CPSC STAFF REPORT:
EVALUATION OF LEAD TEST KITS*

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David Cobb, Kristina Hatlelid, Bhavi Jain, Joel Recht, Lori E. Saltzman

*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.

EVALUATION OF LEAD TEST KITS

I. INTRODUCTION

Lead test kits are products sold to consumers for use in detecting the presence of lead. Historically, test kits have been developed to detect lead-based paint as defined by the "Lead-Safe Housing Rule," (24 C.F.R. Part 35). Under this rule, administered by the Department of Housing and Urban Development (HUD), lead-based paint is paint or other surface coatings that contain lead equal to or exceeding 1.0 milligrams per square centimeter (mg/cm^2) or 0.5 percent by weight (equivalent to 5,000 parts per million or ppm).

Under the law administered by the U.S. Consumer Product Safety Commission (CPSC), lead-containing paint means paint or similar surface coating materials in which the lead content exceeds 0.06 percent by weight (16 C.F.R. Part 1303) (equivalent to 600 ppm). The limit for lead content of paint for products regulated by CPSC is lower than the threshold used by HUD for detecting and controlling lead-based paint in older housing. As a result, test kits that are appropriate for HUD's limit may not be useful for detecting lead paint concentrations that exceed CPSC's 0.06 percent limit but that are less than HUD's 0.5 percent limit.

The two types of test kits that are currently available are based on chemical reactions of either the **rhodizonate ion**, which produces a pink or red color in the presence of lead, or the **sulfide ion**, which produces a gray, brown or black color in the presence of lead. Both types of tests may be limited by interfering substances that can cause inaccurate results (*e.g.*, chromate may interfere with rhodizonate kits; iron may react with sulfide kits). Most test kits come with extensive instructions for use and interpretation of results. While the main use of test kits may still be to detect lead in paint, some test kit products contain instructions for adapting the test for use on materials other than paint, such as solder, vinyl, jewelry, and soil.

On several occasions since 1992, the U.S. Consumer Product Safety Commission (CPSC) staff has evaluated:

1) Whether commercially available lead test kits reliably and accurately detect the presence or absence of lead in consumer products
2) Whether test kit results accurately inform consumers about the presence or absence of lead hazards

SUMMARY OF RESULTS

Four studies conducted by CPSC staff (1992, 1994, 2003, 2007) are discussed in Attachment A. The staff evaluations have consistently indicated that:

1) The usefulness of these test kits may be limited by interfering substances that could cause inaccurate results.
2) Some kits may not reliably detect lead when it is present (false negatives) or may register a positive response in the absence of significant lead levels (false positives). A false negative is when a test kit does not detect lead even when lead is present at high amounts. For example, a clasp of a bracelet may contain over 80 percent lead and the test kits reads negative; *i.e.*, no color change, because of the non-leaded metal plating over the lead base. A false positive is when a test kit displays a positive result by a change in color and there is no or little lead in the item. For example, a painted item may produce a positive test result, but

actually contain only very low levels of lead (*i.e.*, less than the CPSC lead-containing paint standard of 0.06 percent), or no lead at all. The color change in the test kit may result from interference by other chemicals in the item.

3) Even when used for screening, a positive result with a test kit merely indicates that lead might be present, but not the quantitative level, or if a potential risk exists.
4) Even as a screening test, a negative result with a test kit does not assure a consumer that lead is not present in the product, and if it is, whether its presence might pose a hazard under certain uses of the product.
5) Most, if not all, of the test kits were developed to detect lead in paint and may not be appropriate for use with other materials such as metal jewelry or vinyl products. Some kits now include instructions for testing products such as jewelry that call for placing items in vinegar for 4 hours or that suggest using fine sandpaper to score the surface of the metal. These procedures may adversely affect the appearance and usability of tested items, and other chemical compounds in some materials may interfere with obtaining valid test results.
6) Test kits that may be appropriate for use in evaluations using HUD's limit (*i.e.*, detection of lead in paint that exceeds 0.5 percent/5,000 ppm) may not be useful for detecting lead concentrations near the lower CPSC lead-containing paint limit (0.06 percent/600 ppm).
7) In a limited study (2007), X-ray fluorescence spectrometry (XRF) correctly identified the presence or absence of lead for 12 out of 13 samples, with one false negative for a sample of metal jewelry with nickel and copper plating.

CONCLUSIONS

The staff generally does not recommend the use of consumer lead test kits because testing has shown that some kits may not reliably detect lead when it is present (false negatives) or may register a positive response in the absence of significant lead levels (false positives). Because of their unreliable performance, consumers should exercise caution in relying on these test kits to evaluate consumer products for potential lead exposures or hazards. Professional application of XRF technologies may be a useful way to screen for the presence or absence of lead in products, particularly for surface level lead. XRF detectors have limited depth of penetration so, for certain applications, such as children's metal jewelry, it is possible for the surface coating to mask the presence of potentially hazardous leaded base metal underneath, resulting in a false negative test.

The staff believes that laboratory analysis remains the only accurate and reliable way to detect and quantify lead in products and assess any possible risk posed by use of these products.

ATTACHMENT A
CPSC STAFF LEAD TEST KIT STUDIES

CPSC staff conducted evaluations of lead test kits in 1992, 1994, 2003, and 2007. A brief description of these studies and their results is presented here.

NOVEMBER 1992

Staff conducted a limited comparison of four test kits evaluated for their ability to detect lead in latex based and oil based paint.

Conclusion

The reliability of the kits cannot be assured due to substances in older paint that may interfere with lead detection.

SEPTEMBER 1994

Nine test kits (both chemical types) were used to test for the presence or absence of lead in a set of six alkyd oil-based paint standards prepared by CPSC's Directorate for Laboratory Sciences, Division of Chemistry (LSC) staff (at lead concentrations of 0.0 percent, 0.06 percent, 0.10 percent, 0.50 percent, 3.0 percent, and 5.0 percent), 34 paint samples collected from various sites in Washington D.C., and 90 paint samples collected from the Denver metropolitan area.

Conclusion

Some kits did not reliably detect lead even at relatively high levels (false negatives), or registered a positive response in the absence of significant lead levels (false positives).

Based on the studies, CPSC and the U.S. Environmental Protection Agency (EPA) stated the following in their joint booklet, "Protect Your Family from Lead in Your Home (1995, later updated in 2001 with HUD added as a cosponsor): **"Home test kits for lead are available, but may not always be accurate. Consumers should not rely on these tests before doing renovation or to assure safety."**

JULY 2003

Five test kits were evaluated (both types) on standard paints prepared by LSC staff using two lead pigments with known concentrations (0 to 0.5 percent lead by weight). Different pigments were used because their solubility was believed to effect the tests' performance (lead carbonate is relatively soluble and lead chromate, relatively insoluble). Samples of painted children's products previously obtained for other investigations were also tested (lead content determined by standard analytical techniques to range from below the limit of detection to >10 percent).

During this study, two staff members with no experience with test kits and no training in chemistry used the kits according to manufacturer directions. These users were considered to represent typical consumers.

Results

- None of the kits consistently detected paints containing greater than 0.06 percent lead.
- No kit performed well with lead chromate.
- One kit that performed the best at identifying lead-containing paint also incorrectly gave positive results for paints that contained no lead or very low levels of lead.

- Users had difficulty understanding the instructions for kits and reported that some were physically difficult to work with.
- Users reported difficulty interpreting the sometimes faint or uneven color changes (one kit registered at least a slight color change on most of the standard paints, so it was not clear what a positive response should look like).
- Rhodizonate ion based tests performed poorly with red paint due to interference of the paint color with the reaction color.

Conclusion

Staff does not recommend the use of consumer lead test kits because testing shows that some kits may not reliably detect lead when it is present or may register a positive response in the absence of significant lead levels. Because of their poor performance, the staff does not believe that consumers would benefit from using these test kits. Staff believes that laboratory analysis remains the only reliable way to detect products that violate the CPSC's mandatory lead in paint standard and the Federal Hazardous Substances Act.

SEPTEMBER 2007

Four test kits were evaluated (two each of both types) using some of the standard paints prepared by LSC staff for the 2003 study. Two samples were paint containing lead chromate at 0.1 percent or 0.5 percent lead, each covered by a layer of non-leaded paint (0 percent lead), and two samples were paint containing lead carbonate at 0.1 percent or 0.5 percent lead, each covered by a layer of non-leaded paint. A fifth standard paint sample was lead carbonate with 0.5 percent lead, but was not covered by a layer of non-leaded paint, and a sixth sample was non-leaded paint. Samples of children's products were selected from sample storage: one red crayon (lead content: <0.001 percent); one yellow crayon (0.111 percent); two parts of a PVC lunchbox (0.002 percent, 0.712 percent); one jewelry pendant (82.8 percent); one jewelry hook (79.8 percent); and one steel washer (no lead). Two staff members, one with no experience with test kits or training in chemistry and one chemist, used the kits according to manufacturer directions.

X-ray fluorescence spectrometry (XRF) was also used on the same samples to determine its usefulness in screening for lead in consumer products.

Results

- All four test kit products detected lead in the standard paint sample with 0.5 percent lead carbonate with no top coat.
- None of the kits consistently detected the lead in the other standard paint samples that had a non-leaded paint top coat.
- Of the 104 total test results, 56 were false negatives.
- Two false positive results, one each for the two rhodizonate ion-based test kits, occurred with testing a red sample, possibly due to interference of the sample's color with the reaction color.
- XRF correctly identified the presence or absence of lead for 12 out of 13 samples, with one false negative for a sample of metal jewelry with nickel and copper plating.
- Procedures for the sulfide ion-based kits called for placing jewelry items in vinegar for 4 hours; the procedure for one of the other kits called for using fine sandpaper to score

the surface of metal alloys; these procedures may adversely affect the appearance and usability of jewelry items.

Conclusion

The results of this activity showed that commercially available lead test kits may not reliably detect the presence of lead in consumer products such as metal jewelry, PVC lunchboxes, crayons, or paint. Test kits may also indicate the presence of lead where there is none, because sometimes the product's colors interfere with color changes of the test. Although not observed in this small study, other chemical interferences may cause a positive result in the absence of lead.

False negatives proved to be an issue with this study as well, with the test kits failing to detect more than half the lead-containing samples. The negative results may be due to the detection method of the kits and to the types of samples chosen for the study. Specifically, the presence of coatings, such as layers of paint or metal plating over the lead-containing materials, could block the detection of the lead.

Finally, professional use of XRF technologies may be appropriate for screening for the presence or absence of lead in products, particularly for surface level lead. However, XRF detectors have limited depth of penetration, so it is possible for surface coatings or platings to mask the presence of potentially hazardous leaded base metal underneath.