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Investigation of Test Kits for Detection of Lead in Paint, Soil and Dust

INVESTIGATION OF TEST KITS

FOR DETECTION OF LEAD IN PAINT, DUST, AND SOIL

by

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EXECUTIVE SUMMARY

INTRODUCTION

Lead test kits offer an alternative or complement to portable X-ray fluorescence and atomic spectroscopic methods for detection of lead in paint, soil and dust. Several potential advantages of test kits include being inexpensive, rapid, requiring minimal technique and responding to low levels of lead. In light of these potential advantages and the growing need for performance of lead analysis, a study of commercial test kits available as of fall 1990 was performed during 1991. The intent was to perform an initial study of the general behavior and responsiveness of all kits to the same but a limited number of test parameters and materials. No attempts were made to control specific experimental parameters such as pH, ionic strength, or temperature (since these parameters would not be controlled in the field), or to specifically identify or investigate sources of unexpected results. The manufacturer's instructions provided with the test kits were followed without modification for performance of these evaluations.

TEST KIT IDENTIFICATION

Through a search of the literature, trade journals and contact with experts, five test kits were identified. These are:

- LeadCheck [original and new] (Hybrivet Systems)
- Verify LeadTest (Verify, Inc.)
- Frandon Lead Alert (Frandon Enterprises)
- Merck EM Quant [Methods A and B] (EM Science)
- The Lead Detective (Innovative Synthesis Corp.)

The first four kits utilize the reaction between lead ion and rhodizonate ion to form a pink complex. The last utilizes the reaction between lead ion and sulfide ion to form

black lead sulfide.

TEST KIT INVESTIGATION

A relatively simple series of tests was performed to evaluate the following:

- response relative to test sample lead content
- potential metal interferences
- potential salt interferences
- response to laboratory-prepared and real-world paint, dust and soil samples
- color stability
- ease/correctness of use by non-technical personnel

Levels of Response

The lowest levels of lead resulting in positive responses (lower levels of response) were determined by testing each kit with 10 to 80 µL aliquots of lead solution placed on microscope slides. The rhodizonate-based kits had lower levels of response ranging from 0.2 to 1.0 µg Pb^{2+} whereas the sulfide-based kit had a lower level of response of approximately 2 µg Pb^{2+}. It was noted that the chemical form of the lead (i.e., $Pb(NO_3)$ or $PbCl_2$) may have some effect upon the response of the kits. The differences between the amounts of lead yielding all negative responses and the amounts yielding all positive responses were approximately 0.2 µg for the rhodizonate-based kits and about 0.5 µg for the sulfide based kit.

Metal and Salt Interferences

Responses of the kits to a variety of metals and salts were tested for false positive (color formation) results. Also, several of these species were combined in solution with lead to test for false negative (color suppression) results. Ba^{2+} and Ni^{2+} gave false

positive results with the rhodizonate kits tested, whereas NaCl, KNO_3, $NaNO_3$, $KC_2H_3O_2$ and $NaC_2H_3O_2$ all appeared to cause color suppression (gave false negative results) with the rhodizonate kits tested.

The sulfide-based Lead Detective kit showed positive response to Ag^+, Cd^{2+}, Co^{2+}, Cu^{2+}, Fe^{3+}, Hg^{2+}, Ni^{2+}, and Tl^{2+}, all of which are known to form insoluble sulfides.

Response to RTI-Prepared Paint Films and Dusts

A series of oil-based paint films spiked with white lead were tested. The responses varied from kit to kit. For the four rhodizonate kits, values of 0.6 to 1.9 mg/cm^2 resulted in all negative response, whereas values of 1.2 to 2.6 mg/cm^2 resulted in all positive responses. The sulfide-based kit yielded a positive responses with the lowest level prepared $(0.11\ mg/cm)^2$.

Several synthetic dust samples were prepared by mixing lead nitrate, Arizona road dust and cotton linters. The different brands of kits also varied in their response to this material. The LeadCheck and Frandon Lead Alert kits went from all negative responses at 200 µg/g to all positive responses at 500 µg/g with these samples; the Verify LeadTest, Merck EM Quant and Lead Detective went from all negative responses at 500 µg/g to all positive responses at 1000 µg/g. With these dust samples, it was noted that the response of the sulfide-based Lead Detective kit (formation of dark lead sulfide) was difficult to differentiate from the darkness of the sample itself.

Response to Real-World Dust, Soil, and Paint Samples

Real-world dust and soil samples from EMSL-EPA/Las Vegas were tested. Only a limited number of samples was available over the range of 60 to 21,000 µg/g lead for the dust and 330 to 15,000 µg/g lead for the soil. All four rhodizonate-based kits showed all negative responses at 2,300 µg/g and all positive responses at 21,000 µg/g with the dust samples. The sulfide-based Lead Detective yielded all positive response with the dust sample having the lowest lead level, 60 µg/g.

The response to the soil samples was more variable. For the four rhodizonate kits, the levels of lead yielding all negative responses varied from kit to kit and ranged from 330 µg/g lead to 3,400 µg/g lead. For these same kits, levels yielding all positive response varied from 1,000 to 6,400 µg/g lead. The Lead Detective yielded all negative responses at 330 µg/g lead and all positive responses at 1,000 µg/g lead.

The kits yielded all positive responses to real-world paints that were in the range of 1.8% to 5.5% lead.

Color Stability Tests

The rhodizonate-based kits were tested with respect to time stability of the color developed. All kits showed no fading for at least 15 minutes after reaction with lead.

Non-Technical User Tests

Two non-technical staff members were provided with kits, written procedures and RTI-prepared paint films and dusts for analysis. Each was instructed to perform duplicate analyses. Considerable variability in results was observed even at the highest concentration levels tested. Examples of problems noted by an experienced observer included:

- not following instructions
- variation in firmness of rubbing paint samples
- selecting different sample sizes
- making different decisions about whether a color change actually occurred.

Relationships to Proposed Performance Targets

Performance targets have been proposed by the EPA for performance of test kits for different media. These targets are as follows:

Paint (for abatement)	95% pos at 0.7 mg/cm^2 95% neg at 0.1 mg/cm^2
Dust	95% pos at 450 µg/g 95% neg at 150 µg/g
Soil	95% pos at 450 µg/g 95% neg at 150 µg/g

In general, the rhodizonate-based kits did not respond at the positive concentration targets for paints, dusts, and soils, although LeadCheck and Frandon Lead Alert were very close for synthetic RTI dust.

The Lead Detective sulfide-based kit showed positive responses at the negative response targets for paints and real-world dusts, but did not respond at the positive response target concentrations for real-world soils and synthetic dusts.

GENERAL CONCLUSIONS

The results of this limited investigation support the following general conclusions:

(1) All kits tested generally respond to less than 1 µg of Pb^{2+} in solution.

(2) Positive interferences were not found for the rhodizonate kits for the limited set of paint, dust, and soil samples used in this study. However, barium may be a positive interferant in some paints.

(3) The dark colors of certain dusts masked observation of formation of lead sulfide at low levels with the Lead Detective Kit. Positive responses with the Lead Detective resulted from Ag^{+}, Co^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Hg^{2+}, Ni^{2+}, and Tl^{2+}. Many of these metals may be found in paints, dusts, and/or soils.

(4) The kits generally showed response only to high levels of lead with real-world dusts and soils. They also showed variability in responses to dust and soil having similar concentrations. It is probable that these limitations reflect low and also sample-specific variability in lead extractability and/or negative interference from other constituents in the sample matrix and/or shifts in the pH, ionic strength, etc.

(5) All kits showed adequate stability (>15 minutes) of the developed color.

(6) Tests with untrained, non-technical personnel showed significant variability in usage, and consequently, in results.

(7) The measured response ranges (negative to positive) of the rhodizonate-based kits are generally above the targets set by EPA for paint, soil and dust. The sulfide-based kit yielded positive responses to "blank" paint and therefore RTI response ranges were below the targets. For EPA dust, the sulfide-based kit gave responses below the targets, but for RTI dust and EPA soil responses were above the targets.

RECOMMENDATIONS

As a result of this evaluation of the test kits, several recommendations can be made. The first is that the results of this evaluation should be made known to test kit manufacturers so that they can use the data as the basis for improvements in the test kits including (1) improving the instructions provided with the kits, (2) improving the lead extractability of the kits, and (3) providing quality control check samples with each lead kit. This recommendation will, in fact, be carried out through distribution of this report after final approval.

It is anticipated that the lead extractability of the test kits designed for use by consumers can never be quantitative (i.e., >90 percent) since the reagents used to dissolve lead from old paint, dust and soil would be moderately acidic or caustic and therefore unsafe for home use.

Therefore, a second recommendation is that quantitative extraction procedures be developed for paint, soil and dust that could be used as part of quantitative kits designed for professional testers. Measurement would not be confined to the rhodizonate or sulfide colorimetric procedures, but could include field-portable instrumental methods such as electrochemical methods.

If these recommendations are implemented, there should be two types of kits

available. The first type would be suitable for consumers to use in screening for the presence of unacceptable levels of lead. The second would be a quantitative kit for professionals to use to decide whether there is a need to abate or remove paint and/or soil, and also to decide if the levels in house dust are sufficiently low after abatement to allow reoccupancy (i.e., that the dwelling has met clearance requirements).

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SECTION 1
INTRODUCTION

1.1 BACKGROUND

The adverse health effects resulting from exposure of young children to environmental lead have received increasing attention in recent years. Studies have shown that chronic exposure, even to low levels of lead, can result in impairment of the central nervous system, mental retardation, and behavioral disorders.[1] Although young children are at the greatest risk, adults may suffer harmful effects as well.[2]

In the United States, the major sources of exposure to lead in public and private housing are thought to be paint, dust and soil.[3] Food, water, and airborne lead are also potential sources, but are considered to be minor avenues of exposure.[4] Currently, lead-based paint is receiving emphasis as a critical material of concern and a principal medium for lead contamination and exposure. It is particularly significant when painted walls, woodwork, and furniture are accessible to young children to touch and to chew. Soil and dust are also significant routes of exposure.[5] Soil, which is often contaminated with lead from petroleum additives, industrial sources, or from the leaching of exterior paint (near driplines), may be a source of exposure outside dwellings, or it may be tracked into dwellings. Lead-contaminated dust in the dwelling will most likely be a mixture of this tracked-in soil and typical house dust (fibers, hair) contaminated with lead from deteriorating interior paint.[6] Concentrations of lead in paint, dust, and soil must be determined if a comprehensive approach to reducing the problem of lead exposure from housing sources is to be developed.

Under Section 302 of the Lead-Based Paint Poisoning Prevention Act, as amended, Public Housing Authorities (PHA's) are required, by 1994, to randomly inspect all their housing projects for lead-based paint.[7] The most common approach currently used to

test for lead in housing is portable X-ray fluorescence (XRF). The method is relatively inexpensive to perform (5 - 10 minutes of labor per test), easy to use, and gives results rapidly. Depending on the type of XRF used, this method requires scraping only small sections of paint to obtain a substrate or background value, or is totally non-destructive. Inconclusive XRF measurements must be confirmed with field-collected samples back in the laboratory, using a more accurate analytical method such a atomic absorption spectrophotometry (AAS) or inductively coupled plasma emission spectrometry (ICP).[8] Though XRF is currently the most commonly used field method for determining the levels of lead present in lead-based paint, the method has limitations. One of these is that the substrate material (material under the paint) has significant effects on the overall efficiency of production and measurement of the lead X-rays. Another limitation is that the XRF measures in terms of area concentration, that is, mg Pb/cm^2, whereas health effects or risks are considered to be related to mass concentration, or $\mu g/g$.[9]

A possible alternative or complement to the XRF is a chemical test kit. A chemical test kit brings some chemical reagent into contact with the sample matrix; the reagent then reacts with the lead resulting in a visual change. Simple chemical tests have long been used to indicate the presence of a particular chemical species. Fiegl reports several methods for identifying the presence of lead.[10] The two most common commercial approaches taken by lead test kits involve either (1) reaction between solubilized lead ion and rhodizonate ion to form a pink complex, or (2) reaction between solubilized lead ion and sulfide to form black lead sulfide (PbS). General advantages of lead test kits are as follows:

- Inexpensive ($0.50 - $2.00/test for materials [1993 costs]; 1 to 5 minutes/test for labor)
- Rapid
- Requires minimal operator technique
- Responds to μg levels of analyte

- Generally selective for lead.

In light of these potential advantages and the growing need for performance of lead analysis, a study of commercial test kits available as of fall 1990 was performed during 1991. The intent was to perform an initial study of the general behavior and responsiveness of all kits to the same but a limited number of test parameters and materials. No attempts were made to specifically identify or investigate sources of unexpected results. The manufacturer's instructions provided with the test kits were followed without modification for performance of these evaluations.

1.2 IDENTIFICATION OF AVAILABLE TEST KITS

The first part of the study involved an attempt to identify all commercially available test kits for lead designed for the homeowner and/or professional tester. At the start of this project, it was generally believed that five, six, or seven test kits were available. However, no one individual contacted knew of all of these kits by name. Steps to identify test kits included the following:

(1) A general literature search

(2) A search of catalogs of analytical instrument and analytical reagent suppliers

(3) Contacting experts in the field identified through previous preparation of the three documents, "Options for a Lead Analysis Laboratory Accreditation Program,"[11] Options for a Lead Test Kit Certification Program,"[12] and "Performance Criteria for Lead Test Kits and Other Analytical Methods"[13]

(4) Contacting referrals from first level contacts.

A list of contacts and results of the search are presented in Appendix A. Most of the test kits identified were designed, however, for testing for lead in water. Five test kits listed

below were identified as suitable for solids such as ceramics, paint, dust and soil.

Brand of Kit	Intended User
LeadCheck (original - large swab; new - marker pen type) HybriVet Systems P. O. Box 1210 Framington, MA 01701	Homeowner and professional
Verify LeadTest Verify, Inc. 1185 Chess Drive, Suite 202 Foster City, CA 94404	Homeowner
Frandon Lead Alert Frandon Enterprises, Inc. P. O. Box 300321 Seattle, WA 98103	Homeowner
Merck EM Quant EM Science Gibbstown, NJ 08027	Professional
The Lead Detective Innovative Synthesis Corp. 45 Lexington St., Suite 2 Newton, MA 02165	Homeowner and professional

The procedures and other literature provided with these kits are presented in Appendix B. The principal elements of these kits and brief descriptions of their usage are presented in Table 1.

1.3 APPROACH TO TEST KIT EVALUATION

As noted in Section 1.1, this was a preliminary, limited investigation of the responsiveness of several commercially available test kits. The intent of this limited

Table 1. Summary of Lead Test Kit Procedures

Test Kit	w/ Paint Films	w/ Soils/Dust (~10 mg)	w/ Aqueous Soln's (~50 µL)
LeadCheck Original	Cut or scrape through all layers paint. Wet applicator with 2 drops Activator Soln; rub test area 30 sec., check for pink color.	Soak 1 gm soil in 2 mL 4% acetic acid for 30 min. Wet applicator with 2 drops Activator Soln; rub soln (~50µL) for 30 sec; check for pink color.	Wet applicator with 2 drops Activator Soln; rub soln (~50µL) for 30 sec; check for pink color.
New	Crush two vials inside swab; shake, squeeze, rub paint chip for 30 sec.; check for pink color on swab.	Rub dust with dry swab. Crush vials inside swab; shake, squeeze, rub tip on plastic dish (weigh boat); check for pink color on swab.	Crush vials inside swab; shake, squeeze, rub soln for 30 sec.; check for pink color.
Verify LeadTest	Soak paint chip in 5 mL extract soln for 24 hr. Dip LeadTest strip in, remove, allow to dry; check for pink color.	Soak soil in extract soln (enough to cover surface) for 24 hr. Dip LeadTest strip in, remove, allow to dry; check for pink color on strip.	Dip LeadTest strip into soln. Allow to dry and check for pink color.
Frandon Lead Alert	Put 2 drops of Leaching Soln and 2 drops of Indicating Soln on swab. Rub paint chip. Check for pink color.	Put dust on filter paper. Add 2 drops Leaching Soln. Wait 10 min. Add 2 drops Indicating Soln. Check for pink color.	Put 2 drops of Leaching Soln and 2 drops of Indicating Soln on swab. Rub soln. Check for pink color.
Merck EM Quant A	Put 2 drops of reagent on paint chip. Wait 1 min. Press test strip on surface. Wait 1 min. and check for pink color.	Put 2 drops reagent on dust. Wait 1 min. Press test strip into sample. Wait 1 min. and check for pink color.	Dip test strip into soln. Wait 1 min. and check for pink color.
B	Moisten test strip with 1 drop reagent. Press to paint chip. Wait 2 min. and check for pink color.	Moisten test strip with 1 drop reagent. Press into sample. Wait 2 min. and check for pink color.	Dip test strip into soln. Wait 1 min. and check for pink color.
Lead Detective	Add 2 drops sodium sulfide to paint chip. Wait 2 min. and check for dark color development.	Add 2 drops sodium sulfide to dust. Wait 2 min. and check for dark color development.	Add 2 drops sodium sulfide to soln. Wait 2 min. and check for dark color development.

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study was to test the kits in a manner reflecting the ways they would be used in the field by normal users. No attempts were made to control specific experimental parameters such as pH, ionic strength, or temperature since these parameters would not be controlled in the field. Variables that would affect the response of the test kit applicators such as wetting or wicking capabilities, applicator volume and density, and construction materials used, were not evaluated. Also, uniformity of response between individual kits of a given brand was not tested.

The manufacturers' instructions were followed without modification, and no attempts were made to specifically identify or investigate sources of unexpected results. Tests were performed to measure the response to different levels of lead in standard solutions, measure the response to potential interferences from a select group of metals and salts, the stability of formed color, and responses to different types of laboratory-prepared and real-world samples including paints, dusts, and soils. Standard lead solutions were used to characterize the responsiveness of the kits because they allowed simple variation in test sample lead content without the presence of potential interferences.

A brief study of the literature accompanying the test kits revealed them to be designed for qualitative or screening analyses only, except for the Merck EM Quant kit, which provides numerical results when used for water samples. Because there were qualitative tests and also, because only small numbers of tests (2 to 5) would be made under any one set of conditions, it was decided that application of any extensive statistical test design to this investigation would be unwarranted.

SECTION 2
EXPERIMENTAL PROCEDURES AND RESULTS

2.1 INTRODUCTION

As stated in Section 1.3, the intent of this limited study was to test the kits in a manner reflecting their use in the field by homeowners and professional testers, with the outcome being identification of both positive attributes and limitations of the kits. Therefore, a relatively simple series of tests was performed to evaluate the following:

- response relative to test sample lead content
- potential metal interferences
- potential salt interferences
- response to laboratory-prepared and real-world paint, dust and soil samples
- color stability
- ease/correctness of use by non-technical personnel.

2.2 LOWER LEVEL OF RESPONSE

2.2.1 Experimental Procedure

First to be determined was the range of test sample lead content over which the test kit responses went from negative to positive. This experiment was intended to result in estimates of the identification limits of the kits (i.e., lower level of positive response). This procedure involved placing different volumes (10 to 80 µL) of standard lead solutions of known concentration on glass microscope slides, and then testing for the lead content of these droplets following the procedures provided with the kits (see Appendix B). Solutions were used so as to test the kit responses to only Pb^{2+} ion.

Questions of solubilization of Pb^{2+} from the sample and interferences from other metals were avoided in this evaluation step. The test kit applicators were found to be wetted, though not saturated, with < 100 µL of solution. Therefore, it was assumed that the response of the kits was principally a function of the total amount of lead in the droplets and not the concentration, if the droplets were kept below 100 µL. Generally, each kit was tested in triplicate with each level of lead.

Standard lead solutions of 10 µg/mL and 100 µg/mL were prepared from dilution in deionized water of Fisher 1000 µg/mL atomic absorption standard that was prepared from lead nitrate in 2% nitric acid. This material was chosen because it was a NIST-traceable standard for lead. Test solutions were also prepared from solid $PbCl_2$. No effort was made to adjust pH or control ionic strength of either the nitrate or the chloride solutions. The amounts of test kit leaching and indicator solutions used were in accordance with the procedure provided with each individual kit.

The amounts of lead used for each level varied with the brand of the kit tested, and the incremental changes in test sample lead content were of a magnitude such that the transition from negative to positive response occurred over one to four increments. Smaller increments would have yielded a more accurate characterization of the transition, but use of smaller increments was not assumed to be necessary for this preliminary investigation.

The $Pb(NO_3)_2$ samples were tested first. If the first lead level tested yielded all negative responses, then levels were increased until two to three successively increasing levels of lead showed all positive responses. On the other hand, if the first level tested yielded all positive responses, then levels were decreased until two to three successively decreasing levels showed all negative responses. Finally, if the first level tested yielded a mixture of negative and positive responses, both lower and high levels were prepared and tested. The $PbCl_2$ levels tested matched the $Pb(NO_3)_2$ levels in terms of levels of lead.

2.2.2 Results and Discussion

The results of the response tests with standard $Pb(NO_3)_2$ and $PbCl_2$ solutions are presented in Appendix C and summarized in Table 2. The amounts of lead just yielding a majority of positive responses were as follows:

Kit	Amount of Pb (µg) Just Yielding Majority of Positive Responses	
	$Pb(NO_3)_2$	$PbCl_2$
Verify LeadTest	0.2	0.2
Frandon Lead Alert	0.6	0.2
Merck EM Quant	0.6	Not Tested
LeadCheck (new)	0.8	0.5
Lead Detective	2.0	1.0

The kits appeared to be more responsive to Pb^{2+} solutions prepared from $PbCl_2$ than those prepared from $Pb(NO_3)_2$, especially the Frandon Lead Alert kit. Some difference might be expected due to variation in the pH of the test solutions, though there was no explanation for the large differences with the Frandon Lead Alert kit. Subsequently the experiment was repeated with solutions of $Pb(NO_3)_2$, $PbCl_2$ and $Pb(C_2H_3O_2)_2$ using the Frandon Lead Alert and Lead Detective kits. Results of this experiment are presented in Appendix D. Table 3 compares these results with the first test results shown in Table 2. This time the response of the Frandon Lead Alert kit was very similar for $Pb(NO_3)_2$ and $PbCl_2$, that is, all positive responses at 0.3 µg lead. One possible explanation is that the Frandon test kit reagent (which has a stated shelf life of about 5 days) was several days old when the first experiment was performed; the reagent used in the second experiment was prepared just prior to its use. The range from all negative to all positive responses was greater for the acetate than for the nitrate and chloride species for the Frandon Lead Alert kit.

Table 2. Response of Lead Test Kits to Pb^{2+} Solutions Prepared from $Pb(NO_3)_2$ and $PbCl_2$

Test Kit	Total µg Pb(II)												
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	2.0	3.0	4.0
$Pb(NO_3)_2$													
Frandon Lead Alert	N,N,N	N,N,N	N,N,N	N,N,N	N,N,N	P,P,N,P	P,P,P	P,P,P	--	--	--	--	--
LeadCheck (Original)	--	--	--	--	N	--	--	--	--	P	P	P	P
LeadCheck (New)	--	--	--	N,N	N,N,N	--	--	P,P,N,P	--	P,P,N,P	P,P,P	P,P	--
Verify LeadTest	N,N,N	N,P,P	P,P,P	P,P,P	P,P,P	--	--	--	--	--	--	--	--
Merck EM Quant (A)	N	--	--	N	N	P	P	--	P	--	--	--	--
Lead Detective	--	--	--	N,N,N	N,N,N	--	--	--	--	P,N,N	P,P,P	P,P,P	P,P,P
$PbCl_2$													
Frandon Lead Alert	?,N,N	P,N,P	P,P,P	P,P,P	P,P,P	P,P,P	P,P,P	P,P,P	--	--	--	--	--
LeadCheck (Original)	--	--	--	--	?	--	--	--	--	P	P	P	P
LeadCheck (New)	--	--	--	N,P,N	P,N,P,P	--	--	P,P,P	--	P,P	--	--	--
Verify LeadTest	?,N,N,P	P,P,P	P,P,P	P,P,P	P,P,P	P	--	--	--	--	--	--	--
Lead Detective	--	--	--	N,N	N,N,N	--	--	--	--	P,P,P	P,P,P	P,P,P	P,P,P

N = Negative P = Positive ? = Equivocal

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Table 3. Response of Lead Test Kits to Pb^{2+} Solutions Prepared from $Pb(NO_3)_2$, $PbCl_2$ and $Pb(C_2H_3O_2)_2$

Comparison of First and Second Test Results

Test Kit	Total µg Pb(II)												
	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0	2.0	3.0	4.0
$Pb(NO_3)_2$													
Frandon Lead Alert*	N,N,N	N,N,N	N,N,N	N,N,N	N,N,N	P,P,N, P	P,P,P	P,P,P	--	--	--	--	--
Frandon Lead Alert**	N,N,N	N,N,P	P,P,P	P,P,P	P,P,P	--	--	--	--	--	--	--	--
Lead Detective*	--	--	--	N,N,N	N,N,N	--	--	--	--	P,N,N	P,P,P	P,P,P	P,P,P
Lead Detective**	--	--	--	--	--	--	--	--	--	N,N,P	N,P,P	P,P,P	P,P,P
$PbCl_2$													
Frandon Lead Alert*	?,N,N	P,N,P	P,P,P	P,P,P	P,P,P	P,P,P	P,P,P	P,P,P	--	--	--	--	--
Frandon Lead Alert**	N,N,N	N,N,N	P,P,P	P,P,N	P,P,P	P,P,P	--	--	--	--	--	--	--
Lead Detective*	--	--	--	N,N,	N,N,N	--	--	--	--	P,P,P	P,P,P	P,P,P	P,P,P
Lead Detective**	--	--	--	--	--	--	--	--	--	N,N,P	N,P,P	P,P,P	P,P,P
$Pb(C_2H_3O_2)_2$													
Frandon Lead Alert**	N,N,N	N,N,N	N,P,P	N,N, N,P,P	N,P,P, P	P,P,P	--	--	--	--	--	--	--
Lead Detective**	--	--	--	--	--	--	--	--	--	N,N,P	N,P,P	P,P,P	P,P,P

*First test results

**Second test results

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2.3 METAL ION INTERFERENCE TESTS

2.3.1 Introduction

Paints, soils and dusts may contain species other than lead that react with the rhodizonate or sulfide to form a colored product and thus yield false positive results. Species reported to react with rhodizonate include Ag^{+}, Hg^{2+}, Tl^{+}, Pb^{2+}, Cu^{2+}, Cd^{2+}, Zn^{2+}, Ba^{2+}, and Sr^{2+}; these reactions are reported to be pH dependent.[14] Metal species expected to react with sulfide include Ag^{+}, Cu^{2+}, Cd^{2+}, Co^{2+}, Bi^{2+}, Fe^{2+}, Fe^{3+}, Ni^{2+}, Hg^{1+}, Hg^{+2}, Sn^{2+}, and Zn^{2+}.[15] The Frandon Lead Alert kit (one of the more sensitive rhodizonate kits) and the sulfide-based Lead Detective kit were chosen as representative of the five kits and were subsequently tested for color formation (false positives) with a large number of metal species including these potentially interfering metals. Other kits were tested with a limited number of metals. These tests were not designed to test for false negatives (inhibition of color formation).

2.3.2 Experimental Procedure

Lead-free atomic absorption metal standards from Fisher, Spex, and Alfa were used as sources of the metals for the interference tests, which were performed in duplicate. The pH of most of these solutions was expected to be approximately 1; no attempt was made to control the pH. The test solutions were pipetted in 100 µL aliquots onto microscope slides for testing. The amount of potential interferant used (nominally 100 µg) does not necessarily reflect the amount to be found in real-world samples, but does represent a 100 to 500 fold excess over the amount of lead yielding a positive response and should represent a worst case scenario. The procedures provided with the individual test kits as presented in Appendix B were followed.

2.3.3 Results and Discussion

The results of the metal interference tests are listed in Table 4. Barium gave a

Table 4. Response of Test Kits to Potentially Interfering Metals

Metal	Metal µg/mL	Metal µg	Frandon Lead Alert	Lead-Check (original)	Verify LeadTest	Lead Detective	Merck EM Quant (A)
Ag ($AgNO_3$, DIW)	1,000	100	N	-	-	Dk. Br.	-
Al (2% HNO_3)	1,005	100	N	-	-	N	N
As (AsO_3, 2% HNO_3)	1,000	100	N	-	-	N	N
B (Boric acid, DIW)	1,000	100	N	-	N	N	N
Ba (2% HNO_3, pH=1)	996	99	P	P	-	N	N
Be (2% HNO_3)	1,000	100	N	N	N	N	N
Ca ($CaCO_3$, dil HNO_3, pH=2)	1,000	100	N	N	N	N	N
Cd (Cd, 2% HNO_3)	997	99	N	-	-	N-Yellow	N
Co($CoNO_3$, dil HNO_3)	1,000	100	N	N	N	P	N
Cu (NO_3^-, dil HNO_3, pH=2.5)	1,000	100	N	-	-	Lt. Br.	N
Cr($K_2Cr_2O_7$, DIW)	1,000	100	N	N	N	N	N
Fe (NO_3^-, 2% HNO_3, pH=1)	1,000	100	N	N	N	P	N
Ga (2% HNO_3)	1,000	100	N	-	-	N	N
Hg (10% HNO_3, pH=0.5)	1,000	100	N	-	-	N, P	-
In (2% HNO_3)	1,000	100	N	-	-	N	-
K (KCl, DIW)	1,000	100	N	-	-	N	-
Mg (NO_3^-, dil HNO_3)	1,000	100	N	N	N	N	-
Mn (NO_3^-, DIW, pH=5.5)	1,000	100	N	-	-	N	-
Mo (Anhydride, Ag/Re, pH=1)	1,000	100	N	-	-	N	-

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Table 4. Response of Test Kits to Potentially Interfering Metals (continued)

Metal	Metal µg/mL	Metal µg	Frandon Lead Alert	Lead-Check (original)	Verify LeadTest	Lead Detective	Merck EM Quant (A)
Na (NaCl, DIW, pH=6.5)	1,000	100	N	-	-	N	-
Ni (DIW, pH=4.5)	1,000	100	N	N	N	P	-
Ni (DIW, pH=5.5)	4,000	400	P	-	-	P	-
Sb ($SbCl_3$, dil HCl)	1,000	100	N	-	-	N	N
Se (SeO_2, DIW)	1,000	100	N	-	-	N	-
Sc (2% HNO_3)	1,004	100	N	-	-	N	-
Si (Na, DIW)	1,000	100	N	-	-	N	-
Sn, (Cl^-, dil HCl, pH=0.5)	1,000	100	N	-	-	N	-
Sr (NO_3^-, dil HNO_3, pH=0.5)	1,000	100	N	N	N	N	-
Ti (Ti, dil HCl, pH=0.5)	1,000	100	N	-	-	N	-
Tl (NO_3^-, DIW)	1,000	100	N	-	-	Dk. Br.	-
U ($UO_2(NO_3)_2.6H_2O$. DIW)	1,000	100	N	N	N	N	-
V (V_2O_5, HCl)	1,000	100	N	-	-	N	-
W (2% KOH, pH=13)	100	10	N	-	-	-	-
Zn (ZnO, 5% HNO_3, pH=0.5)	1,000	100	N	-	-	N	-
Zr ($ZrOCl_2$, 2% HCl)	1,000	100	N	-	-	-	-

Legend:

---: Not performed
DIW: Dionized water
udil: Diluted

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positive response with the Frandon Lead Alert and original LeadCheck test kits. The smallest amounts of barium, as determined in a separate experiment, that gave positive responses were 1.0 µg, 18 µg and 0.8 µg for Frandon Lead Alert, original LeadCheck and Verify LeadTest, respectively. Merck EM Quant did not respond to barium even at 100 µg. Another interference was nickel, which also gave positive results for both Frandon Lead Alert and Verify LeadTest test kits at a level of 400 µg. However, the test results were negative at the level of 100 µg nickel. These results do not fully agree with those of Feigl and Suter who reported response of rhodizonate to additional metals.[14] However, their test procedure involved mixing high levels of the metals (1%, 10,000 µg/mL) with 0.2% sodium rhodizonate. In addition to concentration differences, other variables such as pH and ionic strength could account for the difference in results.

The Lead Detective test kit showed more positive responses to metal species than the rhodizonate kits. Positive responses (i.e., black or brown precipitate) were obtained with Ag^{+}, Co^{2+}, Cu^{2+}, Fe^{3+}, Hg^{2+}, Ni^{2+}, and Tl^{+} at the 100 µg level.

2.4 SALT INTERFERENCE STUDIES

2.4.1 Introduction

Salts are expected to be present in dusts and soils, and have the potential to cause interferences through complexation and/or precipitation of the lead, or to change the pH and/or ionic strength. In order to test this possibility, several experiments were performed with NaCl, a likely component of dust and soil. First, different kits were tested with solutions prepared from $PbCl_2$. Next, high-level NaCl solutions were prepared and the responses of the kits to this material tested. Finally, high-level NaCl solutions spiked with known levels of Pb^{2+} were tested. Thus, both false negatives (no color formation) as well as changes in response relative to Pb^{2+} were evaluated.

2.4.2 Experimental Procedure

A stock solution of 1000 µg Pb^{2+}/mL was prepared from solid $PbCl_2$. This stock solution was then diluted with deionized water to prepare solutions of 10 and 100 µg Pb^{2+}/mL. High-level sodium chloride solutions (2,000 µg/mL Cl^- and 20,000 µg/mL Cl^-) were prepared by weighing out known amounts of NaCl and diluting to known volumes with deionized water. The solution mixtures of sodium chloride and lead were prepared by weighing out known amounts of NaCl, adding appropriate volumes of standard lead solution, and then taking these mixtures to appropriate volumes. Small volumes of these solutions were then tested with the different test kits.

2.4.3 Results of Tests with NaCl and other Salts

The results of tests with $PbCl_2$ were shown earlier in Tables 2 and 3. Lower levels of response were achieved with lead chloride than lead nitrate for all test kits except the Merck EM Quant. The Merck EM Quant kit yielded a lower level of response to lead nitrate solution than to lead chloride solution.

The results of the study with the NaCl-containing solutions are shown in Table 5. The NaCl (without Pb^{2+}) at 160 µg Cl^- and 1,600 µg Cl^- yielded no responses with the Frandon Lead Alert, Lead Detective, and Verify LeadTest kits. In the presence of 60 µg of Cl^- and 0.3 µg of Pb^{2+} in the form of nitrate, a positive response was seen with the Frandon Lead Alert test kit; Verify LeadTest and Lead Detective showed no response to any of the tested lead levels (0.8 to 1.0 µg Pb) although positive response had been seen at 0.3 µg Pb for the Verify LeadTest (Section 2.2). All lead levels tested were below the positive response level of the Lead Detective. No response was obtained with the Frandon Lead Alert kit when 600 µg of Cl^- and 0.3 µg of Pb^{2+} were present.

Other salts were also tested as possible interferences. These tests were performed with a series of solutions prepared with different concentrations of $NaNO_3$, KNO_3, $NaC_2H_3O_2$, and $KC_2H_3O_2$ mixed with 1 µg of Pb^{2+}. These tests were performed in duplicate using the LeadCheck test kit as the representative rhodizonate kit. The Na^+

Table 5. Effects of Sodium Chloride on Response of Test Kits

TEST SOLUTIONS				TEST KIT RESPONSES					
				Frandon Lead Alert		Verify LeadTest		Lead Detective	
Cl^- std* µg/mL	Cl^- µg	Pb^{2+} std** µl	Pb^{2+} µg	Cl^- only	Cl^- + Pb^{2+}	Cl^- only	Cl^- + Pb^{2+}	Cl^- only	Cl^- + Pb^{2+}
10	20	10	0.1	N	N	-	-	N	N
20	40	20	0.2	N	N	-	-	N	N
30	60	30	0.3	N	P	-	-	N	N
40	80	40	0.4	N	P	-	N	N	N
50	100	50	0.5	N	P	-	N	N	N
60	120	60	0.6	N	P	N	N	N	N
70	140	70	0.7	N	P	N	N	N	N
80	160	80	0.8	N	P	N	N	N	N
100	200	100	1.0	-	-	-	N	-	-
10	200	10	0.1	N	N	-	-	N	N
20	400	20	0.2	N	N	-	-	N	N
30	600	30	0.3	N	N	-	-	N	N
40	800	40	0.4	N	N	-	N	N	N
50	1000	50	0.5	N	N	-	N	N	N
60	1200	60	0.6	N	N	N	N	N	N
70	1400	70	0.7	N	N	N	N	N	N
80	1600	80	0.8	N	N	N	N	N	N
200	--	200	2.0	-	N	-	-	-	-

*Cl^- from 2,000 µg Cl^-/mL standard of NaCl for 20-160 µg cl; from 20,000 µg Cl^-/mL standard of NaCl for 200-1600 µg Cl^-
**Pb(II) from 10 µg Pb/mL standard of $Pb(NO_3)_2$

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(or K^+) to Pb^{2+} ratios at which negative interferences occurred are as follows:

Compound	Salt (in terms of Na^+ or K^+)-to-Pb^{2+} Ratio Yielding Negative Interference
$NaNO_3$	1000:1
KNO_3	1300:1
$NaC_2H_3O_2$	200:1
$KC_2H_3O_2$	200:1

It appeared that, under these conditions, the sodium and potassium salts did interfere. The acetates interfered with the response of the lead to a greater extent that the nitrates. The reasons for this effect, which may include changes in pH and/or ionic strength or effects on the performance of the test kit applicator, were not investigated in this effort. The complexation of Pb^{2+} by acetate ion may also be a factor; the stability constants provided by Ringbom are $10^{1.9}$ for $Pb(C_2H_3O_2)^+$ and $10^{3.3}$ for $Pb(C_2H_3O_2)_2$.[16]

2.5 RESPONSE OF LEAD TEST KITS WITH PAINTS, DUSTS, AND SOILS OF KNOWN CONCENTRATION

The next step in the research was to test the kits' overall performance using the same procedures that the typical user would follow to test paints, dusts and soils. The evaluation of the kits' performance would, therefore, take into consideration all the known and unknown variables, such as the leachability of the lead from solid medias, the transport of the leached lead to the indicator, the chemistry of the color-forming reagent (pH, ionic strength, complexation), the interferences, and the manufacturers' instructions. This effort was performed in three stages. First, National Institute of Standards and Technology (NIST) Standard Reference Materials (SRMs) were tested. Next, laboratory-prepared paint films and dusts were tested. Finally, real-world paints, dusts, and soils were tested (Section 2.6).

2.5.1 Experimental Procedures for Standard Reference Materials

Three NIST SRMs were tested including SRM 2704 (Buffalo River sediment), SRM 1648 (urban particulate), and SRM 1579 (lead-in-paint) using the five kits. These SRM materials are typically <50 μm in particle size. Single aliquots of approximately 10 mg each were tested according to the procedures presented in Appendix B.

2.5.2 Results of Tests with Standard Reference Materials

The results of the test (see Table 6) show only the sulfide kit (Lead Detective) responding to the lowest level of lead (161 μg/g), but all kits responding to the highest level (11.79%). This testing was limited by the number of appropriate SRMs available.

2.5.3 Experimental Procedure for Laboratory-Prepared Paint Films and Dusts

Paint film standards were prepared by spiking oil-based paint with known amounts of white lead and casting the paint into films using a special casting device developed by RTI. The films were allowed to dry and portions of the dried films were analyzed using NIOSH Method 7082 (HNO_3/H_2O_2 digestion; ICP measurement)[17] to determine actual lead concentrations. The synthetic dusts were prepared by thoroughly mixing lead nitrate, Arizona road dust and cotton linters. These materials were also subjected to analysis using NIOSH Method 7082. The paints and dusts were tested in duplicate according to kit manufacturer's procedures, when provided. The paint films tested averaged 1.1 cm^2 in area. If a procedure was not provided (as in the case of Lead Detective for dust), a small amount of sample (approximately 10 mg) was brought into contact with the test solution or element.

2.5.4 Results of Tests with Laboratory-Prepared Paint Films and Dusts

The results of tests with the RTI paint films are presented in Tables 7 and 8. Here the "ppm" values determined with the Merck EM Quant kit are also presented. As noted, the level and subsequent order at which positive response was obtained was as

Table 6. Response of Test Kits to NIST SRMS

Sample	Concentration Pb, µg/g	Frandon Lead Alert	New LeadCheck	Verify LeadTest	Merck EM Quant		Lead Detective Kit
SRMs					A	B	
SRM 2704	161	N	N	N	N (0 ppm)	N (0 ppm)	P
SRM 1648	6,550	P	P	N	N (0 ppm)	N (0 ppm)	P
NBS 1579	11.79%	P	P	P	P (500 ppm)	P (350 ppm)	P

SRM 2704 - NIST Buffalo River Sediment
SRM 1648 - National Institute of Standards and Technology (NIST) Standard Reference Material; Urban Particulate
SRM 1579 - NIST Lead in Paint

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Table 7. Response of Original LeadCheck, Frandon Lead Alert, Verify LeadTest and Merck EM Quant Test Kits to Laboratory-Prepared Paint Films and Dusts

Sample	Nominal Conc. Pb mg/cm^2	Original LeadCheck	Frandon Lead Alert	Verify LeadTest	Merck EM Quant	
Paint Film					A	B
40-1	0.0	-	N	-	N (0 ppm)	N (0 ppm)
38-A3	0.1	N	N	N	N (0 ppm)	---
38-A4	0.1	N	N	N	N (0 ppm)	---
38-A2	0.1	-	N	N	N (0 ppm)	N (0 ppm)
38-A2	0.1	-	-	-	N (0 ppm)	N (0 ppm)
38-A2	0.1	-	-	-	---	N (0 ppm)
35-A3	0.6	N	N	-	---	---
35-A3	0.6	N	N	N	---	---
35-A5	0.6	-	N	N	N (0 ppm)	N (0 ppm)
35-A5	0.6	-	N	N	N (0 ppm)	N (0 ppm)
35-A5	0.6	-	-	-	N (0 ppm)	N (0 ppm)
49-B1	1.2	-	P	P	N (0 ppm)	N (0 ppm)
39-A1	1.9	-	-	P	---	---
39-A2	1.9	N	P	P	P (10 ppm)	P (10 ppm)
39-A2	1.9	N	P	P	P (10 ppm)	N (0 ppm)
39-A2	1.9	-	P	-	P (10 ppm)	N (0 ppm)

Table 7. Response of Original LeadCheck, Frandon Lead Alert, Verify LeadTest and Merck EM Quant Test Kits to Laboratory-Prepared Paint Films and Dusts (continued)

Sample	Nominal Conc. Pb mg/cm^2	Original LeadCheck	Frandon Lead Alert	Verify LeadTest	Merck EM Quant	
Paint Film					**A**	**B**
37B-3	2.6	-	-	P	-	-
37B-1	2.6	P	P	P	P (40 ppm)	N (0 ppm)
37B-1	2.6	P	P	P	P (100 ppm)	P (10 ppm)
37B-1	2.6	-	P	-	P (200 ppm)	N (0 ppm)
Dust	**µg/g**					
40-A	200	N	N	N	N (0 ppm)	N (0 ppm)
40-B	200	N	N	N	N (0 ppm)	---
40-C	200	N	N	-	N (0 ppm)	---
48-1	500	N	P	N	N (0 ppm)	N (0 ppm)
48-2	500	N	P	N	N (0 ppm)	---
48-3	500	N	P	N	N (0 ppm)	---
49-1	1,000	P	P	?	P (40 ppm)	N (0 ppm)
49-2	1,000	P	P	P	P (90 ppm)	---
49-3	1,000	P	P	-	P (40 ppm)	---
47-1	2,000	P	P	P	P (400 ppm)	P (40 ppm)
47-2	2,000	P	P	P	P (400 ppm)	---
47-3	2,000	P	P	-	P (200 ppm)	---

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Table 8. Response of New LeadCheck and Lead Detective Test Kits to Laboratory-Prepared Paint Films and Dusts

Sample	Nominal Conc. Pb mg/cm^2	New LeadCheck	Lead Detective
Paint Film			
40-1	0.0	N	P
38-A2	0.1	N	P
38-A2	0.1	N	P
38-A2	0.1	N	P
35-A3	0.6	---	P
35-A4	0.6	P	---
35-A5	0.6	N	P
35-A5	0.6	N	P
49-B1	1.2	N	P
39-A1	1.9	P	P
39-A2	1.9	P	P
39-A2	1.9	P	P
37-B3	2.6	P	P
37-B1	2.6	P	P
37-B1	2.6	P	P

Table 8. Response of New LeadCheck and Lead Detective Test Kits to Laboratory-Prepared Paint Films and Dusts (continued)

Sample	Nominal Conc. Pb mg/cm^2	New LeadCheck	Lead Detective
Paint Film			
40-D	200	N	?
40-E	200	N	?
40-G	200	N	?
48-8	500	P	?
48-9	500	P	?
48-10	500	P	?
49-3	1,000	P	P
49-4	1,000	P	P
49-5	1,000	P	P
47-8	2,000	---	P
47-9	2,000	---	P
47-10	2,000	---	P

follows:

Lead Detective (0.0 mg/cm^2) <
Frandon Lead Alert (1.2 mg/cm^2) = Verify LeadTest (1.2 mg/cm^2) <
New LeadCheck (1.9 mg/cm^2) = Merck EM Quant (A) (1.9 mg/cm^2) <
Original LeadCheck (2.6 mg/cm^2)

The Lead Detective yielded a positive response at all concentrations including the "blank" film. Unfortunately, the number of test samples was limited and the response range could not be tested in small increments.

The results of the evaluation with the RTI dusts are also presented in Tables 7 and 8. The most responsive kits were the Frandon Lead Alert and new LeadCheck kits, which responded positively to 500 µg/g. The original LeadCheck, Verify LeadTest, Merck EM Quant and Lead Detective did not respond at that level. The Lead Detective gave a positive response with NIST SRM 2704 at 161 µg/g (Table 6) but gave negative responses at 200 and 500 µg/g for the RTI laboratory-prepared dusts. The Lead Detective may have actually had a positive response to these latter samples. However, the dust samples became "muddy" when wetted with the reagent and it was not possible to differentiate dark sample from any small amounts of dark lead sulfide that may have formed.

2.6 RESPONSE OF LEAD TEST KITS WITH REAL-WORLD DUST, SOIL AND PAINT SAMPLES

Following testing of laboratory-prepared samples, real-world samples were tested. These real-world samples were tested in order to challenge the kits with samples having physical and chemical characteristics that would be encountered in the field. Sources of difficulty could include low efficiency of extraction of the lead from the sample matrices, extraction of metals and/or salts that could affect pH, ionic strength and complexation equilibria, and the presence of interferences. Since the number of SRMs

and laboratory samples was limited, real-world samples offered an opportunity to test additional levels of lead.

2.6.1 Experimental Procedure

Dust and soil samples from lead-in-paint contaminated areas were obtained from EMSL-EPA/Las Vegas. These real-world samples were chosen because they had been previously characterized by both laboratory X-ray fluorescence and atomic absorption spectrophotometry by the EPA. The soil particles were 100 to 200 µm in diameter, while the dust particles were 50 to 150 µm in diameter. The average soil particles encountered in the field would by considerably larger since only rough sieving (1 to 2 mm) is normally done in the field to remove gross debris. Average dust particles collected on wipes and air filters would also be greater than 150 µm since these samples would include insect debris, hair and other large particles. Coarse (>250 µm) and fine (<250 µm) real-world paint samples analyzed previously by NIOSH Method 7082 were also used to test all except the Verify LeadTest kits. Soil, dust and paint sample aliquots of approximately 10 mg were used. Single tests were performed with these samples.

2.6.2 Results of Testing with Real-World Dust, Soil and Paint Samples

The results of the tests of dust and soil samples are presented in Table 9. The new LeadCheck, Frandon Lead Alert, Verify LeadTest and Merck EM Quant kits all showed negative response at 2,300 µg/g lead but positive response at 21,000 µg/g lead in dust. It must be noted that no EMSL-EPA/LV dust samples were available in the range between these two levels. The Lead Detective kit clearly gave a positive response for all EPA dust samples.

Response to the soil samples was somewhat different. All kits including the Lead Detective responded negatively to the 330 µg/g sample. As noted, the level and subsequent order at which positive response was obtained was as follows:

Table 9. Response of Test Kits to EMSL-EPA/LV Dust and Soil Samples

Sample	Concentration Pb, µg/g	Frandon Lead Alert	New LeadCheck	Verify LeadTest	Merck EM Quant		Lead Detective
Dust					A	B	
1	60	N	N	N	N (0 ppm)	N (0 ppm)	P
2	290	N	N	N	N (0 ppm)	N (0 ppm)	P
3	300	N	N	N	N (0 ppm)	N (0 ppm)	P
4	1,500	N	N	N	N (0 ppm)	N (0 ppm)	P
5	2,300	N	N	N	N (0 ppm)	N (0 ppm)	P
6	21,000	P	P	P	P (60 ppm)	N (0 ppm)	P
Soil							
1	330	N	N	N	N (0 ppm)	N (0 ppm)	N
2	670	N	N	P	N (0 ppm)	N (0 ppm)	P
3	1,000	N	N	N	N (0 ppm)	N (0 ppm)	P
4	3,400	N	P	P	P (40 ppm)	N (0 ppm)	P
5	6,400	P	P	P	P (200 ppm)	N (0 ppm)	P
6	13,000	P	P	P	P (200 ppm)	P (20 ppm)	P
7	15,000	P	P	P	P (100 ppm)	N (0 ppm)	P

Lead Detective (670 μg/g) = Verify LeadTest (670 μg/g) <
New LeadCheck (3400 μg/g) = Merck EM Quant (A) (3400 μg/g) <
Frandon Lead Alert (6400 μg/g) < Merck EM Quant (B) (13,000 μg/g)

The Verify LeadTest showed positive response at 670 μg/g, but negative at 1,000 μg/g and then positive again at 3,400 μg/g. The variability may reflect extractability or the presence of interferences. The Merck EM Quant, Method A, was found to be more responsive than Method B (See Appendix B).

The paint sample results are presented in Table 10. As noted, the Frandon Lead Alert, LeadCheck, Merck EM Quant and Lead Detective all yielded positive responses for the real-world paint samples with relatively high lead concentration.

2.7 COLOR STABILITY TEST WITH DIFFERENT LEAD TEST KITS

A concern with test kits is the rate of formation and stability of the color formed as a result of a positive response. Slow formation or rapid fading of the color could lead to a positive response being interpreted as a negative response. Tests of color formation and stability were therefore performed.

2.7.1 Experimental Procedure

The test kits were exposed to standard Pb^{2+} solutions prepared from $Pb(NO_3)_2$ both at and also slightly above the lower level of response. The colors formed were then observed over time. The tests were performed in duplicate.

2.7.2 Results of Testing Rate of Color Formation and Stability

The results of the tests are presented in Table 11. Color formation was essentially instantaneous. The yellow (Y) observed with the rhodizonate kits (Frandon Lead Alert, Verify LeadTest, Merck EM Quant, and LeadCheck) corresponded to unreacted rhodizonate, while the pink (P) corresponded to the lead rhodizonate reaction product.

Table 10. Response of Test Kits to Real-World Paint Samples

Sample	Concentration Pb, µg/g	Frandon Lead Alert	New LeadCheck	Verify LeadTest	Merck EM Quant		Lead Detective
					A	B	
Paint (<250 µm)							
P3	1.8%	P	P	---	P (200 ppm)	P (70 ppm)	P
P4	3.3%	P	P	---	P (150 ppm)	P (200 ppm)	P
P1	3.8%	P	P	---	P (500 ppm)	P (500 ppm)	P
P2	5.5%	P	P	---	P (500 ppm)	P (500 ppm)	P
Paint (>250 µm)							
P3	1.8%	P	P	---	P (70 ppm)	P (20 ppm)	P
P4	4.0%	P	P	---	P (70 ppm)	P (20 ppm)	P
P1	4.9%	P	P	---	P (200 ppm)	P (20 ppm)	P
P2	5.5%	P	P	---	P (70 ppm)	P (20 ppm)	P

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Table 11. Color Stability Test Results

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Initial Result	Result at 15 min.	Result at 30 min.	Result at 45 min.	Result at 60 min.	Result at 75 min.	Result at 120 min.	Result at 22 hrs.
Frandon Lead Alert										
60 µL	10	0.60	P P	P P	P P	P PP	PP Y	PP Y	- -	Y Y
70 µL	10	0.70	P P	P P	P P	P P	P P	P P	- -	P P
80 µL	10	8.0	P P	P P	P P	P P	P P	P P	- -	P P
LeadCheck (New)										
80 µL 80 µL	10 10	0.80 0.80	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y
100 µL 100 µL	10 10	1.0 1.0	P P	P P	P P	P P	P P	P P	P P	Y P
80 µL 80 µL	100 100	8.0 8.0	P P	P P	P P	P P	P P	P P	P P	P P
Verify LeadTest										
20 µL 20 µL	10 10	0.20 0.20	P P	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y
30 µL 30 µL	10 10	0.30 0.30	P P	P P	P Y	Y Y	Y Y	Y Y	Y Y	Y Y
80 µL 80 µL	100 100	8.0 8.0	P P	P P	P P	P P	P P	P P	P P	P P
Merck EM Quant (A)										
5.0 mL 5.0 mL	10 10	-- --	P P	C C	C C	C C	C C	C C	C C	C C
5.0 mL 5.0 mL	100 100	-- --	P P	P P	P P	P P	P P	P P	P P	P P

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Table 11. Color Stability Test Results (continued)

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Initial Result	Result at 15 min.	Result at 30 min.	Result at 45 min.	Result at 60 min.	Result at 75 min.	Result at 120 min.	Result at 22 hrs.
Lead Detective										
10 µL	100	1.0	B	B	B	B	B	B	B	-
10 µL	100	1.0	B	B	B	B	B	B	B	-
20 µL	100	2.0	B	B	B	B	B	B	B	-
20 µL	100	2.0	B	B	B	B	B	B	B	-
80 µL	100	8.0	B	B	B	B	B	B	B	-
80 µL	100	8.0	B	B	B	B	B	B	B	-

Legend:

Y - Yellow (negative response)
P - Pink (positive response)
PP - Pale Pink (positive response)
C - Cream (negative response)
B - Black (positive response)

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Pale pink (PP) was interpreted as a weak positive response. The cream (C) color of the Merck EM Quant was interpreted as a negative response. Black (B) for the sulfide-based Lead Detective corresponded to a positive response, that is, formation of lead sulfide.

Only the Verify LeadTest and Merck EM Quant (Method A) kits were observed to fade in less than 30 minutes at low concentration. At the high side of the color development range, all kits yielded color that was stable for at least 15 minutes.

2.8 USE OF LEAD TEST KITS BY NON-TECHNICAL PERSONNEL

The test kits were designed for use by non-technical personnel as well as technical personnel as indicated in Section 1.2. It was observed during this research that new users sometimes made errors with the kits. Any improper use of the kits could affect the outcome of the tests. Therefore, ease and accuracy of use were tested by having two non-technical personnel perform tests with the kits.

2.8.1 Experimental Procedure

Two non-technical personnel were given RTI-prepared paint film and dusts, test kits, and instructions as provided by the kit manufacturers. Each person was asked to analyze each sample in duplicate. Use of the kits by non-technical personnel was observed by a trained, experienced chemist.

2.8.2 Results of Tests with Non-technical Personnel

The results of the tests are presented in Table 12. Variation in results with the paint samples was noted with the new LeadCheck, Frandon Lead Alert, and Merck EM Quant kits for the 0.6 and 1.9 mg/cm^2 levels. Results for the Verify test kit cannot be accurately compared because multiple runs for the paint were not performed by Tester No. 2. There was only one difference for the Lead Detective and this was at the lowest concentration of lead in paint.

Differences in results were obtained with the new LeadCheck and Frandon Lead

Table 12. Results of Testing by Non-Technical Personnel

TESTER NUMBER 1							TESTER NUMBER 2						
Sample	New Lead-Check	Frandon Lead Alert	Verify Lead-Test	Merck		Lead Detective	Sample	New Lead-Check	Frandon Lead Alert	Verify Lead-Test	Merck		Lead Detective
				A	B						A	B	
Paint Film							Paint Film						
0.1 mg/cm^2	N N	N N	N N	N N	N N	P P	0.1 mg/cm^2	N N	N N	N -	N N	N N	N P
0.6 mg/cm^2	P N	N N	N N	N N	N N	P P	0.6 mg/cm^2	N N	N P	- -	N N	N N	P P
1.9 mg/cm^2	N P	N N	P P	N N	N N	P P	1.9 mg/cm^2	N N	P P	P -	P N	N N	P P
Dust							Dust						
200 µg/g	N N	N N	N N	N N	N N	? ?	200 µg/g	N N	N N	N N	N N	N N	? ?
500 µg/g	N N	P P	P P	N N	N N	? ?	500 µg/g	N P	N N	? P	N N	N N	? ?
2000 µg/g	P P	P P	P P	P P	P P	? ?	2000 µg/g	N P	N N	P P	P P	P P	? ?

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Alert kits with the dusts while the Verify LeadTest and Merck EM Quant kits yielded consistent results. Neither person could determine whether the responses were negative or positive with the Lead Detective when analyzing the dust samples.

The trained observer noted that a number of problems were encountered by the testers. Included were the following:

- Instructions unclear about sample size to use
- Stirring extraction solution (Merck EM Quant, Methods A and B) with reactive end of test strip, not "upper end" as called for in instructions
- Failure to use indicator in Frandon Lead Alert kit
- Dust causes the indicator elements to get "muddy"
- Difficulty in breaking reagent tubes in new LeadCheck
- Variation in firmness of rubbing
- Not following instructions: e.g., breaking reagent tube B before A for LeadCheck kit; rubbing sample with indicating solution before leaching solution for Frandon Lead Alert kit
- Variation in sample rubbing time
- Failure to use confirmation card supplied with LeadCheck.

It is apparent that instructions need to be more thorough, especially for items such as sample "rubbing time" and size or area of sample tested. Instructions also need to be clearer and easier to follow. Inclusion of a color chart to differentiate negative response from positive response would also be very helpful.

SECTION 3
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

3.1 INTRODUCTION

Through a search of the literature and trade journals and through contact with experts, five test kits were identified. These are:

- LeadCheck (Hybrivet Systems)
- Verify LeadTest (Verify, Inc.)
- Frandon Lead Alert (Frandon Enterprises)
- Merck EM Quant (EM Science)
- The Lead Detective (Innovative Synthesis Corp.).

A limited study of these five kits was performed to identify both positive attributes and limitations of the devices. Tests performed included the following:

- response relative to test sample lead content
- potential metal interferences
- potential salt interferences
- response to laboratory-prepared and real-world paint, dust and soil samples
- color stability
- ease/accuracy of use by non-technical personnel.

3.2 RESULTS OF LEAD TEST KIT EVALUATION

3.2.1 Lower Level of Response

First to be determined was the range of test sample lead content over which test

kit responses went from negative to positive. This experiment was intended to result in estimates of the identification limits (lower limits of response) of the kits.

Following instructions provided with the test kits, each brand of kit was tested with solutions prepared with $Pb(NO_3)_2$ and $PbCl_2$ to determine ranges of response. The test kits were reacted with 10 to 80 microliter quantities of lead solution from well below the point of color development to well above the point of color development. The test sample lead content ranges corresponding to all negative response to all positive response are given in the following table:

Test Kit Response to Pb^{2+} in Solution
(All Neg - All Pos)

	$Pb(NO_3)_2$	$PbCl_2$
LeadCheck (orig. & new)	0.5 - 1.0 µg	<0.4 - 0.8 µg
Verify LeadTest	0.1 - 0.3 µg	<0.1 - 0.2 µg
Frandon Lead Alert	0.5 - 0.7 µg	0.1 - 0.3 µg
Merck EM Quant (A)	0.5 - 0.6 µg	N.A.
Lead Detective Kit	0.5 - 2.0 µg	0.5 - 1.0 µg

Therefore, the kits, in order of lower level of response, are as follows:

Verify LeadTest (0.3 µg/g) <
Merck EM Quant (A) (0.6 µg/g) <
Lead Alert (0.7 µg/g) <
LeadCheck (1.0 µg/g) <
Lead Detective (2.0 µg/g)

The chemical form of the lead solution may have some effect on the responsiveness of the kits. This effect may be due to a combination of competition for complexation of Pb^{2+} by species other than rhodizonate ion and/or changes in pH or

ionic strength. The range from all negative responses to all positive responses varies from 0.1 µg (Merck EM Quant) to 0.5 µg (LeadCheck), which are rhodizonate kits. This range for the Lead Detective kit varies from about 0.5 µg to about 2 µg.

3.2.2 Metal and Salt Interferences Tests

Paints, dusts and soils may contain metal species other than lead that react with the rhodizonate ion or sulfide to form a colored product and thus yield false positive results. On the other hand, other species in the samples may react with the lead, or cause shifts in pH or ionic strength, and therefore inhibit color formation yielding false negative results.

Color-forming (positive) interferences due to metals were investigated for the Frandon Lead Alert kit using atomic absorption standard solutions. The Frandon Lead Alert kit was used because it appeared to represent the average rhodizonate-based kit. The standard solutions were usually acidic (2% HNO_3, dil. HCl) as is the kit reagent, and thus the test conditions were assumed to be acidic. When nominally 100 µg (100 µL, 1,000 ppm) of potentially interfering metal ions were put in contact with the test element (e.g., swab) of each kit, only Ba^{2+} and Ni^{2+} showed a positive response. Feigl and Suter[14] reported that Ag^{1+}, Hg^{2+}, Tl^{1+}, Pb^{2+}, Cu^{2+}, Sn^{2+}, Zn^{2+}, Ba^{2+} and Sr^{2+} all gave responses to sodium rhodizonate in neutral and/or pH 2.8 solution. Their test procedure involved mixing high levels of the metal (1%, 10,000 ppm) with 0.2% sodium rhodizonate, which could account for the difference in results. They reported that the selectivity of sodium rhodizonate favors Pb^{2+} over the majority of these metals and, in particular, that the selectivity for lead over barium is 10,000 to 1. The sulfide-based Lead Detective kit tested with these same samples showed responses to Ag^{1+}, Cd^{2+}, Co^{2+}, Cu^{2+}, Fe^{3+}, Hg^{2+}, Ni^{2+}, and Ti^{2+}, all of which are known to form insoluble sulfides.

Both high levels (2,000:1, Cl^-:Pb^{2+}) and moderate levels (200:1, Cl^-:Pb^{2+}) of chloride (as NaCl) were found to result in decreased response (negative interference) for the Frandon Lead Alert, Verify LeadTest and Lead Detective kits. Other salts were tested

as possible interferences. A series of solutions was prepared with different concentrations of $NaNO_3$, KNO_3, $Na(C_2H_3O_2)$ and $K(C_2H_3O_20$ mixed with 1 µg of Pb^{2+} and tested in duplicate using the LeadCheck test kit. The Na^{1+} (or K^{1+}) to Pb^{2+} ratios at which negative interferences occurred are as follows:

Compound	Na^{1+}(or K^{1+}):Pb^{2+} Ratio
$NaNO_3$	1,000:1
KNO_3	1,300:1
$Na(C_2H_3O_2)$	200:1
$K(C_2H_3O_2)$	200:1

Thus it appears that the sodium and potassium salts interfere, though it is not clear if the Na^{1+} and/or K^{1+} interfere. The effect of the salts may be a result of a change in ionic strength. The acetate presents even a greater extent of interference, which may be due, in part, to a pH effect or formation of a lead acetate complex.

3.2.3 Response to NIST Standard Reference Materials

The next step in the research was to test the kits' overall response using the same procedures that the typical user would follow to test paints, dusts, and soils. First, NIST SRMs were tested as these materials have been thoroughly characterized.

Three NIST SRMs were tested including SRM 2704 (Buffalo River sediment), SRM 1648 (urban particulate), and SRM 1579 (lead-in-paint) using the five kits. Single aliquots of approximately 10 mg each were tested according to the procedures presented in Appendix B. The results of the test show only the sulfide kit (Lead Detective) responding to the lowest level of lead (161 µg/g), but all kits responding to the highest level (11.79%). This testing was limited by the number of appropriate SRMs available.

3.2.4 Response to Laboratory-Prepared Paint Films and Dusts

Following tests with NIST SRMs, responses to laboratory-prepared paint films and dusts to further challenge the test kits were measured.

A series of oil-based paint films spiked with white lead were prepared. Following kit instructions, paint sections averaging 1.1. cm^2 in area were tested. Concentration ranges over which the color appeared (i.e., all negative to all positive) are given in the following table:

Test Kit Response to Lead in Paint Films
(All Neg - All Pos)

LeadCheck(original)	1.9 - 2.6 mg/cm^2
LeadCheck(new)	1.2 - 1.9 mg/cm^2
Verify LeadTest	0.6 - 1.2 mg/cm^2
Frandon Lead Alert	0.6 - 1.2 mg/cm^2
Merck EM Quant (A)	1.2 - 1.9 mg/cm^2
Lead Detective	<0.11 mg/cm^2 (i.e., transition occurs below 0.11 mg/cm^2)

A test dust was prepared from lead nitrate, Arizona road dust and cotton linters. Following instructions provided with the kits, the following lead concentration response ranges (all negative to all positive) were found:

Test Kit Response to Lead in Dust
(All Neg - All Pos)

LeadCheck(new)	200 - 500 µg/g
Verify LeadTest	500 - 1,000 µg/g
Frandon Lead Alert	200 - 500 µg/g
Merck EM Quant (A)	500 - 1,000 µg/g
Lead Detective	500 - 1,000 µg/g

No procedure was provided with the Lead Detective for dust and soil, and therefore the test was performed by direct contact between the particles and the test solution. The high level of response noted with the Lead Detective is thought to be a result of being unable to see the small amount of dark lead sulfide formed in the presence of the dark dust particles.

3.2.5 Response to Real-World Dust, Soil, and Paint Samples

Finally, following tests with laboratory-prepared paint films and dusts, real-world dust, soil, and paint samples were tested in order to challenge the kits with samples having physical and chemical characteristics that would be encountered in the field.

Real-world dust and soil samples from EMSL-EPA/Las Vegas were tested according to procedures provided. This involved 24 hours of extraction with the Verify LeadTest kit and immediate or, at most, 5 minutes of reaction time with the other kits. The dust sample concentrations which resulted in negative and positive responses are given in the following table:

Test Kit Response to Lead in Dust

	Negative	Positive
LeadCheck(new)	2,300 µg/g	21,000 µg/g
Verify LeadTest	2,300 µg/g	21,000 µg/g
Frandon Lead Alert	2,300 µg/g	21,000 µg/g
Merck EM Quant	2,300 µg/g	21,000 µg/g
Lead Detective	$\leq$60 µg/g	$\geq$60 µg/g

For these dusts, the rhodizonate-based kits were negative for all samples below 2,300 µg/g and positive for the one sample above 20,000 µg/g. The Lead Detective kit response was clearly positive at <100 µg/g lead with these dusts.

With the soil samples, response was more variable. The soil sample

concentrations which resulted in negative and positive responses for the kits are given in the following table:

Test Kit Response to Lead in Soil

	Negative	Positive
LeadCheck(new)	1,000 µg/g	3,400 µg/g
Verify LeadTest	330 µg/g	1,000 µg/g
Frandon Lead Alert	3,400 µg/g	6,400 µg/g
Merck EM Quant	1,000 µg/g	3,400 µg/g
Lead Detective	330 µg/g	1,000 µg/g

The kit procedures calling for direct contact between soil or dust and the test element (LeadCheck, Frandon Lead Alert, Lead Detective) resulted in approximately 10 mg of sample being used. At 2,300 µg/g, this amounts to 23 µg/sample. With the test kits sensitive to 0.5 - 1 µg in solution, this would indicate an apparent extraction efficiency of between 5 and 10 percent (excluding effects of interferences, pH or other parameters). A possible cause for the difference in extraction efficiency is differences in the physical form of the matrix and/or in the chemical form of lead in the two sample types. That is, the lead may be present as an oxide, sulfide, carbonate, etc. in these real-world samples from EMSL-EPA/Las Vegas. Interferences may also have affected responses.

3.2.6 Color Stability Tests

A concern with the test kits was the rate of formation and stability of the color formed as a result of a positive response. Slow formation or rapid fading of the color could lead to a positive response being interpreted as a negative response. In order to test formation of the color and its stability, the rhodizonate-based kits were tested with

respect to time stability of the color developed. When exposed to amounts of lead in solution just above the detection limit, only the Verify LeadTest and EM Quant, Method A kits showed fading of the color from pink to yellow within 30 minutes time. All kits showed no fading for at least 15 minutes after reaction with lead.

3.2.7 Non-Technical User Tests

The test kits were designed for use by homeowners and/or professionals. Any improper use of the kits could affect the outcome of the tests. Therefore ease and accuracy of use were tested by having non-technical personnel use the kits while being observed by an experienced chemist. Two non-technical staff members were provided with kits, written procedures, and RTI-prepared paint films and dusts for analysis. Each was instructed to perform duplicate analyses. Variability in results was observed even at the highest concentration levels tested, as shown in the following:

	Number of Negative and Positive Responses			
	Tester #1		Tester #2	
Paints (1.6 mg/cm^2)	Neg	Pos	Neg	Pos
LeadCheck(new)	1	1	2	0
Verify LeadTest	2	0	0	2
Frandon Lead Alert	0	2	0	1
Merck EM Quant	4	0	3	1
Lead Detective	0	2	0	2
Dust (500 ppm)				
LeadCheck(new)	2	0	1	1
Verify LeadTest	0	2	2	0
Frandon Lead Alert	0	2	?	1
Merck EM Quant	4	0	4	0
Lead Detective	2	0	?	?

Question marks indicate uncertain results. Example problems noted by an experienced observer included the following:

- Not following instructions
- Confusion over reagent tubes A and B in the LeadCheck kit
- Variation in firmness of rubbing paints
- Stirring with reaction zone of Merck Em Quant test strips rather than "upper end" as called for instructions.

3.2.8 Relationship To Proposed Performance Criteria

Target criteria have been developed by the EPA for performance of the test kits for different media.[13] The approach taken was to propose 95% negative response at those levels which correspond to minimal known health effects or do not require regulatory action and 95% positive response at those levels which correspond to suspected significant health effects or do require regulatory action. The target and actual results are shown in Table 13, which shows that the measured ranges of response (negative to positive) to paint were higher than proposed target levels for all the rhodizonate-based kits. The opposite is true for the Lead Detective kit (sulfide based), which had a response range (negative to positive) below target levels.

The response ranges achieved with the EPA dust and soil were all higher than the targets for the four rhodizonate-based kits. However, the Lead Detective showed only positive responses to the available EPA dust samples and thus had a response range below that targeted. The opposite was true for the Lead Detective response to the EPA soil samples; that is, the measured response range was above the target. Though differences between proposed and achieved targets were found, it must be remembered that this was a limited study, and the results presented here are based on very few samples and should be considered indicative at best.

Table 13. Comparison of Target Performance Criteria and Actual Performance Results

		Actual Performance Results	
Test Material	**Target EPA Performance Critera**	**LeadCheck (new)**	**Verify LeadTest**
Paint (RTI)	95% pos. at 0.7 mg/cm^2 95% neg. at 0.1 mg/cm^2	All pos. at 1.9 mg/cm^2 All neg. at 1.2 mg/cm^2	All pos. at 1.2 mg/cm^2 All neg. at 0.6 mg/cm^2
Dust (RTI)	95% pos. at 450 µg/g 95% neg. at 150 µg/g	All pos. at 500 µg/g All neg. at 200 µg/g	All pos. at 1,000 µg/g All neg. at 500 µg/g
Dust (EPA)	95% pos. at 450 µg/g 95% neg. at 150 µg/g	Pos. at approx. 21,000 µg/g Neg. at approx. 2,300 µg/g	Pos. at approx. 21,000 µg/g Neg. at approx. 2,300 µg/g
Soil (EPA)	95% pos. at 450 µg/g 95% neg. at 150 µg/g	Pos. at approx. 3,400 µg/g Neg. at approx. 1,000 µg/g	Pos. at approx. 1,000 µg/g Neg. at approx. 330 µg/g

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Table 13. Comparison of Target Performance Criteria and Actual Performance Results (continued)

		Actual Performance Results	
Test Material	**Target EPA Performance Critera**	**Frandon Lead Alert**	**Merck EM Quant**
Paint (RTI)	95% pos. at 0.7 mg/cm^2 95% neg. at 0.1 mg/cm^2	All pos. at 1.2 mg/cm^2 All neg. at 0.6 mg/cm^2	All pos. at 1.9 mg/cm^2 All neg. at 1.2 mg/cm^2
Dust (RTI)	95% pos. at 450 µg/g 95% neg. at 150 µg/g	All pos. at 500 µg/g All neg. at 200 µg/g	All pos. at 1,000 µg/g All neg. at 500 µg/g
Dust (EPA)	95% pos. at 450 µg/g 95% neg. at 150 µg/g	Pos. at approx. 21,000 µg/g Neg. at approx. 2,300 µg/g	Pos. at approx. 21,000 µg/g Neg. at approx. 2,300 µg/g
Soil (EPA)	95% pos. at 450 µg/g 95% neg. at 150 µg/g	Pos. at approx. 6,400 µg/g Neg. at approx. 3,400 µg/g	Pos. at approx. 3,400 µg/g Neg. at approx. 1,000 µg/g

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Table 13. Comparison of Target Performance Criteria and Actual Performance Results (continued)

		Actual Performance Results
Test Material	**Target EPA Performance Criteria**	**Lead Detective**
Paint (RTI)	95% pos. at 0.7 mg/cm^2 95% neg. at 0.1 mg/cm^2	All pos. at 0.6 mg/cm^2 All neg. at 0.1 mg/cm^2
Dust (RTI)	95% pos. at 450 µg/g 95% neg. at 150 µg/g	All pos. at 1,000 µg/g All neg. at 500 µg/g
Dust (EPA)	95% pos. at 450 µg/g 95% neg. at 150 µg/g	Pos. at approx. $\geq$60 µg/g No. neg. response w/ available samples
Soil (EPA)	95% pos. at 450 µg/g 95% neg. at 150 µg/g	Pos. at approx. 1,000 µg/g Neg. at approx. 330 µg/g

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3.3 GENERAL CONCLUSIONS

The results of this limited investigation support the following general conclusions:

(1) The kits generally respond to less than 1 µg of Pb^{2+} in solution.

(2) Positive interferences were not found for the rhodizonate kits for the limited set of paint, dust, and soil samples used in this study. However, barium may be a positive interferant in some paints.

(3) The dark colors of certain dust samples masked observation of formation of lead sulfide at low levels with the Lead Detective Kit. Positive responses with the Lead Detective resulted from Ag^{+}, Co^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Hg^{2+}, Ni^{2+}, and Tl^{2+}. Many of these metals may be found in paints, dusts, and/or soils.

(4) The kits generally showed response to only high levels of lead with real-world dusts and soils. They also showed variability in responses to dust and soil having similar concentrations. It is probable that these limitations reflect low and also sample-specific variability in lead extractability and/or negative interference from other constituents in the sample matrix and/or shifts in the pH, ionic strength, etc.

(5) All kits showed adequate stability (>15 minutes) of the developed color.

(6) Tests with untrained, non-technical personnel showed significant variability in usage, and consequently, in results.

(7) The measured response ranges (negative to positive) of the rhodizonate-based kits are generally above the targets set by EPA for paint, soil and dust. The sulfide-based kit yielded positive responses to "blank" paint and therefore, for RTI paint, response ranges were below the targets. For EPA dust, the sulfide-based kit gave responses below the targets, but for RTI dust and EPA soil responses were above the targets.

Based on the results of this limited study, the rhodizonate kits may have adequate sensitivity to measure available lead in solution to meet the EPA target criteria. That is, the chemistry of the kits allows easy detection of lead at the lower levels of concern, provided that the lead is available to react with the test kit reagent(s). Further testing

is required to verify these results. The sulfide-based kit responds to levels below the target level for most samples but appears to have uninterpretable responses with certain dusts and soils because of their dark color. Besides this interference problem of sample color, the primary limitation of all the kits when used with real-world samples is lack of response with relatively high levels of lead. This lack of response may be a result of low lead extraction or dissolution efficiency, though it may also be a result of pH or ionic strength changes and/or interferences.

3.4 RECOMMENDATIONS

As a result of this evaluation of the test kits, several recommendations can be made. The first is that the results of this evaluation be made known to test kit manufacturers so that they can use the data as the basis for improvements including (1) improving the instructions provided with the kits, (2) improving the lead extractability of the kits, and (3) providing quality control check samples with each lead kit. This recommendation will, in fact, be carried out through distribution of this report after the final approval.

It is anticipated that the lead extractability of the test kits designed for use by consumers can never be quantitative (i.e., >90 percent) since the reagents used to dissolve lead from old paint, dust and soil would be moderately acidic or caustic and therefore unsafe for home use.

Therefore, a second recommendation is that quantitative extraction procedures be developed for paint, soil and dust that might be used as part of quantitative kits designed for professional testers. Measurement would not be confined to the rhodizonate or sulfide colorimetric procedures, but could include field-portable instrumental methods such as electrochemical methods.

If these recommendations are carried out, it is anticipated that two types of kits would be available. The first type would be suitable for consumers to use in screening for the presence of unacceptable levels of lead. The second would be a quantitative kit

for professionals that would be used to decide whether there is a need to abate or remove paint and/or soil and also to decide if the levels in house dust are sufficiently low after abatement to allow reoccupancy (that the dwelling has met clearance requirements).

SECTION 4

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Appendix A: Test Kit Search Contact List

Pb Test Kit Survey

Company/Organization	Availability of Pb Test Kits For:	
Hybrivet Systems, Inc.	Yes	Ceramics, pottery, soil, dust, paint chip and painted surfaces
Frandon Enterprises, Inc.	Yes	All surfaces and particles for paint, metal, dust, dirt, ceramic, household plumbing, and soldered seams on food cans
Paul N. Gardner (from Mary McKnight)	Yes	Paint Chip (West Germany)
Verify (from Mary McKnight)	Yes	Paint, pottery, toys, and soil (Distributed by Copper Development)
BGI, Inc.	Yes	Paints, metals, ceramics, dust, and soil (Manufactured by HybriVet Systems, Inc.; Different forms of packaging)
Analabs	No	---
Analytical Products, Inc.	No	---
Astro International Corp.	No	---
Baxter's Scientific Products Division	No	---
R. P. Cargille Labs, Inc.	No	---
Chemetrics, Inc.	Yes	Water
Delta Technical Products Co.	No	---
Dexsil Corp.	No	---
EM Science	Yes	Water
ESA, Inc.	Yes	Blood, urine, and water
Fluke Chemical Corp.	No	---
Hach Co.	Yes	Water
Koslow Scientific Co.	No	---
LaMotte Chemical Product Co.	Yes	Solder

Pb Test Kit Survey (continued)

Company/Organization	Availability of Pb Test Kits For:	
Mine Safety Appliance Co.	No	---
Nalge Co.	No	---
Oncor, Inc.	No	---
Orbeco Analytical Systems, Inc.	Yes	Water
Polyscience Corp.	No	---
Sigma Chemical Co.	No	---
Spectrum Medical Industries	No	---
Spectrum Scientific	No	---
Sunshine Technology Corp.	No	---
Thomas Scientific	No	---
Transidyne General Corp.	No	---
United States Biochemical Corp.	No	---
VWR Scientific	Yes	Water (Distributed for EM Science)
Cutting Ceramics	No	---
Carolina Pottery	No	---
Mangum Pottery	No	---
Tumbleweed Pottery	No	---
Bonne's Antiques, Inc.	No	---
Bostic & Wilson Antiques	No	---
Kaselaan and D'Angelo Associates, Inc. (Donald Abramowitz)	Yes	Laboratory-prepared sodium sulfide kit
Civil Engineering Laboratory (Charles Mathews)	yes	Laboratory-prepared sodium sulfide kit

Pb Test Kit Survey (continued)

Company/Organization	Availability of Pb Test Kits For:	
Public Health Dept., Massachusetts (Paul Hunter)	---	(Refer Frandon Kit)
National Institute of Environmental Health Sciences (Ralph Zumwalde)	---	(No response)
EPA, NC (Robert Elias)	---	(Unaware of additional kit)
EPA, Las Vegas (Harold Vincent)	---	(Unaware of additional kit)
EPA, Region 1 (Thomas Spittler)	---	(Unaware of additional kit)
State of Maryland (Merrill Brophy)	---	(Unaware of additional kit)
State of Maryland (Pat McLaine)	Yes	Laboratory-prepared sodium sulfide kit
Georgia Tech (David Jacobs)	---	(No response)
Midwest Psychiatric Institute and Clinic, University of Pittsburgh (Herbert Needleman)	---	(No response)
Copper Development (from James Keck)	Yes	Solder
Water Test (from James Keck)	Yes	Water
Millette Vanderwood Associated	No	(Not aware of test kit)
U.S. Consumer Product Safety Commision, Health Science Laboratory (Miau Huang)	---	(Unaware of additional kit)

Pb Test Kit Survey (continued)

Company/Organization	Availability of Pb Test Kits For:	
Innovative Synthesis Corporation (Carolyn J. Newton)	Yes	Paint chip, pottery, and household items
Service Paint (Carolyn J. Newton)	No	---
HydroTalks (Carolyn J. Newton)	---	No longer in service
Englehart Corp. (Carolyn J. Newton)	Yes	Solder
Lead Based Paint Detection (Carolyn J. Newton)	Yes	Water
Midwest Research Institute, Missouri (Christopher Shumate)	---	(Unaware of additional kit)

Appendix B: Test Kit Procedures

The FRANDON™ LEAD ALERT KIT

Patent Pending

DETECTS LEAD IN THE HOME ENVIRONMENT

INSTRUCTIONS FOR USE

SUMMARY OF TEST METHOD

Filter paper, or a cotton-tipped applicator is moistened with "Leaching Solution". The paper is then placed on a surface and allowed to dry; or, the cotton tip is rubbed on the surface. An "Indicating Solution" is then applied to the filter paper or to the cotton-tipped applicator. The appearance of a rose to rose/red stain indicates lead release. Results are interpreted as follows:

"POSITIVE RESULT"	THE APPEARANCE OF A ROSE TO ROSE/RED STAIN THAT IS SIMILAR IN COLOR TO THE COVER OF THIS INSTRUCTION BOOKLET.
"NEGATIVE RESULT"	THE APPEARANCE OF A YELLOW STAIN THAT FADES AWAY IN A FEW SECONDS OR AFTER A FEW MINUTES.

THIS KIT AIDS IN IDENTIFYING PAINT, CERAMICWARE (DISHWARE, GLASSWARE, COOKWARE), ENAMELED METAL FOODWARE, SOLDER (SEAMS ON FOOD CANS AND JOINTS ON COPPER WATER PIPES), AND OTHER ITEMS AND MATERIALS THAT RELEASE EXCESSIVE (POTENTIALLY HAZARDOUS) AMOUNTS OF LEAD. SENSITIVITY OF TEST IS DESCRIBED ON BACK COVER.*

IMPORTANT NOTE!

BEFORE STARTING TO TEST, YOU MUST PREPARE ONE BOTTLE OF "INDICATING SOLUTION" ACCORDING TO THE INSTRUCTIONS ON NEXT PAGE.

CONTENTS OF THE KIT

1. INDICATING TABLETS	Dark brown-red tablets (color indicator) in tapered plastic vial with flip top lid.
2. INDICATING SOLUTION	Water/alcohol solution in bottles with red caps. Note: One indicating tablet is supplied for each bottle of solution.
3. LEACHING SOLUTION	Tartrate buffer (leaching solution) in bottle with white cap is ready for use.
4. TEST PAPERS	Contained in protective plastic pouch.
5. ABRASIVE STRIPS	Contained in protective plastic pouch.
6. COTTON APPLICATORS	Contained in protective plastic pouch.
7. WHITE PLASTIC BOX	Provides a clean white viewing surface.

CAUTION: READ AND UNDERSTAND ALL OF THE INSTRUCTIONS IN THIS BOOKLET BEFORE TESTING! KEEP ALL CONTENTS AWAY FROM CHILDREN! AVOID CONTACTING EYES WITH SOLUTIONS! IF CONTACT OCCURS, FLUSH EYES THOROUGHLY WITH WATER.

PREPARATION OF "INDICATING SOLUTION"

One of the bottles of "Indicating Solution" must be prepared as follows prior to testing: Remove red cap from one of the two plastic bottles labelled "Indicating Solution". Carefully remove the dropper insert by rolling/twisting it to the side. DO NOT SQUEEZE THE BOTTLE OR THE SOLUTION MAY SPILL! Open the top of the tapered plastic vial and place one of the dark brown-red tablets into the water/alcohol solution. Then hold the bottle firmly (without squeezing), and snap the dropper insert back into place. Replace the red cap and shake the bottle vigorously for one minute. Allow the bottle to stand for five minutes and then shake it again. The tablet will not be completely dissolved and the solution will be dark yellow in color. Following preparation, the "Indicating Solution" can be used for 3 to 5 days or until it no longer gives a bright yellow stain when a drop is applied to white filter paper followed by a drop of "Leaching Solution". The bottle should be shaken lightly for a couple of seconds each time it is used for testing.

Do not prepare the second bottle of indicator solution! It should be prepared after the first bottle of solution has been used or is no longer active. The indicating tablets are light-sensitive. Therefore, keep the second tablet in the tapered vial (with flip top closed) and store in the dark until ready for use.

NOTE: IF THE DROPPER TIP OF THE "INDICATING SOLUTION" BOTTLE BECOMES CLOGGED, REPLACE THE RED CAP. THEN TAP THE BOTTOM OF THE BOTTLE ON A HARD SURFACE. THIS WILL FREE THE DROPPER TIP OF ANY DEPOSITS.

FOLLOW THE INSTRUCTIONS IN THIS BOOKLET WHEN TESTING.

IF YOU GET A "POSITIVE RESULT"

A "positive result" is defined on the cover of this booklet. It is up to one's own judgment if an item that shows a positive result for lead release may be used safely. A rapid and deep color change to rose/red (a color similar to the cover of this booklet) provides an alert that the surface being tested has released a potentially hazardous amount of lead. For example, if the food contact surface of a ceramic bowl or plate shows a strong positive, lead could migrate into food that is prepared, served, or stored in the item. Paint that tests positive should not be sanded or scraped. Lead poisoning could result from inhalation or ingestion of the paint particles and the particles could be spread to other areas.

TESTING PAINTED SURFACES & PARTICLES

TESTING TOP LAYERS OF PAINT

1. Place 2 drops of "Leaching Solution" on a cotton-tipped applicator and rub the painted surface firmly with the moistened tip of the applicator for about 10 seconds using a back-and-forth motion.

2. Place 1 or 2 drops of "Indicating Solution" on the exact area of the cotton tip that was rubbed on the surface. A rose to rose/red stain will appear on the cotton tip if lead has been released. (When testing red-colored paint, a red stain that appears before the "Indicating Solution" is placed on the cotton tip may be caused by paint pigments rather than by lead release).

   NOTE: Any type of commercially available cotton-tipped applicator may be used. Sufficient "Leaching" and "Indicator" solutions are supplied with each kit to conduct scores, or even hundreds of tests using this procedure.

TO TEST UNDERLYING LAYERS OF PAINT

1. Sand a small area (approximately 1 or 2 square centimeters) with an abrasive strip to expose the underlying surface layer.

2. Test the exposed layer using a cotton-tipped applicator as explained in the instructions above for testing top layers. Test every layer of paint for lead release by exposing with an abrasive strip and repeating this procedure.

   NOTE: Use a new abrasive strip for each test. If additional strips are required cut the abrasive strips in half or use a similar type of commercially available sandpaper.

TO TEST PARTICLES OF PAINT, METAL, DUST, ETC.

1. Put a very small amount of fine particles of the material to be tested (paint chips, metal fragments, housedust, or dust from vacuum cleaner bag, etc.) on a piece of filter paper that has been placed on a white viewing surface such as the plastic box supplied with the kit. Apply 2 or 3 drops of "Leaching Solution" to the particles and allow to dry for 5 to 10 minutes.

2. Add 2 drops of "Indicating Solution" to the particles. A rose to rose colored stain will appear on the paper if lead has been released. (The particles may absorb some of the "Leaching Solution" causing the test paper to dry out completely. If this happens, the addition of 1 or 2 drops of "Leaching Solution" may enhance the color reaction).

TESTING CERAMIC & ENAMELED FOODWARE

1. Use the same quick and simple procedure described previously for "Testing Top Layers of Paint" to test surfaces of glazed ceramic and enameled metal foodware for lead release. Procedure 2, described below, may also be used.

2. The following procedure is used by U.S. Food and Drug Administration (FDA) inspectors to screen ceramicware ("dishes") and enameled metal foodware for lead release. Prior to being deemed safe for food use, items that test "positive" using this method must undergo further testing to determine if lead release exceeds the current or proposed FDA guidelines.

   (1) Place one "test paper" on a clean, dry, smooth, horizontal surface of the item to be tested. Reposition the item as necessary to obtain an accessible horizontal surface. If the item is patterned with painted decorations or decals, a portion of the pattern is an ideal test spot.

   (2) Apply 2 or 3 drops of "Leaching Solution" to different areas of the test paper. The paper must be saturated, not just moist, but there should be no excess solution present. The paper must be in complete contact with the surface with no ridges or bubbles present. The moist paper will be almost transparent and the pattern on the item will be visible.

   (3) Allow the test paper to remain on the item until dry (normally 5 to 10 minutes). Then remove it from the item and place it on a clean white surface for viewing. (Use the white plastic box supplied with this kit, a white tissue paper, or a white paper towel for viewing purposes).

   (4) Apply 2 or 3 drops of "Indicating Solution" to different areas of the test paper. A rose to rose/red colored stain will appear on the test paper if lead has been released. The pattern of the stain corresponds exactly to the location on the surface that released lead. In many cases, the design of the pattern (or decal) that released lead will be clearly visible on the test paper.

   NOTE: Based on latest toxicological findings about the danger of low level exposures to lead, the FDA has proposed a 25 to 50-fold reduction of allowable lead release from ceramic pitchers (excluding creamers). The FDA is also evaluating the need to decrease leachable lead from all other categories of ceramicware.

TESTING HOUSEHOLD PLUMBING

Locate an area where water pipes are exposed and determine if soldered joints are present - these are the areas with silver-colored metallic surfaces. A greenish-colored corrosion may also be evident. Test the pipes and/or the pipe joints using the following procedure.

1. Sand the pipe and/or the soldered joint lightly with an abrasive strip to remove corrosion and expose a portion of the bare metal surface.

2. Place 2 drops of "Leaching Solution" on a cotton-tipped applicator and firmly rub the moistened part of the applicator tip on the sanded area of the pipe and/or pipe joint for about 10 seconds.

3. Place 1 or 2 drops of "Indicating Solution" on the exact area of the cotton tip that was rubbed on the pipe or joint. A rose or rose/red stain will appear on the cotton tip if lead has been released.

   NOTE: Use a new abrasive strip for each test. If additional testing is required, cut the abrasive strips in half or use any similar type of commercially available sandpaper and/or cotton-tipped applicator.

IF A "POSITIVE" RESULT IS NOTED

The widespread use of lead, in the form of leaded pipe and lead-containing soldered joints in copper pipe, poses a serious health hazard. In some cases, particularly in areas having corrosive water, significant lead contamination can occur within a building's own water piping. Newer homes (homes less than 5-years-old) tend to have more lead in the water if lead solder was used. (After several years, deposits form on the inside of pipes and lead migration into the water decreases). As a precaution, run the water for at least two minutes from any tap that has not been used for an extended period (such as overnight). It is advisable to have the water tested for lead content if lead water pipes or lead solder connections exist in the home or building plumbing system. Local authorities should know if leaded piping exists in the main water supply system.

TESTING SOLDERED SEAMS ON FOOD CANS

Peel back the label on the can to expose the vertical side seam. (Some newer cans may not have seams). The seam may appear as a clean black line which indicates the it has been welded without lead. A soldered seam has a coating of silver-colored metal about one-half inch in width. The metal may be either shiny or dull. Test this type of seam for lead using the following procedure.

1. Place two drops of "Leaching Solution" on a cotton-tipped applicator and firmly rub the applicator on the suspect seam for about 10 seconds.

2. Place 1 or 2 drops of "Indicating Solution" on the exact area of the cotton tip that was rubbed on the suspect seam. A color change to rose or rose/red indicates lead release.

IF A "POSITIVE" RESULT IS NOTED

If the outside of the seam tests "positive" for lead, carefully examine the inside of the can. If the protective coating on the inside of the can is degraded, test the inside seam for lead release using the method described above. Wash and rinse the inside of the can, and dry it well with a paper towel before testing. If the inside seam tests "positive", the contents are probably tainted with lead.

NOTE: It has been known for decades that lead migrates into food from lead-soldered seams on metal food containers ("tin cans"). This method of sealing cans is outdated. Although newer and safer methods for sealing food cans are available today, about 4% of food cans produced in the United States and a much higher percentage of imported cans are sealed with lead solder. The combined total (domestic and imported) indicates that hundreds of millions of lead soldered cans are placed on market shelves in the United States each year. Untold billions more have been purchased by consumers over the years. Many remain stored in kitchen cupboards for future use. The lead content in the food in cans of this type is, at best, questionable and perhaps hazardous.

GOAL OF THIS TEST KIT

To provide a quick and simple method to alert users to the presence of leachable lead in a variety of materials.

*Sensitivity of test: The test methods described are designed to detect leachable lead at or above the following levels. For paint and paint residue in housedust - approximately 0.5% leachable lead content. For ceramicware and enameled metal foodware - approximately 0.25 micrograms of leachable lead per square centimeter of surface area tested. In all cases, contact a qualified laboratory for quantitative analyses of lead release; for determination of non-leachable lead content of materials; and, for confirmation of lead release from materials that may exist at levels below the detection limits of this test kit.

Recommendations for the use of our products are based on tests we believe to be reliable using the techniques and procedures described in this instruction manual. Manufacturer and seller are not responsible for results where the product is used under conditions beyond our control. Under no circumstances will Frandon Enterprises, Inc. or any manufacturer or vendor of its products be liable for consequential damages or damages to anyone in excess of the purchase price of the products.

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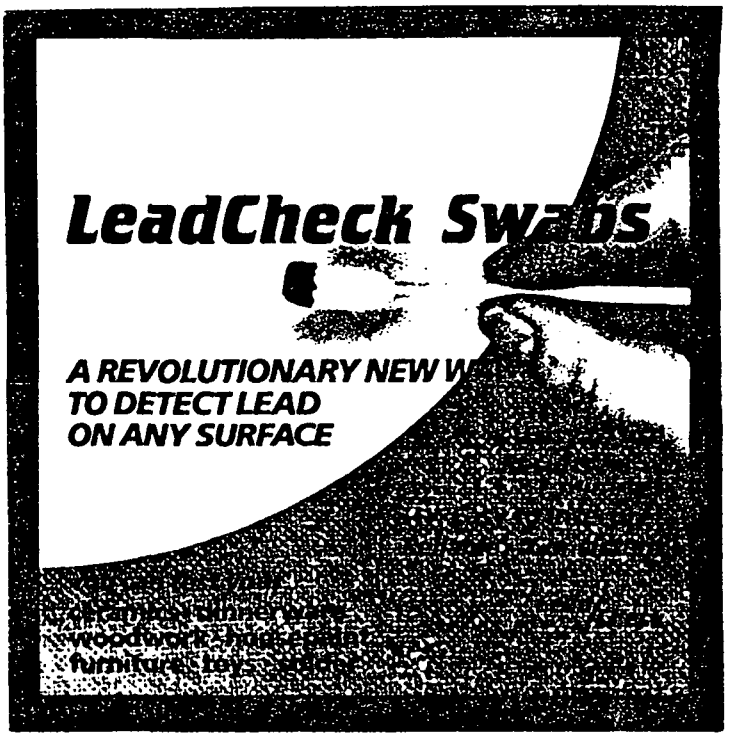
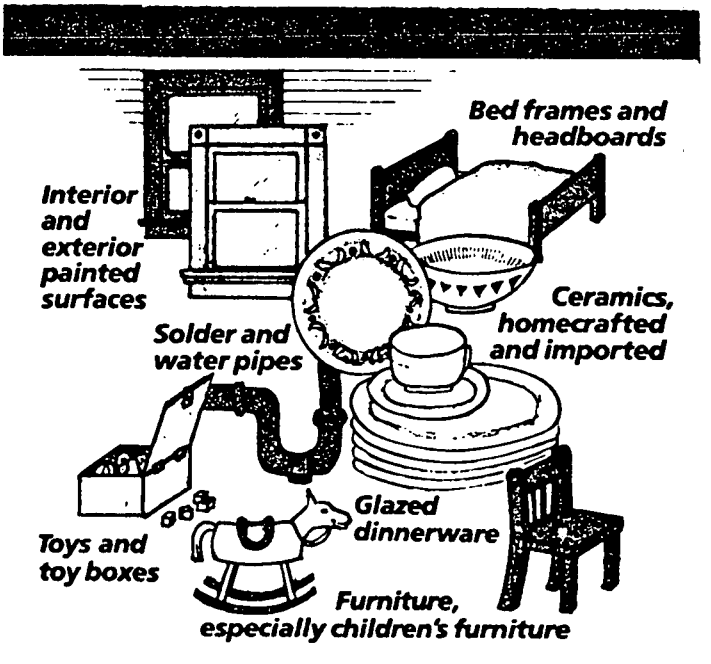
110190


LeadCheck Swabs
A REVOLUTIONARY NEW W
TO DETECT LEAD
ON ANY SURFACE


Bed frames and headboards
Interior and exterior painted surfaces
Ceramics, homecrafted and imported
Solder and water pipes
Glazed dinnerware
Toys and toy boxes
Furniture, especially children's furniture

Paint Millions of homes in the United States contain surfaces contaminated with lead paint. Chips and dust formed when surfaces are scraped or sanded, contain lead and may be inhaled or ingested. The lead content of paint was high, and there can be enough lead in one small chip to cause poisoning.

Toys Toys manufactured in other countries and imported into the United States have been found to contain lead paint.

Solder Water contamination can come from lead leaching out of the lead-containing solder which, until recently, was used with copper plumbing.

Furniture and Antiques Lead-containing paints, varnishes and lacquers used on old or antique furniture are sources of lead contamination.

Ceramics Lead glazed pottery, homemade pottery, porcelain-glazed vessels, or pieces obtained from other countries, can release large amounts of lead into food and drink, particularly if the glaze is chipped, cracked or improperly applied. Since glazes can deteriorate from repeated washing, even pottery previously tested as safe can become unsafe.

Dust and Soil Lead dust can cling to skin, hair, shoes, clothing, and vehicles, and can be carried from workplace to home in this manner. Particles of airborne lead from automobile exhaust and industrial sources deposit in soil and dust. Flaking lead paint adds to this contamination. Even though lead tends to stay in the top inch, soil can be contaminated to a much greater depth.

Lead has no function in the body. It can have poisonous effects on the liver, kidneys, nerves, bones, blood and brain causing a variety of toxic reactions including permanent learning disabilities and even retardation. Children are at high risk because their normal activities introduce non-food items into their bodies, and their developing brains are most susceptible to lead's toxic properties. Since lead accumulates in the body and is only slowly removed, repeated exposures, even to small amounts over long periods of time, may produce lead toxicity. Lead poisoning is not only a problem for children; adults are also susceptible to lead's toxic effects.

HybriVet Systems, Inc. P.O. Box 1210 Framingham, MA 01701

PHONE NUMBER: 800-262-LEAD (800-262-5323)

LeadCheck Swabs **Cat. No. PB-002** **PATENT PENDING**

LeadCheck Swabs provide a convenient method for the detection of lead in paint, on wood building surfaces, ceramics, solder and other items. It is not intended to replace an inspection by a licensed inspector. It is supplied as a kit which includes ready-to-use swabs, a swab-activating solution and lead strips to confirm the test performance. To test a suspect surface follow the steps in the *INSTRUCTIONS FOR USE.*

Kit Contents

Each ***LeadCheck Swabs*** kit contains:

LeadCheck Swabs
1 Bottle of Swab Activator Solution
Lead Strips
1 Instruction Sheet

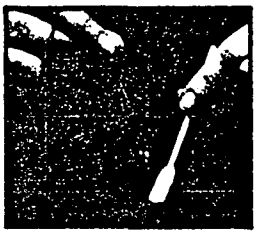
Warranties

The ***LeadCheck Swabs*** kit is intended to be used as a convenient way to detect and track lead contaminated glazed ceramics, pottery, dust, paint chips, and paint on any surface such as painted toys (wood or metal) and furniture. This test is designed as a presumptive test for lead and should not be considered quantitative. Under the conditions described in the instructions, ***LeadCheck Swabs*** will detect dangerous levels of lead. Use of this test is not intended to replace inspection by a licensed inspector. No guarantees are intended or implied.

Liability

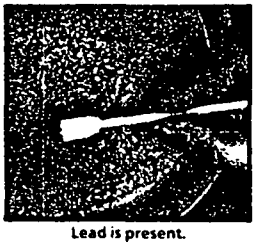
The manufacturer assumes no liability for the misuse of ***LeadCheck Swabs*** or for the interpretation of the results by the user. If lead contamination is suspected based upon this test, a professional testing laboratory or a deleading company should be consulted.

Ceramics • Toys • Solder Glazed dinnerware



1 Holding the swab by the plastic rod with the absorbent tip pointing down, wet the swab with at least 2 full dropper volumes of the Activator Solution provided. (*DO NOT* dip the swab into the Activator Solution!) The swab must be thoroughly wet, but not dripping.

2 Vigorously rub the ***tip*** of the swab over the test area for 30 seconds. Be sure to use the ***tip*** of the swab and not the sides.



Lead is present.

3 Observe the swab for a color change. If the tip of the swab turns pink or scarlet, lead is present. If a color change does not occur, immediately perform the confirmation test.

4 With ceramics be sure to rub the test swab vigorously over all of the glazes which may come in contact with food.

5 After testing, wash pieces well with ordinary dish washing detergent.

***LeadCheck Swabs™** *may be used to detect lead in dust.*

Suggested places and items to test are listed on the other side of this instruction sheet.

Painted Wood Surfaces

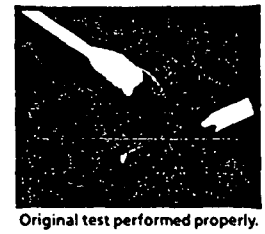
1 Remove all dust* and dirt from the area to be tested.

2 With a clean knife, cut or scrape through all layers of paint to expose approximately one quarter inch diameter bare wood. Do not gouge the wood.

3 Perform steps 1 through 3 of the above instructions.

Confirmation Test

If the pink color does not develop on the ***LeadCheck Swab*** within one minute, immediately confirm that the test was performed properly. Place one of the Lead Strips provided on a piece of plastic wrap and rub the same swab on the Lead Strip. If the swab and/or the Lead Strip turn pink, the original test was performed properly. The absence of pink color on the swab and Lead Strip indicates that the test was not performed properly and must be repeated with a fresh, unused swab. Wrap the used swabs and Lead Strips in plastic wrap to dispose of them.



Original test performed properly.

Interpretation

1 The appearance of any pink color on the swab indicates the presence of dangerous levels of lead.

2 Once developed, a pink swab retains its color for at least one day.

3 In the absence of lead, no pink color appears. The swab may turn yellow. This is a temporary color which fades with time.

4 A lead-free test result on a house painted before 1978 should be confirmed by a Licensed Lead Paint Inspector.

Precautions

1 Once a ***LeadCheck Swab*** has been moistened with the solution provided the test must be performed within 5 minutes. Any swabs moistened with Activator Solution and not used in a test must be discarded. Swabs will not work if they are dried and reused.

2 Store unused ***LeadCheck Swabs*** in the container provided. Keep container tightly closed.

3 Keep the ***LeadCheck Swabs*** kit and all of its component parts out of reach of children.

4 Keep loose paint chips out of reach of children.

5 Keep the bottle of Activator Solution tightly closed when not in use.

6 Avoid contact with skin; wash hands after use. Do not touch absorbent tip of swab; handle only by plastic rod.

Helpful Hints

1 Certain stains, lacquers, and varnishes may also contain lead and should be tested.

2 When testing surfaces that are painted red, first check for "bleeding" of the red paint onto the swabs by moistening household cotton or cotton tipped applicators with a few drops of the Activator Solution provided. Rub the cotton on the red surface. If color appears on the cotton, the ***LeadCheck Swabs*** kit cannot be used. ***LeadCheck I*** (Cat. No. PB-001) may be used to test for lead in paint.

3 To avoid contamination of the solution provided do not allow the dropper to touch any surface being tested.

4 When testing painted surfaces, be sure to test areas where all layers of paint are present. Lead may be present in the first layer of paint, sandwiched between layers of paint, or on the newly exposed wood surfaces.

5 If a surface becomes pink during the test, wash the area with an all-purpose household cleaner and the color will disappear. Baking soda or vinegar will lighten the color.

Lead Check™ SWABS

LEAD TEST KIT *

Instruction Manual Catalog No. PB-002M

THE FACTS -

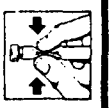
Lead Is a Health Hazard

Lead has no function in the body. It can have poisonous effects on the liver, kidneys, nerves, bones, blood and brain causing a variety of toxic reactions including permanent learning disabilities and even retardation. Children are at high risk because their normal activities introduce non-food items into their bodies, and their developing brains are most susceptible to lead's toxic properties. Lead accumulates in the body and is only slowly removed. The New England Journal of Medicine (January 11, 1990) reported that exposure to low levels of lead over extended periods of time can cause serious behavioral problems and learning disabilities. Adults as well as children are susceptible to the toxic effects of lead.

Symptoms and Signs of lead toxicity are fatigue, pallor, malaise, loss of appetite, irritability, sleep disturbance, sudden behavioral change, and developmental regression. More serious symptoms are clumsiness, muscular irregularities, abdominal pain, persistent vomiting, constipation, and changes in consciousness. Children who display these symptoms need thorough medical evaluation.

INSTRUCTIONS

CERAMICS, GLASSWARE, TOYS, SOLDERED FOOD CANS

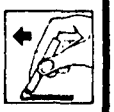


❶ SQUEEZE and CRUSH

Squeeze and crush first "**A**", then "**B**".

❷ SHAKE

With the cotton tip pointing down, shake twice, and squeeze gently. When yellow appears on the cotton tip, the swab is ready to use.



❸ RUB

While squeezing gently, rub the cotton tip on the test area for 30 seconds. With ceramics, be sure to rub the test swab vigorously over all of the glazes which may come in contact with food. With soldered food cans, rub the seam for about ten seconds.

If the cotton tip turns PINK, lead is present. If the tip does not turn pink, immediately rub the same swab on an unused spot on the Test Confirmation Card. If the swab and/or the spot on the Test Confirmation Card then turn pink, the test was performed properly. If the swab and/or the spot on the Test Confirmation Card do not turn pink, repeat the test with a new unused swab.
(See PRECAUTIONS, No. 3.)

PAINTED WOOD OR METAL SURFACES

- Remove all dust and dirt from area to be tested.
- With a clean knife, cut or scrape through all layers of paint to expose bare surface. Lead may be present in the first layer of paint, sandwiched between layers of paint, or on the newly exposed wood or metal surface.
- Perform steps 1 thru 3 of the above instructions.

DESCRIPTION / CONTENTS

LeadCheck™ Swabs, an innovative and proprietary test system*, use an acknowledged method for lead detection. To test a surface follow the steps in the INSTRUCTIONS. The package contains LeadCheck™ Swabs, an instruction sheet and a Test Confirmation Card that is impregnated with a small quantity of lead.

Ceramics - Lead glazed pottery, homemade pottery, glazed porcelain vessels, or ceramic pieces (especially old or imported pieces), can release large amounts of lead into food and drink, particularly if the glaze is chipped, cracked or improperly fired. Since glazes can deteriorate from repeated washing, even pottery previously tested as safe can become unsafe.

<<< >>>

Solder (Water Pipes and Food Cans) - Water contamination can come from lead leaching out of lead solder which, until 1988, was used with copper plumbing. Some food cans are still sealed with lead-containing solder which may contaminate the contents.

<<< >>>

Dust and Soil - Lead dust can cling to skin, hair, shoes, clothing, and vehicles, and can be carried from the workplace to home in this manner. Particles of airborne lead from automobile exhaust and industrial sources deposit in soil and dust. Flaking lead paint adds to this contamination. Lead from contaminated soil is concentrated in the leaves and roots of growing vegetables.

To obtain a procedure for detection of lead in dust or soil using LeadCheck™ Swabs, call 1-800-262-LEAD.

CLEANING TEST SURFACES

If a surface becomes pink during the test, wash the area with an all purpose household cleaner and the color will disappear.

Paint - Millions of homes in the United States contain surfaces contaminated with lead paint. Remodeling or renovation projects often release lead-containing paint chips and dust, especially when old paint is scraped or sanded.

Lead poisoning can result from the inhalation or ingestion of lead-containing particles. Older paints may contain high levels of lead and there can be enough lead in one small chip to cause poisoning. Paints, varnishes and lacquers used on old or antique furniture as well as on toys have been found to contain lead.

Red Painted Surfaces - When testing surfaces that are painted red, first check for "bleeding" of the red paint onto the swabs by moistening household cotton or cotton tipped applicators with a few drops of distilled white vinegar. Rub the moistened cotton on the red surface. If red appears on the cotton, the LeadCheck™ Swabs cannot be used.

<<< >>>

Stains, Lacquers and Varnishes - Certain stains, lacquers, and varnishes may also contain lead and should be tested. If the test is negative for lead (swab does not turn pink) on a house painted before 1978, and you are concerned that lead is present, call a lead paint inspector.

INTERPRETATION

1. If the cotton tip turns pink, high levels of leachable lead are present.

2. In the absence of lead, the cotton tip does not turn pink. Any yellow visible on the cotton tip is a temporary color which fades quickly.

PRECAUTIONS

1. Once a LeadCheck™ Swab has been crushed, use it immediately. Swabs are not reusable.

2. Keep all LeadCheck™ Swabs kit materials and any lead-containing items out of the reach of children.

3. If you wish to test the same item twice, WASH the item thoroughly with any ordinary all-purpose household cleaner before retesting.

4. If the test is positive, exercise precaution in handling the material and consult with a lead paint inspector or testing laboratory.

5. Do not touch the swab tip; wash hands after use.

6. LeadCheck™ Swabs cannot be used to detect lead in water.

7. LeadCheck™ Swabs will not detect lead directly on plaster or gypsum surfaces or in plaster or gypsum dust.

8. When testing soldered food cans, be sure to rub only ten seconds or less. Longer rubbing times cause the swab to turn purple which may mask a positive test for lead.

INTENDED USE

LeadCheck™ Swabs provide a convenient method for the detection of lead on painted wood or metal surfaces, ceramics, decorated glassware, soldered food cans and other items. The test can alert the user to the presence of lead in paint so that proper precautions can be taken while removing it. This test is not intended to replace a professional inspection by a lead paint inspector.

WARRANTIES

The LeadCheck™ Swabs are intended to be used as a convenient way to detect leachable lead in glazed ceramics, pottery, decorated glassware, dust, soldered food cans, paint chips, and any painted surface. This test is designed as a presumptive test for lead and should not be considered quantitative. Under controlled laboratory conditions, LeadCheck™ Swabs will reproducibly detect 2 micrograms of lead. Under the conditions described in the instructions, LeadCheck™ Swabs will detect high levels of leachable lead. **Use of this test is not intended to replace a professional inspection.** No guarantees are intended or implied.

LIABILITY

The manufacturer assumes no liability for the mis-use of LeadCheck™ Swabs or for the interpretation of the results by the user. If lead contamination is suspected based upon this test, consult a professional testing laboratory, a deleading specialist or your local Department of Public Health.

HYBRIVET SYSTEMS INC.
P.O. BOX 1210
Framingham, MA 01701

1-800-262-LEAD

* Patent Pending

LeadCheck™ A ChemCheck Product from HybriVet Systems, Inc.
P. O. Box 1210
Framingham, MA 01701
800-262-LEAD

LEAD IN SOIL PROTOCOL

To one gram of soil add 2 milliliters of 4% acetic acid or distilled white vinegar.

Mix and allow to settle for 30 minutes.

Remove 50 microliters of the clarified extract and place in a small white plastic container (weigh boat).

Activate the LeadCheck Swab according to the directions provided. Be sure you see yellow at the tip of the swab.

Rub the LeadCheck Swab in the 50 microliters of extract for 15 seconds.

If the tip of the swab turns pink, extractable lead is present in the soil sample.

LEADCHECK SWABS DUST PROTOCOL
PB-002M (MONOSWABS)

Introduction:

LeadCheck Swabs are designed to be used as a presumptive test for lead. As such, they cannot be used to determine HOW MUCH lead is present. The instructions listed below will enable the user to determine if lead is present AT OR NEAR the limits currently considered to be safe.

Preliminary Cleanup:

If the rooms to be tested have recently had lead paint removed it is recommended that the following cleanup procedure be performed BEFORE using LeadCheck Swabs.

1. Thoroughly vacuum the area to be tested. If a specially filtered (HEPA filtered) vacuum is not used observe special precautions since very small particles of lead dust can pass through standard vacuum cleaner filters contaminating a larger area. At a minimum wear protective breathing apparatus and allow any dust to settle at least 24 hours before proceeding to step 2.

2. Wash the floor THOROUTHLY one or more times with a solution of Trisodium Phosphate.

Test Instructions:

1. Mark off a one square foot section of floor.

A B

C D

2. Using a DRY swab rub the marked off section of floor in the following pattern. A--> B--> C--> D--> A.

3. Now activate the swab by squeezing and crushing at point A and point B. Shake. With the tip pointing down, squeeze till yellow is observed.

4. Develop the swab by rubbing the tip on a small plastic dish or sheet of wax paper.

5. If pink appears on the tip of the swab high levels of lead are present and the cleanup procedure must be repeated.

The Lead Detective

Lead Paint Detection Kit

Detects lead in paint down to 1% by approved state method

Lead Paint Detection Kit

Innovative Synthesis Corporation
45 Lexington Street, Suite 2
Newton, MA 02165
(617)244-9078

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Lead In Your Home

INTRODUCTION

Lead is a heavy metal common to many minerals. It comprises only a small fraction of the earth's crust. It serves no dietary or biological function in humans and its incorporation into our bodies represents toxic exposure. Lead is a ubiquitous constituent in a variety of industrial chemicals and materials. It serves as antiknock agents in gasoline in the form of tetraethyllead, organolead primers and brighteners in paints, solder, antifouling agents, dyes and glazes in pottery, and a variety of other uses. In some forms such as storage battery casings and radiation shields it is not intrinsically dangerous except when misused, by burning for example.

Lead is an industrial age poison. Bones of our ancestors who died many centuries ago contain virtually no lead. The bones of man living in Ethiopia 3,000 years ago were nearly lead free, the bones of modern Americans may contain one hundred to one thousand times as much.

The recognition that lead is a prevalent and preventable poison and the recognition of plumbism as a disease has spurred our government to act to ban its use in a variety of products. Contrary to popular opinion lead in gasoline was not banned (a phased reduction still in progress) to eliminate this hazard but to protect catalytic converters and limit noxious air emission. A vehicle meeting federal air standards does not require lead-free gas. Lead in paint for home use was banned in 1978, but depletion of paint stocks was allowed to continue into the early 1980's. Lead in solder for home use was banned in 1986.

This kit and its accompanying manual gives you the ability to test for lead in your home.What was once predominantly a disease of the disadvantaged has today with the advent of urban renewal become an egalitarian disease. This test is adaptable for testing other sources of heavy metals and details of procedures are given in the instructions.

THE HISTORY OF PLUMBISM

The Greek physician Dioscorides noted the effects of lead poisoning in patients that ingested lead or lived near smelters. Dietary lead poisoning was common in ancient

Rome from ceramic in earthenware, pottery and drinking vessels such as lead wine goblets. Although the Romans knew about lead poisoning from their mining operations, they used lead in their aqueducts and piping. Dietary lead is believed to have greatly afflicted the upper class—imperial madness, infertility and high miscarriage rates lead some historians to suggest it was one cause of the fall of the Roman empire.

Benjamin Franklin in 1786 noted occupational lead poisoning in a letter to a friend. The hot lead type used in casting by his printing workers, lead to a central nervous disorder then referred to as the "dangles" which caused loss of feeling in the hands and feet. This condition common in painters who work with lead paint is called "painter's wrist" by doctors. Franklin remembered a trip to a Paris hospital in 1767, that served victims of colic. From the list of patients were tradesmen in lead: plumbers, glassiers, and painters.

Lead was banned in the distilling industry by the Massachusetts legislature in the late 18th century after cases of poisoning from rum came to light. Canning was believed to play a role in the loss of some Arctic expeditions in the 1800's. The British Franklin expedition searching for the Northwest Passage in the 1840's were believed poisoned from solder used in the tin cans that stored their food.

SOURCES OF LEAD EXPOSURE

Exposure to lead occurs from a variety of sources. Airborne lead comes from sources such as car exhausts and industry. Lead in water enters from the distribution network—piping and solder. Non-food items such as paint chips or dust, contaminated soil, weights, bullets, ceramic glazes, some cosmetics, printing ink, and specialty paints often contain lead. Some foreign made toys and cookware not subject to US law have been found to contain very high levels of lead in their paint. The sections that follow consider the various sources of lead in the home, how they may be monitored and corrected.

Painted Surfaces

By law in the US since 1977 paint must not contain more than 0.06% (600 ppm) lead. Stock of lead paint continued to be used into the early 1980's. Lead paint before that time contained as much as 50% lead, with 20% being common. The interiors of 27 million US homes built prior to 1940 and 75% of units built between 1940 and 1960— about 22 million additional units are thought to contain large amounts of lead paint. The exclusion of lead in paint applies only to interior paint,

and it is still common to find special purpose exterior, marine, industrial and military paints with lead. Some of this occasionally is used mistakenly in homes.

Pica or the act of eating non-food substances (primarily by children under six) is a major pathway for lead poisoning. It is important to realize that the act of eating paint can involve minute amounts of paint—just a speck—a chip 50 mg in size is enough on a daily basis, over the course of several weeks to seriously poison a child. This weighs the same as a drop of water. There is enough lead contained in a paint chip the size of a fingernail to cause permanent brain damage or death to a child under six were it all metabolized by the body. Fortunately only 5% of ingested lead is metabolized, the remainder is expelled. Lead has a sweet taste, attracting small children. A wet lollipop dropped on a dusty floor or left on a window sill with chipping paint can absorb the doses mentioned. Estimates of the contribution of lead paint to childhood lead poisoning place it as the major cause, with 50-75% being a common estimate.

Lead In Food and Water

In urban dwellings lead in water represents the second major pathway for lead poisoning. By some estimates ingestion of lead from water accounts for to over 50% of exposure, but the EPA estimates that

perhaps 10-20% of the total lead exposure in small children occurs this way.

Levels of lead in water are regulated by federal law with 0.05 mg/L (about 50 parts in a billion) the current federal standard. This is monitored at the utility, but water flowing from your tap may have picked up considerable lead burden. The EPA currently estimates that 42 million U.S. residents drink water in excess of the recommended levels. We offer a **LEAD IN WATER KIT**, write or call for details.

Bad situations occur with acidic or soft water. Acidic water can leach lead from pipe or solder and greatly enhance the level of metallic contaminants. Old homes with lead pipe have very high lead levels, any piping dating from the 1930's or earlier should be suspect. New homes with copper pipes and lead solder between 2-6 years old have shown the highest levels of lead due to solder. Buildings less than 5 years old may have high lead levels and should be tested. Lead in solder is the major cause of lead in water. Lead solder was banned for home use by the 1986 Safe Drinking Water Act. It is used for electronics and can mistakenly finds its way into new construction. Over 5-6 years solder forms a mineral surface coating that lowers the risk of lead being leached into the water.

A common practice of grounding electrical lines to

metallic water pipes increases corrosion in water distribution systems. Electric current from ground wire will accelerate corrosion of pipes. Do not remove these wires yourself, obtain assistance from a qualified electrician to install an new grounding system.

Lead can be removed from water using an appropriate point of use device. Activated charcoal devices are used, but do not work well and other methods are superior. Consider water treatment systems at point of entry to reduce the corrosiveness of your water. Use cold water for drinking as hot water dissolves more contaminants from piping. Run your tap water for 2 minutes first thing in the morning to reduce the lead level in water that stood in your pipes overnight. Store some of this water for bottled use later on in the day. This is especially true if using the water to make a baby formula. Flushing works well for single homes but may be ineffective for high rise apartment buildings with large diameter pipes.

Lead enters food from airborne dust deposited during farming or through contamination during canning (this is not common in the US today). In gardens containing high lead soil content (> 500 ppm) lead can be incorporated into vegetables particularly leafy greens and root crops such as spinach, leaf lettuce, herbs, beet greens, and collards. To reduce lead in food grown in contaminated soil plant mainly fruiting crop such as

tomatos, squash, peppers, cucumbers, peas, beans, corn, and sunflowers. Add lime to increase the pH of the soil to as close to neutral as possible (6.5-7.0) as this will tend to keep lead out of water entering plants. A high organic content in the soil also lowers lead uptake in plants. Discard outer leaves of vegetables and peel root crops before eating. Wash produce with a 1% vinegar in water (1-2 oz. per gallon of water) or with soapy water to remove lead from dust contamination.

Lead In Soil

Lead in soil arises most often from airborne sources. In rural areas a background level of 200 ppm lead is found whereas in urban areas levels can exceed 3,000 ppm. Near smelters or some industrial areas levels as high as 100,000 ppm have been found. An estimate is that for each 100 ppm of lead in surface soil above 500 ppm an increase in childrens' whole blood level of 1 to 2 µg/dL occurs. It is not a common form of exposure route but can be found with some small children. When it occurs it tends to be a seasonal event with summer and outdoor activities exacerbating the problem. Flaking lead paint around homes is usually the culprit. A $15 million pilot program has been initiated in three cities by the EPA using Superfund money to address this problem. Soil can be test either through independent labs (costs are

$25-40) or by government agencies. Only the top 1/2 inch should be sampled.

Airborne Sources

Inhalation of airborne lead generally in the form of dust is a minor exposure risk in most cases. When found, this form of lead poisoning occurs near a busy street or a lead smelter.

Other Sources

Lead is sometimes found in ceramic glazes, pottery, and paints on foreign made toys. Countries of origin include Mexico and Italy. Be aware of antiques, painted cribs, and antique pewter. The FDA began setting limits for lead in pottery in 1969 after a California family was severely lead poisoned by orange juice leaching lead from a Mexican pitcher. Specific lead limits now apply to all cooking utensils, and dinnerware. This kit contains a method for finding lead and heavy metals in pottery.

LEAD POISONING—CAUSES AND SYMPTOMS

Screening

Distribution of Lead In the Body

Lead ingested in any form circulates throughout the body. It is found in hard tissue such as bone and bone marrow, soft tissue such as the stomach and intestinal tract, the central nervous system, and in bodily fluids such as blood. Complex relationships exist between the lead levels found in these various areas and factors such as nutrition, physical state of the patient (young or old, male or female, healthy or ill for example), and the type of lead ingested. The ability of each type of tissue to bind and release lead differs dramatically, with some lead being permanently absorbed in hard bone and some rapidly metabolized in the gut. Blood the common screening standard has a turnover rate on the order of from one to three months depending on the condition of the individual being tested. Some well studied medical estimates are that lead distributes somewhat equally throughout the tissues mentioned above. Diet plays an important role in the ability of lead to poison children.

Well balanced meals with adequate mineral calcium and iron aid in the body's ability to excrete lead wastes. Certain food groups such as fats are harmful.

Testing For Lead In Blood

A blood screening program has been found to be a useful measure of an individual lead exposure. The government recommends 25 µg/dL as the blood lead level above which action should be taken. The level of lead in blood is screened using the erythocyte protoporphyrin level (EP), an enzyme in blood from the hemoglobin group that does not contain iron. When EP exists it is because of elevated lead levels (or iron deficiency) and so is used as a preliminary indicator. An EP level of 35 µg/dL, taken from blood by finger prick, is considered poisoned. Follow-up is done by venous puncture to directly establish blood levels. A safe level of lead in blood has not been established. Testing is recommended for young children 9 months to 3 years old at least twice a year, and once a year for children between the ages of 3 and 6 years old. Test preferably between May and October when levels tend to be the highest. Blood levels by law are taken from young children (a primary risk group) to detect lead toxicity. Some states require a physician to report positive findings for further action. Screening is initiated to measure blood lead levels over time.

Diagnostic Evaluation

Lead is an insidious poison in that its effects are broad and asymptomatic. Manifestations include fatigue, pallor, malaise, loss of appetite, irritability, sleep disturbance, sudden behavioral change, and disturbance in growth patterns. More serious symptoms include clumsiness, muscular irregularities, weakness, abdominal pain, vomiting, constipation, and changes of consciousness. the symptoms are broad and non-specific and often difficult to spot without a blood test. Lead has broad effects and is a neurotoxin, it interferes with the production of numerous enzymes in the body.

Learning disabilities induced by exposure to lead occur in children. In a recent study of blood lead levels versus learning abilities (see reference 18) in very young children there was found to be a direct correlation between blood lead levels at birth and learning ability measured using a Mental Development Index (an IQ scale). Most disturbingly it was found that there was a significant loss of skills at blood lead levels below 25 µg/dL which is the legal limit. There was nearly a 5 point difference (100 point is the mean for the population) between infants with levels at birth of <3 µg/dL vs. >10

µg/dL. This is a large difference. The study shows that these intellectual losses are not possible to detect in normal children because skills lost are among the most complex and subtle.

Treatment

A child who tests positive for lead poisoning above 25 µg/dL must undergo chelation injection therapy or some other treatment to reduce their lead levels. This involves injection of a compound (most commonly Disodium Ethylene Diamine Tetraacetate, EDTA) to bind and remove lead from the body. It is administered venously and consists of a series of injections over time. In some severe cases chelation therapy continues for over a year. Lead in blood is fairly rapidly removed (over weeks), whereas lead in bone marrow for example takes months to flush out. Some level of lead in hard bone will always remain. Lead is a cumulative poison, chelation lowers lead levels but does not reverse the effects of the disease. Some hard tissue such as bone permanently incorporate lead.

HOW TO TEST FOR LEAD

Lead In Paint Detection Instructions

The following is based on a well known literature method. It is by law in most states, and by the federal government one of the two ways that lead in paint may be screened. It detects lead accurately down to 1%, current law sets limits for lead in paint at between the 0.5 to 1% levels.

Product Safety Information

As supplied to you Sodium Sulfide is a material of low toxicity but should be kept out of the reach of small children. Do not expose the kit to extreme heat. In its solid form sodium sulfide is flammable, if ignited it releases hydrogen sulfide gas. As a dilute solution in water sodium sulfide is inflammable. Do not place the solid or solution in contact with acid. Gloves are supplied because sodium sulfide is a mild skin irritant. Should you get some of the solution on your skin it will not do you harm. The area should be thoroughly rinsed with water. The sulfide smell may be removed by cleaning with soap and water. If swallowed

it will make you ill. If splashed in the eyes, thoroughly rinse with water. Seek medical attention in either case.

LEAD SULFIDE IS A POISON

The lead sulfide you form from the paint test is a poison. If you ingest lead sulfide call a physician.

Disposal Information

Unused sodium sulfide solution may be disposed of safely down a utility drain. Run cold water for about two minutes to flush the system. The remainder of the packaging may be disposed of in the trash. Of more concern are the paint chips containing lead sulfide. Be certain to dispose of any lead sulfide created by the test safely in the trash—use the small labelled plastic bag supplied as a container for disposal.

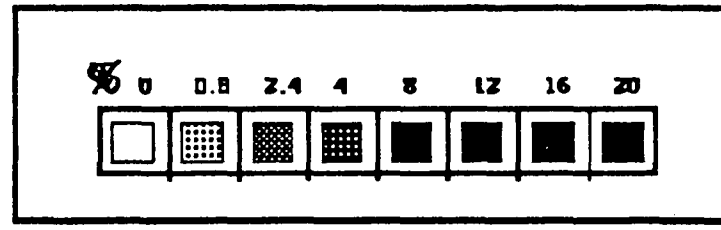
General Instructions

As supplied there are two 15 mL bottles, containing Sodium Sulfide and water. Carefully add the water to the sulfide to obtain a sodium sulfide solution of the right concentration. It will take about 5 minutes with vigorous shaking to dissolve the solid, longer if not shaken. Wait until the solid has completely dissolved before use. Mark down the date you prepared the solution, and an expiration date 6 weeks in the future.

Lead is detected by applying a few drops of sodium sulfide solution to the paint. The black color indicates the formation of lead sulfide and is a positive test for the presence of lead above 4%. Between 2-4% lead there will be a color change from dark gray to black. Below 1% there may be a light gray color formed and this should not be interpreted as an absolutely positive reaction. Modern paint uses metals like titanium dioxide that turn a gray color when reacted with sodium sulfide.

It may take a couple of minutes for the paint to blacken. Check both surfaces of a chip. Cleave the chip (use the straight edged razor blades supplied) to test paint layers sandwiched in between. Use the plastic tweezers as a convenience in handling your paint chips. Cut a groove through a surface in a diagonal or V-shape. Apply solution and check for color change. You may want to use the magnifying glass supplied to examine your work.

Lead Color Chart



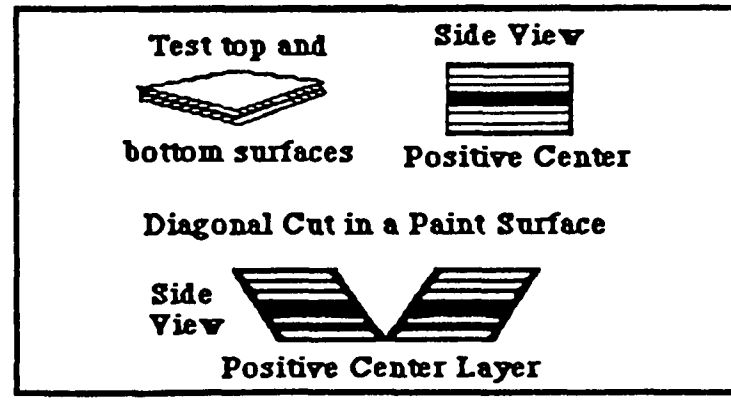
Color Changes in Paint of Established Lead Content

Be careful when applying sodium sulfide to the paint chip or painted surface tested that you keep the dropper tip clean. If you touch the dropper tip to a paint sample containing lead you may contaminate the solution and invalidate your future results.

DO NOT JUST TEST THE PAINT SURFACE

Lead layers may be in between non-lead paint. Primer can contain lead while outer coats are lead free. Do the test under good lighting. Dark paint can obscure the black color. Buried lead layers are potentially just as toxic as surface lead paint.

Testing Paint Chips and Surfaces



Included at the bottom of the kit is a piece of leaded paint to be used as a reference for the color change. This will serve as a reference check that the test is working properly.

Try to test paint in inconspicuous locations. This test will discolor woodwork, so either use a paint chip or work carefully. You can paint over any cut in the paint after you wash the area with soap and water.

SODIUM SULFIDE HAS A LIMITED LIFETIME

Keeping the bottle stoppered, out of the light and refrigerated will extend its shelf life. This pertains to

both the solution and solid form. Use the testing solution at once if possible. If you run out of solution, or cannot for some reason do the testing in the allotted time a reorder card for additional material is supplied with the kit.

Other Considerations

Lead was added to paint in the past in the form of organic compounds to add brightening and luster to the paint. Other heavy metals such as zinc, titanium, and barium have been added but none of these reacts with the sulfide to give a black precipitate. Other metals used such as cadmium, chromium, cobalt, iron, manganese, magnesium, mercury, molybdenum, and nickel were generally added to pigments in amounts under 1%. Black sulfides are formed by iron, mercury, and molybdenum but in the quantities they were used in the past they will not test strongly positive.

Copper also forms a black sulfide, but it was used only in paint that required strong anti-fouling capability, such as that used in ocean going ships. If you test wood that has been varnished, or treated with copper sulfate, or where copper based stains are used you will get a false positive reading.

In evaluating black or very dark gray paint it is difficult to be certain it contains lead. Note that lead was not commonly used in black paint because it was primarily a whitening agent.

All of these considerations aside, sodium sulfide is an excellent test for lead in paint and yields consistently accurate results.

TESTING VARIOUS AREAS OF YOUR HOME

Certain areas of your home have a higher priority for testing than others. Any area with flaking or peeling paint is of immediate concern no matter where it is. If you have small children test vigorously areas within the child's potential reach—3 to 4 feet high. Check exterior surfaces including walls, doors, windows, porches, guard rails, fences, bulkheads, cornerboards, and baseboards, dripboards and skirts. Also check auxiliary structures if they exist, garages, sheds, fences, and playground equipment. Intact paint on walls or ceilings does not constitute an immediate hazard but should be removed Test outside areas and a garage if you have one.

Be particularly observant of small areas, interior and exterior sills on windows, mullions and sashes (the cross pieces inside windows), door jambs, door planes and casings, and built-in cabinets, cupboards, closets, hutches, fireplaces, shelves and bookcases, and painted furniture.

Do not use the sodium sulfide test solution with painted metallic surfaces such as pipes or radiators, or metallic wallcoverings as you will get a false positive reading due to iron or copper in the metal. This kit is

designed to detect lead in paint covering wood, wallboard, or plaster.

As you test it is a good idea to record your findings. Make generalized maps and diagrams of rooms marked with compass directions. Record each room and sample each area of concern. If you do not know which direction is which, record the location by using specific objects—any specific comment that is meaningful to you.

Any surface paint that tests positive can be assumed to be positive everywhere. Don't assume a surface that tests negative doesn't cover up another positive layer somewhere else. Should you decide to do abatement or remediation work your record will be prove quite useful. If you have an inspector come for further testing you can specify where you want testing done and save both time and money.

What To Do If Your Paint Tests Positive

We recommend that before you undertake serious renovation work to delead a house you do additional testing. A device commonly used to detect lead is an X-ray fluorescence analyzer. It is safe and specific to lead, but requires a trained operator. It can only be used on flat surfaces. Manufacturers include Texas Nuclear or Princeton Gamma Tech. It costs several thousand

and inspecting a single family home costs between $150-250. A listing of inspectors may be obtained from one of your state's environmental agencies.

Your state may also offer testing services, often for free. **BEWARE!** In some states if lead is detected in the paint and children under six are residents, the state can force you to remove the lead paint from your entire home. Some state law gives municipalities the right to enter your home, monitor your family's health and supervise the removal of lead under the threat of strong civil penalties. Failure to comply could even result in state custody of your children.

If you decide to delead your home, read carefully the section in this manual on the nature and hazards of deleading a home. Be informed. It is a hazardous and costly job.

Lead In Pottery Instructions

Using our **LEAD PAINT DETECTION KIT** you can test for lead or other heavy metals in pottery or other household items. The directions are taken from an FDA analytical procedure. Cover the surface to be tested with distilled white vinegar (acetic acid—slightly greater that 4%). Acetic acid will dissolve metals out of a glaze or paint. Leave for 24 hours. Pour a portion into a white bowl or cup, and add an equal amount of sodium sulfide solution. A color change to black indicates the presence of metal in the pottery glaze.

Detecting Lead In Water

Lead in water is detected most commonly by an atomic absorption spectrometer. A sample of water is ionized by a hot flame. Lead (and other elements) are then detected to very minute levels by the wavelength and intensity of light that each specifically emits. Our **LEAD IN WATER KIT** measures two samples of your drinking water. A first draw sample indicates the quality of your home distribution system (pipes), and a full flush sample indicates the quality of the system water coming into your home from the outside.

HOME LEAD ABATEMENT

Lead paint removal is serious business and should be undertaken only by a professional contractor or by a well informed home owner. If you contract out the work seek professional references and if possible a guarantee. Typically prices for deleading a single family home range from $2,000 to $10,000 with $5,000 being an average amount.

Lead paint removal entails most of the following steps. 1. Removal of all lead paint from wood trim and walls up to a minimum of four feet high. 2. Collecting the debris. 3. Wash all surfaces with Phosphate (trisodium phosphate or TSP—the more the better) containing detergent twice followed by a water rinse. Phosphate binds lead and creates an inactive form.

There is some controversy concerning the best method for removing lead paint. Be especially wary of methods such as sanding because they create vast amounts of toxic dust greatly compounding the danger. In general the methods that work the best are dry scraping paint off (if necessary with a hot air blower) or dipping woodwork such as doors in a vat of paint remover. Sometimes the easiest and most cost effective way is just to replace the woodwork or fixture. Another effective method for remediating lead painted surfaces that are difficult to remove is to cover them with a hard surface such as fabric backed wallpaper or wallboard. New methods continue to come to market and more recently wet methods have been introduced. In a wet removal scheme a solution is applied to the paint that dries to a solid film. This film, polymeric in nature, incorporates the lead paint and may be peeled off as sheets.

Removal is tedious exacting work and you need to be properly equipped for the job. Reference 11 is recommended to you if you undertake this job. This includes wearing respirator masks (not dust masks), goggles and coveralls. Launder these separately. As you work seal off the room until all lead dust is removed. Exposed furniture should be covered with plastic, all belongings bagged or moved, and cleaned after work. The lead paint removed is a toxic material and by law must be disposed of in a toxic waste dump when a large quantity is removed. This is generally not necessary for a single family home. Do not dispose of the material in common trash. It is probably a good idea to evacuate the house while it is being renovated and to have serial blood tests done on those deemed at risk.

In the "Resources and References" section are a list of publications that may be of use to you in this area. Many are free for the asking from state agencies. New

methods continue to be developed for lead paint removal and careful evaluation is the key to success.

LEAD AND THE LAW

Test cases of severe and lethal lead poisoning have recently come to trial naming lead paint manufacturers as defendants in class action suits. Some have arisen out of poisoning through lead removal efforts by contractors. No precedence has been established making the lead industry liable for damages.

In most states it is the responsibility of the owner of property to remove lead from dwellings. Specific civil penalties including fines and prison sentences can apply to owners who knowingly allow children to inhabit such houses. Each state has different laws, and concerned citizens should contact their state agencies regarding.

Massachusetts Lead Laws

Massachusetts in 1971 passed the toughest state law on lead paint (interior paint above 0.5% or >1.2 mg/cm^2 is banned) to date. This law and a recent bill passed on the last legislative session of 1987 create a standard that will probably serve as a model for future state lead laws around the US. The bill authorizes loans and a $1000 tax credit for homeowners who delead their properties. It targets hot spots or Emergency Lead Paint Areas (ELPA's) and subjects them to systematic inspection and deleading.

The law requires sellers and their agents to provide to buyers material on: 1. The current lead paint law. 2. The buyer's responsibility for deleading if occupied by a child under six. 3. The availability of licensed inspectors and deleaders. 4. The buyers right to inspect the home within 10 days upon request—unless an inspection has been scheduled in the previous 30 days. This inspection upon transfer of property represents a departure from past practices. State inspection only took place upon report of a child being poisoned. Before a purchase and sale agreement, the current law requires disclosure of possible lead paint, or if deleading has occurred of a letter of compliance. An owner not in compliance is subject to damages and to a civil penalty of $1000. Lenders and banks are not responsible unless they foreclose on a property. Banks may reserve the right to deny financing on a house known to contain lead paint due to the reduction in appraised value anticipated. It is anticipated that a certified lead free home will have an enhanced value.

RESOURCE MATERIALS AND REFERENCES

1. "Preventing Lead Poisoning in Young Children: A Statement by the Centers for Disease Control", January 1985, Publication 99-2230, US Dept. of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Environmental Health, Chronic Diseases Division, Atlanta, Georgia 30333. A comprehensive guide to lead poisoning, its causes, symptoms, and cures.

2. "Lead Chemicals", Dorothy Greninger, International Lead Zinc Research Organization, New York, N Y 1976.

3. "Lead in Man and the Environment", J. M. Ratcliffe, Halsted Press, NY 1981.

4. "Lead in the Human Environment", National Academy of Sciences, Washington, DC, 1980. A position statement on medical aspects of lead poisoning

5. "Lead Toxicity", edited by Radhey L. Singhai and J. A. Thomas, Urban and Schwartzenberg, Baltimore, 1980. A medical study.

6. "Lead Toxicity:History and Environmental Impact",

edited by Richard Landsdown and William Yule, John Hopkins Press, Baltimore, 1986.A good general introduction.

7. "Lead and Your Drinking Water", EPA, Office of Water, April 1987, OPA-87-006. A free government pamphlet available from the EPA or the US Government Printing Office.

8. Chemical and Engineering News, December 21, 1987, p. 5. New EPA standard proposed 10 µg/L (current MCL is 50), in blood USA median lead level is 10-13 µg/dL, this is above the levels recommended.

9. "Statement on Childhood Lead Poisoning", Pediatrics, 79, 3, March 1987, page 457. American Academy of Pediatrics, Committee on Environmental Hazards and Committee on Accident and Poison Prevention. Medical aspects of plumbism.

10. Lead in Pottery Kit, $ 24.95, Frandon Enterprises, 511 North 48th Street, Seattle, WA 98103.

11. "Deleader's Manual: A Handbook For Safe Lead Paint Removal", Commonwealth of Massachusetts, Dept. of Public Health, Childhood Lead Poisoning Prevention Program, May, 1984. A free publication, contact the organization cited in reference 12. An

invaluable guide to lead paint removal. If you decide to delead you should definitely obtain this guide.

12. The Commonwealth of Massachusetts, Executive Office of Human Services, Department of Public Health, Childhood Lead Prevention Program, 305 South Street, Jamaica Plain, MA 02130. Telephone (800)532-9571, or (617)424-5965. Information on state programs and publications.

13. "Employee Guide to OSHA Standards for Lead", reprinted by Lead Industries Association, Inc. and the International Lead Zinc Research Organization, 292 Madison Avenue, New York, NY 10017, April 30, 1981. Occupational standards and practices for the lead industry, and lead removal industry.

14. "When Will We Stop Poisoning Our Children? Lead Paint and the Law", by Renee Loth, The Boston Globe Magazine Section, Boston MA, February 21, 1988. Cover story addresses lead paint poisoning, legal cases, and the toxicology of lead as it relates specifically to Massachusetts.

15. "Landmark Lead Paint Suits are Focusing on the Manufacturers", Linda Corman, Banker and Tradesman, Warren Publishing, Boston, MA, December 2, 1987, page 1.

16. "Lead Paint Statute Has Sharper Teeth But Still Lacks Funding", Victoria McNamara, Banker and Tradesman, Warren Publishing, Boston, MA, February 3, 1988, page 1.

17. "Management of Childhood Lead Poisoning", Sergio Piomelli, John Rosen, J. Julian Chisholm and John W. Graef, Pediatrics, 105, 4, October, 1984, page 523. Medical treatment of plumbism, chelation therapy and diagnostic methods.

18. "Longitudinal Analyses of Prenatal and Postnatal Lead Exposure and Early Cognitive Development", David Bellinger, Alan Leviton, Christine Waternaux, Herbert Needleman, and Michael Rabinowitz, The New England Journal of Medicine, 316, 17, April 23, 1987, page 1037. A study of plumbism versus learning disabilities.

19. U/Mass (Suffolk County) Cooperative Extension, 150 Causeway Street, Boston, MA 02114, Telephone (617)482-9258 and Massachusetts Cooperative Extension, Suburban Experimental Station, Waltham, MA 02254, Telephone (617)891-0650. Provides low cost soil testing for residents.

20. "Heavy Metal on Tap", Michael Kanor, Sierra

Magazine, November/December 1987, page 18. Lead in drinking water issues explored.

21. U.S. Environmental Protection Agency, 401 M Street SW, Washington, DC, 20460, Telephone (202)755-0707. US EPA Region 1, JFK Federal Building, Boston, MA 02203. Telephone (617)565-5715. An invaluable source of reference materials and resource contacts. Look in your yellow pages for the regional branch of the EPA nearest your home.

22. "Lead Astray: The Poisoning of America", by Michael Weisskopf, Discover Magazine, December, 1987, page 68.

This kit is dedicated to Mike and Noreen Francis and the Francis family who inspired its creation.

Merckoquant® 10077

Lead Test

Test strips and reagent for the detection and semiquantitative determination of lead ions

General

The Merckoquant® Lead test strip is suitable for the semiquantitative determination of lead ions in solutions and for the detection of metallic lead and lead compounds on surfaces.

In spite of its toxicity (accumulation of lead in the body [saturnism] through inhalation and absorption of lead vapours and dust) lead is used for many purposes such as cable sheathing, radiation protection against X-ray and gamma radiation, accumulators, manufacture of containers and tubes, in paints (red lead) as well as in tetraethyllead (antiknock compound in petrol), because of its versatility and ease of processing (soft and malleable) as well as its resistance to corrosive liquids.

The lead detectable in the environment (waters, soils, foods) mainly originates from automotive exhaust gases from the combustion of leaded petrol. Lead and lead oxide are formed which enter the atmosphere and can also be detected in the exhaust pipe so that it can be ascertained whether a vehicle has been run on leaded petrol or not.

Poisoning of a catalytic converter can also be detected. The catalytic converter is rendered useless by malicious or accidental use of leaded petrol so that high concentrations of NO_x compounds enter the atmosphere with the exhaust gases.

The Merckoquant® Lead Test only detects ionic lead and not organic compounds of lead such as tetraethyllead in petrol.

Method of determination

In acidic solution lead reacts with rodizonic acid to form a red coloured complex.

Directions for use

In aqueous solutions:

1. Rinse the measuring vessel with the solution to be tested and fill to the 5-ml mark.
2. Add 2 drops of reagent (acetic acid) and mix carefully.
3. Dip the reaction zone of the test strip in the solution to be tested for 1 second such that the reaction zone is properly wetted. Wipe the edge of the test strip against the edge of the vessel to remove excess liquid.
4. Compare the reaction zone with the colour scale after 2 minutes.

Remarks

The pH of the solution to be tested should lie between 2 and 5. This is normally achieved with the reagent. If the pH value is not obtained with the amount of reagent given in the Directions for use (check with a pH indicator strip), strongly acidic solutions must be buffered with 1 mol/l sodium hydroxide solution and alkaline solutions with 1 mol/l nitric acid.

No further reagent is required and solutions which already lie within the correct pH range do not require any reagent either.

On surfaces:

A) 1. Drop 1—3 drops of reagent onto the surface to be tested.

2. Stir the reagent around several times with the upper end of the test strip and leave to react for 1 minute.

3. Briefly gently press the reaction zone of the test strip onto the surface to allow the solution to soak into the reaction zone.

4. After 1 minute, compare the reaction zone with the colour scale.

B) 1. Moisten the reaction zone of the test strip with 1 drop of reagent and immediately gently press against the surface to be tested for 2 minutes.

2. Compare the reaction zone with the colour scale.

Evaluation: any red coloration indicates the presence of lead. If the reaction zone is colorless to yellow, no lead is present.

If it is not possible to conduct a direct determination on a surface, for instance if it is inaccessible as with an exhaust pipe which is turned down at an angle, a sample from the surface to be tested must be transferred to the measuring vessel to be able to conduct a determination.

1. Scrape a little of the exhaust residue into the measuring vessel using for instance a screwdriver.
2. Add 5 drops of reagent, mix and leave to react for 1 minute.
3. Dip the reaction zone of the test strip into the solution to be tested for 1 second such that the reaction zone is fully wetted. Wipe the edge of the test strip against the edge of the vessel to remove excess liquid.
4. After 1 minute, compare the reaction zone with the colour scale.

Evaluation: Any red coloration indicates the presence of lead. If the reaction zone is colorless to yellow, no lead is present.

For further information (e.g. on interference by anions and cations) please send for our Merckoquant® Tests leaflet.

Storage

The package should be stored cool (5—20 °C) and dry. Immediately reclose the tube after removing the necessary test strips and replace the screw cap on the reagent bottle.

Safety precautions

Store test kits such that they cannot fall into the hands of children, instruct young persons as to the safety precautions. Avoid contact with skin and eyes (the reagent contains dilute acetic acid), also do not touch the reaction zone. After completion of the determination, wash away the sample in a place where no contact with food or eating utensils is possible. Thoroughly wash away with water and immediately wash the hands.

Further rapid tests

Numerous colorimetric and titrimetric rapid tests as well as ion-specific Merckoquant® test strips are available for the determination of further ions and compounds.

Our brochure "Rapid test kits for analyzing water, soil samples, solids, foodstuffs" provides further information on the overall range.

E. Merck, Postfach 41 19, D-6100 Darmstadt 1,
Tel. (0 61 51) 7 20, Telex 4 19 328-0 em d

Verify™

LeadTest™

Test Parameters

Test Type:	Qualitative Reagent Test For Lead
Applications:	Household Items; including paint, plumbing, dishes, toys, ceramics, cookware. Not intended for the direct testing of water.
Nominal Sensitivity:	5 parts per million.
Number of Tests:	Eight

Kit Contents:

8 LeadTest Strips

5 Testing Cups

Distilled White Vinegar

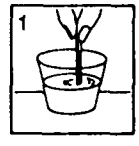
Complete Instructions

Water Test Order Form

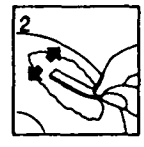
NOTE: LeadTest is intended as a qualitative test for lead in household materials other than water. Tests for lead in water should be performed by a certified testing laboratory.

Keep LeadTest Strips out of direct sunlight. Store in a cool, dry place.

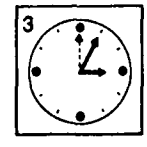
LeadTest is Easy to Use!



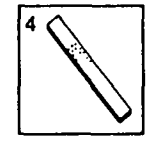
Dip LeadTest Strip into liquid sample or



Rub LeadTest Strip against metal sample



Wait 5 minutes



Lead shows up red!

Verify™

LeadTest™

Where to Check for Lead in Your Home

Dishes & Ceramics
- Imported pottery
- Glazed pottery
- Porcelain dishware
- Stoneware
- Decorative figurines

Painted Objects
- Wall paint
- Trim paint
- Wooden toys

Metal Objects
- Water pipes
- Solder joints
- Pewter plates and cups
- Aerators in water faucets
- Cooking utensils
- Fishing weights and tackle
- Toys

Soil
- Yards adjacent to roadways
- Playgrounds
- Crawl spaces
- Storage yards

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LeadTest™

Verify, Inc.
1185 Chess Drive, Suite 202
Foster City, California 94404

Verify™

LeadTest™

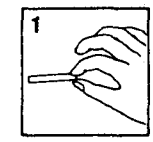
Why test for lead?

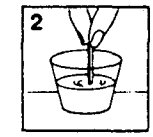
Microscopic particles of lead are a hidden household threat to children and adults alike! These particles of lead are easily swallowed, absorbed through the skin, and inhaled. Lead is toxic to humans, and even a trace of lead can be hazardous to your health. Lead poisoning can cause learning disorders, brain damage, anemia, high blood pressure, kidney damage, miscarriage, premature birth, and cancer.

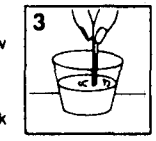
The potential threat increases with every exposure to lead. Why take chances? Find the lead in your home **today**!

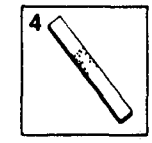
0 49153 00001 7

Handling LeadTest Strips









1. LeadTest strips are made of an absorbent material which has been impregnated with a testing agent. For best results, handle LeadTest strips only by one end, as shown in **Figure 1**.
2. To test for lead, dip one end of a LeadTest strip into the test solution, up to a depth of about ¼ inch. (See **Figure 2**.) DO NOT IMMERSE THE ENTIRE STRIP IN THE TEST SOLUTION.
3. The test solution will be drawn up the LeadTest strip by capillary action. (This action is known as "wicking.") Allow the test solution to rise ½ to ¾ of the way up the LeadTest strip. (See **Figure 3**.) The test strip may turn a shade of yellow. This is a normal part of the testing process, and is not indicative of the presence of lead.

   After dipping, place the wet test strip on a clean surface and allow it to dry.
4. If lead is present in the material tested, the LeadTest strip will appear pink or red in color after it has dried. You may need to look carefully at the LeadTest strip to see the pink coloration. If a marginal amount of lead is present, you may see only a few specks of pink along the edges of the test strip, or at a point ½ to ¾ of the way up the test strip where the wicking action stopped. (See **Figure 4**.)

   The chemical testing agent of each LeadTest strip is expended after one test. Therefore, DO NOT RE-USE LEADTEST STRIPS.

How to Test for Lead:

Dishes, Pottery, Ceramic Objects

Place the item to be tested on a flat surface. Pour one teaspoon of distilled white vinegar onto the item, and allow to stand for 24 hours. (During this standing period, any lead present will be released into the vinegar solution.) Holding a LeadTest strip between your thumb and forefinger, dip one end of the test strip into the vinegar solution (as shown in **Figure 2**). Place the wet test strip on a clean surface, and allow the strip to dry.

The LeadTest strip will turn pink or red if lead is present in the sample being tested.

Painted Objects

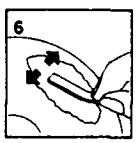
Using a clean knife, scrape a few chips of paint into a testing cup. (Be sure to scrape chips from all layers of paint, not just the surface layer.) Using a blunt plastic instrument, such as a plastic spoon, break the paint chips into small pieces. Add one teaspoon of distilled white vinegar to the chips in the testing cup. Allow the paint chips to soak in the vinegar for 24 hours. Gently swirl the testing cup. Holding a LeadTest strip between your thumb and forefinger, dip one end of the test strip into the solution as shown in **Figure 3**. Place the wet test strip on a clean surface, and allow the strip to dry.

The LeadTest strip will turn pink or red if lead is present in the paint sample being tested.

Water Pipes, Solder, Metallic Objects

NOTE: To determine if lead is present in your household plumbing system, perform the LeadTest on unplated pipes and solder connections. Unplated pipes are generally found in concealed areas — in walls, in attic spaces, and in crawl spaces beneath flooring. An unplated section of pipe may be readily accessible in the area near your hot-water-heater.

Metal objects to be tested must be clean and free from oxidation and corrosion. Using a sturdy knife or wire brush, scrape the area to be tested to expose clean metal. (See **Figure 5**.) Hold a LeadTest strip between your thumb and forefinger, and dip one end of the strip into distilled white vinegar. Allow the vinegar to "wick" about ¾ of the way up the test strip. Place the wet LeadTest strip against the clean metal. Gently rub the strip back and forth across the metal several times. (See **Figure 6**.) Place the wet test strip on a clean surface, and allow it to dry.



If the LeadTest strip appears pink or red in color when dry, it indicates the presence of lead in the metal item tested.

Soil

Place approximately one level teaspoon of surface soil into a testing cup. Add just enough distilled white vinegar to cover the soil. Allow the soil sample to stand for 24 hours. During this standing period, any lead present in the soil will be released into the vinegar solution. Gently swirl the testing cup to mix the solution. Holding a LeadTest strip between your thumb and forefinger, dip one end of the test strip into the vinegar solution (as shown in **Figure 3**). Be sure to allow the solution to "wick" up the test strip. Place the wet test strip on a clean surface, and allow the strip to dry.

The LeadTest strip will turn pink or red if lead is present in the sample being tested.

What to Do If Lead Is Present

Ingestion of lead into the body is the most prevalent danger from lead in the home. Minute particles of lead may be swallowed directly, or can be absorbed through the skin when handling lead-containing objects.

Most likely, you will want to reduce the risk of lead ingestion by disposing of dishware, utensils, and children's playthings which contain lead. Contact absorption can be minimized by keeping all decorative objects containing lead away from children.

If your home is more than five years old, you may find lead paint on the walls and woodwork. Even if you have recently repainted with lead-free latex paints, the lead in the older coats can leach to the surface. To minimize your health risk, have the old paint stripped by professionals trained in the removal of hazardous materials. If you must strip the paint yourself, evacuate other family members from the premises, wear eye protection and a respirator while working, and discard work clothes after completing the job.

If a test of your plumbing indicates the presence of lead in pipes or solder joints, you may wish to have a laboratory analysis performed to determine if lead is present in your tap water. Verify LeadTest Strips are not designed for this purpose. However, you can order a laboratory water test kit directly from Verify Inc. An order card is included in the LeadTest package.

You can minimize the risk of ingestion by allowing tap water to run for at least one minute before filling pots or glasses. Also, since hot tap water typically contains higher levels of lead than cold water, avoid using hot tap water for boiling vegetables or other cooking purposes. Instead, use your stove to heat cold tap water to the proper temperature for cooking. You also may wish to consider purchasing distilled water for drinking and cooking purposes.

Lead which has accumulated in the top soil is difficult to remove. You can reduce your health risks by avoiding contact with lead-containing soil. Your county's agriculture or health departments may have specific recommendations for the management of lead-containing soil.

Where to Check for Lead in Your Home

Dishes & Ceramics
- Imported pottery
- Glazed pottery
- Porcelain dishware
- Stoneware
- Decorative figurines

Painted Objects
- Wall paint
- Trim paint
- Wooden toys

Metal Objects
- Water pipes
- Solder joints
- Pewter cups and dishes
- Aerators in water faucets
- Cooking utensils
- Fishing weights and tackle
- Toys

Soil
- Yards adjacent to roadways
- Playgrounds
- Crawl spaces
- Storage yards

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Appendix C: Response of Lead Test Kits to Pb^{2+} Solutions Prepared from $Pb(NO_3)_2$ and $PbCl_2$

Response of Lead Test Kits to Pb^{2+} Solution Prepared from $Pb(NO_3)_2$ and $PbCl_2$

Frandon "Lead Alert" Test Kit

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Result with $Pb(NO_3)_2$	Result with $PbCl_2$
10 µL	10.0	0.1	Neg, Neg, Neg	?, Neg, Neg
20 µL	10.0	0.2	Neg, Neg, Neg	Pos, Neg, Pos
30 µL	10.0	0.3	Neg, Neg, Neg	Pos, Pos, Pos
40 µL	10.0	0.4	Neg, Neg, Neg	Pos, Pos, Pos
50 µL	10.0	0.5	Neg, Neg, Neg	Pos, Pos, Pos
60 µL	10.0	0.6	Pos, Pos, Neg, Pos	Pos, Pos, Pos
70 µL	10.0	0.7	Pos, Pos, Pos	Pos, Pos, Pos
80 µL	10.0	0.8	Pos, Pos, Pos	Pos, Pos, Pos

LeadCheck (Original) Test Kit

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Result with $Pb(NO_3)_2$	Result with $PbCl_2$
50 µL	10	0.5	Neg	?
10 µL	100	1.0	Pos	Pos
20 µL	100	2.0	Pos	Pos
30 µL	100	3.0	Pos	Pos
40 µL	100	4.0	Pos	Pos

Response of Lead Test Kits to Pb^{2+} Solution Prepared from $Pb(NO_3)_2$ and $PbCl_2$ (continued)

LeadCheck (New) Test Kit

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Result with $Pb(NO_3)_2$	Result with $PbCl_2$
40 µL	10	0.4	Neg, Neg	Neg, Pos, Neg
50 µL	10	0.5	Neg, Neg, Neg	Pos, Neg, Pos, Pos
80 µL	10	0.8	Pos, Pos, Neg, Pos	Pos, Pos, Pos
100 µL	10	1.0	Pos, Pos, Neg, Pos	Pos, Pos
10 µL	100	1.0	Pos, Pos, Pos	---
20 µL	100	2.0	Pos, Pos, Pos	---
30 µL	100	3.0	Pos, Pos	---
40 µL	100	4.0	---	---

Verify LeadTest Test Kit

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Result with $Pb(NO_3)_2$	Result with $PbCl_2$
10 µL	10	0.1	Neg, Neg, Neg	?, Neg, Neg, Pos
20 µL	10	0.2	Neg, Pos, Pos	Pos, Pos, Pos
30 µL	10	0.3	Pos, Pos, Pos	Pos, Pos, Pos
40 µL	10	0.4	Pos, Pos, Pos	Pos, Pos, Pos
50 µL	10	0.5	Pos, Pos, Pos	Pos, Pos, Pos
60 µL	10	0.6	---	Pos

Response of Lead Test Kits to Pb^{2+} Solution Prepared from $Pb(NO_3)_2$ and $PbCl_2$ (continued)

Merck EM Quant Test Kit (Method A)

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Result with $Pb(NO_3)_2$
10 µL	10.0	0.1	Neg
40 µL	10.0	0.4	Neg
50 µL	10.0	0.5	Neg
60 µL	10.0	0.6	Pos
70 µL	10.0	0.7	Pos
90 µL	10.0	0.9	Pos

Lead Detective Kit

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Result with $Pb(NO_3)_2$	Result with $PbCl_2$
40 µL	10	0.4	Neg, Neg, Neg	Neg, Neg
50 µL	10	0.5	Neg, Neg, Neg	Neg, Neg, Neg
10 µL	100	1.0	Pos, Neg, Neg	Pos, Pos, Pos
20 µL	100	2.0	Pos, Pos, Pos	Pos, Pos, Pos
30 µL	100	3.0	Pos, Pos, Pos	Pos, Pos, Pos
40 µL	100	4.0	Pos, Pos, Pos	Pos, Pos, Pos

Appendix D: Response of Test Kits to Pb^{2+} Solutions Prepared from $Pb(NO_3)_2$, $PbCl_2$, and $Pb(C_2H_3O_2)_2$

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Response of Test Kits to Pb^{2+} Solution Prepared from $Pb(NO_3)_2$, $PbCl_2$, and $Pb(C_2H_3O_2)_2$

Frandon Lead Alert Kit

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Result with $Pb(NO_3)_2$	Result with $PbCl_2$	Result with $Pb(C_2H_3O_2)_2$
10 µL	10	0.1	Neg, Neg, Neg	Neg, Neg, Neg	Neg, Neg, Neg
20 µL	10	0.2	Neg, Neg, Pos	Neg, Neg, Neg	Neg, Neg, Neg
30 µL	10	0.3	Pos, Pos, Pos	Pos, Pos, Pos	Neg, Pos, Pos
40 µL	10	0.4	Pos, Pos, Pos	Pos, Pos, Neg	3(Neg), 2(Pos)
50 µL	10	0.5	Pos, Pos, Pos	Pos, Pos, Pos	1(Neg), 3(Pos)
60 µL	10	0.6	---	Pos, Pos, Pos	Pos, Pos, Pos

The Lead Detective Kit

Volume	Conc. Pb^{2+}, µg/mL	Total µg Pb^{2+}	Result with $Pb(NO_3)_2$	Result with $PbCl_2$	Result with $Pb(C_2H_3O_2)_2$
10 µL	100	1.0	Neg, Neg, Pos	Neg, Neg, Pos	Neg, Neg, Pos
20 µL	100	2.0	Neg, Pos, Pos	Neg, Pos, Pos	Neg, Pos, Pos
30 µL	100	3.0	Pos, Pos, Pos	Pos, Pos, Pos	Pos, Pos, Pos
40 µL	100	4.0	Pos, Pos, Pos	Pos, Pos, Pos	Pos, Pos, Pos