

## Lead Testing by XRF Frequently Asked Questions (FAQ)

The U.S. Consumer Product Safety Commission (CPSC) staff has received numerous inquiries into the proper use and interpretation of X-ray Fluorescence (XRF) for determination of lead in paint, and other similar uses.\*

There are many different XRF systems in the marketplace with highly varied power levels, filter systems, and analysis algorithms for converting raw data to user output. For any analytical equipment and technique, it is critical for the analyst to understand the capabilities, principles, and settings of the particular instrument and technique, especially with regard to the particular application and the sample in question. The underlying chemistry, physics, engineering, mathematics, and instrumental effects must always be considered when developing and implementing an analytical methodology.

The CPSC Laboratory Sciences staff has experience and knowledge of a limited number of analytical instruments within the category of energy dispersive XRFs, and their application for various elemental analyses including lead in paint. The comments that follow are based on that knowledge and experience.

**Q** The CPSC currently enforces a limit for the total lead content in paint and painted surfaces of children's products according to 16 CFR part 1303 at a level of 0.06% (which can equivalently be expressed as 600ppm). Many XRF instruments provide results in micrograms per square centimeter ( $\mu\text{g}/\text{cm}^2$ ). Can the XRF results be correlated to the requirements of the CPSC regulations?

**A** Many commercially available instruments are designed to measure lead in paint coatings on various household surfaces for inspection and abatement and report lead levels per area, as State and Federal agencies have established limits in these units. It is impossible to make a general correlation for results in  $\mu\text{g}/\text{cm}^2$  to either percent or ppm. In order to make the conversion, one needs to know the thickness and density of the paint coating in the area measured. Paint thickness and density can vary widely depending on the type of paint and the application. Furthermore, if any lead is present in the substrate, the results would be skewed.

XRF use in quantifying lead in paint for a painted surface is a challenging endeavor, as the thickness of the paint is likely to vary and to be less than the actual penetration depth of the X-rays. This is problematic for the quantitative analysis of the mass concentration of lead in the paint coating. Because the X-ray beam may penetrate into the substrate, an instrument that is set to report concentration in percent or ppm may erroneously perform calculations based on the assumption that the instrument is aimed at a homogeneous sample. Thus the composition of the substrate could either result in an apparently higher or lower concentration than is present in the paint, depending on the concentration of lead in the substrate.

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\* These comments are those of the CPSC staff, have not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

XRF can be used as a screening tool for lead in paint, but requires an understanding of this limitation and how it relates to a particular painted surface. One conservative approach to screening by XRF would be to analyze the raw data, or use a "thin-sample" mode such as for filters or wipes, or other means (depending on the instrument) to detect even low levels of lead at the surface. It would then be necessary to conduct more sensitive testing according to traditional chemical means for any samples that are questionable or that yield any positive result for detectable lead. It is also important to discern paint from substrate, or even from surface dirt. Another possibility is to scrape the paint and accumulate a large enough quantity to press a disk of paint with sufficient thickness to perform a calibrated analysis for total content by XRF.

In any case, manufacturers, importers, and retailers must meet the requirements of 16 CFR 1303, when tested by traditional chemical analysis methods for total lead, so it is important that firms develop an understanding of the capabilities and limitations of any screening method and the particular instrument used to be sufficiently conservative to prevent the "passing" of violative products. Understanding of the product itself may help in properly assessing the correct technique.

- Q Calibration of XRF is done by standard disk with known thickness and flat area to cover the XRF sampling window, as the thickness, shape and size/area of the painted surface would affect the XRF result. Because toys or other products may have irregular or curved surfaces, can XRF be used to screen such products?
- A As described above, a possible approach would be to scrape sufficient coating and press it into a similar disk as for the calibrations, or else to use XRF as a screening tool if set up in the correct analysis mode and with sufficient operator experience to understand any limitations.
- Q As paint coating is quite thin and the base material can be composed of plastic or metallic materials, would the XRF result reflect mostly the total lead content of the base material instead of the total lead content of the surface paint? For example, considering the mass dilution effect of the surface paint from the base material, would a surface paint containing 700ppm lead indicate a "positive" result?
- A As described in the first response, it can be difficult to differentiate the base material (or substrate) from the paint when analyzing directly by XRF, but it is important to do so. Once again, firms should choose an approach that is sufficiently conservative to assure compliance with applicable regulations.
- Q Is there any comparison data between XRF results and chemical test results by ICP or AAS for our reference?
- A All chemical instrumental analyses require correct sample preparation, adequate methodologies and operators with sufficient knowledge and skills to understand possible limitations, interferences and complexities and to deduce the correct interpretation of the machine-provided data. XRF, ICP (Internally Coupled Plasma Spectroscopy) and AAS

(Atomic Absorption Spectroscopy) are all useful tools in elemental analysis, but each can be used correctly or incorrectly.

Q Can XRF be used to measure lead (or other elements) in items other than paint?

A XRF instruments can be set up and operated in such a way to measure lead and many other elements in many products. For each application, however, it is important (as described above for lead in paint) that the proper methodology be used and that the intricacies of the sample, the method, the equipment, and the regulations all be properly taken into account. For instance, non-homogeneous samples, such as plated jewelry, may contain lead under a coating of copper and nickel. To screen for lead in such a product may in some cases (depending on the coating) require destructive preparation of the sample to reveal the base metal. XRF is particularly well-suited for measuring lead in homogeneous samples, such as certain plastic products which may have lead additives throughout the plastic, but it is still important to use the correct method for the instrument and sample in question.