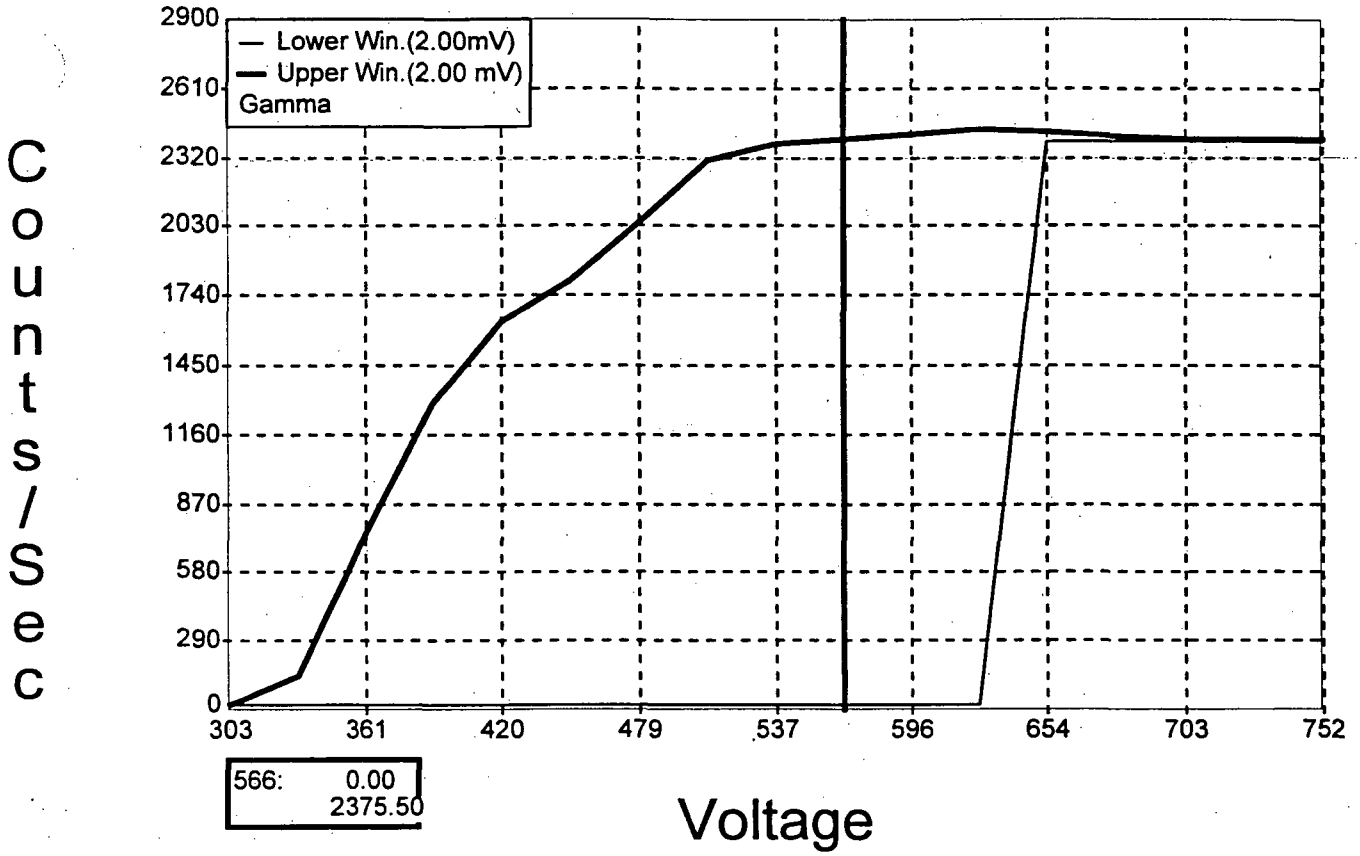
SPA-8 723415
Voltage Plateau Curve



LL28u

LUDLUM MODEL 19
CALIBRATION DATA SHEET

Model: 19 **Serial #:** 131255 **Date:** 26 Jun 97

Detector Type: SCINTILLATION **OUIC:** W4GV91 **Manf:** LUDLUM

Type of Cal: SOURCE/ELECTRONIC

CALIBRATION STANDARDS:

Pulser S/N: 43859 **Calibration Due:** 13 DEC 97

Source S/N: CS-05 **Calibration Due:** 4 SEP 97 **Isotope:** Cs-137

High Voltage: **as found:** 625 **as left:** 625

SCALE	APPLIED	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE (µR/hr)	C.F
5000 µR/hr	4000 µR/hr	4100	4000	3.6K - 4.4K	1.00
1000 µR/hr	1000 µR/hr	1050	1000	900 - 1100	1.00

SCALE	APPLIED PULSER (CPM)	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE	CORRECTION FACTOR
5000	814,000	N/A	4000	3,600-4,400	1.00
5000	200,000	N/A	1,000	900-1,100	1.00
500	81,400	430	400	360-440	1.00
500	20,000	105	100	90-110	1.00
250	40,700	220	200	180-220	1.00
250	10,000	55	50	45-55	1.00
50	8,140	42	40	36-44	1.00
50	2,000	11	10	9-11	1.00
25	4,070	22	20	18-22	1.00
25	1,000	5.0	5.0	4.5-5.5	1.00

Remarks: This calibration is traceable to the National Institute of Standards and Technology. Response Tested with TA-23a SN:1303. 11.2-16.8 µR/hr.

Bard [illegible]
Performed by

Hugo Bianchi
Reviewed by

LUDLUM MODEL 19
CALIBRATION DATA SHEET

Model: 19 Serial #: 131300 Date: 26 Jun 97

Detector Type: SCINTILLATION OUIC: W4GV91 Manf: LUDLUM

Type of Cal: SOURCE/ELECTRONIC

CALIBRATION STANDARDS:

Pulser S/N: 43859 Calibration Due: 13DEC97

Source S/N: ~~7440R~~ CS-05 Calibration Due: 4SEP97 Isotope: Cs-137

High Voltage: as found: 575 as left: 575

SCALE	APPLIED	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE (µR/hr)	C.F
5000 µR/hr	4000 µR/hr	4000	4000	3.6K - 4.4K	1.00
1000 µR/hr	1000 µR/hr	1000	1000	900 - 1100	1.00

SCALE	APPLIED PULSER (CPM)	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE	CORRECTION FACTOR
5000	845,000	N/A	4000	3,600-4,400	1.00
5000	213,000	N/A	1,000	900-1,100	1.00
500	84,500	400	400	360-440	1.00
500	21,300	100	100	90-110	1.00
250	42,300	200	200	180-220	1.00
250	10,700	50	50	45-55	1.00
50	8,450	40	40	36-44	1.00
50	2,130	10	10	9-11	1.00
25	4,230	20	20	18-22	1.00
25	1,070	5	5	4.5-5.5	1.00

Remarks: This calibration is traceable to the National Institute of Standards and Technology. Response tested with TA-230 SN:1303. 12-18 µR/hr.

Performed by: [signature] Reviewed by: Hugo Bianchi

LUDLUM MODEL 19
CALIBRATION DATA SHEET

Model: 19 **Serial #:** 111348 **Date:** 26 Jun 97

Detector Type: SCINTILLATION **OUIC:** W4GV91 **Manf:** LUDLUM

Type of Cal: SOURCE/ELECTRONIC

CALIBRATION STANDARDS:

Pulser S/N: 43859 **Calibration Due:** 13 DEC 97

Source S/N: Cs-05 **Calibration Due:** 4 SEP 97 **Isotope:** Cs-137

High Voltage: **as found:** 575 **as left:** 600

SCALE	APPLIED	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE (µR/hr)	C.F
5000 µR/hr	4000 µR/hr	4300	4000	3.6K - 4.4K	1.00
1000 µR/hr	1000 µR/hr	1100	1050	900 - 1100	0.95

SCALE	APPLIED PULSER (CPM)	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE	CORRECTION FACTOR
5000	841K	N/A	4000	3,600-4,400	1.00
5000	193K	N/A	1,000	900-1,100	1.00
500	84.1K	440	400	360-440	1.00
500	19,300	105	100	90-110	1.00
250	42,000	230	200	180-220	1.00
250	9,650	55	50	45-55	1.00
50	8410	44	40	36-44	1.00
50	1930	11	10	9-11	1.00
25	4200	20	20	18-22	1.00
25	965	5	5	4.5-5.5	1.00

Remarks: This calibration is traceable to the National Institute of Standards and Technology. Response Tested with TA-230 SN:1303 11.2-16.8 uR/hr.

Performed by

Hugo Bianchi
Reviewed by

LUDLUM MODEL 19
CALIBRATION DATA SHEET

Model: 19 Serial #: 131319 Date: 26 Jun 97

Detector Type: SCINTILLATION OUIC: W4GV91 Manf: LUDLUM

Type of Cal: SOURCE/ELECTRONIC

CALIBRATION STANDARDS:

Pulser S/N: 43859 Calibration Due: 13 DEC 97

Source S/N: Cs-05 Calibration Due: 4 SEP 97 Isotope: Cs-137

High Voltage: as found: 625 as left: 600

SCALE	APPLIED	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE (µR/hr)	C.F
5000 µR/hr	4000 µR/hr	4100	4000	3.6K - 4.4K	1.00
1000 µR/hr	1000 µR/hr	1050	1000	900 - 1100	1.00

SCALE	APPLIED PULSER (CPM)	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE	CORRECTION FACTOR
5000	854,000	N/A	4000	3,600-4,400	1.00
5000	210,000	N/A	1000	900-1,100	1.00
500	~~427~~ 85,400	420	400	360-440	1.00
500	21,000	105	100	90-110	1.00
250	42,700	230	200	180-220	1.00
250	10,500	55	50	45-55	1.00
50	8,540	44	40	36-44	1.00
50	2100	11	10	9-11	1.00
25	4,270	21	20	18-22	1.00
25	1,050	5.0	5.0	4.5-5.5	1.00

Remarks: This calibration is traceable to the National Institute of Standards and Technology. Response tested with TK-230 SN:1303. 10.4 - 15.6 µR/hr.

Performed by

Reviewed by Hugo Bianchi

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER FT MONMOUTH/US ARMY ORDER NO. 963033

Mfg. Ludlum Measurements, Inc. Model 19 Serial No. 131318

Mfg. Model Serial No.

Cal. Date 07/31/96 Cal Due Date 07/31/97 Cal. Interval 1 Year Meterface 202-016

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 50 % Alt 703.8 mm Hg

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

☑ 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 12/19/89.

Instrument Volt Set 682 V Input Sens. 33 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	4000uR/hr		4000
5000	1000uR/hr		1000
500	400uR/hr = 71700cpm		400
500	100uR/hr		100
250	200uR/hr = 36900 cpm		200
250	100uR/hr		100
50	7170 cpm		40
50	1790 cpm		10
25	3690 cpm		20
25	922 cpm		5

*Uncertainty within ± 10% C.F. within ± 20% 50, 25 **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 MIL-STD-45662A 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 ☐ Neutron Am-241 Be S/N T-30

☐ Alpha S/N ☐ Beta S/N ☐ Other

☑ m 500 S/N 50800 ☐ Oscilloscope S/N ☑ Multimeter S/N 61341135

Calibrated By: Connie Tomlinson Date 7-31-96

Reviewed By: Rhonda Harris Date 7-31-96

FORM C22A 02/27/96

LUDLUM MODEL 19
CALIBRATION DATA SHEET

Model: 19 **Serial #:** 127410 **Date:** 29NOV96
Detector Type: SCINTILLATION **OUIC:** W4GV91 **Manf:** LUDLUM
Type of Cal: SOURCE/ELECTRONIC

CALIBRATION STANDARDS:

Pulser S/N: 539 **Calibration Due:** 16NOV97

Source S/N: Cs-05 **Calibration Due:** 4SEP97 **Isotope:** Cs-137

Source S/N: N/A **Calibration Due:** N/A **Isotope:** N/A

High Voltage: as found: 570 **as left :** 570

SCALE	APPLIED	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE (µR/hr)	C.F
5000 µR/hr	4000 µR/hr	3700	4000	3.6K - 4.4K	1.000
1000 µR/hr	1000 µR/hr	950	1000	900 - 1100	1.000

SCALE	APPLIED PULSER (CPM)	INITIAL READING µR/hr	FINAL READING µR/hr	SPECIFICATIONS (µR/hr)	CORRECTION FACTOR
5000	800k	4200	N/A	N/A	N/A
5000	200K	1200	N/A	N/A	N/A
500	80K	420	420	420 (±10%)	1.000
500	20K	120	120	120 (±10%)	1.000
250	40k	220	210	210 (±10%)	1.000
250	10K	61	60	60 (±10%)	1.000
50	8K	40	41	42 (±10%)	1.024
50	2K	12	12	12 (±10%)	1.000
25	4K	20	20	21 (±10%)	1.050
25	1.K	6.0	6.0	6.0 (±10%)	1.000

Remarks: This calibration is traceable to the National Institute of Standards and Technology.

Bert [illegible]
Performed by

Hugo Bianchi
Reviewed by

Attachment 1

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER FT MONMOUTH/US ARMY ORDER NO. 963033

Ludlum Measurements, Inc. Model 19 Serial No. 127410

3. Model Serial No.

Cal. Date 07/31/96 Cal Due Date 07/31/97 Cal. Interval 1 Year Meterface 202-016

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 50 % Alt 703.8 mm Hg

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

☑ 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 12/19/89.

Instrument Volt Set 571 V Input Sens. 33 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	4000uR/hr		4000
5000	1000uR/hr		1000
500	400uR/hr = 72500 cpm		400
500	100uR/hr		110
250	200uR/hr = 37000 cpm		200
250	100uR/hr		105
50	7250 cpm		40
50	1810 cpm		10
25	3700 cpm		20
25	925 cpm		5

*Uncertainty within ± 10% C.F. within ± 20% 50, 25 **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 MIL-STD-45662A 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 ☐ 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 61341135

Calibrated By: Connie Tomlinson Date 7-31-96

Reviewed By: Rhonda Harris Date 7-31-96

FORM C22A 02/27/96

LUDLUM MODEL 19
CALIBRATION DATA SHEET

Model: 19 **Serial #:** 131280 **Date:** 29 NOV 96
Detector Type: SCINTILLATION **OUIC:** W4GV91 **Manf:** LUDLUM
Type of Cal: SOURCE/ELECTRONIC

CALIBRATION STANDARDS:

Pulser S/N: 539 **Calibration Due:** 16 NOV 97

Source S/N: CS-05 **Calibration Due:** 4 SEP 97 **Isotope:** Cs-137

Source S/N: N/A **Calibration Due:** N/A **Isotope:** N/A

High Voltage: as found: 600 **as left :** 600

SCALE	APPLIED	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE (µR/hr)	C.F
5000 µR/hr	4000 µR/hr	4000	4000	3.6K - 4.4K	1.000
1000 µR/hr	1000 µR/hr	1000	1000	900 - 1100	1.000

SCALE	APPLIED PULSER (CPM)	INITIAL READING µR/hr	FINAL READING µR/hr	SPECIFICATIONS (µR/hr)	CORRECTION FACTOR
5000	800 K	3700	N/A	N/A	N/A
5000	200 K	1100	N/A	N/A	N/A
500	80 K	390	370	370 (±10%)	1.000
500	20 K	115	110	110 (±10%)	1.000
250	40 K	185	185	185 (±10%)	1.000
250	10 K	55	55	55 (±10%)	1.000
50	8 K	35	37	37 (±10%)	1.000
50	2 K	11	11	11 (±10%)	1.000
25	4 K	17	18.5	18.5 (±10%)	1.000
25	1 K	5.0	5.5	5.5 (±10%)	1.000

Remarks: This calibration is traceable to the National Institute of Standards and Technology.

Burt Immingy
Performed by

Hugo Bianchi
Reviewed by

Attachment 1

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER FT MONMOUTH/US ARMY ORDER NO. 963033

Ludlum Measurements, Inc. Model 19 Serial No. 131280

Mfg. Model Serial No.

Cal. Date 07/31/96 Cal Due Date 07/31/97 Cal. Interval 1 Year Meterface 202-016

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 50 % Alt 703.8 mm Hg

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

☑ 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 12/19/89.

Instrument Volt Set 596 V Input Sens. 34 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	4000uR/hr		4000
5000	1000uR/hr		1000
500	400uR/hr = 72800 cpm		400
500	100uR/hr		100
250	200uR/hr = 36100 cpm		200
250	100uR/hr		100
50	7280 cpm		40
50	1820 cpm		10
25	3610 cpm		20
25	902 cpm		10

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

50, 25 **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 MIL-STD-45662A 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 ☐ 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 61341135

Calibrated By: Connie Tomlinson Date 7-31-96

Reviewed By: Rhonda Harris Date 7-31-96

FORM C22A 02/27/96

LUDLUM MODEL 19
CALIBRATION DATA SHEET

Model: 19 **Serial #:** 131245 **Date:** 29NOV96
Detector Type: SCINTILLATION **OUIC:** W4GV91 **Manf:** LUDLUM
Type of Cal: SOURCE/ELECTRONIC

CALIBRATION STANDARDS:

Pulser S/N: 539 **Calibration Due:** 16NOV97

Source S/N: Cs-05 **Calibration Due:** 4SEP97 **Isotope:** Cs-137

Source S/N: N/A **Calibration Due:** N/A **Isotope:** N/A

High Voltage: as found: 576 **as left :** 576

SCALE	APPLIED	INITIAL READING µR/hr	FINAL READING µR/hr	TOLERANCE (µR/hr)	C.F
5000 µR/hr	4000 µR/hr	4200	4000	3.6K - 4.4K	1.000
1000 µR/hr	1000 µR/hr	1050	1000	900 - 1100	1.000

SCALE	APPLIED PULSER (CPM)	INITIAL READING µR/hr	FINAL READING µR/hr	SPECIFICATIONS (µR/hr)	CORRECTION FACTOR
5000	800k	3900	N/A	N/A	N/A
5000	200k	1000	N/A	N/A	N/A
500	80k	400	390	390 (±10%)	1.000
500	20K	100	100	100 (±10%)	1.000
250	40K	200	195	195 (±10%)	1.000
250	10k	50	50	50 (±10%)	1.000
50	8K	40	39	39 (±10%)	1.000
50	2K	10	10	10 (±10%)	1.000
25	4K	20	19.5	19.5 (±10%)	1.000
25	1K	5.0	5.0	5.0 (±10%)	1.000

Remarks: This calibration is traceable to the National Institute of Standards and Technology.

Bert [illegible] — **Performed by**

Hugo Bianchi — **Reviewed by**

Attachment 1

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER FT MONMOUTH/US ARMY ORDER NO. 963033

Ludlum Measurements, Inc. Model 19 Serial No. 131265

Model Serial No.

Cal. Date 07/31/96 Cal Due Date 07/31/97 Cal. Interval 1 Year Meterface 202-016

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 50 % Alt 703.8 mm Hg

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

☑ 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 12/19/89.

Instrument Volt Set 576 V Input Sens. 32 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	4000uR/hr		4000
5000	1000uR/hr		1000
500	400uR/hr = 72600 cpm		400
500	100uR/hr		100
250	200uR/hr = 37300 cpm		200
250	100uR/hr		100
50	7260 cpm		40
50	1810 cpm		10
25	3730 cpm		20
25	932 cpm		5

*Uncertainty within ± 10% C.F. within ± 20% 50, 25 **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 MIL-STD-45662A 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 ☐ 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 61341135

Calibrated By: Connie Tomlinson Date 7-31-96

Reviewed By: Rhonda Harris Date 7-31-96

FORM C22A 02/27/96

Ludlum Model 2360
Calibration Data Sheet

Serial Number: 133666 Date: 11AUG97
Detector Type: SCINTILLATION OUIC: W4GV91
Type Of Calibration: Electronic/Source

Standards:
Pulser Serial Number: 43589 Calibration Due: 13 DEC 97
Volt/Ohm Meter Serial Number: 43589 Calibration Due: 13 DEC 97
Source: Cs-12 Isotope: Cs-137 Source: P1482 Isotope: Pu-239

Calibration:
Beta Threshold: 3.5 **mV** **Beta Window:** 29 **mV** **Alpha Threshold:** 110 **mV**

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400K	400K	1.00
x1000	100k	100K	100K	1.00
x100	40k	40K	40K	1.00
x100	10k	10K	10K	1.00
x10	4k	4K	4K	1.00
x10	1k	1K	1K	1.00
x1	400	400	400	1.00
x1	100	100	100	1.00

Integrate/Scaler Mode			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	402734	402734	0.95
40k	40287	40287	0.99
4k	4030	4030	0.99
400	403	403	0.99
40	40	40	1.00

Efficiency:

Source	Activity (2π)	5 min Count	CCPM	Efficiency
Pu-239	11,811 dpm	24,940	4968	42.06%
Cs-137	30548 dpm	32452	6261	20.50%

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. Response tested with Cs-137 SN: Cs-12 and Pu-239 SN: P2608.

Performed By: [signature] Reviewed By: Hugo Bianchi

Attachment 1 Report Number: 081197139659

Detector Worksheet

Model: 43-89 Serial Number: 139659

Instrument Model: 2360 Serial Number: 133666

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
650	48231	2764	5.4%	1	5120	0.02%	0	103
675	49560	2693	5.2%	0	5773	0.00%	0	158
700	50785	3251	6.0%	1	6251	0.02%	0	211
725	51754	7615	12.8%	1	6489	0.02%	0	307
750	51505	6201	10.7%	0	6514	0.00%	0	447
775	52078	3044	5.5%	3	6207	0.05%	0	437

Efficiency: Alpha: 42.06% Beta: 20.50%

(.5 min.) Background: Alpha : 0 (2 min.) Background Beta: 459

30 sec Alpha Source Counts

	Gross ctns	Corr cnts	
1	25583	25583	34633
2	25676	25676	8668
3	25835	25835	4343
4	25790	25790	437
5	25919	25919	22470
6	25742	25742	734
7	25610	25610	25313
8	25999	25999	52854
9	26118	26118	121731
10	25776	25776	48
11	25851	25851	6708
12	25765	25765	17
13	25816	25816	2200
14	25722	25722	2218
15	26105	26105	112829
16	25516	25516	64060
17	25989	25989	48356
18	25498	25498	73495
19	25620	25620	22231
20	25452	25452	100552
	AVERAGE	25769	35195
	Standard Deviation		188

2 min. Beta Source Counts

	Gross ctns	Corr cnts	
1	13009	12550	44584
2	12854	12395	3153
3	12730	12271	4604
4	12861	12402	3988
5	12859	12400	3739
6	12933	12474	18266
7	12686	12227	12510
8	12760	12301	1433
9	12667	12208	17122
10	12840	12381	1777
11	12680	12221	13889
12	12760	12301	1433
13	12728	12269	4879
14	12678	12219	14364
15	12730	12271	4604
16	12780	12321	319
17	12805	12346	51
18	12797	12338	1
19	12837	12378	1533
20	12963	12504	27275
	AVERAGE	12339	8976
	Standard Deviation		95

ALPHA CONTROL CHART

+3 SIGMA	**26332**
+2 SIGMA	**26144**
+1 SIGMA	**25957**
AVERAGE	**25769**
-1 SIGMA	**25581**
-2 SIGMA	**25394**
-3 SIGMA	**25206**

Background Corrected

BETA CONTROL CHART

+3 SIGMA	**12623**
+2 SIGMA	**12528**
+1 SIGMA	**12434**
AVERAGE	**12339**
-1 SIGMA	**12244**
-2 SIGMA	**12149**
-3 SIGMA	**12055**

Ludlum Model 2360
Calibration Data Sheet

Serial Number: 133661
Detector Type: SCINTILLATION
Type Of Calibration: Electronic/Source

Date: 11 AUG 97
OUIC: W4GV91

Standards:
Pulser Serial Number: 43589 — Calibration Due: 13 DEC 97
Volt/Ohm Meter Serial Number: 43589 — Calibration Due: 13 DEC 97
Source: Cs-12 Isotope: Cs-137 — Source: P1482 Isotope: Pu-239

Calibration:
Beta Threshold: 3.5 **mV** **Beta Window:** 29 **mV** **Alpha Threshold:** 110 **mV**

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	410K	410K	0.99
x1000	100k	100K	100K	1.00
x100	40k	41K	41K	0.98
x100	10k	10K	10K	1.00
x10	4k	4100	4100	0.98
x10	1k	1000	1000	1.00
x1	400	410	410	0.98
x1	100	105	105	0.95

Integrate/Scaler Mode			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	402464	402464	0.99
40k	40252	40252	0.99
4k	4027	4027	0.99
400	403	403	0.99
40	40	40	1.00

Efficiency:

Source	Activity (2π)	5 min Count	CCPM	Efficiency
Pu-239	11,811 dpm	24185	4837	40.95%
Cs-137	30,549 dpm	28360	5513	18.04%

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. Response tested with Cs-137 SN: Cs-12 and Pu-239 SN: P2608.

Performed By: [signature] Reviewed By: Hugo Bianchi

Attachment 1 Report Number: 081197139658

Detector Worksheet

Model: 43-89 Serial Number: 139658

Instrument Model: 2360 Serial Number: 133661

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
625	45645	2609	5.4%	0	3793	0.00%	0	60
650	48247	2501	4.9%	0	4770	0.00%	2	96
675	49416	2425	4.7%	1	5556	0.02%	1	144
700	51431	3393	6.2%	1	6340	0.02%	0	288
725	52066	11598	18.2%	0	6999	0.00%	1	606
750	52570	12768	19.5%	3	6841	0.04%	0	864

Efficiency: Alpha: 40.95% Beta: 18.04%

(.5 min.) Background: Alpha : 0 (2 min.) Background Beta: 317

30 sec Alpha Source Counts

	Gross ctns	Corr cnts	
1	24956	24956	1
2	24981	24981	666
3	25196	25196	57985
4	24976	24976	433
5	24625	24625	109032
6	24922	24922	1102
7	24797	24797	25027
8	25163	25163	43181
9	24589	24589	134102
10	24879	24879	5806
11	24991	24991	1282
12	25032	25032	5898
13	25043	25043	7709
14	24916	24916	1537
15	25096	25096	19825
16	24764	24764	36557
17	25066	25066	12277
18	24963	24963	61
19	25090	25090	18171
20	25059	25059	10774
	AVERAGE	24955	24571
	Standard Deviation		157

2 min. Beta Source Counts

	Gross ctns	Corr cnts	
1	11294	10977	1211
2	11416	11099	24586
3	11119	10802	19656
4	11468	11151	43597
5	11257	10940	5
6	11185	10868	5506
7	11178	10861	6593
8	11244	10927	231
9	11335	11018	5746
10	11369	11052	12056
11	11178	10861	6593
12	11239	10922	408
13	11061	10744	39283
14	11134	10817	15675
15	11458	11141	39521
16	11290	10973	949
17	11333	11016	5446
18	11123	10806	18550
19	11092	10775	27956
20	11411	11094	23043
	AVERAGE	10942	14831
	Standard Deviation		122

ALPHA CONTROL CHART

+3 SIGMA	**25425**
+2 SIGMA	**25269**
+1 SIGMA	**25112**
AVERAGE	**24955**
-1 SIGMA	**24798**
-2 SIGMA	**24642**
-3 SIGMA	**24485**

Background Corrected

BETA CONTROL CHART

+3 SIGMA	**11308**
+2 SIGMA	**11186**
+1 SIGMA	**11064**
AVERAGE	**10942**
-1 SIGMA	**10820**
-2 SIGMA	**10699**
-3 SIGMA	**10577**

Ludlum Model 2360
Calibration Data Sheet

Serial Number: 133661
Date: 20 FEB97
Detector Type: SCINTILLATION
OUIC: W4GV91
Type Of Calibration: Electronic/Source

Standards:
Pulser Serial Number: 43589
Calibration Due: 13 DEC 97
Volt/Ohm Meter Serial Number: 43589
Calibration Due: 13 DEC 97
Source: Cs-12 Isotope: Cs-137
Source: P1482 Isotope: Pu-239

Calibration:
Beta Threshold: 3.5 **mV** **Beta Window:** 29 **mV** **Alpha Threshold:** 110 **mV**

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400K	400K	1.00
x1000	100k	100K	100K	1.00
x100	40k	40K	40K	1.00
x100	10k	10K	10K	1.00
x10	4k	4K	4K	1.00
x10	1k	1K	1K	1.00
x1	400	400	400	1.00
x1	100	100	100	1.00

Integrate/Scaler Mode			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	401,963	401,963	0.95
40k	40,233	40,233	0.99
4k	4,037	4,037	0.99
400	400	400	1.00
40	40	40	1.00

Efficiency:

Source	Activity (2π)	5 min Count	CCPM	Efficiency
Pu-239	11,811 dpm	20960	4192	35.49%
Cs-137	30,900 dpm	37,559	7182	23.24%

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. Response tested with Cs-137 SN: Cs-12 and Pu-239 SN: P2608.

Performed By: [signature] Reviewed By: Hugo Bianchi

Attachment 1 Report Number: 022097133661

Detector Worksheet

Model: 43-89 Serial Number: 139658

Instrument Model: 2360 Serial Number: 133661

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
575	28418	3730	11.5%	1	1825	0.06%	0	29
600	37735	2980	7.2%	0	2983	0.00%	0	58
625	42064	2702	5.8%	0	4135	0.00%	0	104
650	43520	2693	5.5%	1	5089	0.02%	0	136
675	44459	2850	5.6%	1	5696	0.02%	0	197
700	46274	4887	8.6%	0	6501	-0.02%	1	523
725	46823	14910	22.9%	1	7206	0.02%	0	1003

Efficiency **Alpha: 35.49%** **Beta: 23.24%**

(2 min.) **Background: Alpha : 1** **Beta: 658**

Alpha Source Counts (2 min.)

	Gross ctns	Corr cnts	
1	99213	99212	147034
2	99244	99243	124221
3	99849	99849	64288
4	99169	99168	182714
5	99516	99515	6472
6	99819	99818	49529
7	99503	99502	8733
8	100007	100006	168551
9	99438	99437	25106
10	99524	99523	5249
11	100065	100064	219539
12	99720	99719	15265
13	99486	99485	12199
14	100044	100043	200301
15	99802	99801	42251
16	99883	99882	82111
17	99317	99316	78092
18	99391	99390	42210
19	99453	99452	20578
20	99466	99465	17017
	AVERAGE	99595	75573
	Standard Deviation		275

Beta Source Counts

	Gross ctns	Corr cnts	
1	14997	14339	6964
2	14943	14285	18893
3	14984	14326	9303
4	14742	14084	114548
5	14998	14340	6798
6	14960	14302	14508
7	15149	14491	4699
8	14951	14293	16757
9	15053	14395	754
10	15243	14585	26423
11	15073	14415	56
12	15111	14453	933
13	15204	14546	15265
14	15090	14432	91
15	15267	14609	34801
16	15202	14544	14774
17	15167	14509	7491
18	15121	14463	1644
19	15131	14473	2555
20	15223	14565	20321
	AVERAGE	14422	15879
	Standard Deviation		126

ALPHA CONTROL CHART

+3 SIGMA	**100420**
+2 SIGMA	**100145**
+1 SIGMA	**99870**
AVERAGE	**99595**
-1 SIGMA	**99321**
-2 SIGMA	**99046**
-3 SIGMA	**98771**

Background Corrected

BETA CONTROL CHART

+3 SIGMA	**14800**
+2 SIGMA	**14674**
+1 SIGMA	**14548**
AVERAGE	**14422**
-1 SIGMA	**14296**
-2 SIGMA	**14170**
-3 SIGMA	**14044**

Detector Worksheet

Detector Model: 43-89 Serial Number: 139658
Instrument Model: 2360 Serial Number: 133661

Alpha Source Counts (2 min)

1	99213	146268
2	99244	123517
3	99849	64288
4	99169	181860
5	99516	6312
6	99819	49975
7	99503	8547
8	100007	169373
9	99433	24791
10	99524	5105
11	100065	220477
12	99720	15513
13	99486	11979
14	100044	201197
15	99802	42663
16	99883	82685
17	99317	77534
18	99391	41800
19	99453	20292
20	99466	16757
AVERAGE	99595	75547
Sum of Squares		1510933
Chi Square:		15.1707

Beta Source Counts (2 min)

1	14997	6964
2	14943	18893
3	14984	9303
4	14742	114548
5	14998	6798
6	14960	14508
7	15149	4699
8	14951	16757
9	15053	754
10	15243	26423
11	15073	56
12	15111	933
13	15204	15265
14	15090	91
15	15267	34801
16	15202	14774
17	15167	7491
18	15121	1644
19	15131	2555
20	15223	20321
AVERAGE	15080	15879
Sum of Squares		317577
Chi Square:		21.05885

Ludlum Model 2360
Calibration Data Sheet

Serial Number: 133668
Detector Type: SCINTILLATION
Type Of Calibration: Electronic/Source

Date: 14 Jul 97
OUIC: W4GV91

Standards:
Pulser Serial Number: 43589 — Calibration Due: 13 DEC 97
Volt/Ohm Meter Serial Number: 43589 — Calibration Due: 13 DEC 97
Source: Cs-12 Isotope: Cs-137 — Source: P1482 Isotope: Pu-239

Calibration:
Beta Threshold: 3.5 **mV** **Beta Window:** 30 **mV** **Alpha Threshold:** 110 **mV**

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400K	400K	1.00
x1000	100k	100K	100K	1.00
x100	40k	40K	40K	1.00
x100	10k	10K	10K	1.00
x10	4k	4K	4K	1.00
x10	1k	1K	1K	1.00
x1	400	400	400	1.00
x1	100	100	100	1.00

Integrate/Scaler Mode			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	403,851	403,851	0.99
40k	40,375	40,375	0.99
4k	4,038	4,038	0.99
400	404	404	0.99
40	41	41	0.98

Efficiency:

Source	Activity (2π)	5 min Count	CCPM	Efficiency
Pu-239	11,811 dpm	22,254	4451	37.69 %
Cs-137	30,602 dpm	32,539	6267	20.48%

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. Response tested with Cs-137 SN: Cs-12 and Pu-239 SN: P2608.

Performed By: [signature] Reviewed By: Hugo Bianchi

Attachment 1 Report Number: 071497133668

Detector Worksheet

Model: 43-89 Serial Number: 139117

Instrument Model: 2360 Serial Number: 133668

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
550	51598	2294	4.3%	0	4688	0.00%	0	84
575	49424	2106	4.1%	0	5102	0.00%	0	108
600	49936	2210	4.2%	4	6194	0.06%	2	166
625	51116	5156	9.2%	0	6310	0.00%	2	194
650	51156	5072	9.0%	0	6644	0.00%	0	350
675	51702	1564	2.9%	8	6186	0.13%	2	454
700	51958	668	1.3%	24	6006	0.40%	0	504

Efficiency Alpha: 37.69% Beta: 20.48%

(.5 min.) Background: Alpha : 0 (2 min.) Background Beta: 536

(.5 min.) Alpha Source Counts

	Gross ctns	Corr cnts	
1	25175	25175	48202
2	25507	25507	12645
3	25286	25286	11783
4	25329	25329	4297
5	25338	25338	3198
6	25358	25358	1336
7	25316	25316	6170
8	25441	25441	2158
9	25692	25692	88477
10	25162	25162	54080
11	25471	25471	5845
12	25346	25346	2357
13	25480	25480	7302
14	25457	25457	3900
15	25557	25557	26390
16	25534	25534	19446
17	25334	25334	3666
18	25374	25374	422
19	25332	25332	3913
20	25402	25402	56
	AVERAGE	25395	15282
	Standard Deviation		124

(2 min.) Beta Source Counts

	Gross ctns	Corr cnts	
1	13010	12474	4837
2	13036	12500	1897
3	13186	12650	11332
4	13062	12526	308
5	13035	12499	1985
6	13260	12724	32562
7	12950	12414	16783
8	12930	12394	22365
9	13036	12500	1897
10	12997	12461	6815
11	13015	12479	4167
12	13184	12648	10910
13	13084	12548	20
14	13182	12646	10496
15	12985	12449	8940
16	13033	12497	2167
17	12981	12445	9712
18	13398	12862	101410
19	13280	12744	40180
20	12947	12411	17570
	AVERAGE	12544	15318
	Standard Deviation		124

ALPHA CONTROL CHART

+3 SIGMA	25765
+2 SIGMA	25642
+1 SIGMA	25518
AVERAGE	25395
-1 SIGMA	25271
-2 SIGMA	25147
-3 SIGMA	25024

Background Corrected

BETA CONTROL CHART

+3 SIGMA	12915
+2 SIGMA	12791
+1 SIGMA	12667
AVERAGE	12544
-1 SIGMA	12420
-2 SIGMA	12296
-3 SIGMA	12172

Ludlum Model 2360
Calibration Data Sheet

Serial Number: 133663
Detector Type: SCINTILLATION
Type Of Calibration: Electronic/Source

Date: 07-14-97
OUIC: W4GV91

Standards:
Pulser Serial Number: 43589
Volt/Ohm Meter Serial Number: 43589
Source: Cs-12 Isotope: Cs-137

Calibration Due: 13 DEC 97
Calibration Due: 13 DEC 97
Source: ~~P2608~~ P1482 Isotope: Pu-239

Calibration:
Beta Threshold: 3.5 **mV** **Beta Window:** 30 **mV** **Alpha Threshold:** 110 **mV**

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400K	400K	1.00
x1000	100k	100K	100K	1.00
x100	40k	40K	40K	1.00
x100	10k	10K	10K	1.00
x10	4k	4K	4K	1.00
x10	1k	1K	1K	1.00
x1	400	400	400	1.00
x1	100	100	100	1.00

Integrate/Scaler Mode			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	404,483	404,483	0.99
40k	40,471	40,471	0.99
4k	4,047	4,047	0.99
400	405	405	0.99
40	40	40	1.00

Efficiency:

Source	Activity (2π)	5 min Count	CCPM	Efficiency
Pu-239	11,811 dpm	21,864	4373	37.00%
Cs-137	30,602 dpm	29,723	5774	18.87 %

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. Response tested with Cs-137 SN: Cs-12 and Pu-239 SN: P2608.

Performed By: [signature] Reviewed By: Hugo Bianchi

Attachment 1 Report Number: 071497133663

Detector Worksheet

Model: 43-89 Serial Number: 136345

Instrument Model: 2360 Serial Number: 133663

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
600	7366	6620	47.3%	0	526	0.00%	0	2
625	27018	4152	13.3%	0	1650	0.00%	0	14
650	35386	3276	8.5%	0	2126	0.00%	0	46
675	41888	2714	6.1%	0	2932	0.00%	0	62
700	47456	2126	4.3%	0	4250	0.00%	0	102
725	50280	2082	4.0%	1	5564	0.02%	0	120
750	51092	2240	4.2%	1	5850	0.02%	0	190
775	51244	2870	5.3%	0	6408	0.00%	0	232

Efficiency: Alpha: 37.00% Beta: 18.87%

(.5 min.) Background: Alpha : 0 (2 min.) Background Beta: 395

30 sec Alpha Source Counts

	Gross ctns	Corr cnts	
1	25617	25617	6806
2	25611	25611	5852
3	25496	25496	1482
4	25412	25412	15006
5	25671	25671	18632
6	25735	25735	40200
7	25670	25670	18360
8	25668	25668	17822
9	25677	25677	20306
10	25774	25774	57360
11	25669	25669	18090
12	25502	25502	1056
13	25543	25543	72
14	25220	25220	98910
15	25518	25518	272
16	25318	25318	46872
17	25278	25278	65792
18	25575	25575	1640
19	25215	25215	102080
20	25521	25521	182
	AVERAGE	25535	26840
	Standard Deviation		164

2 min. Beta Source Counts

	Gross ctns	Corr cnts	
1	11995	11600	24196
2	12202	11807	2647
3	12045	11650	11141
4	12198	11803	2252
5	11905	11510	60295
6	12121	11726	873
7	12136	11741	212
8	12225	11830	5543
9	12342	11947	36653
10	12195	11800	1976
11	12081	11686	4837
12	12075	11680	5708
13	12150	11755	0
14	12176	11781	648
15	12197	11802	2158
16	12091	11696	3546
17	12276	11881	15738
18	12188	11793	1403
19	12232	11837	6634
20	12181	11786	927
	AVERAGE	11756	9369
	Standard Deviation		97

ALPHA CONTROL CHART

+3 SIGMA	26026
+2 SIGMA	25862
+1 SIGMA	25698
AVERAGE	25535
-1 SIGMA	25371
-2 SIGMA	25207
-3 SIGMA	25043

Background Corrected

BETA CONTROL CHART

+3 SIGMA	12046
+2 SIGMA	11949
+1 SIGMA	11852
AVERAGE	11756
-1 SIGMA	11659
-2 SIGMA	11562
-3 SIGMA	11465

Detector Worksheet

Model: 43-89 Serial Number: 139661

Instrument Model: 2360 Serial Number: 133670

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
725	49632	1832	3.6%	0	4543	0.00%	0	84
750	50798	1960	3.7%	0	5345	0.00%	2	186
775	50464	2334	4.4%	0	6016	0.00%	0	180
800	51590	4792	8.5%	1	6477	0.02%	0	390
825	52184	13574	20.6%	2	6565	0.03%	0	522
850	52562	9752	15.6%	2	6648	0.03%	2	804
875	52546	3134	5.6%	5	6389	0.08%	2	1352

Efficiency: Alpha: 41.46% Beta: 19.53%

(.5 min.) Background: Alpha : 0 (2 min.) Background Beta: 393

30 sec Alpha Source Counts

	Gross ctns	Corr cnts	
1	25453	25453	20335
2	25351	25351	1648
3	25059	25059	63202
4	25329	25329	346
5	25378	25378	4570
6	25214	25214	9293
7	25388	25388	6022
8	25390	25390	6336
9	25489	25489	31898
10	25295	25295	237
11	25348	25348	1414
12	25516	25516	42271
13	25313	25313	7
14	25201	25201	11968
15	25268	25268	1798
16	25154	25154	24461
17	25131	25131	32184
18	24982	24982	107847
19	25413	25413	10527
20	25536	25536	50895
	AVERAGE	25310	21363
	Standard Deviation		146

2 min. Beta Source Counts

	Gross ctns	Corr cnts	
1	12042	11649	29498
2	12129	11736	7183
3	12239	11846	638
4	12261	11868	2233
5	12359	11966	21098
6	12181	11788	1073
7	12149	11756	4193
8	12371	11978	24728
9	12142	11749	5148
10	12223	11830	86
11	12378	11985	26978
12	12422	12029	43368
13	12003	11610	44416
14	12068	11675	21243
15	12292	11899	6123
16	12174	11781	1580
17	12081	11688	17623
18	12218	11825	18
19	12160	11767	2889
20	12383	11990	28646
	AVERAGE	11821	14438
	Standard Deviation		120

ALPHA CONTROL CHART

+3 SIGMA	**25749**
+2 SIGMA	**25603**
+1 SIGMA	**25457**
AVERAGE	**25310**
-1 SIGMA	**25164**
-2 SIGMA	**25018**
-3 SIGMA	**24872**

Background Corrected

BETA CONTROL CHART

+3 SIGMA	**12181**
+2 SIGMA	**12061**
+1 SIGMA	**11941**
AVERAGE	**11821**
-1 SIGMA	**11701**
-2 SIGMA	**11580**
-3 SIGMA	**11460**

Ludlum Model 2360
Calibration Data Sheet

Serial Number: 133670
Detector Type: SCINTILLATION
Type Of Calibration: Electronic/Source

Date: 11AUG-97
OUIC: W4GV91

Standards:
Pulser Serial Number: 43589 — Calibration Due: 13 DEC 97
Volt/Ohm Meter Serial Number: 43589 — Calibration Due: 13 DEC 97
Source: Cs-12 Isotope: Cs-137 — Source: P1482 Isotope: Pu-239

Calibration:
Beta Threshold: 3.5 **mV** **Beta Window:** 29 **mV** **Alpha Threshold:** 110 **mV**

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400K	400K	1.00
x1000	100k	100K	100K	1.00
x100	40k	40K	40K	1.00
x100	10k	10K	10K	1.00
x10	4k	4K	4K	1.00
x10	1k	1K	1K	1.00
x1	400	400	400	1.00
x1	100	100	100	1.00

Integrate/Scaler Mode			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	402426	402426	0.99
40k	40246	40246	0.99
4k	4024	4024	0.99
400	404	404	0.99
40	40	40	1.00

Efficiency:

Source	Activity (2π)	5 min Count	CCPM	Efficiency
Pu-239	11,811 dpm	24,485	4897	41.46%
Cs-137	30,548 dpm	30,813	5944	19.53%

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. Response tested with Cs-137 SN: Cs-12 and Pu-239 SN: P2608.

Performed By: [signature] Reviewed By: Hugo Bianchi

Attachment 1 Report Number: 081997139661

Ludlum Model 2224
Calibration Data Sheet

Serial Number: 119806
Detector Model: 43-37-1
Detector Type: GAS FLOW PROPORTIONAL
Type Of Calibration: Electronic/Source

Date: 07 Feb 97
Serial Number: 136363
OUIC: W4GV91

Standards:
Pulser Serial Number: 43589 — Calibration Due: 13 DEC 97
Volt/Ohm Meter Serial Number: 43589 — Calibration Due: 13 DEC 97
Source: ES928 Isotope: Pu-238 — Source: H-045 Isotope: Cs-137

Calibration:
Beta Threshold: 3.5 mV Beta Window: 40 mV Alpha Threshold: 100 mV

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400k	400k	1.000
x1000	100k	100k	100k	1.000
x100	40k	40k	40k	1.000
x100	10k	10k	10k	1.000
x10	4k	4k	4k	1.000
x10	1k	1k	1k	1.000
x1	400	400	400	1.000
x1	100	100	100	1.000

Digital Readout (Integrate/Scaler Mode)			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	402,741	402,741	0.993
40k	40,373	40,373	0.991
4K	4,009	4,009	0.998
400	401	401	0.998
40	40	40	1.00

Source Activity	Meter Indication	Efficiency (%)
Alpha (2π) 184,602 dpm	54,875	29.72 Pu-238
Beta (2π) 85,084 dpm	37,391	43.95 Cs-137

Response Test Range Alpha (Rate Meter)	1,920 - 2,880 cpm
Response Test Range Beta (Rate Meter)	2,000 - 3,000 cpm

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. Scaler/Integrate mode **CALIBRATED** electronicly only. Probe SN:134334 would not pass ±3 sigma test with source. Do not use in integrate mode. Limited calibration lable applied. Response tested with Pu-239 SN: P2724 and Cs-137 SN: BB-960.

Performed By: Bert Cummings Reviewed By: Hugo Bianchi

Report Number: 020797119806

Ludlum Model 2360
Calibration Data Sheet

Serial Number: 133666
Detector Type: SCINTILLATION
Type Of Calibration: Electronic/Source

Date: 20 FEB 97
OUIC: W4GV91

Standards:
Pulser Serial Number: 43589
Volt/Ohm Meter Serial Number: 43589
Source: Cs-12 Isotope: Cs-137

Calibration Due: 13 DEC 97
Calibration Due: 13 DEC 97
Source: P1482 Isotope: Pu-239

Calibration:
Beta Threshold: 3.5 **mV** **Beta Window:** 29 **mV** **Alpha Threshold:** 110 **mV**

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400K	400K	1.00
x1000	100k	100K	100K	1.00
x100	40k	40K	40K	1.00
x100	10k	10K	10K	1.00
x10	4k	4K	4K	1.00
x10	1k	1K	1K	1.00
x1	400	400	400	1.00
x1	100	100	100	1.00

Integrate/Scaler Mode			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	402,761	402,761	0.99
40k	40,299	40,299	0.99
4k	4,051	4,051	0.99
400	401	401	0.99
40	40	40	1.00

Efficiency:

Source	Activity (2π)	5 min Count	CCPM	Efficiency
Pu-239	11,911 dpm	21,379	4276	36.20%
Cs-137	30,900 dpm	53,650	10,41A	33.88%

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. Response tested with Cs-137 SN: Cs-12 and Pu-239 SN: P2608.

Performed By: [signature] Reviewed By: Hugo Bianchi

Attachment 1 Report Number: 022097133666

Ludlum Model 2360
Calibration Data Sheet

Serial Number: 133670
Detector Type: SCINTILLATION
Type Of Calibration: Electronic/Source

Date: 20 FEB 97
OUIC: W4GV91

Standards:

Pulser Serial Number: 43589 — Calibration Due: 13 DEC 97
Volt/Ohm Meter Serial Number: 43589 — Calibration Due: 13 DEC 97
Source: Cs-12 Isotope: Cs-137 — Source: P1482 Isotope: Pu-239

Calibration:

Beta Threshold: 3.5 **mV** **Beta Window:** 29 **mV** **Alpha Threshold:** 110 **mV**

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400K	400K	1.00
x1000	100k	100K	100K	1.00
x100	40k	40K	40K	1.00
x100	10k	10K	10K	1.00
x10	4k	4K	4K	1.00
x10	1k	1K	1K	1.00
x1	400	400	400	1.00
x1	100	100	100	1.00

Integrate/Scaler Mode			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	401722	401,722	0.99
40k	40,139	40,138	0.99
4k	4,019	4,019	0.99
400	401	401	0.99
40	40	40	1.00

Efficiency:

Source	Activity (2π)	5 min Count	CCPM	Efficiency
Pu-239	11,811 dpm	~~[illegible]~~ 21755	4,351	36.84
Cs-137	30,900 dpm	37,725	7,350	23.79%

Remarks:

This calibration is Traceable to the National Institute of Standards and Technology. Response tested with Cs-137 SN: Cs-12 and Pu-239 SN: P2608.

Performed By: [signature] Reviewed By: Hugo Bianchi

Attachment 1 Report Number: 022097133670

Detector Worksheet

Model: 43-89 Serial Number: 139661

Instrument Model: 2360 Serial Number: 133670

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
625	22456	4207	15.7%	0	705	0.00%	0	24
650	29814	3480	10.4%	0	1839	0.00%	0	26
675	36013	2863	7.3%	0	3491	0.00%	0	41
700	41891	2157	4.7%	0	4111	0.00%	0	73
725	43613	1919	4.0%	2	4613	0.05%	0	101
750	45390	2092	4.0%	1	5752	0.00%	1	184
775	46575	2897	5.3%	1	6489	0.00%	1	282

Efficiency **Alpha: 36.84%** **Beta: 23.79%**

(2 min.) Background: Alpha : 2 **Beta: 390**

Alpha Source Counts (2 min.) Beta Source Counts

	Gross ctns	Corr cnts			Gross ctns	Corr cnts	
1	103464	103462	218323	1	15313	14923	27822
2	103593	103591	114413	2	15060	14670	7430
3	103761	103761	28308	3	15118	14728	795
4	104068	104066	18701	4	15117	14727	853
5	104041	104039	12045	5	15222	14832	5746
6	103818	103816	12826	6	15380	14990	54662
7	104133	104131	40703	7	15195	14805	2381
8	103903	103901	798	8	15270	14880	15326
9	104415	104413	234014	9	15078	14688	4651
10	103840	103838	8327	10	15155	14765	77
11	104256	104254	105463	11	14995	14605	22861
12	103334	103332	356708	12	15237	14847	8245
13	103988	103986	3221	13	14887	14497	67185
14	104493	104491	315563	14	15508	15118	130899
15	103580	103578	123377	15	15015	14625	17213
16	103682	103680	62126	16	15105	14715	1697
17	104135	104133	41514	17	14978	14588	28291
18	104375	104373	196914	18	15021	14631	15675
19	103703	103701	52098	19	15057	14667	7957
20	104003	104001	5148	20	15213	14823	4462
	AVERAGE	103929	97529		AVERAGE	14756	21212
	Standard Deviation		312		**Standard Deviation**		146

ALPHA CONTROL CHART

+3 SIGMA	**104866**
+2 SIGMA	**104554**
+1 SIGMA	**104242**
AVERAGE	**103929**
-1 SIGMA	**103617**
-2 SIGMA	**103305**
-3 SIGMA	**102992**

Background Corrected

BETA CONTROL CHART

+3 SIGMA	**15193**
+2 SIGMA	**15047**
+1 SIGMA	**14902**
AVERAGE	**14756**
-1 SIGMA	**14611**
-2 SIGMA	**14465**
-3 SIGMA	**14319**

Detector Worksheet

Model: 43-89 Serial Number: 139659

Instrument Model: 2360 Serial Number: 133666

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
625	37905	3088	7.4%	0	3401	-0.03%	1	76
650	42450	2749	5.9%	1	4928	0.02%	0	93
675	44889	2717	5.4%	0	5868	0.00%	0	164
700	45283	3240	6.3%	0	6271	0.00%	0	199
725	46256	4320	8.1%	0	6479	-0.02%	1	246
750	46805	9738	16.6%	0	6436	-0.02%	1	399
775	47018	5846	10.3%	0	6480	-0.02%	1	436

Efficiency **Alpha: 36.20%** **Beta: 33.88%**

(2 min.) Background: Alpha : 0 **Beta: 262**

Alpha Source Counts (2 min.) Beta Source Counts

	Gross ctns	Corr cnts			Gross ctns	Corr cnts	
1	102534	102534	2525	1	23543	23281	79722
2	102113	102113	137456	2	23245	22983	245
3	102293	102293	36386	3	23256	22994	22
4	103183	103183	488951	4	23513	23251	63681
5	102427	102427	3221	5	23434	23172	30050
6	102077	102077	165446	6	23422	23160	26034
7	102270	102270	45689	7	23119	22857	20065
8	102472	102472	138	8	23164	22902	9341
9	102387	102387	9361	9	23469	23207	43410
10	102329	102329	23948	10	23586	23324	105853
11	102690	102690	42539	11	23173	22911	7683
12	102420	102420	4064	12	22966	22704	86819
13	102602	102602	13983	13	23050	22788	44373
14	102327	102327	24571	14	23275	23013	206
15	102131	102131	124433	15	22932	22670	108011
16	102299	102299	34133	16	22931	22669	108669
17	102995	102995	261377	17	23355	23093	8902
18	102495	102495	127	18	23200	22938	3678
19	102841	102841	127628	19	23227	22965	1132
20	102790	102790	93789	20	23353	23091	8529
	AVERAGE	102484	81988		AVERAGE	22999	37821
	Standard Deviation		286		Standard Deviation		194

ALPHA CONTROL CHART

+3 SIGMA	103343
+2 SIGMA	103056
+1 SIGMA	102770
AVERAGE	102484
-1 SIGMA	102197
-2 SIGMA	101911
-3 SIGMA	101625

Background Corrected

BETA CONTROL CHART

+3 SIGMA	23582
+2 SIGMA	23388
+1 SIGMA	23193
AVERAGE	22999
-1 SIGMA	22804
-2 SIGMA	22610
-3 SIGMA	22415

Detector Worksheet

Detector Model: 43-89 Serial Number: 139661
Instrument Model: 2360 Serial Number:133670

Alpha Source Counts (2 min)

1	103464	216458
2	103593	113064
3	103761	28308
4	104068	19252
5	104041	12488
6	103818	12377
7	104133	41514
8	103903	689
9	104415	235953
10	103840	7966
11	104256	106766
12	103334	354323
13	103988	3452
14	104493	317814
15	103580	121976
16	103682	61133
17	104135	42333
18	104375	198693
19	103703	51189
20	104003	5439
AVERAGE	103929	97559
Sum of Squares		1951184
Chi Square:		18.77415

Beta Source Counts (2 min)

1	15313	27822
2	15060	7430
3	15118	795
4	15117	853
5	15222	5746
6	15380	54662
7	15195	2381
8	15270	15326
9	15078	4651
10	15155	77
11	14995	22861
12	15237	8245
13	14887	67185
14	15508	130899
15	15015	17213
16	15105	1697
17	14978	28291
18	15021	15675
19	15057	7957
20	15213	4462
AVERAGE	15146	21212
Sum of Squares		424231
Chi Square:		28.00908

Detector Worksheet

Model: 43-37-1 Serial Number: 136363

Instrument Model: 2224 Serial Number: 119806

Count time = 60 seconds								
High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
1750	41,631	6963	13.2%	5	33797	0.00%	6	547
1775	45,538	6475	11.1%	1	36814	-0.02%	9	705
1800	49,796	6096	9.2%	22	40091	0.05%	1	949
1825	54,887	5972	8.0%	302	38506	0.75%	12	1115
1850	57,755	6187	8.0%	1010	35322	2.72%	20	1068
~~1875~~	~~64368~~	~~5416~~	~~6.3%~~	~~5845~~	~~25155~~	~~18.70%~~	~~47~~	~~1002~~ BC
		~~6062.989~~ BC						

Efficiency **Alpha: 29.720%** **Beta: 43.95%**

Background: **Alpha : 12** **Beta: 1115**

Ludlum Model 2224
Calibration Data Sheet

Serial Number: 132155
Detector Model: 43-37-1
Detector Type: GAS FLOW PROPORTIONAL
Type Of Calibration: Electronic/Source

Date: 07 Feb 97
Serial Number: 134335
OUIC: W4GV91

Standards:
Pulser Serial Number: 43589 — Calibration Due: 13 DEC 97
Volt/Ohm Meter Serial Number: 43589 — Calibration Due: 13 DEC 97
Source: ES928 Isotope: Pu-238 — Source: H-045 Isotope: Cs-137

Calibration:
Beta Threshold: 3.5 mV Beta Window: 40 mV Alpha Threshold: 100 mV

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400k	400k	1.000
x1000	100k	100k	100k	1.000
x100	40k	40k	40k	1.000
x100	10k	10k	10k	1.000
x10	4k	4k	4k	1.000
x10	1k	1k	1k	1.000
x1	400	400	400	1.000
x1	100	100	100	1.000

Digital Readout (Integrate/Scaler Mode)			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	401,765	401,765	0.996
40k	40,480	40,480	0.988
4K	4,003	4,003	0.999
400	400	400	1.00
40	40	40	1.00

Source Activity	**Meter Indication**	**Efficiency (%)**
Alpha (2π) 184,602 dpm	58,529	31.70 Pu-238
Beta (2π) 85,084 dpm	34,201	40.19 Cs-137

Response Test Range Alpha (Rate Meter)	2,240 - 3,360 cpm
Response Test Range Beta (Rate Meter)	2,080 - 3,120 cpm

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. Scaler/Integrate mode **CALIBRATED** electronicly only. Probe SN:134334 would not pass ±3 sigma test with source. Do not use in integrate mode. Limited calibration lable applied. Response tested with Pu-239 SN: P2724 and Cs-137 SN: BB-960.

Performed By: Bert Cummings Reviewed By: Hugo Bianchi

Report Number: 020797132155

Detector Worksheet

Model: 43-37-1 Serial Number: 134335

Instrument Model: 2224 Serial Number: 132155

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
1725	49,380	5919	9.3%	6	38625	0.00%	6	756
1750	51,853	5802	8.5%	49	40230	0.10%	9	890
1775	54,344	5623	7.7%	161	39354	0.38%	9	1013
1800	58,537	5691	7.2%	988	35255	2.70%	8	1054
1825	62,508	5560	6.6%	3176	29938	9.48%	36	1060
1850	64368	5416	6.3%	5845	25155	18.70%	47	1002
		~~5918.988~~						

Efficiency **Alpha: 31.70%** **Beta: 40.19%**

Background: **Alpha : 8** **Beta: 1054**

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

MER MODERN TECHNOLOGIES ORDER NO. 965263

Ludlum Measurements, Inc. Model 2224 Serial No. 132155

Mfg. Ludlum Measurements, Inc. Model 43-37-1 Serial No. PR 136363

Cal. Date 10/30/96 Cal Due Date 10/30/97 Cal. Interval 1 Year Meterface 202-783

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 38 % Alt 703.8 mm Hg

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

☑ 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 12/19/89.

Instrument Volt Set 1650 V Input Sens. Comments mV Det. Oper. 1650 V at Comments mV Threshold Dial Ratio = mV

☑ HV Readout (2 points) Ref./Inst. 505 / 500 V Ref./Inst. 2018 / 2000 V

COMMENTS:

Firmware version: 39006N03
Alpha Threshold: 90mV.
Beta Threshold: 4mV.
Beta Window: 40mV.
Overload not set.
HV set with detector not connected.
Instrument calibrated using 5ft. 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*
x1000	400kcpm		400
x1000	100kcpm		100
x100	40kcpm		400
x100	10kcpm		100
x10	4kcpm		400
x10	1kcpm		100
x1	400cpm		400
x1	100cpm		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		40038(0)	Log Scale			
	40kcpm		4004(0)				
	4kcpm		400(0)				
	400cpm		40(0)				
	40cpm		4(0)				

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 MIL-STD-45662A 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 Tc-99 0.0099μCi / Sr90/90 0.0112μCi ☐ Neutron Am-241 Be S/N T-304

Alpha S/N 4337 Pu-239 15700cpm ☑ Beta S/N 443-68-3A / 443-69-3 ☐ Other

☑ m 500 S/N 63888 ☐ Oscilloscope S/N ☐ Multimeter S/N

Calibrated By: Stephen Kensington Date 10-30-96

Reviewed By: Rhonda Harn Date 10-31-96

FORM C22A 02/27/96

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 43-37-1 Serial No. PR 136363 Order #. 965263

Customer MODERN TECHNOLOGIES Alpha Input Sensitivity 90 mV

Counter 2224 Serial No. 132155 Beta Input Sensitivity 4 mV

Count Time 1 Minute Beta Window 40 mV

Other HV set with detector not connected Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Pu-239 Size 15700cpm Alpha	Isotope Pu-239 Size 15700cpm Beta	Isotope Tc-99 Size 0.00997µCi Alpha	Isotope Tc-99 Size 0.00997µCi Beta	Isotope Sr90Y90 Size 0.0112µCi Alpha	Isotope Sr90Y90 Size 0.0112µCi Beta
1600	10	659	5662	1113	3	5308	3	10829
1625	2	908	5933	1340	5	6008	3	12987
1650	4	1205	6208	1667	14	6238	9	14863
1675	9	1485	6516	1898	39	6049	97	16110
1700	24	1627	6709	2045	175	5614	416	16378

Signature Stephen Henrington Date 10-30-96

FORM C4B 02/23/94

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. (915) 235-4672
SWEETWATER, TEXAS 79556, U. S. A.
1-800-622-0828

This Certifies that Ludlum Model 239-1F Serial No. PR 137014
has been functionally checked.

Date 10-31-96 Order No. 96-5263

Final Check by Stephen Herington

Form 34

Ludlum Model 2224
Calibration Data Sheet

Serial Number: 132143
Detector Model: 43-37-1
Detector Type: GAS FLOW PROPORTIONAL
Type Of Calibration: Electronic/Source

Date: 07 Feb 97
Serial Number: 134334
OUIC: W4GV91

Standards:
Pulser Serial Number: 43589 — Calibration Due: 13 DEC 97
Volt/Ohm Meter Serial Number: 43589 — Calibration Due: 13 DEC 97
Source: ES928 Isotope: Pu-238 — Source: H-045 Isotope: Cs-137

Calibration:
Beta Threshold: 3.5 mV Beta Window: 40 mV Alpha Threshold: 100 mV

Rate Meter				
Meter Range	Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
x1000	400k	400k	400k	1.000
x1000	100k	100k	100k	1.000
x100	40k	40k	40k	1.000
x100	10k	10k	10k	1.000
x10	4k	4k	4k	1.000
x10	1k	1k	1k	1.000
x1	400	400	400	1.000
x1	100	100	100	1.000

Digital Readout (Integrate/Scaler Mode)			
Applied (cpm)	Initial Reading (cpm)	Final Reading (cpm)	Correction Factor
400k	402,965	402,965	0.996
40k	40,330	40,330	0.992
4K	4,006	4,006	0.999
400	400	400	1.00
40	40	40	1.00

Source Activity	Meter Indication	Efficiency (%)
Alpha (2π) 184,602 dpm	58,512	31.70 Pu-238
Beta (2π) 85,084 dpm	38,332	45.05 Cs-137

Response Test Range Alpha (Rate Meter)	2,000 - 3,000 cpm
Response Test Range Beta (Rate Meter)	2,000 - 3,000 cpm

Remarks:
This calibration is Traceable to the National Institute of Standards and Technology. * Scaler/Integrate mode **CALIBRATED** electronicly only. Probe SN:134334 would not pass ±3 sigma test with source. Do not use in integrate mode. Limited calibration lable applied. Response tested with Pu-239 SN: P2724 and Cs-137 SN: BB-960.

Performed By: [signature] Reviewed By: Hugo Bianchi

Report Number: 020797132143

Detector Worksheet

Model: 43-37-1 Serial Number: 134334

Instrument Model: 2224 Serial Number: 132143

Count time = 60 seconds

High	Alpha Source			Beta Source			Background	
Voltage	Alpha	Beta	xtalk	Alpha	Beta	xtalk	Alpha	Beta
1750	45,320	6632	11.9%	3	33742	0.00%	4	439
1775	48220	6321	10.4%	2	36432	-0.01%	6	622
1800	56232	5965	8.4%	16	38443	0.03%	3	750
1825	58517	5760	7.4%	195	39350	0.48%	5	1018
1850	59,455	5844	6.8%	650	37431	1.61%	37	1377

6631.992

Efficiency **Alpha: 31.70%** **Beta: 45.05%**

Background: **Alpha : 5** **Beta: 1018**

EBERLINE E-600 CALIBRATION REPORT

Date: 03/27/97 **OUIC: W4GV91**
Standard: Model 81 **Isotope: Cs-137** **SN: 7140**
Type of Calibration: Source

E-600 Serial Number	**951**
Program Version	E600 V3.06
Calibration Date	03/27/97
Calibration Due Date	09/22/97
Scaler Precision	10%
Lower Threshold Slope	0.8205
Lower Threshold Intercept	-0.1487 mV
Upper Threshold Slope	0.9741
Upper Threshold Intercept	-0.6963 mV
Alarm Editing	Enabled
Latching Alarms	Enabled
Auto Ranging	Enabled
Beep on Auto-Range	Yes
Ignore E-600 Cal. Date	No
Ignore Probe Cal. Date	No
Ratemeter Mode Support	Enabled
Integrate Mode Support	Enabled
Scaler Mode Support	Enabled
Peak Hold Mode Support	Enabled
Background Update Mode Support	Enabled
Log ID Source	Internal/Aux.
Star Key Ratemeter Function	Zero Display
Star Key Integrate Function	Zero Display
Scaler Display Units	Rate
Scaler Counting Mode	Fixed Time

Smart Probe Serial Number	**723417**
Type	S-SPA-8
Calibration Date	03/27/97
Calibration Due Date	09/22/97
Dead Time	18.5 usec
Surface Area	5.00 cm2
Max High Voltage	1500 Vdc
Overrange	45000 cps

Channel 1

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	537 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.12E+10 counts/R
Scaler Time	10 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Channel 2

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	537 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.12E+10 counts/R
Scaler Time	10 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Channel 3

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	537 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.12E+10 counts/R
Scaler Time	10 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Gamma Channel Linearity Test Results - Pass Tolerance Plus/Minus 10.0%

Field	Response	%Error	Pass/Fail
0.0040 R/hr	0.0038 R/hr	-4.96%	Pass
0.0004 R/hr	0.0004 R/hr	-4.24%	Pass
5.00E-05 R/hr	5.50E-05 R/hr	9.99%	Pass

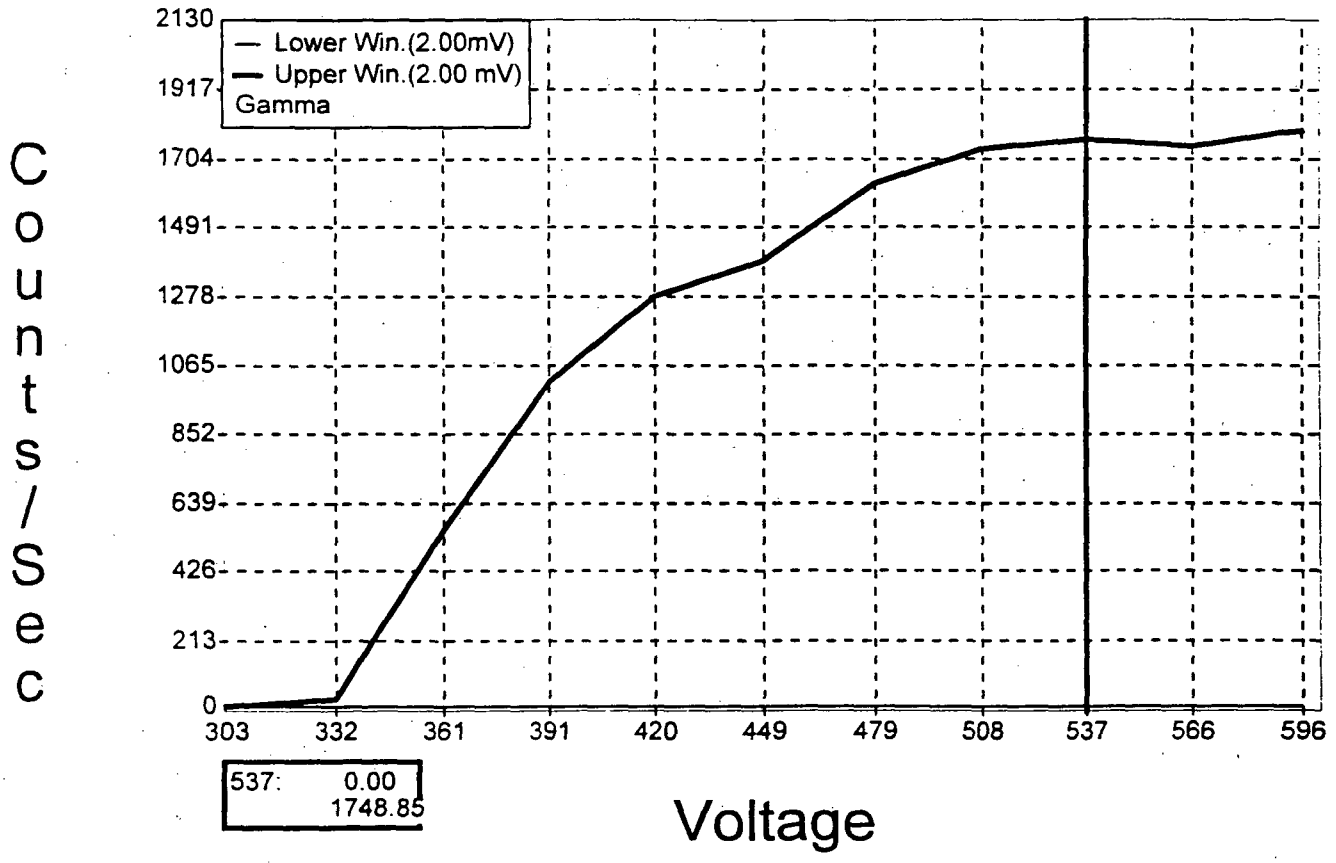
Response Test Range: 7.60 - 11.4 μR/hr

Remarks:
This Calibration is Traceable to the National Institute of Standards and Technology.
Response Tested with Cs-137, SN: CS-12.

Performed By: Bud [illegible] Reviewed By: Hugo Bianchi

Report Number: 032777723417

SPA-8 723417
Voltage Plateau Curve



EBERLINE E-600 CALIBRATION REPORT

Date: 03/27/97 **OUIC: W4GV91**
Standard: Model 81 **Isotope: Cs-137** **SN: 7140**
Type of Calibration: Source

E-600 Serial Number	**926**
Program Version	E600 V3.06
Calibration Date	03/27/97
Calibration Due Date	09/22/97
Scaler Precision	10%
Lower Threshold Slope	0.8974
Lower Threshold Intercept	-0.2564 mV
Upper Threshold Slope	1.00
Upper Threshold Intercept	-0.8000 mV
Alarm Editing	Enabled
Latching Alarms	Enabled
Auto Ranging	Enabled
Beep on Auto-Range	No
Ignore E-600 Cal. Date	No
Ignore Probe Cal. Date	No
Ratemeter Mode Support	Enabled
Integrate Mode Support	Enabled
Scaler Mode Support	Enabled
Peak Hold Mode Support	Enabled
Background Update Mode Support	Enabled
Log ID Source	Internal/Aux.
Star Key Ratemeter Function	Zero Display
Star Key Integrate Function	Zero Display
Scaler Display Units	Rate
Scaler Counting Mode	Fixed Time

Smart Probe Serial Number	**723416**
Type	S-SPA-8
Calibration Date	03/27/97
Calibration Due Date	09/22/97
Dead Time	24.0 usec
Surface Area	5.00 cm2
Max High Voltage	1500 Vdc
Overrange	45000 cps

Channel 1

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	566 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.17E+10 counts/R
Scaler Time	10 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Channel 2

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	566 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.17E+10 counts/R
Scaler Time	10 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Channel 3

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	566 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.17E+10 counts/R
Scaler Time	10 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Gamma Channel Linearity Test Results - Pass Tolerance Plus/Minus 10.0%

Field	Response	%Error	Pass/Fail
0.0041 R/hr	0.0037 R/hr	-9.51%	Pass
0.0004 R/hr	0.0004 R/hr	-9.11%	Pass
5.42E-05 R/hr	5.85E-05 R/hr	8.00%	Pass

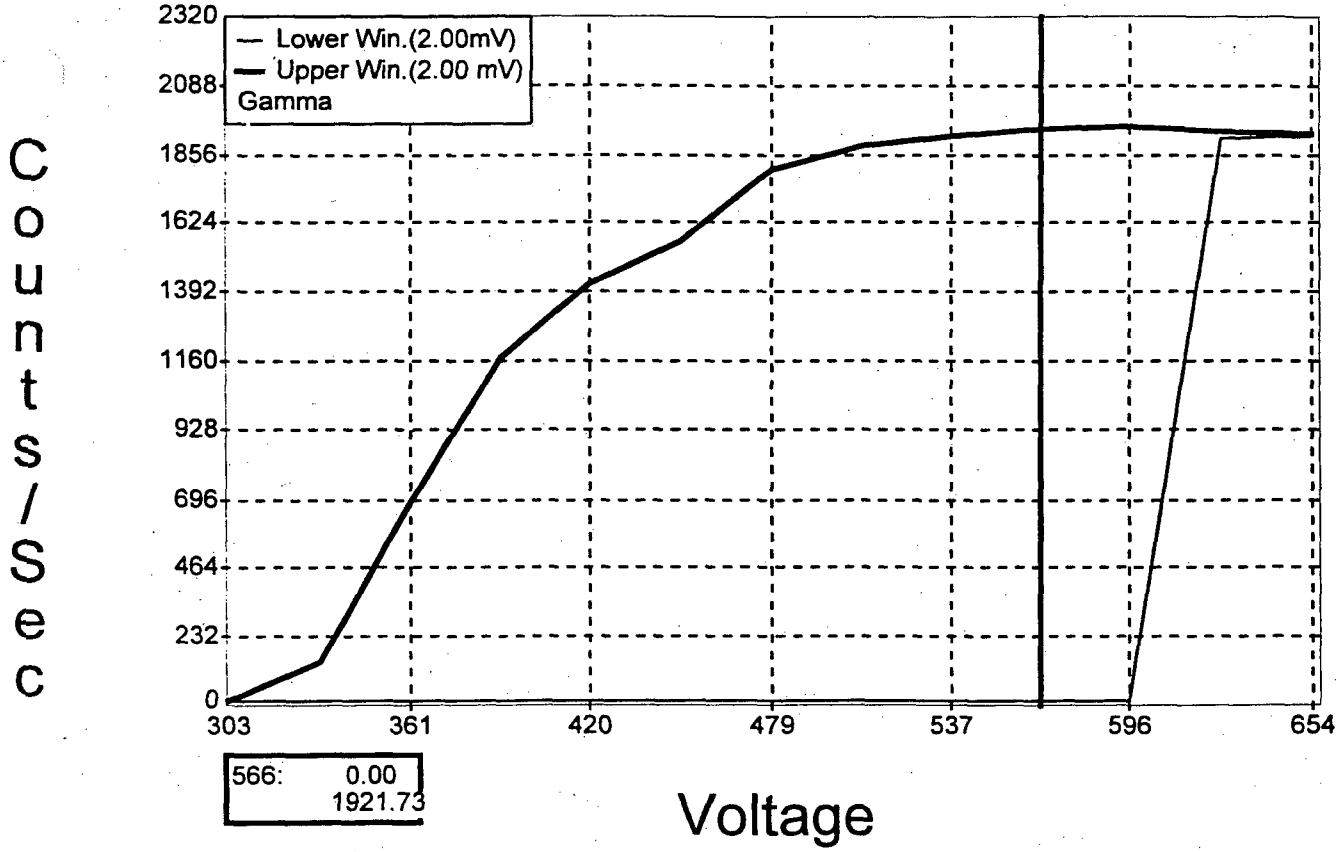
Response Test Range: 7.84 - 11.76 μR/hr

Remarks:
This Calibration is Traceable to the National Institute of Standards and Technology.
Response Tested with Cs-137, SN: CS-12.

Performed By: [illegible] Reviewed By: Hugo Bianchi

Report Number: 032797723416

SPA-8 723416
Voltage Plateau Curve



EBERLINE E-600 CALIBRATION REPORT

Date: 03/27/97 **OUIC: W4GV91**
Standard: Model 81 **Isotope: Cs-137** **SN: 7140**
Type of Calibration: Source

E-600 Serial Number	**916**
Program Version	E600 V3.06
Calibration Date	03/27/97
Calibration Due Date	09/22/97
Scaler Precision	10%
Lower Threshold Slope	0.9231
Lower Threshold Intercept	-0.2256 mV
Upper Threshold Slope	0.9741
Upper Threshold Intercept	-0.6963 mV
Alarm Editing	Enabled
Latching Alarms	Enabled
Auto Ranging	Enabled
Beep on Auto-Range	No
Ignore E-600 Cal. Date	No
Ignore Probe Cal. Date	No
Ratemeter Mode Support	Enabled
Integrate Mode Support	Enabled
Scaler Mode Support	Enabled
Peak Hold Mode Support	Enabled
Background Update Mode Support	Enabled
Log ID Source	Internal/Aux.
Star Key Ratemeter Function	Zero Display
Star Key Integrate Function	Zero Display
Scaler Display Units	Rate
Scaler Counting Mode	Fixed Time

Smart Probe Serial Number	**723414**
Type	S-SPA-8
Calibration Date	03/27/97
Calibration Due Date	09/22/97
Dead Time	21.5 usec
Surface Area	5.00 cm2
Max High Voltage	1500 Vdc
Overrange	45000 cps

Channel 1

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	508 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.13E+10 counts/R
Scaler Time	60 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Channel 2

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	508 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.13E+10 counts/R
Scaler Time	60 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Channel 3

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	508 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.13E+10 counts/R
Scaler Time	60 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Gamma Channel Linearity Test Results - Pass Tolerance Plus/Minus 10.0%

Field	Response	%Error	Pass/Fail
0.0041 R/hr	0.0038 R/hr	-7.27%	Pass
0.0004 R/hr	0.0004 R/hr	-7.25%	Pass
5.42E-05 R/hr	5.95E-05 R/hr	9.84%	Pass

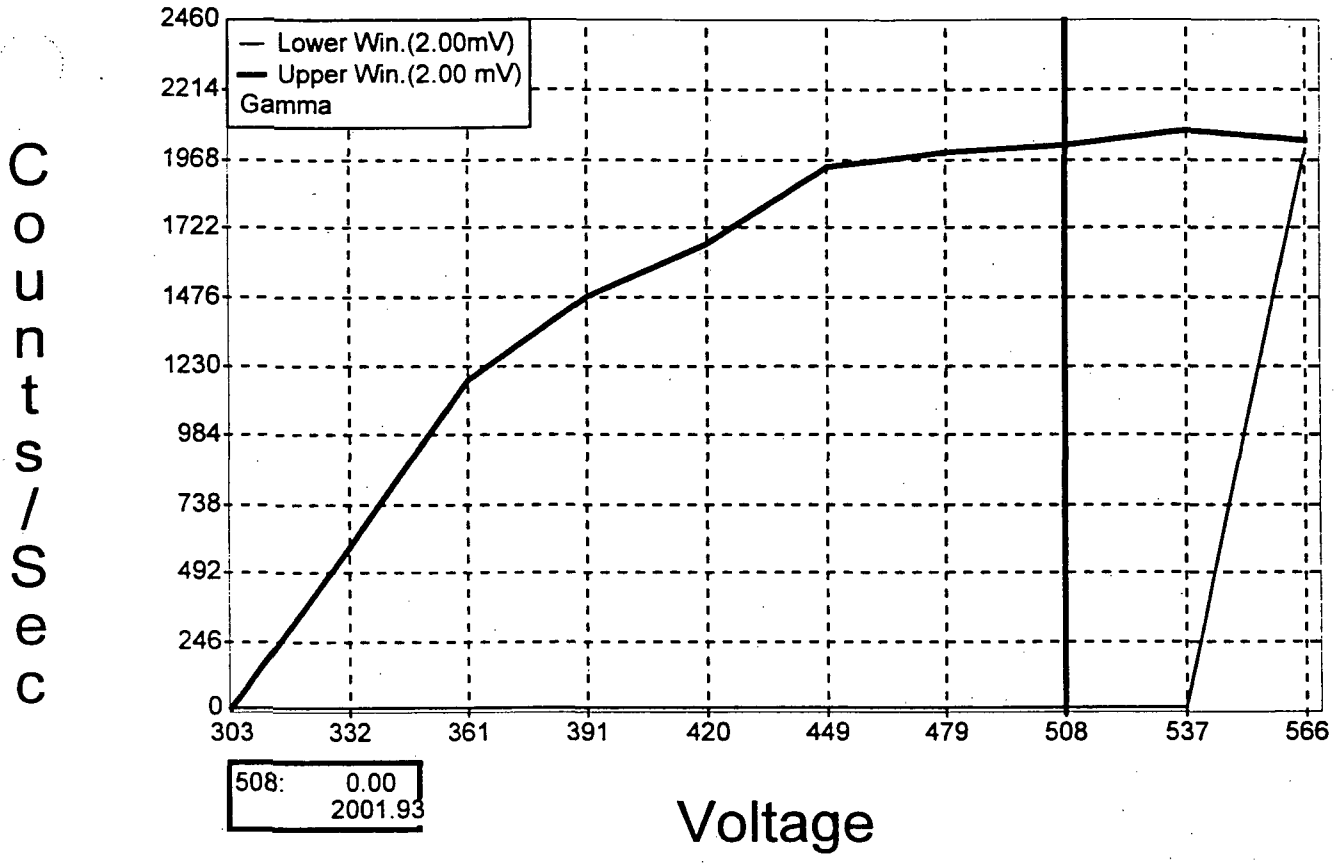
Response Test Range: 7.80 - 11.70 μR/hr

Remarks:
This Calibration is Traceable to the National Institute of Standards and Technology.
Response Tested with Cs-137, SN: CS-12.

Performed By: Bud [illegible] Reviewed By: Hugo Bianchi

Report Number: 032797723414

SPA-8
Voltage Plateau Curve



EBERLINE E-600 CALIBRATION REPORT

Date: 03/27/97 **OUIC: W4GV91** **Type of Calibration: Source**
Standard: Model 81 **SN: 7140** **Isotope: Cs-137**

E-600 Serial Number	**914**
Program Version	E600 V3.06
Calibration Date	03/27/97
Calibration Due Date	09/22/97
Scaler Precision	10%
Lower Threshold Slope	0.9231
Lower Threshold Intercept	-0.1590 mV
Upper Threshold Slope	0.9556
Upper Threshold Intercept	-0.6222 mV
Alarm Editing	Enabled
Latching Alarms	Enabled
Auto Ranging	Enabled
Beep on Auto-Range	No
Ignore E-600 Cal. Date	No
Ignore Probe Cal. Date	No
Ratemeter Mode Support	Enabled
Integrate Mode Support	Enabled
Scaler Mode Support	Enabled
Peak Hold Mode Support	Enabled
Background Update Mode Support	Enabled
Log ID Source	Internal/Aux.
Star Key Ratemeter Function	Zero Display
Star Key Integrate Function	Zero Display
Scaler Display Units	Rate
Scaler Counting Mode	Fixed Time

Smart Probe Serial Number	**723415**
Type	S-SPA-8
Calibration Date	03/27/97
Calibration Due Date	09/22/97
Dead Time	20.0 usec
Surface Area	5.00 cm2
Max High Voltage	1500 Vdc
Overrange	45000 cps

Channel 1

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	566 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.16E+10 counts/R
Scaler Time	60 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Channel 2

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	566 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.16E+10 counts/R
Scaler Time	10 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Channel 3

Channel Type	Gamma
Rate Units	R/hr
Response Times	20,10,3 secs
High Voltage	566 Vdc
Lower Threshold	2.00 mV
Upper Threshold	2.00 mV
Selected Window	Upper
Upper Cal. Constant	1.16E+10 counts/R
Scaler Time	10 secs
Lower to Upper Crossover	0.0
Upper to Lower Crossover	0.0

Gamma Channel Linearity Test Results - Pass Tolerance Plus/Minus 10.0%

Field	Response	%Error	Pass/Fail
0.0041 R/hr	0.0037 R/hr	-9.73%	Pass
0.0004 R/hr	0.0004 R/hr	-9.06%	Pass
5.42E-05 R/hr	5.53E-05 R/hr	2.02%	Pass

Response Test Range: 7.76 - 11.64 μR/hr

Remarks:
This Calibration is Traceable to the National Institute of Standards and Technology.
Response Tested with Cs-137, SN: CS-12.

Performed By: [illegible] Reviewed By: Hugo Bianchi

Report Number: 032797723415