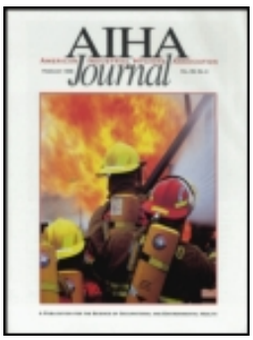

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MONITORING THE PERFORMANCE OF OCCUPATIONAL HEALTH LABORATORIES

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To monitor the performance of occupational health laboratories analyzing workplace air, the American Industrial Hygiene Association (AIHA), with assistance from the National Institute for Occupational Safety and Health, has established four national quality assurance programs. They are the Proficiency Analytical Testing (PAT) Program, the AIHA Laboratory Accreditation Program, the Asbestos Analysts Registry, and the Bulk Quality Assurance Program. This paper focuses on the PAT program, a quality audit program that provides samples of asbestos, silica, metals, and solvents to laboratories quarterly. PAT data for asbestos, silica, and lead were examined for trends in precision. Simple graphs of coefficient of variation during the 18-yr history of the program provide evidence of improved agreement among laboratories performing these analyses. The improvement took place in spite of growth in the number of laboratories and decreases in the levels being analyzed. The improvement is attributed to several factors, including improved analytical methods and the very existence of the PAT and AIHA Laboratory Accreditation Programs.

Accurate exposure data are required for the development of occupational health standards and for assessing compliance with Occupational Safety and Health Administration (OSHA) and Mine Safety and Health Administration (MSHA) permissible exposure limits (PELs). In order to obtain accurate exposure data, the sampling and analytical methods used to characterize the work environment must yield reproducible results regardless of which laboratory performs the analysis. To improve the accuracy and reproducibility of these results, the National Institute for Occupational Safety and Health (NIOSH), the Bureau of Mines (BOM), OSHA, MSHA, and other laboratories continually develop and disseminate sampling and analytical methods. To monitor the performance of the analytical laboratories that use those methods, the American Industrial Hygiene Association (AIHA), in cooperation with NIOSH, has established three national quality assurance (QA) programs. They are the Proficiency Analytical Testing (PAT) Program,[1] the AIHA Laboratory Accreditation Program,[2] and the Asbestos Analysts Registry (AAR) Program.[3,4] These QA programs indicate the level of agreement among laboratories analyzing workplace environmental samples as well as the number of laboratories performing these analyses.

Figure 1 shows the growth in the PAT and AIHA Laboratory Accreditation Programs. The PAT Program distributes quarterly samples of asbestos, silica, metals, and organic solvents to laboratories and rates their analytical performance. The AIHA Laboratory Accreditation Program has many prerequisites for membership in addition to successful PAT performance, including supervision by an experienced laboratory director and the compilation of analytical and quality control procedures specific to the laboratory. These requirements are examined during a laboratory site visit.

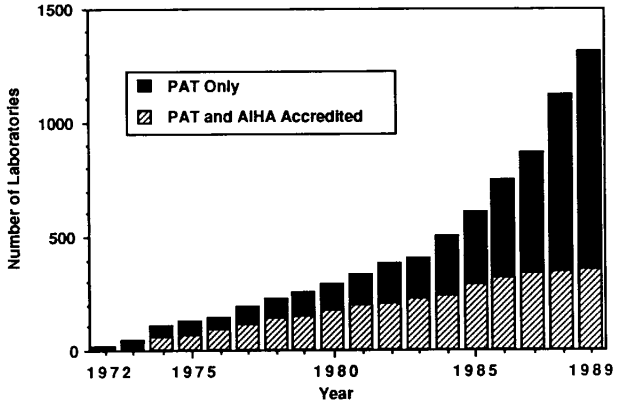

FIGURE 1. Growth in occupational health analytical laboratories analyzing quality assurance samples for metals, organic solvents, silica, and asbestos from 1972 to 1989

The PAT Program was begun by NIOSH in 1972 with government laboratories only. They were joined by commercial laboratories seeking AIHA accreditation in 1974. Today, government, commercial, and industrial laboratories voluntarily participate in these programs. Although these programs were established for those laboratories performing a full range of occupational health analytical services, approximately two-thirds of the 1500 laboratories participating in the PAT Program in 1991 analyze for asbestos only. These laboratories

account for much of the growth in PAT since 1983 and particularly since 1986 when the Asbestos Hazard Emergency Response Act (AHERA)[5] was enacted by the Environmental Protection Agency.

The AAR Program was established for individuals who perform fiber counts, particularly those counters who are located away from central laboratories at asbestos abatement sites. Participants must count asbestos quality audit samples each quarter and must meet application requirements regarding training and quality control, which are similar to those specified by OSHA.[6] Figure 2 shows the level of participation in this program.

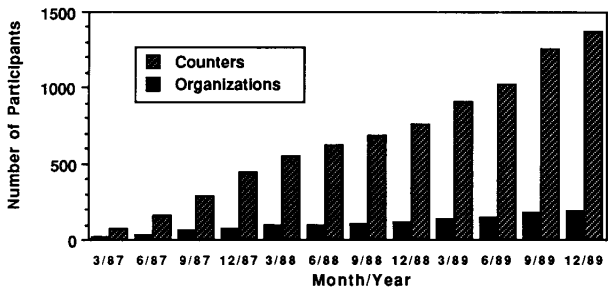

FIGURE 2. Growth in the number of counters participating in the Asbestos Analysts Registry Program during its first 3 yr. The number of organizations represented by the counters also is shown. Currently, the average number of counters per organization is 7.3 and the maximum in any organization is 60.

The rest of this paper discusses trends in the analysis of three common workplace contaminants. The trends are based on data obtained in the PAT Program, and the three contaminants, asbestos, silica, and lead, were the first to be provided by that program.

TRENDS IN CONTAMINANT ANALYSES

Asbestos

The number of laboratories reporting asbestos results in the PAT Program has grown. The growth is influenced by national and local regulations (Figure 3).

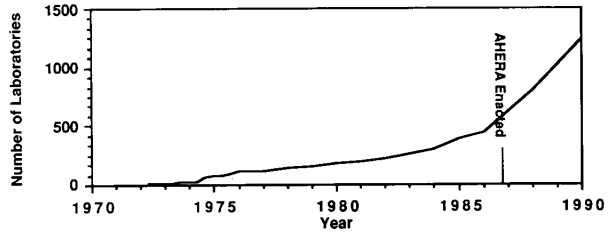

FIGURE 3. Growth in the number of laboratories reporting asbestos results in the Proficiency Analytical Testing Program from 1972 to 1989

During the last 18 yr, there has been improved agreement among the asbestos fiber counts submitted to the PAT Program. Improvement is indicated by the reduction in the coefficient of variation (CV) among laboratories. The CV is determined by dividing the standard deviation of the reported results by their average. This improvement has occurred partly because of improved analytical methods (Figure 4).

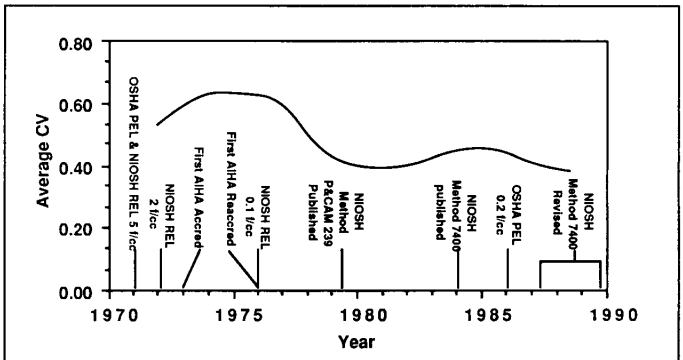

FIGURE 4. The smoothed curve represents the average coefficient of variation in the fiber-count results submitted by laboratories to the PAT Program from 1972 to 1989

When the commercial laboratories applying for AIHA accreditation joined the government laboratories already in PAT in 1974, the agreement of asbestos results among laboratories worsened. From 1978 to 1981, agreement improved considerably, as reflected by a drop of approximately one-third in interlaboratory CV. This improvement occurred with the introduction of a new NIOSH asbestos fiber counting method[7] and the first large-scale reaccreditation of laboratories by AIHA. Reaccreditation requires a site visit. The new NIOSH method was not published until 1979, but it had circulated in draft form for several years. It stressed counter training, standardization of microscopes, new sample preparation techniques, and internal quality control procedures. Laboratory agreement became slightly worse again from 1982 to 1985. This deterioration can be attributed to the explosive growth in the number of laboratories performing asbestos analyses, which was primarily because of the AHERA regulation. In 1984, NIOSH published method 7400.[8] It emphasized a standard counting area by using a specific graticule, resolution testing of microscopes by using a test slide, and exchange of samples between laboratories to quantify and reduce interlaboratory differences. Agreement between laboratories improved again in the late 1980s.

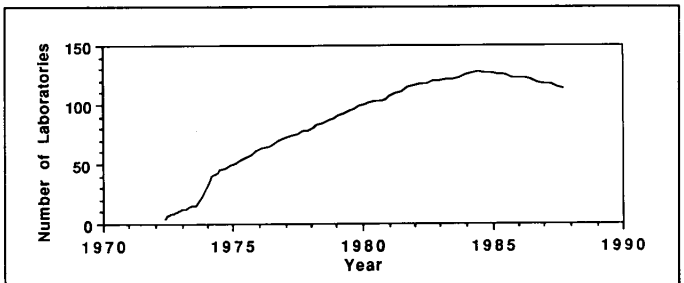

FIGURE 5. Growth in the number of laboratories reporting silica results in the Proficiency Analytical Testing Program from 1972 to 1988

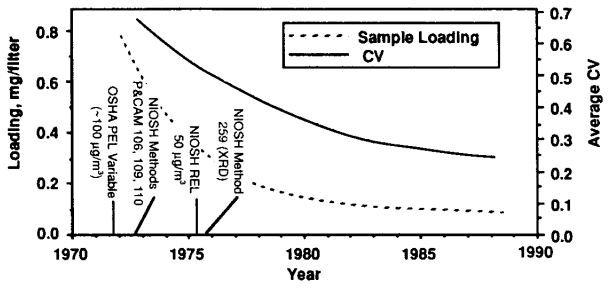

FIGURE 6. The smoothed curves represent the amount of silica on PAT filters and the average coefficient of variation in the reported silica results from 1972 to 1989. NIOSH P&CAM methods 106, 109, and 110 were based on colorimetric, x-ray diffraction, and infrared spectroscopy techniques, respectively.

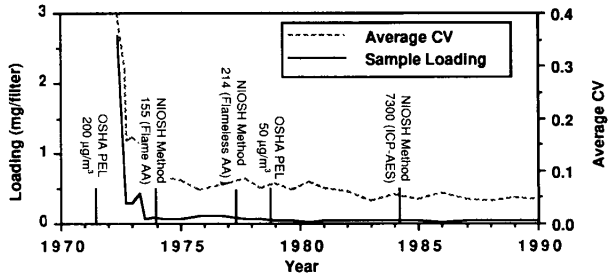

FIGURE 8. The curves represent the amount of lead on PAT filters and the average coefficient of variation in the reported lead results from 1972 to 1990. The NIOSH methods indicated as AA are based on atomic absorption spectrometry. ICP-AES is inductively coupled plasma–atomic emission spectrometry.

Silica

The determination of airborne free silica has received considerable attention during the last 20 yr. The number of laboratories performing silica analyses in the PAT Program is currently about 120 (Figure 5).

The agreement of laboratories has steadily improved over the last 18 yr in part because of the introduction of improved sampling and analytical methods by NIOSH, BOM, and others. Among the changes introduced were recommendations to use standard quartz powders of smaller particle size so that they more closely matched the dust collected with size-selective samplers and the introduction of a quartz Standard Reference Material by the National Institute of Standards and Technology. Figure 6 shows the decline in the CV for silica analysis with data from the PAT Program.

Lead

There has been steady growth in the number of laboratories performing lead analyses in the PAT Program (Figure 7). That

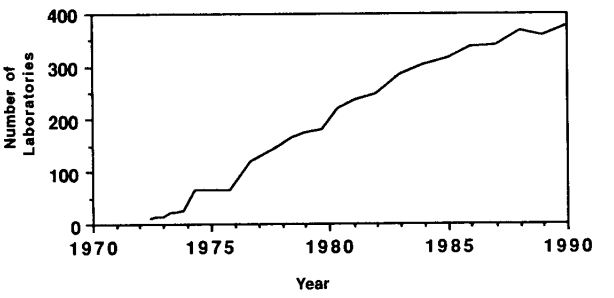

FIGURE 7. Growth in the number of laboratories reporting lead results in the Proficiency Analytical Testing Program from 1972 to 1990

number is currently 350. Lead analysis always has been more precise and accurate than silica or asbestos analysis, so that agreement among laboratories has been relatively good. Nevertheless, agreement has improved (Figure 8), and interlaboratory CVs are now approaching intralaboratory CVs.

CONCLUSIONS

Proficiency Analytical Testing Program data for laboratories performing asbestos, silica, and lead analyses were examined for trends. Simple CV graphs during the 18-yr history of the program provide evidence of improved agreement among laboratories performing these analyses. The improvement took place in spite of the growth in the number and diversity of laboratories and decreases in the levels of contaminant being analyzed.

Outside influences, such as new regulations or improved analytical instrumentation, can explain some of these trends, but the very existence of the PAT Program and the AIHA Laboratory Accreditation Program is undoubtedly responsible in part for the improved agreement among laboratories.

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