Taylor & Francis
Taylor & Francis Group

Applied Occupational and Environmental Hygiene

ISSN: 1047-322X (Print) 1521-0898 (Online) Journal homepage: https://www.tandfonline.com/loi/uaoh20

# ELPAT Program Report

## Background and Current Status

**Paul C. Schlecht Column Editor & Jensen H. Groff Column Editor**

**To cite this article:** Paul C. Schlecht Column Editor & Jensen H. Groff Column Editor (1993) ELPAT Program Report, Applied Occupational and Environmental Hygiene, 8:11, 912-918, DOI: 10.1080/1047322X.1993.10388224

**To link to this article:** https://doi.org/10.1080/1047322X.1993.10388224

Published online: 24 Feb 2011.

# ELPAT Program Report

## Background and Current Status

*Paul C. Schlecht and Jensen H. Groff, Column Editors*

### Introduction

The Environmental Lead Proficiency Analytical Testing (ELPAT) Program is administered by the American Industrial Hygiene Association (AIHA), in cooperation with researchers at the Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH), and the U.S. Environmental Protection Agency (EPA), Office of Pollution Prevention and Toxics (OPPT) to evaluate and improve the performance of laboratories conducting analyses associated with lead abatement.[1,2] Proficiency test samples are prepared by an AIHA contractor, Research Triangle Institute (RTI), using real-world paint chips, dusts, and soils. Quarterly samples are sent to participating laboratories by RTI and the performance of the laboratories is evaluated at NIOSH with sufficient time for laboratories to obtain repeat samples and to correct analytical problems before the next round of samples is sent.

The ELPAT Program is open to *all* interested laboratories, including laboratories outside the United States, laboratories seeking accreditation by various private or state laboratory accreditation systems, and laboratories that do not intend to seek laboratory accreditation. The ELPAT Program is part of an EPA Program, the National Lead Laboratory Accreditation Program (NLLAP), to recognize private and state laboratory accreditation systems.[3] NLLAP draft requirements include successful participation in the ELPAT Program for EPA recognition of accreditation. Two organizations, the American Association for Laboratory Accreditation (A2LA)[4] and AIHA,[5] have announced environmental lead laboratory accreditation systems. Each of these accreditation systems requires participation in ELPAT for environmental lead analysis of paint chips, dusts, and soils. Information on specific A2LA or AIHA laboratory accreditation requirements can be obtained from A2LA and AIHA at the addresses listed at the end of this column, or by attending A2LA/AIHA jointly sponsored environmental lead laboratory accreditation seminars.[4,5]

### ELPAT Performance Evaluation

Laboratories are evaluated at NIOSH each quarter (designated a round) for each sample analyzed, by comparing the laboratory's reported result against an acceptable performance range. The acceptable performance range is based upon consensus values from reference laboratories, and is modeled after the evaluation procedures currently used in an industrial hygiene proficiency testing program, the Proficiency Analytical Testing (PAT) Program.[6] Reference laboratories are preselected to provide the performance limits for each sample. Initially, reference laboratories are those ELPAT Program laboratories that:

1. have met the reference laboratory requirements of an industrial hygiene proficiency test program, the PAT Program. (PAT reference laboratories must be proficient in analyzing a wide variety of industrial hygiene air samples including airborne lead, and industrial hygiene laboratory operations must be accredited by AIHA); or
2. have performed well in a recent EPA-sponsored interlaboratory evaluation conducted by RTI of sample digestion techniques (microwave and hotplate) used to analyze paint chip and soil samples.[7]

Once a history of ELPAT performance is available, reference laboratories will include all participating laboratories in the ELPAT Program that have previously demonstrated proficient performance in analyzing all matrices of the ELPAT Program. Eventually, a requirement will be added that ELPAT reference laboratories must be accredited by an EPA NLLAP-recognized accrediting organization.

After data from reference laboratories are collected and extreme reference laboratory data have been statistically treated, the mean $\pm 3$ standard deviations of the treated reference laboratory data become the acceptable performance range. Laboratory results are acceptable if they fall within the performance limits. Results falling outside the performance limits are designated as outliers. These are the same criteria used by NIOSH to establish acceptable and outlier performance of industrial hygiene laboratories in the PAT Program.[6]

Laboratories are rated based upon performance in the ELPAT Program over the last year (i.e., four rounds) for each lead matrix—paint chips, soil, and dust wipes. The laboratory is proficient for the lead matrix if:

1. all four results have been reported and all are designated as acceptable for the last two consecutive rounds; or
2. three-fourths or more of the results reported in the last four consecutive rounds are designated as acceptable.

However, if a laboratory does not report values for the lead matrix on the round being evaluated, the laboratory is not rated.

Initial criteria for proficient performance is similar to the procedure used in the PAT Program.[6] However, the ELPAT statistical protocol and related computer programs have been designed to permit future change to



1047-322X/93/0811-912$6.00/6 © 1993 AIH

harmonize these proficiency test requirements with internationally harmonized proficiency test protocols. An international protocol for consensus values from reference laboratories using Z-Scores is being developed by the International Organization for Standardization (ISO), the Association of Official Analytical Chemists International (AOAC), and the International Union of Pure and Applied Chemists (IUPAC).[8]

### ELPAT Round 2, March 1993

Paint samples for Round 2 were prepared from paint chips collected from a hospital built in the late 19th century, a warehouse, and a military base. The chips were ground to a maximum particle size of 150 $\mu$m.

Round 2 dust wipes were prepared by gravimetrically loading Whatman 40 filter paper with sterilized (gamma-irradiated) household and postabatement dust, sieved to a maximum particle size of 250 $\mu$m. The loaded filters were moistened with 1 ml of 6 percent hydrogen peroxide solution. Some laboratories reported that ELPAT Round 2 filters were charred after shipment with the introduction of this amount of hydrogen peroxide. When the filter charring was severe, the samples were replaced. If the charring was not severe, laboratories calling about samples were instructed to quantitatively transfer the entire contents of the vial containing the dust wipe. To avoid this problem on subsequent rounds, the quantity of hydrogen peroxide to be used on Whatman filters has been reduced. The blank wipe was prepared from a Whatman filter moistened with the same hydrogen peroxide solutions. Whatman filters are easier to digest than other wipe media (e.g., baby wipes, hand wipes) used by many laboratories.

In the future, the wipe medium may be changed from the Whatman filter to a commercially available wipe to more closely represent field sample media if a single sample medium is recommended by various lead methods.

Soil samples came from two primary sources: drip lines around older houses

**TABLE I. Environmental Lead Proficiency Analytical Testing (ELPAT) Program Summary Statistics of Reference Laboratories for Round 002**

| Sample Type | Sample | N | Mean | Minimum | Maximum | STD | RSD (%) | Acceptable Range |
|---|---|---|---|---|---|---|---|---|
| Paint chips (%) | 1 | 31 | 0.2007 | 0.1817 | 0.23 | 0.014 | 7.2 | 0.1576-0.2439 |
| | 2 | 31 | 3.218 | 2.88 | 3.5383 | 0.197 | 6.1 | 2.6257-3.8104 |
| | 3 | 31 | 0.3809 | 0.338 | 0.42 | 0.026 | 6.7 | 0.3043-0.4575 |
| | 4 | 31 | 9.5536 | 7.57 | 10.8 | 0.912 | 9.5 | 6.8171-12.2902 |
| Soil (mg/kg) | 1 | 21 | 580.7 | 478.9 | 635 | 44.5 | 7.7 | 447.3-714.1 |
| | 2 | 21 | 432.5 | 365.9 | 509 | 46.3 | 10.7 | 293.7-571.2 |
| | 3 | 21 | 1969.6 | 1710.4 | 2180 | 145 | 7.4 | 1534.4-2404.7 |
| | 4 | 21 | 163.1 | 136 | 184 | 15.1 | 9.3 | 117.7-208.4 |
| Dust wipes (ug) | 1 | 28 | 862.8 | 645.4 | 971 | 92.4 | 10.7 | 585.5-1140.1 |
| | 2 | 28 | 179.8 | 150 | 237 | 23.0 | 12.8 | 110.9-248.6 |
| | 3 | 27 | 21.7 | 15.9 | 28.8 | 3.70 | 17.1 | 10.6-32.8 |
| | 4 | 28 | 44 | 23.5 | 54 | 7.72 | 17.6 | 20.8-67.2 |

and an industrial plant having lead-contaminated soil. Soil samples were dried, then sterilized by heating the soil to 325°F for a minimum of 2 hours and seived to a maximum particle size of 250 $\mu$m.

A total of 179 laboratories were enrolled for the second round of the ELPAT Program, with 170 laboratories submitting results. Table I lists summary statistics of reference laboratories for each matrix and sample number. Agreement among laboratories is demonstrated by relative standard deviations ranging from 6.1 to 9.5 percent for paint chips, 7.4 to 10.7 percent for soils, and 10.7 to 17.6 percent for dust wipes for reference laboratories. This is very good performance considering that this was early in the program, and laboratories used a wide variety of sample digestion and analytical methods. The percentage of all participating laboratory analyses that were identified as outliers was under 13.5 percent (9.8 to 13.5% for paint chips, 8.1 to 11.1% for soils, and 9.1 to 10.5% for dust wipes). (See Table II.)

Hotplate techniques are classified as NIOSH-HOT, EPA-HOT, and OTHER-HOT. NIOSH-HOT is a nitric acid–hydrogen peroxide hotplate digestion modified from NIOSH Method 7082.[9] EPA-HOT is EPA Method 3050A which is a nitric–hydrogen peroxide hotplate digestion [reflux with hydrochloric acid for flame atomic absorption (FAA) or inductively coupled plasma (ICP)].[10] OTHER-HOT is a variety of other methods reported by ELPAT-participating laboratories.

Microwave methods are classified as EPA-MICRO, EPA-3051, OTHER-MIC. EPA-MICRO is a nitric acid–hydrochloric acid microwave digestion technique, modified from AREAL (RTP-MRDD-037) standard operating procedure.[7] EPA-3051 is EPA Method 3051 which is a nitric acid–microwave digestion technique.[11] OTHER-MIC is a variety of other microwave digestion techniques used by ELPAT participating laboratories. The category ALL-OTHER includes all sample preparation techniques that were not clearly identified as being hotplate or microwave and include leaching techniques, Parr bomb, and X-ray fluorescence (XRF) sample preparation techniques.

A criterion was used where participating laboratories were classified into two groups: those that had no outliers on the four ELPAT samples of the matrix and those that had one or more outliers. For each sample matrix (paint chips, soil, and dust wipes), Fisher's exact test was performed for each of the combinations of sample preparation techniques (NIOSH-HOT, EPA-HOT, EPA-MICRO, EPA-3051) and instrumental methods [FAA, ICP, graphite furnace atomic absorption (GFAA)].[12] No statistically significant differences were found among the combinations of sample preparation and analytical methods that could be tested.

Table III shows that laboratories using a wide variety of microwave and hotplate digestion techniques were able to meet ELPAT Program acceptance limits. One laboratory successfully used a Parr bomb to digest paint chip samples and two laboratories successfully used acid leaching techniques on all three matrices. One laboratory used ICP–mass spectrometry (ICP-MS) and was able to meet acceptable performance limits for all paint chips, soil, and dust wipe samples. One

**TABLE II. Summary of Performance—All Laboratories Participated**

| Sample Type | Sample No. | No. of Labs Rated | Acceptable Labs | Low Outlier | High Outlier |
|---|---|---|---|---|---|
| Paint chips (%) | 1 | 163 | 142 | 10 | 11 |
| | 2 | 163 | 141 | 10 | 12 |
| | 3 | 163 | 140 | 13 | 10 |
| | 4 | 163 | 147 | 13 | 3 |
| Soil (mg/kg) | 1 | 135 | 124 | 8 | 3 |
| | 2 | 135 | 124 | 7 | 4 |
| | 3 | 135 | 120 | 10 | 5 |
| | 4 | 135 | 120 | 7 | 8 |
| Dust wipes (ug) | 1 | 143 | 128 | 12 | 3 |
| | 2 | 143 | 130 | 9 | 4 |
| | 3 | 143 | 130 | 5 | 8 |
| | 4 | 143 | 130 | 8 | 5 |

**TABLE III. ELPAT Round 002 All Labs Performance Summary**

| Method | Sample Preparation | Paint Chips (%) | | | | Soil (mg/kg) | | | | Dust Wipes (ug) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Acceptable | | Failure | | Acceptable | | Failure | | Acceptable | | Failure | |
| | | N | % | N | % | N | % | N | % | N | % | N | % |
| FAA | NIOSH-HOT | 129 | 90 | 15 | 10 | 75 | 89 | 9 | 11 | 173 | 92 | 15 | 8 |
| | EPA-HOT | 123 | 85 | 21 | 15 | 159 | 92 | 13 | 8 | 85 | 92 | 7 | 8 |
| | Other-HOT | 81 | 92 | 7 | 8 | 19 | 79 | 5 | 21 | 41 | 85 | 7 | 15 |
| | EPA-MICRO | 4 | 100 | 0 | 0 | 4 | 100 | 0 | 0 | 4 | 100 | 0 | 0 |
| | EPA-3051 | 7 | 88 | 1 | 13 | 16 | 100 | 0 | 0 | 4 | 100 | 0 | 0 |
| | OTHER-MIC | 10 | 83 | 2 | 17 | 4 | 100 | 0 | 0 | 4 | 100 | 0 | 0 |
| | All Other | 4 | 100 | 0 | 0 | 4 | 100 | 0 | 0 | 7 | 88 | 1 | 13 |
| GFAA | NIOSH-HOT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 38 | 5 | 63 |
| | EPA-HOT | 8 | 67 | 4 | 33 | 14 | 70 | 6 | 30 | 20 | 100 | 0 | 0 |
| | Other-HOT | 3 | 75 | 1 | 25 | 3 | 75 | 1 | 25 | 4 | 100 | 0 | 0 |
| ICP-AES | NIOSH-HOT | 29 | 91 | 3 | 9 | 28 | 100 | 0 | 0 | 45 | 94 | 3 | 6 |
| | EPA-HOT | 120 | 88 | 16 | 12 | 122 | 90 | 14 | 10 | 82 | 85 | 14 | 15 |
| | Other-HOT | 11 | 92 | 1 | 8 | 12 | 100 | 0 | 0 | 16 | 100 | 0 | 0 |
| | EPA-MICRO | 9 | 75 | 3 | 25 | 8 | 100 | 0 | 0 | 8 | 100 | 0 | 0 |
| | EPA-3051 | 8 | 100 | 0 | 0 | 8 | 100 | 0 | 0 | 10 | 83 | 2 | 17 |
| | OTHER-MIC | 8 | 100 | 0 | 0 | 4 | 100 | 0 | 0 | 8 | 100 | 0 | 0 |
| | All Other | 7 | 88 | 1 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LAB-XRF | All Other | 2 | 50 | 2 | 50 | 0 | 0 | 4 | 100 | 0 | 0 | 0 | 0 |
| Others | NIOSH-HOT | 3 | 75 | 1 | 25 | 0 | 0 | 0 | 0 | 4 | 100 | 0 | 0 |
| | EPA-HOT | 0 | 0 | 0 | 0 | 4 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| | EPA-MICRO | 0 | 0 | 0 | 0 | 4 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | | 566 | 88 | 78 | 12 | 488 | 90 | 52 | 10 | 518 | 91 | 54 | 9 |

Abbreviations: NIOSH-HOT = NIOSH 7082/7106
EPA-HOT = SW846-3050A
EPA-MICRO = EPA AREAL
EPA-3051 = EPA SW846
OTHER-MIC = Other Microwave
OTHER-HOT = Other Hotplate

laboratory performed laboratory XRF, but was unable to meet the criteria for proficiency.

A more complete comparison of biases and interlaboratory precision differences among digestion techniques and instrumental methods is being undertaken at NIOSH.

## ELPAT Round 1 Re-Visited

Further analysis of ELPAT Round 1 results were performed to confirm if there were any statistically significant biases among sample preparation techniques and instrumental methods. Analysis of variance (ANOVA) was utilized to detect for differences in the mean of the reported lead values among sample preparation techniques and instrumental methods for each lead matrix. The analyses only include principal sample preparation techniques (EPA-MICRO,[7] NIOSH-HOT,[9] and OTHER-HOT) and instrumental methods (FAA and ICP). Grubb's statistics were used for eliminating outliers. The necessary assumptions for ANOVA procedure were tested and met (Levin's statistics for the homogeneity of variance and Shapiro-Wilk statistics for the normality of data).[13,14]

A one-way ANOVA procedure was used to test for differences in mean lead levels among combinations of sample preparation techniques and instrumental methods whenever there was more than three laboratories using the sample preparation/instrumental method. No statistically significant differences were found.

A two-way ANOVA procedure was also used to test for differences among sample preparation techniques and among instrumental methods.

No statistically significant differences were found in mean lead levels among principal sample preparation techniques [EPA-MICRO,[7] NIOSH-HOT,[9] OTHER-HOT (various techniques grouped together) and among instrumental methods (FAA, ICP) by two-way ANOVA at $\alpha = 0.05$ level with one exception. For soil sample no. 4, the lowest ELPAT Round 1 lead soil sample (reference value = 133 mg/kg), a statistically significant difference ($p = 0.033$) among sample preparation methods (EPA-MICRO, NIOSH-HOT, OTHER-HOT) was found. However, the differences in means found were small (maximum difference = 9 mg/kg), with the NIOSH-HOT technique giving the highest recovery and OTHER-HOT (various techniques grouped together) techniques giving the lowest recovery.

## Lead Reference Materials

The ELPAT Program is designed to supplement, but not replace, a laboratory's internal quality control program. Use of materials of known lead content in suitable matrices is important in obtaining accurate and reliable lead results. Such materials should be used to

validate methods when sample preparation techniques or instrumental methods are adopted or modified. In addition, the materials should be used for daily quality control charting of laboratory/analyst performance. ELPAT paint chip, soil, and dust wipe samples from completed ELPAT rounds are available from AIHA at the address listed at the end of this column. ELPAT materials differ from the certified reference materials listed below. ELPAT materials are destroyed in one analysis (dust wipes), or the amount of material in bottles is limited to reduce the number of times that analyses can be repeated by laboratories reporting in the proficiency test round. National Institute of Standards and Technology (NIST) Standard Reference Materials values report lead as total lead, whereas ELPAT and EPA-certified reference materials report extractable lead.

Certified reference materials are commercially available from NIST and commercial reference material suppliers participating in the EPA/A2LA environmental reference material certification program.[15] The materials listed in Table IV are useful for daily quality control of analyses and initial evaluation of methods associated with residential or steel structure lead abatement. Work continues on developing additional reference materials, so this list of certified reference materials is subject to significant change. Updated lists of available certified reference materials are available from NIST, EPA-EMSL Cincinnati, and A2LA at the addresses listed at the end of this column.

## EPA National Lead Laboratory Accreditation Program (NLLAP)

Under Title X of the Housing and Community Development Act of 1992, EPA, in consultation with the Department of Health and Human Services (DHHS), has the responsibility to periodically review and determine if effective voluntary laboratory accreditation systems are in place. If EPA determines effective voluntary laboratory accreditation systems are not in place, EPA is responsible for establishing a federal laboratory certification system.[16]

Requirements for an NLLAP are being finalized within EPA's OPPT for the recognition of U.S. private and/or state laboratory accreditation systems covering lead analysis in paint chips, soils, and dusts associated with lead abatement. Although requirements for EPA-recognition of laboratory accreditation systems are not final, proposed EPA recognition involves two aspects: (1) successful participation in the ELPAT Program; and (2) review of laboratory operations. NLLAP requirements are based upon the Laboratory Accreditation Guidelines of a Federal Interagency Lead-Based Paint Task Force, ISO Guide 25-1990, "General Requirements for the Competence of Calibration and Testing Laboratories" (a guide already in use by many national laboratory accreditation systems worldwide) as well as input obtained from various groups including laboratory accreditation organizations, for example, A2LA and AIHA.[17,18] The review of laboratory operations involves both review of laboratory accreditation applications and periodic on-site assessment by qualified assessors.

Both the A2LA and AIHA have developed programs for the accreditation of laboratories conducting environmental paint chip, soil, and dust analyses. A2LA and AIHA also jointly sponsor Environmental Lead Laboratory Accreditation seminars to meet proposed technical requirements for laboratory assessors/site visitors, and to orient laboratory personnel on environmental laboratory accreditation requirements.

A complete list of EPA NLLAP-recommended laboratories is available to the public on the NIOSH 800 number (1-800-35-NIOSH) and the National Lead Information Clearinghouse (1-800-424-LEAD), and is updated after completion of each ELPAT round.

## Upcoming ELPAT Round Information

The shipment of the third round of

**TABLE IV. Certified Reference Materials**

| NIST Standard Reference Materials (SRMs) | Lead |
|---|---|
| SRM 1579a Powdered Lead-Based Paint | 11.995 ± 0.031% |
| SRM 2580 Powdered Lead-Based Paint to be released 09/93 (nominal value 4%) | |
| SRM 2581 Powdered Lead-Based Paint to be released 12/93 (nominal value 0.5%) | |
| SRM 2582 Powdered Lead-Based Paint to be released 06/94 (nominal value 500 ppm) | |
| Total lead by weight | |
| SRM 2709 Lead in Soil | 18.9 ± 0.5 ppm |
| SRM 2710 Lead in Soil | 5532 ± 80 ppm |
| SRM 2711 Lead in Soil | 1162 ± 31 ppm |
| SRM 2579 Lead Paint Film on Mylar (Set of 5) | 3.53 ± 0.24 mg/cm$^2$ |
| | 1.63 ± 0.08 mg/cm$^2$ |
| | 1.02 ± 0.04 mg/cm$^2$ |
| | 0.29 ± 0.01 mg/cm$^2$ |
| | less than 0.001 mg/cm$^2$ |
| (Intended for checking the calibration of portable, hand-held, X-ray fluorescence analyzers when testing for lead in paint coatings on interior and exterior building surfaces ifn the field.) | |
| SRM 1648 Urban Particulate Matter | 0.655 ± 0.008% |
| SRM 2704 Buffalo River Sediment | 161 ± 17 ppm |
| Total lead by weight | |

| EPA/A2LA Certified Reference Materials | Lead |
|---|---|
| Commercial Supplier | |
| RT Corp. through Fischer Scientific | |
| SRS014-50 Bag House Dust | 1914 ± 180 ppm* |
| SRS013-50 Paint Blasting Waste | 643 ± 56 ppm* |
| SRS006-50 Paint Sludge | 753 ± 51 ppm* |

* The concentrations of lead determined in a sample following digestion by EPA Methods 3010, 3020, or 3050. All concentrations expressed on dry weight basis. The 50-g samples should be mixed well before removing subsamples.

ELPAT samples was sent on May 17, 1993. The reporting date of the laboratories was June 24, 1993. There will be only one minor change in the samples for next time. The dust wipes will be preserved with 0.5 ml of 3 percent hydrogen peroxide instead of 1 ml of the 6 percent concentration. This is to retard the formation of any fungal growth in the samples, and should not have any effect on the digestion and analysis of them.

---

Disclaimer: Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention.

## Information

A2LA Laboratory Accreditation, A2LA Certified Reference Materials, and A2LA/AIHA seminars on Environmental Lead Laboratory Accreditation:

American Association for Laboratory Accreditation (A2LA)
656 Quince Orchard Road
Gaithersburg, MD 20878
Phone: (301) 670-1377
FAX: (301) 869-1495

AIHA Laboratory Accreditation, ELPAT Program information, ELPAT sample orders, and A2LA/AIHA seminars on Environmental Lead Laboratory Accreditation:

ELPAT Coordinator
American Industrial Hygiene Association (AIHA)
2700 Prosperity Avenue, Suite #250
Fairfax, VA 22031
Phone: (703) 849-8888
FAX: (703) 207-3561

NIST Standard Reference Materials (SRMs) and orders for NIST SRMs:

National Institute of Standards and Technology
Standards Reference Materials Program
Room 204, Building 202
Gaithersburg, MD 20899
Phone: (301) 975-6776
FAX. (301) 948-3730



SRS series reference materials:

RT Corporation
2931 Soldier Springs
P.O. Box 1346
Laramie, WY 82070
Phone: (307) 742-5452
FAX: (307) 745-7936
or your local Fischer Scientific representative at (800) 766-7000.

Information on other EPA Certified Reference Materials:

Jim Longbottom
EPA-EMSL
Quality Assurance Research Division
26 West Martin Luther King Drive
Cincinnati, OH 45268
Phone: (513) 569-7308
FAX: (513) 569-7115

## References


1. Cooperative Research and Development Agreement Between the National Institute for Occupational Safety and Health (NIOSH) and the American Industrial Hygiene Association (AIHA): CRADA #NIOSH 92-1 (August 5, 1992).
2. Memorandum of Understanding (MOU) on Collaboration Between the Office of Pollution Prevention and Toxics of the U.S. Environmental Protection Agency (EPA) and the Division of Physical Sciences and Engineering of the National Institute for Occupational Safety and Health (NIOSH): MOU #PW75935570-01-0 (July 6, 1992).
3. Draft Memorandum of Understandings (MOUs) Between the U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics and Laboratory Accreditation Organizations Working in Cooperation with the EPA National Lead Laboratory Accreditation Program (March 24, 1993).

4. American Association for Laboratory Accreditation: A2LA Environmental Lead Program Requirements, Gaithersburg, MD: A2LA (November 1992).
5. American Industrial Hygiene Association: AIHA Environmental Lead Program Policies, Fairfax, VA: AIHA (December 14, 1992).
6. National Institute for Occupational Safety and Health: Laboratory Reports and Rating Criteria for the Proficiency Analytical Testing Program. DHHS (NIOSH) Pub. No. 91-102. NIOSH, Cincinnati, OH (1990).
7. Environmental Protection Agency: Standard Operating Procedures for Lead in Paint by Hotplate or Microwave-based Acid Digestions and Atomic Absorption or Inductively Coupled Plasma Emission Spectrometry. (PB92-114172). Research Triangle Park, NC (September 1991).
8. International Standards Organization: ISO/REMCO The International Harmonized Protocol for the Proficiency Testing of (Chemical) Analytical Laboratories, Geneva (1993).
9. National Institute of Occupational Safety and Health: Manual of Analytical Methods, 3rd ed. Method 7082. DHHS (NIOSH) Pub. No. 84-100. NIOSH, Cincinnati, OH (1984).
10. U.S. Environmental Protection Agency: Method SW846-3050A, Acid Digestion of Sediments, Sludges and Soils (Metals). In: U.S. EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Method SW846, 3rd ed. (revised November 1990).
11. U.S. Environmental Protection Agency: Method SW876-3051, Microwave Assisted Acid Digestion of Sediments, Sludges, Soils and Oils (Metals). In: U.S. EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Method SW846, 3rd ed. (revised November 1990).
12. Fleiss, J.: Statistical Methods for Rates and Proportions, 2nd ed. pp. 24–25. John Wiley, New York (1981).
13. Milliken, G.A.; Johnson, D.E. Analysis of Messy Data V(1): Designed Experiments. Van Nostrand Reinhold, 1984.
14. Shapiro, S.S.; Wilk, M.B. An Analysis of Variance Test for Normality (Complete Samples). Biometrika 52:591–611 (1965).
15. Memorandum of Understanding (MOU) Between Environmental Monitoring Systems Laboratory–Cincinnati (EPA) and the American Association for Laboratory Accreditation (A2LA), Cincinnati, OH (June 18, 1991).
16. Title X, Residential Lead-Based Paint Hazard Reduction Act of 1992 of the Housing and Community Development Act of 1992 (Public Law 102-550).
17. International Standards Organization/International Electrochemical Commission: ISO/IEC Guide 25 1990 (E) General Requirements for the Competence of Calibration and Testing Laboratories, Geneva (1990).
18. Task Group on Methods and Standards of the Federal Interagency Lead-Based Paint Task Force: Laboratory Accreditation Program Guidelines: Measurement of Lead in Paint, Dust and Soil, Final Report (EPA 747-R-92-001) (March 1992).