Designation: E 1333 – 96 (Reapproved 2002)

Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber[1]

This standard is issued under the fixed designation E 1333; 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 test method measures the formaldehyde concentration in air and emission rate from wood products containing formaldehyde under conditions designed to simulate product use (see 11.5 and Note 7). The concentration in air and emission rate is determined in a large chamber under specific test conditions of temperature and relative humidity. The general procedures are also intended for testing product combinations at product-loading ratios and at air-exchange rates typical of the indoor environment **(1)**.[2] The products tested, the loading ratios and the air exchange rates employed are described in the test report.

1.2 This test method determines the average formaldehyde concentration in air and emission rate from a number of large size samples. The average concentration and emission rate reported, thus, will not provide information on higher or lower emitting panels in the test lot.

1.3 This method is primarily used for testing newly manufactured panel products that are shipped for testing either seal-wrapped in polyethylene or with waster sheets, or with both. When this test method is used for evaluating other than newly manufactured panel products (after original application, installation or use), the method of packaging and shipping the product for testing shall be described in the test report.

1.4 The quantity of formaldehyde in the air sample taken from the chamber is determined by an adaptation of the National Institute for Occupational Safety and Health (NIOSH) 3500 chromotropic acid test procedure. If another analytical procedure is used to determine the quantity of formaldehyde in the air sample, that procedure shall give results of equivalent or greater accuracy and precision than the adapted chromotropic acid procedure. Detailed procedures based on acetylacetone, pararosaniline (see Test Method D 5221), 2,4-dinitrophenylhydrazine (DNPH) (see Test Method D 5197) and 3-methyl-2-benzothiazoline (MBTH) (see Test Method D 5014) have been found to give results equivalent or greater in accuracy and precision than chromotropic acid. The test report shall note the analytical procedure employed.

NOTE 1—[3] The chromotropic acid analytical procedure described in this test method is applicable for testing urea-formaldehyde bonded wood products. According to NIOSH (4th Edition, 8/15/94) the low end of the working range for the chromotropic acid analytical procedure is 0.02 ppm. A more sensitive analytical procedure is recommended for testing wood panel products where formaldehyde concentrations in air are anticipated to be at or below this level. DNPH is recognized as such a method.

1.5 This test method is used to determine compliance with requirements such as those established for building materials by the U.S. Department of Housing and Urban Development Rules and Regulations 24 CFR 3280 for manufactured housing and by Minnesota Statutes Section 144.495. Measurement results are also used for comparing concentrations in air and emission rates from different wood products **(2)** and for determining compliance with product standards.

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.7 This test method is not designed for determining general organic emissions from all indoor materials and products.

NOTE 2—ASTM Committee D22 has developed Guide D 5116 which describes small-scale environmental equipment and techniques suitable for determining organic emissions and emission rates from materials and products used indoors.

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 and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*

D 3195 Practice for Rotameter Calibration[4]

[1] This test method is under the jurisdiction of ASTM Committee D07 on Wood and is the direct responsibility of Subcommittee D07.03 on Panel Products.

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[2] The boldface numbers in parentheses refer to a list of references at the end of the text.

[3] The notes appearing in this test method are not part of the mandatory sections of this standard, are informative in nature, and appear below that section of the standard to which they pertain.

[4] *Annual Book of ASTM Standards*, Vol 11.03.

D 5014 Test Method for Measurement of Formaldehyde in Indoor Air (Passive Sampler Methodology)[4]

D 5116 Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products[4]

D 5197 Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)[4]

D 5221 Test Method for Continuous Measurement of Formaldehyde in Air[4]

E 77 Test Methods for Inspection and Verification of Thermometers[5]

E 220 Method for Calibration of Thermocouples by Comparison Techniques[5]

E 337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)[4]

E 741 Test Methods for Determining Air Change in a Single Zone by Means of Tracer Gas Dilution[6]

2.2 *U.S. Department of Housing and Urban Development (HUD) Document:*[7]

Manufactured Home Construction and Safety Standards, 24 CFR 3280, Federal Register, Vol 49, No. 155, Aug. 8, 1984

2.3 *NIOSH Document:*[7]

Formaldehyde Method, 3500, U.S. Department of Health and Human Services, 1989

2.4 *ANSI Standards:*[8]

HPVA/ANSI HP-1-1994 Hardwood and Decorative Plywood

ANSI A208.1-1993 Particleboard

ANSI A208.2-1994 Medium Density Fiberboard

2.5 *Other Document:*[9]

Minnesota Statutes Section 144.495, 325F.18 and 325F.181, Formaldehyde Gases in Building Materials, 1986

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *air change rate*—the ratio of hourly conditioned and filtered outside air brought into the chamber, and chamber volume measured in identical volume units (normally expressed in air changes per hour, AC/h).

3.1.2 *emission rate*—formaldehyde emissions per area of exposed surface of tested product in the large chamber per time duration of air sample, normally expressed in mg/(m^2 ·h).

3.1.3 *loading ratio*—the total exposed surface area (not including panel edges) of each product divided by the test chamber volume.

4. Significance and Summary of Test Method

4.1 *Significance and Use*:

4.1.1 Limitations on formaldehyde concentrations in air have been established for some building products permanently installed in manufactured and conventional homes. This test method provides a standard means of testing typical product sizes, such as 1.2 by 2.4 m (4 by 8 ft) sheets, at product loadings consistent with product end use.

4.2 *Summary of Test Method*:

4.2.1 This test method incorporates a chamber of 22 m^3 (800 ft^3) minimum size to evaluate formaldehyde concentrations in air and emission rates from building products over a specified duration of time. This test method employs a single set of environmental conditions but different product loading ratios to assess formaldehyde concentrations in air and emission rates from certain wood products. Conditions controlled in the procedure are as follows:

4.2.1.1 Conditioning of specimens prior to testing,

4.2.1.2 Exposed surface area of the specimens in the test chamber,

4.2.1.3 Test chamber temperature and relative humidity,

4.2.1.4 Number of air changes per hour, and

4.2.1.5 Air circulation within the chamber.

4.2.1.6 At the end of a 16- to 20-h period in the test chamber, the air is sampled and the concentration of formaldehyde in air and emission rate are determined.

NOTE 3—Care must be exercised in the extension of the results to formaldehyde concentrations in air and emission rates from products under different conditions of air change rate or loading ratio, or both.

5. Interferences

5.1 The NIOSH 3500 analytical method lists phenols as a negative interference when present at an 8:1 excess over formaldehyde. Modification in the analytical procedure shall be made when relatively high phenol formaldehyde concentrations (8:1) are anticipated **(3, 4)**.

6. Apparatus

6.1 *Test Chamber*:

6.1.1 The interior volume of the chamber shall be a minimum of 22 m^3 (800 ft^3). The interior of the test chamber shall be free of refrigeration coils that condense water and items such as humidifiers with water reservoirs as condensate will have the potential of collecting formaldehyde and thus influencing test results. The interior surfaces of the chamber shall be of materials found to minimize adsorption. (Stainless steel, aluminum, and polytetrafluoroethylene (PTFE) have produced recoveries of ≥95 % at a 0.4 ppm formaldehyde challenge concentration in air and have been found appropriate as chamber lining materials.) All joints except for doors used for loading and unloading specimens shall be sealed. Doors shall be self-sealing. The test chamber shall be equipped with metal specimen racks with dividers spaced a minimum of 150 mm (6 in.) to support specimens on edge.

6.1.2 *Make-Up Air*:

6.1.2.1 The make-up air shall come from a filtered dust-free environment and not contain more formaldehyde than is capable of being measured considering the sensitivity of the analytical procedure using the sampling rate and volume of air as described in 10.2. This shall be accomplished by passing make-up air through a filter bed of activated carbon, activated

[5] *Annual Book of ASTM Standards*, Vol 14.03.

[6] *Annual Book of ASTM Standards*, Vol 04.11.

[7] Available from Superintendent of Documents, U.S. Government Printing Office, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

[8] Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

[9] Available from Print Communications, Dept. of Administration, 117 University Ave., St. Paul, MN 55155.

alumina impregnated with potassium permanganate, or other materials capable of absorbing, adsorbing, or oxidizing formaldehyde.

6.1.2.2 Make-up air for the chamber must pass through a calibrated, totalizing dry gas test meter or other airflow rate measuring device with calibration traceable to the National Institute of Standards and Technology (NIST). It is also acceptable to calibrate the airflow rate measuring device, as installed, using a tracer gas technique described in Test Method E 741. Air change rate per hour (AC/h) is calculated as $(V_2 - V_1) \div ((t - 0) \times$ chamber volume); where V_2 and V_1 are dry-gas test-meter readings in cubic metres at time, t (in hours), and time 0 divided by the chamber volume in cubic metres. The air-intake port and exhaust port shall be on different walls of the chamber and at different elevations. The chamber test shall be operated at a positive pressure of 1 Pa (0.004 in. of water) or greater as determined by a permanently mounted differential pressure device.[10]

6.1.3 *Nonsparking Fan Sizing and Positioning*—A nonsparking fan shall be used to circulate air within the chamber. The air flow shall be directed horizontally in the direction of the chamber length above where the test samples are to be placed in the chamber. The fan shall be sized and positioned to achieve a uniform concentration in air of formaldehyde (within 0.03 ppm) as determined from a minimum of six air sampling locations. These locations shall be at three elevations, 0.3 m (12 in.) from the chamber floor and ceiling, and at a height between 1.3 and 1.5 m (51 and 59 in.); and at two vertical placements, ⅓ the chamber length from each end of the chamber and at chamber mid-width.

6.1.4 *Air Sampling Ports*—For testing, at least two air-sampling ports shall be used, located at equal distance along the chamber length at an elevation between 1.3 and 1.5 m (51 and 59 in.) and shall be placed at least 0.6 m (24 in.) from any interior wall. The sampling lines shall be of materials found to minimize adsorption such as stainless steel, PTFE and aluminum, securely fixed to supports during the test, and shall be as short as possible. The length of the sampling line outside the chamber shall not exceed 6 m (20 ft).

6.2 Examples of acceptable reagents, materials, and equipment are provided in Appendix X1.

7. Hazards

7.1 *Chromotropic Acid Reagent Treatment* (see 10.3.4 and A4.5)—During this hazardous operation, the operator shall wear rubber gloves, apron, and a full face mask or be protected from splashing by a transparent shield such as a hood window. The solution becomes extremely hot during addition of sulfuric acid. Add acid slowly to avoid loss of sample due to splattering.

7.2 *Cleaning Chemicals for Glassware*—Appropriate precautions shall be taken if cleaning chemicals are considered to be hazardous.

8. Test Specimens

8.1 *Standard Face and Back Configuration Testing*:

8.1.1 Loading is defined as the total exposed specimen surface area, exclusive of edge area, divided by the chamber volume (on effect of loading refer to Ref **5**). If the edge exposure is greater than 5 % of the surface area, include the total edge-exposure area in the calculation of surface-exposure area. Loading ratios used for testing wood panel products containing formaldehyde are as follows:

Loading Ratios, ±2 %		
(m^2/m^3)	(ft^2/ft^3)	Product
0.95	0.29	Hardwood Plywood Wall Paneling
0.43	0.13	Particleboard Flooring Materials Industrial Particleboard Panels Industrial Hardwood Plywood Panels
0.26	0.08	Medium Density Fiberboard (MDF)

NOTE 4—See Appendix X3 for a discussion of loading ratios.

8.2 *Non-Standard Sample Configuration Testing*:

8.2.1 *Testing Products with Single Surface Exposed*—Some products have significantly different formaldehyde release characteristics for each surface and have only one surface exposed to the indoor living space.[11] In those cases, panels shall be tested back-to-back with edges taped together. The panels shall be identified as tested in the back-to-back mode.

8.2.2 *Testing Cabinets and Furniture*—Some products are made of assembled wood panel products. Such items shall be designated in the test report by the product name and a description of the cabinet or furniture items. (See Appendix X4 for a discussion of shipment of such products for testing.)

8.2.3 *Combination Testing*—Where different products are tested in combination, the test report shall fully describe the purpose of the test and the nature of the products and must note the loading ratios for each of the products tested.

NOTE 5—HUD in 24 CFR 3280 does not indicate that panels are tested back-to-back (see 8.2.1) or that different products are tested in combination. This test method, however, provides an option of performing tests on components or assembled panels in the back-to-back mode or testing products in combination where appropriate to simulate use in certain structures.

9. Sample Material Shipping and Specimen Conditioning

9.1 *Shipping*—Materials selected for testing shall be shipped from the manufacturer, distributor or building site to the laboratory in bundles, seal-wrapped in minimum 0.15-mm (6-mil) thickness polyethylene plastic, or shipped with a top and bottom waster sheet taken from the same population of the sample, or both. Materials selected for testing shall not include the top or bottom panels or pieces in a stack, unit or pallet. All material shall be held intact prior to specimen conditioning. When other than newly manufactured wood products (after original application, installation or use) are tested, the method

[10] A differential pressure transmitter Model 607-0 with an output signal range corresponding to 0 to 25 Pa (0–0.10 in. of water) and a digital readout (Model A-701) available from Dwyer Instruments, Inc., P.O. Box 373, Michigan City, IN, have been found suitable for determining that the chamber is at positive pressure.

[11] Examples of products exhibiting this characteristic are interior wall and ceiling finish building materials that contain decorative liquid applied finishes that emit significant quantities of formaldehyde, and laminates not containing emitable formaldehyde from the exposed surfaces that are bonded to a substrate that prevents or significantly restricts emissions from the unexposed back surface of the laminates.