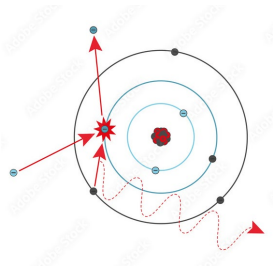
VIKEN DETECTION

Surface ("L-shell") vs. Depth ("K-shell) XRF Analyzers for Lead-in-Paint Inspections

Q: How do L-shell and K-shell XRF analyzers work?



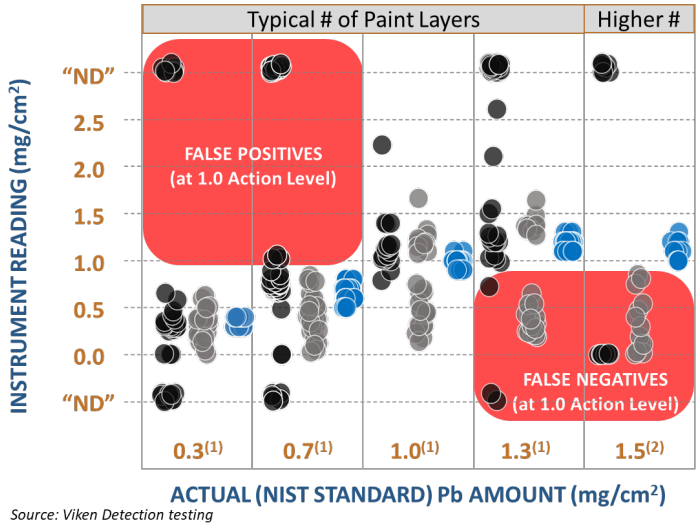
A: XRF is a proven technique in which an X-ray source excites the atoms of a target, which in turn emits electrons at element-identifiable energies. Algorithms are then used to deduce the concentration of the targeted element (i.e., Pb) over a designated area (i.e., 1.0 mg/cm^2). Where the two methods differ is that L-shell analyzers detect "lower-energy" emitted electrons, while K-shell analyzers detect "higher-energy" ones. Since the L-shell (lower) energies are more easily absorbed by overlaying paints and primers, they are commonly referred to as "surface" analyzers. On the other hand, K-shell energies can easily pass-through many layers of paint and primers and are thus referred to "depth" analyzers. Both techniques have been known to the industry for decades, and the K-shell technique has been, by far, the preferred and field-tested method. In fact, surface analyzers that rely on L-shells techniques are banned in France.

Q: For lead-in-paint inspections, is there difference in accuracy between the two types of analyzers?

A: Yes, a significant one. While surface analyzers can be reasonably accurate for Pb at or near the surface (i.e., with proper correction algorithms), the *accuracy rapidly deteriorates* when multiple of layers of certain, but common, paints and primers are applied. For example, when testing for Pb under a reasonable number of layers of commonly available paints and primers, set at the most-used action level of 1.0mg/cm^2, surface analyzers showed a ~15% false-positive rate (when the actual Pb level was 0.7mg/cm^2), and a ~15% false-negative rate (when the actual Pb level was 1.3mg/cm^2). K-shell analyzers had 0% false-positives and 0% false-negatives for the same sample set. Also, as can be seen below, the spread of L-shell analyzer readings is much wider, demonstrating the inherent inaccuracies of algorithm correction, even when correctly designating a positive or negative reading. Furthermore, when more layers are applied (which represents the existing lead-era housing stock), at an actual Pb level of 1.5 mg/cm^2, the L-shell analyzer's correction algorithm completely broke down, with a near 0 mg/cm^2 reading and 100% false negative rate (vs. 0% for K-shell). Relying on correction algorithms is risky for painted over Pb, and an inferior method to assess Pb hazards in homes with small children.

ACCURACY COMPARISON (Set @ 1.0 mg/cm^2 Action Level)

– VIKEN's Pb200i Analyzer vs. L-shell/Surface Analyzers –



VIKEN *Pb200i/K-shell/Depth Analyzer*
L-shell/Surface Analyzers

Analyzer	Actual Pb Level (mg/cm^2)	FALSE NEGATIVES	FALSE POSITIVES
VIKEN *Pb200i*	0.3		0%
	0.7		0%
	1.3	0%	
	1.5	0%	
L-shell / Surface Analyzer	0.3		< 10%
	0.7		~15%
	1.3	~15%	
	1.5	~100%	

"ND" displayed without a Pb measurement assumed to mean "Not Detected." "Positive" and "Negative" were still displayed.

Source: Viken Detection testing

Notes: (1) Reasonable # of layers of various paints & primers; (2) Higher # of layers of various paints & primers; paints/primers purchased at big box, local paint store, etc.

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Q: If this is true, then why does HUD also permit surface analyzers for their inspections?

A: Viken believes that HUD's current PCS testing methodology is insufficient to certify surface analyzers for three primary reasons:

1) The archive (or samples) used to qualify lead-in-paint analyzers were collected in 1997, and is outdated; in other words, the samples haven't been primed or painted for at least 25+ years, which is clearly no longer representative of the current housing stock
2) The archive has an insufficient sample size to test all the types of primers, paints, glazes, fillers, etc., particularly with multiple layers of paints and at low-action levels to statistically validate a surface-type L-shell analyzer (there are millions of paint, primer, filler, etc. multilayer combinations, which increases with time)
3) For buried lead, the "residual terms" used in the PCS analysis are biased and are strongly skewed to negative values; as such, it is susceptible to false-negatives, making the PCS analysis error prone for surface analyzers

To further illustrate this point, when just a few layers of galvanized paint (commonly used over rusting radiators, staircases, etc.) are placed over a 20-lb brick of pure Pb (enough to poison ~1bn children), K-shell readings are off the charts, whereas L-shell analyzers report "negative."

Q: Why should I be concerned about accuracy?

A: False-positive and false-negative readings undermine the core mission of Pb inspection programs – to protect young children from the debilitating effects of lead-poisoning. With false-positives, significantly more inspection results will be challenged by landlords (or resources wasted on unnecessary remediations), or with false-negatives, parents of young children will be given a false peace of mind that their home is Pb-free, when in fact it will not be. The financial and societal costs of Pb inspection inaccuracy, which can easily be avoided, is staggering.

Q: Isn't a tube-based system more reliable and less expensive than a radioisotope?

A: The *Pb200i* has passed the military drop test (Mil-STD810G) and is IP65 rated. X-ray tubes, similar to light bulbs, operating at higher power, burn-out and break frequently and unexpectedly. Radioisotopes do not and resourcing can be pre-scheduled, without any warranty-claim hassles (with also an instrument and calibration factory check). Thus, you don't lose time with unpredictable tube failures.

Q: What about the licensing requirement with radioisotopes?

A: Viken understands the steps and expense that goes into this process and prices our instruments accordingly. Given the very low hazard risk[3], Viken has been actively working with the NRC to remove the license requirements for the *Pb200i*. We are optimistic that we will have good news for our customers in the coming months.

Note: (3) Stanford University designates Co-57 at < 20 mCi a low hazard; the Viken Pb200i uses Co-57 at 5-6 miC, well below other K-shell analyzers (https://ehs.stanford.edu/reference/co-57-radionuclide-fact-sheet)

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Q: In addition to detection accuracy, what are the other benefits of Viken's Pb200i?

A: Several. Since the *Pb200i* is a dedicated and tailor-made Pb-analyzer, as opposed to a general-use surface analyzer altered to be one - it is lighter, more compact, and better balanced for repeated and ergonomic inspector use (for both women and men). The *Pb200i* is half the size and half the weight of other top-heavy and large surface analyzers. Furthermore, since most inspections are done on a vertical surface with one-arm extended (and with a critical requirement of a flush mount on the surface to ensure inspection accuracy), the *Pb200i*'s design (with a lower lip) is ideal for simple self-leveling with a easy and simple push. In fact, in the Canadian version of OSHA recommends that precision tools used in this way be close to 1 lb. - like the *Pb200i*.
