

Screening for Lead in Consumer Products with a Handheld Thermo Scientific NITON® XL3t XRF Analyzer

The solution to eliminating lead for regulators, manufacturers, importers, distributors, and retailers – Simply Superior XRF



Introduction

What do shipping and receiving, product integrity and legal departments have in common with the U.S. Consumer Products Safety Commission (CPSC), the U.S. Environmental Protection Agency (EPA), European Union member countries, local regulators, community activists, and your customers?

The need to know absolutely whether consumer goods contain toxic materials. When you need to know the composition quickly, accurately, and precisely, a Thermo Scientific NITON XL3t 700 Series x-ray fluorescence (XRF) analyzer can provide the answer.

Lead-based paint and dust isn't the only source of childhood lead poisoning. Regulators are considering toys, dishware, jewelry, and other household items as likely co-sources of lead in children's blood.

"...any firm that purchases a product for resale is responsible for determining whether that product contains lead..."¹

The EPA is reminding manufacturers and importers that they have an obligation to notify the agency if they have information suggesting that their products pose a lead-poisoning risk to children. And the Australian Federal Government has announced random testing and fines of up to AU\$1.1 million for breaches of its previously voluntary compliance system.

While lead poisoning prevention activists are increasingly targeting retailers as the last opportunity to test and remove lead-bearing items from the market, manufacturers and brand owners are beginning to acknowledge that the further back in the supply chain testing takes place, the easier it is to prevent lead from entering the hands of a child. Insurers are threatening to drop coverage of importers who fail to implement a due diligence screening program, and the media always stands ready to announce a nationwide recall.

Lead Is Still on the Market

A startling number of lead-laden children's toys and accessories find their way to retailers' shelves.

Recalls – In the first nine months of 2007, in the United States alone and based on CPSC data, more than 18 million toys, jewelry items, and various accessories ranging from backpacks to key chains were recalled for reports of excessive lead content. Companies both large and small share the responsibility. This issue reaches worldwide, extending to Europe and Asia, where awareness and recalls are also on the rise.

Jewelry – The 2004 death of a child after his accidental ingestion of a lead locket prompted CLEARCorps, a U.S.-based non-profit advocacy group, to conduct nationwide screening for lead content of children's jewelry at the retail level. More than 8% of the tested items contained at least one component with a lead content higher than acceptable standards, with several items containing more than 60% lead.

Clothing – The 2005 recall of millions of zipper tags for excessive levels of lead created a logistical and financial nightmare for the companies involved. Even the ink on silk-screened items can contain unacceptably high levels of lead.

NITON XL3 Benefits At-a-Glance

- **Portable** – The test can occur on the finished toy, in the factory, lab, on the dock, or in the warehouse
- **Easy to use** – Any shift personnel can learn to perform the test in a matter of minutes
- **Fast** – Testing takes minutes, not days. Decisions to ship product can happen immediately
- **Non-invasive** – The analyzed product is not defaced or affected in any way
- **XRF offers a rapid GO/NO-GO test with decision based on the underpinnings of scientific study**



The paint on this wooden cross contains a high amount of lead, even though the label reads "Guaranteed non-toxic finish."

Plastics – From lunchboxes to action figures, wagon wheels to bathtub toys, plastic products containing lead as a coloring agent or stabilizer create a hazard for children. “Just in Time” manufacturing and smaller lot sizes increase the chances that one batch will contain dangerous amounts of lead, or can contribute to mixed batches containing both safe and unsafe lead-bearing items marked with the same lot number.

Ceramics & Dishware – Concern about lead in consumer products goes beyond toys and jewelry to potential hazards in ceramic mugs, pitchers, and other tableware. The major issue is with glazes, which help the products maintain their shine and rich colors. If the glaze is not sealed at a high enough temperature, lead can leach from the item, potentially resulting in high blood lead levels. Just recently, tens of thousands of mugs were recalled in Japan because the glaze contained excessive lead, and sickened at least one individual. The U.S. Food and Drug Administration (FDA) regulates the sale of lead-bearing tableware.

Other Health Risks – Small, strong magnets made of neodymium (Nd) are found in numerous consumer products for children. Though not toxic in and of themselves, these small-size magnets, in addition to their danger as choking hazards, are powerful and shatter quite easily. If ingested and allowed to pass beyond the stomach, the magnets, or the pieces of a single magnet, can attract each other through opposing intestinal walls, which can lead to obstruction, necrosis, and perforation of the intestines.

With today’s multi-vendor supply chains, it is nearly impossible to identify each source of an individual product’s components. Consequently, sole reliance on material certifications is a recipe for disaster. To reduce their risk, stakeholders should implement material testing as part of their due diligence program.

Packaging Adds to the Issue

Currently, 19 U.S. states have toxics in packaging laws that prohibit the sale or distribution of packaging containing intentionally added cadmium, lead, mercury, and hexavalent chromium, and limit the incidental concentration of these materials. Additionally, the European Union Directive 94/62/EC calls for Member States to enforce similar standards. The intent of these laws is to prevent the use of toxic heavy metals in packaging materials that enter landfills, waste incinerators, recycling streams, and ultimately, the environment.

Such vigilance requires a strong verification program at all stages of a product’s life cycle. The Toxics in Packaging Clearinghouse (TPCH) is a national organization that coordinates testing and implementation of legislation on behalf of its member states and serves as a single point of contact for manufacturers and retailers seeking information. It recently released the results of its first ever comprehensive test program of packaging in the U.S., which they conducted using a Thermo Scientific NITON x-ray fluorescence (XRF) analyzer.

Stating that “TPCH and its member states support the use of XRF technology to screen packages and packaging materials for compliance with state requirements,”² findings showed that, in fact, toxic metals in packaging are still present in the U.S. above allowed levels, with the majority of violations found in the packaging of imported products.

The Thermo Scientific Solution

Thermo Scientific NITON XRF analyzers are designed to quickly and reliably provide accurate metals analysis, and have become the worldwide standard for identifying and quantifying lead in houses, toys, and jewelry. What’s more, their powerful 50 kV x-ray tubes permit users to identify the presence of neodymium through the plating on the smallest magnets, an indication of a potential problem with the product. These are the very same tools used each day to keep products containing toxic metals from reaching consumers of electrical and electronic goods in the European Union (Restriction of Hazardous Substances, or RoHS), and for compliance with China RoHS, Korea RoHS, and California’s Proposition 65.

Handheld NITON XRF analyzers supply fast, nondestructive analysis for lead, cadmium, and more than a dozen other elements of interest in parts per million in virtually any substrate. The measurement is completed in seconds and is stored within an encrypted data stream for legally defensible results. Inspectors can screen an entire store’s inventory in a matter of a few hours, catching problems before they are placed on store shelves and, more importantly, before they end up in the hands of our children. Today, even unskilled employees are capable of turning out large amounts of quality testing data with the highest confidence in the integrity of the results.

Screening products using handheld Thermo Scientific NITON XRF analyzers provides nearly instantaneous results and can greatly reduce the need for costly, time-consuming traditional laboratory testing. In an economic environment that is as sensitive to cost as our children are to traces of lead, the NITON XL3t 700 Series offers a simple, efficient, and cost-effective portable screening solution that supplements the need to send samples to the lab.

- Simple enough for the receiving crew: just press the orange trigger. The NITON XL3t displays results on the integrated VIP™ tilting touch-screen color display in seconds.
- Stringent enough for your Product Integrity staff, with low limits of detection; all results are reported to 95% confidence.
- Strict enough for your legal department, with completely locked and encrypted data for a legally defensible documentation trail.
- Fast enough for your Production Manager, with little interruption to manufacturing cycles

The Proof Is in the Performance

Recently, we performed a study to explore the practical limits of detection for lead (Pb) in painted toys, while still maintaining the ability to also screen for seven other elements of interest.

The smallest amount of paint detected was 2.29 milligrams (mg) at 502 parts per million (ppm), which is equivalent to 1.92 mg of paint at 600 ppm.

Our conclusions show that the minimum measurable thickness of 600 ppm concentration Pb in a dry film of paint is 15 microns (µm), approximately ½ mil thick, when analyzing a sample of 8 mm in diameter or larger for 120 seconds.

$$0.77 \text{ mm}^3 / 50.3 \text{ mm}^2 = 0.015 \text{ mm}$$

$$0.015 \text{ mm} = 15 \text{ microns } (\mu\text{m}) = \text{approx. } \frac{1}{2} \text{ mil}$$

Therefore, the Limit of Detection* (LOD) of the NITON XL3t 700 is 1 microgram (µg) of lead total in a painted surface confined within the measuring

aperture of the analyzer, based on GO/NO-GO analysis, when measuring for 120 seconds.

If the analysis time is reduced to 60 seconds, then the LOD will rise with the square root of the difference in the ratio of measurement times (in this case = 2). The result is that the thinnest detectable layer of at least 8 mm diameter would be 21 microns.

$$15 \mu\text{m} * \sqrt{2}$$

$$15 \mu\text{m} * 1.4 = 21 \text{ microns} = \text{approx. } 1 \text{ mil}$$

Based on this calculation, therefore, the LOD is 1.6 µg of lead in 60 seconds measurement time.

For illustration purposes, Figures 1 through 4 show various analysis results – pass, fail, inconclusive – using different measurement times and modes.

Our testing led us to conclude that handheld XRF is the most efficient, cost effective, and practical way to screen for toxins in large volumes of toys and other consumer products. It is more comprehensive at finding restricted elements when compared with laboratory techniques, simply because more samples can be tested, in a much shorter period of time than when solely relying on laboratory analysis. The screened materials are also left intact – allowing those testing positive for toxic materials to be sent for confirmatory laboratory analysis. The tests on significant quantities of homogeneous substances will correlate nicely with certified lab values. At the same time, the “screening” test yields a simple GO/NO-GO result, with the scientific confidence in the determination to prove due diligence has been performed.

Optimized To Fit a Variety of Analysis Needs

As the longtime industry leader in handheld XRF analysis, we are uniquely capable of providing handheld non-destructive testing solutions for manufacturers, importers, distributors, retailers, and regulators worldwide.

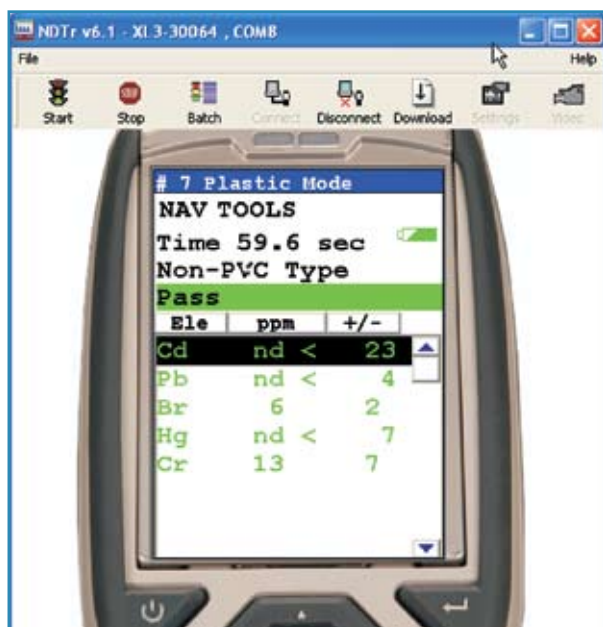


Figure 1. Example of “Pass” for all elements in Plastic Mode, Non-PVC Type sample, tested at 60 seconds



Figure 2. Example of “Fail” for lead in Plastic Mode, Non-PVC Type sample, though inconclusive for six other displayed elements of interest, tested at 8 seconds

*LOD is defined as the minimum detectable amount of an element that can be discerned from “zero” concentration with 99.7% confidence.

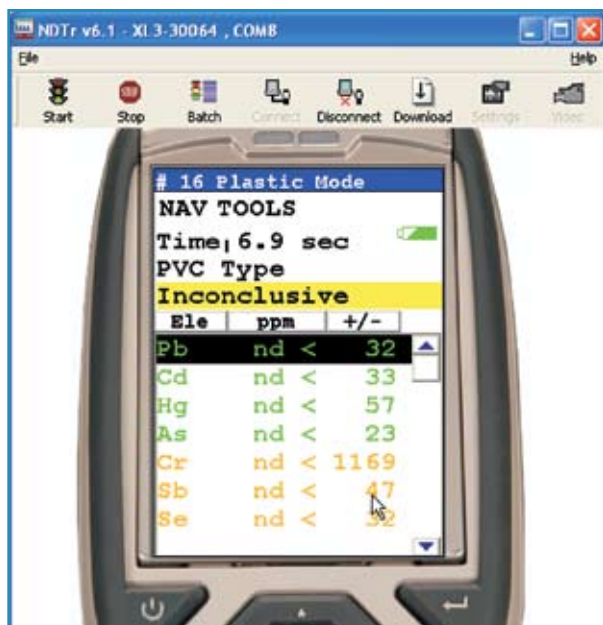


Figure 3. Example of "Pass" for lead, cadmium, mercury, and arsenic; inconclusive for the other elements of interest in Plastic Mode, PVC Type sample, tested at 7 seconds

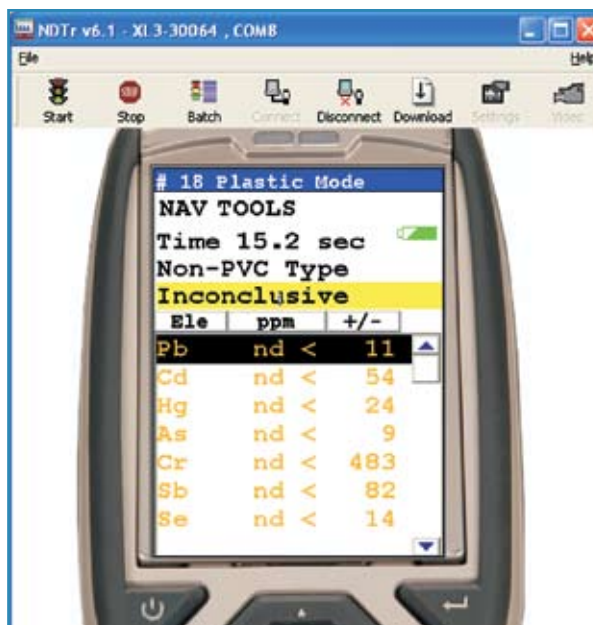


Figure 4. Example of "Inconclusive" for all elements of interest in Plastic Mode, Non-PVC Type sample, tested at 15 seconds

Thermo Scientific NITON XL3t 700 Series analyzers combine fast, reliable, repeatable elemental analysis in a fully portable instrument that is environmentally sealed against dust and moisture. The 50 kV x-ray tube, improved source filtering, and advanced analog and digital electronics produce more precise and accurate values than previous generation XRF instruments for every measured element.

Since the XRF analysis technique is non-destructive, selected samples can subsequently be analyzed using traditional lab techniques for confirmatory analysis, or when necessary to resolve vendor disputes. Increased testing permits manufacturers, distributors, and retailers to "trust but verify," translating into better compliance at lower cost than other available methods.

Optional Small Spot Analysis

The NITON XL3t features an optional small-spot x-ray area that allows users to isolate and analyze individual areas as small as 3 mm in diameter. The small-spot focus feature, combined with the first CCD camera and sample imaging system to be integrated into a handheld XRF analyzer, is ideal for positioning, analyzing, and recording the analytical results of small components or small areas of pigment – something previously only achievable with bench top XRF analyzers. The NITON XL3t displays a picture of the tested area on the instrument screen and stores the image along with the analysis data for easy reference, data management, and data integrity.

NITON XL3 700 Series Analyzers – For Confidence and Compliance

The primary goal of screening is not to accurately analyze the chemical composition of all components or parts of the product, but to weed out and eliminate from the market toys and consumer goods containing toxic elements.

Thermo Scientific NITON XL3t 700 Series analyzers are ideal screening tools, from inspection of incoming materials through analysis of finished products. By providing real-time results, they allow users to quickly verify or refute the validity of supplier certifications.

They provide importers, manufacturers, retailers, distributors, and regulators with real solutions to the problem of screening children's toys, jewelry, and other child-accessible goods for lead content, helping to promote and streamline compliance with regulatory requirements while at the same time protecting our children's health.

¹<http://www.cpsc.gov/businfolleadguid.html> US Consumer Products Safety Commission website, September 25, 2007

²"An Assessment of Heavy Metals in Packaging: Screening Results Using a Portable X-Ray Fluorescence Analyzer." *Toxics in Packaging Clearinghouse Final Report*, June 20, 2007, p. 23.

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All competitive references are based on an internal direct comparison of commercially available handheld XRF analyzers, July 2007.

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