



Designer and Manufacturer
of
Scientific and Industrial
Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.

501 Oak Street
325-235-5494
Sweetwater, TX 79556, U.S.A.

231 Sam Rayburn Parkway
865-270-8962
Lenoir City, TN 37771, U.S.A.

CUSTOMER CABRERA SERVICES

ORDER NO. 20215924/387735

Mfg. Ludlum Measurements, Inc. Model 2224-1 Serial No. 227246

Mfg. Ludlum Measurements, Inc. Model 43-93 Serial No. PR244549

Cal. Date 7-Feb-13 Cal Due Date 7-Feb-14 Cal. Interval 1 Year Meterface 202-848

Check mark Applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 36 % 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.

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

HV Readout (2 points) Ref./Inst. 500 / 508 V Ref./Inst. 1000 / 988 V

COMMENTS:

Alpha Sens: 120mv Beta Window: 30mv Overload set to simulate light leak.
Beta Sens: 3.5mv Firmware: 390094 HV set with detector not connected.
Th230 SN:E121495 Size:19800dpm, Counts:4109cpm, Background:1cpm, 4pi Eff:20.74%
Tc99 SN:5280 Size:93200dpm, Counts:18309cpm, Background:223cpm, 4pi Eff:19.40%
SrY90 SN:5281 Size:97293dpm, Counts:32411dpm, Background:223cpm, 4pi Eff:33.08%
Ni63 SN:4017 Size:278438dpm, Counts:379cpm, Background:223cpm, 4pi Eff:0.05%
Th230 SN:E121495 Size:10100cpm, Counts:4109cpm, Background:1cpm, 2pi Eff:40.67%
Tc99 SN:5280 Size:58300cpm, Counts:18309cpm, Background:223cpm, 2pi Eff:31.02%
SrY90 SN:5281 Size:68105cpm, Counts:32411dpm, Background:223cpm, 2pi Eff:47.26%
Ni63 SN:4017 Size:139219cpm, Counts:379cpm, Background:223cpm, 2pi Eff:0.11%

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	800k cpm	800	800
x1000	200k cpm	200	200
x100	80k cpm	800	800
x100	20k cpm	200	200
x10	8k cpm	800	800
x10	2k cpm	200	200
x1	800 cpm	800	800
x1	200 cpm	200	200

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

ALL Range(s) Calibrated Electronically

REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	Log Scale	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	800kcpm	799868	799868			
	80kcpm	79988	79988			
	8kcpm	7998	7998			
	800cpm	799	799			
	80cpm	80	80			

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. State of Texas Calibration License No. LO-1963
The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978

Reference Instruments and/or Sources: 059 280 720 734 781 1131 1616 1696 5105 5717CO 5719CO

60646 70897 73410 E551 E552 G112 M565 S-394 S-1054 T-304 T879 T10081 T10082 Y982

Alpha S/N Th230 SN:E121495 Beta S/N Tc99 SN:5280,SrY90 Other _____

m 500 S/N 190566 Oscilloscope S/N _____ Multimeter S/N 86250390

Calibrated By: [Signature] Date 7-FEB-13

Reviewed By: [Signature] Date 8 Feb 13

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



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Bench Test Data For Detector

Detector 43-93 Serial No. PR244549 Order # 20215924/387735
 Customer CABRERA SERVICES Alpha Input Sensitivity 120 mV
 Counter 2224-1 Serial No. 227246 Beta Input Sensitivity 3.5 mV
 Count Time 1Minute Beta Window 30 mV
 Other _____ Distance Source to Detector Surface

High Voltage	Background		Isotope <u>Th230</u> Size <u>19800dpm</u>		Isotope <u>Tl99</u> Size <u>93200dpm</u>		Isotope <u>Si1490</u> Size <u>97293dpm</u>	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
<u>850</u>	<u>1</u>	<u>125</u>	<u>3697</u>	<u>387</u>	<u>27</u>	<u>11236</u>	<u>1</u>	<u>22897</u>
<u>875</u>	<u>1</u>	<u>132</u>	<u>3881</u>	<u>425</u>	<u>31</u>	<u>15726</u>	<u>4</u>	<u>27953</u>
<u>900</u>	<u>1</u>	<u>223</u>	<u>4109</u>	<u>626</u>	<u>24</u>	<u>18309</u>	<u>5</u>	<u>32411</u>
<u>925</u>	<u>0</u>	<u>269</u>	<u>4003</u>	<u>750</u>	<u>36</u>	<u>21232</u>	<u>12</u>	<u>35045</u>

- Gas Proportional detector count rate decreased \leq 10% after 15 hour static test using 39" cable.
- Gas proportional detector count rate decreased \leq 10% after 5 hour static test using 39" cable and alpha/beta counter.

Signature *Jan F...* Date 7 Feb. 13