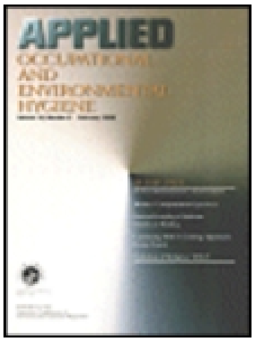

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ELPAT Program Report: Background and Current Status

Paul C. Schlecht & Jensen H. Groff Column Editors

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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, 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 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] are now recognized as accrediting organizations under NLLAP and 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.

Reference Laboratories

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 Proficiency Analytical Testing (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 an earlier EPA-sponsored interlaboratory evaluation conducted by RTI of sample digestion techniques (microwave and hotplate) used to analyze paint chip and soil samples.[6]

Once a significant 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 LPAT reference laboratories must be accredited by an EPA NLLAP recognized accrediting organization.

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 PAT Program.[7]

After data from reference laboratories are collected and extreme reference laboratory data have been statistically treated, the mean ± 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. This is the same criterion used by NIOSH to establish acceptable and outlier performance of industrial hygiene laboratories in the PAT Program.[7]

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 the following occurs:

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 are similar to the procedure used in the PAT Program.[7] However, the ELPAT statistical protocol and related computer programs have been designed to permit future change to 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, the Association of Official Analytical Chemists International, and the International Union of Pure and Applied Chemists.[8]

ELPAT Round 7, May 1994

Paint samples for round 7 were prepared from paint chips collected from a variety of sites, including a textile mill. The chips were ground to a maximum particle size of 120 μm.

Soil samples came from driplines around older houses in North Carolina and from industrial sites in Colorado and Louisiana. Soil samples were dried and then sterilized by heating the soil to 325°F for a minimum of 2 hours, and finally sieved to a maximum particle size of 150 μm.

Round 7 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 150 μm. The loaded filters were moistened with 0.5 ml of 3 percent hydrogen peroxide solution. The blank wipe was prepared from a Whatman filter moistened with the same hydrogen peroxide solution. 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 that more closely represents field sample media, if a single sample medium is recommended by various lead methods.

A total of 307 laboratories were enrolled for round 7 of the ELPAT program, with 295 (96%) laboratories submitting results either by paper or by the ELPAT automated data entry system. Table I lists summary statistics of reference laboratories for each matrix and sample number. Agreement among reference laboratories is demonstrated by relative standard deviations ranging from 6.9 to 10.3 percent for paint chips, 6.8 to 10.6 percent for soils, and 6.5 to 17.4 percent for dust wipes. This is similar

TABLE I. ELPAT Program Summary Statistics of Reference Laboratories for Round 007

Sample type	Sample	N	Mean	Minimum	Maximum	STD	RSD (%)	Acceptable Range
Paint chips (%)	1	38	0.7454	0.63	0.825	0.064	8.6	0.5536–0.9372
	2	38	0.1135	0.098	0.1262	0.008	6.9	0.09–0.137
	3	38	0.2729	0.2244	0.302	0.024	8.9	0.2–0.3459
	4	38	1.7189	1.3733	1.96	0.177	10.3	1.1867–2.2511
Soil (mg/kg)	1	29	959.4	764	1070	84.0	8.8	707.4–1211.5
	2	29	89.6	75	110.6	9.52	10.6	61–118.1
	3	29	1754.3	1500	1968.3	139	7.9	1335.9–2172.6
	4	29	413.2	364	468	28.1	6.8	328.9–497.5
Dust wipes (μg)	1	36	485.8	402	558	46.3	9.5	346.9–624.7
	2	36	872.8	754.4	969	73.0	8.4	653.9–1091.7
	3	36	492.4	433	541	31.9	6.5	396.6–588.1
	4	36	20.7	13.8	26	3.60	17.4	9.9–31.5

to the agreement among reference laboratories on previous ELPAT rounds for each matrix.

Table II shows the number of all participating laboratory analyses that were identified as outliers. The percentage of outliers for all analyses was under 14.3 percent (4.1 to 9.6% for paint chips, 3.2 to 14.3% for soils, and 5.2 to 10.7% for dust wipes). This is also similar to the frequency of outliers reported on the earlier rounds of ELPAT for each matrix.

Sample digestion techniques are grouped into the most common hotplate, microwave, and all other techniques reported by participants. Hotplate digestion categories are: NIOSH 7082/7105 (a nitric acid/hydrogen peroxide digestion method modified from NIOSH Manual of Analytical Methods Method 7082[9]), EPA SW846-3050A[10] (an EPA nitric acid/hydrogen peroxide method), and other hotplate techniques. Microwave digestion categories are: EPA SW846-3051[11] (a nitric acid digestion method), EPA AREAL[6] [a nitric/hydrochloric acid digestion method from AREAL (RTP-MRDD-037) standard operating procedure], and other microwave techniques. The "all other" category includes nonmicrowave and nonhotplate techniques such as X-ray fluorescence sample preparation, leaching techniques, muffle furnace, and Parr bomb.

Instrumental methods are categorized into flame atomic absorption (FAA), graphite furnace atomic absorption (GFAA), inductively coupled plasma–atomic emission spectroscopy (ICP-AES), laboratory X-ray fluorescence (lab XRF), and "others," including ICP-mass spectroscopy (ICP-MS).

Table III shows a summary of failures (outliers) for the three lead matrices by digestion technique and analytical method used by participating laboratories. A series of Fischer's exact tests (nonparametric tests) were used to compare the various combinations of digestion techniques (hotplate and microwave) and analytical methods (FAA, GFAA, ICP-AES) for statistically significant differences in the ability of the digestion techniques/analytical method combinations to meet ELPAT performance limits.[12] To detect differences in performance, a criterion was then used where participating laboratories are 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. Fischer's exact test was then repeated for each ELPAT matrix. No statistically significant differences were detected among the different methods.

Inspection of Table III shows that the predominant analytical methods were FAA and ICP-AES. One laboratory used ICP-MS, one used DC plasma, and one used the dithizone spectrophotometric method. These laboratories were able to meet acceptable performance limits for paint chip, soil, and dust wipe samples. Two laboratories used lab XRF and had three of four samples acceptable for paint chip and soil samples, respectively. One that did not report either analytical method or sample preparation technique failed all the paint chip and soil samples, and three of four dust wipe samples.

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

TABLE II. Summary of Performance—All Laboratories Participated for Round 007

Sample type	Sample No.	No. of Labs Rate	Acceptable Labs	Low Outlier	High Outlier
Paint chips (%)	1	292	274	11	7
	2	292	264	19	9
	3	292	272	8	12
	4	292	280	9	3
Soil (mg/kg)	1	251	243	3	5
	2	251	215	15	21
	3	251	238	7	6
	4	251	232	9	10
Dust wipes (μg)	1	270	253	11	6
	2	270	256	12	2
	3	270	241	20	9
	4	270	244	8	18

ELPAT Round 6 Bias Analysis

Statistical significance tests are performed for investigating differences in

TABLE III. ELPAT Program Round 007—All Labs Performance Summary

			Paint Chips (%)				Soil (mg/kg)				Dust Wipes (μg)			
			Acceptable		Failures		Acceptable		Failures		Acceptable		Failures	
Method	**Sample**	**Preparation**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
FAA	Hotplate	NIOSH-7082/7105	160	98	4	2	85	92	7	8	231	96	9	4
		EPA-SW846-3050A	335	92	29	8	377	93	27	7	248	94	16	6
		Other-hotplate	90	98	2	2	34	94	2	6	47	90	5	10
	Microwave	EPA AREAL	4	100	0	0	7	88	1	13	4	100	0	0
		EPA-SW846-3051	34	94	2	6	40	100	0	0	28	100	0	0
		Other-microwave	17	85	3	15	0	0	0	0	15	94	1	6
	Other	All others	24	100	0	0	6	75	2	25	24	67	12	33
GFAA	Hotplate	NIOSH-7082/7105	4	50	4	50	0	0	4	100	8	67	4	33
		EPA-SW846-3050A	12	100	0	0	19	95	1	5	22	92	2	8
	Microwave	EPA-SW846-3051	2	50	2	50	5	63	3	38	7	88	1	13
ICP-AES	Hotplate	NIOSH-7082-7105	36	100	0	0	27	96	1	4	59	98	1	2
		EPA-SW846-3050A	249	94	15	6	252	94	16	6	203	92	17	8
		Other-hotplate	31	97	1	3	15	94	1	6	37	93	3	8
	Microwave	EPA AREAL	8	100	0	0	0	0	0	0	4	100	0	0
		EPA-SW846-3051	28	88	4	13	28	88	4	13	29	91	3	9
		Other-microwave	18	90	2	10	11	92	1	8	12	60	8	40
	Other	All others	9	75	3	25	4	100	0	0	0	0	0	0
LAB-XRF	—	—	6	75	2	25	6	75	2	25	0	0	0	0
Others	Hotplate	EPA-SW846-3050A	7	88	1	13	8	100	0	0	7	88	1	13
	Microwave	EPA-SW846-3051	4	100	0	0	4	100	0	0	4	100	0	0
		Other-microwave	12	100	0	0	0	0	0	0	0	0	0	0
+—	—	—	0	0	4	100	0	0	4	100	5	63	3	38
Total			1090	93	78	7	928	92	76	8	994	92	86	8

— = Not reported.

bias among the principal sample preparation and instrumental methods and among the combinations of these two factors. The tests are performed for each matrix (paint chips, soils, and dust wipes) and ELPAT sample (sample numbers 1, 2, 3, and 4) whenever at least three laboratories use the sample preparation and instrumental method.

Analysis of variance (ANOVA) is used if the data meet the general assumptions of the ANOVA procedure, homogeneity of variances and normality. Bartlett's test is used for testing homogeneity of variances and the Shipiro-Wilk test is used for testing normality.[13,14] If the ANOVA assumptions are violated, the Box-Cox transformation procedure is used to examine the data for possible transformations to correct the problem.[15] If the transformed data meet the ANOVA assumptions, then the ANOVA tests are performed on the transformed data. If homogeneity of variance and normality are not achieved by transformation of the data, then a nonparametric approach is used.

In instances where variances are homogeneous and data are normally distributed (either before or after transformation), a one-way ANOVA followed by the Scheffe's multiple comparison test procedure is performed to test for differences in bias among the combinations of the principal sample preparation techniques and instrumental methods.[16] A two-way ANOVA followed by Scheffe's multiple comparison test procedure to test for any difference among principal sample preparation techniques and principal instrumental methods is also performed. Two-way ANOVAs separate bias that may be the result of sample preparation, instrumental method, or interaction of these two factors.

In instances where ANOVA cannot be performed on either the original data or transformed data, one of two nonparametric tests is performed. If transformed data meet the homogeneity of variances but not the normality assumptions, then the Kruskal-Wallis rank sums test followed by the Mann-Whitney-Wilcoxon test with a Bonferroni adjustment is used.[17] If no transformation can equalize the variances, then the median scores test followed by the sign test with Bonferroni adjustment is used.[18]

Further analyses of ELPAT round 6 were performed to determine if there were any statistically biased differences among sample preparation techniques and instrumental methods. The analyses compared the following principal sample preparation techniques: NIOSH 7082/7105,[9] EPA SW846-3050A,[10] EPA SW846-3051,[11] and EPA AREAL,[6] and the following principal instrumental methods: FAA, GFAA, and ICP-AES.

One-way ANOVA procedures found bias among sample preparation/instrumental method combinations for dust wipe sample 2 ($p = 0.0008$). Subsequent Scheffe's multiple comparison tests for differences in mean lead levels among any of the combinations found NIOSH 7082/7105 sample preparation with GFAA analysis to give lower results than NIOSH 7082/7105 sample preparation with FAA analysis for dust wipe sample 2.

Two-way ANOVA procedures separate bias that may be the result of sample preparation, instrumental method, or interaction of these two factors. Two-way ANOVAs found two instances where bias was identified on ELPAT round 6: dust wipe sample 2 ($p = 0.0008$) and dust wipe sample 3 ($p = 0.006$). Subsequent Scheffe's multiple comparison tests attributed both differences in bias to differences in instrumental methods. For dust wipe sample 2, GFAA was found to give lower results than either ICP or FAA. For dust wipe sample 3, GFAA was found to give lower results than FAA. (The mean of ICP results fell between GFAA and FAA means and was not statistically significantly different from either of the two other means on dust wipe sample 3).

ELPAT round 6 is the first ELPAT round where a statistically significant difference in bias between GFAA and other instrumental methods was demonstrated. In addition, the difference is found not only at low lead loadings (ELPAT dust whip sample 2 reference laboratory mean = 99.8 μg), but also at higher lead loadings (ELPAT dust wipe sample 3 reference laboratory mean = 988 μg). For ELPAT dust wipe sample 2, the maximum difference in means is about 25 μg or about 25 percent of the corresponding ELPAT reference laboratory mean. For dust wipe sample 3, the maximum difference in means is about 150 μg or about 15 percent of the corresponding ELPAT reference laboratory mean. This is the first instance in which statistically significant differences in means were attributed to differences in GFAA with other instrumental methods. However, these results are based upon only five laboratories using GFAA. The lower 95 percent limit on the differences in means is much smaller: 8 μg for dust wipe sample 2 and 25 μg for dust wipe sample 3. It may therefore be premature to place much importance on this finding.

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. Either 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 material 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 from commercial reference material suppliers participating in the EPA/A2LA environmental reference material certification program.[19] The materials listed in Table IV are useful for daily quality control of analyses and initial evaluation of methods associated with residential or steel struc-

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 9/94 (nominal value 4%)	
SRM 2581 Powdered lead-based paint to be released 9/94 (nominal value 0.5%)	
SRM 2582 Powdered lead-based paint to be released 9/94 (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 2583 Lead in household dust to be released 10/94 (nominal value 100–200 ppm)	
SRM 2579 Lead paint film on Mylar (set of 5)	3.53 ± 0.24 mg/cm²
	1.63 ± 0.08 mg/cm²
	1.02 ± 0.04 mg/cm²
	0.29 ± 0.01 mg/cm²
	less than 0.001 mg/cm²
(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 in the field.)	
SRM 1648 Urban particulate matter	0.655% ± 0.008%
SRM 2704 Buffalo River sediment total lead by weight	161 ± 17 ppm
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.

ture lead abatement. Since work continues on developing additional reference materials, 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 NLLAP

Under Title X of the Housing and Community Development Act of 1992, EPA, in consultation with the Department of Health and Human Services, has the responsibility to review and determine if effective voluntary laboratory accreditation systems are in place. If EPA determines that effective voluntary laboratory accreditation systems are not in place, EPA is responsible to establish a federal laboratory certification system.[20]

The EPA has established an NLLAP to recognize laboratories performing analysis associated with lead abatement. NLLAP recognition of laboratories analyzing lead in paint chips, soils, and dusts has two requirements: (1) successful participation in proficiency testing using real-world matrices; and (2) laboratory accreditation including on-site assessment of laboratory operations. NLLAP requirements are based upon the recommendations of a Federal Interagency Taskforce on Lead Based Paint, a group of 17 federal agencies involved with lead issues, that recognition should be based upon both proficiency testing and laboratory accreditation.[21] Similarly, proficiency testing and laboratory accreditation requirements were also part of the recommendations for environmental laboratories of a 1991 National Conference on Laboratory Issues in Childhood Lead Poisoning Prevention sponsored by the Association of State and Territorial Public Health Laboratory Directors, the CDC, and EPA. NLLAP requirements for laboratories are based upon Guide 25-1990, "General Requirements for the Competence of Calibration and Testing Laboratories,"[22] a guide already in use by many national laboratory accreditation systems worldwide.

The ELPAT program began providing paint chip, soil, and dust audit samples to evaluate laboratory performance in the fall of 1992 and has grown to over 300 participating laboratories. Lists of laboratories that have performed successfully (rated proficient) in the ELPAT program are prepared at NIOSH and are provided upon request to the public via a toll-free number by the Lead Information Clearinghouse (1-800-424-LEAD).

In December 1993 the first two laboratory accreditation organizations, A2LA and AIHA, were recognized by NLLAP. Laboratories interested in obtaining accreditation information such as the program requirements, time needed to complete the process, and cost should contact the recognized laboratory accreditation organizations. If other laboratory accreditation organizations are recognized, this information will be included in subsequent ELPAT columns.

Laboratory accreditation takes some time to achieve. Laboratory accreditation involves submittal of a description of a laboratory's quality system and manual to the accrediting organization and the on-site evaluation by NLLAP qualified assessors of laboratory operations including equipment, facilities, analytical methods, staff, and internal quality control. In the near future, accreditation status of laboratories will be included on the list of NLLAP-recognized laboratories. At that time, both laboratories that are accredited and those that are not will be listed and provided to the public.

Once a sufficient number of laboratories (several hundred) geographically dispersed across the United States have received accreditation, only accredited laboratories which are ELPAT proficient will be NLLAP recognized and included on the list of laboratories provided to the public by the Lead Clearinghouse. Given the capacity of cooperating laboratory accreditation organizations to perform on-site assessments and initial laboratory demand for accreditation, it is projected that this will occur in the first quarter of 1995.

Participation in the ELPAT proficiency testing program would continue to be open to all interested laboratories. That means laboratories outside the United States and laboratories that do not wish to be accredited can continue to participate in ELPAT. However, starting in 1995 laboratories that are not accredited by an NLLAP-recognized laboratory accrediting organization will not be included on lists of NLLAP-recognized laboratories provided to the public by the federal government.

Upcoming ELPAT Round Information

Round 8 ELPAT samples were sent to participants on August 1, 1994. The reporting date of the laboratories was September 8, 1994. The dust wipes were preserved with 0.5 ml of 3 percent hydrogen peroxide solution. 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. The ELPAT automated data entry system is available to laboratories that want to submit their laboratory data over a modem for faster and more reliable transmittal.

Disclaimer: Mention of company names or products does not constitute endorsement by the CDC.

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

Orders for NIST Standard Reference Materials (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

Orders for RT Corporation commercial 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

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