



Designation: D6803 – 19

Standard Practice for Testing and Sampling of Volatile Organic Compounds (Including Carbonyl Compounds) Emitted from Architectural Coatings Using Small-Scale Environmental Chambers¹

This standard is issued under the fixed designation D6803; 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 practice describes procedures for testing the emissions of volatile organic compounds (VOCs), formaldehyde, and other carbonyl compounds, from alkyd paint, latex paint, primer, and other architectural coating samples using a small-scale environmental chamber test facility.

1.2 This practice describes the requirements for the chamber test facility, the small-scale test chamber, the clean air supply system, the environmental controls, the environmental monitoring and data acquisition system, and the chamber air sampling system.

1.3 This practice describes procedures for documenting the paint and coating samples and for the handling and storage of these samples including splitting of samples into smaller containers for storage and subsequent testing.

1.4 This practice identifies appropriate substrates to be used for the preparation of test specimens of paints and coatings, as well as procedures for preparing substrates for use.

1.5 This practice provides detailed procedures for preparing test specimens of paint and coating samples.

1.6 This practice generally describes chamber test procedures and chamber air sampling procedures. The details of these procedures are dependent upon the objectives of the test.

1.7 This practice does not recommend specific methods for sampling and analysis of VOCs, formaldehyde, and other carbonyl compounds. The appropriate methods are dependent upon the objectives of the test.

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

1.9 *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 appro-*

priate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.10 *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

[D16 Terminology for Paint, Related Coatings, Materials, and Applications](#)

[D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers](#)

[D1212 Test Methods for Measurement of Wet Film Thickness of Organic Coatings](#)

[D1356 Terminology Relating to Sampling and Analysis of Atmospheres](#)

[D3687 Practice for Analysis of Organic Compound Vapors Collected by the Activated Charcoal Tube Adsorption Method](#)

[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 \(Canister Sampling Methodology\)](#)

[D6196 Practice for Choosing Sorbents, Sampling Parameters and Thermal Desorption Analytical Conditions for Monitoring Volatile Organic Chemicals in Air](#)

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

Current edition approved Aug. 1, 2019. Published September 2019. Originally approved in 2002. Last previous edition approved in 2013 as D6803 – 13. DOI: 10.1520/D6803-19.

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.

D6886 Test Method for Determination of the Weight Percent Individual Volatile Organic Compounds in Waterborne Air-Dry Coatings by Gas Chromatography

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

E355 Practice for Gas Chromatography Terms and Relationships

3. Terminology

3.1 *Definitions*—For definitions and terms used in this practice, refer to Terminology **D1356**, Terminology **D16**, and Practice **E355**. For definitions and terms related to test methods using small-scale environmental chambers, refer to Guide **D5116**.

3.1.1 *chamber loading ratio, n*—the total amount of test specimen exposed in the chamber divided by the net or corrected internal air volume of the chamber. **D5116**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *alkyd paint, n*—a paint, also referred to as oil paint, that contains drying oil or oil varnish as the basic ingredient.

3.2.2 *clean air, n*—air that does not contain any airborne contaminants in excess of defined limits.

3.2.3 *environmental enclosure, n*—a temperature controlled enclosure of sufficient size to contain the test chamber(s) and allow adequate access to conduct testing.

3.2.4 *latex paint, n*—a paint containing a stable aqueous dispersion of synthetic resin, produced by emulsion polymerization, as the principal constituent of the binder and other potential modifying resins.

3.2.5 *primer, n*—a paint used as a preparatory coating that is applied to materials to facilitate adhesion of a finish coating to the surface.

3.2.6 *coverage rate, n*—the area covered by a unit volume of coating material expressed as m²/L or cm²/mL.

3.2.7 *test specimen, n*—a subsample of a paint sample applied to a substrate such as gypsum wallboard, wood, engineered wood products, or metal and used for testing in an environmental chamber.

4. Summary of Practice

4.1 Large quantities of architectural coatings are used indoors in buildings. Primers and various types of paint are applied to walls and other large surface areas. Wood floors and concrete floors are finished with different types of architectural coatings. Surfaces may be re-coated relatively frequently often while buildings are in use and occupied. There is a need for standardized procedures to qualitatively and quantitatively characterize the emissions of VOCs from such coatings as these emissions have impacts on indoor air quality and potential inhalation exposures of building occupants.

4.2 The purpose of this practice is to define standardized procedures for testing paints and other architectural coatings for their emissions of VOCs, formaldehyde, and other carbonyl

compounds. These procedures expand upon the best practices for small-scale chamber emission testing described in Guide **D5116**.

4.3 Requirements are defined for an appropriate chamber test facility that includes one or more small-scale test chambers and the associated clean air supply system, the environmental control and monitoring systems, and the system for sampling chamber exhaust air for VOCs.

4.4 Procedures are defined for documenting representative samples of paints and coatings and for their handling in the laboratory prior to conducting emission tests.

4.5 VOC emissions from paints and coatings often are strongly influenced by the substrate to which they are applied. In order to assess potential impacts of VOC emissions on indoor air quality, substrates should be representative of how the products are typically used. This practice identifies representative substrates and application procedures for several common types of interior paints and coatings.

4.6 This practice generally describes chamber test procedures and chamber air sampling procedures but does not recommend specific methods for sampling and analysis of VOCs, formaldehyde, and other carbonyl compounds.

4.7 This practice does not extend to the measurement of emissions of semi-volatile organic compounds (SVOCs). Refer to Guide **D8141** for a discussion of methods appropriate for SVOCs.

5. Significance and Use

5.1 Latex paints, alkyd paints, and primers are used as coatings for walls, wooden trim, and furnishings in occupied buildings. Paint may be applied to large surface areas and may be applied repeatedly during the lifetime of a building. VOCs are emitted from paint after application to surfaces.

5.2 Many other types of architectural coatings may be used in large quantities indoors in buildings. In particular, many different types of coatings are used for floors including wood floor stains and finishes and concrete sealers, hardeners, and stains. Two component finishes are often mixed on site and are applied to floors and other surfaces to create a finished surface.

5.3 There is a need for standardized procedures for measuring the emissions of VOCs from paint and coating samples that can be reproduced by different laboratories and that can be used for the assessment of the acceptability of VOC emissions from paints and coatings that are intended for use indoors in occupied spaces. This practice describes standardized procedures that can be incorporated into test methods used for the purpose of estimating the impacts of cured paints and coatings on indoor air quality. Different procedures are required for the estimation of VOC exposures to workers applying such products.

6. Apparatus

6.1 This practice requires the use of an environmental chamber testing facility and an air sample collection system.

6.2 *Environmental Chamber Testing Facility*—The facility consists of a test chamber, a controlled-temperature environmental enclosure, a system for supplying clean air to the

chamber, a humidification system, and a manifold on the chamber exhaust outlet for the collection of air samples. All materials and components in contact with the test specimen or air prior to sample collection shall be chemically inert and accessible for cleaning. Suitable materials include stainless steel and glass. All gaskets and flexible components shall be made from chemically inert materials. General guidance for design, construction, configuration, and validation of a test chamber facility is provided in Guide **D5116**.

6.2.1 Test Chamber—The test chamber shall be constructed of inert materials, either electro-polished stainless steel or glass. The chamber shall be of sufficient size to hold the test specimen. Chambers may range in size from a few litres to a few cubic metres as described in Guide **D5116**. A volume of 0.053 m³ is used in this practice only for discussion and illustrative purposes. Small-scale chambers of different sizes and shapes may be used if the test conditions can be maintained and chamber performance at these conditions can be demonstrated. The chamber shall be equipped with an opening large enough for loading the test specimen and for cleaning the chamber. The chamber shall be equipped with a port to supply air to the chamber, an air outlet from the chamber, and ports for temperature and relative humidity probes. The chamber may be equipped with a fan to promote mixing in the chamber and to achieve the desired air speed across the surface of the test specimen. See Guide **D5116**, Section 5.3.3, for additional guidance on the use of fans. The performance of the chamber shall be evaluated prior to its use to determine airtightness, surface adsorption effects and air mixing. If a fan is used, the air speed at 1 cm above the surface of the substrate shall be demonstrated to be in the range of 0.1 m/s to 0.3 m/s. The chamber performance for air mixing (and air speed if a fan is used) shall be evaluated with representative substrate in place. The chamber performance shall be tested and demonstrated following the guidelines presented in Guide **D5116**.

6.2.2 Environmental Enclosure—The chamber shall be maintained in an enclosure that is of sufficient size to accommodate one or more test chambers and that is capable of maintaining the desired temperature of the chamber(s) within $\pm 1^\circ\text{C}$. The enclosure shall be constructed of inert materials and be easily accessible for air sampling

6.2.3 Clean Air Supply System—A controlled flow of clean air shall be supplied to the test chamber, as described in Guide **D5116**. The system shall incorporate hardware for removing particles, ozone, and VOCs from the supply air. Concentrations of VOCs and aldehydes measured at the chamber inlet shall not exceed 2 $\mu\text{g}/\text{m}^3$ for any single target compound and 20 $\mu\text{g}/\text{m}^3$ for the sum of all measurable VOCs. The flow rate of the air supplied to the chamber shall be controlled within $\pm 2\%$ of the set-point airflow rate with an accuracy of $\pm 2\%$. It is recommended that inlet airflow rate be controlled using a calibrated electronic mass flow controller(s). The airflow rate shall be referenced to standard temperature and pressure, typically 25°C, 101 kPa for indoor air applications. The chamber system shall be designed such that a positive pressurization of the chamber of ≤ 10 Pa relative to the environmental enclosure is maintained throughout the test. The relative humidity (RH) of the air supplied to the chamber(s) shall be

controlled to the desired set point within $\pm 5\%$ RH with an accuracy of $\pm 5\%$. This is often achieved by splitting the inlet airflow rate 50/50 between dry air and air that passes through a water bubbler held at the same temperature as the chamber.

6.2.4 Environmental Measurement System—A data acquisition system consisting of hardware and software shall be used to measure and record the temperature, RH, inlet airflow rate, and sampling airflow rates throughout each test. A system for relatively high frequency recording of the data is required. Sampling at one hertz with recording of averages at one-minute intervals is recommended. At a minimum, data shall be recorded every five minutes.

6.3 Air Sampling System—An air sampling system consisting of a sampling manifold, a vacuum pump(s), and airflow controllers/meters shall be used. Airflow controllers shall control the sampling airflow rates to within $\pm 2\%$ of the specified values with an accuracy of $\pm 2\%$. It is recommended that sampling airflow rates be controlled using calibrated electronic mass flow controllers. Sampling airflow rates shall be referenced to standard temperature and pressure, typically 25°C, 101 kPa. Sampling initiation and termination times can be programmed and controlled with solenoid valves operated by the data acquisition system.

6.3.1 All system components between the chamber and the sampling media shall be constructed of chemically inert materials. A glass or stainless-steel manifold shall be connected to the outlet of the chamber for collection of air samples. The manifold shall be designed for collection of multiple samples simultaneously. The manifold shall be maintained at the same temperature as the chamber. It is recommended that the exhaust from the manifold be vented into a laboratory fume hood or other appropriate exhaust to minimize contamination of the air in the environmental enclosure.

6.3.2 A vacuum pump shall be used to draw air through the sampling media. The required airflow rate is a function of the type of sampler used, the air change rate and the chemical source strength. The total airflow rate through the samplers generally shall not exceed 50% of the airflow rate from the chamber exhaust or shall be demonstrated to not reduce the positive pressurization of the chamber. For collection of VOC samples, the typical sampling airflow rate range is 10 to 200 cm³/min. For collection of air samples for analysis of formaldehyde and other low molecular weight carbonyl compounds, the typical sampling airflow rate is 100 to 1000 cm³/min.

6.3.3 Provisions shall be made to collect multiple air samples of each type at each time point. Replicate samples may be required for quality control purposes and also to accommodate potentially large concentration differences among analytes of interest at early time points.

7. Procedure for Paint and Coating Selection, Handling, and Storage

7.1 Procedures for selection of the paint or coating sample to be tested are a function of the study objectives. Paint and coating samples may be procured from manufacturers, distributors, retailers, or other sources. Record pertinent information upon receipt of the sample including date of acquisition, source of the sample, manufacturer, container size,