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STANDARD METHODS FOR SAMPLING AND ANALYSIS OF INDOOR AIR: ASTM SUBCOMMITTEE D22.05 ON INDOOR AIR

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INTRODUCTION

Comparability and reliability of indoor air sampling and analytical results are necessary to improve understanding and accelerate improvement of indoor air quality. Accurate and reliable characterization of indoor air, establishment of guidelines or regulations, and implementation of regulatory actions require practical, consistent and reliable sampling and analytical practices and test methods. Useful interpretation of measurement results and selection of appropriate remedial or mitigative actions for indoor air problems require valid baseline data or guidelines. However, practical, standard methods for sampling and analysis of indoor air are not now available for most indoor air pollutants.

ASTM Subcommittee D22.05 on Indoor Air was established by ASTM Committee D22 on Sampling and Analysis of Atmospheres in April, 1985. Subcommittee D22.05 is developing standard methods which will be useful for local and state officials, industrial hygienists and private sector investigators of indoor air quality.

ASTM is a voluntary, consensus standards development organization. Membership is open to any qualified individual upon completion of an application and payment of a minimal annual fee. Attendance at committee meetings and participation in development and draft documents does not require membership in ASTM. However, voting on documents submitted for subcommittee, committee, or Society ballot is open only to ASTM members.

Subcommittee D22.05 has begun to develop standard terminololgy, standard test methods, standard practices, and guides. The subcommitte is divided into sections which include Organic Gases and Vapors, Inorganic Gases and Vapors, Particulate Matter, Radionuclides, Biological Aerosols, and Asbestos. Additional sections are developing standard methods, practices and guides for Related Factors (building parameters, investigatory protocols, and modeling) and for Statistical Methods.

Avoiding duplication of effort and production of conflicting results is an objective of the subcommittee leadership. The Indoor Air subcommittee draws from the experience of other ASTM committees and has established liasons with APCA and ASHRAE technical committees.

Subcommittee D22.05 has adopted a scope which includes development and promotion of knowledge and the formulation of standard terminology for sampling and analysis of indoor air. The results and use of the subcommittee's work will enhance understanding and accelerate improvement of indoor air quality.

SPECIAL ACTIVITES

From time to time the subcommittee will sponsor conferences and symposia on topics within its scope of interest. Additionally, subcommittee members participate in Committee D22 annual summer conferences. In alternate years, conferences are held in Boulder, CO, and Johnson, VT. The Boulder meeting results in a Special Technical Publication (STP) which includes peer reviewed papers presented at the meeting. The Johnson Conference is an off-the-record meeting to explore emerging issues; no papers are published from the conference.

In 1985, four papers were presented by Subcommittee D22.05 members at the Boulder Conference, Sampling and Calibration of Atmospheric Measurements (Levin 1987; Fortman et al 1987; Sterling et al 1987; Fradkin 1987). One day at the 1986 Johnson Conference was organized by Levin on indoor air including discussions radon health risks, formaldehyde, and public health issues. Another day organized by Mike Beard of EPA focused on asbestos sampling and analysis. The 1988 Johnson Conference will be devoted to asbestos monitoring in the context of federal AHERA legislation.

The subcommittee sponsored a Symposium on Design and Protocols for Monitoring Indoor Air in Cincinnati during April 1987. The symposium covered a broad range of topics including study and investigation design, equipment and method availability and selection, protocols for monitoring activities, statistical considerations in sampling, and the use of questionnaires. Papers prepared for the symposium have been peer reviewed and are now in preparation for printing as an ASTM STP (Nagda, in press).

ABOUT ASTM

ASTM was established in 1898 and is now the world's largest source of voluntary consensus standards. The charter of ASTM states its purpose to be "the development of standards on characteristics of performance of materials, products, systems and services, and the promotion of related knowledge." ASTM is organized into approximately 140 standards-writing main technical committees and over 2000 subcommittees whose members voluntary contribute their time and effort. The Society currently has over 30,000 active members.

The by-laws and regulations of ASTM assure full consensus and due process to all interested parties. Figure 1 presents the "life cycle" of a standard. The process usually takes between one and three years, depending on the urgency of the standard,

the dedication of those writing it, and the degree of acceptability during the approval process. Once adopted, the standards are published in the approximately 66 volume Annual Book of ASTM Standards. Indoor air and other atmospheric sampling standards are contained in Volume 11.03, Atmospheric Analysis; Occupational Health and Safety (1987).

SUBCOMMITTEE D-22.05

Establishment

Subcommittee D22.05 was organized within main committee D22 on Sampling and Analysis of Atmospheres. The impetus for its formation came from the Consumer Federation of America (CFA) which had identified indoor air as a major priority area of involvement. In the Fall fo 1984, a position paper was submitted by CFA to the Committee through Subcommittee D22.04 on Workplace Atmospheres, and the initiative for a new activity received support from Committee D22 leadership. Over 100 people attended the organizing meeting in Spring, 1985, and Subcommittee D22.05 was established. It was organized into task groups (now called sections) and has met semi-anually since that time. It currently has approximately 110 active members.

Committee D22 on Sampling and Analysis of Atmospheres was established in 1951. As environmental interests have expanded from ambient air to source analysis, the workplace atmosphere, and more recently to indoor air and acid deposition, so have the activities of D22.

Organization

Subcommittee D22.05 is organized into sections as shown in Table 1. The sections include Organic Gases and Vapors, Inorganic Gases and Vapors, Particulate Matter, Radionuclides, Biological Aerosols, and Asbestos. Additional sections are organized for Related Factors (building parameters, investigatory protocols, and modeling) and for Statistical Methods.

The subcommittee meets twice a year in various North American cities. Much of the work is conducted between meetings when authors work on documents, drafts are reviewed and revised, and balloting takes place. The meetings themselves present opportunities to discuss on drafts, respond to ballot comments, and discuss the needs for new standards. Membership is not required to attend meetings and there is no charge to visitors or members who attend.

Standards Adoption Proceedures

The ASTM standards adoption proceedure is designed to assure that consensus is achieved and that negative voters are accorded due process. Figure 2 presents the highlights of the balloting sequence and requirements which are summarized below.

Subcommittee ballot. When a draft document is deemed ready for ballot by the author, the section leader, and the subcommittee chairperson, it is sent to all members of the Subcommittee. Members have thirty days to respond to the ballot by voting affirmative, negative or abstaining. Negative votes must be accompanied by written comments or they are counted as abstentions.

Comments may be either editorial or substantive. In Subcommittee D22.05, the comments are sent to their author, the document lead author, the section chairperson, and the subcommittee chairperson. Substantive comments with negative votes must be addressed by the subcommittee before the document is sent for Committee D22 ballot. Negative votes must either be withdrawn by the negative voter, determined to be "not related," determined to be "not persuasive," or determined to be persuasive causing the document to be revised accordingly. The subcommittee chairperson or section leader attempts to communicate with the negative voter to resolve issues in advance of the meeting.

Committee and Society ballot. After a document has passed the subcommittee ballot, it is submitted for Committee D22 ballot, and a similar process is followed. Then the proposed standards are submitted to Society ballot where a similar process is followed. After a successful Society ballot, the proposed standard is submitted to the Committee on Standards which reviews the ballot process and all negative votes to determine whether all negative voters have been accorded due process. Subcommittee members and the document's lead author remain involved until the standard is through the process.

STANDARDS CURRENTLY UNDER DEVELOPMENT

Subcommittee D22.05 on Indoor Air currently has over 40 separate standards under development. In addition, nearly a dozen other standards have been identified as significant. If the subcommittee were to try to write standards for every method of sampling and analysis used in indoor air, the task would be virtually impossible. Therefore, the subcommittee attempts to identify the most useful and the most used methods as well as the most appropriate ones in selecting standards for development. To date, no prospective author has been discouraged from preparing a draft document for consideration.

Questions are raised from time to time regarding the "best" method for sampling a particular chemical or class of compounds. The subcommittee's approach has been that nearly every method in use has some appropriate applications and the adoption of standards for the use of the method will improve the quality of data generated by the method. For some chemicals such as formaldehdye and nitrogen oxide, the subcommittee is developing more than one standard.

The standards themselves identify the appropriate application, range and sensitivity of methods; limitations; potential interferences; and necessary precautions. They describe the quality control/quality assurance procedures appropriate to the method and special considerations for sample collection and handling.

ASTM Standard methods are definitive procedures that produce a test result; their adoption by ASTM requires validation by controlled inter-laboratory comparisons. Standard practices are definitive procedures that do not produce a test result, and their adoption does not require inter-laboratory data. Standard guides present a series of options or instructions without recommending a specific course of action. The subcommittee is currently developing guides for sampling and analysis of asbestos and of biological aerosols, and protocols for investigations of indoor air quality, as well as several others.

New methods can be published as proposals based on bolloting by the committee without a Society ballot. This is useful for publishing methods more rapidly and for encouraging the use of new methods so that sufficient experience is generated to conduct reliable inter-laboratory comparisons. Often a standard method will be adopted as a proposal when it has not had sufficient popular use for feasible round-robin validation. If the methods are found effective and become widely used, they can be revised and adopted as standard methods. Proposals are published in the grey pages at the end of the appropriate ASTM volume. Publishing proposals in the grey pages before Society adoption provides information and opportunities for comment prior to consideration as a standard. The subcommittee has developed a relatively new practice for pesticide and PCB sampling and analysis which has been approved for publication as a proposal.

PARTICIPATION

ASTM committees operate from a base of volunteer interest and effort. Drafting and reviewing documents, attending meetings, and voting on ballot items are the basis for standards development. Membership in Subcommittee D22.05 is open to all interested individuals, and participation in the subcommittee's work is encouraged whether individuals are members or not.

Progress in consensus standardization is expedited and the quality of the standards is improved as more persons cooperate in the activity. Subcommittee D22.05 is continually seeking interested and knowledgeable scientists, engineers and others with technical expertise to pool their effort to advance standardization activities. Further information is available from the staff manager at ASTM Headquarters in Philadelphia.

REFERENCES

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Table 1. ASTM Subcommittee D22.05, List of Sections

Section #	Name
D22.05.01	Related Factors
D22.05.02	Organic Chemicals
D22.05.03	Particulate Matter
D22.05.04	Inorganic Gases and Vapors
D22.05.05	Radionuclides
D22.05.06	Biological Aerosols
D22.05.07	Asbestos
D22.05.08	Terminology
D22.05.09	Statistical Methods

Table 2. ASTM Subcommittee D22.05, Section 01, Related Factors, Documents in Development

Building Systems
- Characterization of Indoor Environments G/D
- Small-Scale Environmental Chamber Measurement of Emission Factors from Solid Materials G/T
- Measurement and Modeling of Pollutant Emissions from Solid Materials G/T
- Inspection and Evaluation of HVAC Systems. G/T
- Sampling and Analysis of Environmental Tobacco Smoke G/T
- Evaluation of Indoor Air Quality Models G/T

Protocols
- Investigation of IAQ in Office Buildings G/D
- Planning the Sampling and Analysis of Indoor Air P/D
- Pre-Occupancy Evaluation of IAQ in Office Buildings G/D
- Interpetation of Results from IAQ Monitoring G/D
- Chambers for Emissions Testing P/T,D
- Use of Passive Monitors G/D
- Reporting the Characterization of Smoking Product Atmospheres Used to Expose Biological Systems ASTM D3688-78(1983). G/R

Odors:
- Subjective Evaluation of Human Response G/T

KEY TO NOTATIONS USED IN TABLES 2 - 9:

DOCUMENT TYPE
- G = GUIDE
- P = PRACTICE
- M = METHOD

DOCUMENT STATUS
- T = TITLE AND SCOPE
- D = DRAFT DEVELOPMENT
- S = SUBCOMMITTEE BALLOT
- C = COMMITTEE BALLOT
- A = SOCIETY BALLOT
- R = REVISION/EXISTING STANDARD

Table 3 ASTM Subcommittee D22.05, Section 02, Organic Chemicals; Documents in Development

Pesticides, Related Semivolatile Organic Chemicals	
Pesticides and PCBs	P/C
Chordane and Heptachlor Residues in Indoor Air	P/S
Polynuclear Aromatic Hydrocarbons	
Polyunuclear aromatic hydrocarbons	P/D
Volatile Organic Chemicals	
Tenax Adsorption Tube Sampling Procedure	P/T
Canister Procedure	P/T
Formaldehyde	
Liquid MBTH (Passive Sampler) Method	M/S
Sulfite Filter Procedure	M/D
DNPH Method	M/D
Nicotine	
Nicotine in Indoor Air	M/D

Key: see Table 2

Table 4 ASTM Subcommittee D22.05, Section 03, Particulate Matter Documents in Development

Calibration Techniques for Direct Reading Particulate Measurement Devices	G/D
Characterization of Particulate Matter	G/D
IP_{10} Particles in Indoor Environment	P/S

Key: see Table 2

Table 5. ASTM Subcommittee D22.05, Section 04, Inorganic Gases and Vapors; Documents in Development

Nitrogen Dioxide, Diffusion Tubes	M/C
Nitrogen Dioxide, Chemiluminescent Methods, Amended ASTM D3824-79	M/R
Ozone, UV Absorption	M/D
Ozone, Chemiluminescence	M/D
Carbon Monoxide, NDIR	M/D
Carbon Dioxide, NDIR	P/T
Sampling Guidelines, Passive Monitors	G/D

Key: see Table 2

Table 6. ASTM Subcommittee D22.05, Section 05, Radionuclides; Documents in Development

Activated Carbon Canister P/S
Alpha-Track Detectors P/D

Key: see Table 2

Table 7. ASTM Subcommittee D22.05, Section 06, Biological Aerosols; Documents in Development

Guidelines for Assessment and Sampling of Saphrophytic Bioaerosols in the Indoor Environment (ACGIH Bioaerosols Committee draft published 9/87 AIHJ) G/D
Sampling of Microbiological Contaminants in Indoor Air G/D

Key: see Table 2

Table 8. ASTM Subcommittee D22.05, Section 07, Asbestos; Documents in Development

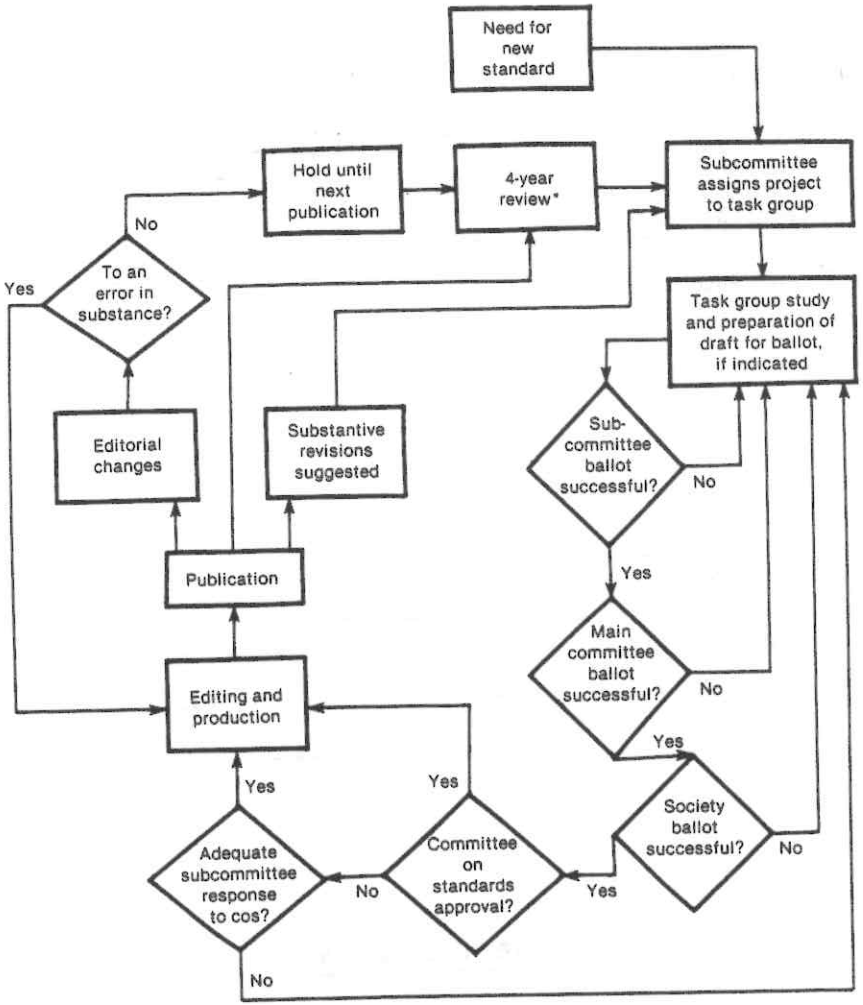
Phase Contrast Microscopy M/S
Polarized Light Microscopy M/S
Scanning Electron Microscopy M/D
Transmission Electron Microscopy M/D
Sampling Methods G/S
Asbestos Sampling and Analysis in Indoor Air G/S

Key: see Table 2

Table 9. ASTM Subcommittee D22.05, Section 08, Statistical Methods; Documents in Development

Initial Strategies for Indoor Air Investigations G/D
Statistical Design Elements and Issues for Indoor Air Studies and Investigations G/D

Key: see Table 2



*Standards must be reviewed and balloted for either revision, reapproval or withdrawal in the fourth year following their last approval, with action to be completed within the fifth year.

FIGURE 1 **"Life Cycle" of a Standard**

Level	*To Initiate*	*To Complete Successfully and Proceed to Next Level*
Task group study	No formal requirements	No formal requirements
SUBCOMMITTEE BALLOT	• Subcommittee chairman approval or motion passed at subcommittee meeting • At least 30 days between issue & closing date • Cover letter explaining reasons for ballot	• 60% of ballots returned • 2/3 affirmative votes (of total affirmative & negative votes cast on each item) • All negative votes considered • No negative votes are persuasive
MAIN COMMITTEE BALLOT	• Completed submittal form sent to Headquarters with item • All main committee ballots issued by Headquarters	• 60% of ballots returned • 9/10 affirmative vote (of total affirmative & negative votes cast on each item) • All negative votes considered • All Pink Forms completed & returned to staff • No negative votes are persuasive
SOCIETY BALLOT	• Staff submits items to Society ballot after successful main committee ballot	• All negative votes considered • All Green Forms completed & returned to staff • No negative votes are persuasive
COMMITTEE ON STANDARDS REVIEW	• Staff submits item to Committee on Standards after successful Society ballot	• Committee on Standards agrees that correct procedures were followed.
APROVAL & PUBLICATION		

FIGURE 2 **Balloting Sequence and Requirements**