

Appendix B

Appendix B Radiological Calculations and Calibrations

REACTOR PRESSURE VESSEL EXTERNAL DOSE RATE

A gamma dose rate measurement was taken at the Reactor Pressure Vessel (RPV) external wall near the core mid-height location. The reading was 7 mR/hour, as measured on inside wall of the Neutron Shield Tank. This dose is attributable to the residual Co-60, which was estimated from previous analytical analysis to be 1108 curies distributed throughout the internals and structural components of the RPV. Though other nuclides are known to reside in the RPV, only the gamma rays from Co-60 (1.17 and 1.32 MeV) are sufficiently energetic to penetrate the thermal shields and RPV wall, resulting in measurable doses above background external to the vessel.

Other isotopes within the RPV that contribute to the total curie content include Ni-59 and Ni-63 with trace amounts of Fe-55, C-14, and Nb-94. Ni-59 decays by electron capture and emits K-shell X-rays with a maximum energy of 8 keV. The large attenuation coefficients in stainless and carbon steel resulting from the photoelectric effect for these low energy photons would preclude their contribution to dose rates external to the vessel. Ni-63 decays by beta emission with an average beta energy of 17 keV. Even if it is conservatively assumed that all beta energies are converted to radiation by deceleration in the electric field of a nucleus (bremsstahlung), as with Ni-59, the emitted photons would not penetrate the vessel wall.

In addition, the carbon steel RPV contains no natural nickel or cobalt that would have been activated during reactor operation. Previous calculations also showed that the thin stainless steel liner on the interior of the vessel contributes negligible activity to the current internal curie content.

The distribution of Co-60 activation in the RPV is heterogeneous, being dependent on stainless steel location, geometry, and neutron thermal flux profiles in the reactor during operation. The core basket and upper and lower transition nozzles comprise over 80% of the total Co-60 curie content in the vessel. The core barrel and inner and outer shield are intended to reduce the total neutron fluence on the RPV wall, thereby limiting degradation of the vessel's ability to endure abnormal transients.



An estimate of dose rate at the exterior of the RPV was made using a point source approximation located at the centerline of the vessel at the core mid-height. Though all internals and structural components provide some absorption and attenuation of Co-60 gamma photons, primarily through Compton scattering, shielding credit was taken only for the inner and outer shield, core barrel, RPV wall and steel annulus external to the RPV where the dose measurement was taken.

Appendix B

The following formula was used to estimate the exposure rate from a point that emits gamma rays:

$$D (R/hour) = 0.5 C E/r^2$$
,

where

- C = activity in curies = 1108 curies from previous analysis,
- E = gamma energy in MeV = 1.17 MeV + 1.32 MeV = 2.49 MeV,
 (Note: Co-60 emits two gamma rays in over 99% of its disintegrations)
- r = distance from point source in meters = 1.12 m,

 $D_{0} = 1108 \text{ R/hour.}$

Using this quantity for the gamma flux incident on the slab shield formed by the inner and outer shield, core barrel, RPV wall and steel annulus for insulation containment, the exposure dose external to the RPV was calculated using the formula for uncollided gamma flux multiplied by a suitable buildup factor:

D (measurement point)/D_o = B(E, μ t) e^{- μ t},

where

- μ = energy-dependent linear attenuation coefficient for steel = 0.395 /cm,
- t = thickness of shield material between reference point and measurement point = 9.82 cm,
- B = buildup factor dependent on gamma energy (E) and relaxation lengths (μ t)= 10.

Substituting these values in the above equation and solving for D:

$$D = 85 \text{ mR/hour}$$
.



CRUD ANALYSIS

Smears of the interior piping of the primary system were taken at the entrance to the port and starboard side steam generators by removing access covers. A total of five smear samples was obtained from inlet of each steam generator hot leg, including three in the vicinity of the access cover, one on the interior of the access cover, and one at the tube sheet entrance. The principal isotope in the crud was confirmed to be Co-60 through use of gamma spectroscopy.

All 10 smears were counted on the Ludlum 2929 counter (#2). The smear taken at the port side tube sheet had a count rate 2.3 higher than any of the other nine smears and was used for crud analysis.

Net count rate = 78,764 counts per minute (cpm) Counter efficiency = 20.8%

All smears were assumed to be 100 cm^2 , so the activity level in disintegrations per second (dps) is:

 $78,764/0.208 = 378,673 \text{ dpm}/100 \text{ cm}^2 \times 60 \text{ sec/min} = 6311 \text{ dps}/100 \text{ cm}^2$.

1 curie = 3.7E10 dps .

Activity = $6311 \text{ dps}/100 \text{ cm}^2 \text{ x} 3.7\text{E}10 = 1.71\text{E}-9 \text{ C/cm}^2$.

Assuming this crud concentration to be uniformly distributed over the interior surface of the reactor pressure vessel:

Reactor Pressure Vessel dimensions = 27 ft. H x 8 ft. D . Surface area = $6.79E2 \text{ ft}^2 \times 9.29E2 \text{ cm}^2/\text{ft}^2 = 6.30E5 \text{ cm}^2$.

Activity = $(1.71E-9 \text{ C/cm}^2) \times (6.30E5 \text{ cm}^2) = 1.08E-3 \text{ C} \sim 1 \text{ mC}$.

This is a negligible quantity compared to the total estimated activity level in the pressure vessel of 4066 curies.



Smear/Air Sample Counting LLD, MDA, and Activity Determinations

Each counter's average background count rate was determined and source efficiency tests performed. Background and source counts were based on a series of 20-minute counts. Results were as follows:

Counter #1

Alp	ha	Beta				
Background	Efficiency	Background	Efficiency			
0.325 cpm	33.6%	39.2 cpm	25.2%			

Counter #2

Alp	ha	Beta			
Background	Efficiency	Background	Efficiency		
0.525 cpm	31.2%	42.15 cpm	20.8%		

Lower limit of detection (LLD) (also referred to as net minimum detectable count rate [MDCR]) and minimum detectable activity (MDA) calculations were performed for several counting times based on NUREG/CR-4007.

MDA (dpm) = LLD

Fff

LLD (net cpm) =
$$2.71 + (3.29) / \frac{R_b (t_s) (t_s + t_B)}{t_B}$$

where:

- R_b = background count rate (cpm),
- $t_{\rm B}$ = background count time (min),
- t_s = sample count time (min).

Gross minimum detectable counts were determined for each count time by the following formula.

$$MDC = t_{S} [net MDCR (cpm) + background (cpm)]$$

For air samples of 100 ft³ volume, MDA concentration in μ Ci/cc were calculated for appropriate counting times using the following formula:



MDA (μ Ci/cc) = MDA(dpm) 1 μ Ci 1 ft³ 1 L (2.22E6 dpm) (100 ft³) (28.32 L) 1000 cc

Results for all the above calculations for each counter are tabulated in the following charts.

Counter # 1 (Serial #102001)								
	ŀ	Alpha			Beta			
	Count	time (mir	nute)			Net MDCR		
Count	Net	Gross	MDA	Air	Net	Gross	MDA	Air MDA**
time	MDCR	MDC	(dpm)	MDA**	MDCR	MDC	(dpm)	(µCi/cc)
(minutes)	(cpm)			(µCi/cc)	(cpm)			
60	0.529	51	1.57	2.5E ⁻¹³	5.35	2673	21.2	3.4E ⁻¹²
30	0.632	28	1.88	2.99E ⁻¹³	6.03	1357	23.9	3.8E ⁻¹²
10	0.997	13	2.97	4.7E ⁻¹³	8.2	474	32.5	5.2E ⁻¹²
1	4.63	5	13.78	-	23.8	63	94.4	1.5E ⁻¹¹
0.5	8.1	4	24.1	-	34.9	37	139	-

** For 100-ft³ samples only.

Counter #2 (Serial #160019)								
		Alpha				Beta		
	Count	time (mi	nute)			Net M	DCR (cpr	n)
Count	Net	Gross	MDA	Air	Net	Gross	MDA	Air MDA**
time in	MDCR	MDC	(dpm)	MDA**	MDCR	MDC	(dpm)	µCi/cc
(minutes)	(cpm)			(µCi/cc)	(cpm)			
60	0.66	71	2.12	3.36E ⁻¹³	5.56	2862	26.7	4.25E ⁻¹²
30	0.779	39	2.50	3.97E ⁻¹³	6.26	1452	30.1	4.79E ⁻¹²
10	1.19	17	3.81	6.07E ⁻¹³	8.54	506	41.1	6.53E ⁻¹²
1	5.15	6	16.52	-	24.6	66	118	1.88E ⁻¹¹
0.5	8.8	4	28.3	-	36	39	173	_

** For 100-ft³ samples only.

Smear Activity Determination

When count rates exceed LLD values, smear activity is determined as follows.

Where net cpm = <u>gross count</u> – background cpm count time

Values for LLD and smear scanning trigger levels are tabulated below.



Counter #1

Beta counts								
1-minu	ute count	30-second count						
Gross count	Activity (dpm)	Gross count	Activity (dpm)					
63	95 (MDA)	37	139 (MDA)					
165	500	82	500					
291	1000	145	1000					
Alpha counts								
1-minu	ute count	30-second count						
Gross count	Activity (dpm)	Gross count	Activity (dpm)					
5	14 (MDA)	4	24 (MDA)					
7	20	16	100					
33	33 100		-					

Counter #2

Beta counts							
1-minu	ute count	30-seco	nd count				
Gross count	Activity (dpm)	Gross count	Activity (dpm)				
66	118 (MDA)	39	173 (MDA)				
146	500	73	500				
250	1000	125	1000				
Alpha counts							
1-minu	ute count	30-second count					
Gross count	Activity (dpm)	Gross count	Activity (dpm)				
5	16 (MDA)	4	28 (MDA)				
6	20	15	100				
31	100	-	-				



Air Sample Activity Determinations

When count rates exceed LLD values, air sample activity is determined as follows:

Activity (μ Ci/cc) = <u>net cpm</u> 1 μ Ci Eff 2.22E6 dpm volume (cc)

For 100-ft³ (2.832E⁶-cc) air samples, the net count rate can be inserted into the following instrument-specific equations as applicable.

Counter #1

Alpha airborne activity (μ Ci/cc) = (net cpm) x (4.73E⁻¹³). Beta airborne activity (μ Ci/cc) = (net cpm) x (6.31E⁻¹³).

Counter #2

Alpha airborne activity (μ Ci/cc) = (net cpm) x (5.1E⁻¹³). Beta airborne activity (μ Ci/cc) = (net cpm) x (7.65E⁻¹³).

Instrument Calibration and Use Logs are attached to this appendix.



(×41 2-24-03

Duratek Instrument Services 628 Gallaher Road Kingston, TN 37763 Phone: (865) 376-8337 Fax: (865) 376-8331

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

CUSTOMER INFORMATION				INSTRUMENT INFORMATION				
Customer Name: Duratek Instrument Services				Manufacturer:	: Ludlum	/		
Address: 628 Gal	laher Rd Kingston, TN 377	/63 '		Model: 19	Serial Number: 95469			
Contact Name: T	homas F. Scott		1	Probe: N/A	N/A Serial Number: N/A			
Customer Purchas	se	Work Orde	er	Calibration Mo	ethod:			
Order Number: N	<u>/A</u>	Number: 20	005-02653	Electro	Electronic And Source			
		TRUMENT CA	LIBRATIO	N INFORMAT	TION			
Range	Calibration Standard	Tolerances	lnst Re	rument sponse	Com	ments		
(µR/hr)	Value	(µR/hr)	As Found (µR/hr)	As Left (µR/hr)	Calibrated in accorda CP-IN-WI-211 Rev 1	nce with		
5000	4000 μR/hr	3600 - 4400	*N/A	3800	Pulser: 101500	Cal Due: 09/24/05		
Black	2500 μR/hr	2250 - 2750	*N/A	2500	D-812: 2816	Cal Due: 04/15/05		
	1000 μR/hr	900 - 1100	*N/A	1000	DVM: TW12663	Cal Due: 03/22/05		
	400 μR/hr	360 - 440	*N/A	390	DTH-1A: 100799	Cal Due: 11/11/05		
500 Black	250 μR/hr	225 - 275	*N/A	250				
	100 μR/hr	90 - 110	*N/A	100	Temp: 20.5°C	Humidity: 31%		
	Input cpm = 32,600	180 - 220	*N/A	195	Pressure: 742mmHg			
250 Red	Input cpm = 19,500	108 - 132	*N/A	120				
	Input cpm = 8,150	45 - 55	*N/A	50	Geotropism: SAT	Over Range: SAT		
	Input cpm = 6,560	36 - 44	*N/A	39.5	Batteries: SAT	Mech. Zero: SAT		
50 Black	Input cpm = 4,090	22.5 – 27.5	*N/A	25	F/S Response: SAT	Audio: SAT		
	Input cpm = 1,440	9 - 11	*N/A	10	Light: SAT	Precision Test: SAT		
	Input cpm = 3,260	18 - 22	*N/A	19.5	Source: Cs-137 04971	1 Cert. Date: 04/09/04		
25 Red	Input cpm = 1,956	10.8 – 13.2	*N/A	12	High Voltage As Found: 800V As Left: 725V			
	Input cpm = 815	4.5 – 5.5	*N/A	5	cpm/µR/hr: As Found	l: 192 As Left: 163		
COMMENTS								
	Special	Remarks: High '	Voltage: 725	Volts com/uR/	/hr: 163			

* All As Founds off by more than 20% due to HV being set outside of correct plateau voltage setting.

STATEMENT OF CERTIFICATION

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

Instrument

Calibrated By:

Calibration Date: 03/18/05

Reviewed By: Limos F Date: 3-18-05

Calibration Due: 03/18/06r

LUDLUM 19 HIGH VOLTAGE PLATEAU DATA SHEET

Date: 03/18/05

Serial Number: 95469

High Voltage	Background	uR/hr
575	2	190
600	2	1600
625	3	2200
650	3	2900
675	4	3500
700	4	4100
725 (SET)	5	4600
750	6	4600
775	7	4900
800	9	offscale

* Source Geometry on contact with Detector-Cs137 #019455 @ 5uCi*

Performed By: Mike Aul' Date: 3-18-05 Reviewed By: *June Reviewed* By: *June Reviewed* By: *June Reviewed* Date: 3-18-05



R/1 3-24-05

Duratek Instrument Services 628 Gallaher Road Kingston, TN 37763 Phone: (865) 376-8337 Fax: (865) 376-8331

CUSTOMER INFORMATION				INSTRUMENT INFORMATION			
Customer Name: Duratek Instrument Services				Manufacturer:	lanufacturer: Ludlum		
Address: 628 Gallaher Rd Kingston, TN 37763				Model: 19	Serial Number: 95499	/	
Contact Name: T	homas F. Scott			Probe: N/A	Serial Number: N/A		
Customer Purchas	ie	Work Orde	r	Calibration Me	ethod:		
Order Number: N		Number: 20	105-02653	Electro	nic And Source		
- Le	Пл9	I KUMENI CA	Inst				
Range	Calibration Standard	Tolerances	Re	sponse	Comi	nents	
(µ R/hr)	Value	(µR/hr)	As Found	As Left	Calibrated in accorda	nce with	
			(µR/hr)	<u>(μR/hr)</u>	CP-IN-WI-211 Rev 1		
5000	4000 μR/hr	3600 - 4400	3800	3800	Pulser: 101500	Cal Due: 09/24/05	
Black	2500 μR/hr	2250 - 2750	2450	2450	D-812: 2816	Cal Due: 04/15/05	
	1000 µR/hr	900 - 1100	950	950	DVM: TW12663	Cal Due: 03/22/05	
	400 μR/hr	360 - 440	400	400	DTH-1A: 100799	Cal Due: 11/11/05	
500 Black	250 μR/hr	225 - 275	250	250			
	100 μR/hr	90 - 110	105	105	Temp: 20.5°C	Humidity: 31%	
	Input cpm = 40,000	180 - 220	205	205	Pressure: 742mmHg		
250 Red	Input cpm = 24,000	108 - 132	120	120			
	Input cpm = 10,000	45 - 55	50	50	Geotropism: SAT	Over Range: SAT	
	Input cpm = 7,880	36 - 44	40	40	Batteries: SAT	Mech. Zero: SAT	
50 Black	Input cpm = 4,990	22.5 – 27.5	25	25	F/S Response: SAT	Audio: SAT	
	Input cpm = 1,960	9 - 11	10	10	Light: SAT	Precision Test: SAT	
	Input cpm = 4,000	18 – 22	20	20	Source: Cs-137 04971	1 Cert. Date: 04/09/04	
25 Red	Input cpm = 2,400	10.8 - 13.2	12	12	High V As Found: 650V	/oltage As Left: 650V	
	Input cpm = 1,000	4.5 - 5.5	5	5	cpm/µR/hr: As Found	i: 194 As Left: 200	
		C	COMMENTS				
	Specia	l Remarks: High V	Voltage: 650	Volts cpm/µR/	hr: 200		
· · ·		STATEMENT	r of cert	IFICATION			
We Certify that the inst further certify that our shipment or use of this	rument listed above was calibrate Calibration Measurements are tra	ed and inspected prior aceable to the National	to shipment and Institute of Star	that it met all the M ndards and Technolo	anufacturers published opera gy. (We are not responsible f	ting specifications. We or damage incurred during	
Instrument				\sim			
Calibrated By:	M. Paul.	Reviewed B	x Clon	as (5. Area	Date:	3-18-05	
Calibration Date: 03/18/05				Calibration Du	e: 03/18/06		



(164P 3-24-05

Duratek Instrument Services 628 Gallaher Road Kingston, TN 37763 Phone: (865) 376-8337 Fax: (865) 376-8331

CUSTOMER INFORMATION				INSTRUMENT INFORMATION			
Customer Name: Duratek Instrument Services				Manufacturer: Ludlum			
Address: 628 Gallaher Rd Kingston, TN 37763				Model: 19	Serial Number: 42972		
Contact Name: T	homas F. Scott			Probe: N/A	Serial Number: N/A		
Customer Purchas	se	Work Orde	r	Calibration Mo	ethod:		
Order Number: N	/A	I Number: 20	105-02653	Electro	onic And Source		
		INUMENICA	LIDAA I IU				
Range	Calibration Standard	Tolerances	Re	sponse	Com	ments	
(µR/hr)	Value	(µR/hr)	As Found	As Left	Calibrated in accorda	nce with	
····			(µR/hr)	(µR/hr)	CP-IN-WI-211 Rev 1		
5000	4000 μR/hr	3600 - 4400	3950	3950	Pulser: 101500	Cal Due: 09/24/05	
Black	2500 μR/hr	2250 - 2750	2500	2500	D-812: 2816	Cal Due: 04/15/05	
	1000 µR/br	900 - 1100	1000	1000	DVM: TW12663	Cal Due: 03/22/05	
700	400 µR/hr	360 - 440	410	380	DTH-1A: 100799	Cal Due: 11/11/05	
500 Black	250 μR/hr	225 - 275	260	250			
	100 µR/hr	90 - 110	110	105	Temp: 20.5°C	Humidity: 31%	
	Input cpm = 42,000	180 - 220	200	200	Pressure: 742mmHg		
250 Red	Input cpm = 25,200	108 - 132	120	120			
	Input cpm = 10,500	45 - 55	50	50	Geotropism: SAT	Over Range: SAT	
	Input cpm = 8,450	36 - 44	40	40	Batteries: SAT	Mech. Zero: SAT	
50 Black	Input cpm = 5,240	22.5 – 27.5	25	25	F/S Response: SAT	Audio: SAT	
	Input cpm = 2,070	9 - 11	10	10	Light: SAT	Precision Test: SAT	
	Input cpm = 4,200	18 – 22	20	20	Source: Cs-137 04971	l Cert. Date: 04/09/04	
25 Red	Input cpm = 2,520	10.8 - 13.2	12	12	High V As Found: 660V	/oltage As Left: 660V	
	Input cpm = 1,050	4.5 - 5.5	5	5	cpm/µR/hr: As Found	l: 213 As Left: 210	
	- -	C	OMMENTS				
	Specia	l Remarks: High V	oltage: 660	Volts cpm/µR/	hr: 210		
		STATEMENT	OF CERT	IFICATION			
We Certify that the inst further certify that our f	rument listed above was calibrate	ed and inspected prior t	to shipment and	that it met all the M	anufacturers published operating	ting specifications. We	
shipment or use of this i	instrument).		Institute of Star	Marus anu 1 CUIII010	BY. (WE are not responsible in	or cannage incurred during	
Instrument							
Calibrated By:	M'. Paul	Reviewed B	y: Clon	e (- A	al Date:	3-18-05	
Calibration Date:	03/18/05			Calibration Du	e: 03/18/06		



)(W 3-24-05

Duratek Instrument Services 628 Gallaher Road Kingston, TN 37763 Phone: (865) 376-8337 Fax: (865) 376-8331

CUSTOMER INFORMATION				INSTRUMENT INFORMATION			
Customer Name: Duratek Instrument Services				Manufacturer: Ludlum			
Address: 628 Gallaher Road, Kingston, TN 37763				Model: 12	Serial Number: 91037		
Contact Name: Thom:	as Scott			Probe: 44-9	Serial Number: N/A		
Contract/Task		Work Orde	er	Calibration Me	thod:		
Number: N/A		Number: 2	2005-02626	TON INFORM	Electronic and Sol	urce	
	INS	IRUME	VI CALIBRAI	ION INFORM			
			Instrumen	t Response	Response Comments		
Instrument Range	Calibration Standar	rd Value	Before Calibration	After Calibration	Calibrated in accordan Manual	ce with OEM Technical	
X1	100		100	100	Pulser: 101500	Cal Due: 09/24/05	
X 1	250		250	250	D-812: 2816	Cal Due: 04/15/05	
X 1	400		400	400	DTH-1A: 100799	Cal Due: 11/11/05	
X 10	1,000		1,000	1,000			
X 10	2,500		2,500	2,500	Temperature: 23.0 °C		
X 10	4,000		4,000	4,000	Pressure: 738mmH	Ig	
X 100	10,000		10,000	10,000	Humidity: 23%		
X 100	25;000		25,000	25,000			
X 100	40,000		40,000	40,000			
	100,000-		100,000	100,000	Audio: SAT	Batt. Check: SAT	
X 1000	250,000		- 250,000	250,000	Fast/Slow: SAT	Reset: SAT	
X 1000	400,000		400,000	400,000	HV Pushbutton: SAT	Overange: SAT	
	EFFICIENCY DE?	FERMINA	TION		Geotropism: SAT		
Instrument Range	Source ID and V	/alue	Net cpm	Efficiency	Background: 50cpm	Threshold: 35mV	
EFF X1	Tc-99#119720 at 2,	562dpm	290	11.3%			
EFF X10	Tc-99#119718 at 20,	,520dpm	2,600	12.7%			
EFF X100	Tc-99#109408 at 259	9,518dpm	29,950	11.5%			
Average	N/A		N/A	11.8	Limited Use: X1000 Sc Use with 44-9.	ale for information only.	
High Voltage	900V		897V	897V			
a.		STAT	EMENT OF CI	ERTIFICATIO	N		
We Certify that the instrum further certify that our Calil during shipment or use of the	ent listed above was calibra bration Measurements are tr his instrument).	ted and inspe aceable to th	ected prior to shipme e National Institute	ent and that it met al of Standards and Te	l the Manufacturers published chnology. (We are not respon	l operating specifications. We sible for damage incurred	
Lastrument Calibrated By: Mille Pauli Reviewed By: Clames (T. Acalt Date: 3-10-05 V						3-10-051	
Calibration Date: 03/10/05				Calibration Du	ie: 03/10/06 🖌		





CUS	TOMER INFORMATION	INSTRUMENT INFORMATION				
Customer Name: Durat	tek Instrument Services	Manufacturer: Ludlum				
Address: 628 Gallaber R	load, Kingston, TN 37763		Model: 12	Serial Number: 75809 🗸		
Contact Name: Thomas	s Scott		Probe: 44-9-	Serial Number: N/A		
Contract/Task	Work Orde	r	Calibration Me	thod:		
Number: N/A	Number: 2	005-02626		Electronic and Source		
	INSTRUMEN	T CALIBRA				
		Instrumen	t Response	Comments		
Instrument Range	Calibration Standard Value	Before Calibration	After Calibration	Calibrated in accordance with OEM Technical Manual		
X 1	100	100	100	Pulser: 101500 Cal Due: 09/24/05		
X 1	250	250	250	D-812: 2816 Cal Due: 04/15/05		
X1	400	400	400	DTH-1A: 100799 Cal Due: 11/11/05		
X 10	1,000	1,000	1,000			
X 10	2,500	2,500	2,500	Temperature: 23.0 °C		
X 10	4,000	4,000	4,000	Pressure: 738mmHg		
X 100	10,000	10,000	10,000	Humidity: 23%		
X 100	25,000	25,000	25,000			
X 100	40,000	40,000	40,000			
X 1000	100,000	100,000	100,000	Audio: SAT Batt. Check: SAT		
X 1000	250,000	250,000	250,000	Fast/Slow: SAT Reset: SAT		
X 1000	400,000	400,000	400,000	HV Pushbutton: SAT Overange: SAT		
	EFFICIENCY DETERMINA	TION		Geotropism: SAT		
Instrument Range	Source ID and Value	Net cpm	Efficiency	Background: 40cpm Threshold: 36mV		
EFF X1	Tc-99#119720 at 2,562dpm	305	11.9%			
EFF X10	Tc-99#119718 at 20,520dpm	2,460	12.0%			
EFF X100	Tc-99#109408 at 259,518dpm	29,460	11.4%	The Mail Mark W1000 Carls for information only		
Average	N/A	N/A	11.8%	Use with 44-9.		
High Voltage	900V	901V	901V			
	STAT	EMENT OF C	ERTIFICATIO)N		
We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all the Manufacturers published operating specifications. further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred						
Instrument Mile Pili Barianad Pur Ange Angel Date: 270-05						
Calibrated By: 1V	0/05	uy	Calibration D	ue: 03/10/06		
Canor acion Date. 05/1	v, vv		1			



84P 3-24-05

Duratek Instrument Services 628 Gallaher Road Kingston, TN 37763 Phone: (865) 376-8337 Fax: (865) 376-8331

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

5

CUST	OMER INFORMATIC	ON	INSTRUMENT INFORMATION			
Customer Name: Durate	k Instrument Services		Manufacturer:	Ludlum	/	
Address: 628 Gallaher R	oad, Kingston, TN 37763		Model: 3	Serial Number: 97416		
Contact Name: Thomas J	F. Scott		Probe: 44-9	Serial Number: N/A		
Contract/Task Number: N/A	W	Vork Order Tumber: 2005-02626	Calibration Me	thod: Electronic and Sou	irce	
	INSTRU	UMENT CALIBRA	TION INFORM	IATION		
		Instrumo	-+ Domoneo	Com	mante	
Instrument Range	Calibration Standard V	alue Before	After	Calibrated in accordance	e with	
mon ament Range		Calibration	Calibration	CP-IN-WI-219, Rev.0.		
X0.1	100	100	100	Pulser: 101500	Cal Due: 09/24/05	
X0.1	250	250	250	DVM: TW12663	Cal Due: 03/22/05	
X0.1	400	400	400	D-812: 2816	Cal Due: 04/15/05	
X 1	1,000	1,000	1,000	DTH-1A: 100799	Cal Due: 11/11/05	
X1	2,500	2,500	2,500	-		
X 1	4,000	4,000	4,000	Temperature: 23.0 °	С	
X10	10,000	10,000	10,000	Pressure: 738 mmH	g	
X10	25,000	25,000	25,000	Humidity: 23 %		
X10	40,000	40,000	40,000			
X100	100,000	100,000	100,000	Audio: SAT	Batt. Check: SAT	
X100	250,000	250,000	250,000	Fast/Slow: SAT	Reset: SAT	
X100	400,000	400,000	400,000	Background: 40 cpm	Threshold: 35mV	
	EFFICIENCY DETERM	MINATION*		Overange: SAT		
Instrument Range	Source ID and Value	e Net cpm	Efficiency	* Efficiency determined	~¼ " from 45 mm disc.	
EFF X1	Tc-99#119720 at 2,562d	dpm 260	10.1%			
EFF X10	Tc-99#119718 at 20,520c	dpm 2,260	11.0%			
EFF X100	Tc-99#109408 at 259,518	8dpm 29,460	11.4%			
Average Efficiency	N/A	N/A	%	Limited Use: X100 Scale Use with 44-9.	e for information only.	
High Voltage	900V (±5%)	902V	902V			
	S	TATEMENT OF C	ERTIFICATIO	N		
We Certify that the instrumen further certify that our Calibra during shipment or use of this	t listed above was calibrated an ation Measurements are traceable instrument).	nd inspected prior to shipn ble to the National Institute	ent and that it met al of Standards and Te	I the Manufacturers published chnology. (We are not respons	operating specifications. We ible for damage incurred	
Instrument			\sim			
		\sim		with Date	3-10-05	
Calibrated By: Nu	Allan K	keviewed By: OC	Calibration Du		<i>) 70 °</i> 0	
Calloration Date: 03/10	1 U J		I CAUNIALION DU	N. 43/ 14/00 P		



Duratek Instrument Services 528 Gallaher Road Kingston, TN 37763 Phone: (865) 376-8337 Fax: (865) 376-8331

	CUSTOMER IN	FORMATION		INSTRUMENT INFORMATION			
Customer Name:	Duratek Instrumen	t Services		Manufacturer: A	utomess		
Address: 628 Ga	llaher Road Kingsto	n, TN. 37763		Model: 6112D	Serial Number: 28991		
Contact Name: T	om Scott			Probe: N/A	Serial Number: N/A		
Contract/Task		Work Order	•	Calibration Metho	d:		
Number: N/A		INSTRUME	- NT CALIBRAT	L ION INFORMAT	Electronic and Source		
Instrument	Desired	**Toloranco	Inst	rument			
Range	Desireu	Tolerance	Re	sponse	Comments		
			Before Calibration	After Calibration	Timer: 02010806 Cal Due: 03/04/05		
		mR/hr	,	1	DVM: TW12662 Cal Due: 03/08/05		
mR/h	1	.80-1.20	1	1	D-812: 2816 Cal Due: 04/15/05		
mR/h	40	32 - 48	42	40	DTH-1A: 100799 Cal Due: 11/11/05		
mR/h	200	160-240	161	170	Sources Used:		
mR/h	616	493-739	530	631	Cs137 019701 Cert. Date: 07/16/04		
					Cs137 019702 Cert. Date: 04/08/04		
		R/hr			Cs137 049711 Cert. Date: 04/09/04		
R/h	1.88	1.50 - 2.26	2.1	1.9	Temp: 24.1 °C Humidity: 36 %		
R/h	21.1	16.9 - 25.3	23.3	21.7	Pressure: 738 mmHg		
R/h	98	78.4 -118	111	116	**Per manufacturer manual, instrument precision is ± 20%.		
R/h	360	288-432	390	344	Geotropism: N/A		
R/h	720	576 - 864	806	700	Sensitivity Check: SAT		
]	mR (Exposure Rate)		****	Batteries: SAT		
mR	10.2	8.2 – 12.3	11	11	Over Range: SAT		
	Exposed to	616 mR/hr field for 6	0 seconds		Precision Test: SAT		
		High Voltage			Digital Zero: SAT		
HV	#-600 vdc	#-600	-546	-546	* Returned repaired from Eberline.		
-		STATI	EMENT OF CE	RTIFICATION			
We Certify that the in certify that our Calibr or use of this instrume	We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment						
Instrument			/	ل			
Calibrated By:	Altrafte	Reviewed By:	into (T-+	Selt	Date: 5 - 15 - 95		
Calibration Date:	02/14/05			Calibration Due: 02/14/06			



WPI - Richmond Office

11 S. 12th Street – Suite 210 Richmond, VA 23219 Tel: (804) 783-0183 Fax: (804) 783-0185



DBR-1 Reader Calibration Certificate

DBR-1 Reader Serial Number:	230011
ROM Version:	1.02
RAM Version:	1.16.53
Calibration Plug Serial Number:	204024
Calibration Plug Calibration Date:	25Feb2005 / Battery Voltage: 8.9V/8.8V

The Calibration of the DBR-1 Reader was performed in accordance with DBR-1 User's Guide version 1.16, Section 3.4 entitled "Calibrating the DBR-1".

As-Found readings for the DBR-1 Reader were:

Parameter	Reading	Tolerance	Parameter	Reading	Tolerance
G	-2	+/- 26	M	42	+/- 26
R	30	+/- 26	L	2	+/- 26
Н	325	+/- 101	1	110	+/- 5001

As-Left readings for the DBR-1 Reader were:

Parameter	Reading	Tolerance	Parameter	Reading	Tolerance		
G	0	+/- 26	M	0	+/- 26		
R	0	+/- 26	L	0	+/- 26		
Н	12	+/- 101	I	110	+/- 5001		

MARAD Contract # DTMA2P05133 Work Performed In Accordance with WPI's Nuclear QA Manual

Date: <u>014762005</u> Calibrated by: John Bowen Reviewed by:

Robert Pennock



	This Certifica	te will be accomp	anied by Calibrat	bration Charts or Readings where applicable				
C	USTOMER INFO	RMATION		INSTRUMENT INFORMATION				
Customer Name: WI	PI			Manufacturer	: Radeco			
Contact Name: John	n Bowen			Model: H-810DC				
Address: 2000 Kraf	t Drive, Suite 2100, B	lacksburg, VA 2	4060	Serial Number: 0865				
Contract/Task Numb	er: WP105-0079	Work Order :	2005-02636	Calibration M	lethod: Air Flow			
		INSTRUMEN	T CALIBRAT	ION INFORM	IATION			
Instrument Range (LPM)	Standard Value (LPM)	Tolerance (±10%)	As Found	As Left	Comme	ents		
14 - 99	43	39-47	42	42	Barometer: 8029	Cal Due: 12/13/05		
	70	63 - 77	68	68	Thermometer: 8029	Cal Due: 12/13/05		
	93	82 - 102	93	93	Venturi: 8029	Cal Due: 12/13/05		
					DTH-1A: 100799	Cal Due: 11/11/05		
					Temperature: 20.4 °C			
					Pressure: 739mmHg			
					Humidity: 32%			
					Previous Media: N/A			
· · · · · · · · · · · · · · · · · · ·		*****			Current Media: Customer	Provided Glass Fiber		
					Final Range: 14 – 99 LPM			
					Calibrated IAW OEM			
	L	STATE	MENT OF CE	RTIFICATIO	N			
We Certify that the instru- further certify that our C:	iment listed above was ca alibration Measurements :	librated and inspect are traceable to the i	ted prior to shipmen National Institute of	t and that it met all Standards and Tee	the Manufacturers published oper chnology. (We are not responsible	ating specifications. We for damage incurred during		
Instrument	11.15				1			
Calibrated By:	Very	Reviewed By:	(long)	5. ACat Date: 3-22-05				
Calibration Date: 03	11/1/05			Calibration Due: 03/17/06				



	This Certificat	te will be accomp	anied by Calibra	tion Charts or Re	adings where applicable				
CUS	STOMER INFO	RMATION		INSTRUMENT INFORMATION					
Customer Name: WPI				Manufacturer: Radeco					
Contact Name: John B	lowen			Model: H-810DC					
Address: 2000 Kraft D	rive, Suite 2100, Bl	acksburg, VA 2	4060	Serial Number: 0864					
Contract/Task Number:	: WP105-0079	Work Order :	2005-02636	Calibration M	ethod: Air Flow				
1 - Carlos -	n an	INSTRUMEN	T CALIBRAT	ION INFORM	ATION				
Instrument Range (LPM)	Standard Value (LPM)	Tolerance (±10%)	As Found	As Left	Comm	ients			
14 - 99	42	38-46	31	42	Barometer: 8029	Cal Due: 12/13/05			
	68	61 - 75	57	68	Thermometer: 8029	Cal Due: 12/13/05			
	89	80 - 98	82	89	Venturi: 8029	Cal Due: 12/13/05			
					DTH-1A: 100799 Cal Due: 11/11/0				
					Temperature: 20.4 °C				
					Pressure: 739mmHg				
					Humidity: 32%				
					Previous Media: N/A				
					Current Media: Custome	r Provided Glass Fiber			
					Final Range: 42 – 89 LPM	l			
			*****		Calibrated IAW OEM				

					· · · · · · · · · · · · · · · · · · ·				
		STATE	MENT OF CE	RTIFICATIO	N				
We Certify that the instrumer further certify that our Calibr shipment or use of this instru	nt listed above was cali ation Measurements ar ment).	brated and inspecte e traceable to the N	ed prior to shipment lational Institute of	and that it met all Standards and Tecl	the Manufacturers published oper mology. (We are not responsible	rating specifications. We for damage incurred during			
Instrument				\sim					
Calibrated By: Hu	my me	Reviewed By:	Clamo	Date: 3-22-05					
Calibration Date: 03/11	/05			Calibration Du	ie: 03/17/06				





	CUSTOMER INFO		INSTRUMENT INFORMATION							
Customer Nam	e: Duratek Instrument S	ervices		Manufacturer	: Ludlum					
Address: 628 (Gallaher Road, Kingston	, TN 37763		Model: 2221		Serial Numb	Serial Number: 197766			
Contact Name:	Tom Scott			Probe: N/A	Probe: N/A Serial Number: N/A					
Customer Purc	hase Order	Work Order Number: 2004	_02391	Calibration Method:						
Number: IVA		INSTRUM	MENT CALIBRA	ATION INFOR	MATION					
		Rate	meter			Toloroncor	Sca	aler		
Instrument	Calibration Standard	Res	ponse	Calibration Standard	Time Base	(cpm)	KCS	00130		
Range	Value CPM	As Found	As Left	Value CPM	(min)	±10%	As Found	As Left		
X 1	100	100	100	1,000 CPM	.1	90 - 110	99	99		
X 1	250	250	250	1,000 CPM	.2	180 - 220	200	200		
X 1	400	400	400	1,000 CPM	.5	450 - 550	499	499		
X 10	1,000	1,000	1,000	1,000 CPM	1	900 - 1,100	994	994		
X 10	2,500	2,500	2,500	1,000 CPM	2	1.8K-2.2K	1,987	1,987		
X 10	4,000	4,000	4,000	1,000 CPM	5	4.5K-5.5K	4,987	4,987		
X 100	10,000	10,000	10,000							
X 100	25,000	25,000	25,000							
X 100	40,000	40,000	40,000					×		
X 1000	100,000	100,000	100,000							
X 1000	250,000	250,000	250,000							
X 1000	400,000	400,000	400,000							
		STA	TEMENT OF	CERTIFICAT	TION					
We Certify that the certify that our Ca use of this instrum	e instrument listed above was a libration Measurements are tra nent).	calibrated and inspendent contract of the second se	cted prior to shipmer nal Institute of Stand	nt and that it met all lards and Technolog	the Manufac gy. (We are no	turers published ope ot responsible for da	rating specification mage incurred dur	ns. We further ring shipment or		
Instrument			<u></u>	<u> </u>	,					
Calibrated By	· M.Paul	Reviewed By:	Clomes ?	J- Acrit]	Date: 17	- 7-04			
Calibration D	ate: 12/07/04 🖌		Calibration Du	ne: 12/07/05						

Model: <u>2221</u>

Serial Number: 197766

	M	&TE			Environmental Conditions						
Volt Meter	Due Date:	03/08/05	D	TW12662	2 D-	812	Due Date:	04/15/05	ID:	2816	
Pulser	Due Date:	09/24/05	D	101500	DT	H-1A	Due Date:	11/1/05	ID:	100799	
Timer	Due Date:	03/04/05	D	02010806	5 Temp:	22.1 °C	Pressure:	736 mmHg	Hu	midity: 54%	
	L	INS	TRU	MENT CALIBRA	TION IN	FORMATI	ON				
				Specia	l Test						
Geotropi	sm	Sat	(√) Uı	nsat ()		Hold		Sat (√) Un	sat ()	
BAT > 4.5 Sat (√) Unsat (nsat ()		Volume Te	est	Sat (√) Un	sat ()		
Mechanical	Zero	Sat	(√) Uı	nsat ()		Audio Divi	de	Sat (√) Un	sat ()	
Digital Z	ero	Sat	(√) Uı	nsat ()	V	Vindow Sw	itch	Sat (√) Un	sat ()	
Count		Sat	(√) U	nsat ()		Lamp		Sat (√) Un	sat ()	
	High Voltage Calibration										
VoltageTolerance± 2%					I	As Found		As	Left		
400		18			404		4	104			
1,000	980-1,020						1,001		. 1	,001	
1,500	·	1,470-1,530				1,501			1,501		
1,900	1,900 1,862-1,932						1,900		1	,900	
Threshold/Gain Calibration (Desired Ratio 10 mV/100)											
Input	ut <u>As Found Value</u> <u>As Found Rati</u>			atio (mV/1	<u>00)</u>	<u>As Left Valu</u>	e <u>As</u>]	Left R	atio (mV/100)		
10		96		1	0.4		96		10.4		
20		203		9	.9	203			9.9		
30		309		9	0.7	309			9.7		
40		411		9	0.7	411				9.7	
				Logmeter Scale	Linearity	Check					
	Input			±20%]	<u> Folerance</u>		<u>As Found</u>		<u>A</u>	s Left	
LOG		400		320)-480		400			400	
LOG		4,000		3,200)-4,800		4,000			4,000	
LOG		40,000		32,000	-48,000		40,000		4	0,000	
LOG		400,000		320,000	0-480,000		400,000		4	00,000	
				COM	MENTS				and a state of the state		
Calibrated in accordance with the OEM Technical Manual											
Instrument		>				7	- In-	h n	ate:	12-7-04	
Calibrated By:	M. Ta	ul		Calibratic	Dy: (//	107/05	2. 1.0		<u>utt.</u>	· · · · · · · · · · · · · · · · · · ·	
Calibration Date:	12/0//04										



3-30-05 CALIBRATION CERTIFICATE Page 1 of 2

Calibrated By: M.

Calibration Date: 08/05/04 🗸

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

	CUSTOMER INFO		INSTRUMENT INFORMATION							
Customer Nam	e: Duratek Instrument S	ervices		Manufacturer: Ludlum						
Address: 678 (Gallaher Road, Kingston	. TN 37763		Model: 2221		Serial Numbe	Serial Number: 94954			
Contact Name	Tom Scott			Probe: N/A Serial Number: N/A						
Customer Purc	hase Order	Work Order		Calibration Method:						
Number: N/A		Number: 2004	-01977	Electroni	c					
		INSTRUM	MENT CALIBRA	ATION INFORM	MATION					
		Rate	emeter	Calibration	Time	Tolerances	Sci Rest	aler Jonse		
Instrument Range	Calibration Standard Value CPM	As Found	As Left	Standard Value CPM	Base (min)	(cpm) ± 10%	As Found	As Left		
X 1	100	100	100	1,000 CPM	.1	90 - 110	98	98		
X 1	250	250	250	1,000 CPM	.2	180 - 220	198	198		
X1	400	400	400	1,000 CPM	.5	450 - 550	494	494		
X 10	1,000	1,000	1,000	1,000 CPM	1	900 - 1,100	988	988		
X 10	2,500	2,500	2,500	1,000 CPM	2	1.8K-2.2K	1,975	1,975		
X 10	4,000	4,100	4,100	1,000 CPM	5	4.5K-5.5K	4,940	4,940		
X 100	10,000	10,000	10,000							
X 100	25,000	25,000	25,000							
X 100	40,000	40,500	40,500							
X 1000	100,000	100,000	100,000							
X 1000	250,000	250,000	250,000			······				
X 1000	400,000	400,000	400,000							
		STA	ATEMENT OF	CERTIFICAT	TION			We firther		
We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or the instrument)							ring shipment or			
Instrument	time to a second se			\sim .						
Calibrated B	Instrument Colibrated By: M. P. L. Reviewed By: Clame J. Acat Date: 8-5-04									

Calibration Due: 08/05/05 🖍

Model: <u>2221</u>

Serial Number: 94954

	M&TE					Environmental Conditions					
Volt Meter	Due Date:	03/08/05	D	TW12662	: D	-814	Due Date:	10/22/04	D:	2525	
Pulser	Due Date:	09/18/04	D	101500	Psy	chron	Due Date:	02/10/05	D:	7480	
Timer	Due Date:	10/23/04	D	22226011	Temp	: 20.4°C	Pressure:	738mmHg	Hu	midity: 48%	
		INS	TRU	MENT CALIBRA	TION IN	FORMAT	ION				
				Special	Test						
Geotropi	Geotropism Sat (√) Unsat (Hold		Sat (√) Un	sat ()	
BAT > 4	1.5	Sat	(√) Uı	nsat ()		Volume Te	est	Sat (√) Un	sat ()	
Mechanical	Zero	Sat	(√) Uı	nsat ()		Audio Divi	de	Sat (√) Un	sat ()	
Digital Z	ero	Sat	(√) Uı	nsat ()	V	Vindow Sw	itch	Sat (√) Un	sat ()	
Count	ł	Sat	(√) Uı	nsat ()		Lamp		Sat (√) Un	sat ()	
				High Voltage	Calibrati	D n					
Voltage	VoltageTolerance± 2%					ł	As Found		As	Left	
400		392-408					388		4	100	
1,000		20		981			1,	003			
1,500		530		1,468			1,500				
1,900		1,8	862-1,9	932			1,855		1,	.898	
Threshold/Gain Calibration (Desired Ratio 10 mV/100)											
Input	:	As Found Va	lue	As Found Ra	tio (mV/1	<u>00)</u>	As Left Valu	<u>e As l</u>	eft R	atio (mV/100)	
10		91		10	.9				10.9		
20		183		10	.9	183			10.9		
30		289		10).4			10.4			
40		391		10).2 <u>391</u> 10.					10.2	
				Logmeter Scale	Linearity	Check					
	Input			<u>±20% T</u>	olerance		<u>As Found</u>		<u>A</u>	s Left	
LOG		400		320	-480		400			400	
LOG		4,000		3,200	-4,800		4,000		4	1,000	
LOG		40,000		32,000	-48,000		45,000		4	5,000	
LOG		400,000		320,000	-480,000		450,000		45	50,000	
				COMM	ENTS						
Calibrated in acco	rdance with th	ie CP-IN-WI	-237 r	ev 1							
Instrument	. (\rightarrow				7 1	$\overline{}$	1		a	
Calibrated By:	nike'	`	Reviewed 1	Reviewed By: Clama (J-ACall Date: 8-5-04							
Calibration Date:	08/05/04			Calibration	n Due: 08/	US/US					



R&P 3-30-65

DETECTOR CERTIFICATE

Duratek Instrument Services 628 Gallaher Road Kingston, TN 37763 Phone: (865) 376-8337 Fax: (865) 376-8331

C	CUSTOMER INFORMATION					DETECTOR INFORMATION			
Customer Name: Duratek	Instrument S	ervices			Manufacturer: Ludlum				
Address: 628 Gallaher Rd	Kingston, T	N 37763			Detector Model: 43-5				
Contact Name: Thomas So	ott				Serial Number:	: 1	27385 🖌		
Customer Purchase Order		Work Order	004-01610		Evaluation Met	thod: ce	201101 (2017) (2017) (2017) (2017) (2017) (2017) (2017) (2017) (2017) (2017) (2017) (2017) (2017) (2017) (2017)		
IVIIIDEI. IVA	DETEC	TOR EFFIC	IENCY/RESPONS	E/PRECI	SION INFORM	ATI	ON		
1) Source Nuclide: Th ²³⁰ Serial Number: 119739 Activity (dpm) : 18,600					C	ertifi	cation Date: 10/2	0/97	
Parameter	As Found	As Left	L		L Test		CPM (S	ource #1)	
Count 1	2,270	2,270	С	ount 1 (E	leel)		2,3	355	
Count 2	2,171	2,171	Co	ount 2 (Ce	nter)		2,	173	
Count 3	2,230	2,230	Count 3 (Toe)			2,3	329		
Average	2,224	2,224	Average			2,286			
Background (cpm)	4.6	4.6	Pass/Fail			PASS			
Net Counts	2,219	2,219				Toleran	ce ±10%		
Efficiency %	11.9%	11.9%					Min: 2,057	Max: 2,515	
SCA	LER INFOR	MATION			DETECTOR INFORMATION				
<u>Modei</u>	<u>Serial I</u>	Number	Due Date	Bac	ckground (cpm)		<u>Operating</u> <u>Voltage</u>	Threshold	
2221	197	766	12/07/05		4.6		550V	$100 = 10 \mathrm{mV}$	
Detector Setup Report	YES	NO 🖌	Barcode Rep	port Y	ES NO 🗸		Voltage Plateau	YES 🖌 NO	
			COMMEN	NTS					
			5 minute back	ground					
		STA	ATEMENT OF CE	RTIFIC	TION				
We Certify that the detector listed above was evaluated for proper operation prior to shipment and that it met all the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology. (We are not responsible for damage incurred during shipment or use of this detector).									
Detector	7		~	\sim				_	
Certified By: M. He	<u> </u>	Reviewed By	: Clamo 6	I. A	est 1	Date:	3-28-	05	
Certification Date: 04/30/0	14 🖌		Certification	Due: 04/	30/05 🖌				



R# 3-30-03

Duratek Instrument Services 628 Gallaher Road Kingston, TN 37763 Phone: (865) 376-8337 Fax: (865) 376-8331

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

						_		4 *	1	
	Cus	stomer Informatio	n]	Instrument Informa	1100		
Customer Name:	Durate	k Instrument Serv	vices		Manufacturer:	Ludl	um			
Address: 628 Gal	laher R	oad, Kingston, TI	N 37763		Model: 2929	Serial	Number: 160019			
Contact Name: T	homas]	F. Scott			Probe: 43-10-1	Serial	Number: 167229	/		
Customer Purchas	ie		Work Order		Calibration Met	hod: Sourc	·e			
Order Number:	N/A		Number: N/A	amont Celi	hrstion Informatio	n				
			TUPU	Caliba	tion Dro Date		Environmen	tal Co	nditions	
M&TE		LD Nun	nder	Canor		Toma	areture (°C)		21.8	
Thermomete	r	252:	5		10/22/04	Deere	une (mmHg)	748		
Barometer		252:	5		10/22/04	Press			18	
Hygrometer	r	748	0		02/10/05	Hum	idity (%)		40	
Pulse Generat	tor	762	2		04/13/05	Calib	rated in accordance	iance with OEM.		
DVM		TW12	662		03/08/05			Decayed Activity (dam)		
Isotope		Source ID	Number .	Origina	l Activity (dpm)	So	urce Cert. Date	Dec	10.090	
Th ²³⁰		1197	01	19,080			10/14/97		19,080	
Pu ²³⁹		0194	42		13,613	<u> </u>	06/01/92		13,608	
Tc ⁹⁹	1094	10/01/94		24,287						
Sr/Y ⁹⁰		0902	13		45,200		08/04/98		39,063	
				Frequen	cy Calibration					
Desired (cnm)	Tole	erances (cpm)	Alpha As I	Found	Alpha As Lef	t	Beta As Found		Beta As Left (cpm)	
40		40	(CPM	/	<u> </u>		<u> </u>		40	
40		(202.409)	400		400		400		400	
400		(392-408)	4.000		4 000		4,000		4,000	
4,000	(3	5,920-4,080)	4,000	, ,			40 004		40,004	
40,000	(3)	9.2K-40.8K)	40,00	4	40,004		40,004		400.041	
400,000	(3	392K-408K)	400,04		400,040	94.	Data As Formal		Reta Ac Left	
Backgrour	nd Deter	rmination	Alpha As l	Found	Aipha As Lei		Deta As round		1 1 20	
Co	unts, C	Сь	20		6		1,3/4			
Time,	Ть	(min)	20		20		20			
Rate,	R _b	(cpm)	1		0.3		68.7		57.5	
				Statemen	t of Certification					
We Certify that the specifications. We	e instru	nent listed above v certify that our Ca	vas calibrated at libration Measument or use of the	nd inspected arements are his instrume	d prior to shipment a e traceable to the Na ent).	and tha ational i	t it met all the Manuf Institute of Standards	acturer and Te	s published operating echnology. (We are not	
Instrument	mage III								. <u> </u>	
Calibrated By:	A.	ife)	Reviewed B	y:Tur	no F.A.	,et	, Date: C	5-4	1-0Ý	

Calibration Date: 08/04/04 -

Calibration Due: 08/04/05

CROSS TALK SHEET & EFFICIENCY SHEET

A - D	and Alaha	Threehold (*	nv)				As I	eft Alpha Tl	nreshold (m	v)
As Fo		 ТШСЭПОІЯ (П	u† <i>j</i>					175		
	20	v	Alpha So	urce: Perfort	ned using	Pu ²³⁹ (019442			
Descritor and Talamas		Inha As Fou	nd	Alpha	As Left		l	Beta As Four	ıd	Beta As Left
Faramter and Tolerand		26 040		25	.562			1,510		259
					5			5		5
Data R (mm)	_	$R_{1} = 5207$		R-r-1=	= 5112.4			$R_{s(b)} = 302$		$R_{s[\beta]} = 51.8$
EFE (9(c(d) (>25%)		$\frac{1}{38.3\%}$		37	.6%			N/A		N/A
%Crosstalk [α to β] (< 10%)				I R	R _{3[β]} - R _{b[β]} _{3[α] -} R _{b[α]}		51.8 – 5,112.4	$\frac{59.5}{-0.3} = 0$	%	
As Found Beta Low T	hreshold	As Left]	Beta Low	Threshold	As Fou	ind Bet	ta High 7	hreshold	As Left l	Beta High Threshold
6.0 mv			4.0 mv			6	65 mv			50 mv
		L	Beta Se	ource: Perform	med using	Tc" 1	09407			
Paramter and Tolerand	e A	lpha As Fou	nd	Alpha	As Left]	Beta As Fou	nd	Beta As Left
Source Count, C.		2			2			29,607		25,562
Time, T _s (min)		5			5			5		5
Rate, R, (cpm)		$R_{s[\alpha]} = 0.4$		Rsio	_{4]} = 0.4			$\mathbf{R}_{s[\beta]} = 5852.$	7	$R_{s[\beta]} = 5,112.6$
EFF (% c/d) (>10%)		N/A		1	N/A			24.1%		20.8%
%Crosstalk [β to α] (< 1%)				R _{s[a]} 	_R _{b[α]} - R _{b[β]}		0. 5,8	4 – 0.3 82.6 – 59.5	=	0.002%
	L			High Vol	tage Powe	er				
Desired Voltage	Tole	rance	DVM	As Found	DV	M As I	Left	2929 Meter	As Found	2929 Meter As Left
600	540	- 660		603		603		60	0	600
800	720	- 880		807		807		80	0	800
1,000	900 -	- 1,100		1,014		1,014		1,0	00	1,000
1,200	1,080	- 1,320		1,214		1,214		1,2	.00	1,200
1,300	1,170	- 1,430		1,318		1,318		1,3	600	1,300
Eli-L I	altere		A	Found	Vern	Dial R	eading	As	Left	Vern Dial Reading
	unage			883V		3.42		80	0V	3.20
We Certify that the instr specifications. We further responsible for damage	ument listed er certify the	l above was c at our Calibra	alibrated a tion Meas or use of	Statement of and inspected p urements are to this instrument	of Certification of Certification of Certification of the second	pment the Na	and that i ational In	t met all the stitute of Star	Manufacture ndards and T	rs published operating echnology. (We are not
Instrument Calibrated By:	With	<u>)</u>	Review	ved By: 0	oma	F	- A	al	Date: S	-4-04
Calibration Date: 08/	14/04					Calib	ration D	ue: 08/04/	05	

EFFICIENCY SHEET

Instrument ID: 160019

As Foun	d Alpha Th	reshold (mv)			As Left Alpha	Threshold (1	nv)
	175				17	'5	
			Alpha Source	: Th ²³⁰ #119738			
Paramter and Tolerance	Alph	a As Found	Alpha	As Left	Beta As Fou	Ind	Beta As Left
Source Count, C _s		N/A	29	,721	N/A		4,300
Time, T, (min)		5		5	5		5
Rate, R, (cpm)	R,	$f[\alpha] = N/A$	R _{s[a]}	= 6,759	$\mathbf{R}_{\mathbf{s}[\boldsymbol{\beta}]} = \mathbf{N}/A$	N	$R_{s[\beta]} = 800.5$
EFF (% c/d) (>25%)		N/A	31	.2%	N/A		N/A
%Crosstalk [α to β] (< 10%)				$\frac{\mathbf{R}_{\mathbf{s}[\beta]} - \mathbf{R}_{\mathbf{b}[\beta]}}{\mathbf{R}_{\mathbf{s}[\alpha]} - \mathbf{R}_{\mathbf{b}[\alpha]}} =$	<u>N/A</u> =	N/A	
As Found Beta Low Thr	eshold	As Left Beta Low	Threshold	As Found Be	ta High Threshold	As Left	Beta High Threshold
4.0mv		4.0mv			50mv		50mv
			Beta Source:	Sr/Y** 090213			
Paramter and Tolerance	Alph	a As Found	Alpha	As Left	Beta As Fou	nd	Beta As Left
Source Count, C,		N/A	. 1	12	N/A		84,221
Time, T, (min)		5		5	5		5
Rate, R, (cpm)	R,	[a] = N/A	R _{s[a]}	= 22.1	$\mathbf{R}_{s[\beta]} = \mathbf{N}/A$		$R_{s[\beta]} = 16784.7$
EFF (% c/d) (>10%)		N/A	N	V/A	N/A		43.0%
%Crosstalk [β to a] (< 1%)			: 	$\frac{R_{s[\alpha]} - R_{b[\alpha]}}{R_{s[\beta]} - R_{b[\beta]}} =$	<u>N/A</u> =	N/A	
			Statement of	Certification			
We Certify that the instrume specifications. We further con- responsible for damage incu Instrument	ent listed abo ertify that our rred during s	ve was calibrated ar r Calibration Measu shipment or use of th	nd inspected pr rements are tra his instrument)	rior to shipment acceable to the Na	and that it met all the l tional Institute of Star	Manufacture adards and T	rs published operating echnology. (We are not
Calibrated By: Wax Calibration Date: 08/04/0	4	Review	ed By: (7)	Calib	Acut ration Due: 08/04/0	Date: 2	9=4-04

																							A	Beta	11	34		4	-40	-40	-84	-505		อ
																							Z	Alpha	c			5		7-	<u>-</u>		0	0
																								Reta	14		5	-41	-46	-48	-84	-505	0	0
		Beta																					Ń	Alnha			5	0	0	?	-	0	0	0
	AN	Alpha											A/A				8/4/04	104.59		i0///IC#			66	Deta	1007	1824	2012	4022	5060	5820	5734	5387	0	0
		Beta											~ _										To-	- chalv	BILAN	5	5	0	0	0	-1	0	0	0
ts) .	N/A	Alpha											IA				8/4/04	104.59		i0//IC#			30	0,00	חכומ	-11-	109	156	171	224	413	1178	0	0
Data (Coun	6	Beta	1835	3106	4063	5106	5868	5818	5892				2									V	C-IIG		Alpila	4199	47/0	5028	5145	5149	5199	5277	0	0
7229 Raw	Tc-9	Alpha	0	0	0	0	2	0	0			rce Info		109407	24288	10/1/94	8/4/04	9.84	2 125105	24287		Net CPN			(0/)	30.9%	35.1%	36.9%	37.8%	37.8%	38.2%	38.8%	%0.0	0.0%
43-10-1 #16	39	Beta		203	197	217	272	497	1683			Sou									ADC VDC		0.40 0.44		(9,	7.51%	12.65%	16.56%	20.83%	23.96%	23.61%	22.18%	%00'0	0.00%
Detector -	Pu-2	Alpha	4199	4770	5028	5145	5151	5200	5277				ou-239	19442	13613	6/1/92	B/4/04	12.18		2.4 ICT04 13608	20				seta-Alpha	0.0%	0.0%	0.0%	%0.0	%0.0	0.0%	0.0%	#DIV/01	#DIV/01
	pur	Beta	11	34	41	46	48	84	505				Nuclide	Q	nitial DPM	ation Date	dav's Date	de (Years)		ure (rears) ed Activity	crements:		In Tells		Alpha MUA	8.8	7.7	7.3	7.2	24.6	19.3	7.0	#DIV/0!	i0//IC#
	Backgrot	Alpha	0	0	0	0	2	+	0							Cartific		Source A		Correctu	Voltage In				Beta MUA 1/	241.6	235.9	196.3	164.5	145.8	192 1	483.6	#DIV/0	#DIV/0i
		Voltage	600	650	200	750	800	850	900	950	1000														Voltage	600	650	700	750	800	850	006	950	1000

8-5-04 8-4-04

R Comes



0840 3-30-05

Duratek Instrument Services 628 Gallaher Road Kingston, TN 37763 Phone: (865) 376-8337 Fax: (865) 376-8331

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

	Cu	stomer Informati	on				Instrument Informa	ation		
Customer Name:	Durate	k Instrument Ser	vices		Manufacturer	: Lu	dlum			
Address: 628 Ga	llaher R	oad, Kingston, T	N 37763		Model: 2929	Seri	al Number: 102001			
Contact Name: 7	homas .	F. Scott			Probe: 43-10-2	Seri	al Number: 103276	, <i>v</i>		
Customer Purcha Order Number:	se N/A		Work Order Number: 200)4-02092	Calibration M Electronic A	ethod: nd Sou	rce			
			Instr	ument Cali	bration Informs	tion				
M&TE		ID Nu	nber	Calibra	ation Due Date		Environmen	tal Conditions		
Thermomete	er	252	5	1	10/22/04	Ten	perature (°C)	21.1		
Barometer		252	5	1	10/22/04	Pre	ssure (mmHg)		746	
Hygrometer	r	748	0		02/10/05	Hu	nidity (%)	76%		
Pulse Genera	tor	1209	35		04/13/05	C_9]	ibrated in accordance	with (CP-IN-WI-235.	
DVM		6565	015	1	10/14/04					
Isotope		Source ID	Number .	Origina	Activity (dpm)		ource Cert. Date	Dec	ayed Activity (dpm)	
Th ²³⁰		1197	39		18,600		10/20/97		18,600	
Tc ⁹⁹		1197	718 24		20,520		10/14/97		20,520	
Pu ²³⁹		0194	42		13,613		06/01/92		13,613	
		<u> </u>		Frequence	y Calibration					
Desired (cpm)	Tole	erances (cpm)	Alpha As I (cpm)	Found)	Alpha As L (cpm)	eft	Beta As Found (cpm)		Beta As Left (cpm)	
4		4	4		4		4		4	
40		(39-41)	40		40		40		40	
400	1	(392-408)	398		398		398		398	
4,000	(3	,920-4,080)	3,984	· [3,984		3,982		3,982	
40,000	(39	9.2K-40.8K)	39,83	6	39,836		39,824		39,824	
400,000	(3	92K-408K)	398,31	8	398,318		398,345		398,345	
Backgroun	d Deter	mination	Alpha As l	Found	Alpha As I	eft	Beta As Found			
Co	unts, C	-Ъ	6		4		1,193		1,088	
Time,	Ть	(min)	20		20		20		20	
Rate,	R _b	(cpm)	.30		.20 59.65 54.4					
				Statement	of Certification					
We Certify that the specifications. We responsible for data	e instrum further (nent listed above w certify that our Cal surred during ship	vas calibrated an libration Measument or use of the	nd inspected rements are his instrume	prior to shipmer traceable to the l nt).	t and th National	at it met all the Manufa Institute of Standards	acturer: and Te	s published operating echnology. (We are not	
Instrument		A/		C.	- A	At			8-04	
Calibrated By:	00/12/	in in the second	Reviewed B	y: V UN	Calil	ecc	Date: 7	-/ 2		
Calibration Date:	09/13/	'V4 🖌				ration	Duc: 07/13/03 🖊			

.

CROSS TALK SHEET

As Fou	nd Alpha	Threshold (mv)			As l	Left Alpha I	'hreshold (m	ıv)
	18	0					18	0	
		Alpha S	bource:	Cross Talk	- Performed usi	ng Pu ²³⁹	019442		
Paramter and Tolerance	A	lpha As Fou	nd	Alpha	n As Left	-	Beta As Fou	nd	Beta As Left
Source Count, Cs		26,546		20	5,546		982		982
Time, T _s (min)		5			5		5		5
Rate, R. (cpm)]]	$R_{s[\alpha]} = 5,309.$	2	R _{s[a]} =	= 5,309.2		$\mathbf{R}_{\mathbf{s}[\beta]} = 196.$	4	$R_{s[\beta]} = 196.4$
EFF (% c/d) (>25%)		28.5%		28	8.5%		N/A		N/A
%Crosstalk [α to β] (< 10%)				H 	$\frac{R_{s[\beta]} - R_{b[\beta]}}{R_{s[\alpha]} - R_{b[\alpha]}} =$	196.4 - 5309.2	- 54.4 - 0.2 =	2.68%	
As Found Beta Low Th	reshold	As Left]	Beta Low	Threshold	As Found Be	ta High '	Threshold	As Left]	Beta High Threshold
4mv			4mv			50mv			50mv
		Beta S	ource:	Cross Tal	k-Performed usi	ng Tc " 1	19718		
Paramter and Tolerance	A	lpha As Fou	nd	Alph	a As Left		Beta As Fou	nd	Beta As Left
Source Count, C _s		5			5		26,119		26,119
Time, T, (min)		5			5		5		5
Rate, R _s (cpm)		$R_{s[\alpha]} = 1$		R,	_[4] = 1		$R_{s[\beta]} = 5,223$.8	$R_{s[\beta]} = 5,223.8$
EFF (% c/d) (>25%)		N/A]	N/A		25.2%		25.2%
%Crosstalk [β to α] (< 1%)				R _{s(}	$\frac{a_{j}-R_{b[\alpha]}}{R_{b[\beta]}} =$	<u></u> 5233	0 - 0.20 5.8 - 54.4	= 0.0001	5%
				High Vol	tage Power			<u> </u>	
Desired Voltage	Toler	ance	DVM	As Found	DVM As]	Left	2929 Mete	r As Found	2929 Meter As Left
600	540 -	- 660		600	600		6)0	600
800	720 -	- 880		800	800		8)0	800
1,000	900	1,100		1,000	1,000		1,0	00	1,000
1,200	1,080 -	- 1,320		1,200	1,200		1,2	200	1,200
1,300	1,170 -	- 1,430		1,300	1,300		1,3	i 0 0	1,300
High Vo	tere		As	Found	Vern Dial R	eading	As	Left	Vern Dial Reading
	ilage			750V	3.26		75	0V	3.26
				Statement o	f Certification				
We Certify that the instrum specifications. We further responsible for damage in	nent listed certify that curred duri	above was ca t our Calibrat ng shipment	alibrated a ion Measu or use of t	nd inspected p trements are to his instrument	prior to shipment raceable to the Na :).	and that i ational In	t met all the stitute of Star	Manufacture ndards and T	rs published operating echnology. (We are not
Instrument	, A /			_	7 /	ור	,		_
Calibrated By:	ly		Review	red By:	omas T-	Aca	H	Date: 9	-13-04
Calibration Date: 09/13	/04				Calib	ration D	ue: 09/13	/05	

EFFICIENCY SHEET

Instrument ID: 102001

As Found	l Alpha Threshold	(mv)			As Left	Alpha I	hreshold (1	nv)
	180					18	0	
	Alph	a Source:	Efficiency	determined usin	g Th ²³⁰ #1197	39		
Paramter and Tolerance	Alpha As Fo	ound	Alpha	a As Left	Beta	As Fou	nd	Beta As Left
Source Count, C,	31,208		31	1,208		N/A		N/A
Time, T, (min)	5			5		N/A		N/A
Rate, R _s (cpm)	$\mathbf{R}_{\mathbf{s}[\alpha]}=6,24$	1.6	R _{\$[a]} =	= 6,241.6	Rs	_[] = N/A	\	$R_{s[\beta]} = N/A$
EFF (% c/d) (>25%)	33.6%		3.	3.6%		N/A		N/A
%Crosstalk [α to β] (< 10%)			_	$\frac{\mathbf{R}_{\mathfrak{s}[\beta]} - \mathbf{R}_{\mathfrak{b}[\beta]}}{\mathbf{R}_{\mathfrak{s}[\alpha]} - \mathbf{R}_{\mathfrak{b}[\alpha]}} =$	N/A N/A	_ =	N/A	
As Found Beta Low Thre	eshold As Lef	t Beta Low	Threshold	As Found B	eta High Thre	shold	As Left	Beta High Threshold
4.3mv		4.3mv			50mv			50mv
	Beta	Source:	Efficiency	determined usi	ng Tc ⁹⁹ #1197	15		
Paramter and Tolerance	Alpha As Fo	ound	Alph	a As Left	Beta	As Fou	ınd	Beta As Left
Source Count, C _s	N/A			N/A		26,119		26,119
Time, T _s (min)	N/A			N/A		5		5
Rate, R, (cpm)	$\mathbf{R}_{s[e]} = \mathbf{N}/\mathbf{I}$	'A	Rsie	$a_i = N/A$	R _{s[\$}	₁ = 5,223	3.8	$R_{s[\beta]} = 5,223.8$
EFF (% c/d) (>25%)	N/A			N/A		25.2%		25.2%
%Crosstalk [β to a] (< 1%)			-	$\frac{\mathbf{R}_{\mathbf{s}[\alpha]} - \mathbf{R}_{\mathbf{b}[\alpha]}}{\mathbf{R}_{\mathbf{s}[\beta]} - \mathbf{R}_{\mathbf{b}[\beta]}} =$	N/A 	_ =	N/A	
			Statement of	of Certification				
We Certify that the instrume specifications. We further corresponsible for damage incur	ent listed above was ertify that our Calib nred during shipme	calibrated a ration Meas nt or use of	and inspected j urements are t this instrumen	prior to shipment raceable to the N t).	and that it me ational Institut	t all the te of Sta	Manufactur ndards and	ers published operating Fechnology. (We are not
Instrument Calibrated By:	no	Review	ved By:	omas (7-	South		Date:	9-13-04
Calibration Date: 09/13/0	4			Cali	bration Due:	09/13	6/05	

			N.S. SAV	ANNA	H			Page	of
		INSTR	UMENT SOL	JRCE C	HECK	LOG			
Collibration	<u>LUPLUM (*</u>	OPEL IL Fr	<u>RIGNAR</u> Ser	ial No.	/5	809			
Average a s		5-10-06		Pane		<u>ι</u> α_	to		
Average β s	ource count	800	cpm	Rang	де	1.45	$\frac{10}{10}$	9/.x	 + > . (
			opm			010		100	
Date	bkg. Count (cpm)	a Source Co	ount (cpm)	Res	ults fail	_	Initial d	& Comment	
3-31-65	30		780	V		RUP			
4-1-05	30	-aum.	700			BLP			
4-4-05	30		780			Rul			
4-5-05	20		830	1		RGP			
4-6-05	30	- mar	800	\checkmark		REP			
4-7-05	30		800	V		RUM			
4-8-05	30	-	860	\checkmark		RGP			
4-11-05	30	nter commenter e	800			TEC			
41-12-65	70		800	~		RLP			
4-13-05	30		900	~		++			
4-14-05	30		800	~		AHL			
4-15-05	30		800	!~	t	EFF			
4-18-05	30		800	v		EAL			
4-14-05	40	-	750	V		RUP			
+-20.05	30		800	~		2HZ		······	
4-21-05	30	·	800	~		AHZ			
1-22-05	20		800	\checkmark		8HL			
						r (*			
								· · · · · · · · · · · · · · · · · · ·	
<u> </u>									

			N.S. SAV	ANNA	<u>H</u>			Page	of
T		INSTR	UMENT SOL	JRCE C	HECI	K LOG			
Calibration	<u>LUDLUM / 10</u>	Z-10 AL	<u>CISK</u>	ai No.	710	137			
Average a s		5-10-00	EIII	Rang		<u>0 10</u> a	to		
Average β s	ource count	400	cpm	Rang	;e	1.11	to	91 X	
			op		,			160	/010
Date	bkg. Count (cpm)	Source Co	B	Res	ults fail		Initial	& Comment	
3-31-05	37)		7/00		1411	RUN			
21-105	40	_	4/20	V		11 W			
4-4-05	40	-	860	V		RGP			5 - 1
4-5-05	40		770			REA			
4-6-05	30		460	\mathcal{V}		Rh	,	**************************************	
4-7-05	20		800	ν		RUP	,		
4-8-05	20		Ø 7 X	\vee		PIP			
4-11-05	30		800			BIS			
4-12-05	40		860	~		RLP			
4-13-05	30	-	860			& iff	·		
4-14-03	30		800	V		1th			
4-15-05	30	. <u></u>	850	~		8HL		*****	
4-18.05	20	-	900	r		PIP			
4-14-05	30	_	800	~		Bill			
4-20-05	30		800	\checkmark		EAL			
4-21-05	30		800	/		AHL			
1-22-05	30	_	800			AHL			
			-						

		N	. s. s.	AVAN	NAH		Page_of
		INSTRUM	ENT S	OURCE	CHECK	LOG	
Instrumen	t 2221 Lu	AUM FRIS	<u>K14</u> 2	Se	rial No	94954	
Calibration	Due Date						
Average so	urce count		_µR/hr	Ra	ange	to	
Date	bkg. Count	Source Count	Re	sults	-	Initial & Comment	:
	(µK/nr)	(µR/nr)	pass	fail			
		XII		11	W C		·····
		/ X60		09	12		
		and the second se	and the second		h/	7	
				1	/11/		
	· · · · · · · · · · · · · · · · · · ·			//			
					<u></u>		

			N.S. SAV	VANNA	H			Pag	e of
	<u>.</u>		UMENT SO	URCE C	HECK	K LOG			
Instrument	LUNLUM MO	DRUX3 Fr	<u>ISKRR</u> Sei	rial No.	97	416			
Average g a	Due Date	5-10-06	Eff	β		<u>0.1%</u> a	~		
Average ß s	ource count	N/A Sm	cpm	Rang	ge	L1 M)	to	1 (~~)	
		500	Opin			-700	10	600	
Date	bkg. Count (cpm)	Source C	B	Resi	ults fail	-	Initial	& Comment	
3-31-65	30	-	500			R4P			
4-1-05	40	<u> </u>	< MI	/		BLA			
4-11-05	2/		Cali	-		RhP			
4-5-05	36	-	500			RIN)		
41-6-05	3/		5190			R/P			
4-7-05	31)	-	SM	V		RI. P			
1-4-05	 3_^		511			RGI	2		
4-11-05	20		500			RIC			
4-12-05	30		500			RUP			
11.13-15	20		550			Jul I			
1-14-05	30		<u>550</u>		· ·····			*****	
4-15-05	30	<u> </u>	550			ALL			
1 10-05	30		500		(Q14			•*************************************
1-18-05	20	-	Sind			RIN			++
H-20.05	30		500			Dill			
4-11-05	30		500		c	AND			
1-21 05	30	· · · · · · · · · · · · · · · · · · ·	FOO			ANT			
1 25.05	22				4	NON CO			
	30	<u>ـــــــــــ</u>	500			VEÇ	•		
									18191 g 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 19 1

			N.S. SAV	ANNA	H.	Page of
		INSTR	UMENT SOU	J RCE C	HECK	LOG
Instrument	LUDLUM MODA	a 2221 R /	FRIGHTSA Ser	ial No.	197	766 / 127385 PROBE
Calibration 1	Due Date _/2	-1-05 / 4.	<u>- 70 - 05</u> Eff	iciency `f	3	<u> </u>
Average a s	ource count	2700	cpm	Rang	ge [.]	<u>2/60 to 3240</u>
Average β s	ource count	N/A	cpm	Rang	ge	to
Date	bkg. Count	Source C	ount (cpm)	Res	ults	Initial & Comment
	(cpm)	a	β	pass	fail	
4-6-05	0	2700		V		Rul
4-14-05	Ô	:2750	_	V		RGP
			1			
			+			
			+			
			+			
			· ·			
			· · · ·	· · · ·		
			````			
		·				

		N	. S. SA	VAN	NAH		Page_of
		INSTRUM	ENT SC	DURCI	E CHECK	K LOG	
Instrument	LUDLUM 1	9 pr R Mite	r v	Se	rial No.	42972	
Calibration I	Due Date	3-18-06					
Average sou	rce count	7.5 u K/h	$\mu R/hr$	R	ange	<u>bu R/m</u> to	<u>9 м R/h</u>
Date	bkg. Count	Source Count	Results		-	Initial & Co	omment
	(µR/hr)	(µR/hr)	pass	fail	011		
3-31-05	3	7	V		RUP		
4-1-05	3	7.5			RH		
4-4-05	2	8	V		014		
4-5-05	2	2	~		RAP		
4-6-65	2	7.5	~		RUP		
4-7-05	2	7.5			RUP		
4-8-05	3	6.5	$\checkmark$		RUP	,	
4-11-05	3	7.0	V		S.H.		
4-12-05	2	8	V	i.	RYP		
4-13-05	3	8	r		SHL		
4-14-05	3	8	V		HK.		
4-15-05	3	8	$\checkmark$	L	ANL	_	
4-18-03	3	8	/		SHL		
4-14-05	2	7.5	~		574 <i>[</i> ^		
4-20-05	2	7	~		JHL.		
1-21-05	2.5	8	r		JHL		
1-22-05	2.5	8	$\checkmark$		2HL		
			1				
						·····	
							*****

		N	. S. SA	VAN	NAH			]	Page_of
			ENT SC	URCI	E CHECK	LOG			
Instrument	LUDLUM 1	9 juit MIETR,	17	Se	rial No	9546	9		
Calibration 1	Due Date	3-18-06							
Average sou	irce count	<u> </u>	$\mu R/hr$	R	ange	5,6	_ to	8,4	
Date	bkg. Count (µR/hr)	Source Count (µR/hr)	Res	ults fail	-	Initial & Comment			
3-31-05	2.5	2	- F====		R4P				
4-1.05	3	7.5	~		R4P				
4-4-05	2	7	$ \nu $		RGP	******			
4-5-05	2	2	V		RUP				
4-6-65	2	2			Rup				
4-7-05	2	6.5	V		Rhp				
4-8-85	2	042	$\checkmark$		REP				
4-11-05	3	0 5.5 6.5	r		SHE				
4-12-05	2	6	1		RUP				
4-13-05	2-5	4	~		JHZ.				
1-14-05	2	6	4		SHL			· · · · · · · · · · · · · · · · · · ·	
+-15-05	2	6	6		9HL.				
1-18-05	3	6	C		Ede				
1-19-05	2	6	~		RYP_				
1-20-05	2	6	~		AH				
1-21-05	3	6	~		JHL.				
1-22-05	2.5	6			8HL				
1-25-05	3	7		ć	Si 4f				

INSTRUMENT SOURCE CHECK LOG           Instrument $\underline{\int u \partial Lum} 19 \mu \overline{d} margac         Serial No. \underline{954999}           Calibration Due Date \underline{3-19-00}           Average source count \overline{9} \mu R/hr Range \underline{6.4} to \overline{9.6}           Date bkg. Count (\mu R/hr)         Results Initial & Comment (\mu R/hr)           Date bkg. Count (\mu R/hr)         Source Count (\mu R/hr)           Average Source count (\mu R/hr)         Results Initial & Comment (\mu R/hr)           Job \overline{3} \overline{9} \overline{9} \overline{9} \overline{9} \overline{9} \overline{9} \overline{9}           Date bkg. Count (\mu R/hr)         Results Initial & Comment \overline{9} \overline{9}$	ge of	Page			NAH	AVAN	. S. SA	N			
Instrument $\int u \partial L u dtimest \int u \partial L u dtimest f and f and$			, r	K LOG	E CHECH	DURCI	ENT SC	INSTRUM			
Calibration Due Date 3-14-06         Average source count $ighthered pass       Range       ighthered pass       ighthered pass         Date       bkg. Count(µR/hr)       Source Count(µR/hr)       Resultspass       Initial & Comment         ighthered pass       ighthered pass       ighthered pass       ighthered pass       Initial & Comment         ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       Initial & Comment         ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass         ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass         ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass       ighthered pass ighthered pass$			/99	95 49	rial No.	Se	<u>(</u>	9 MR MATRA	LUDLUM 1	Instrument	
Average source count $\mathcal{G}$ $\mu Rhr$ Range $\mathcal{G}$ $\mathcal{G}$ $\mathcal{G}$ Date       bkg. Count ( $\mu R/hr$ )       Source Count ( $\mu R/hr$ )       Results pass       Initial & Comment $\mathcal{G}$ $\mathcal{I}$ $\mathcal{G}$ $G$								-19-06	Due Date3	Calibration	
Date         bkg. Count ( $\mu$ R/hr)         Source Count ( $\mu$ R/hr)         Results pass         Initial & Comment           3-31-05         3         V         V         01//           4-1-65 $\lambda$ .5         8         V         01//           4-1-65 $\lambda$ 8         V         01//           4-1-65 $\lambda$ 8         V         01//           4-1-65 $\lambda$ 8         V         01//           4-2-05 $3$ 8         V         01//           4-2-05 $\lambda$ 8         V         01//           4-2-05 $\lambda$ 8         V         01//           4-10-05 $\lambda$ 8         V         01//           4-10-05 $\lambda$ 8         V         01//           4-11-05 $\lambda$ 8         V         01//           4-11-05 $\lambda$ 8         V         01//           4-14-05 $\lambda$ 8         V         01//           4-14-05 $\lambda$ $\lambda$ 01//         01//           4-20-05 $3$ $7.5$ V         01	±20	9.6	to	6.4	ange	R	_µR/hr	8	Irce count	Average sou	
$(\mu R/hr)$ $(\mu R/hr)$ pass         fail $3 - 31.05$ $3$ $1$ $1$ $1$ $1$ $4 - 1/4.65$ $2.5$ $8$ $1$ $1$ $1$ $4 - 1/4.65$ $2.5$ $8$ $1$ $1$ $1$ $1$ $4 - 1/4.65$ $2.5$ $3$ $3$ $1$ $1$ $1$ $4 - 1/4.65$ $2.5$ $7.5$ $1$ $11/7$ $11/7$ $4 - 7.05$ $2$ $8$ $1$ $11/7$ $4 - 7.05$ $2$ $8$ $1$ $11/7$ $4 - 7.05$ $2$ $8$ $1$ $11/7$ $4 - 7.05$ $3$ $8$ $1$ $11/7$ $4 - 18.05$ $3$ $8$ $1$ $11/7$ $4 - 14.05$ $3$ $8$ $1$ $11/7$ $4 - 14.05$ $3$ $8$ $1$ $11/7$ $4 - 14.05$ $3$ $8$ $1$ $11/7$		nment	nitial & Com	Ini	-	Results		Source Count	bkg. Count	Date	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$						fail	pass	(µR/hr)	(µR/hr)		
4/.465 $2.5$ $8$ $V$ $H/P$ $4.4.05$ $2$ $8$ $V$ $H/P$ $4.5.05$ $3$ $8$ $V$ $H/P$ $4.6.65$ $2$ $7.5$ $V$ $H/P$ $4.7.05$ $2$ $8$ $V$ $H/P$ $4.7.05$ $2$ $8$ $V$ $H/P$ $4.7.05$ $2$ $8$ $V$ $H/P$ $4.7.05$ $3$ $8$ $V$ $9$ $4.7.05$ $3$ $8$ $V$ $7/P$ $4.7.05$ $3$ $8$ $V$ $7/P$ $4.7.05$ $3$ $8$ $V$ $7/P$ $4.7.05$ $3$ $8$ $V$ $9/P$ $4.7.05$ $3$ $8$ $V$				,	RYP		1	8	3	3-31-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					REP		V	8	2.5	4-1-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$				•	RYP		$\nu$	8	2	L1-4-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					JHL		$\checkmark$	8	3	4-5-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					REP		V	7,5	2	4-6-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					IHL.		$\checkmark$	8	2	4-7-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					GHL	2	V	8	3	4-8-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$				-	2HL	(	V	8	3	4-11-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					RUP		$\checkmark$	7.5	2.5	4-12-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					SHL		~	8	3	4-13-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$				<u> </u>	I HL		V	8	3	4-14-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$				<u>`</u>	JHL.		ir	8	3	4-15-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					8HL		1	8	3	4-18-05	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					J740	```````````````````````````````````````	$ \nu$	8	2	4-14-05	
4-21-05 3 8 V 9HA 4-22-05 3 8 V 9HA				·	J.H.		V	7.5	3	4-20-05	
4-22-05 3 8 V 8HA				<u> </u>	SHA		~	8	3	4-21-05	
					8HK		V	8	3	4-22-05	
			<b>-</b>								
						†					

### N.S. SAVANNAH DAILY DOSIMETRY READER CALIBRATION CHECK

#### **RADOS DBR-1**

### Dosimeter reader

Limits: $G = \pm 26$ , $R = \pm 26$ , $H = \pm 101$ , $M = \pm 26$ , $L = \pm 26$ , $I = \pm 5001$													
Date	4-2-05	4-1	1-05	4-5	-05	4-0	4-6-05		-05	4-8-05			
Code	Value	Code	Value	Code	Value	Code	Value	Code	Value	Code	Value		
G	/	G	/	G	2	G	2	G	2	G	2		
R	0	R	4	R	3	R	2	R	2	R	0		
H	41	H	97	H	65	H	15	H	3	H	48		
<u>M</u>	6	M	19	M	17	M	6	M	2	M	3		
L	4	L	9	L	16	L	4	L	5	L	0		
I	110	I	110	I	110	I	011	Ι	110	Ι	110		
Pass REP REP REP REP REP													
Date	4-11-05	4-1	1-12-05 41-13-05				4-14-05 4-15-05.				4-18-05		
Code	Value	Code	Value	Code	Value	Code	Value	Code	Value	Code	Value		
G		G	2	G	2	G	え	G	2	G	1		
R	4	R	3	R	5	R	4	R	3	R	5		
Н	28	H	27	H	8	H	26	H	40	H	35		
M	9	M	/	M	7	M	)	M	7	M	10		
L	3	L	/	L	2	L	0	L	4	L	4		
I	110	I	110	Ι	110	Ι	110	I	110	Ι	110		
Pass	REP		RH		RUP		RGP	-	REP		Rh		
Date	4-19-05	4/.	20-05	4-2	1-05	4-22-05		41-25-05		4-26-05			
Code	Value	Code	Value	Code	Value	Code	Value	Code	Value	Code	Value		
G	2	G	1	G	2	G	1	G	1	G	1		
R	7	R	3	R	4	R	4	R	0	R	1		
H	5	H	37	Н	7/	H	85	Н	8	H	5		
M	8	M	3	M	11	M	22	Μ	0	М	1		
L	3	L	2	L	6	L	9	L	6	L	1		
1	110	I	110	I	110	I	102	Ι	108	Ι	108		
Pass MAP REP INT MAD MAD AND													
1 400	RAP		REP		INT		Int		NNS		AWAY		
Date	RAP		RYP		INT		jut		Jus		7w19		
Date Code	Value	Code	R4P Value	Code	/w ⁷ Value	Code	JWD Value	Code	Ji M Value	Code	Jw 19 Value		
Date Code G	Value	Code G	R4P Value	Code G		Code G	<b>W</b> Value	Code G	Jw Value	Code G	Value		
Date Code G R		Code G R		Code G R		Code G R	Jutz Value	Code G R	July Value	Code G R			
Date Code G R H		Code G R H		Code G R H		Code G R H	Value	Code G R H		Code G R H	Value		
Date Code G R H M	Value	Code G R H M		Code G R H M		Code G R H M		Code G R H M	MMS Value	Code G R H M	Value		
Date Code G R H M L		Code G R H M L		Code G R H M L		Code G R H M L		Code G R H M L	Value	Code G R H M L	Value		
Date Code G R H M L I		Code G R H M L I		Code G R H M L I		Code G R H M L I		Code G R H M L I	Value	Code G R H M L I	Value		

Initial under Value column for Pass

Page ____ of ____