APPENDIX E

Instrument and Check Source Calibration Certificates

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER US ARMY CORPS OF ENGINEERS ORDER NO. 20200290/378285

Mfg. Ludlum Measurements, Inc. Model 2360 Serial No. 138251

Mfg. Ludlum Measurements, Inc. Model 43-37-1 Serial No. PR136361

Cal. Date 23-May-12 Cal Due Date 23-May-13 Cal. Interval 1 Year Meterface 202-855

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 36 % Alt 699.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☐ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☐ Geotropism
☑ Audio ck. ☑ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC ☑ RS-232 Port OK
☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 1600 V

☑ HV Readout (2 points) Ref./Inst. 500 / 505 V Ref./Inst. 2000 / 2002 V

Firmware Version: 39010v25
Alpha Threshold: 90 mv
Beta Threshold: 4 mv
Beta Window: 30 mv
Overload Checked But not set.
Instrument calibrated with a 39' cable.
High voltage set with detector not connected.

(EEPROM Settings)
User Time: 1.0
Alpha Alarm: 999999
Beta Alarm: 999999
A/B Alarm: 999999
Model 2360 Date: 5/23/2012
Calibration Date Due: 5/23/2013

COMMENTS:

Pu239 SN:7053 Size:12600cpm, Background:6cpm, Counts:5281cpm, 2pi Eff:41.86%
Tc99 SN:5280 Size:58300cpm, Background:1002cpm, Counts:26891cpm, 2pi Eff:44.40%
SrY90 SN:5281 Size:69345cpm, Background:1002cpm, Counts:25826cpm, 2pi Eff:35.79%

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
x1000	400k cpm	400	400
x1000	100k cpm	100	100
x100	40k cpm	400	400
x100	10k cpm	100	100
x10	4k cpm	400	400
x10	1k cpm	100	100
x1	400 cpm	400	400
x1	100 cpm	100	100

*Uncertainty within ± 10% C.F. within ± 20% ALL **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm	39986(0)	39986(0)	Log Scale			
	40kcpm	3998	3998				
	4kcpm	400	400				
	400cpm	40	40				
	40cpm	4	4				

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ 73410 ☐ 1131 ☐ 781 ☐ 059 ☐ 280 ☐ 60646 ☐ 70897 ☐ Ra-226 S/N Y982
Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ☐ Beta S/N ☐ Other

☑ m 500 S/N 190566 ☐ Oscilloscope S/N ☑ Multimeter S/N 86250390

Calibrated By: Date 23-May-12

Reviewed By: Date 24May12

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 43-37-1 Serial No. PR136361 Order #. 20200290/378285

Customer US ARMY CORPS OF ENGINEERS Alpha Input Sensitivity 90 mV

Counter 2360 Serial No. 138251 Beta Input Sensitivity 4 mV

Count Time 1Minute Beta Window 30 mV

Other Distance Source to Detector Surface

High Voltage	Background		Isotope Pu239 Size 24900dpm		Isotope Tc99 Size 93200dpm		Isotope SrY90 Size 99065dpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
1575	5	818	5084	1091	37	25158	3	21603
1600	6	1002	5281	1354	37	26891	3	25826
1625	4	1268	5333	1586	38	27067	9	28900
1650	9	1534	5484	2018	78	25432	58	31340

☐ Gas Proportional detector count rate decreased ≤ 10% after 15 hour static test using 39" cable.

☐ Gas proportional detector count rate decreased ≤ 10% after 5 hour static test using 39" cable and alpha/beta counter.

Signature Jason Fox Date 23-May-12

ENERGYSOLUTIONS

CALIBRATION CERTIFICATE

EnergySolutions Services, Inc.
1570 Bear Creek Road
Oak Ridge, TN 37830
Phone: (877) 462-4873
Fax: (865) 220-1346

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		INSTRUMENT INFORMATION	
Customer Name: EnergySolutions Services, Inc.		Manufacturer: Ludlum	
Address: 1570 Bear Creek Road Oak Ridge, TN 37830		Model: 2360	Serial Number: 275713
Contact Name: Tony Riggs		Probe: N/A	Serial Number: N/A
Customer Purchase Order Number: N/A	Work Order Number: ~~2011-11061~~ 2011-11061	Calibration Method: Electronic	

INSTRUMENT CALIBRATION INFORMATION

Instrument Range	Calibration Standard Value	Ratemeter Response (± 10% of Standard Values)		Calibration Standard Value CPM	Time Base (minutes)	Tolerances (cpm) ± 2%	Scaler Response	
		As Found	As Left				As Found	As Left
X 1	100	100	100	1,000 CPM	0.1	90 – 110	100	100
X 1	250	250	250	1,000 CPM	0.5	450 – 550	500	500
X 1	400	400	400	1,000 CPM	1	900 – 1,100	1,002	1,002
X 10	1,000	1,000	1,000	1,000 CPM	2	1.8K–2.2K	2,003	2,003
X 10	2,500	2,500	2,500	1,000 CPM	5	4.5K-5.5K	5,008	5,008
X 10	4,000	4,000	4,000	1,000 CPM	10	9K-11K	10,015	10,015
X 100	10,000	10,000	10,000					
X 100	25,000	25,000	25,000					
X 100	40,000	40,000	40,000					
X 1000	100,000	100,000	100,000	Calibrated in accordance with OEM Technical Manual				
X 1000	250,000	250,000	250,000					
X 1000	400,000	400,000	400,000					

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated By: M. Paul	Reviewed By: [signature] Date: 8/30/11
Calibration Date: 08/30/2011	*Calibration Due (6mo): 02/29/2012
	*Calibration Due (12mo): 08/30/2012

* Calibration due date is dependant on users regulatory requirements.

ENERGYSOLUTIONS

Model: 2360 Serial Number: 275713

M&TE				Environmental Conditions		
Volt Meter	ID# 94710023	Cal Due:	10/28/2011	Barometer	ID# 3590	Cal Due: 09/21/11
Pulser	ID# 112860	Cal Due:	04/26/2012	Thermometer	ID# 3590	Cal Due: 09/21/11
Humidity	ID# 958670	Cal Due:	06/07/2012	Temp: 22.4 ° C	Pressure: 741 mmHg	Humidity: 58%

Special Test			
BAT Check	Sat (√) Unsat ( )	Geotropism	Sat (√) Unsat ( )
LCD Display Check	Sat (√) Unsat ( )	Audio Check	Sat (√) Unsat ( )
Mechanical Zero	Sat (√) Unsat ( )	Low BAT Set	Sat (√) Unsat ( )
Reset	Sat (√) Unsat ( )		
HV Analog Display	Sat (√) Unsat ( )	As Found	As Left

High Voltage Calibration (± 10%)			
Voltage	Tolerance	As Found	As Left
500	450-550	514	514
1000	900-1100	983	983
1500	1350-1650	1,490	1,490

Alpha Sensitivity =	125 mv	Alpha Sensitivity =	120 mv
Beta Sensitivity =	3.8 mv	Beta Sensitivity =	3.5 mv
Beta Window =	32 mv	Beta Window =	30 mv

Beta Setpoints--Pulser counts detected at 3.5mv ± 1mv and shut off at 30mv for beta. For Alpha channel counts detected at 120mv and above.

H.V. Set With Detector Not Connected

Overload to be set with detector to be used

COMMENTS

Calibrated in accordance with OEM Technical Manual

See detector certificate for High Voltage setting

Calibrated with 5ft cable

Instrument

Calibrated By: M Paul

Reviewed By: [signature] Date: 8/30/11

Calibration Date: 08/30/2011

*Calibration Due (6mo): 02/29/2012

*Calibration Due (12mo): 08/30/2012

* Calibration due date is dependant on users regulatory requirements.

ENERGY*SOLUTIONS*

CALIBRATION CERTIFICATE

Energy*Solutions* Instrument Services
1570 Bear Creek Road
Oak Ridge, TN 37830
Phone: (877) 462-4873
Email: ISFstaff@energysolutions.com

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		DETECTOR INFORMATION
Customer Name: Energy*Solutions* Instrument Services		**Manufacturer: Ludlum**
Address: 1570 Bear Creek Road Oak Ridge, TN 37830		**Detector Model: 43-37A**
Contact Name: Tony Riggs		**Serial Number: 093966**
Customer Purchase Order Number: N/A	**Work Order Number: 2011-11248**	**Evaluation Method: Source**

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION

Source Nuclide: Th^{230}	Serial Number: 119738	Activity: 18,600 dpm	2 Pi Emissions: 8,640	Certification Date: 10/20/97

Parameter	As Found	As Left	Precision Test	CPM
Count 1	3,852	3,852	Count 1 (Heel)	3,514
Count 2	3,816	3,816	Count 2 (Center)	3,681
Count 3	3,652	3,652	Count 3 (Toe)	3,746
Count 4	3,773	3,773	Average	3,647
Count 5	3,594	3,594	Tolerance	±10%
Count 6	3,523	3,523	Pass/Fail	Pass
Average	3,702	3,702		
Background (CPM)	14.6	14.6		
Net Counts	3,687	3,687		
2pi Efficiency	42.7%	42.7%		
4pi Efficiency	19.8%	19.8%		

Low Sample Activity: Source #: N/A	High Sample Activity: Source #: N/A	Dead Time (DT): N/A	Calibration Constant (CC): N/A

SCALER INFORMATION			DETECTOR INFORMATION		
Model	Serial Number	Due Date	Background (cpm)	Operating Voltage	Threshold
2360	275713	08/30/2012	14.6	1700V	Alpha (120mV) Beta (3.5-30mV)

Detector Setup Report YES NO √	Barcode Report YES NO √	Voltage Plateau YES √ NO

COMMENTS

5 minute background performed Efficiency performed on contact with 5Ft. cable 1 layer mylar (0.4mg/cm2)

STATEMENT OF CERTIFICATION

We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).

Detector Certified By: M. Paul	Reviewed By: Jeff Dickinson	Date: 5/30/12
Certification Date: 05/30/2012	*Certification Due (6mo): 11/30/2012	
	* Certification Due (12mo): 05/30/2013	

* Calibration due date is dependant on users regulatory requirements.

ENERGY*SOLUTIONS*

CALIBRATION CERTIFICATE

Energy*Solutions* Instrument Services
1570 Bear Creek Road
Oak Ridge, TN 37830
Phone: (877) 462-4873
Email: ISFstaff@energysolutions.com

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		DETECTOR INFORMATION
Customer Name: Energy*Solutions* Instrument Services		**Manufacturer: Ludlum**
Address: 1570 Bear Creek Road Oak Ridge, TN 37830		**Detector Model: 43-37B**
Contact Name: Tony Riggs		**Serial Number: 093966**
Customer Purchase Order Number: N/A	**Work Order Number: 2012-12264**	**Evaluation Method: Source**

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION

Source Nuclide: Tc^{99}	Serial Number: 099608	Activity: 21,312 dpm	2 Pi Emissions: 10,500	Certification Date: 08/08/96

Parameter	As Found	As Left	Precision Test	CPM
Count 1	4,539	4,539	Count 1 (Heel)	4,553
Count 2	4,468	4,468	Count 2 (Center)	4,520
Count 3	4,429	4,429	Count 3 (Toe)	4,726
Count 4	4,493	4,493	Average	4,600
Count 5	4,765	4,765	Tolerance	±10%
Count 6	4,823	4,823	Pass/Fail	Pass
Average	4,586	4,586		
Background (CPM)	714.6	714.6		
Net Counts	3,872	3,872	Calibrated in accordance with ERIN-WI-239	
2pi Efficiency	36.9%	36.9%		
4pi Efficiency	18.2%	18.2%		

Low Sample Activity: Source #: N/A	High Sample Activity: Source #: N/A	Dead Time (DT): N/A	Calibration Constant (CC): N/A

SCALER INFORMATION			DETECTOR INFORMATION		
Model	Serial Number	Due Date	Background (cpm)	Operating Voltage	Threshold
2360	275713	08/30/2012	714.6	1700 V	Alpha (120mV) Beta (3.5-30mV)

Detector Setup Report YES NO √	Barcode Report YES NO √	Voltage Plateau YES √ NO

COMMENTS

5 minute background performed Efficiency performed on contact with 5Ft. cable 1 layer mylar (0.4mg/cm2)

STATEMENT OF CERTIFICATION

We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).

Detector Certified By: M. Paul	Reviewed By: J. Dickinson	Date: 5/30/12
Certification Date: 05/30/2012	*Certification Due (6mo): 11/30/2012	
	* Certification Due (12mo): 05/30/2013	

* Calibration due date is dependant on users regulatory requirements.

ENERGY*SOLUTIONS*

CALIBRATION CERTIFICATE

Energy*Solutions* Instrument Services
1570 Bear Creek Road
Oak Ridge, TN 37830
Phone: (877) 462-4873
Email: ISFstaff@energysolutions.com

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		DETECTOR INFORMATION
Customer Name: Energy*Solutions* Instrument Services		**Manufacturer: Ludlum**
Address: 1570 Bear Creek Road Oak Ridge, TN 37830		**Detector Model: 43-37B**
Contact Name: Tony Riggs		**Serial Number: 093966**
Customer Purchase Order Number: N/A	**Work Order Number: 2012-12264**	**Evaluation Method: Source**

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION

Source Nuclide: C^{14}	Serial Number: 010002	Activity: 260,460 dpm	2 Pi Emissions: N/A	Certification Date:

Parameter	As Found	As Left	Precision Test	CPM
Count 1	25,917	25,917	Count 1 (Heel)	25,671
Count 2	25,604	25,604	Count 2 (Center)	26,628
Count 3	26,697	26,697	Count 3 (Toe)	28,323
Count 4	25,882	25,882	Average	26,874
Count 5	28,245	28,245	Tolerance	±10%
Count 6	27,953	27,953	Pass/Fail	Pass
Average	26,716	26,716		
Background (CPM)	714.6	714.6		
Net Counts	26,002	26,002		
2pi Efficiency	N/A	N/A		
4pi Efficiency	10.0%	10.0%		

Low Sample Activity: Source #: N/A	High Sample Activity: Source #: N/A	Dead Time (DT): N/A	Calibration Constant (CC): N/A

SCALER INFORMATION			DETECTOR INFORMATION		
Model	Serial Number	Due Date	Background (cpm)	Operating Voltage	Threshold
2360	275713	08/30/2012	714.6	1700 V	Alpha (120mV) Beta (3.5-30mV)

Detector Setup Report YES NO √	Barcode Report YES NO √	Voltage Plateau YES √ NO

COMMENTS

5 minute background performed Efficiency performed on contact with 5Ft. cable 1 layer mylar (0.4mg/cm2)

STATEMENT OF CERTIFICATION

We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).

Detector Certified By: M. Paul	Reviewed By: Jeff Dutkinson	Date: 5/31/12
Certification Date: 05/30/2012	*Certification Due (6mo): 11/30/2012	
	* Certification Due (12mo): 05/30/2013	

* Calibration due date is dependant on users regulatory requirements.

ENERGYSOLUTIONS

CALIBRATION CERTIFICATE

EnergySolutions Services, Inc
1570 Bear Creek Road
Oak Ridge, TN 37830

Phone: (877) 462-4873
Fax: (865) 220-1346
Email: Isfstaff@energysolutions.com

http://www.energysolutions.com/

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION				INSTRUMENT INFORMATION			
Customer Name:	Energy Solutions			Manufacturer:			
Address:	1570 Bear Creek Road Oak Ridge, TN 37830			Model:	2360	S.N.	275713
Contact Name:	Tony Riggs			Probe:	43-37	S.N.	093966
Customer PO No.:	N/A	Work Order Number:	2012-12264	Calibration Method:	Source		

Source Information

	Isotope	Source ID	Certifcation Date	Activity (dpm)
α Source	Pu-239	019442	6/1/92	13,607
β Source	Tc-99	099608	8/8/96	21,311

Ludlum Model 43-37 Alpha Scintillation Probe S/N 093966

Operating Voltage	High Voltage	Background Alpha	Background Beta	Alpha Source	Beta Source	Alpha Efficiency	Beta Efficiency	Alpha Crosstalk	Beta Crosstalk	Alpha Efficiency	Beta Efficiency
	1,600	10.0	182.0	2,661.0	462.0	22.0	3,719.0	11.29%	0.34%	19.48%	16.60%
	1,625	8.0	250.0	2,886.0	578.0	16.0	4,239.0	12.44%	0.20%	21.15%	18.72%
	1,650	12.0	335.0	2,999.0	618.0	25.0	4,625.0	10.62%	0.30%	21.95%	20.13%
	1,675	16.0	501.0	3,080.0	642.0	28.0	4,913.0	5.47%	0.27%	22.52%	20.70%
SET	**1,700**	**15.0**	**646.0**	**3,035.0**	**743.0**	**22.0**	**4,740.0**	**4.06%**	**0.17%**	**22.19%**	**19.21%**
	1,725	11.0	733.0	3,058.0	761.0	22.0	4,858.0	1.20%	0.27%	22.39%	19.36%
	1,750	18.0	846.0	3,309.0	1,061.0	106.0	3,954.0	8.73%	2.83%	24.19%	14.58%

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this instrument).

Comments:

Calibrated By: M. Paul Reviewed By: J. Jeff Dickinson Date: 5/30/12

Calibration Date: 5/30/12 Calibration Due: 5/30/13

ENERGY*SOLUTIONS*

CALIBRATION CERTIFICATE

EnergySolutions Services, Inc.
1570 Bear Creek Road
Oak Ridge, TN 37830
Phone: (877) 462-4873
Fax: (865) 220-1346

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		INSTRUMENT INFORMATION	
Customer Name: EnergySolutions Services, Inc.		Manufacturer: Ludlum	
Address: 1570 Bear Creek Road Oak Ridge, TN 37830		Model: 2360	Serial Number: 275724
Contact Name: Tony Riggs		Probe: N/A	Serial Number: N/A
Customer Purchase Order Number: N/A	Work Order Number: 2011-11716	Calibration Method: Electronic	

INSTRUMENT CALIBRATION INFORMATION

Instrument Range	Calibration Standard Value	Ratemeter Response (± 10% of Standard Values)		Calibration Standard Value CPM	Time Base (minutes)	Tolerances (cpm) ± 2%	Scaler Response	
		As Found	As Left				As Found	As Left
X 1	100	100	100	1,000 CPM	0.1	90 – 110	99	99
X 1	250	250	250	1,000 CPM	0.5	450 – 550	493	493
X 1	400	400	400	1,000 CPM	1	900 – 1,100	988	988
X 10	1,000	1,000	1,000	1,000 CPM	2	1.8K–2.2K	1,979	1,979
X 10	2,500	2,500	2,500	1,000 CPM	5	4.5K-5.5K	4,948	4,948
X 10	4,000	4,000	4,000	1,000 CPM	10	9K-11K	9,896	9,896
X 100	10,000	10,000	10,000					
X 100	25,000	25,000	25,000					
X 100	40,000	40,000	40,000					
X 1000	100,000	100,000	100,000	Calibrated in accordance with OEM Technical Manual				
X 1000	250,000	250,000	250,000					
X 1000	400,000	400,000	400,000					

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated By: M. Paul	Reviewed By: [signature] Date: 10/6/11
Calibration Date: 10/06/2011	*Calibration Due (6mo): 04/06/2012
	*Calibration Due (12mo): 10/06/2012

* Calibration due date is dependant on users regulatory requirements.

ENERGYSOLUTIONS

Model: 2360 Serial Number: 275724

M&TE					Environmental Conditions		
Volt Meter	ID#	94710023	Cal Due:	10/28/2011	Barometer	ID# 2551	Cal Due: 10/19/2011
Pulser	ID#	120935	Cal Due:	09/29/2012	Thermometer	ID# 2551	Cal Due: 10/19/2011
Humidity	ID#	958670	Cal Due:	06/07/2012	Temp: 21.4 °C	Pressure: 747 mmHg	Humidity: 45%

Special Test

BAT Check	Sat (√) Unsat ( )	Geotropism	Sat (√) Unsat ( )
LCD Display Check	Sat (√) Unsat ( )	Audio Check	Sat (√) Unsat ( )
Mechanical Zero	Sat (√) Unsat ( )	Low BAT Set	Sat (√) Unsat ( )
Reset	Sat (√) Unsat ( )		
HV Analog Display	Sat (√) Unsat ( )	As Found	As Left

High Voltage Calibration (± 10%)			
Voltage	Tolerance	As Found	As Left
500	450-550	502	502
1000	900-1100	1,018	1,018
1500	1350-1650	1,514	1,514

Alpha Sensitivity =	128 mv	Alpha Sensitivity =	120 mv
Beta Sensitivity =	3.7 mv	Beta Sensitivity =	3.5 mv
Beta Window =	30.8 mv	Beta Window =	30 mv

Beta Setpoints--Pulser counts detected at 3.5mv ± 1mv and shut off at 30mv for beta. For Alpha channel counts detected at 120mv and above.

H.V. Set With Detector Not Connected

Overload to be set with detector to be used

COMMENTS

Calibrated in accordance with OEM Technical Manual

See detector certificate for High Voltage setting

****Calibrated with 5ft cable****

Instrument Calibrated By: M. Powell	Reviewed By: [signature] Date: 10/6/11
Calibration Date: 10/06/2011	*Calibration Due (6mo): 04/06/2012
	*Calibration Due (12mo): 10/06/2012

* Calibration due date is dependant on users regulatory requirements.

ENERGYSOLUTIONS

CALIBRATION CERTIFICATE

EnergySolutions Services, Inc
1570 Bear Creek Road
Oak Ridge, TN 37830

Phone: (877) 462-4873
Fax: (865) 220-1346
Email: Isfstaff@energysolutions.com

http://www.energysolutions.com/

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION				INSTRUMENT INFORMATION			
Customer Name:	Energy Solutions			Manufacturer:			
Address:	1570 Bear Creek Road Oak Ridge, TN 37830			Model:	2360	S.N.	275724
Contact Name:	Tony Riggs			Probe:	43-37	S.N.	092501
Customer PO No.:	N/A	Work Order Number:	2012-12264	Calibration Method:	Source		

Source Information

	Isotope	Source ID	Certifcation Date	Activity (dpm)
α Source	Pu-239	019442	6/1/92	13,607
β Source	Tc-99	099608	8/8/96	21,311

Ludlum Model 43-93 High Voltage Plateau with crosstalk

Operating Voltage	High Voltage	Background		Alpha Source		Beta Source		Crosstalk		Efficiency	
		Alpha	Beta	Alpha	Beta	Alpha	Beta	α to β	β to α	α	β
	1,650	6.0	400.0	2,318.0	563.0	7.0	4,457.0	8.50%	0.02%	16.99%	19.04%
SET	**1,675**	**7.0**	**445.0**	**2,527.0**	**611.0**	**11.0**	**4,545.0**	**7.97%**	**0.10%**	**18.52%**	**19.24%**
	1,700	5.0	422.0	2,452.0	732.0	7.0	4,330.0	15.27%	0.05%	17.98%	18.34%
	1,725	10.0	805.0	2,692.0	1,047.0	12.0	4,629.0	12.82%	0.05%	19.71%	17.94%

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this instrument).

Comments:

Calibrated By: _____ Reviewed By: _____ Date: 5/30/12

Calibration Date: 5/30/12 Calibration Due: 5/30/13

ENERGYSOLUTIONS

CALIBRATION CERTIFICATE

EnergySolutions Instrument Services
1570 Bear Creek Road
Oak Ridge, TN 37830
Phone: (877) 462-4873
Email: ISFstaff@energysolutions.com

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		DETECTOR INFORMATION
Customer Name: EnergySolutions Instrument Services		Manufacturer: Ludlum
Address: 1570 Bear Creek Road Oak Ridge, TN 37830		Detector Model: 43-37B
Contact Name: Tony Riggs		Serial Number: 092501
Customer Purchase Order Number: N/A	Work Order Number: 2012-12264	Evaluation Method: Source

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION

Source Nuclide: C^{14}	Serial Number: 010002	Activity: 260,460 dpm	2 Pi Emissions: N/A	Certification Date:

Parameter	As Found	As Left	Precision Test	CPM
Count 1	32,658	32,658	Count 1 (Heel)	32,658
Count 2	32,097	32,097	Count 2 (Center)	32,041
Count 3	32,006	32,006	Count 3 (Toe)	33,092
Count 4	32,041	32,041	Average	32,597
Count 5	32,759	32,759	Tolerance	±10%
Count 6	33,092	33,092	Pass/Fail	Pass
Average	32,442.2	32,442.2		
Background (CPM)	503	503		
Net Counts	31,939.2	31,939.2		
2pi Efficiency	N/A	N/A		
4pi Efficiency	12.3%	12.3%		

Low Sample Activity: Source #: N/A	High Sample Activity: Source #: N/A	Dead Time (DT): N/A	Calibration Constant (CC): N/A

SCALER INFORMATION			DETECTOR INFORMATION		
Model	Serial Number	Due Date	Background (cpm)	Operating Voltage	Threshold
2360	275724	10/06/2012	503	1675V	Alpha (120mV) Beta (3.5-30mV)

Detector Setup Report YES NO √	Barcode Report YES NO √	Voltage Plateau YES √ NO

COMMENTS

5 minute background performed Efficiency performed on contact with 5Ft. cable 1 layer mylar (0.4mg/cm2)

STATEMENT OF CERTIFICATION

We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).

Detector Certified By: [signature] Reviewed By: [signature] Date: 5/30/12

Certification Date: 05/30/2012

*Certification Due (6mo): 11/30/2012

* Certification Due (12mo): 05/30/2013

* Calibration due date is dependant on users regulatory requirements.

ENERGY*SOLUTIONS*

CALIBRATION CERTIFICATE

EnergySolutions Instrument Services
1570 Bear Creek Road
Oak Ridge, TN 37830
Phone: (877) 462-4873
Email: ISFstaff@energysolutions.com

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		DETECTOR INFORMATION
Customer Name: EnergySolutions Instrument Services		Manufacturer: Ludlum
Address: 1570 Bear Creek Road Oak Ridge, TN 37830		Detector Model: 43-37A
Contact Name: Tony Riggs		Serial Number: 092501
Customer Purchase Order Number: N/A	Work Order Number: 2012-12264	Evaluation Method: Source

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION

Source Nuclide: Th^{230}	Serial Number: 119738	Activity: 18,600 dpm	2 Pi Emissions: 8,640/min	Certification Date: 10/20/97

Parameter	As Found	As Left	Precision Test	CPM
Count 1	2,899	2,899	Count 1 (Heel)	2,899
Count 2	2,927	2,927	Count 2 (Center)	2,811
Count 3	2,811	2,811	Count 3 (Toe)	2,968
Count 4	3,022	3,022	Average	2,892.7
Count 5	2,968	2,968	Tolerance	±10%
Count 6	2,864	2,864	Pass/Fail	Pass
Average	2,915.2	2,915.2		
Background (CPM)	6.9	6.9		
Net Counts	2,908.3	2,908.3		
2pi Efficiency	33.7%	33.7%		
4pi Efficiency	15.6%	15.6%		

Low Sample Activity: Source #: N/A	High Sample Activity: Source #: N/A	Dead Time (DT): N/A	Calibration Constant (CC): N/A

SCALER INFORMATION			DETECTOR INFORMATION		
Model	Serial Number	Due Date	Background (cpm)	Operating Voltage	Threshold
2360	275724	10/06/2012	6.9	1675V	Alpha (120mV) Beta (3.5-30mV)

Detector Setup Report YES NO √	Barcode Report YES NO √	Voltage Plateau YES √ NO

COMMENTS

5 minute background performed Efficiency performed on contact with 5Ft. cable 1 layer mylar (0.4mg/cm2)

STATEMENT OF CERTIFICATION

We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).

Detector Certified By:	Reviewed By:	Date: 5/30/12
Certification Date: 05/30/2012	*Certification Due (6mo): 11/30/2012	
	* Certification Due (12mo): 05/30/2013	

* Calibration due date is dependant on users regulatory requirements.

ENERGY*SOLUTIONS*

CALIBRATION CERTIFICATE

Energy*Solutions* Instrument Services
1570 Bear Creek Road
Oak Ridge, TN 37830
Phone: (877) 462-4873
Email: ISFstaff@energysolutions.com

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION		DETECTOR INFORMATION
Customer Name: Energy*Solutions* Instrument Services		Manufacturer: Ludlum
Address: 1570 Bear Creek Road Oak Ridge, TN 37830		Detector Model: 43-37B
Contact Name: Tony Riggs		Serial Number: 092501
Customer Purchase Order Number: N/A	Work Order Number: 2012-12264	Evaluation Metbod: Source

DETECTOR EFFICIENCY/RESPONSE/PRECISION INFORMATION

Source Nuclide: Tc^{99}	Serial Number: 099608	Activity: 21,312 dpm	2 Pi Emissions: 10,500/min	Certification Date: 08/08/96

Parameter	As Found	As Left	Precision Test	CPM
Count 1	4,820	4,820	Count 1 (Heel)	4,820
Count 2	4,983	4,983	Count 2 (Center)	4,922
Count 3	4,922	4,922	Count 3 (Toe)	5,003
Count 4	4,767	4,767	Average	4,915
Count 5	4,857	4,857	Tolerance	±10%
Count 6	5,003	5,003	Pass/Fail	Pass
Average	4,892	4,892		
Background (CPM)	503	503		
Net Counts	4,389	4,389		
2pi Efficiency	41.8%	41.8%		
4pi Efficiency	20.6%	20.6%		

Low Sample Activity: Source #: N/A	High Sample Activity: Source #: N/A	Dead Time (DT): N/A	Calibration Constant (CC): N/A

SCALER INFORMATION			DETECTOR INFORMATION		
Model	Serial Number	Due Date	Background (cpm)	Operating Voltage	Threshold
2360	275724	10/06/2012	503	1675V	Alpha (120mV) Beta (3.5-30mV)

Detector Setup Report YES NO √	Barcode Report YES NO √	Voltage Plateau YES √ NO

COMMENTS

5 minute background performed Efficiency performed on contact with 5Ft. cable 1 layer mylar (0.4mg/cm2)

STATEMENT OF CERTIFICATION

We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).

Detector Certified By:	Reviewed By:	Date: 5/30/12
Certification Date: 05/30/2012	*Certification Due (6mo): 11/30/2012	
	* Certification Due (12mo): 05/30/2013	

* Calibration due date is dependant on users regulatory requirements.

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER US ARMY CORPS OF ENG BALTIMORE ORDER NO. 20181694/366617

Mfg. Ludlum Measurements, Inc. Model 19 Serial No. 245026

Mfg. _____ Model _____ Serial No. _____

Cal. Date 11-Aug-11 Cal Due Date 11-Aug-12 Cal. Interval 1 Year Meterface 202-1070

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 41 % Alt 698.8 mm Hg

☐ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☑ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☑ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 650 V Input Sens. 30 mV Det. Oper. _____ V at _____ mV Threshold Dial Ratio _____ = _____ mV

☐ HV Readout (2 points) Ref./Inst. _____ / _____ V Ref./Inst. _____ / _____ V

COMMENTS:

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
5000	4000µR/hr	N/A	4000
5000	1000µR/hr		1000
500	400µR/hr = 76,800 cpm		400
500	100µR/hr		100
250	200µR/hr = 38,000 cpm		200
250	100µR/hr		100
50	7680 cpm		40
50	1920 cpm		10
25	3800 cpm		20
25	950 cpm		5

*Uncertainty within ± 10% C.F. within ± 20%

Range(s) Calibrated Electronically _____

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978

State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ 73410 ☐ 1131 ☐ 781 ☐ 059 ☐ 280 ☐ 60646 ☐ 70897

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☑ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N _____ ☐ Beta S/N _____ ☐ Other _____

☑ m 500 S/N 94940 ☐ Oscilloscope S/N _____ ☑ Multimeter S/N 78401031

Calibrated By: Scott Strom Date 11-Aug-11

Reviewed By: Rhod Hai Date 11 Aug 11

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: _____

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER US ARMY CORPS OF ENG BALTIMORE ORDER NO. 20131691/366617 ~~20131691/366614~~

Mfg. Ludlum Measurements, Inc. Model 19 Serial No. 253050

Mfg. _____ Model _____ Serial No. _____

Cal. Date 11-Aug-11 Cal Due Date 11-Aug-12 Cal. Interval 1 Year Meterface 202-1070

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 38 % Alt 698.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC

☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☑ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 686 V Input Sens. 29 mV Det. Oper. _____ V at _____ mV Threshold Dial Ratio _____ = _____ mV

☐ HV Readout (2 points) Ref./Inst. _____ / _____ V Ref./Inst. _____ / _____ V

COMMENTS:

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
5000	4000µR/hr	4100	4000
5000	1000µR/hr	1100	1000
500	400µR/hr = 76,000 cpm	395	400
500	100µR/hr	95	100
250	200µR/hr = 37,600 cpm	210	200
250	100µR/hr	110	100
50	7600 cpm	39.5	40
50	1900 cpm	9.5	10
25	3760 cpm	19.5	20
25	940 cpm	4.5	5

*Uncertainty within ± 10% C.F. within ± 20%

Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques.
The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ 73410 ☐ 1131 ☐ 781 ☐ 059 ☐ 280 ☐ 60646 ☐ 70897

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☑ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N _____ ☐ Beta S/N _____ ☐ Other _____

☑ m 500 S/N 94940 ☐ Oscilloscope S/N _____ ☑ Multimeter S/N 78401031

Calibrated By: Scott Stone Date 11-Aug-11

Reviewed By: Richard Wiese Date 11 Aug 11

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: _____

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 7155
P.O.# C/C

Description of Standard:

Model No. DNS-11 Serial No. 7241-11 Isotope Th-230

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 75322-201

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

11,300 ± 338

The total disintegration rate (dpm) assuming 1.5% backscatter of alpha particles from the surface of the disc, was:

22,200 ± 666 (0.0100 μCi)

The uncertainty of the measurement is 3 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Art Reust Q.A. Manager: Lori Archer

Calibration Date: 10-03-2011 Reviewed Date: 10/10/2011

Source Manufacturing Lab
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 761-5413 Fax (505) 761-5416
art.reust@eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 7155
P.O.# C/C

Description of Standard:

Model No. DNS-11 Serial No. 7242-11 Isotope Th-230

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 75322-201

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

14,600 ± 438

The total disintegration rate (dpm) assuming 1.5% backscatter of alpha particles from the surface of the disc, was:

28,800 ± 863 (0.0130 μCi)

The uncertainty of the measurement is 3 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Art Reust Q.A. Manager: Lori Jordan

Calibration Date: 10-03-2011 Reviewed Date: 10/10/2011

Source Manufacturing Lab
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 761-5413 Fax (505) 761-5416
art.reust@eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 7155
P.O.# C/C

Description of Standard:

Model No. DNS-11 Serial No. 7244-11 Isotope Th-230

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 75322-201

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

12,200 ± 365

The total disintegration rate (dpm) assuming 1.5% backscatter of alpha particles from the surface of the disc, was:

24,000 ± 720 (0.0108 μCi)

The uncertainty of the measurement is 3 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Art Reust Q.A. Manager: Lori Jordan

Calibration Date: 10-03-2011 Reviewed Date: 10/10/2011

Source Manufacturing Lab
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 761-5413 Fax (505) 761-5416
art.reust@eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 7156
P.O.# C/C

Description of Standard:

Model No. DNS-12 Serial No. 7246-11 Isotope Tc-99

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi beta emission rate was measured using an internal gas flow proportional chamber. Absolute counting of beta particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated beta source S/N 75323-201.

Measurement Result:

The observed beta count rate from the surface of the disc per minute (cpm) on the calibration date was:

11,500 ± 458

The total disintegration rate (dpm) assuming 25 % backscatter of beta particles from the surface of the disc, was:

18,300 ± 733 (0.00826 μCi)

The uncertainty of the measurement is 4 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Q.A. Manager:

Calibration Date: 10-03-2011 Reviewed Date: 10/10/2011

Source Manufacturing Lab
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 761-5413 Fax (505) 761-5416
art.reust@eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 7156
P.O.# C/C

Description of Standard:

Model No. DNS-12 Serial No. 7245-11 Isotope Tc-99

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi beta emission rate was measured using an internal gas flow proportional chamber. Absolute counting of beta particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated beta source S/N 75323-201.

Measurement Result:

The observed beta count rate from the surface of the disc per minute (cpm) on the calibration date was:

6,600 ± 329

The total disintegration rate (dpm) assuming 25 % backscatter of beta particles from the surface of the disc, was:

10,600 ± 527 (0.00475 μCi)

The uncertainty of the measurement is 5 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Art Reust Q.A. Manager: Lori Wallace

Calibration Date: 10-03-2011 Reviewed Date: 10/10/2011

Source Manufacturing Lab
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 761-5413 Fax (505) 761-5416
art.reust@eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 7156
P.O.# C/C

Description of Standard:

Model No. DNS-12 Serial No. 7248-11 Isotope Tc-99

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi beta emission rate was measured using an internal gas flow proportional chamber. Absolute counting of beta particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated beta source S/N 75323-201.

Measurement Result:

The observed beta count rate from the surface of the disc per minute (cpm) on the calibration date was:

10,800 ± 430

The total disintegration rate (dpm) assuming 25 % backscatter of beta particles from the surface of the disc, was:

17,200 ± 688 (0.00775 μCi)

The uncertainty of the measurement is 4 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Art Reust Q.A. Manager: Lori Jordan

Calibration Date: 10-03-2011 Reviewed Date: 10/10/2011

Source Manufacturing Lab
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
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art.reust@eberlineservices.com