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		Design Authority				2	1	SPO: JL Maupin		2/15/01	T4-06
		Design Agent				2	1	TL Welsh		2-15-01	T4-40
2	1	Cog. Eng. DM Fazzari	<i>DM Fazzari</i>	2/15/01	T5-06	2	1	GA Westsik		2-9-01	T5-53
2	1	Cog. Mgr. EW Curfman	<i>EW Curfman</i>	2/15/01	T5-05						
2	1	QA DR Groth	<i>DR Groth</i>	02-09-01	T4-15	2	1	SPO: P.J. CRANE			T4-04
		Safety	<i>per telcon for Don Groth</i>								
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18. <i>Jeanette M Snyder</i> JM Snyder Signature of EDT Originator Date: 2-9-01	19. <i>DM Fazzari</i> Authorized Representative for Receiving Organization Date: 2-9-01	20. <i>EW Curfman</i> Design Authority/Cognizant Manager Date: 2-9-01	21. DOE APPROVAL (if required) Ctrl No. _____ <input type="checkbox"/> Approved <input type="checkbox"/> Approved w/comments <input type="checkbox"/> Disapproved w/comments
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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

HNF-7331  
Revision 0  
~~EDT 623584~~ *CAW 2/15/01*  
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ORIGINAL EDT  
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IN CORRECT

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Document Type: RPT

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**DM Fazzari**  
Fluor Hanford

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

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NUMBER WAS  
INCORRECT

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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:

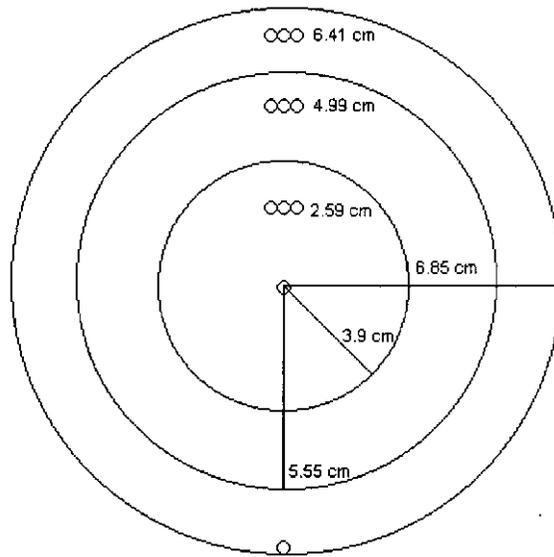


Figure 1

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.

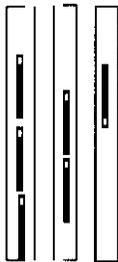


Figure 2

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

Tube #	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

Source	Activities		
	Am-241	Eu-152	
	kBq		
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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# 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<sup>(1)</sup></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>Enerov (keV)</u>	<u>Intensiv (%)</u>
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	<b>7.51</b>
		344.286	26.6
		<b>778.920</b>	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

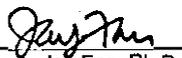
**SOURCE DESCRIPTION**

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. emciency 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. adively 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 Januaw 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 (5.654 µCi)	3.31%	13.33 ± 0.04 years

## PRINCIPLE EMISSIONS<sup>(1)</sup>

	<u>Type</u>	<u>Enerov (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

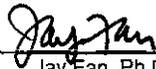
## SOURCE DESCRIPTION

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 A6246

Reference Date January 1, 1997

<u>Radionuclide</u>		Total <u>Uncertainty (±)</u>	<u>Half Life<sup>(1)</sup></u>
Am-241	198.4 kBq (5.363 µCi)	3.54%	432.7 ± 0.5 years
Eu-152	232.3 kBq (6.277 µCi)	3.28%	13.33 ± 0.04 years

### PRINCIPLE EMISSIONS<sup>1</sup>

	<u>Type</u>	<u>Energ (keV)</u>	<u>Intensiv (%)</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

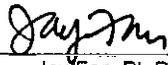
### SOURCE DESCRIPTION

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.

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 Pan*  
 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 •

97-04

# 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 µCi)	3.56%	432.7 ± 0.5 years
Eu-152	221.3 kBq (5.980 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

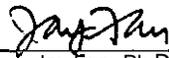
### SOURCE DESCRIPTION

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.

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 (±)</u>	<u>Half Life'''</u>
Am-241	199.2 kBq (5.385 µCi)	3.56%	432.7 ± 0.5 years
Eu-152	221.2 kBq (5.979 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	<b>26.6</b>
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

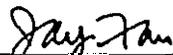
## SOURCE DESCRIPTION

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 A6251  
 Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life<sup>(1)</sup></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<sup>\*\*\*</sup>

	<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
		<b>778.920</b>	12.98
		964.110	14.5
		1112.075	13.6
		<b>1408.002</b>	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*

Jay Fan, Ph.D.  
 Calibration Laboratory Manager,

January 20, 1997

Date

REFERENCES

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

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97-4.

# 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<sup>(1)</sup></u>
An-241	198.6 kBq (5.366 $\mu$ Ci)	3.56%	432.7 $\pm$ 0.5 years
Eu-152	225.6 kBq (6.097 $\mu$ Ci)	3.30%	13.33 $\pm$ 0.04 years

## PRINCIPLE EMISSIONS<sup>(1)</sup>

	<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

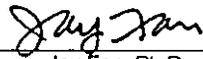
## SOURCE DESCRIPTION

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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97-4

# CERTIFICATE OF CALIBRATION

**CUSTOM POINT SOURCE**  
**SERIAL NUMBER A6253**  
**Reference Date January 1, 1997**

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life<sup>(1)</sup></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<sup>(1)</sup>**

	<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 m	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, 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<sup>(1)</sup></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<sup>(1)</sup>**

	<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

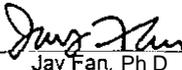
**SOURCE DESCRIPTION**

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  
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**REFERENCES**

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

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# CERTIFICATE OF CALIBRATION

**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	192.6 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<sup>(1)</sup>**

	<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

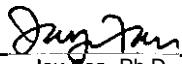
**SOURCE DESCRIPTION**

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 **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	<b>26.6</b>
		778.920	12.98
		964.110	14.5
		1112.075	<b>13.6</b>
		1408.002	20.8

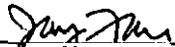
## SOURCE DESCRIPTION

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 **A6257**  
 Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty(±)</u>	<u>Half Life<sup>(1)</sup></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<sup>\*\*\*</sup>

	<u>Type</u>	<u>Enerw(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

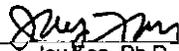
SOURCE DESCRIPTION

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

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97-4

# 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 µCi)	3.56%	432.7 ± 0.5 years
Eu-152	220.5 kBq (5.960 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

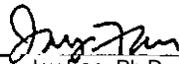
### SOURCE DESCRIPTION

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

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97.6

# 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<sup>(1)</sup></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<sup>(1)</sup>**

	<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
		<b>344.286</b>	26.6
		778.920	12.98
		964.110	14.5
		<b>1112.075</b>	13.6
		1408.002	20.8

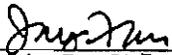
**SOURCE DESCRIPTION**

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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97-4

# 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	<b>26.6</b>
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

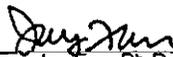
### SOURCE DESCRIPTION

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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97-4

# 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<sup>(1)</sup></u>
Am-241	172.6 kBq (4.666 µCi)	3.58%	432.7 ± 0.5 years
Eu-152	206.4 kBq (5.579 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

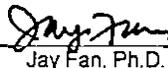
### SOURCE DESCRIPTION

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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97-4

# CERTIFICATE OF CALIBRATION

**CUSTOM POINT SOURCE**  
**SERIAL NUMBER A6263**  
**Reference Date Januaw 1, 1997**

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life<sup>(1)</sup></u>
Am-241	155.9 kBq (4.213 µCi)	3.60%	432.7 ± 0.5 years
Eu-152	216.5 kBq (5.851 µCi)	3.30%	13.33 ± 0.04 years

PRINCIPLE EMISSIONS<sup>(1)</sup>:

	<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

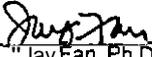
SOURCE DESCRIPTION

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

### PRINCIPLE EMISSIONS"

	<u>Type</u>	<u>Energy (keV)</u>	<u>Intensiv (%)</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

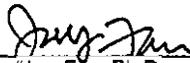
### SOURCE DESCRIPTION

Active Diameter:	2 mm	Nature of Active <b>Deposit:</b>	activity in ion exchange beads in resin matrix
<b>Overall</b> 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.

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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 $\mu$ Ci)	3.60%	432.7 $\pm$ 0.5 years
Eu-152	221.3 kBq (5.981 $\mu$ 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

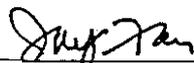
SOURCE DESCRIPTION

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 interwmparisons 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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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<sup>(1)</sup></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<sup>(1)</sup>

	<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

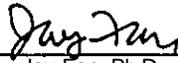
### SOURCE DESCRIPTION

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 A6268

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainty (±)</u>	<u>Half Life<sup>(1)</sup></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

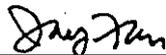
SOURCE DESCRIPTION

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

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97

# CERTIFICATE OF CALIBRATION

## CUSTOM POINT SOURCE

SERIAL NUMBER A6269

Reference Date January 1, 1997

<u>Radionuclide</u>	<u>Activity</u>	Total <u>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.

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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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97-

# CERTIFICATE OF CALIBRATION

**CUSTOM POINT SOURCE**  
**SERIAL NUMBER A6270**  
**Reference Date Januaw 1, 1997**

<u>Radionuclide</u>	<u>Activity</u>	<u>Total Uncertainh. (±)</u>	<u>Half Life<sup>(1)</sup></u>
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<sup>(1)</sup>**

	<u>Type</u>	<u>Enerov (keV)</u>	<u>Intensitv (%)</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 Fin. 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 A6271

Reference Date January 1, 1997

Radionuclide	Activity	Total Uncertainty (±)	Half Life"
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"

	Type	Energ (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

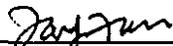
### SOURCE DESCRIPTION

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.

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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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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<sup>(1)</sup></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<sup>(1)</sup>**

	<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

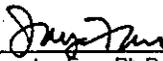
**SOURCE DESCRIPTION**

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

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# CERTIFICATE OF CALIBRATION

**CUSTOM POINT SOURCE**  
**SERIAL NUMBER A6273**  
**Reference Date January 1, 1997**

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

## PRINCIPLE EMISSIONS<sup>(1)</sup>

Radionuclide	Type	Energy (keV)	Intensity (%)
Am-241	gamma	59.5364	35.7
Eu-152	gamma	121.7758	28.4
		244.6923	7.51
		344.296	26.6
		778.920	12.98
		964.110	14.5
		1112.075	13.6
		1408.002	20.8

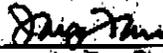
## SOURCE DESCRIPTION

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, 1996

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APPENDIX II  
ENERGY AND SHAPE CALIBRATIONS

\*\*\*\*\*  
 \*\*\*\*\* 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

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

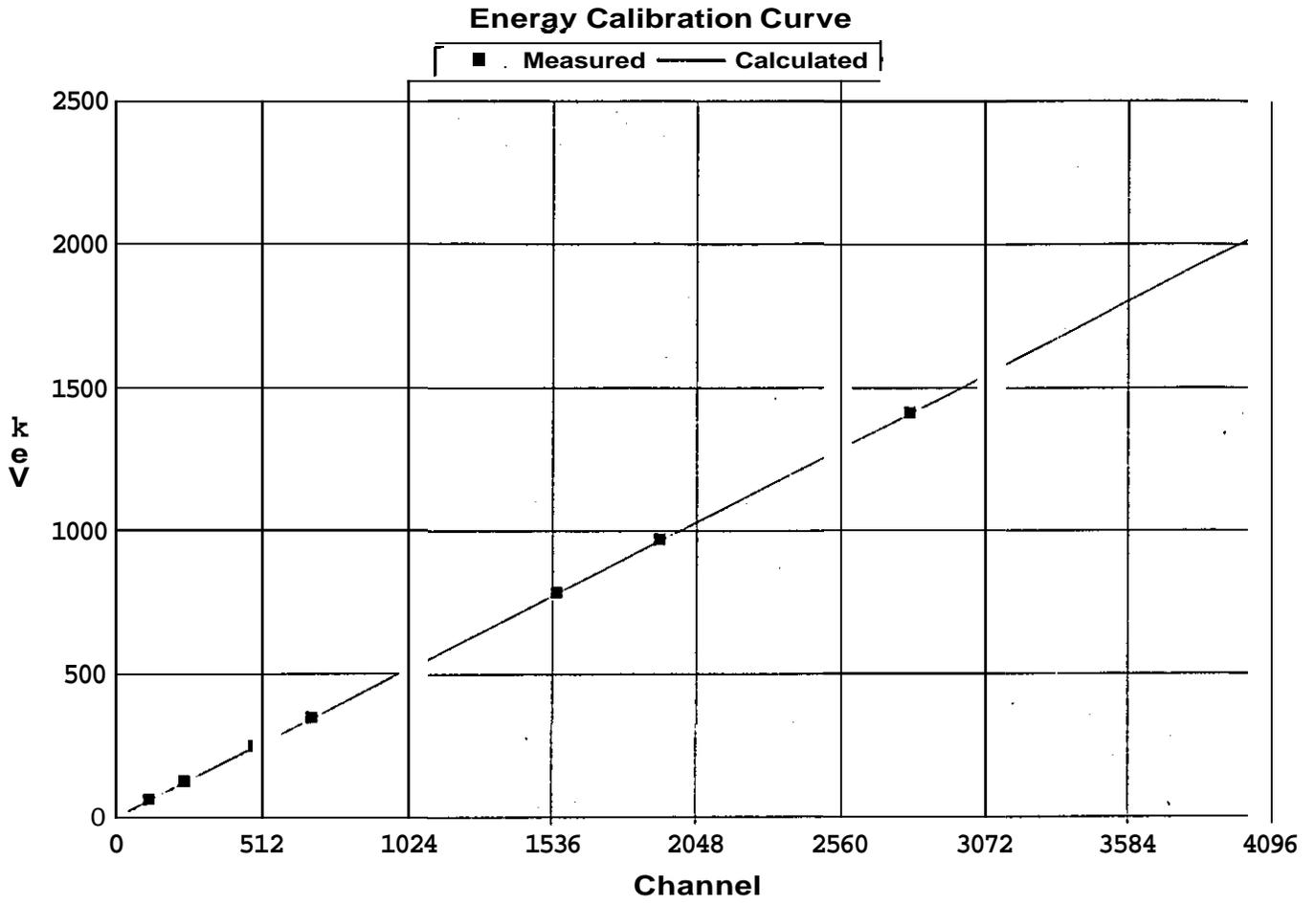
$$\text{LOW TAIL} = 0.0\text{E+}00 + 0.0\text{E+}00 \cdot \text{E}$$

\*\*\*\*\* 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 =  $-2.233e-01$  keV     $+5.038e-01$ \*Ch     $-3.947e-07$ \*Ch<sup>2</sup>  
 FWHM =  $1.392e+00$  keV     $+1.861e-02$ \*E<sup>1/2</sup>

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

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

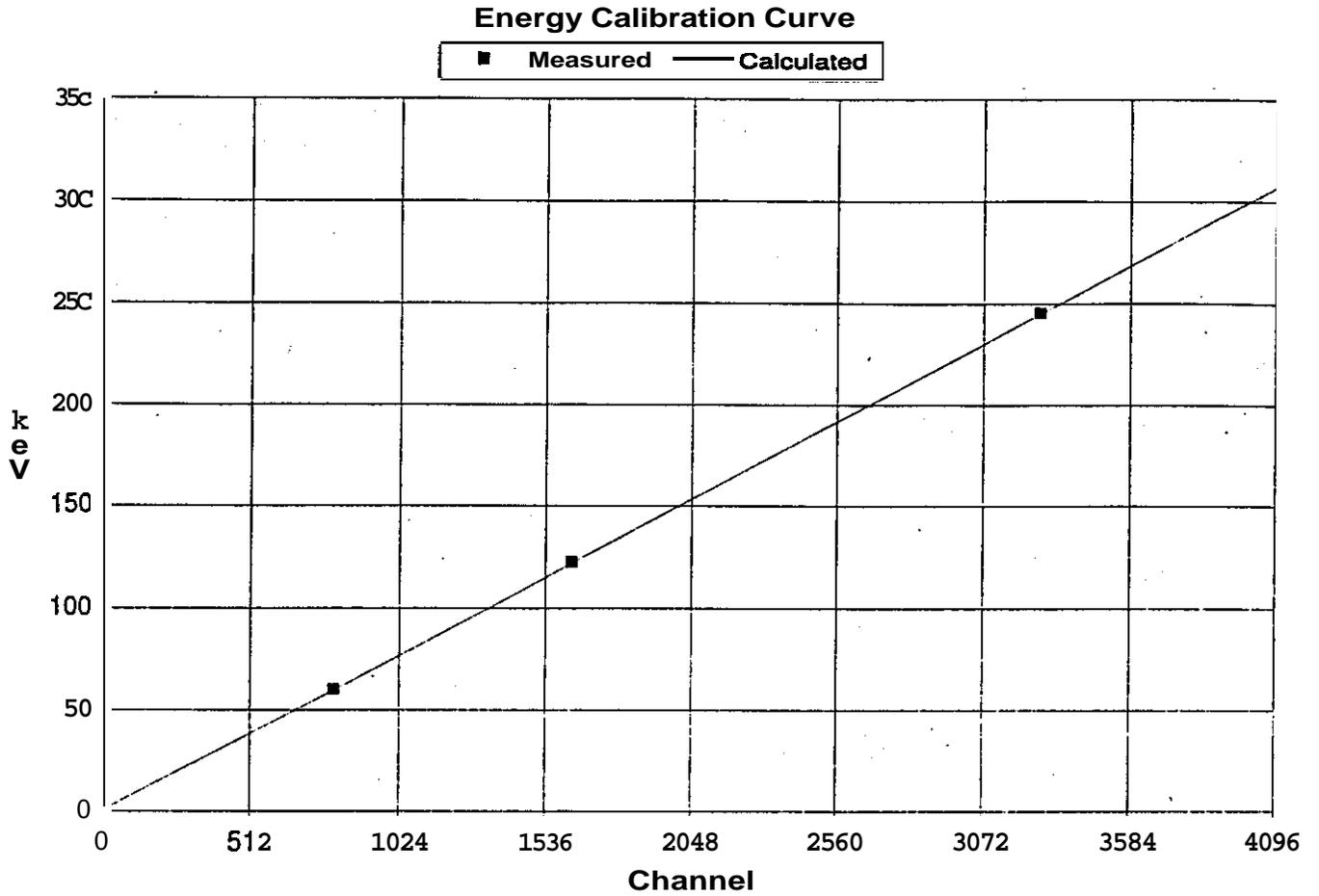
$$\text{LOW TAIL} = 0.0\text{E}+00 + 0.0\text{E}+00 \cdot \text{E}$$

\*\*\*\*\* 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 =  $-3.409e-03$  keV     $+7.490e-02 \cdot \text{Ch}$   
FWHM =  $1.861e-01$  keV     $+4.095e-02 \cdot \text{E}^{1/2}$

APPENDIX III  
EFFICIENCY CALIBRATIONS

```

*****
*****  E F F I C I E N C Y   C A L I B R A T I O N   R E P O R T   *****
*****

```

```

=====
      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
<b>121.80</b>	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

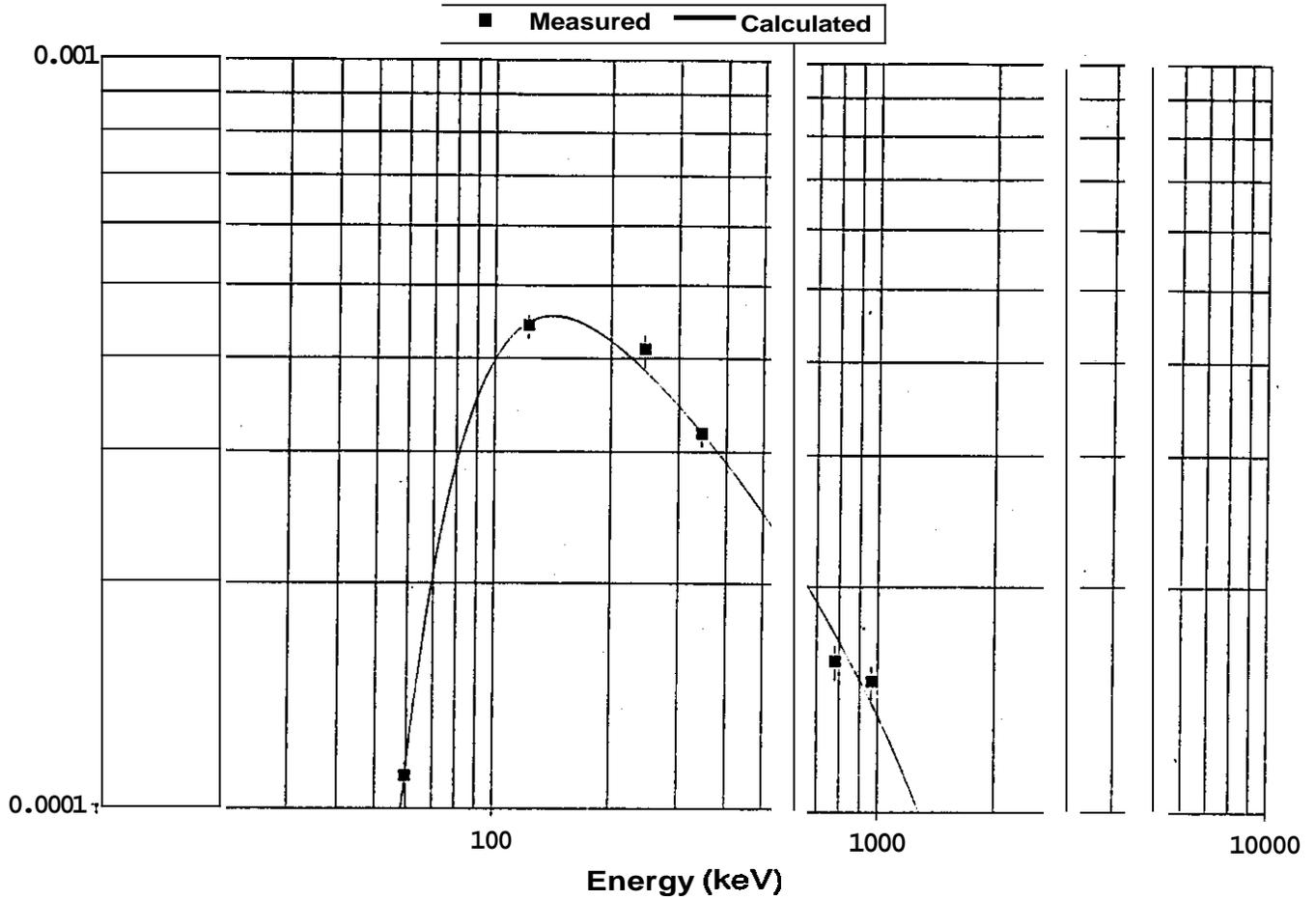
## LINEAR Efficiency Calibration Equation

=====

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

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

APPENDIX IV  
TRANSMISSION CALIBRATION

## Transmission Calibration Report

8-29-00 3:06:35 PM

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\*\*\*\*\*  
 \*\*\* TRANSMISSION CALIBRATION REPORT \*\*\*  
 \*\*\*\*\*

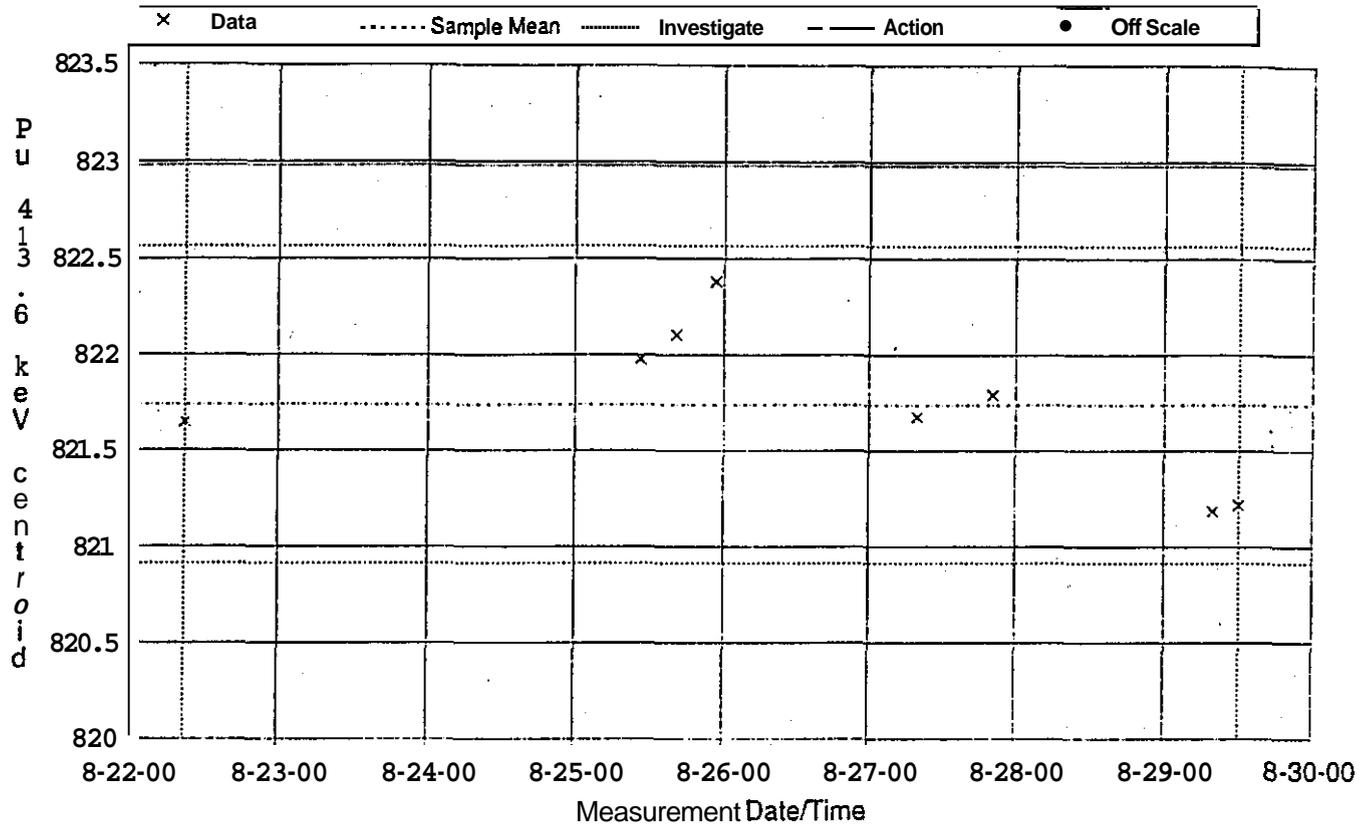
Detector Name: DET01  
 Container Type: SLIP LID  
 Collimator: 0

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

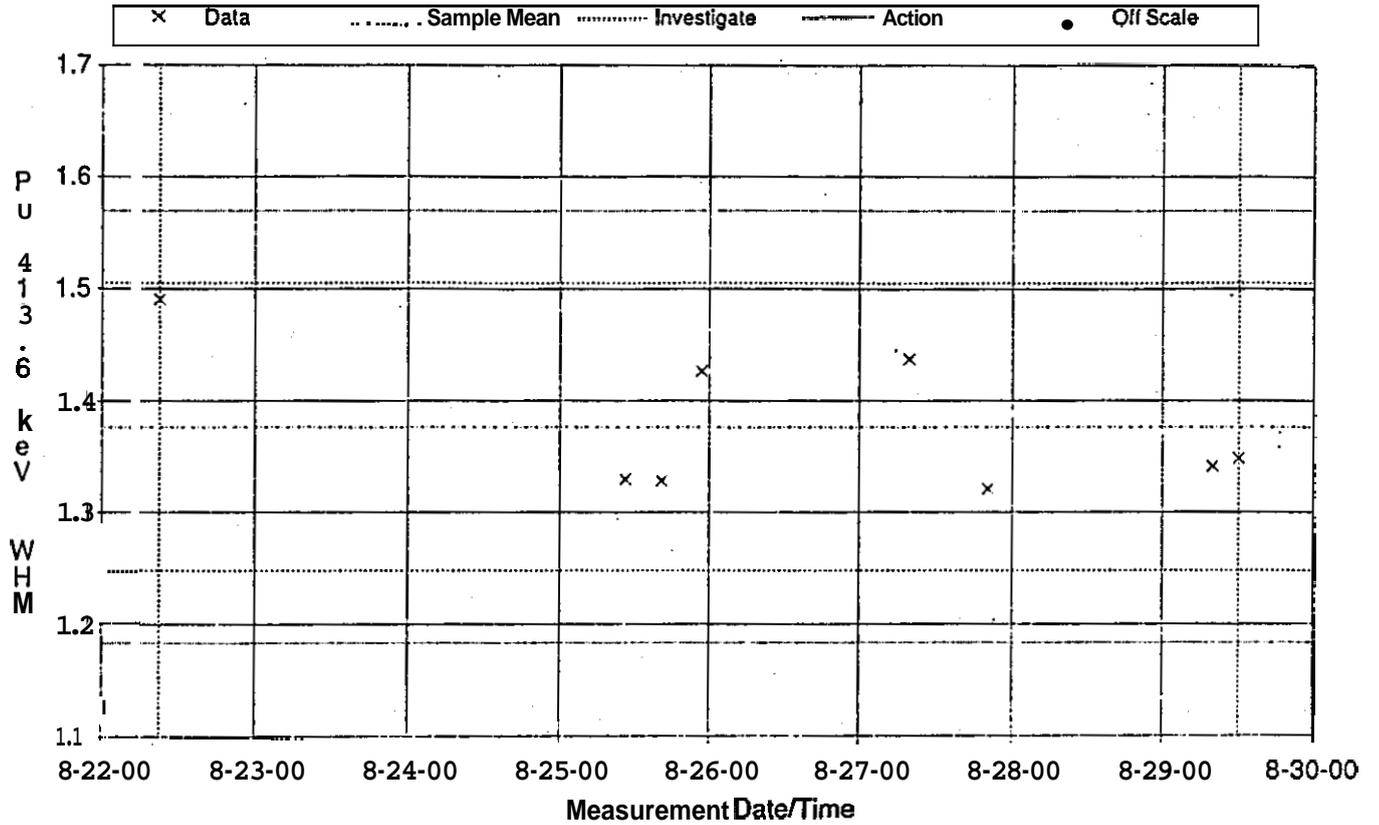
Record	Nuclide	Energy (keV)	Peak Area (Cnts)	Peak Area Error (Cnts)	Half-Life (sec)
1	SE-75	264.70	4.66E+04	2.47E+02	1.03E+07
2	SE-75	400.70	3.55E+04	1.93E+02	1.03E+07

**APPENDIX V**  
**QA COUNT PLOTS AND REPORTS**

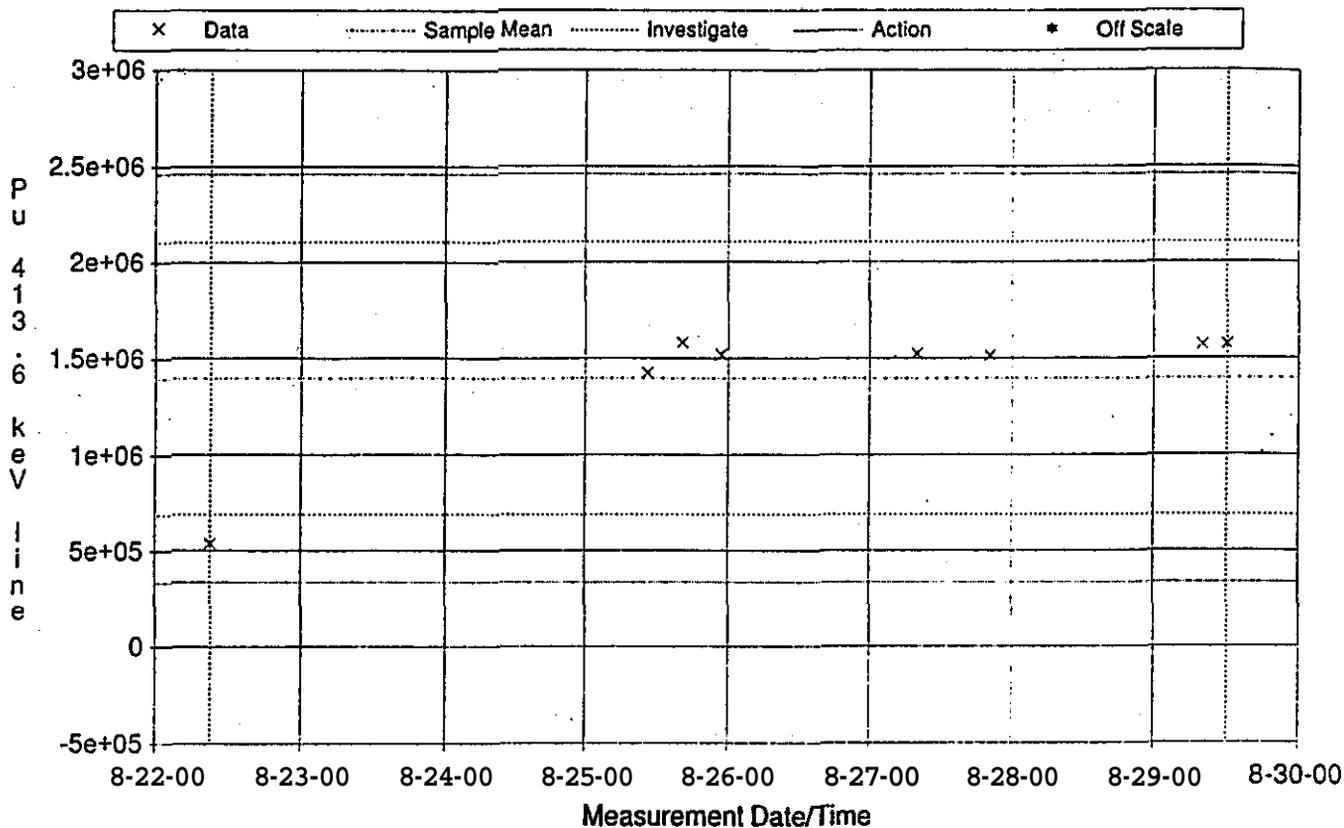




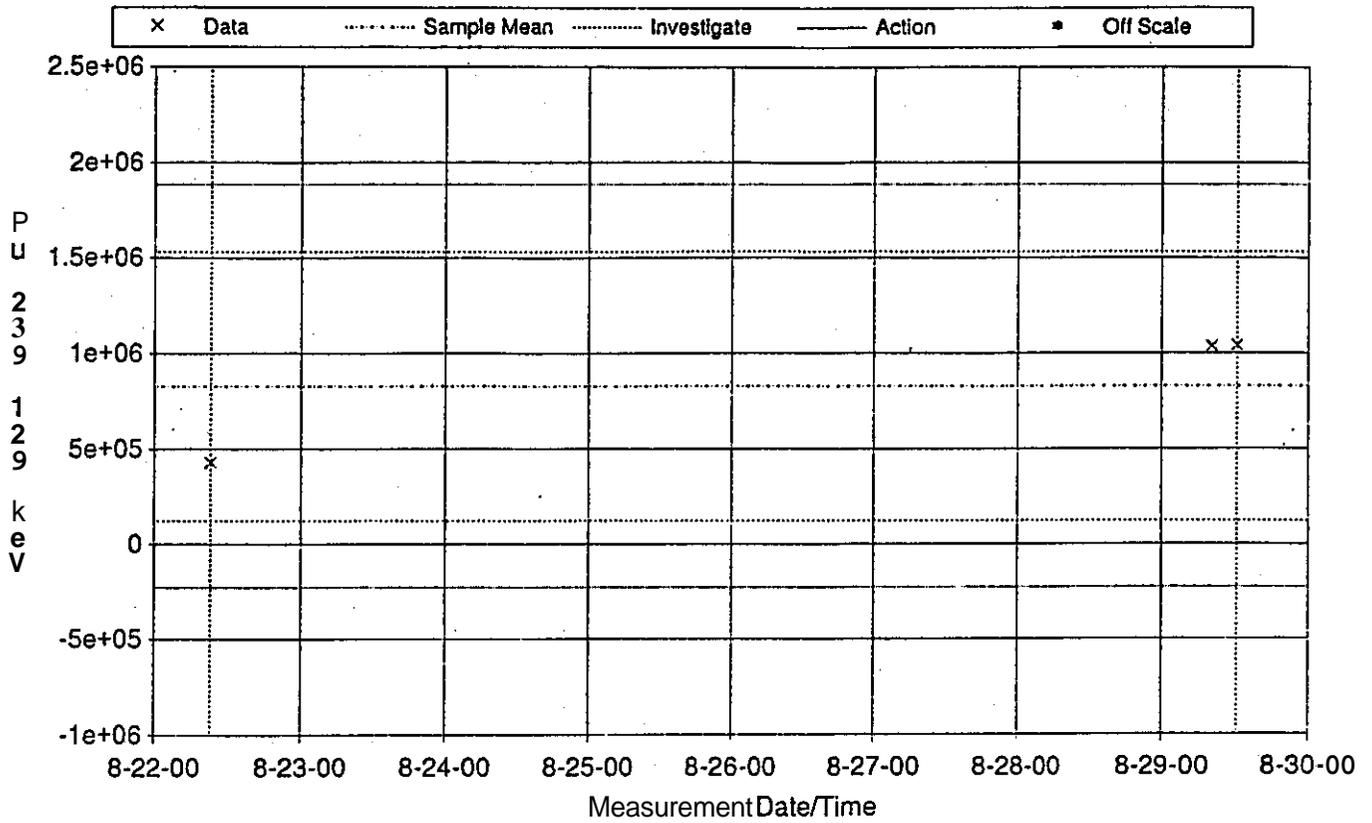
QA Filename : C:\WAS\CTRS\CTR1\ARR1\A04\_CAL.QAF  
 Parameter Description : Pu-413.6keV centroid (ch)  
 Selection Dates : 8-22-00 9:04:38 AM - 8-29-00 12:12:29 PM  
 Sample Mean +-Std Dev : 821.739 +- 0.413



**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

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

Report of Gamma Waste Assay System:

9-05-00 10:21:07 AM

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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

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:
      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\COMBALL.ASF
Report :
  Report              Enable C:\WAS\ASF\RPTSEGS.ASF
    
```

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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

