Applied Occupational and Environmental Hygiene
Volume 14: 149–152, 1999

1047-322X/99 $12.00 + .00

PAT Program

Background and Current Status

Curtis A. Esche and Jensen H. Groff, Column Editors

Introduction

The Proficiency Analytical Testing (PAT) Program is managed by the American Industrial Hygiene Association (AIHA) in Fairfax, Virginia. The PAT Program provides quality control reference samples to approximately 1,200 occupational health and environmental laboratories in 17 countries. Although one objective of the PAT Program is to evaluate the analytical ability of participating laboratories, the primary objective is to assist these laboratories in improving their laboratory performance.

Each calendar quarter (designated as a round), samples are mailed to participating laboratories and the data are analyzed to evaluate laboratory performance on a series of analyses. Each mailing and subsequent data analysis is completed in time for participants to obtain repeat samples and to correct analytical problems before the next calendar quarter starts. The PAT Program currently includes four sets of samples as shown in Table I. Mixtures of three of the four possible metals, and one to three of the fifteen possible organic solvents, are rotated for each round. Fibers alternate between amosite and chrysotile asbestos and manmade fibers; no fiber mixtures are provided. Each set consists of four concentrations and a blank. The metals, silica, and fibers samples are on filters and the organic solvents are on charcoal, carbon molecular sieve, or silica gel tubes. The organic solvent set also includes five blank charcoal, carbon molecular sieve, or silica gel tubes for desorption efficiency determination.

Laboratories are evaluated for each analysis by comparing their reported results against an acceptable performance limit for each PAT Program sample the laboratory analyzes. After the data from all laboratories are collected and statistically treated, the mean of the collected data is calculated and the performance limits equal the mean ± 3 standard deviations. Data are acceptable if they fall within the performance limits. Data falling outside the performance limits are reported as outliers.

Laboratories are rated based upon performance in the PAT Program over the last year (i.e., four calendar quarters), as well as on individual contaminant performance. Individual contaminants are metals, silica, asbestos/fibers, 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; and (2) proficient in all other cases if three-fourths or more of the results reported in the last four consecutive rounds are classified as acceptable.[1]

PAT Round 134, July 1998

A total of 1,188 laboratories were enrolled in the PAT Program, with 1,096 laboratories submitting results on round 134. Of the 1,096 laboratories submitting results, 793 used the Internet data entry system (www.aiha.org/proftest.htm). Table II lists the reference values, performance limits, and participants for each sample type in the PAT Program. Table III presents the summary of the PAT proficiency ratings for each analytical area.

PAT Diffusive Sampler Round 134, July 1998

A total of 176 kits containing two passive monitors exposed to test atmospheres of benzene, toluene, and o-xylene was sent to 164 participating laboratories for round 134 of the PAT Diffusive Sampler program on July 1, 1998. By the due date of August 3, 1998,

TABLE I
Current sets of samples in proficiency analytical testing (PAT) program

Metals	Cadmium	
	Chromium	
	Lead	
	Zinc	
Silica	Quartz	
Asbestos/fibers	Amosite	
	Chrysotile	
	Manmade fibers	
Organic solvents	Benzene	Methyl ethyl ketone
	n-Butyl acetate	Methyl isobutyl ketone
	Chloroform	Tetrachloroethylene
	1,2-Dichloroethane	Toluene
	p-Dioxane	1,1,1-Trichloroethane
	Ethyl acetate	Trichloroethylene
	Isopropanol	o-Xylene
	Methanol	

TABLE II
Reference values, performance limits, and participants for each sample type PAT Round 134 (July 1998)

Contaminant	Sample number	No. of labs	Reference value	RSD (%)	Performance limits		No. of outliers
					Lower	Upper	
Cadmium (mg)	1	308	0.0024	6.2	0.0019	0.0028	18
	2	308	0.0038	5.4	0.0032	0.0044	20
	3	308	0.0057	4.8	0.0049	0.0066	15
	4	308	0.0096	4.4	0.0083	0.0109	19
Chromium (mg)	1	304	0.0593	5.6	0.0493	0.0692	20
	2	304	0.0887	5.7	0.0736	0.1038	22
	3	304	0.1176	5.7	0.0974	0.1379	25
	4	304	0.1474	5.8	0.1217	0.1732	21
Lead (mg)	1	311	0.0147	5.9	0.0120	0.0173	23
	2	311	0.0290	4.8	0.0248	0.0332	14
	3	311	0.0434	4.4	0.0377	0.0492	15
	4	311	0.0728	4.0	0.0640	0.0816	17
Silica (mg)	1	80	0.0663	18.4	0.0296	0.1030	3
	2	80	0.0876	17.1	0.0427	0.1325	3
	3	80	0.1160	16.0	0.0603	0.1716	4
	4	80	0.1152	16.0	0.0599	0.1706	6
Asbestos/fibers (amosite) (f/mm^2)	1	943	211	18.6	110	344	58
(Manmade fiber)	2	943	74	20.0	36	125	71
	3	943	451	15.9	261	692	59
	4	943	280	17.4	153	445	62
n-Butyl acetate (mg)	1	268	0.1933	6.0	0.1585	0.2281	27
	2	268	0.4120	6.0	0.3379	0.4862	19
	3	268	0.5670	6.0	0.4649	0.6690	16
	4	268	0.7844	6.0	0.6432	0.9256	17
Ethyl acetate (mg)	1	267	0.1018	5.0	0.0866	0.1171	44
	2	267	0.3014	5.0	0.2562	0.3466	24
	3	267	0.6946	5.0	0.5904	0.7988	29
	4	267	1.0193	5.0	0.8664	1.1721	25
Isopropanol (mg)	1	267	0.0973	9.0	0.0710	0.1236	40
	2	267	0.2914	9.0	0.2127	0.3701	24
	3	267	0.4884	9.0	0.3565	0.6203	25
	4	267	0.7172	9.0	0.5235	0.9108	23

TABLE III
PAT proficiency ratings based upon Rounds 131 to 134 (October 1997—September 1998)

Contaminant	Number of labs rated	Number of labs rated proficient	Percent labs rated proficient
Metals	361	332	92.0
Silica	82	81	98.8
Asbestos/fibers	1030	986	95.7
Organic solvents	332	300	90.4

TABLE IV
Diffusive sampler Round 134—reference values, performance limits, and performance summary

Contaminant	Sample	Reference value (ppm)*	Lower performance limit (ppm)	Upper performance limit (ppm)	Number of labs rated	Number of outliers
Benzene	1	14.8	12.136	17.464	160	14
	2	36.0	29.520	42.48	160	15
o-Xylene	1	10.0	8.200	11.800	160	17
	2	17.64	14.465	20.815	161	18
Toluene	1	14.8	12.136	17.464	161	13
	2	46.44	38.081	54.799	160	15

* ppm = parts per million.

160 laboratories submitted results. One hundred thirty-one laboratories were rated proficient. The acceptable performance limit is the reference value +/– 18 percent. Laboratory analyses within this performance limit were rated as acceptable. A laboratory was rated proficient if three-fourths or more of the analyses reported were rated acceptable. Table IV presents the summary of reported results from all laboratories, reference values, and performance limits for passive monitors.

PAT Silica Analytical Standards

The returns of a survey from 80 laboratories on PAT round 133 concerning analytical techniques used for the determination of crystalline silica are being analyzed by National Institute of Occupational Safety and Health (NIOSH) researchers to identify and reduce sources of variability in PAT silica results. One aspect of this investigation, the standard material for calibration of quartz analytical methods, is addressed below by Drs. Peter M. Eller and Ruiguang Song of NIOSH/DPSE.

Twelve different standard materials were used by PAT silica laboratories in round 133, the most common being National Institute of Standards and Technology (NIST) SRM 1878 (35 labs; 44 percent of total labs) and Min-U-Sil 5 (30 labs; 38 percent). Other materials used for standards were: old PAT samples (4 labs), NIST SRM 2679a (2 labs), Min-U-Sil 10 (2 labs); and Sikron-F-600, IITRI Q-1, BCR#66, BCH, CanMet, Ricca silica solution, and Fyle quartz (1 lab each).

Regardless of analytical method, laboratories using SRM 1878 in Rounds 130–133 tended to get lower PAT results (mean Z-score = – 0.179, where the Z-score is defined as [result-mean]/standard deviation), than those using Min-U-Sil 5 (mean Z-score = + 0.226). The reason for this is not known, but it is consistent with a higher crystalline silica content in SRM 1878. Also, SRM 1878 gave better precision than Min-U-Sil 5 for IR laboratories.

An analysis of variance of Z-scores for these 80 laboratories from Rounds 130 through 133 was performed. Tukey's studentized range test and Scheffe grouping both showed that significant differences in Z-scores occurred between labs using standard materials other than SRM 1878 and Min-U-Sil 5. Significant (at 95 percent confidence level) differences of more than 3.0 Z-score units separated the four labs using the standard materials SRM 2679a, IITRI Q-1, and the BCH standard. However, because this analysis is not based on a controlled experiment, factors other than standard material used may also have contributed to these interlaboratory differences.

Therefore, existing supplies of SRM 1878 should be used for calibration when PAT samples are to be analyzed. If the SRM is not available, the next best option is the use of Min-U-Sil 5. The rationale for this recommendation is as follows: X-ray diffraction (XRD) methods (used by 50 percent of PAT labs on Round 133) and infrared (IR) methods (used by 40 percent of labs) are sensitive to silica particle size, but in opposite ways. XRD gives larger signals for larger particles,[2] while IR absorption is highest for small particles,[3] in the 1–3 μm range. For example, IR results in the authors' laboratory show that Min-U-Sil 10 gives an 18 percent smaller IR response than either SRM 1878 or Min-U-Sil 5 at the same mass of quartz.

NIST SRM 2679a, Quartz on Filter Media, consists of 47-mm filters with SRM 1878 co-deposited with about 370 μg of clay. The presence of the clay renders this standard material inappropriate for PAT samples, which do not contain clay.

In selecting a standard material for these methods, it is important to match the particle size of the quartz in the sample. The PAT samples are generated from Min-U-Sil 5, which was the starting material for, and closely resembles, SRM 1878. Therefore, both of these materials are appropriate standards. SRM 1878 is presently out of stock at NIST, but a replacement is planned. Min-U-Sil 5 is available from U.S. Silica, P.O. Box 187, Berkeley Springs, WV 25411.

PAT Round 135, October 1998

PAT Round 135, was sent to participating laboratories on October 1, 1998.

For this round, the organic solvents were metyl ethyl ketone and methyl isobutyl ketone and metals included cadmium, lead, and zinc. Silica had a calcite background and asbestos/fibers were chrysotile with one manmade fiber sample.

Errata—PAT Round 132 article

The organic solvents analyzed in PAT round 132 were benzene, o-xylene, and toluene instead of n-butyl acetate, ethyl acetate, and isopropanol as listed in Table II of the PAT round 132 article.

REFERENCES

1. Esche, C.A.; Groff, J.H.; Schlecht, P.C.; and Shulman, S.A.: Laboratory Evaluations and Performance Reports for the Proficiency Analytical Testing (PAT) and Environmental Lead Proficiency Analytical Testing (ELPAT) Programs. DHHS (NIOSH) Number 95-104. National Institute for Occupational Safety and Health, Cincinnati, OH (1994).
2. Brindley, G.W.: The X-ray Identification and Crystal Structures of Clay Minerals (G. Brown, Ed.). p. 507, Mineralogical Society London (1972).
3. Tuddenham, W.M. and R.J.P. Lyon: Infrared Techniques in the Identification and Measurement of Minerals. *Anal. Chem. 32*: 1620 (1960).

EDITORIAL NOTE: Curtis A. Esche and Jensen H. Groff are with the National Institute for Occupational Safety and Health, Division of Science and Engineering, Quality Assurance and Statistics Activity.

Applied Occupational and Environmental Hygiene

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

Background and Current Status

Curtis A. Esche

To cite this article: Curtis A. Esche (1999) Background and Current Status, Applied Occupational and Environmental Hygiene, 14:3, 149-152, DOI: 10.1080/104732299303061

To link to this article: https://doi.org/10.1080/104732299303061