KRONUS Ludlum 3000 Survey Meter & 44-21 Beta Gamma Probe Suitability Assessment

Report Author: Brian Deis

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This assessment was performed to determine the suitability of the recently purchased Ludlum 3000 Survey Meter & 44-21 Beta Gamma Probe for use in routine surveys and contamination detection at KRONUS.

Suitability was evaluated by comparing the results of the Ludlum device to the wipe test procedure in four assessments as described below. Comparison was also made to the TBM-3 survey meter.

1. Radioactivity was measured for several lab surfaces that are considered high risk for contamination such as keyboards, work benches, refrigerator door handle, and the liquid ^{125}I disposal sink basin.

2. The laboratory's in-use solid ^{125}I waste container was surveyed as it was expected this item would have higher-than-background radiation levels due to the amount of ^{125}I waste stored in the container currently.

3. Two mock ^{125}I tracer spills to determine instrument response at each stage of clean up.

4. Three ^{125}I vials were surveyed to determine responsiveness of each the instrument at relatively high levels of ^{125}I radiation.

In all assessments, radiation was measured as Counts Per Minute (CPM) with all devices.

Lab Surface Area Survey

To take surface measurements, the detectors of both the Ludlum and TBM-3 survey meters were slowly passed along the entire surface of each survey area, taking care to ensure that the detectors were within an inch from the surface while measuring radiation levels. Furthermore, two discrete subareas within each survey area were wiped and a wipe tests were performed with the laboratory's RiaStar gamma counter per SOP 12.

Survey values for the different lab surfaces ranged from 330 to 519 CPM for the Ludlum 3000; similar to the 450 CPM reported on the manufacturer's datasheet for background. All wipe tests resulted in values below detection (Table 1). Background for the RiaStar was determined to be 36 CPM during the last scheduled service interval in December 2020. Values ranged from 20 to 60 CPM for the TBM-3 and were consistent with historic background values for this instrument at KRONUS.

Table 1. Survey meter readings and wipe test results for all lab surfaces evaluated. B.D. = Below Detection.

Lab Area	Ludlum 3000 S/N 25022104	RIASTAR (two swabs per area)	TBM-3 S/N 13736
	CPM		
Sink Basin	448 - 519	B.D. / B.D.	20 – 60
Gamma Counter - Keyboard	330 - 360	B.D. / B.D.	20 – 40
Work Bench - 1	360 - 380	B.D. / B.D.	20 – 40
Work Bench - 2	390 - 460	B.D. / B.D.	20 – 60
Refrigerator Door Handle	380 - 400	B.D. / B.D.	20 - 40
Computer Keyboard	330 - 370	B.D. / B.D.	20 - 40

^{125}I Solid Waste Container Survey

The ^{125}I Solid Waste Container Survey was conducted much like the Lab Surface Area Survey. Briefly, the detectors of each handheld device were passed across the surface of the waste container's fastened lid at about an inch height. The lid was then removed from the waste container, placed on disposable absorbent material and surveyed again to confirm that the lid's surface wasn't the source of radiation. A wipe test of the lid was also performed. While the lid was removed, the top of the waste container was measured again with both handheld devices.

The range of values obtained for the ^{125}I solid waste container lid were consistent with the results of the Lab Surface Area Survey. Values for the Ludlum 3000 ranged from 450 to 480 CPM while wipe test result for the container's lid was below detection. Values of 20 to 60 were recorded for the TBM-3. Both surveys of the waste container (i.e. lid on and lid off) resulted in ranges higher for the handheld devices than those for the lid when it was removed (Table 2). Both instruments resulted in reading that were about two-times higher than their respective background readings when surveying the closed waste container.

Table 2. Survey meter readings and wipe test results for the I-125 solid waste container. B.D. = Below Detection. N.T.= Not Tested.

^{125}I Solid Waste Container Survey	Ludlum 3000 S/N 25022104	RiaStar	TBM-3 S/N 13736
	CPM		
Lid – removed from container	450 - 480	B.D.	20 - 60
Container – fastened lid	820 - 860	N.T.	60 - 80
Container – lid removed	945 – 1,100	N.T.	60 - 100

Mock Tracer Spill Surveys

Two mock spills were set up by pipetting reconstituted TPOAb tracer (Lot TP3273D exp. 05JUL21) at a volume of 0.5 mL and 1.5 mL into standard laboratory weigh boats (4.5 inch x 4.5 Inch). Measurements were taken with the two survey meters followed by a wipe test at the following intervals: 1. prior to

adding tracer to the weigh boats; 2. after adding the tracer to the weigh boats 3. after the first cleanup step; and 4. after the final cleanup step. The first cleanup step included applying absorbent material to the spills for approximately one minute and then disposing of the absorbent material as ^{125}I solid waste. In the second cleanup step, Alconox was applied to the spills and left to sit for about one minute. Absorbent material was applied to the areas for one additional minute before being disposed of as ^{125}I solid waste. In the final step, new absorbent material was used to wipe up the existing moisture. This absorbent material was also treated as ^{125}I solid waste.

Ludlum 3000 measurements results indicated that contamination was present after the initial "spill" had occurred and after first application of absorbent material. Measurements taken after the final clean up step generated CPM values comparable to "pre-spill" CPMs. As seen with the Ludlum 3000, the wipe test yielded high CPM values after the initial "spill" had occurred and after first application of absorbent material. Wipe test results were below detectable levels after the final clean up step.

Results from the TBM-3 survey meter also agreed with those obtained from the Ludlum 3000. Specifically, when compared to their respective "pre-spill" values, both instruments detected high CPM values after the initial spill with levels 133% to 158% higher than "pre-spill" levels prior to the addition of Alconox and levels comparable to "pre-spill" levels once the cleanup procedure was complete (Table 3).

Table 3. Results from Mock Tracer Spill Surveys. Values for % above Pre-Spill measurements were calculated as (highest reading/highest "pre-spill" reading)x100. The RiaStar's established background of 36 CPM was used as the "pre-spill" value for gamma counter calculations. B.D. = Below Detection.

	0.5 mL Tracer Mock Spill			**1.5 mL Tracer Mock Spill**		
Mock Spill Step	**Ludlum 3000 S/N 25022104**	**RiaStar**	**TBM-3 S/N 13736**	**Ludlum 3000 S/N 25022104**	**RiaStar**	**TBM-3 S/N 13736**
	CPM (% above Pre-Spill measurement)					
Pre-Spill	381-415 (0%)	B.D.	20-60 (0%)	360-397 (0%)	B.D.	20-60 (0%)
Post-Spill	4,960-5,330 (1,284%)	35,134 (97,594%)	100-120 (200%)	16,500-17,400 (4,383%)	56,460 (156,833%)	500-600 (1,000%)
After applying absorbent material	538-572 (138%)	1,278 (3,550%)	20-80 (133%)	575-627 (158%)	3,174 (8,817%)	40-80 (133%)
After applying Alconox & drying	387-423 (8%)	B.D.	20-60 (0%)	418-451 (14%)	B.D	20-40 (-33%)

Measurement of ^{125}I Vials

When measuring vials of lyophilized and reconstituted tracer, both survey meters resulted in values significantly higher than values obtained during the Lab Surface Survey (Table. 4).

Table 4. Survey meter values for I-125 reagent vials.

Tracer Vial	µCi/Vial	Lot	Expiration Date	Reconstituted	Ludlum 3000 S/N 25022104	TBM-3 S/N 13736
				Y/N	CPM	
AChRAb	1.9	RB309	6/14/21	N	61,300	1,800
TPOAb	2.7	TP3273D	7/5/21	Y	72,000	2,000
IAA	1.1	IT304R	6/18/21	N	36,700	1,400

Conclusions

The Ludlum 3000 paired with the 44-21 Beta Gamma Probe demonstrated acceptable performance when compared to the corresponding wipe tests conducted with the RiaStar gamma counter.

When assessing contamination of laboratory surfaces, the Ludlum 3000 yielded CPM values similar to the 450 CPM reported by the manufacturer for background and wipe test results were below detection. TheTBM-3 survey meter values were typical of historic background values.

Furthermore, results from the Ludlum 3000 agreed well with those from the wipe test during the mock spill cleanup evaluation.

The TBM-3 also agreed with the Ludlum when exposed to varying amounts of ^{125}I contamination. Specifically, both handheld units resulted in relatively high readings in response to the initial mock spill and direct ^{125}I vial measurements. Likewise, when normalized for their respective background levels, both survey meters had similar relative response characteristics (i.e. reading/background) when detecting the moderate and low levels of radiation associated with the ^{125}I solid waste container and cleanup steps of the mock spills.

The findings described in this report indicate that the Ludlum 3000 and 44-21 Beta Gamma Probe, when used together, are suitable for regular use at KRONUS.