Portable Technologies for Measuring Lead in Dust

The U.S. EPA Environmental Technology Verification (ETV) Program's Site Characterization and Monitoring Technologies (SCMT) Pilot, which was operated by Oak Ridge National Laboratory (ORNL) under an interagency agreement with EPA, and was an element of the Advanced Monitoring Systems (AMS) Center, has verified the performance of six field screening analyzers for lead in dust.[1] A technical panel of experts in lead testing, which included representation from the U.S. Department of Housing and Urban Development (HUD), National Institute for Occupational Safety and Health, National Institute of Standards and Technology, American Industrial Hygiene Association, Massachusetts Childhood Lead Poisoning and Prevention Program, and several EPA offices, including the Office of Pollution Prevention and Toxics, assisted with the design of the verification test and the reporting of results. These portable analyzers allow quick identification of lead levels in dust onsite and enable the user to react to potential health risks in a timely manner.

Environmental, Health, and Regulatory Background of Lead at a Glance

Lead is a highly toxic metal that was used for many years in products (e.g., as a pigment in paint products) found in and around homes. Lead may cause a range of health effects, such as behavioral problems and learning disabilities, and, at high levels of exposure, can result in brain damage or death. Research suggests that the primary sources of lead exposure for most children are deteriorating lead-based paint, lead contaminated dust, and lead contaminated residential soil. Children six years old and under are most at risk because their bodies are growing quickly.

The Centers for Disease Control and Prevention have determined in children elevated blood lead levels (BLLs) of 10 micrograms per deciliter or higher are associated with adverse health effects. To address the hazards of lead poisoning, the U.S. Consumer Product Safety Commission banned lead-based paint in 1978. However, homes built prior to 1978 are still in use and may have interior or exterior paint containing lead. In 1992, the U.S. Congress enacted the Residential Lead-Based Paint Hazard Reduction Act. Under this act, EPA and other federal agencies such as HUD established numerical standards for hazardous levels of lead in dust for pre-1978 housing and child-occupied facilities, required disclosure of known lead-based paint and lead-based paint hazards to buyers and tenants, and provided grants for low-income families who occupy lead-based-paint hazards in private housing. The grants include clean-up, control, testing, awareness, and training.

Technology Description and Verification Testing

The technologies verified by the ETV Program are portable and designed to be used to analyze dust samples in the field. The verified technologies use either X-ray fluorescence (XRF) or anodic stripping voltammetry (ASV). XRF allows for non-destructive analysis of a sample. This technique uses a radioisotope source or X-ray tube to excite lead atoms in the sample. The atoms, in turn, emit characteristic X-rays that are detected, quantified, and identified by the spectrometer. ASV is a destructive analysis method. A test sample is contacted with acid to bring lead into solution. The solution is subsequently mixed with a buffer salt solution. Lead in the solution is plated on and then stripped off an electrode. Each metal will strip from the electrode at a different potential, allowing for its identification, while the amount of current produced is quantified and correlated to sample concentration. **Table 1** identifies the six ETV-verified technologies and the technique used by each.

A verified lead in dust analyzer

A primary objective of the ETV test was to assess whether the participating field portable technologies produced results that were comparable to National Lead Laboratory Accreditation Program (NLLAP) recognized data. During verification testing, 160 dust wipe samples were analyzed. These wipes contained between 2 and 1,500 micrograms of lead per dust wipe, which is representative of levels found in house dust wipe samples collected using ASTM methods. The ETV Program evaluated the technologies on the following performance parameters: precision, accuracy, comparability to NLLAP recognized laboratory results, detectable blanks, false positive results, false negative results and other parameters. **Table 2** summarizes some of the performance data for the individual verified technologies. Additional information is available in the full verification reports and verification summary statements which can be found at http://www.epa.gov/etv/verifications/vcenter1-22.html.

[1]The ETV Program operates largely as a public-private partnership through competitive cooperative agreements with non-profit research institutes. The program provides objective quality-assured data on the performance of commercial-ready technologies. Verification does not imply product approval or effectiveness. ETV does not endorse the purchase or sale of any products and services mentioned in this document.

Table 1. Verified Portable Technologies for Measuring Lead in Dust		
Vendor	**Verified Technology**	**Technology Type**
KeyMaster Technologies	X-Ray Fluorescence Instrument Pb-Test	XRF
Monitoring Technologies International	PDV 5000 Trace Element Analyzer	ASV
Thermo Electron Corporation, NITON Analyzers Business Unit (Formerly NITON LLC)	X-Ray Fluorescence Spectrum Analyzer XLt 700 Series	XRF
	X-Ray Fluorescence Spectrum Analyzer XL 700 Series	XRF
	X-Ray Fluorescence Spectrum Analyzer XL 300 Series	XRF
Palintest	Scanning Analyzer SA-5000 System	ASV

Selected Outcomes of Verified Portable Technologies for Measuring Lead in Dust

- Based on a hypothetical projection of 25% market penetration, the ETV-verified portable measurement technologies could be deployed at up to approximately 9.5 million housing units out of an estimated potential market of 38 million (Jacobs et al. 2002) that were built before 1978 to:
  - screen for lead hazards (e.g., as part of a lead hazard screen) and assess potential risks (e.g., during a risk assessment).
  - temporarily clear residences for occupation following abatement or lead hazard control activities followed by final clearance based on fixed site laboratory analysis.
  - develop a focused and cost-effective sampling and analysis strategy provided the technology is used by a portable laboratory or field service and measurement organization that has been accredited by NLLAP[1].
- The information provided by these technologies can assist in the reduction of lead exposure, with associated human health and economic benefits, particularly for children. These technologies can be used to investigate instances of elevated BLLs in children.
- ETV verification also can potentially increase acceptance and use of the portable measurement technologies. ETV reports have been cited as a resource for promoting the use of the lead monitoring technologies such as the XRF instruments for residential lead soil and dust testing. Previous ETV verifications of similar technologies have assisted in the development of approved EPA methods for using field portable measurement technologies.

[1] The limitations to this assumption is explained on p. 48 of the ETV Case Studies: Demonstrating Program Outcomes. EPA/600/R-06/001. January 2006

Table 2. Performance of Verified Portable Technologies for Measuring Lead in Dust							
Vendor[a]	**Average relative accuracy[b],%**	**Average relative precision[c],%**	**Rate of false positives**	**Rate of false negatives**	**Comparability[d]**		
					slope	**intercept**	**r^2**
A	168 to 189	15 to 18	26 of 50	15 of 50	0.662 to 1.060	66 to 121	0.967 to 0.989
B	88 to 93	21 to 22	7 of 41	19 of 57	0.885 to 1.074	–14.345 to 15.633	0.988 to 0.999
C	91 to 97	7 to 8	0 of 42	36 of 58	0.849 to 0.936	7.495 to 11.262	0. 999
D	107 to 119	8	27 of 46	4 of 54	1.112 to 1.206	–3.29 to 13.283	0.999
E	80 to 91	5 to 8	0 of 50	39 of 50	0.839 to 0.926	5.539 to 6.506	0.995 to 1.000
F	97 to 101	11	9 of 49	18 of 51	0.977 to 0.995	3.076 to 4.775	0.999

[a] Because the ETV Program does not compare technologies, the performance results shown in this table do not identify the technologies associated with each result and are not in the same order as the list of technologies in Table 1.
[b] A result of 100% indicates perfect accuracy relative to the tested lead concentration.
[c] A result of 0% indicates perfect precision.
[d] Comparability of the technologies to the standard test method was evaluated using linear regression analysis.

References:

U.S. EPA, ETV Case Studies: Demonstrating Program Outcomes. EPA/600/R-06/001. January 2006 (primary source). http://www.epa.gov/etv/pdfs/publications/600r06001/600r06001pv.pdf.

U.S. EPA, ETV. http://www.epa.gov/etv.

U.S. EPA, Lead in Paint, Dust, and Soil. 06 Feb. 2007. http://www.epa.gov/lead/index.html.

Jacobs DE, Clickner RP, Zhou JY, Viet SM, Marker DA, Rogers JW, et al. 2002. The Prevalence of Lead-Based Paint Hazards in U.S. housing. Environmental Health Perspectives 110(10):A599–A606. October.

ETV Advanced Monitoring Systems Center

Robert Fuerst, EPA,
fuerst.robert@epa.gov
Tel: (919) 541-2220

Amy Dindal, Battelle
dindala@battelle.org
Tel: (561) 422-0113

EPA/600/S-07/028
August 2007