ASTM Standards

for monitoring chemical hazards in the workplace

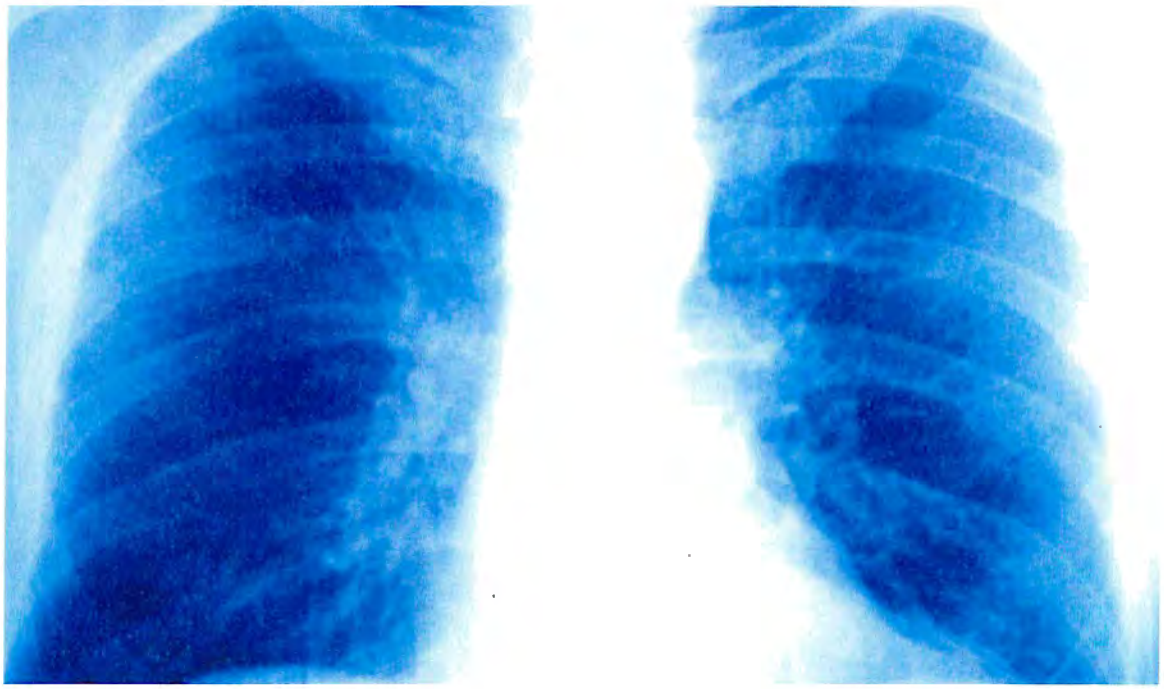
BY KEVIN ASHLEY, PH.D., AND MARTIN HARPER, PH.D., CIH

The health of workers in many industries is at risk through occupational exposure to toxic substances. In order to estimate workers' exposures, occupational contact with airborne hazardous materials at the job site is typically monitored by sampling and analyzing workplace atmospheres. This monitoring takes place because, in occupational settings, inhalation is ordinarily the most likely route of entry of hazardous substances into the body. Dermal contact and ingestion are other potential routes of occupational exposure to chemical agents. Hence in addition to methods for workplace air monitoring, procedures for measuring surface contaminants in the workplace are also desirable.

Within ASTM International Committee D22 on Sampling and Analysis of Atmospheres, Subcommittee D22.04 on Sampling and Analysis of Workplace Atmospheres produces standards that describe methods of collecting and measuring chemical hazards in the workplace. This subcommittee has been active for decades, and its members (presently numbering more than 50) have developed many needed standards consisting of test methods, practices, and guides. These consensus standards are meant for use by industrial hygienists, chemists, engineers, health physicists, toxicologists, epidemiologists, and myriad other professionals. To date, D22.04 has promulgated more than 30 standards (Table 1). Many of these standards have also appeared in ASTM compendia publications such as *Environmental Sampling and Analysis.* Different types of standards are produced, including standards for terminology, as well as standard guides, practices, and test methods (in order of increasingly detailed specification).

WORKPLACE STANDARDS DEVELOPMENT

Standards developed by Subcommittee D22.04 cover a broad range of subjects. Chemical agents covered include, for instance, toxic organic and inorganic gases and vapors; acid mists; and metals and metalloids in aerosols and surface dusts. Examples of standard methods for monitoring toxic organic vapors of concern include methods for isocyanates, vinyl chloride, and ethylene oxide. Standard procedures for measuring inorganic species such as fluorides, sulfuric acid mist, and hy-



Chemical hazards to workers occur primarily through inhalation and can damage lungs.

drogen sulfide have also been developed. ASTM sampling and analytical methods for harmful metals such as lead and hexavalent chromium in workplace air have recently been published. In addition to specific chemical species, standard test methods for determining toxic agents such as crystalline ceramic whiskers, asphalt fumes, and diesel particulate matter have also been promulgated.

Ordinarily, the portions of these ASTM standard methods dealing with sampling are meant for use by industrial hygienists, while the sample preparation and analysis aspects are targeted for use by laboratory personnel, that is, chemists. Standard sample collection procedures may involve filter sampling for aerosols of interest, sorbent tube sampling of gases and vapors, and/or sampling of specific aerosol fractions of a particular size range of concern. Depending on the sampling objectives, the industrial hygienist could rely on standard procedures to obtain personal samples of air to which workers are exposed by attaching a sampling device to the worker. Alternatively, the industrial hygienist might instead obtain area samples of airborne substances in specific work areas, for example, near emission sources.

Samples can be "spot" measurements, taken by using direct-reading methods (for example, colorimetric techniques), or they may be long-term samples requiring laboratory analysis. Depending on the application, standard analytical test methods might be based on techniques as simple as gravimetry, or more complicated methodologies such as gas or liquid chromatography, and electrochemical or spectrometric measurement, to cite a few examples. Extraction or digestion, and derivatization techniques are also described, where necessary for analysis. These ASTM standard methods are available for use by analysts in industrial hygiene chemistry laboratories.

In addition to the numerous standard test methods that can be applied in measuring toxic agents in the workplace, ASTM standard procedures for other matters of concern in workplace monitoring have been developed. For instance, standards on workplace sampling strategies, calibration of sampling instrumentation, and minimization of errors associated with weighing collected aerosols have been published. Quality assurance and quality control aspects are addressed in all standards, thus ensuring consistency in sampling and analysis and optimal data quality.

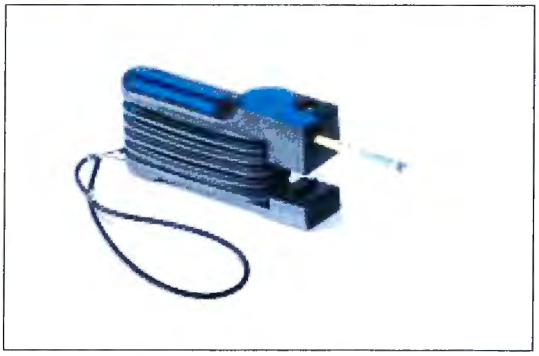
Currently, the subcommittee is addressing several new work items. These include a draft document on counting collected airborne fibers (including asbestos), another draft describing the determination of metals and metalloids by atomic emission spectrometry, as well as new work items under consideration for the sampling and analysis of airborne silica dusts. The membership of D22.04 would like to solicit ideas for any additional new standards that may be needed for workplace exposure monitoring purposes.

SYMPOSIA

A number of ASTM symposia sponsored or co-sponsored by Committee D22 are concerned, at least in part, with workplace monitoring; some of these past and future symposia are listed in Table 2. D22 holds biennial summer week-long informal conferences on new developments in its areas of interest, and formal conferences in alternate years. The latter have resulted in a number of ASTM Special Technical Publications. Occasionally other, shorter symposia (ordinarily two days) are held in conjunction with D22 meetings during ASTM committee week. ASTM International has ceased publishing Special Technical Publications; however, papers presented at ASTM-sponsored symposia can be submitted for consideration for publication in the new, peer-reviewed *Journal of ASTM International.*

Worker inhalation exposures can be extremely high. ASTM standards for monitoring workplace atmospheres are instrumental in exposure reduction efforts.

Sorbent tube samplers for workplace gases and vapors are used in a number of standards developed by Subcommittee D22.04.

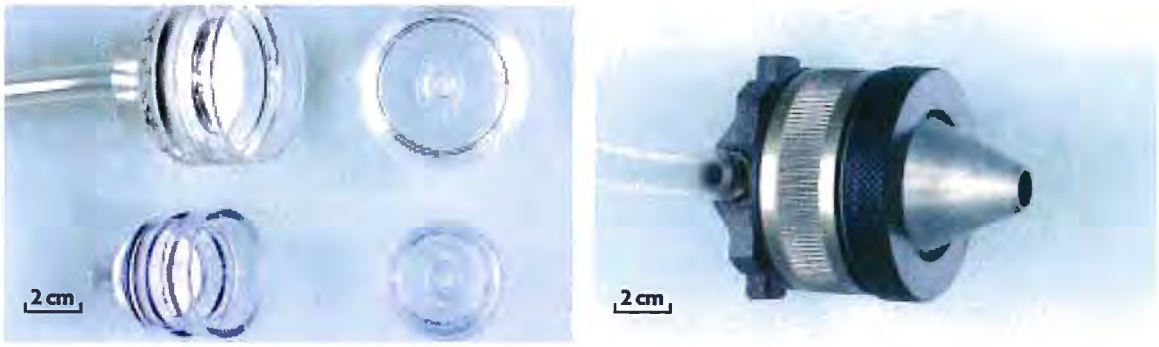


CONCLUSION

Consensus standards are considered by many to be the most technically sound and most credible documents for use in their particular fields of application. This was recognized by the U.S. Congress through passage of the National Technology Transfer and Advancement Act of 1995 (Public Law 104-113), which directs federal agencies to (a) rely upon consensus standards in their guidelines and ac-

Table 1: Standards of Subcommittee D22.04 on Workplace Atmospheres

D 3686-95(2001), Practice for Sampling Atmospheres to Collect Organic Compound Vapors (Activated Charcoal Tube Adsorption Method)
D 3687-01, Practice for Analysis of Organic Compound Vapors Collected by the Activated Charcoal Tube Adsorption Method
D 4185-96(2001), Practice for Measurement of Metals in Workplace Atmosphere by Flame Atomic Absorption Spectrophotometry
D 4413-98(2003), Test Method for Determination of Ethylene Oxide in Workplace Atmospheres (Charcoal Tube Methodology)
D 4490-96(2001), Practice for Measuring the Concentration of Toxic Gases or Vapors Using Detector Tubes
D 4532-97(2003), Test Method for Respirable Dust in Workplace Atmospheres
D 4597-03, Practice for Sampling Workplace Atmospheres to Collect Gases or Vapors with Solid Sorbent Diffusive Samplers
D 4599-03, Practice for Measuring the Concentration of Toxic Gases or Vapors Using Length-of-Stain Dosimeters
D 4600-95(2000), Test Method for Determination of Benzene-Soluble Particulate Matter in Workplace Atmospheres
D 4765-03, Test Method for Fluorides in Workplace Atmospheres
D 4766-98(2003), Test Method for Vinyl Chloride in Workplace Atmospheres (Charcoal Tube Method)
D 4856-99, Test Method for Determination of Sulfuric Acid Mist in the Workplace Atmosphere (Ion Chromatographic)
D 4913-00, Practice for Determining Concentration of Hydrogen Sulfide by Direct Reading, Length of Stain, Visual Chemical Detectors
D 5337-97, Practice for Flow Rate for Calibration of Personal Sampling Pumps
D 5578-94(1999), Test Method for Determination of Ethylene Oxide in Workplace Atmospheres (HBr Derivatization Method)
D 5836-03, Test Method for Determination of 2,4-Toluene Diisocyanate (2,4-TDI) and 2,6-Toluene Diisocyanate (2,6-TDI) in Workplace Atmospheres (1-2 PP Method)
D 5932-96(2002), Test Method for Determination of 2,4-Toluene Diisocyanate (2,4-TDI) and 2,6-Toluene Diisocyanate (2,6-TDI) in Air (with 9-(N-Methylaminomethyl) Anthracene Method) (MAMA) in the Workplace
D 6056-96(2001), Test Method for Determining Concentration of Airborne Single-Crystal Ceramic Whiskers in the Workplace Environment by Transmission Electron Microscopy
D 6057-96(2001), Test Method for Determining Concentration of Airborne Single-Crystal Ceramic Whiskers in the Workplace Environment by Phase Contrast Microscopy
D 6058-96(2001), Practice for Determining Concentration of Airborne Single-Crystal Ceramic Whiskers in the Workplace Environment
D 6059-96(2001), Test Method for Determining Concentration of Airborne Single-Crystal Ceramic Whiskers in the Workplace Environment by Scanning Electron Microscopy
D 6061-01, Practice for Evaluating the Performance of Respirable Aerosol Samplers
D 6062M-96(2001), Guide for Personal Samplers of Health-Related Aerosol Fractions [Metric]
D 6246-02, Practice for Evaluating the Performance of Diffusive Samplers
D 6494-99, Test Method for Determination of Asphalt Fume Particulate Matter in Workplace Atmospheres as Benzene Soluble Fraction
D 6552-00, Practice for Controlling and Characterizing Errors in Weighing Collected Aerosols
D 6561-00, Test Method for Determination of Aerosol Monomeric and Oligomeric Hexamethylene Diisocyanate (HDI) in Air with (Methoxy-2-phenyl-1) Piperazine (MOPIP) in the Workplace
D 6562-00, Test Method for Determination of Gaseous Hexamethylene Diisocyanate (HDI) in Air with 9-(N-methylaminomethyl) Anthracene Method (MAMA) in the Workplace
D 6669-01, Practice for Selecting and Constructing Exposure Scenarios for Assessment of Exposures to Alkyd and Latex Interior Paints
D 6785-02, Test Method for Determination of Lead in Workplace Air Using Flame or Graphite Furnace Atomic Absorption Spectrometry
D 6832-02, Test Method for the Determination of Hexavalent Chromium in Workplace Air by Ion Chromatography and Spectrophotometric Measurement Using 1,5-Diphenylcarbazide
D 6877-03, Test Method for Monitoring Diesel Particulate Exhaust in the Workplace
D 6966-03, Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Determination of Metals
E 1370-96(2002), Guide for Air Sampling Strategies for Worker and Workplace Protection



Examples of Filter Samplers Used in ASTM Methods for Collecting Workplace Aerosols in Order to Monitor Worker Exposure.

tivities, and (b) participate in the consensus standards development process. Voluntary consensus standards are often used as a basis for commercial and regulatory action. For instance, in the United States, many ASTM standards having to do with the workplace and the environment have been cited in regulations promulgated by the U.S. Environmental Protection Agency and the Occupational Safety and Health Administration. Employees of both of these agencies as well as the National Institute for Occupational Safety and Health of the Centers for Disease Control and Prevention regularly attend meetings of Committee D22 and its subcommittees.

ACKNOWLEDGMENT

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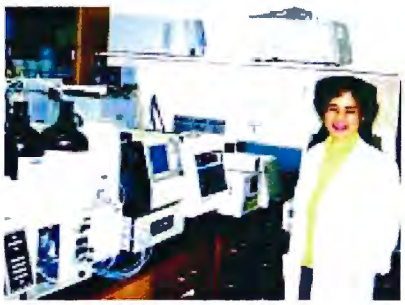

Laboratory analytical procedures for analyzing workplace atmospheric samples are covered in many of the standards developed in subcommittee D22.04.

Table 2: Examples of D22-Sponsored or Co-Sponsored Symposia Related to Workplace Exposure Monitoring

- Symposium on Calibration in Air Monitoring (1974)
- Sampling and Analysis of Toxic Organics in the Atmosphere (1978)
- Toxic Materials in the Atmosphere: Sampling and Analysis (1980)
- Definitions for Asbestos and Other Health-Related Silicates (1982)
- Quality Assurance for Environmental Measurements (1983)
- Sampling and Calibration for Atmospheric Measurements (1985)
- Monitoring Methods for Toxics in the Atmosphere (1988)
- Biological Contaminants in Indoor Environments (1989)
- Modeling of Indoor Air Quality and Exposure (1992)
- Lead in Paint, Soil and Dust (1993)
- Sampling Environmental Media (1995)
- Advances in Environmental Measurement Methods for Asbestos (1997)
- Sampling and Analysis of Isocyanates (2000)
- Asbestos Monitoring at the World Trade Center Site (2002)
- Symposium on Silica Sampling and Analysis (2004)
- Symposium on Beryllium Sampling and Analysis (2005)

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Feature

ASTM Standards for Monitoring Chemical Hazards in the Workplace

by Kevin Ashley, Ph.D., and Martin Harper, Ph.D., CIH

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