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Standard Guide for Using Reference Material to Characterize Measurement Bias Associated with Volatile Organic Compound Emission Chamber Test[1]

This standard is issued under the fixed designation D7911; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide provides procedures for using a reference material with a known emission rate of a volatile organic compound (VOC) to estimate the bias associated with a VOC emission chamber test.

1.2 This guide may be used to assess measurements of VOC emissions conducted in a variety of environmental chambers, such as small-scale chambers, full-scale chambers, emission cells, and micro-scale chambers.

1.3 This guide may be used to assess measurements of VOC emissions from a variety of sources including "dry" materials (for example, carpet, floor tile and particleboard) and "wet" materials (for example, paint and cleaning products).

1.4 This guide can be used to support quality control efforts by emissions testing laboratories, third party accreditation of testing laboratories participating in emissions testing programs, and quality control efforts by manufacturers of building and other materials.

1.5 This guide may be used to support the determination of precision and bias of other commonly used VOC emission standards including Guide D5116, Test Method D6007, ISO 16000-9, ANSI/BIFMA M7.1, and CDPH/EHLB/Standard Method V1.2.

1.6 This guide also describes the attributes of a suitable emission reference material and the different methods available to independently determine the reference material's VOC emission rate.

1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D5116 Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products

D5197 Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)

D5466 Test Method for Determination of Volatile Organic Compounds in Atmospheres (Canister Sampling Methodology)

D6007 Test Method for Determining Formaldehyde Concentrations in Air from Wood Products Using a Small-Scale Chamber

D6196 Practice for Choosing Sorbents, Sampling Parameters and Thermal Desorption Analytical Conditions for Monitoring Volatile Organic Chemicals in Air

D6299 Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance

D6330 Practice for Determination of Volatile Organic Compounds (Excluding Formaldehyde) Emissions from Wood-Based Panels Using Small Environmental Chambers Under Defined Test Conditions

D6617 Practice for Laboratory Bias Detection Using Single

[1] This guide is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.05 on Indoor Air.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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Test Result from Standard Material
D6670 Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products
D6803 Practice for Testing and Sampling of Volatile Organic Compounds (Including Carbonyl Compounds) Emitted from Architectural Coatings Using Small-Scale Environmental Chambers
D7143 Practice for Emission Cells for the Determination of Volatile Organic Emissions from Indoor Materials/Products
D7339 Test Method for Determination of Volatile Organic Compounds Emitted from Carpet using a Specific Sorbent Tube and Thermal Desorption / Gas Chromatography
D7440 Practice for Characterizing Uncertainty in Air Quality Measurements
D7706 Practice for Rapid Screening of VOC Emissions from Products Using Micro-Scale Chambers
D8141 Guide for Selecting Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs) Emission Testing Methods to Determine Emission Parameters for Modeling of Indoor Environments
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E741 Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution
E1333 Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber

2.2 *ISO Standards:*[3]
ISO 12219-3 Interior Air of Road Vehicles—Part 3: Screening Method for the Determination of the Emissions of Volatile Organic Compounds from Vehicle Interior Parts and Materials—Micro-Scale Chamber Method
ISO 16000-3 Indoor Air—Part 3: Determination of Formaldehyde and Other Carbonyl Compounds in Indoor Air and Test Change Air—Active Sampling Method
ISO 16000-6 Indoor Air—Part 6: Determination of Volatile Organic Compounds in Indoor and Test Chamber Air by Active Sampling on Tenax TA Sorbent, Thermal Desorption and Gas Chromatography Using MS or MS-FID
ISO 16000-9 Indoor Air—Part 9: Determination of the Emission of Volatile Organic Compounds from Building Products and Furnishing—Emission Test Chamber Method
ISO 16000-10 Indoor Air—Part 10: Determination of the Emission of Volatile Organic Compounds from Building Products and Furnishing—Emission Test Cell Method
ISO 16000-11 Indoor Air—Part 11: Determination of the Emission of Volatile Organic Compounds from Building Products and Furnishing—Sampling, Storage of Samples and Preparation of Test Specimens
ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories
ISO/IEC 17034 General Requirements for the Competence of Reference Material Producers
ISO/IEC Guide 98 Guide to the Expression of Uncertainty in Measurement (GUM)
ISO Guide 30 Terms and Definitions Used in Connection with Reference Materials
ISO Guide 33 Uses of Certified Reference Materials
ISO Guide 35 Reference Materials—General and Statistical Principles for Certification

2.3 *Other Standards:*
ANSI/BIFMA M7.1 2011 Test Method for Determining VOC Emissions from Office Furniture Systems, Components, and Seating[4]
CDPH/EHLB/Standard Method V1.2 Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.2, 2017[5]
Method TO-17 "Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes," Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition (EPA/625/R-96/010b), 1999[6]

3. Terminology

3.1 *Definitions*—For definitions and terms commonly used in Commitee D22 standards, refer to Terminology D1356. For definitions and terms commonly used when testing materials and products for VOC emissions, refer to Guide D5116. For definitions and terms commonly used to describe reference materials, refer to ISO Guide 30.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *constant emission source, n*—an emission source where the concentration of the chemical at the material surface does not change with time.

3.2.2 *diffusion-controlled source, n*—an emission source that is limited by the movement of contaminants within the material boundaries.

3.2.2.1 *Discussion*—The rate of diffusion depends on the diffusivity of the VOC, the temperature, and the structure of the material.

3.2.3 *dynamic emission source, n*—an emission source where the concentration of the chemical at the material surface changes with time.

3.2.3.1 *Discussion*—A dynamic source can still generate emissions in a predictable and consistent manner.

3.2.4 *evaporative-controlled source, n*—an emission source that is limited by the ability of a contaminant to transfer from the material surface through a boundary layer to the surrounding air.

3.2.4.1 *Discussion*—The rate of mass transfer at the surface

[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

[4] Available from Business + Institutional Furniture Manufacturers Association (BIFMA), 678 Front Ave. NW, Ste. 150, Grand Rapids, Michigan 49504-5368, https://www.bifma.org.

[5] Available from California Department of Public Health (CDPH), PO Box 997377, MS 0500, Sacramento, CA 95899-7377, http://www.cdph.ca.gov.

[6] Available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov.

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of an evaporative-controlled source is dependent on VOC volatility, air velocity, and turbulence near the material surface.

3.2.5 *primary reference measurement procedure, n*—"Reference measurement procedure used to obtain a measurement result without relation to a measurement standard for a quantity of the same kind" (**1**).[7]

3.2.6 *reference emission rate value, n*—the independently-determined mass of VOC emitted per unit of time from a reference emission source at specified conditions.

3.2.6.1 *Discussion*—If the reference emission rate value is "certified," the reference value and associated uncertainty will be available on the accompanying certificate for the reference material.

3.2.7 *reference material, n*—a material that is "sufficiently homogeneous and stable with respect to one or more specified properties, which has been established to be fit for its intended use in a measurement process" (ISO Guide 30).

3.2.7.1 *Discussion*—A certified reference materials provides traceability assurance through ISO/IEC 17034. A reference material can also be produced that is not directly traceable through ISO/IEC 17034 but rather is fit for purpose.

4. Summary of Guide

4.1 This guide describes procedures for using a reference material to evaluate the measurement bias associated with tests of VOC emissions from materials and products. The reference materials described in this guide have independently-determined emission rates that can be measured in an environmental test chamber according to commonly used VOC emission and analytical standards and by following the instructions in the reference material's accompanying documentation.

4.2 In general, reference materials used in laboratory emission tests can provide traceability for test results determined at different times and in different laboratories using the same environmental conditions (for example, chamber airflow rate, temperature, and relative humidity). Chamber air samples are collected at specific times and analyzed according to referenced standards. If no analytical standard is prescribed, samples are analyzed according to a laboratory's standard operating procedures. Chamber concentrations and source emission rates are calculated. The measured emission rates, at defined time periods, are then compared with the known value for the reference material to estimate the measurement bias of the value obtained in the emission chamber. If applicable, the value of the measurement bias can be compared with acceptance criteria for the emission testing program of interest to the user.

4.3 This guide also describes the qualities of an emission reference material, the different methods available to independently determine the VOC emission rate of a reference material, and the chamber operating parameters that potentially influence a reference material's emission results.

5. Significance and Use

5.1 Chamber testing is a globally-accepted method for measuring the emissions of VOCs from building materials and products. Chamber emission test data have a variety of uses including identification and labeling of products as low-VOC emitting for improved indoor air quality, manufacturing quality control, and development of new and improved products for reduced VOC emissions.

5.2 Currently, an inter-laboratory study (ILS) is the most frequently used method for assessing the bias of a laboratory's VOC emission test results. An ILS typically relies on a VOC source with an uncharacterized emission rate. Consequently, a large number of participants (Practice E691 recommends 30, with a minimum requirement of six) are needed to produce the data required to calculate a laboratory's performance relative to the central tendency and distribution of the results for all participants. Due to the participant size requirement and other logistical issues, an ILS involves significant planning and coordination to achieve useful results.

5.3 Inter-laboratory studies have often shown significant variations in measured VOC emission rates among participating laboratories for a given source. Variability in the emission rate from the source often is suspected to be a contributing factor, but it is difficult to be certain of the cause. Thus, better characterized sources are needed for evaluating the ability of laboratories to generate VOC emission test results with acceptable bias as discussed in 8.6.

5.4 Proficiency tests (PT) for VOC emission testing typically focus on a laboratory's analytical capabilities. For example, an analytical PT relies on a certified standard prepared by an accredited vendor as a reference. A laboratory analyzes the PT sample without knowledge of its concentration value. Acceptance of the results is judged by the deviation from the known value. Use of reference materials can expand analytical PT schemes to also include the impacts of test sample handling, test specimen preparation, chamber operation, and chamber air sampling.

5.5 Laboratories accredited under ISO/IEC 17025 are required to derive uncertainty estimates for their test results. Typically, this is done by developing an uncertainty budget and estimating an expanded uncertainty (ISO/IEC Guide 98, Practice D7440). Reference materials not accredited under ISO/IEC 17025 should still be delivered with documented uncertainty budgets. An uncertainty budget for a VOC emission test combines relevant sources of measurement uncertainty for all steps in the testing process from test specimen preparation through air sample analysis. A more efficient approach to determining the overall bias and precision for a VOC emission test is with repeated testing of a reference material (see ISO/IEC Guide 98, ISO Guide 33). This guide addresses the estimation of bias through comparison of the measured value to the reference material value. The precision is determined through repeated testing of multiple reference materials, ideally from the same production batch (see Practices D6299 and E691).

[7] The boldface numbers in parentheses refer to the list of references at the end of this standard.

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