Designation: ~~E3087 – 17~~ E3087 – 18

Standard Test Method for Measuring Capture Efficiency of Domestic Range Hoods[1]

This standard is issued under the fixed designation E3087; 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 capture efficiency of wall-mounted domestic range hoods under controlled conditions in a test chamber.

1.2 This test method applies to range hoods that exhaust air to outside and does not apply to recirculating range hoods.

1.3 This test method only applies to range hood air flows up to 200 L/s and widths up to 0.91 m (36 in.).

1.4 This test method is intended to quantify the capture efficiency of range hoods under controlled laboratory conditions suitable for rating.

1.5 The values stated in SI units are to be regarded as standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

1.6 *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.*

1.7 *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 Standard:*[2]

E631 Terminology of Building Constructions

2.2 *Other Standards:*

HVI Publication 916 HVI Airflow Test Procedure[3]

ASHRAE 51/AMCA 210 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating[4]

IEC 61591 Household range hoods - Methods for measuring performance[5]

3. Terminology

3.1 *Definitions:* For definitions used in this test method not otherwise defined below, refer to Terminology E631.

3.1.1 *capture efficiency, n*—the fraction of emitted tracer gas that is directly exhausted by the range hood to be tested.

3.1.2 *range hood, n*—a device for capturing cooking-generated contaminants over a stove, range or cooktop, and exhausting the contaminants to outside the building.

4. Summary of Test Method

4.1 This method measures the capture efficiency of a range hood using tracer gas techniques in a defined test chamber.

4.2 A tracer gas is emitted at the test surface at a fixed rate with the range hood to be tested operating at specified conditions.

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[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.41 on Air Leakage and Ventilation Performance.

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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.

[3] Available from Home Ventilating Institute (HVI), 1740 Dell Range Blvd., Ste. H, PMB 450, Cheyenne, WY 82009, http://www.hvi.org.

[4] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

[5] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st Floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, http://www.iec.ch.

4.3 The concentration of the tracer gas in the exhaust stream of the range hood, the test chamber and air entering the test chamber are measured and used to determine the capture efficiency under steady-state conditions.

5. Significance and Use

5.1 Cooking can be one of the most polluting activities commonly and regularly occurring in residential environments. Capturing airborne cooking contaminants before they can mix with the indoor air is a critical indoor air quality control method.

5.2 Range hoods are used in homes to remove cooking-generated contaminants above cooking surfaces before they mix with air in the rest of the house. This test method is used to measure the capture efficiency under specific conditions that permit comparisons and ratings of range hoods.

5.3 Range hoods may be manufactured and intended to operate at different flow rates or using different inserts such as filters. This test method may be used to determine capture efficiency over the range of rated air flows and operating configurations of a range hood. The rated air flows shall be listed and shall be tested in accordance with HVI Test Procedure 916, IEC 61591, ASHRAE 51/AMCA 210, or equivalent. The maximum air flow allowed for this test method is 200 L/s.

6. Apparatus for Wall-Mounted Range Hoods

6.1 *Test Chamber:*

6.1.1 The capture efficiency testing shall be performed inside a test chamber. The chamber shall have minimum wall lengths of 2.5 m and 3.5 m. The wall height shall be 2.4 to 2.5 m. The volume (V) of the test chamber shall be calculated. A sketch of the test chamber is shown in ~~Fig. 1~~Figs. 1-3, together with an example 0.75 m (30 in. nominal) wide range hood.

6.1.2 The test chamber air leakage shall be measured with intentional inlets and outlets sealed and any access doors or panels closed. Intentional inlets and outlets include the range hood exhaust duct. The test chamber shall be pressurized to 50 Pa. The air flow required to maintain this pressure (Q_{50} (L/s)) shall be measured and recorded. This flow shall be converted into Air Changes per Hour using Eq 1:

$$\text{Air Changes per Hour} = \frac{3.6 \times Q_{50}}{V} \tag{1}$$

The test chamber shall have less than 2.5 Air Changes per Hour at 50 Pa leakage.

6.1.3 The test chamber shall have one or more air inlets in the test chamber.

6.1.3.1 The air inlets shall be sized so that the maximum air flow through the range hood depressurizes the test chamber by less than 5 Pa.

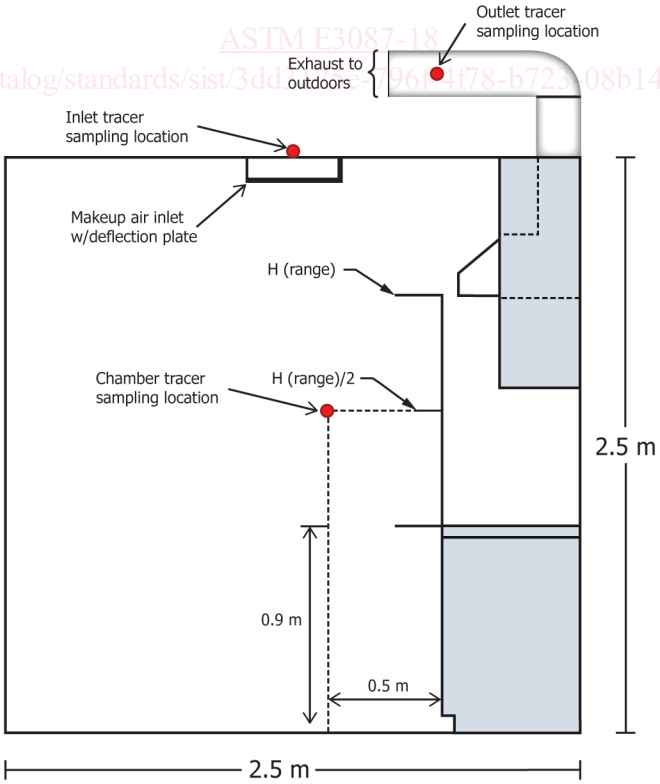

FIG. 1 Sketch of Example Test Chamber - Section

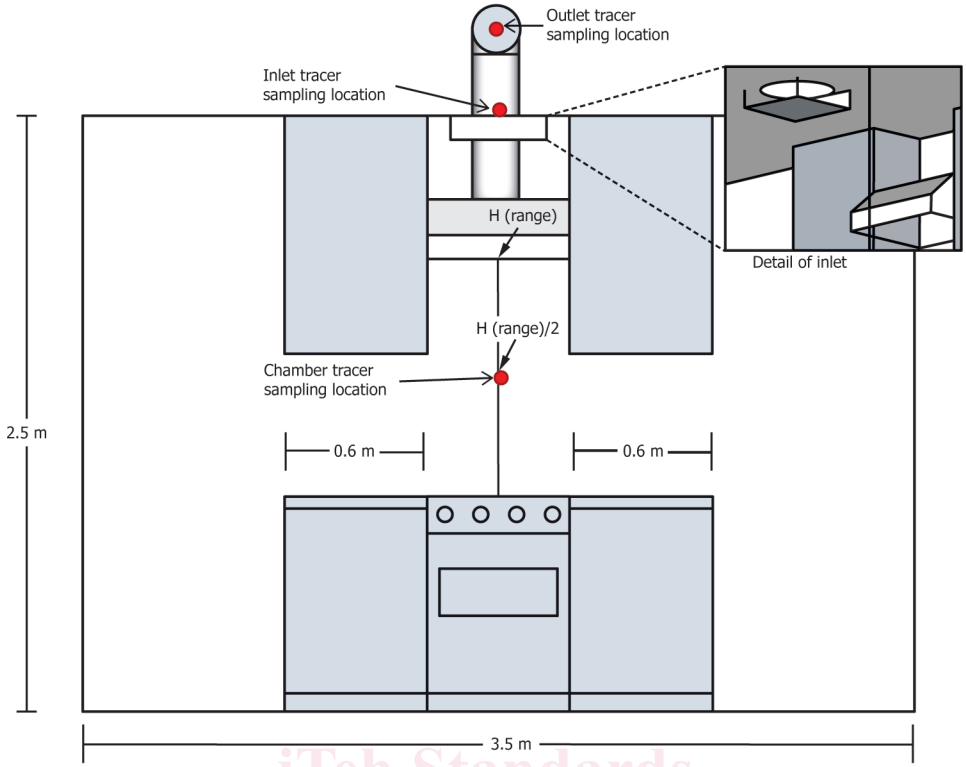

FIG. 2 Sketch of Example Test Chamber - Elevation

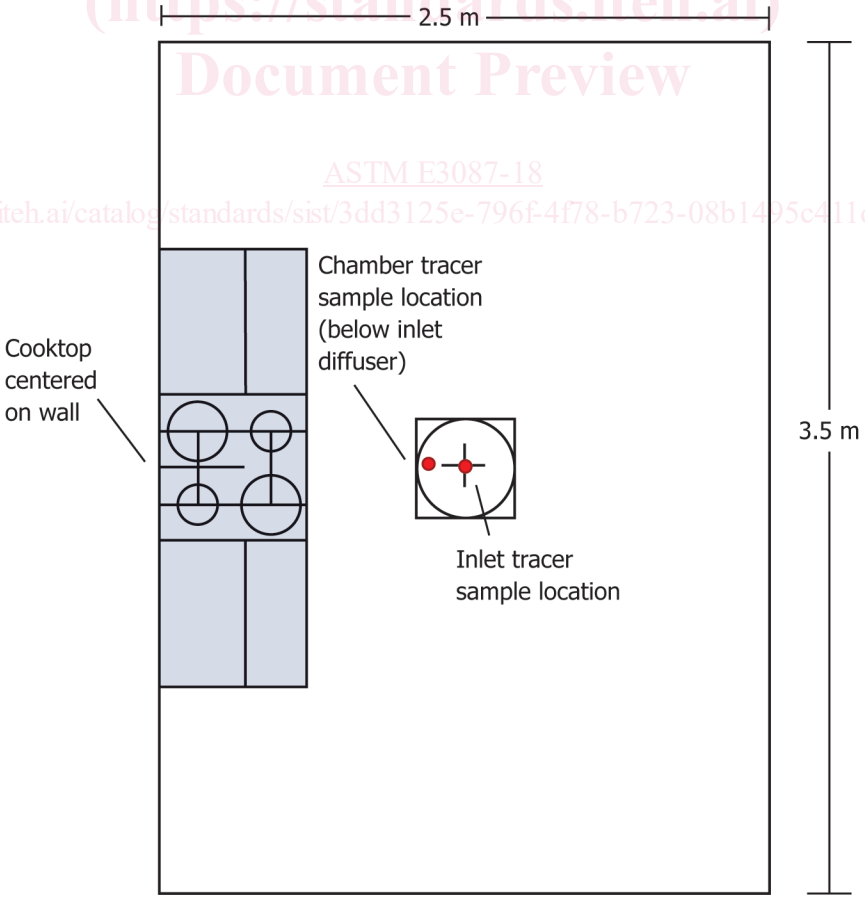

FIG. 3 Sketch of Example Test Chamber - Plan

6.1.3.2 The inlets shall be constructed so that the air coming through them will not directly impinge on the range hood or tracer gas emitters, incoming air is directed away from the wall where the range hood is mounted, and there is at least a 1 m separation between the air inlet and the range hood being tested or the cooktop, or both.

6.1.3.3 The inlets shall be sized to have an average inlet velocity less than 0.5 m/s. A diffuser shall be used on the air inlets to ensure uniform air flow entering the test chamber. The inlets shall be constructed such that air flow does not impinge directly on the range hood being tested or on the area between the range hood and the cooktop.

6.1.4 The range hood to be tested shall be installed on the longest wall of the test chamber. Cabinetry shall be installed on both sides of the range hood that extends laterally at least 0.5 m and has a depth of 0.3 to 0.4 m. The cabinetry shall be mounted to touch the ceiling and extend down vertically 1 to 1.1 m. No cabinets shall be installed above the range hood.

6.1.5 A countertop shall be installed below the range hood and cabinets, with its upper surface 0.9 m (±0.025 m) from the floor. The gap between the countertop and the floor shall be completely filled by kitchen cabinets or solid materials to simulate kitchen cabinetry. The countertop shall extend to at least 0.5 m on each side of the range hood and have a depth from the wall of ~~0.65 m.~~0.65 m (±0.025 m).

6.2 *Electric Heating Elements, Tracer Gas Emitters, and Tracer Gas Sample Locations:*

6.2.1 Each electric heating element shall be 200 ± 10 mm in diameter. The ~~average power input for each electric heating element during the test shall be 1.0 ± 0.1 kW. For 0.61 m (24 in. nominal) and 0.75 m (30 in. nominal) wide range hoods,~~ electric heating elements shall be coil elements (not induction or hot plate). For hoods up to 0.75 m (30 in. nominal) wide, two non-induction electric surface heating elements shall be used for testing. For ~~0.90 m (36~~ hoods greater than 0.75 m (30 in. nominal) range hoods, three non-induction electric surface heating elements shall be used for testing.

6.2.2 A plume diffusion/tracer gas emitter assembly (see Fig. 4) shall be provided for each electric heating element. The ~~assembly~~ emitter assembly shall be placed directly on top of and in contact with the electric heating element. The assembly consists of two circular metal plates of unpolished aluminum or steel and an injector array. Each plate shall have a diameter of 250 ± 5 mm and a thickness of 13 ± 1 mm. Metal spacers shall be placed between the plates to maintain a gap of 13 ± 1 mm. The emitter array shall emit tracer gas evenly over both the upper and lower surface of the top plate via holes 3.5 mm in diameter. For the upper surface, a minimum of 30 holes is required. For the lower surface, a minimum of 15 holes is required. An illustration of the emitter is given in Fig. 4.

6.2.3 A temperature sensor with an accuracy of ±5 °C shall be mounted on top of the top plate ~~in the~~ of the tracer gas emitter within 25 mm of the center of the plate.

6.2.4 A tracer gas that is non-toxic, non-flammable, and stable up to 400 °C (for example, CO_2) shall be introduced through the emitter.

6.2.5 The tracer gas injection rate shall be controlled to within ±1 % using a mass flow control system. The flow rate of tracer gas injection shall be less than 0.5 % of the air flow through the range hood.

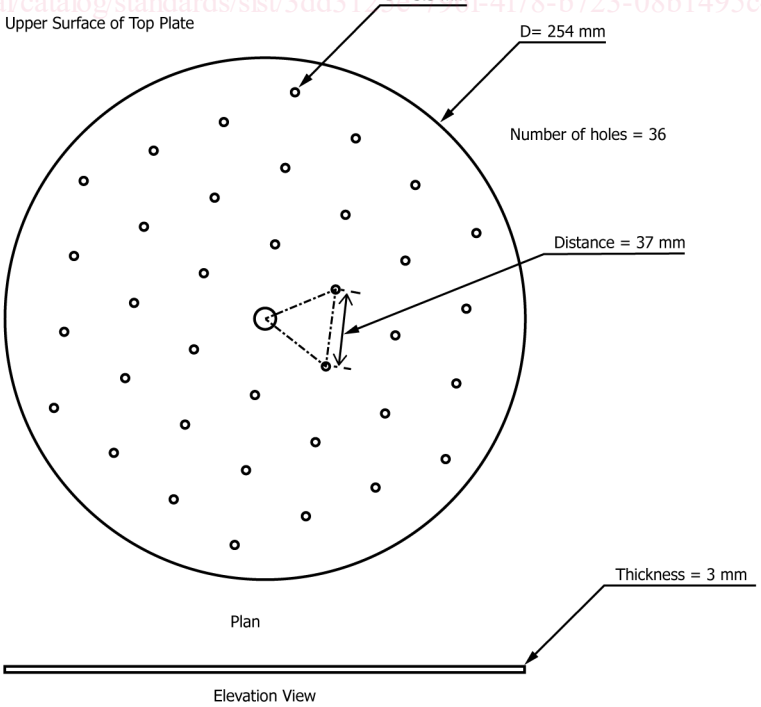

FIG. 4 Plume Diffusion/Tracer Gas Emitter Assembly