



Eckert & Ziegler

Isotope Products

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#14

CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide:	Eu-152	Customer:	DUKE UNIVERISTY, PHYSICS DEPT.
Half-life:	4933 ± 11 days	P.O. No.:	4520562595
Catalog No.:	RFQ788-152-1U	Reference Date:	1-Mar-07 12:00 PST
Source No.:	1233-6	Contained Radioactivity:	0.9517 μCi 35.21 kBq

Physical Description:

A. Capsule type:	D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit:	Evaporated metallic salt
C. Active diameter/volume:	10 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

Eu-154 = 0.875% on 1-Mar-07

Method of Calibration:

This source was prepared from a weighed aliquot of solution whose activity in μCi/g was determined using gamma ray spectrometry.

Peak energy used for integration:	344.3 keV
Branching ratio used:	0.266 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.5 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.4 %
D. Total uncertainty at the 99% confidence level:	± 3.1 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 5 years.


Quality Control

23 Jun 07
Date

IPL Ref. No.: 1233-6

ISO 9001 CERTIFIED

Medical Imaging Laboratory

24937 Avenue Tibbitts Valencia, California 91355

Industrial Gauging Laboratory

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21 A

CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide: Mn-54
Half-life: 312.3 ± 0.4 days
Catalog No.: GF-290-1D
Source No.: 1217-72-1

Customer: DUKE UNIVERSITY, PHYSICS DEPT.
P.O. No.: 4520517794/RA#3595
Reference Date: 1-Feb-07 12:00 PST
Contained Radioactivity: 1.013 μCi 37.48 kBq

Physical Description:

A. Capsule type:	D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit:	Evaporated metallic salt
C. Active diameter/volume:	5 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

None detected

Method of Calibration:

This source was assayed using gamma ray spectrometry.

Peak energy used for integration:	834.8 keV
Branching ratio used:	0.9998 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	$\pm 0.3 \%$
B. Type B (systematic) uncertainty:	$\pm 3.0 \%$
C. Uncertainty in aliquot weighing:	$\pm 0.0 \%$
D. Total uncertainty at the 99% confidence level:	$\pm 3.0 \%$

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 2 years.


Quality Control

7-Dec-06
Date

IPL Ref. No.: 1217-72

ISO 9001 CERTIFIED

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1800 North Keystone Street Burbank, California 91504

CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide:	Cd-109	Customer:	DUKE UNIVERSITY, PHYSICS DEPT.
Half-life:	462.6 ± 0.7 days	P.O. No.:	4520517794/RA#3595
Catalog No.:	GF-290-1D	Reference Date:	1-Feb-07 12:00 PST
Source No.:	1217-72-2	Contained Radioactivity:	0.9929 μ Ci 36.74 kBq

Physical Description:

A. Capsule type:	D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit:	Evaporated metallic salt
C. Active diameter/volume:	5 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

Zn-65 < 0.0001%; Sb-124 < 0.0001% on 1-Feb-07

Method of Calibration:

This source was assayed using gamma ray spectrometry.

Peak energy used for integration:	88.0 keV
Branching ratio used:	0.0363 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.8 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.0 %
D. Total uncertainty at the 99% confidence level:	± 3.1 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 2.5 years.


Quality Control


Date

IPL Ref. No.: 1217-72



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21 C

CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide:	Ba-133	Customer:	DUKE UNIVERSITY, PHYSICS DEPT.
Half-life:	3862 ± 15 days	P.O. No.:	4520517794/RA#3595
Catalog No.:	GF-290-1D	Reference Date:	1-Feb-07 12:00 PST
Source No.:	1219-69-1	Contained Radioactivity:	1.003 μCi 37.11 kBq

Physical Description:

A. Capsule type:	D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit:	Evaporated metallic salt
C. Active diameter/volume:	5 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

None detected

Method of Calibration:

This source was assayed using gamma ray spectrometry.

Peak energy used for integration:	302.9, 356.0 keV
Branching ratio used:	0.183, 0.619 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.3 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.0 %
D. Total uncertainty at the 99% confidence level:	± 3.0 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 5 years.

Daniel James Van Dalsem
Quality Control

7-Dec-06
Date

IPL Ref. No.: 1219-69

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CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide:	Co-57	Customer:	DUKE UNIVERSITY, PHYSICS DEPT.
Half-life:	271.79 ± 0.09 days	P.O. No.:	4520517794/RA#3595
Catalog No.:	GF-290-1D	Reference Date:	1-Feb-07 12:00 PST
Source No.:	1219-69-2	Contained Radioactivity:	1.012 μCi 37.44 kBq

Physical Description:

A. Capsule type:	D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit:	Evaporated metallic salt
C. Active diameter/volume:	5 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

Co-56 = 0.00074%; Co-58 = 0.00022% on 1-Feb-07

Method of Calibration:

This source was assayed using gamma ray spectrometry.

Peak energy used for integration:	122.1, 136.5 keV
Branching ratio used:	0.8560, 0.1068 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.2 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.0 %
D. Total uncertainty at the 99% confidence level:	± 3.0 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 18 months.

Daniel James Van Dalsen
Quality Control

7-Dec-06
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#21
E

CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide: Co-60
Half-life: 5.272 ± 0.001 years
Catalog No.: GF-290-1D
Source No.: 1219-69-3

Customer: DUKE UNIVERSITY, PHYSICS DEPT.
P.O. No.: 4520517794/RA#3595
Reference Date: 1-Feb-07 12:00 PST
Contained Radioactivity: 1.013 μ Ci 37.48 kBq

Physical Description:

A. Capsule type:	D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit:	Evaporated metallic salt
C. Active diameter/volume:	5 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

None detected

Method of Calibration:

This source was assayed using gamma ray spectrometry.

Peak energy used for integration:	1173, 1333 keV
Branching ratio used:	0.9986, 0.9998 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.6 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.0 %
D. Total uncertainty at the 99% confidence level:	± 3.1 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 5 years.

Daniel James Van Dalsen
Quality Control

7-Dec-06
Date

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CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide: Cs-137
Half-life: 30.17 ± 0.16 years
Catalog No.: GF-290-1D
Source No.: 1219-69-4

Customer: DUKE UNIVERSITY, PHYSICS DEPT.
P.O. No.: 4520517794/RA#3595
Reference Date: 1-Feb-07 12:00 PST
Contained Radioactivity: 1.021 μ Ci 37.78 kBq

Physical Description:

A. Capsule type: D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit: Evaporated metallic salt
C. Active diameter/volume: 5 mm
D. Backing: Epoxy
E. Cover: Acrylic

Radioimpurities:

None detected

Method of Calibration:

This source was assayed using gamma ray spectrometry.

Peak energy used for integration: 661.7 keV
Branching ratio used: 0.851 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty: ± 0.4 %
B. Type B (systematic) uncertainty: ± 3.0 %
C. Uncertainty in aliquot weighing: ± 0.0 %
D. Total uncertainty at the 99% confidence level: ± 3.0 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 5 years.

Daniel James Van Dalsen
Quality Control

7-Dec-06
Date

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CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide:	Na-22	Customer:	DUKE UNIVERSITY, PHYSICS DEPT.
Half-life:	950.8 ± 0.9 days	P.O. No.:	4520517794/RA#3595
Catalog No.:	GF-290-1D	Reference Date:	1-Feb-07 12:00 PST
Source No.:	1219-69-5	Contained Radioactivity:	0.9399 μ Ci 34.78 kBq

Physical Description:

A. Capsule type:	D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit:	Evaporated metallic salt
C. Active diameter/volume:	5 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

None detected

Method of Calibration:

This source was assayed using gamma ray spectrometry.

Peak energy used for integration:	1275 keV
Branching ratio used:	0.9994 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.4 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.0 %
D. Total uncertainty at the 99% confidence level:	± 3.0 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 5 years.


Quality Control

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CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide:	Co-56	Customer:	DUKE UNIVERSITY, PHYSICS DEPT.
Half-life:	77.31 \pm 0.19 days	P.O. No.:	4520517794/RA#3595
Catalog No.:	GF-056-D	Reference Date:	1-Feb-07 12:00 PST
Source No.:	1219-69-6	Contained Radioactivity:	1.080 μ Ci 39.96 kBq

Physical Description:

A. Capsule type:	D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit:	Evaporated metallic salt
C. Active diameter/volume:	5 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

Co-57 = 8.69%; Co-58 = 0.526% on 1-Feb-07

Method of Calibration:

This source was assayed using gamma ray spectrometry.

Peak energy used for integration:	846.8, 1238.3 keV
Branching ratio used:	0.999, 0.661 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	\pm 0.4 %
B. Type B (systematic) uncertainty:	\pm 3.0 %
C. Uncertainty in aliquot weighing:	\pm 0.0 %
D. Total uncertainty at the 99% confidence level:	\pm 3.0 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 5 months.

Daniel James Van Dalsem
Quality Control

7-Dec-06
Date

IPL Ref. No.: 1219-69

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CERTIFICATE OF CALIBRATION GAMMA STANDARD SOURCE

Radionuclide:	Co-56	Customer:	DUKE UNIVERSITY & HEALTH SYSTEMS
Half-life:	77.31 ± 0.19 days	P.O. No.:	4600041988
Catalog No.:	GF-056-D	Reference Date:	1-Jan-12 12:00 PST
Source No.:	1560-17	Contained Radioactivity:	1.023 μCi 37.85 kBq

Physical Description:

A. Capsule type:	D (25.4 mm OD x 6.35 mm THK)
B. Nature of active deposit:	Evaporated metallic salt
C. Active diameter/volume:	5 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

Co-57 = 5.57%; Co-58 = 0.549% on 1-Jan-12

Method of Calibration:

This source was assayed using gamma ray spectrometry.

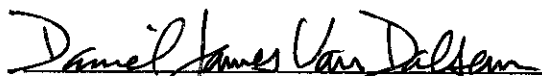
Peak energy used for integration:	846.8, 1238.3 keV
Branching ratio used:	0.999, 0.661 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.3 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.0 %
D. Total uncertainty at the 99% confidence level:	± 3.0 %

Notes:

- See reverse side for leak test(s) performed on this source.
- EZIP participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (as in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 5 months.


Quality Control

15-NOV-11
Date

EZIP Ref. No.: 1560-17

ISO 9001 CERTIFIED

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