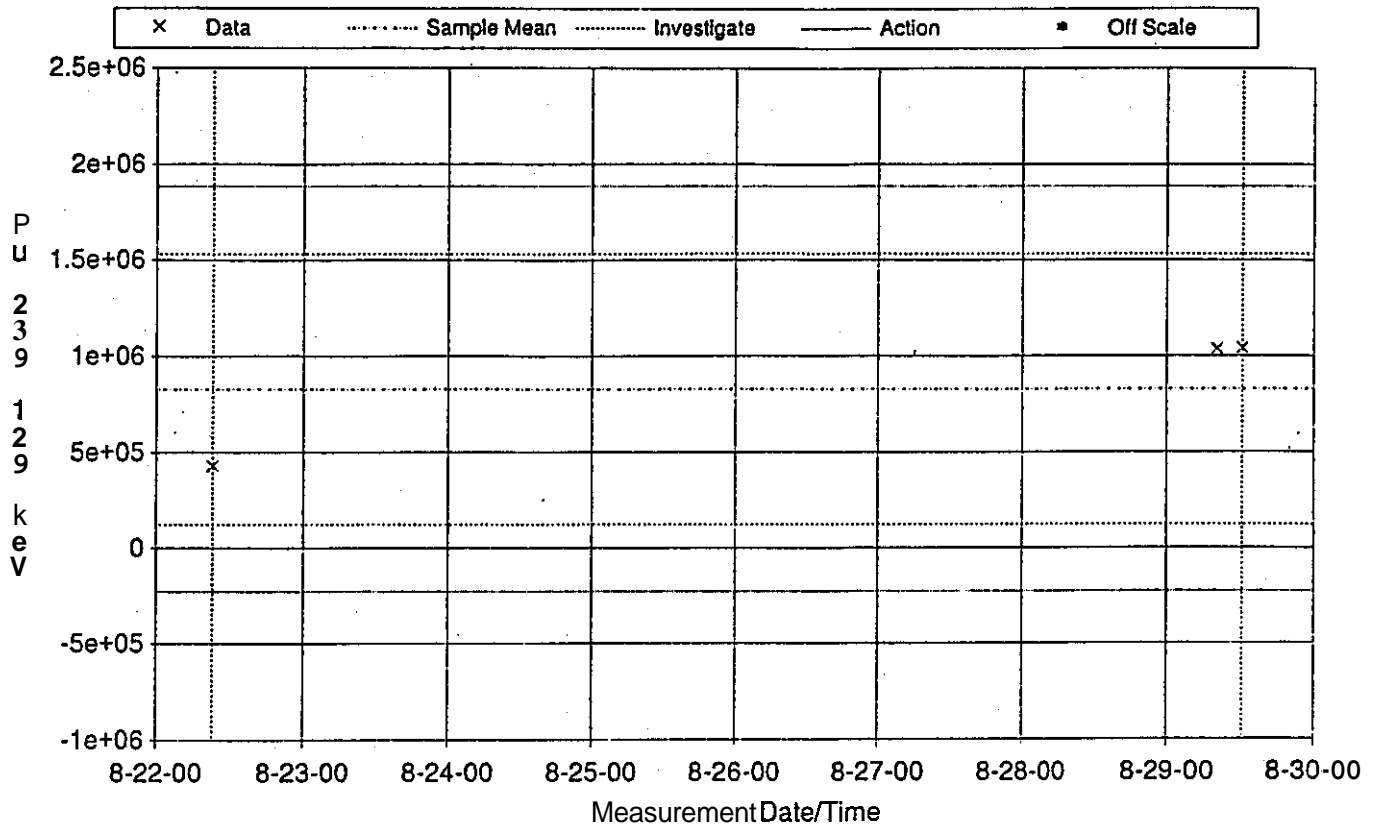
QA Filename : C:\WAS\CTRS\CTR1\ARR1\A04_CAL.QAF
Parameter Description : Pu-413.6keV centroid (ch)
Selection Dates : 8-22-00 9:04:38 AM - 8-29-00 12:12:29 PM
Sample Mean +-Std Dev : 821.739 +- 0.413



QA Filename : C:\WAS\CTRS\CTR1\ARR1\A04_CAL.QAF
Parameter Description : Pu 413.6 keV FWHM (keV)
Selection Dates : 8-22-00 9:04:38 AM - 8-29-00 12:12:29 PM
Sample Mean +-Std Dev : 1.376 +- 0.064



QA Filename : C:\WAS\CTRS\CTR1\ARR1\A05_CAL.QAF
Parameter Description : Pu 413.6 keV line (uCi/unit)
Selection Dates : 6-22-00 9:04:37 AM - 6-29-00 12:12:28 PM
Sample Mean +-Std Dev : 1.40e+06 +- 3.54e+05



QA Filename : C:\WAS\CTRS\CTR1\ARR1\A05_CAL.QAF
 Parameter Description : Pu-239 129 keV (uCi/unit)
 Selection Dates : 8-22-00 9:04:37 AM - 8-29-00 12:12:28 PM
 Sample Mean +-Std Dev : 8.26e+05 +- 3.52e+05

APPENDIX VI SYSTEM PARAMETERS

Report of Gamma Waste Assay System:

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Gamma Waste Assay

Counter Definition

Counter Description: SGS & MGA Detectors
 File name: C:\WAS\CTRS\CTR1.SUF
 Facility: Flour Hanford (RM19 Can Scanner)
 Instrument Interface:
 Type: PLC
 COM Port: COM1
 Baud rate: 19200
 PLC Setup Parameters:

R11-R12	0	R13-R14	0
R15-R16	0	R17-R18	0
R19	0	R20	0
R21	0	R22	0
R23	0	R24	600
R25	2000	R26	0
R27	0	R28	0
R29	0	R30	0
R31	0	R32	0
R33	0	R34	0
R35	0		

Scale conversion factor: 0.000 g /unit
 Configuration:
 Scanning platform: Yes
 Helical Scan: No
 Transmission source: Yes
 MSS module: No
 Measurement control: No
 Collimator/geometry: No
 Dosimeters: No
 Setup:
 Archive Storage Information:
 Disk: A:
 Sample file directory: WAS_DATA
 Units Selection (conversion factor):
 Length: cm (1.000)
 Weight: g (0.001)
 Volume: ml (0.001)
 Disk free space Warning: < 4.0 Megabytes
 Background Subtraction:
 Matching container type only: No
 Transfer Host Setup:
 Transfer Host Name: NONE
 Path: C:\NAS
 Export Transfer Path: A:\
 Bar Code Terminal Setup:
 COM Port: NONE
 Baud rate: 9600

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Arrangement Definition

Arrangement Description:	Scanning System
File name:	C:\WAS\CTRS\CTR1\ARR1.SUF
Scanning Platform:	
Start position:	0 mm
Position delta:	12 mm
Number of positions:	15
Separated segments:	No
Number of segments:	15
Segment offset:	0
Collimator/Geometry:	
Number of positions:	1
Transmission:	
Number of sources:	1

Count Type Definitions

Count Type Description:	ASSAY
File name:	C:\WAS\CTRS\CTR1\ARR1\CT01.SUF
Default count type for automatic startup:	NO
Sample Information:	
Information type:	Sample
Container type:	SLIP LID
Entry of sample IDs:	Manual/generated series
Use sample database:	No
Acquisition Information:	
Preset Time:	
With transmission:	30 sec
Without transmission:	50 sec
Type:	Real Time
Transmission:	
Mode:	Two pass
Source:	0
Collimator/Geometry:	
Position:	0 Fixed
Dosimeter Assays:	
Bottom/External:	No
Segmented:	No
Rotational:	No
MSS enabled:	No
Scanning enabled:	Yes
Disable load/unload:	No

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Count Type Description: Background QC
File name: C:\WAS\CTRS\CTR1\ARR1\CT02.SUF
Default count type for automatic startup: No
Sample Information:
Information type: Bkgd Check
Container type: SLIP LID
Entry of sample IDs: Manual/generated series
Use sample database: No
Acquisition Information:
Preset Time:
With transmission: 0 sec
Without transmission: 300 sec
Type: Real Time
Transmission:
Mode: One pass without
Source: 0
Collimator/Geometry:
Position: 0 Fixed
Dosimeter Assays:
Bottom/External: No
Segmented: No
Rotational: No
MSS enabled: No
Scanning enabled: No
Disable load/unload: Yes

Count Type Description: MEASUREMENT CONTROL
File name: C:\WAS\CTRS\CTR1\ARR1\CT03.SUF
Default count type for automatic startup: No
Sample Information:
Information type: Cal Check
Container type: SLIP LID
Entry of sample IDs: Manual/generated series
Use sample database: No
Acquisition Information:
Preset Time:
With transmission: 30 sec
Without transmission: 50 sec
Type: Real Time
Transmission:
Mode: Two pass
Source: 0
Collimator/Geometry:
Position: 0 Fixed
Dosimeter Assays:
Bottom/External: No
Segmented: No
Rotational: No
MSS enabled: No
Scanning enabled: Yes
Disable load/unload: No

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Count Type Description: Environmental Background
File name: C:\WAS\CTRS\CTR1\ARR1\CT04.SUF
Default count type for automatic startup: No
Sample Information:
 Information type: Background
 Container type: <Container Type>
 Entry of sample IDs: Manual/generated series
 Use sample database: No
Acquisition Information:
 Preset Time:
 With transmission: 0 sec
 Without transmission: 600 sec
 Type: Live Time
Transmission:
 Mode: One pass without
 Source: 0
Collimator/Geometry:
 Position: 0 Fixed
Dosimeter Assays:
 Bottom/External: No
 Segmented: No
 Rotational: No
MSS enabled: No
Scanning enabled: No
Disable load/unload: No

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Group Definitions

Group Description:	SEGE		
File name:	C:\WAS\CTRS\CTR1\ARR1\DG01.SUF		
Segmented:	Yes		
Group Detectors:	DET:DETO1		
Count Type:	ASSAY		
File Name:	C:\WAS\CTRS\CTR1\ARR1\DG01CT01.SUF		
Processing Information:			
Processing:	NORMAL		
View report on screen:	Yes		
Group Analysis:			
Assay Segment:	Enable	C:\WAS\ASF\SEGTRCOR.ASF	
Trans. Segment:	Enable	C:\WAS\ASF\SEGTRANS.ASF	
Comb. Non-Segmented:	Disable	C:\WAS\ASF\NO_ANALY.ASF	
N/A			
Summed Spectrum:	Enable	C:\WAS\ASF\SEGSUM.ASF	
Summed Segment			
Comb. Segment NID:	Enable	C:\WAS\ASF\COMBSEG.ASF	
Combine Segment			
Comb. NID Results:	Disable	C:\WAS\ASF\COMBNID.ASF	
Combine NID			
Comb. All Results:	Disable	C:\WAS\ASF\COMBALL.ASF	
Combine All			
Report :	Enable	C:\WAS\ASF\RPTSEGS.ASF	
Report			

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Count Type: Background QC
 File Name: C:\WAS\CTRS\CTR1\ARR1\DG01CT02.SUF
 Processing Information:
 Processing: BACKGROUND CK
 View report on screen: Yes
 Group Analysis:
 Assay Segment:
 Enable C:\WAS\ASF\BKGCOUNT.ASF
 Trans. Segment:
 Enable C:\WAS\ASF\BKGCOUNT.ASF
 Comb. Non-Segmented:
 N/A Disable C:\WAS\ASF\NO_ANALY.ASF
 Summed Spectrum:
 Summed Segment Enable C:\WAS\ASF\BKGCOUNT.ASF
 Comb. Segment NID:
 Combine Segment Disable C:\WAS\ASF\NO_ANALY.ASF
 Comb. NID Results:
 Combine NID Disable C:\WAS\ASF\NO_ANALY.ASF
 Comb. All Results:
 Combine All Disable C:\WAS\ASF\NO_ANALY.ASF
 Report:
 Report Disable C:\WAS\ASF\NO_ANALY.ASF

Count Type: MEASUREMENT CONTROL
 File Name: C:\WAS\CTRS\CTR1\ARR1\DG01CT03.SUF
 Processing Information:
 Processing: CALIBRATION CK
 View report on screen: Yes
 Group Analysis:
 Assay Segment:
 Enable C:\WAS\ASF\SEGTRCOR.ASF
 Trans. Segment:
 Enable C:\WAS\ASF\SEGTRANS.ASF
 Comb. Non-Segmented:
 N/A Disable C:\WAS\ASF\NO_ANALY.ASF
 Summed Spectrum:
 Summed Segment Enable C:\WAS\ASF\SEGSUM.ASF
 Comb. Segment NID:
 Combine Segment Enable C:\WAS\ASF\COMBSEG.ASF
 Comb. NID Results:
 Combine NID Disable C:\WAS\ASF\COMBNID.ASF
 Comb. All Results:
 Combine All Disable C:\WAS\ASF\NO_ANALY.ASF
 Report:
 Report Enable C:\WAS\ASF\RPTSEGS.ASF

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Count Type: Environmental Background
 File Name: C:\WAS\CTRS\CTR1\ARR1\DG01CT04.SUF
 Processing Information:
 Processing: ENV BACKGROUND
 View report on screen: No
 Group Analysis:
 Assay Segment:
 Enable C:\WAS\ASF\BKGCOUNT.ASF
 Trans. Segment:
 Disable C:\WAS\ASF\NO_ANALY.ASF
 Comb. Non-Segmented:
 N/A Disable C:\WAS\ASF\NO_ANALY.ASF
 Summed Spectrum:
 Summed Segment Disable C:\WAS\ASF\NO_ANALY.ASF
 Comb. Segment NID:
 Combine Segment Disable C:\WAS\ASF\NO_ANALY.ASF
 Comb. NID Results:
 Combine NID Disable C:\WAS\ASF\NO_ANALY.ASF
 Comb. All Results:
 Combine All Disable C:\WAS\ASF\NO_ANALY.ASF
 Report:
 Report Disable C:\WAS\ASF\NO_ANALY.ASF

Group Description: LEGE
 File name: C:\WAS\CTRS\CTR1\ARR1\DG02.SUF
 Segmented: No
 Group Detectors: .
 DET: DET02
 Count Type: ASSAY
 File Name: C:\WAS\CTRS\CTR1\ARR1\DG02CT01.SUF
 Processing Information:
 Processing: NORMAL
 View report on screen:.. No
 Group Analysis:
 Non-Segmented:
 Enable C:\WAS\ASF\MGAMGAU.ASF

Count Type: Background QC
 File Name: C:\WAS\CTRS\CTR1\ARR1\DG02CT02.SUF
 Processing Information:
 Processing: BACKGROUND CK
 View report on screen: No
 Group Analysis:
 Non-Segmented:
 Enable C:\WAS\ASF\BKGCOUNT.ASF

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Count Type: MEASUREMENT CONTROL
File Name: C:\WAS\CTRS\CTR1\ARR1\DG02CT03.SUF
Processing Information:
 Processing: CALIBRATION CK
 View report on screen: Yes
Group Analysis:
 Non-Segmented:
 Enable C:\WAS\ASF\CALENG.ASF

Count Type: Environmental Background
File Name: C:\WAS\CTRS\CTR1\ARR1\DG02CT04.SUF
Processing Information:
 Processing: ENV BACKGROUND
 View report on screen: No
Group Analysis:
 Non-Segmented:
 Disable C:\WAS\ASF\NO_ANALY.ASF

Container Definitions

Container Type Description:	SLIP LID
File name:	C:\WAS\CONT\CONT1.SUF
Material handling type:	0
Geometric correction factor:	0.725
Diameter:	13.800 cm
Height:	17.750 cm
Volume:	2700.000 ml
Empty weight:	230.000 g