Inst.#2221 218557 BKGD		
QC Daily Source		
Date	Result (cpm)	P/F
1/4/2007	8916	Pass
1/5/2007	9015	Pass

Inst.#2221 218557 BKGD		Source Ser. #	1161
Initial Source Readings		Nuclide	Cs-137
Date	Result (cpm)		
1/3/2007	8726		
1/3/2007	8678		
1/3/2007	8623		
1/3/2007	9147		
1/3/2007	8643		
1/3/2007	8434		
1/3/2007	8629		
1/3/2007	8496		
1/3/2007	8451		
1/3/2007	8301		
	Average		
	8613		

Inst.#2221 218557 Gamma		
QC Daily Source		
Date	Result (cpm)	P/F
1/4/2007	213287	Pass
1/5/2007	216974	Pass

Inst.#2221 218557 Gamma		Source Ser. #	1161
Initial Source Readings		Nuclide	Cs-137
Date	Result (cpm)		
1/3/2007	209383		
1/3/2007	214368		
1/3/2007	211499		
1/3/2007	213125		
1/3/2007	214297		
1/3/2007	214585		
1/3/2007	218134		
1/3/2007	217334		
1/3/2007	220453		
1/3/2007	227306		
	Average		
	216048		

CABRERA ALPHA-BETA COUNTING INSTRUMENT (Rev 5)

Counting Instrument:			2360		Detector:	43-93		Calibration Date:		6/25/2006								
Serial #:			202398		Serial #:	PR211706		12 month calibration:		OK								
Detector Active Area or Area Covered by Smear (cm^2):						125		NRC 6 Mo Cal. Due Date?		WARNING								
	Efficiency (fraction)	Source Nuclide	Source Number	Original Source Activity (DPM)	Source Creation Date	$T_{1/2}$ (yr)	Source Decayed Activity	Required MDA ($DPM/100cm^2$)	Control Chart & Daily Bkg Count Time	Control Chart & Daily Source-Sample Count Time	Control Chart bkg Average α/β cpm	Control Chart bkg 1 sigma, cpm	Control Chart Source-bkg Average α/β cpm	Control Chart source 1 sigma, cpm				
Alpha	0.2001	Th-230	3973-02	17,500	4/29/2002	7.54E+04	17,499	100	1	1	1.30	1.49	3501.7	84.48				
Beta	0.1151	Tc-99	3975-02	17,500	4/29/2002	2.13E+05	17,500	1000	1	1	107.00	7.38	2013.7	61.71				

Date	Daily Bkg Counts		Daily Check Source Counts		Daily Bkg Rate (cpm)		Net Daily Source Rate (cpm)		Bkg QC Pass/Fail		Source QC Pass/Fail				α MDA OK?	β MDA OK?	H.P. Technician	Technician Initials
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	MDA α (dpm)	MDA β (dpm)				
1/4/2007	1	100	3605	2163	1.0	100.0	3604.0	2063.0	PASS	PASS	PASS	PASS	30.59	344	Yes	Yes	Gbright	GB
1/5/2007	0	108	3405	2125	0.0	108.0	3405.0	2017.0	PASS	PASS	PASS	PASS	11.99	357	Yes	Yes	Gbright	GB

CABRERA ALPHA-BETA COUNTING INSTRUMENT (Rev 5)

Initial Background and Source Counts for Control Chart

#	Initial bkg counts				Initial source plus bkg counts			
	Alpha	cpm	Beta	cpm	Alpha	cpm	Beta	cpm
1	0	0	98	98	3539	3539	2114	2114
2	5	5	95	95	3505	3505	2181	2181
3	1	1	102	102	3470	3470	2087	2087
4	0	0	110	110	3669	3669	2082	2082
5	0	0	105	105	3577	3577	2065	2065
6	2	2	112	112	3445	3445	2213	2213
7	1	1	111	111	3368	3368	2029	2029
8	1	1	106	106	3542	3542	2198	2198
9	1	1	111	111	3437	3437	2130	2130
10	2	2	120	120	3478	3478	2108	2108
Mean		1.30		107.0		3503.0		2120.7
$S_{(n-1)}$		1.49		7.38		84.01		60.16
-3 sigma		-3.18		84.86		3250.98		1940.23
+3 sigma		5.78		129.14		3755.02		2301.17
-2 sigma		-1.69		92.24		3334.99		2000.39
+2 sigma		4.29		121.76		3671.01		2241.01
					Mean-bkg	3501.7		2013.7
					$S_{(n-1)}$	84.48		61.71
				Mean-bkg	-3 sigma	3248.26		1828.56
				Mean-bkg	+3 sigma	3755.14		2198.84
				Mean-bkg	-2 sigma	3332.74		1890.27
				Mean-bkg	+2 sigma	3670.66		2137.13
						3539		2016
						3500		2086
						3469		1985
						3669		1972
						3577		1960
						3443		2101
						3367		1918
						3541		2092
						3436		2019
						3476		1988

Trial MDA Calculator	α	β
Sample Count Time (min)	1	
Bkg Count Rate (cpm)	0.1	
Bkg Count Time (min)	1	
Counter Efficiency	0.200106	0.11507
MDCR (cpm)	4.471333	#DIV/0!
MDA (dpm)	22.34485	#DIV/0!

Cabrera Services, Inc.

Instrumentation Logbook

Great Lakes Ash Sampling

Project #03-3040.30

Jan 2007

Instrument Inventory Log

Vendor	Make	Model / Probe	S/N	Cal Cert	Date Rec'd	Date Ret'd	Comments
Cabrera	Ludlum	2360/4393	202398/ PR211706	Y	1/3/07	1/5/07	
Cabrera	Ludlum	3/44-9	79517/PR137500	Y	1/3/07	1/5/07	
Cabrera	Ludlum	2221/44-20	218559/PR215448	Y	1/3/07	1/5/07	

Source Data Page

Source	Activity	S/N	Half Life (years)	Generation Date	Vendor
Th-230	17,500 dpm	3973-02	75,400	4-29-2002	Eberline
Tc-99	17,700 dpm	3975-02	211,000	4-25-2002	Eberline
Cs-137		1161	30.07		

DAILY F D LOG
Instrument QC

units are cpm ur/hr

Make	Model	S/N	Probe	S/N	DOC
Ludlum	2360	202398	43-93	PR211706	6/25/06
Bkgd Count	**Source Count**	**Source #1 ID**	**Source #2 ID**	**Source #3 ID**	**CDD**
1	1	DNS-11	PNS-12		

Date	1/3/0										
Intial QC's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tech**
Bkgd	0/98	5/95	1/102	0/110	0/105	2/112	1/111	1/106	1/111	2/120	GB
Source #1	3539	3505	3480	3669	3577	3445	3368	3542	3437	3478	GB
Source #2	2114	2181	2087	2082	2065	2213	2029	2198	2130	2108	GB
Source #3											

Daily QC's

Date	Bkgd	Source #1 (Th-230) α / β / γ	Source #2 ( ) α / β / γ	Source #3 ( ) α / β / γ	Battery OK	Tech
1/4/07	1/100	3605	2163		Yes / No	GB
1/5/07	0/108	3405	2125		Yes / No	GB
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	

DAILY F[illegible]D LOG
Instrument QC

units are cpm [illegible]ur/hr

Make	Model	S/N	Probe	S/N	DOC
Ludlum	2221	218357	44-20	215468	8/19/06
Bkgd Count	**Source Count**	**Source #1 ID**	**Source #2 ID**	**Source #3 ID**	**CDD**
1	1				

Date	1/3/07										
Intial QC's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tech**
Bkgd	8726	8678	8623	9147	8643	8434	8629	8496	8451	8301	GB
Source #1	209383	214368	211499	213125	214297	214585	218034	217334	220453	227306	GB
Source #2											
Source #3											

Daily QC's

Date	Bkgd	Source #1 (Cs-137) α / β / γ	Source #2 ( ) α / β / γ	Source #3 ( ) α / β / γ	Battery OK	Tech
1/4/07	8916	213287			Yes / No	GB
1/5/07	9015	216974			Yes / No	GB
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	

DAILY F D LOG
Instrument QC

units are cpm ur/hr

Make	Model	S/N	Probe	S/N	DOC
Ludlum	3	79517	44-9	PR137500	5/23/06
Bkgd Count	**Source Count**	**Source #1 ID**	**Source #2 ID**	**Source #3 ID**	**CDD**
1	1	DNS-12			

Date	1/3/07										
Intial QC's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Tech**
Bkgd	30 GB	30	20	20	30	30	30	50	40	40	GB
Source #1	~~3539~~										GB
Source #2	2700	2800	3100	3200	3300	3100	3000	3200	3000	3100	
Source #3											

Daily QC's

Date	Bkgd	Source #1 ( ) α / β / γ	Source #2 ( ) α / β / γ	Source #3 ( ) α / β / γ	Battery OK	Tech
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	
					Yes / No	

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 3863
P.O.# 02-055

Description of Standard:

Model No. DNS-11 Serial No. 3973-02 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 2393/91.

Measurement Result:

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

8,860 ± 265

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

17,500 ± 523 (0.00786 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: [signature]

Calibration Technician: [signature] Q.A. Representative [signature]

Calibration Date: 4-29-2002 Reviewed Date: 4-29-02

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 345-3461 Fax (505) 761-5416
Toll Free (866) RAD-LABS (723-5227)
www.eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 3863
P.O.# 02-055

Description of Standard:

Model No. DNS-12 Serial No. 3975-02 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 2148/90.

Measurement Result:

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

11,000 ± 441

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

17,700 ± 706 (0.00796 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. Representati

Calibration Date: 4-25-2002 Reviewed Date: 4-29-02

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 345-3461 Fax (505) 761-5416
Toll Free (866) RAD-LABS (723-5227)
www.eberlineservices.com

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 CABRERA SERVICES ORDER NO. 257191/303228

Mfg. Ludlum Measurements, Inc. Model 2360 Serial No. 202398

Mfg. Ludlum Measurements, Inc. Model 43-93 Serial No. PR 211706

Cal. Date 25-Jun-06 Cal Due Date 25-Jun-07 Cal. Interval 1 Year Meterface 202-855

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 42 % Alt 700.8 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.

nstrument Volt Set 725 V

☑ HV Readout (2 points) Ref./Inst. 500 / 503 V Ref./Inst. 1500 / 1510 V

Firmware Version: 39010n25
Alpha Threshold: 120 mV
Beta Threshold: 3.5mV
Beta Window: 30 mV
Overload SET TO SIMULATE LIGHT LEAK
Instrument calibrated with a 5' cable.
High voltage set with detector CONNECTED

(EEPROM Settings)
User Time: 1.0
Alpha Alarm: 50000
Beta Alarm: 50000
A/B Alarm: 50000
Model 2360 Date: 6/25/~~07~~ 06
Calibration Date Due: 6/25/07

COMMENTS:

Efficiency Formula:
Source Count - Bkgrd=? /source size (dpm)=? x100 = %
4 pi efficiencies for Th230, Tc99, Sr90Y90, and Ni63 are as follows:
Th230≈20%,Tc99≈16%,Sr90Y90≈25%,Ni63≈0.06%

* SEE PLATEAU SHEETS FOR ALL *

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	400kcpm	400	400
x1000	100kcpm	100	100
x100	40kcpm	400	400
x100	10kcpm	100	100
x10	4kcpm	400	400
x10	1kcpm	100	100
x1	400kcpm	400	400
x1	100kcpm	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	39993(0)	39993(0)	Log Scale			
	40kcpm	3995	3995				
	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: ☐ S-394 ☐ 1122 ☐ 781
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 Th230/E121495 ☑ Beta S/N Tc99/NI-EV,Sr90Y90/4016,Ni63/4017 ☐ Other

☑ m 500 S/N 189496 ☐ Oscilloscope S/N ☑ Multimeter S/N 83750186

Calibrated By: Michael Jones Date 25 June 06

Reviewed By: W Robins Date 26 June 06

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22S 06/02/2006

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 43-93 Serial No. PR 211706 Order #. 257191/303228

Customer CABRERA SERVICES Alpha Input Sensitivity 120 mV

Counter 2360 Serial No. 202398 Beta Input Sensitivity 3.5 mV

Count Time 1Minute Beta Window 30 mV

Other Distance Source to Detector Surface

High Voltage	Background		Isotope Th230 Size ≈19800 dpm		Isotope Size		Isotope Size	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
700	1	124	3918	505				
725	1	213	4047	568				
750	0	554	4132	1153				

☐ 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 Michael Torres Date 25 June 06

FORM C4B 04/09/2003

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 43-93 Serial No. PR 211706 Order #. 257191/303228

Customer CABRERA SERVICES Alpha Input Sensitivity 120 mV

Counter 2360 Serial No. 202398 Beta Input Sensitivity 3.5 mV

Count Time 1Minute Beta Window 30 mV

Other Distance Source to Detector surface

High Voltage	Background		Isotope Tc 99 Size ≈ 22600 dpm		Isotope Sr90/90 Size ≈ 59077 dpm		Isotope Ni 63 Size ≈ 290696 dpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
700	1	124	2	2969	5	11583	1	141
725	1	213	4	3829	4	15130	3	391
750	0	554	6	5266	4	18207	1	1634

☐ 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 Michael Torres Date 25 June 06

FORM C4B 04/09/2003

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 CABRERA SERVICES ORDER NO. 252136/300508

Mfg. Ludlum Measurements, Inc. Model 3 Serial No. 79517

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR-137500

Cal. Date 23-Mar-06 Cal Due Date 23-Mar-07 Cal. Interval 1 Year Meterface 202-002

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 20 % Alt 705.8 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.

nstrument Volt Set 900 V Input Sens. 28 mV Det. Oper. 900 V at 28 mV Threshold Dial Ratio = mV

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

COMMENTS:

Efficiency readings(4pi using 44-9)
Th230sn:5020-03, Act=5730dpm, background≈30cpm, Source count≈1100cpm, Eff≈18.6%
Ni-63sn:4017, Act=291364dpm, background≈30cpm, Source count≈2000cpm, Eff≈0.6%
Tc99sn:5279-04, Act=28800dpm, background≈30cpm, Source count≈8000cpm, Eff≈27.7%
Sr90Y90sn:4016, Act=59453dpm, background≈30cpm, Source count≈24000cpm, Eff≈40.3%

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*
X 100	400 K cpm	4K	4K
X 100	100 K cpm	1K	1K
X 10	40 K cpm	4K	4K
X 10	10 K cpm	1.1K	1.1K
X 1	4 K cpm	4K	4K
X 1	1 K cpm	1.1K	1.1K
X 0.1	400 cpm	4K	4K
X 0.1	100 cpm	1K	1K

*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				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:

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 50800 ☐ Oscilloscope S/N ☑ Multimeter S/N 83990502

Calibrated By: Charles Disk Date 23 Mar 06

Reviewed By: [signature] Date 24-Mar-06

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22A 11/26/2003

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.

CONVERSION CHART

Customer CABRERA SERVICES Date 23-Mar-06 Order #. 252136/300508

Model 3 Serial No. 79517 Detector Model 44-9 Serial No. PR-137500

Source Cs-137 150 mCi Cs-137 21 mCi High Voltage 900 V

Input Sensitivity 28 mV

	"As Found" Readings (CPM):		After Adjustment Readings (CPM):	
Reference Point	Meter Reading	Range/Scale	Meter Reading	Range/Scale
150 mR/hr	3K	x 100	3K	x 100
50 mR/hr	1.5K	x 100	1.5K	x 100
15 mR/hr	0.6K	x 100	0.6K	x 100
5 mR/hr	1.9K	x 10	1.9K	x 10
1.5 mR/hr	0.6K	x 10	0.6K	x 10
1.0 mR/hr	3.2K	x 1	3.2K	x 1

Signature: Charles Dick Date 23 Mar 06

FORM C17-1A 04/09/2003

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 CABRERA SERVICES ORDER NO. 257115/303187

Mfg. Ludlum Measurements, Inc. Model 2221 Serial No. 218559

Mfg. Ludlum Measurements, Inc. Model 44-20 Serial No. PR215468

Cal. Date 19-Aug-06 Cal Due Date 19-Aug-07 Cal. Interval 1 Year Meterface 202-159

Check mark ✓ applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 43 % Alt 700.8 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) 4.4 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 Comments V Input Sens Comments mV Det. Oper Comments V at Comments mV Threshold Dial Ratio 100 = 10 mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 2008 V

COMMENTS:

	Peak settings	Gross Counts
High Voltage:	687V	1050V
Threshold dial:	642	100(10mv)
Window dial:	40	n/a
Window Position:	"IN"	"OUT"
Resolution for Cs137:	≈8.7%	n/a

Model 2221 currently set for Gross Counts
High voltage set with detector connected.

Firmware: 261028 ~~8~~ TT

Calibrated with 5foot cable.

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*
X 1K	400kcpm	400	400
X 1K	100kcpm	100	100
X 100	40kcpm	400	400
X 100	10kcpm	100	100
X 10	4kcpm	400	400
X 10	1kcpm	100	100
X 1	400cpm	400	400
X 1	100cpm	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	40215(0)	40215(0)	Log Scale	500kcpm	450 K	450K
	40kcpm	4013(0)	4013(0)		50kcpm	50 K	50K
	4kcpm	402(0)	402(0)		5kcpm	5 K	5K
	400cpm	40(0)	40(0)		500cpm	500	500
	40cpm	4(0)	4(0)		50cpm	55	55

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:

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 57881 ☐ Oscilloscope S/N ☑ Multimeter S/N 56110559R

Calibrated By: Michael J Thomas Date 19-Aug-06

Reviewed By: [illegible] Date 21 Aug 06

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22A 11/26/2003

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 44-20 Serial No. PR 215468

Customer CABRERA SERVICES Order #. 257115/303187

Counter 2221 Serial No. 218559 Counter Input Sensitivity 10 mV

Count Time 6 sec Distance Source to Detector Surface

Other

High Voltage	Background	Isotope Am-241 Size ≈0.79uCi	Isotope Size	Isotope Size	Isotope Size
700	1704	1745			
750	1823	14477			
800	2019	16053			
850	2008	18828			
900	2046	19983			
950	2024	21056			
1000	2020	20841			
→ 1050	2137	20868			
1100	2043	20941			
1150	2160	20636			
1200	2249	20971			
1250	2651	21456			

Signature Michael T Thomas Date 19-Aug-06

FORM C4A 04/09/2003