LABORATORY EVALUATIONS AND PERFORMANCE REPORTS FOR THE PROFICIENCY ANALYTICAL TESTING (PAT) AND ENVIRONMENTAL LEAD PROFICIENCY ANALYTICAL TESTING (ELPAT) PROGRAMS

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ABSTRACT

This is a statistical protocol for the Proficiency Analytical Testing (PAT) and Environmental Lead Proficiency Analytical testing (ELPAT) Programs. Section 1 describes the PAT Program, while section II describes the ELPAT Program. The National Institute for Occupational Safety and Health (NIOSH), Division of Physical Sciences and Engineering, Quality Assurance and Statistics Activity provides the technical assistance to ensure the quality of the programs and statistical analysis of data for the PAT and ELPAT Programs.

The PAT Program is a collaborative effort of the American Industrial Hygiene Association (AIHA) and NIOSH. The PAT Program provides quality control reference samples to over 1500 occupational health and environmental laboratories in over 15 countries in which hazardous substances in air are analyzed. Although one objective of the PAT Program is to evaluate the analytical ability of participating laboratories, the primary objective is to assist participating laboratories in improving and analytical performance. The ELPAT Program is a cooperative effort of AIHA and NIOSH to improve and evaluate the performance of laboratories involved in the analysis for lead in paint, soil, and dust matrices. NIOSH performs data analysis under a Memorandum of Understanding (MOU #PW593570-01-0) with the U.S> Environmental Protection Agency (EPA). AIHA contracts for ELPAT and PAT sample production and administers the ELPAT and PAT programs as permitted under a Cooperative Research and Development Agreement (CRADA # NIO,C92.001.00) with NIOSH covering cooperation in analytical research and proficiency test programs.

Each section of this protocol describes the procedures used to evaluate data from laboratories, and consists of three parts. Part I contains a general description of the programs; Part II has an example of the laboratory data report filled out by the laboratories; and Part III contains examples and explanations of the laboratory performance reports provided to participants.

ABBREVIATIONS

A2LA	American Association for Laboratory Accreditation
AAR	Asbestos Analysts Registry
AAT	Asbestos Analytical Testing
AIHA	American Industrial Hygiene Association
AOAC	Association of Official Analytical Chemists International
AREAL	Atmospheric Research and Exposure Assessment Laboratory
BAQA	Bulk Asbestos Quality Assurance
BNZ	Benzene
CAD	Cadmium
CDC	Centers for Disease Control and Prevention
CFM	Chloroform
CHR	Chromium
CRADA	Cooperative Research and Development Agreement
CTC	Carbon Tetrachloride
DCE	1,2-Dichloroethane
ELPAT	Environmental Lead Proficiency Analytical Testing
EPA	Environmental Protection Agency
FAA	Flame Atomic Absorption
GFAA	Graphite Furnace Atomic Absorption
HI	High
ICP-AES	Inductively Coupled Plasma - Atomic Emission Spectroscopy
IHLAP	Industrial Hygiene Laboratory Accreditation Program
ISO	International Standards Organization
IUPAC	International Union of Pure and Applied Chemists
Lab ID	Laboratory Identification
LEA	Lead
LO	Low
MCM	1,1,1 - Trichloroethane (methyl chloroform)
MOU	Memorandum of Understanding
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NLLAP	National Lead Laboratory Accreditation Program
OPPT	Office of Pollution Prevention and Toxics
OSHA	Occupational Safety and Health Administration
OXY	o-Xylene
PAT	Proficiency Analytical Testing
PCE	Tetrachloroethylene (perchloroethylene)
PDX	p-Dioxane
Q1	First Quartile
Q3	Third Quartile
Ref Lab	Reference Laboratory
Reptd	Reported
RSD	Relative Standard Deviation
RTI	Research Triangle Institute

SD	Standard Deviation
TCE	Trichloroethylene
THHP	Target Health Hazards Program
TOL	Toluene
Z Score	Difference of the laboratory's reported result and the reference mean value, divided by the reference standard deviation
ZIN	Zinc

CONTENTS

ACKNOWLEDGMENTS

We want to thank Kenneth Busch and William Crouse who assisted in the development of the statistical procedures used. We especially want to thank Amy Feng of Atlantic Research Corporation, and Sue Nowlin of NIOSH for developing the computer programs.

SECTION I: THE PROFICIENCY ANALYTICAL TESTING (PAT) PROGRAM

Part I: INTRODUCTION

In 1972, the Occupational Safety and Health Administration (OSHA) Target Health Hazards Program (THHP), (outlined in OSHA Program Directive #72-1, January 3, 1972), was aimed at detecting possible health hazards from asbestos, cotton dust, silica, lead, and carbon monoxide. The resulting problems encountered by state and federal laboratories performing the OSHA compliance sample analyses for THHP made a collaborative proficiency testing program a necessity. The National Institute for Occupational Safety and Health (NIOSH) was given the responsibility for developing and implementing this collaborative proficiency testing program. By May 1972, NIOSH initiated the Proficiency Analytical Testing (PAT) Program and distributed the first proficiency samples to ten government laboratories.

The PAT Program initially consisted of four lead filter samples, four silica filter samples, and blanks, with asbestos filter samples included soon afterwards. The sample mix of metals, silica, asbestos, and organic solvents was finalized in 1974. New individual analytes, various sample matrices, and improved generation methods have since been added to the Program. In January 1987, the PAT Program was turned over to the American Industrial Hygiene Association (AIHA) to administer with the data and statistical analysis being done by NIOSH. Due to the number of new laboratories participating in the PAT Program, there is a continual need to improve and update the data and statistical analysis of the Program. The purpose of this statistical protocol is to describe the procedures used to evaluate laboratories and provide explanations and examples of the statistics used and of the reports sent to participating laboratories. All statistical procedures have been performed and reports have been prepared using SAS® (SAS Institute Inc., Cary, NC) programming language.

Reference Samples

Each quarter, sample kits are mailed to participating laboratories and data are analyzed to evaluate performance on a series of industrial hygiene analyses. Each mailing and subsequent data analysis is referred to as a round. Each round is completed in time for participants to obtain repeat samples and to correct analytical problems before the next round starts.

The reference samples included in a kit are designed to cover a variety of analytical methods used by laboratories and include some contaminants in which analytical agreement is poor. As of October 1990, the program included four sets of samples: metals (a combination of three of the following: cadmium, chromium, lead, and zinc), silica, asbestos, and organic solvents (a combination of three of the following: benzene, carbon tetrachloride, chloroform, 1,2 dichloroethane, methylene chloride, methyl chloroform, p-dioxane, toluene, tetrachloroethylene, and o-xylene). The metals and organics are rotated from the above list for each round. Additional metals and organics will be included in the future.

The reference sample concentrations are randomly selected from the measurement ranges stated in NIOSH methods[1] or from ranges found to have acceptable reference sample homogeneity from previous experience in generating reference samples.[2] In the case of asbestos, reference samples may be above the fiber density range observed at abatement sites in order to expand the range of concentrations used to challenge laboratories. Each contaminant set consists of four concentrations and a blank. The organic solvent set also includes five blank charcoal tubes for desorption efficiency determination.

Participant Procedures

Each participating laboratory in the PAT Program is required to analyze and submit results for all sets which are similar to the analytical workload of the laboratory. The results for each contaminant set must be complete (4 values reported) or the laboratory will not be rated. This ensures that all participants are rated over the entire concentration range for that round. The analyst for a given contaminant set should change each round so that all analysts performing similar field analyses are eventually evaluated. In this way, the PAT Program is a laboratory proficiency program, not an individual analyst certification program. PAT Program participants are instructed to use analytical methods identical to or as similar as possible to the methods routinely used to analyze field samples. Also, the PAT Program is not designed to replace a laboratory's internal quality control program. Internal controls such as spiked samples, calibration checks, and duplicate samples routinely run with field samples should be run with PAT samples so that the effectiveness of the internal quality control system can be evaluated.

Evaluation of Laboratories

Laboratories are statistically evaluated on the current round. This involves the establishment of acceptable performance limits or an acceptable concentration range for each PAT Program sample. Each reported value is then determined to be either acceptable (i.e., within designated performance limits), or an outlier, (i.e., outside designated performance limits).

The calculation of acceptable performance limits involves four steps:

The first step is to identify the analytical results reported by a preselected group of reference laboratories. Reference laboratories are selected to ensure that performance limits are based upon the results of laboratories that have good performance records. Reference laboratories meet the following criteria: 1) The laboratory was rated proficient in the previous PAT round for all PAT contaminants, and; 2) the laboratory, if located in the United States, is AIHA accredited.

In 1990, approximately 100 laboratories in the PAT Program analyzed all PAT analytes to potentially qualify as a reference laboratory. Of these 100 laboratories, a little over 5 percent were eliminated from consideration as a reference laboratory because of previous PAT performance and one quarter was eliminated because the laboratory was not AIHA accredited.

The second step is the treatment of reference laboratory data which appears to be inconsistent with the remainder of that set of data. Mistakes in analysis or in reporting results (especially those mistakes which result in order of magnitude errors) substantially affect estimates of central tendency and dispersion unless treated.[3] Reference laboratory data are Winsorized. Winsorization involves the ranking of reference laboratory results for each PAT sample. Those reference laboratory results which fall in the top 5 percent of results are replaced by a value equal to the highest result remaining in the set. Similarly, those results which fall in the bottom 5 percent of results are replaced by a value equal to the lowest result remaining in the set. Unlike other approaches, the extreme values are not eliminated, but are adjusted.[4]

To use reference laboratory data without any modification requires one to assume that reference laboratories never make mistakes. If reference laboratory data involving mistakes are not treated, then the standard deviation estimate will be inflated and the performance limits will be too wide. One problem with outlier tests is that it is not always easy to distinguish between outliers obtained due to analytical mistakes and outliers which are extreme merely due to random chance. Since Winsorization adjusts suspected outliers rather than eliminating them (unlike other outlier tests), there is less risk that the standard deviation will be underestimated and performance limits too narrow if some data are inadvertently treated as outliers when no mistakes have actually occurred.

The third step is used only for nonsymmetric distribution of data. Asbestos exhibits such a distribution. To obtain approximately normal distributions, the Winsorized reference data for asbestos are transformed by taking square roots.[5] Statistical theory for the normal distribution is well developed and only a small percentage of the results by PAT laboratories will be determined to be an outlier by random chance if the distribution is approximately normal.

The fourth step is the calculation of reference laboratory means and standard deviations using Winsorized data. The reference value equals the mean, and the performance limits equal the mean ± 3 standard deviations (on a transformed scale for asbestos). This results in a very low probability, less than 1 percent, that an outlier is obtained by a PAT laboratory by random chance, if approximate normality holds on the scale used for performance analysis.

After the performance limits have been calculated, the data from all participating laboratories including reference laboratories are compared to these limits to determine acceptability. For asbestos, these comparisons are actually done on the transformed data. Data are acceptable if they fall within the performance limits. Data falling outside the performance limits are reported as outliers.

Proficiency Ratings

Laboratories are rated based upon performance in the PAT Program over the last year, (four rounds). The proficiency criteria are designed to:

1) Require multiple errors in different rounds before nonproficiency is determined.

2) Minimize the lag in ratings when performance changes.

3) Limit any advantage a laboratory may have in improving its rating by not performing on the next round.

4) Adversely rate laboratories which fail to correct analytical problems in a timely manner.

5) Limit the risk that laboratories rated nonproficient are nonproficient due to random chance and not because of analytical mistakes within the laboratory.

Laboratories are rated on individual contaminant performances and overall performances. Individual contaminants include metals, silica, asbestos, and organic solvents.

Individual Contaminant Performance is rated as:

1) Proficient if all results have been reported and all are classified as acceptable for the last two consecutive rounds.

2) Proficient in all other situations if three-quarters or more of the results reported in the last four consecutive rounds are classified as acceptable.

   (NOTE: Missed rounds of data are ignored in calculating proficiency; no rating is given if a round is missed.)

Overall Laboratory Performance is rated as:

1) Proficient if two-thirds or more of the individual PAT contaminant performances are rated proficient, but

2) Nonproficient if any individual PAT contaminant performances are rated nonproficient for more than four consecutive rounds (one year).

A rating of nonproficiency indicates that a serious analytical problem has been identified and warrants immediate action. However, PAT proficiency ratings have limitations.

1) Samples are provided to participants only quarterly. In addition, only one analyst in the laboratory is evaluated each round on each contaminant.

2) PAT samples, which contain unknown concentrations, are known to the laboratory as special test samples. The program relies upon the integrity of participants to ensure that PAT samples do not receive special treatment.

3) The PAT Program can cover only a limited number of the analyses performed by laboratories.

4) The use of synthetic reference samples may not uncover all the analytical problems that may be encountered with similar field samples.

5) The statistical power of the PAT Program to detect excessive bias and poor precision is dependent upon the variability of PAT reference laboratories and the small number of samples (4 to 16) used to determine proficiency over 4 rounds (i.e., one year). For silica and asbestos, PAT reference laboratory variability is large, and it takes considerable bias or imprecision for a participating laboratory to have a high probability of being rated nonproficient.

The PAT Program does not evaluate laboratory personnel, facilities, equipment, or internal quality control procedures. A laboratory interested in a more complete evaluation of their laboratory program is encouraged to contact AIHA about the AIHA Laboratory Accreditation Program. (Laboratory Accreditation Coordinator, AIHA, 2700 Prosperity Avenue, Suite #250, Fairfax, VA 22031-4307. Phone: 703/849-8888). AIHA also administers the Asbestos Analyst Registry (AAR) and Industrial Hygiene Laboratory Accreditation Program (IHLAP) as a part of their accreditation and registry programs. The PAT Program is one of AIHA's performance testing programs, as well as the Bulk Asbestos Quality Assurance (BAQA) and Asbestos Analytical Testing (AAT) Programs. Laboratories must participate in the PAT Program to achieve accreditation under IHLAP. Likewise, participation in AAT is mandatory for those seeking recognition under the AAR Program.[6]

Corrective Actions

The primary purpose of the PAT Program is to assist laboratories in improving analytical performance. PAT results are provided to participating laboratories so that laboratories have approximately one month to investigate and correct analytical problems before the next PAT round. If necessary, limited supplies of extra samples may be purchased by participants from AIHA to help in this investigation. However, results from practice samples are not reported to the PAT Program.

Laboratories in the PAT Program that are also in the AIHA Laboratory Accreditation Program must provide information to AIHA indicating how the laboratory has corrected analytical problems uncovered by the PAT Program. If PAT Program performance problems involve a laboratory in the initial process of applying for accreditation, these performance problems can delay a laboratory in obtaining AIHA accreditation.

The PAT Program is designed to complement, not replace, a participating laboratory's internal quality control (QC) program. Internal controls such as spiked samples, calibration checks, and duplicate samples can sometimes uncover analytical problems that are not uncovered by the PAT Program.

Analytical problems may be a result of:

(1) Differences between PAT samples and internal QC samples (e.g., matrices, concentrations, interferences, or analytical steps covered by the evaluation);

(2) Inclusion of the laboratory-to-laboratory component of variation in PAT performance limit calculations, which may mask intralaboratory variability (precision) problems, especially for analyses such as silica and asbestos where laboratory-to-laboratory variability is large; and

(3) Statistical power limitations of the PAT Program related to the use of 3 standard deviation limits for performance limits, and nonproficiency criteria designed to have a low risk of rating a laboratory as poorly performing when no analytical problem truly exists;

(4) Use of a small number of samples (4 to 16) to determine proficiency. Therefore, it is not warranted to ignore out-of-control situations identified by the laboratory's internal quality control program merely because the laboratory has not had outliers in the PAT Program.

Similarly, the PAT Program may identify analytical problems when the laboratory's internal controls do not. In these instances, the investigation by the laboratory not only should determine the source of the analytical problems and their correction, but should also examine plausible reasons why the laboratory's internal QC program did not catch the problems and determine if the laboratory's internal QC system should be changed.

Part II: Laboratory Data Report

An example report of the laboratory form follows. The address label is placed in the upper left corner of the laboratory reporting form. The first line contains the 5-digit laboratory identification number, followed by the round number and year. The next four characters on the top line represent the sample code. Possible codes are M,S,A, and O which stand for metals, silica, asbestos, and organics respectively. An "X" signifies that the laboratory is not enrolled to analyze this contaminant. The remaining lines of the address label list the contact name, company name, and address.

The upper right corner of the form displays the deadline for submitting results to NIOSH. Results can be submitted by fax or mail. The address and fax number are on the back of the form.

The remainder of the form is for reporting results. The first three rows are for metals. Cadmium and lead are analyzed every round, while zinc and chromium are rotated. Rows 4 and 5 are for reporting silica and asbestos respectively. The bottom 3 rows are for reporting organic solvents.

Part III: Laboratory Performance Report

Proficiency Analytical Testing Program Laboratory Performance - Round 115

The PAT Program individual laboratory report includes the items listed below and an example report follows.

First page - Proficiency Analytical Testing Program Laboratory Performance - Round 115

The left section of this page contains laboratory name and address.

Laboratory Name & Address — Complete laboratory name and address. Top line of address includes the PAT laboratory identification number (5 digit numeric) and the sample analysis code (M = metals, S = silica, A = asbestos, O = organic solvents, X = no sample of this type).

Contaminant — Contaminants are metals, silica, asbestos, and organic solvents. (As of October 1990, metals were given one single performance rating for a group of three metals from the list: cadmium, chromium, lead, zinc.)

Sample — Filter or charcoal tube number (1,2,3,4).

The middle section of this page contains the Round 115 Statistical Summary.

Reference Value — Arithmetic mean of Winsorized reference laboratory data for all contaminants except asbestos. For asbestos the reference value is the arithmetic mean of transformed reference laboratory data.

Performance Limits — Range considered acceptable. See Part I for an explanation of calculations. These limits correspond to the -3 SD and +3 SD areas shown on the plots.

No. Labs — Number of laboratories reporting results for current round for a given contaminant.

Overall No. Labs — Total number of laboratories reporting results for current round.

Outliers High — Number of laboratories reporting unacceptably high results for a sample.

Outliers Low — Number of laboratories reporting unacceptably low results for a sample.

Outliers Total	Total number of outliers for a given sample. The right section of this page reports the individual laboratory results.
R115 Data	Actual data submitted for each contaminant by the individual laboratory.
Proficiency Rating	Summary of the laboratory's performance on all contaminants over the last four rounds (i.e., the last year). The legend at the bottom of the page is used to interpret the ratings shown. A laboratory will not be rated when results have not been submitted.
Outlier Summary	Summary of the laboratory's results for the last four rounds. Uses high outlier (HI) and low outlier (LO) to indicate those analytical results that were determined to be outliers. If the area next to the sample is blank, the analysis is acceptable. A dash (-) indicates the laboratory does not analyze for that contaminant.
Second page	Proficiency Analytical Testing Program. Rounds 112-115 Standard Deviation Plots.

These plots are provided to summarize a laboratory's performance over the last four rounds.

The area under zero standard deviation (0 SD), represents the location of the reference value (mean calculated from the Winsorized reference laboratory data) and indicates the center of the distribution. The area to the right of the +3 SD indicates the laboratory has exceeded the upper performance limit whereas the area to the left of the -3 SD indicates the laboratory has exceeded the lower performance limit.

The plots for asbestos use transformed variables so that symmetric limits are shown. Thus limits are equidistant from 0 SD. The plots for organic solvents show the codes to identify the specific solvent used and are defined as follows:

BNZ	Benzene	OXY	o-Xylene
CTC	Carbon Tetrachloride	PCE	Tetrachloroethylene (perchloroethylene)
CFM	Chloroform	PDX	p-Dioxane
DCE	1,2-Dichloroethane	TCE	Trichloroethylene
MCM	1,1,1-Trichloroethane (methyl chloroform)	TOL	Toluene

The plots for metals show the codes to identify the specific metals used in each round and are defined as follows:

CAD	Cadmium	LEA	Lead
CHR	Chromium	ZIN	Zinc

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Proficiency Analytical Testing (PAT) Program
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01234 R115-93 M S A O
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Anytown USA 56789

☐ **Check box if address incorrect**
Make changes directly on label
Print clearly

Proficiency Analytical Testing

Round 115 results must be received by November 5, 1993. The return address is on the label and the back.

Put # of method in box	#1	#2	#3	#4	Blank
CAD Cadmium 1. Flame Atomic Absorption 2. Furnace Atomic Absorption 3. ICP-AES 4. Anodic Strip. Voltammetry 5. Other, Specify:_____ Method [3]	mg 0.0188	mg 0.0115	mg 0.0072	mg 0.0148	mg <0.005
LEA Lead 1. Flame Atomic Absorption 2. Furnace Atomic Absorption 3. ICP-AES 4. Anodic Strip. Voltammetry 5. Other, Specify:_____ Method [3]	mg 0.0203	mg 0.0955	mg 0.0279	mg 0.0698	mg <0.005
ZIN Zinc 1. Flame Atomic Absorption 2. Furnace Atomic Absorption 3. ICP-AES 4. Anodic Strip. Voltammetry 5. Other, Specify:_____ Method [3]	mg 0.1442	mg 0.0873	mg 0.0652	mg 0.1832	mg <0.005
SIL Silica 1. Colorimetric Method 2. Infrared Spectroscopy 3. X-ray Diffraction 4. Other Specify: _____ Method [3]	mg 0.1328	mg 0.0580	mg 0.0583	mg 0.0857	mg <0.184
ASB Asbestos 1. NIOSH 7400, A Rules 2. Other, Specify:_____ Method [1]	f/mm^2 6780	f/mm^2 6550	f/mm^2 2730	f/mm^2 2030	f/mm^2 1.9
CTC Carbon Tetrachloride Desorption Efficiency 0.984	mg 0.8567	mg 0.6018	mg 1.7346	mg 1.1778	mg <0.1
DCE 1,2-Dichloroethane Desorption Efficiency 0.979	mg 1.0083	mg 1.6164	mg 1.3753	mg 0.7131	mg <0.1
TCE Trichloroethylene Desorption Efficiency 0.969	mg 1.3901	mg 1.1329	mg 0.6025	mg 0.9167	mg <0.1

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PROFICIENCY ANALYTICAL TESTING PROGRAM
LABORATORY PERFORMANCE - ROUND 115

	CONTAMINANT	SAMPLE	RND115 STATISTICAL SUMMARY: REF. VALUE	PERFORMANCE LIMITS	NO. LABS	OUTLIERS HI	OUTLIERS LO	OUTLIERS TOT	LABORATORY RESULTS: R115 DATA	PROF RATING	OUTLIER SUMMARY 112	113	114	115
METALS	CADMIUM (CAD)	1	0.0177	0.0156-0.0198	399	13	21	34	0.0188	P				
	(MG)	2	0.0108	0.0097-0.0119		25	16	41	0.0115					
		3	0.0069	0.0060-0.0078		14	9	23	0.0072					
		4	0.0137	0.0119-0.0155		15	9	24	0.0148					
	LEAD (LEA)	1	0.0214	0.0178-0.0250	403	15	16	31	0.0203					
	(MG)	2	0.0931	0.0816-0.1045		15	16	31	0.0955					
		3	0.0281	0.0243-0.0318		22	16	38	0.0279					
		4	0.0676	0.0586-0.0767		14	12	26	0.0698					
	ZINC (ZIN)	1	0.1407	0.1224-0.1590	396	15	24	39	0.1442					
	(MG)	2	0.0849	0.0732-0.0967		25	16	41	0.0873					
		3	0.0628	0.0542-0.0714		26	17	43	0.0652					
		4	0.1753	0.1493-0.2013		14	14	28	0.1832					
SILICA	SILICA (SIL)	1	0.1257	0.0362-0.2152	95	1	0	1	0.1328	P		-	-	
	(MG)	2	0.0653	0.0080-0.1226		2	0	2	0.0580			-	-	
		3	0.0756	0.0175-0.1337		2	0	2	0.0583			-	-	
		4	0.0822	0.0284-0.1360		0	0	0	0.0857			-	-	
ASBESTOS	ASBESTOS (ASB)	1	532	236.9- 944.8	1169	34	48	82	678	P				
	(F/MM2)	2	514.6	222.6- 927		19	56	75	655					
		3	217.1	87.7- 404.1		48	51	99	273					
		4	259.9	99.1- 496.9		123	34	157	203					
ORGANIC SOLVENTS	CARBON TETRACHLORIDE (CTC)	1	0.8860	0.7638-1.0083	366	22	15	37	0.8567	P				
	(MG)	2	0.6013	0.5150-0.6877		29	14	43	0.6018					
		3	1.7813	1.5631-1.9996		19	23	42	1.7346					
		4	1.1986	1.0795-1.3178		32	30	62	1.1778					
	1,2-DICHLOROETHANE (DCE)	1	1.0188	0.8604-1.1773	366	15	10	25	1.0003					
	(MG)	2	1.5863	1.4148-1.7577		23	28	51	1.6164					
		3	1.3786	1.2005-1.5566		20	13	33	1.3753					
		4	0.7085	0.6150-0.8021		27	9	36	0.7131					
	TRICHLOROETHYLENE (TCE)	1	1.3881	1.2014-1.5748	366	14	16	30	1.3901					
	(MG)	2	1.1161	0.9543-1.2779		16	13	29	1.1329					
		3	0.6049	0.5078-0.7021		13	14	27	0.6025					
		4	0.9124	0.7963-1.0285		14	21	35	0.9167					
	OVERALL:				1361					P				

PROFICIENCY RATINGS: P =PROFICIENT
NP =# OF TIMES NONPROFICIENT
- =ANALYSIS NOT PERFORMED OR NOT RATED

OUTLIER SUMMARY: BLANK =ANALYSIS ACCEPTABLE
- =ANALYSIS NOT PERFORMED
HI =HIGH OUTLIER
LO =LOW OUTLIER

NOTE: ONLY ONE PROFICIENCY RATING IS GIVEN FOR METALS AND ONLY ONE PROFICIENCY RATING IS GIVEN FOR ORGANIC SOLVENTS.

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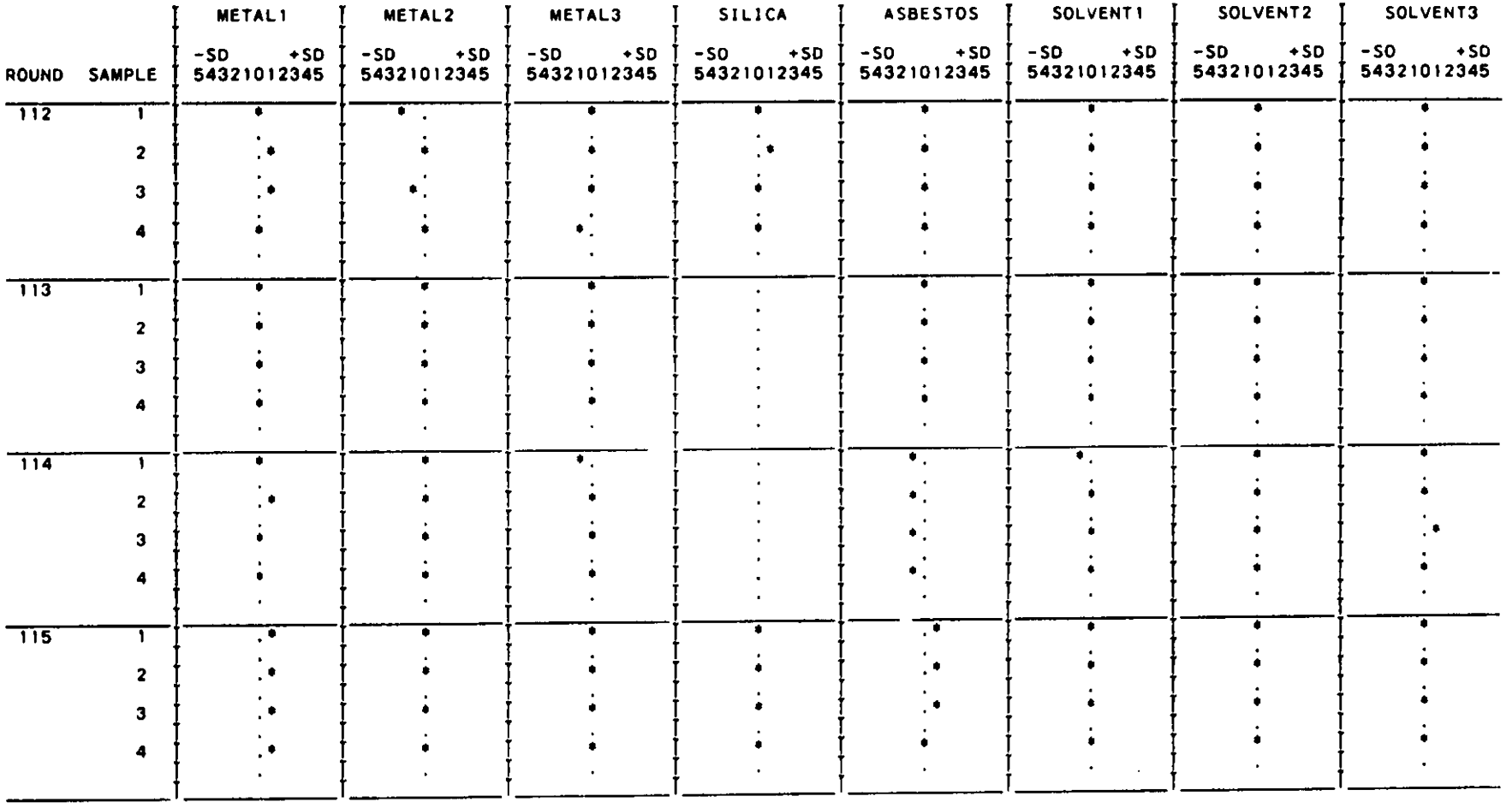
PROFICIENCY ANALYTICAL TESTING PROGRAM
ROUNDS 112 - 115 STANDARD DEVIATION PLOTS



METALS USED - R112: CAD CHR LEA
R113: CAD LEA ZIN
R114: CAD CHR LEA
R115: CAD LEA ZIN

SOLVENTS USED - R112: MCM PCE TCE
R113: CFM CTC DCE
R114: BNZ OXY TOL
R115: CTC DCE TCE

SECTION II: THE ENVIRONMENTAL LEAD PROFICIENCY ANALYTICAL TESTING (ELPAT) PROGRAM

Part I: INTRODUCTION

Title X of the Housing and Community Development Act of 1992 mandates that there be a program to certify laboratories for the analysis of lead; hence the Environmental Lead Proficiency Analytical Testing (ELPAT) Program was established. The abatement of lead from a residence, steel structure, school or business can be a major financial undertaking. Therefore, the decision to abate must be based on accurate analytical results. The ELPAT Program provides environmental and industrial hygiene laboratories the opportunity to analyze for lead in challenging real-world matrices (paint chips, soil, and dust wipes). In order to be recognized by the U.S. Environmental Protection Agency (EPA) under the National Lead Laboratory Accreditation Program (NLLAP) as an accredited laboratory for the analysis of lead in these matrices, participation in the ELPAT Program is mandatory.[7] The 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 EPA Office of Pollution Prevention and Toxics (OPPT). The program is designed to improve the performance of environmental and industrial hygiene laboratories performing analyses associated with lead abatement of housing and other structures.[8,9] The statistical analysis for ELPAT was modeled after the existing PAT Program, with a few minor exceptions. Proficiency ratings are only given for individual matrices with no overall laboratory rating. Also if any or all results are not reported by a laboratory, no rating is given. The statistical software used to perform the analysis and generation of reports is SAS® (SAS Institute Inc., Cary, NC).

In November 1992, the first round of ELPAT samples were mailed to over 100 participating laboratories. Presently, there are over 200 laboratories enrolled in the ELPAT Program. In each matrix category, there are four real-world samples to analyze. The dust wipes category is the only one with a blank. The units for reported results are percentage (%) for paint chips, milligrams/kilogram (mg/kg) for soil, and micrograms (μg) for dust wipes.

Reference Samples

Paint chips are typically collected from a variety of sites, such as old houses, hospitals, and military bases. Paint chip samples are usually ground to a maximum particle size of 150 micrometers (μm) or less. Soil samples have come from drip lines around older houses and industrial plants with lead-contaminated soil. Soil samples are dried, then sterilized by heating the soil to 325°F for at least 2 hours and sieved to a maximum particle size of 150 micrometers (μm). Dust wipe samples are gravimetrically loaded onto Whatman 40 filter paper with sterilized (gamma-irradiated) household dust, and post-abatement dust sieved to a maximum particle size of 250 micrometers (μm). To prevent mold growth, the filters are moistened with 0.5 Ml of 3% hydrogen peroxide. The blank

dust wipe is prepared with Whatman 40 filter paper moistened with the same hydrogen peroxide solution. However, there are plans to change the wipe material to a commercially available wipe.

Participant Procedures

Participants in the ELPAT Program are required to analyze and submit results for each lead matrix for which they are enrolled. If no results are submitted for a particular matrix, no rating will be given. Ratings are only given for a particular lead matrix. There are no overall laboratory ratings.

Evaluation of Laboratories

Laboratories are rated on results they submit on the current round, which occurs quarterly. An individual result is acceptable if it falls within acceptable performance limits, and is unacceptable if it falls outside that range. Once again, these performance limits are established by calculation of the mean and standard deviation from values reported by a preselected group of reference laboratories. Determination of the acceptable performance limits is as follows.

The first step in the calculation of the acceptable performance limits is to identify the sample analytical results reported by a preselected group of reference laboratories. For the early rounds of the ELPAT Program, reference laboratories have been selected from the reference laboratories of the PAT Program and those laboratories that performed acceptably in the EPA/Research Triangle Institute (RTI) round robin for lead in paint and dust. Reference laboratories in the PAT Program must meet the following criteria: the laboratory was proficient in the previous PAT round for a wide variety of industrial hygiene laboratory operations, and the laboratory must be accredited by AIHA. Eventually, all reference laboratories must be accredited under NLLAP. There are generally 30 reference laboratories for each lead matrix in the ELPAT Program.

The second step is the treatment of the reference laboratory data which appears to be inconsistent with the rest of that set of data. Mistakes in analysis or in reporting results substantially affect estimates of the mean and standard deviation unless treated. Reference laboratory data are thus treated by Winsorization. Winsorization involves the ranking of reference laboratory results for each of the samples. Those reference laboratory results which fall in the top 5 percent of results are replaced by a value equal to the highest result remaining in the set. Similarly, those results which fall in the bottom 5 percent of results are replaced by a value equal to the lowest result remaining in the set. Unlike other approaches, the extreme values are not eliminated, but are adjusted.

The use of reference laboratory data without any modification requires one to assume that reference laboratories never make mistakes. If reference laboratory data involving mistakes are not treated, then the standard deviation estimate will be inflated and the acceptable range will be too wide. One problem with outlier tests is that it is not always easy to distinguish between outliers due to mistakes and outliers which are extreme

merely due to random chance. Since Winsorization adjusts suspected outliers rather than eliminating them (unlike other outlier tests), there is less risk that the standard deviation will be underestimated and performance limits too narrow if some data are inadvertently treated as outliers when no mistakes have actually occurred.

The last step is the calculation of the reference laboratory means and standard deviations using Winsorized data. The reference values equal the means, and the acceptable ranges equal the means plus or minus 3 standard deviations. Acceptable ranges based on the means plus or minus 3 standard deviations result in a very low probability, less than 1 percent, that an outlier is obtained by a laboratory by random chance. After the acceptable ranges have been calculated, the data from all participating laboratories including the reference laboratories are compared to these ranges to determine acceptability. Data falling within the ranges are acceptable and data falling outside the ranges are reported as either high (HI) or low (LO) outliers.

Lead Reference Material

Similar to the PAT Program, the ELPAT Program is designed to supplement, but not replace the internal quality control program of a laboratory. Using materials of known lead content in suitable matrices is important to obtain 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. ELPAT materials differ from certified reference materials in that either the sample is 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.

Standard reference materials are commercially available from the National Institute of Standards and Technology (NIST), and certified reference materials are available from commercial reference material suppliers participating in the EPA/American Association for Laboratory Accreditation (A2LA) environmental reference material certification program. These materials 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.

Laboratory Accreditation Information

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 the establishment of a federal laboratory certification system.

Requirements for NLLAP are 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. Requirements for EPA recognition of laboratory accreditation systems involve two aspects: (1) successful participation in the ELPAT Program; and (2) review of laboratory operations. NLLAP requirements are based upon ISO Guide 25-1990, already in use by many national laboratory accreditation systems worldwide, and Laboratory Accreditation Guidelines of a Federal Interagency Lead-Based Task Force, with input from various groups including laboratory accreditation organizations.[10] 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 are recognized as accrediting organizations under NLLAP and have developed programs for 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 NLLAP requirements.

Proficiency Ratings

Like the PAT Program, ratings of laboratories in the ELPAT Program are based upon performance over the last year, (four rounds). The purposes of proficiency criteria are to:

1) Require multiple errors in different rounds before nonproficiency is determined.

2) Minimize the lag in ratings when performance changes.

3) Limit any advantage a laboratory may have in improving its rating by not performing on the next round.

4) Adversely rate laboratories which fail to correct analytical problems in a timely manner.

5) Limit the risk that laboratories rated nonproficient are nonproficient due to random chance and not because of analytical mistakes within the laboratory.

Laboratories are rated on individual lead matrix performance. However, there is no rating for overall laboratory performance. A laboratory must submit results to receive a rating for each matrix.

Individual Lead Matrix Performance is rated as:

1) Proficient if all results have been reported and all are classified as acceptable for the last two consecutive rounds.

2) Proficient in all other situations if three-quarters or more of the results reported in the last four consecutive rounds are classified as acceptable.

A rating of nonproficiency indicates that a serious analytical problem has been identified and warrants immediate action. However, ELPAT proficiency ratings have limitations because:

1) Samples are provided to participants only quarterly. In addition, only one analyst in the lab is evaluated each round on each lead matrix.

2) ELPAT samples contain unknown concentrations of lead, presumably within a certain range. These samples should not receive special treatment.

3) The ELPAT Program can only cover a limited number of the analyses performed by the laboratories.

4) The statistical power of the ELPAT Program to detect excessive bias and poor precision is dependent upon the variability of ELPAT reference laboratories and the small number of samples (4 to 16) used to determine proficiency over 4 rounds (i.e., one year).

Corrective Actions

The purpose of the ELPAT Program is to help laboratories improve their performance in challenging real-world matrices of lead in paint chips, soil, and dust wipes. The timetable is identical to the PAT Program in that ELPAT participants receive their results and have approximately one month to make necessary adjustments before they receive the next ELPAT sample kits. ELPAT sample kits from previous rounds may be purchased through AIHA. These sample kits are not reported in the ELPAT program and are for practice only.

Laboratories applying for accreditation must provide information to the accrediting body regarding how the laboratory has corrected analytical problems discovered by the ELPAT Program. If a laboratory is applying for accreditation, performance problems in the ELPAT Program could delay obtaining accreditation.

The ELPAT Program is not intended to replace a laboratory's internal quality control program. The use of internal controls like duplicate samples, spiked samples, and calibration checks can also aid in the discovery of analytical problems.

Analytical problems may be a result of:

(1) Variations between internal quality control samples and ELPAT samples (for example, interferences, concentrations, matrices, analytical procedures);

(2) Laboratory-to-laboratory component of variability in ELPAT performance limit calculations which may mask intralaboratory variability (precision) problems;

(3) Limited statistical power of the ELPAT Program attributed to the use of 3 standard deviation limits for performance limits, and nonproficiency criteria designed to have a low probability of rating a laboratory as poorly performing when no analytical problem truly exists;

(4) Use of a low number of samples to establish a proficiency rating. Therefore, the fact that a laboratory had no outliers in the ELPAT Program does not mean that laboratory personnel should ignore out-of-control situations that are discovered in an internal quality control program.

The ELPAT Program may uncover analytical problems left undetected by the internal quality control program of a laboratory. In instances such as these, laboratory personnel need to investigate why the internal quality control program failed to detect such problems, as well as the source of the analytical problem and its correction. If such problems occur, the internal quality control program may need to be revised.

Part II: Laboratory Data Report

Included on the ELPAT Reporting Form are spaces designated for a laboratory to record their laboratory identification number, analytical method, sample preparation technique, and lead results. The selections for analytical methods include flame atomic absorption, graphite furnace atomic absorption, inductively-couple plasma atomic emission spectroscopy, laboratory x-ray fluorescence, and other. Options for sample preparation technique include NIOSH 7082/7105 hotplate, EPA-SW 846 3050/3050A hotplate, other hotplate, EPA/Atmospheric Research and Exposure Assessment Laboratory (AREAL) (PB-114172) microwave, EPA-SW846-3051 microwave, other microwave, and other preparation/digestion method. Also, there are instructions for completing the form, as well as the fax number and mailing address at NIOSH.

Part III: Laboratory Performance Report

On the upper-half of the page of the individual laboratory report, there are columns for sample type, sample number, reported results, reference values, acceptable range (lower and upper), lab performance, and z-score. The sample type indicates whether the lead matrix is paint chips, soil, or dust wipes. Sample number is the particular sample in the kit. Reference values are the mean of the reference laboratories. The acceptable lower range limit is the reference value minus three standard deviations while the upper range limit is the reference value plus three standard deviations. In the lab performance column, an "A" means the result was acceptable, "H" indicates an outlier above the acceptable performance limit, "L" indicates an outlier below the acceptable performance range, and a "-" means that results were not reported. The z-score is the difference of the reported result and the reference value divided by the standard deviation.

The lower portion of the individual laboratory report page displays the cumulative performance over the last four rounds. Sample type indicates the type of lead matrix analyzed. Round number denotes a specific ELPAT round of testing. The fraction in the

round performance column indicates the current round performance where the numerator is number of acceptable results and the denominator is the total number of samples analyzed. The accumulated four round performance column displays the number of acceptable results over the last four rounds. Likewise, the performance two rounds column shows the number of acceptable results over the last two rounds. The proficiency rating column indicates a "P" for proficient, "NP" for nonproficient, or a "-" for no rating. Proficiency may be achieved by attaining 75 percent or greater acceptable results over the last four rounds or 100 percent over the last two rounds.

The top portion of the summary statistics page shows the results of the reference laboratories for the current round. The sample type and sample number columns have been explained previously. The "N" column is the number of reference laboratories reporting results for each particular lead matrix. The "Mean" column is the winsorized mean of all values reported from reference laboratories. The "Minimum" column is the winsorized minimum value reported by a reference laboratory, while "Maximum" is the highest winsorized value reported. The "STD" column lists the standard deviations for each lead sample. The "RSD" is the standard deviation divided by the mean. The "Acceptable Range" is the mean plus or minus 3 standard deviations.

The middle portion is a summary of statistics for all of the laboratories participating in an ELPAT Round. The "Mean" column displays the mean values for each lead matrix based on all of the laboratories' data. The "Minimum" column shows the lowest value reported. The "Q1" column displays values that represent the first quartile, meaning that 25 percent of all reported data are below this figure. The "Median" column shows median values, which means that 50 percent of all reported data fall below this figure, and 50 percent were above. The "Q3" column represents the third quartile, meaning that 75 percent of all reported values fell below this figure. The "Maximum" column displays the maximum value reported.

The bottom portion of the summary of statistics page gives the breakdown of acceptable results and outliers. The "Number of Labs Rated" column shows how many labs reported values for each sample. The number of "Acceptable Labs" are the number of labs who reported values within the acceptable performance limits. The "Low Outlier" column represents the number of labs who reported results greater than 3 standard deviations below the reference value. The "High Outlier" column shows the number of labs who reported values greater than 3 standard deviations above the reference value.

The last three pages are frequency plots displaying the z-score distribution of all reporting laboratories for each sample of paint chips, soil, and dust wipes.

01234 R005-93 P S W
John Smith
Acme Environmental Labs Inc.
123 Anywhere Street
Anytown USA 56789

ELPAT

Environmental Lead Proficiency Analytical Testing

Please print your 8 digit Laboratory Identification number here. (It is the upper left - hand number in the address label.)

Results must be received via fax or mail by December 9, 1993

ROUND 005

Ground Paint Chips (%)

* **

#1 #2 #3 #4

Soil (mg/kg)

* **

#1 #2 #3 #4

Dust Wipes (micrograms)

* **

#1 #2 #3 #4 (Blank)

INSTRUCTIONS

* Please print the number of the ANALYTICAL METHOD used:
1 = Flame Atomic Absorption
2 = Graphite Furnace Atomic Absorption
3 = ICP-AES
4 = Laboratory X-ray Fluorescence
6 = Other, Specify _____

** Please print the SAMPLE PREPARATION TECHNIQUE used:
HOTPLATE:
N = NIOSH 7082 / 7105
S = EPA - SW 846-3050/3050A
A = Other HOTPLATE, Specify _____
MICROWAVE:
E = EPA/AREAL (PB 92-114172)
P = EPA SW846-3051
X = Other MICROWAVE, Specify _____
OTHER:
R = Other Preparation / Digestion, Specify _____

If your sample kit is incomplete or contains damaged samples, call the ELPAT Coordinator, AIHA at (703) 849-8888.

Explanation of the mailing label: Upper left hand number = Laboratory Identification Number. Middle number = round number and year. Right hand letters = sample code.

All reported results for the dust wipes must have the blank result subtracted. For each analyte you are reporting, fill in the result form as follows. Report all four results (or the data will not be analyzed), paying attention to the units (% = percent, mg/kg = milligrams per kilogram, and micrograms). Fill every box, using leading and trailing zeros where needed. For dust wipes, fill in the blank result, using " less than " values when appropriate. The soil sample is to be analyzed and reported based on drying it to a constant weight at 105 C.

Fax this page to (513) 841- 4545

Mailing Address:

ELPAT Program
NIOSH R-8
4676 Columbia Parkway
Cincinnati, Ohio
45226-1998

The Environmental Lead Proficiency Analytical Testing (ELPAT) Program is a cooperative effort to improve and evaluate the performance of laboratories involved in the analysis for lead in paint, dust, and soil matrices. The National Institute for Occupational Safety and Health (NIOSH) performs ELPAT data analysis under a Memorandum of Understanding (MOU # PW593570-01-0) with the U.S. Environmental Protection Agency (EPA). The American Industrial Hygiene Association (AIHA) contracts for ELPAT sample production and administers the ELPAT program as permitted under a Cooperative Research and Development Agreement (CRADA # NIO.CS2.001.00) with NIOSH covering cooperation in analytical research and proficiency test programs.

ELPAT 93278

ENVIRONMENTAL LEAD PROFICIENCY ANALYTICAL TESTING (ELPAT) PROGRAM
INDIVIDUAL LABORATORY REPORT FOR ROUND 005
LAB ID= 01234

SAMPLE TYPE	SAMPLE NO.	REPORTED RESULTS	REFERENCE VALUES *	ACCEPTABLE RANGE # LOWER	UPPER	LAB @ PERFORMANCE	Z & SCORE
Paint Chips (%)	1	1.83	1.761	1.2524	2.2695	A	0.41
	2	0.0207	0.0222	0.014	0.0304	A	-0.54
	3	2.91	4.4022	2.6708	6.1337	A	-2.59
	4	0.5814	0.5568	0.3923	0.7212	A	0.45
Soil (mg/kg)	1	371.6	361.9	260.7	463	A	0.29
	2	366.3	359.6	276	443.3	A	0.24
	3	624.5	580.9	467.4	694.3	A	1.15
	4	1760	1597.7	1237.1	1958.3	A	1.35
Dust Wipes (ug)	1	20.4	21.0118	9.3	32.8	A	-0.16
	2	42.3	39.1176	23	55.2	A	0.59
	3	73.7	69.6971	45.8	93.6	A	0.50
	4	89.3	77.8059	50.7	104.9	A	1.27

* Reference value is the mean of the reference laboratories
\# Upper limit: reference value + 3 standard deviations
Lower limit: reference value - 3 standard deviations
@ A : Analysis acceptable; - : Results not reported
H: Results > upper limit, not acceptable
L: Results < lower limit, not acceptable
& Z Score = (reported result-reference value)/standard deviation

LABORATORY YEAR-TO-DATE PERFORMANCE REPORT
LAB ID= 01234

SAMPLE TYPE	ROUND NO.	ROUND * PERFORMANCE	ACCUMULATED 4 ROUNDS(%)		PERFORMANCE 2 ROUNDS(%)		PROFICIENCY RATING #
Paint Chips (%)	002	4/4					
	003	4/4					
	004	4/4					
	005	4/4	16/16	100	8/8	100	P
Soil (mg/kg)	002	4/4					
	003	4/4					
	004	3/4					
	005	4/4	15/16	93	7/8	87	P
Dust Wipes (ug)	002	4/4					
	003	4/4					
	004	4/4					
	005	4/4	16/16	100	8/8	100	P

* The denominators represent the number of total samples analyzed
The numerators represent the number of acceptable results
\# P : Proficent NP: Nonproficient -: Not Rated
Performance ratings are based on accumulated results over four rounds (one year). A lab's performance in ground paint chips, soil, or dust wipes is rated proficient (P), if: 1) three-fourths (75%) or more of the accumulated results over four rounds are acceptable or 2) for the last two rounds, all samples are analyzed and the results are 100% acceptable

ENVIRONMENTAL LEAD PROFICIENCY ANALYTICAL TESTING (ELPAT) PROGRAM
SUMMARY STATISTICS OF REFERENCE LABORATORIES FOR ROUND 005

SAMPLE TYPE	SAMPLE	N	MEAN	MINIMUM	MAXIMUM	STD	RSD(%)	ACCEPTABLE RANGE
Paint Chips (%)	1	36	1.761	1.4	1.992	.170	9.6	1.2524 - 2.2695
	2	36	0.0222	0.0186	0.0271	.003	12.3	0.014 - 0.0304
	3	36	4.4022	2.91	5.0212	.577	13.1	2.6708 - 6.1337
	4	36	0.5568	0.464	0.6603	.055	9.8	0.3923 - 0.7212
Soil (mg/kg)	1	27	361.9	308	427.5	33.7	9.3	260.7 - 463
	2	27	359.6	319.3	418.4	27.9	7.8	276 - 443.3
	3	27	580.9	515.4	636	37.8	6.5	467.4 - 694.3
	4	27	1597.7	1304	1760	120	7.5	1237.1 - 1958.3
Dust Wipes (ug)	1	34	21	13	26.2	3.92	18.7	9.3 - 32.8
	2	34	39.1	29.2	47.3	5.37	13.7	23 - 55.2
	3	34	69.7	56.3	84.2	7.95	11.4	45.8 - 93.6
	4	34	77.8	64.6	94.5	9.04	11.6	50.7 - 104.9

SUMMARY STATISTICS OF ALL LABORATORIES PARTICIPATED

SAMPLE TYPE	SAMPLE	N	MEAN	MINIMUM	Q1	MEDIAN	Q3	MAXIMUM
Paint Chips (%)	1	222	1.7895	0.0261	1.6880	1.82	1.9300	4.3134
	2	222	0.0337	0.0048	0.0190	0.0209	0.0240	2.3655
	3	222	4.4309	0.045	4.1700	4.63105	4.8919	10.9
	4	222	0.6665	0.1407	0.5230	0.566	0.5930	10.6
Soil (mg/kg)	1	192	361.3	54	334.150	358.65	376.000	881
	2	192	363.4	173.8	337.050	360.15	384.500	882
	3	192	590	354.3	551.000	583.4	611.100	1600
	4	192	1625.4	650	1539.50	1611.55	1688.75	3963.4
Dust Wipes (ug)	1	200	25.2	2.4	19.1000	21.8	24.6000	404
	2	200	44.9	12.1	34.8500	39.05	42.9500	702
	3	200	77.9	36.3	62.0500	68.9	74.6500	1232
	4	200	90.2	18	70.8000	79.05	85.6500	1648

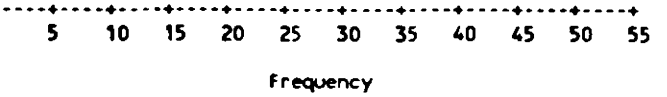
SUMMARY OF PERFORMANCE - ALL LABORATORIES PARTICIPATED

SAMPLE TYPE	SAMPLE NO.	N OF LABS RATED	ACCEPTABLE LABS	LOW OUTLIER	HIGH OUTLIER
Paint Chips (%)	1	222	208	10	4
	2	222	202	4	16
	3	222	207	12	3
	4	222	206	5	11
Soil (mg/kg)	1	192	177	8	7
	2	192	172	10	10
	3	192	180	6	6
	4	192	178	7	7
Dust Wipes (ug)	1	200	190	1	9
	2	200	186	6	8
	3	200	183	11	6
	4	200	188	7	5

ENVIRONMENTAL LEAD PROFICIENCY ANALYTICAL TESTING ROUND:005
FREQUENCY OF ALL LABS Z SCORES

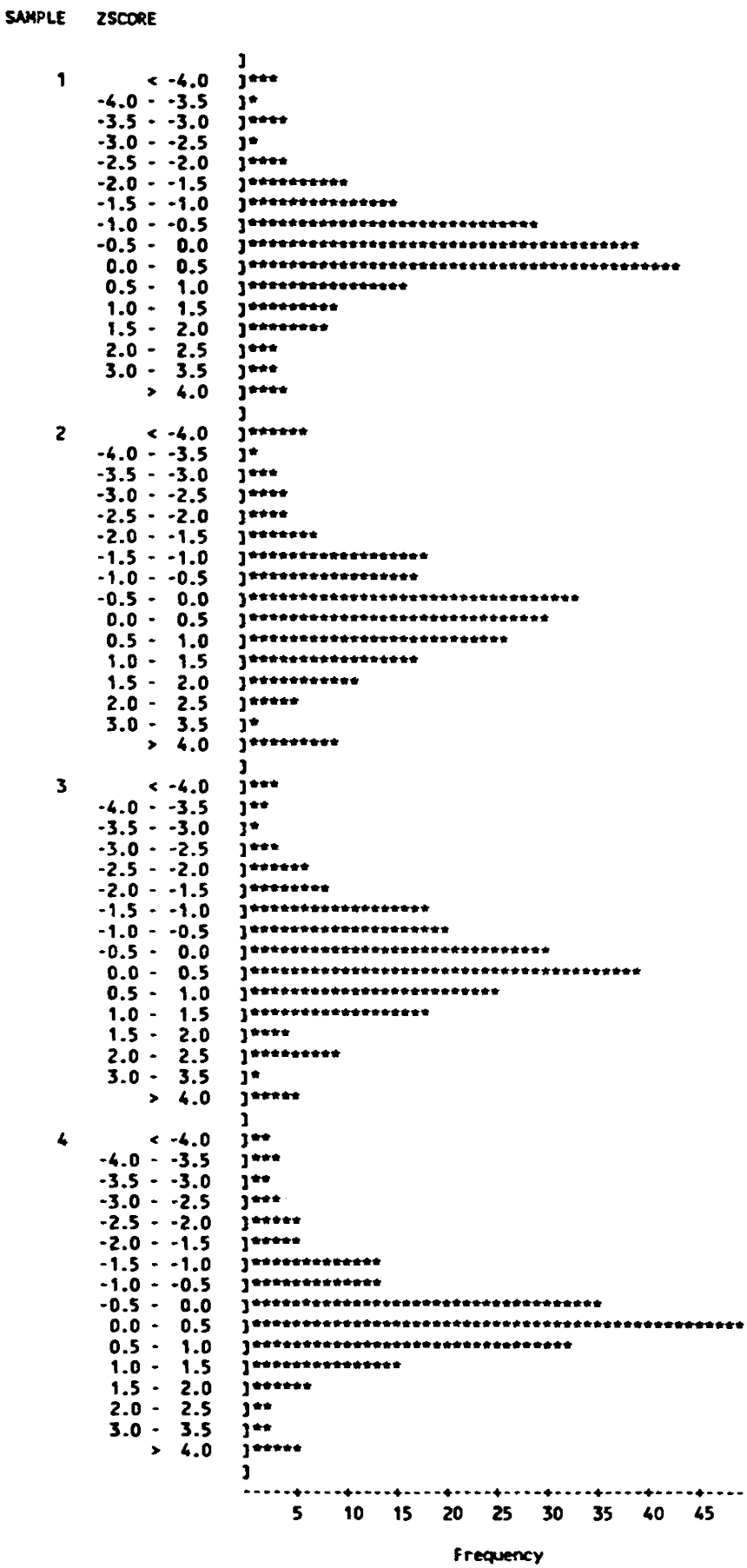
Paint Chips (%)

SAMPLE	ZSCORE		Freq
		]	
1	< -4.0	]*****	5
	-4.0 - -3.5	]**	2
	-3.5 - -3.0	]***	3
	-3.0 - -2.5	]******	6
	-2.5 - -2.0	]****	4
	-2.0 - -1.5	]*****	5
	-1.5 - -1.0	]******	6
	-1.0 - -0.5	]*******************	19
	-0.5 - 0.0	]********************************	32
	0.0 - 0.5	]***	47
	0.5 - 1.0	]**************************************	39
	1.0 - 1.5	]*****************************	28
	1.5 - 2.0	]***********	11
	2.0 - 2.5	]***********	11
	3.0 - 3.5	]**	2
	> 4.0	]**	2
		]	
2	< -4.0	]***	3
	-4.0 - -3.5	]	0
	-3.5 - -3.0	]*	1
	-3.0 - -2.5	]******	6
	-2.5 - -2.0	]**************	14
	-2.0 - -1.5	]****************	16
	-1.5 - -1.0	]*******************************	30
	-1.0 - -0.5	]************************************	37
	-0.5 - 0.0	]************************	25
	0.0 - 0.5	]**********************	22
	0.5 - 1.0	]**********************	21
	1.0 - 1.5	]************	12
	1.5 - 2.0	]*******	7
	2.0 - 2.5	]************	12
	3.0 - 3.5	]**	2
	> 4.0	]**************	14
		]	
3	< -4.0	]***********	11
	-4.0 - -3.5	]*	1
	-3.5 - -3.0	]	0
	-3.0 - -2.5	]****	4
	-2.5 - -2.0	]**	2
	-2.0 - -1.5	]*****	5
	-1.5 - -1.0	]***	3
	-1.0 - -0.5	]*********************	21
	-0.5 - 0.0	]*******************************	30
	0.0 - 0.5	]**	53
	0.5 - 1.0	]**	50
	1.0 - 1.5	]*****************************	29
	1.5 - 2.0	]*****	5
	2.0 - 2.5	]*****	5
	3.0 - 3.5	]**	2
	> 4.0	]*	1
		]	
4	< -4.0	]***	3
	-4.0 - -3.5	]*	1
	-3.5 - -3.0	]*	1
	-3.0 - -2.5	]**	2
	-2.5 - -2.0	]******	6
	-2.0 - -1.5	]************	12
	-1.5 - -1.0	]************	12
	-1.0 - -0.5	]*********************	21
	-0.5 - 0.0	]************************************	39
	0.0 - 0.5	]**	55
	0.5 - 1.0	]**********************************	35
	1.0 - 1.5	]****************	16
	1.5 - 2.0	]*******	7
	2.0 - 2.5	]*	1
	3.0 - 3.5	]****	4
	> 4.0	]*******	7
		]	



ENVIRONMENTAL LEAD PROFICIENCY ANALYTICAL TESTING ROUND:005
FREQUENCY OF ALL LABS Z SCORES

Soil (mg/kg)



ENVIRONMENTAL LEAD PROFICIENCY ANALYTICAL TESTING ROUND:005
FREQUENCY OF ALL LABS Z SCORES

Dust Wipes (ug)

SAMPLE	ZSCORE		Freq
		]	
1	< -4.0	]*	1
	-4.0 - -3.5	]	0
	-3.5 - -3.0	]	0
	-3.0 - -2.5	]****	4
	-2.5 - -2.0	]**********	10
	-2.0 - -1.5	]****	4
	-1.5 - -1.0	]*********	9
	-1.0 - -0.5	]**********************	22
	-0.5 - 0.0	]**************************************	37
	0.0 - 0.5	]**************************************	37
	0.5 - 1.0	]******************************	30
	1.0 - 1.5	]**********************	21
	1.5 - 2.0	]*********	9
	2.0 - 2.5	]*******	7
	3.0 - 3.5	]***	3
	> 4.0	]******	6
		]	
2	< -4.0	]*	1
	-4.0 - -3.5	]	0
	-3.5 - -3.0	]*****	5
	-3.0 - -2.5	]****	4
	-2.5 - -2.0	]********	8
	-2.0 - -1.5	]********	8
	-1.5 - -1.0	]************	12
	-1.0 - -0.5	]******************************	30
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	0.0 - 0.5	]*********************************	32
	0.5 - 1.0	]**************************	26
	1.0 - 1.5	]******************	18
	1.5 - 2.0	]******	6
	2.0 - 2.5	]*********	9
	3.0 - 3.5	]***	3
	> 4.0	]*****	5
		]	
3	< -4.0	]*	1
	-4.0 - -3.5	]***	3
	-3.5 - -3.0	]*******	7
	-3.0 - -2.5	]****	4
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	-2.0 - -1.5	]***********	11
	-1.5 - -1.0	]************	13
	-1.0 - -0.5	]************************	24
	-0.5 - 0.0	]**************************************	38
	0.0 - 0.5	]******************************	29
	0.5 - 1.0	]*****************************	27
	1.0 - 1.5	]*******************	19
	1.5 - 2.0	]***	3
	2.0 - 2.5	]*****	5
	3.0 - 3.5	]**	2
	> 4.0	]****	4
		]	
4	< -4.0	]**	2
	-4.0 - -3.5	]*	1
	-3.5 - -3.0	]****	4
	-3.0 - -2.5	]****	4
	-2.5 - -2.0	]*********	9
	-2.0 - -1.5	]*********	9
	-1.5 - -1.0	]***************	15
	-1.0 - -0.5	]***************	15
	-0.5 - 0.0	]**********************************	34
	0.0 - 0.5	]******************************	30
	0.5 - 1.0	]**********************************	34
	1.0 - 1.5	]**********************	21
	1.5 - 2.0	]*********	9
	2.0 - 2.5	]********	8
	3.0 - 3.5	]*	1
	> 4.0	]****	4
		]	

-----+----+----+----+----+----+----+---
5 10 15 20 25 30 35

Frequency

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