



# Standard Test Method for Determining the Change in Room Air Particulate Counts as a Result of the Vacuum Cleaning Process<sup>1</sup>

This standard is issued under the fixed designation F2608; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method provides a laboratory test for the measurement of particulate generated as a direct result of the vacuuming process.

1.2 This test method is applicable to all residential/commercial uprights, canisters, stick vacs, central vacuum systems, and combination cleaners.

1.3 This test method applies to test dust removal from floor coverings not the removal of surface litter and debris.

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

1.5 *This test method may involve hazardous materials, operations, and equipment. 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.*

## 2. Referenced Documents

- 2.1 *ASTM Standards:*<sup>2</sup>
- F555 Test Method for Motor Life Evaluation of an Upright Vacuum Cleaner
  - F608 Test Method for Evaluation of Carpet Embedded Dirt Removal Effectiveness of Household/Commercial Vacuum Cleaners
  - F655 Specification for Test Carpets and Pads for Vacuum Cleaner Testing
  - F884 Test Method for Motor Life Evaluation of a Built-In (Central Vacuum) Vacuum Cleaner
  - F922 Test Method for Motor Life Evaluation of an Electric Motorized Nozzle
  - F1038 Test Method for Motor Life Evaluation of a Canister,

Hand-held, Stick, and Utility Type Vacuum Cleaner Without a Driven Agitator

F1334 Test Method for Determining A-Weighted Sound Power Level of Vacuum Cleaners

F1409 Test Method for Straight Line Movement of Vacuum Cleaners While Cleaning Carpets

2.2 *AHAM Standard:*

ANSI/AHAM AC-1-2006 Test Method for Performance of Portable Household Electric Room Air Cleaners<sup>3</sup>

2.3 *Other References:*

IEC 60312 Vacuum Cleaners for Household Use—Methods for Measuring the Performance

Standard Laboratory Practice for Quantifying Respirable Particulate Emissions Generated by Residential/Commercial Vacuums and Central Vacuum Systems, Carpet and Rug Institute, 12/4/02

## 3. Terminology

3.1 *Definitions:*

3.1.1 *model, n*—designation of a group of vacuum cleaners having identical mechanical and electrical construction with only cosmetic or nonfunctional differences.

3.1.2 *population, n*—total of all units of a particular model vacuum cleaner being tested.

3.1.3 *repeatability limit, n*—value below which the absolute difference between two individual test results obtained under the repeatability condition may be expected to occur with a probability of approximately 0.95 (95 %).

3.1.4 *test run, n*—definitive procedure that produces a singular measured result.

3.1.5 *unit, n*—single vacuum cleaner of the model being tested.

## 4. Significance and Use

4.1 In this test method, the amount of particulate generated into the air by operating a vacuum cleaner over a specific floor covering that is contaminated with dust will be determined. Particles from the motor, floor covering, and the test dust will

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<sup>2</sup> 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.

<sup>3</sup> Available from the Association of Home Appliance Manufacturers, 19th St. NW, Suite 402, Washington, DC 20036.

all be measured. The amount of dust generated in the laboratory practice will differ from that in residential/commercial installations because of variations in floor coverings, soil and other solid particulate compositions, the vacuuming process used by individual operators, the air exchange rate of heating, ventilation, and air conditioning (HVAC) systems, and other factors.

4.2 To provide a uniform basis for measuring the performance in 4.1, a standardized test chamber, equipment, floor covering material, and dust particulate are used in this test method.

5. Apparatus

5.1 An air-conditioned laboratory at  $21 \pm 1.5^\circ\text{C}$  ( $70 \pm 5^\circ\text{F}$ ) and 50 % relative humidity  $\pm 5$  % is to be used for sample preparation.

5.2 *Environmentally Controlled Test Chamber (per ANSI/AHAM AC-1-2006):*

5.2.1 *Chamber Size*—Nominal dimensions of 3.2 by 3.7 by 2.4 m (10.5 by 12 by 8 ft) up to a 20 % difference in volume is permitted.

5.2.2 *Framework*—Standard 5.1 by 10.2 cm (2 by 4 in.) or equivalent construction sealed to the floor line with caulking compound.

5.2.3 *Walls*—Any hard, cleanable surface, such as wallboard (sealed with a washable latex semi-gloss paint) or stainless steel. Seal with caulking compound.

5.2.4 *Flooring*—Any hard, seamless cleanable surface such as seamless full-width vinyl, stainless steel, or sealed concrete.

5.2.5 *Filtration*—HEPA filtration (>99.97 % at 0.3  $\mu\text{m}$ , 0.5  $\text{m}^3/\text{s}$  (1000  $\text{ft}^3/\text{min}$ ) minimum).

5.2.6 *Motor and Blower for Conditioning Loop*—0.35- $\text{m}^3/\text{s}$  (750- $\text{ft}^3/\text{min}$ ) fan.

5.2.7 *Relative Humidity*— $50 \pm 5$  %.

5.2.8 *Temperature*— $21 \pm 1.5^\circ\text{C}$  ( $70 \pm 5^\circ\text{F}$ ).

5.2.9 *Chamber Sealing*—Chamber sealing shall be verified as follows: Particulate level in the sealed room shall not rise above 1000 particles/ $\text{ft}^3$  at  $\geq 0.3 \mu\text{m}$  after 20 min of HEPA off, with the room static.

5.3 Real-time aerosol particle counter in the range of 0.3 to 5  $\mu\text{m}$ . A laser photometer may be used, in addition to the particle counter, with a range of 0.1 to 1000  $\mu\text{g}/\text{m}^3$ .

5.4 Particulate sampling pickoff probe shall be  $152.4 \pm 12.7$  cm ( $60 \pm 5$  in.) above the test carpet, facing up, on centerline of carpet.

5.5 *Weighing Scale (for Weighing Test Dirt)*, accurate to 0.01 g (0.000353 oz) and having a weighing capacity of at least 100 g (3.53 oz) for weighing the dust for embedding.

5.6 *Dirt Embedment Tool*—Roller may be locked or unlocked (see Fig. 1).

5.7 *Dirt Dispenser*—Dispensing system that provides the operator with a method to distribute the test dirt uniformly on the carpet test area.

5.8 *Voltmeter*, to measure input volts to the vacuum cleaner, to provide measurements accurate within  $\pm 1$  %.

5.9 *Voltage-Regulator System*, to control the input voltage to the vacuum cleaner. The regulator shall be capable of maintaining the vacuum cleaner's rated voltage  $\pm 1$  % and rated frequency having a wave form that is essentially sinusoidal with 3 % maximum harmonic distortion for the duration of the test.

5.10 Carpet bed length of 182.9 cm (72 in.) and minimum width of 68.6 cm (27 in.). See an example of a suitable cleaning bed apparatus in Fig. 2.

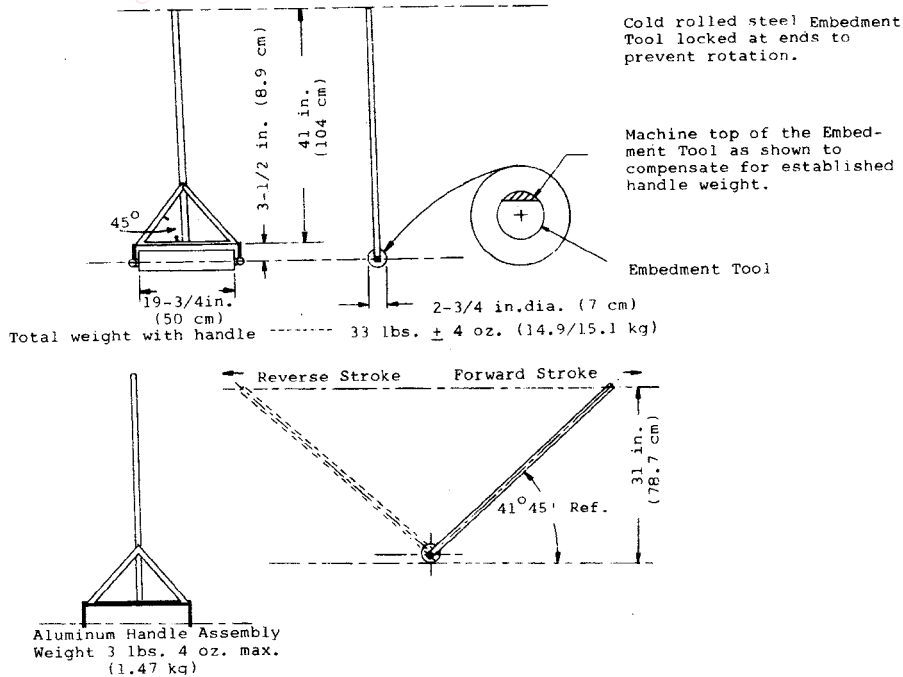


FIG. 1 Dirt Embedment Tool



FIG. 2 Cleaning Bed Apparatus

5.11 Drive for carpet or vacuum cleaner capable of maintaining specified test speed of 55 cm/s (1.8 ft/s) both forward and reverse in a straight pattern. Bed must be equipped with brackets to hold the test vacuum handle at 80 cm (31.5 in.) above the test material.

5.12 If moving the vacuum cleaner, a suitable system is described in Test Method F608. Travel length and width are as specified in the procedure.

5.13 Tachometer or equivalent device for calibrating conveyor or vacuum drive speed.

5.14 *Rotating Agitator Conditioning Vacuum Cleaner/Equipment or a Central Vacuum Cleaning System equipped with a powered, rotating agitator-equipped nozzle*, for conditioning new test carpets and removing residual dirt from the test carpet before each test run. This cannot be the unit tested.

## 6. Materials

6.1 *Level Loop Carpet and Padding*, as described in Specification F655.

6.2 *ISO 12103-A2 Arizona Test Dust (IEC 60312)*—Weigh and record 10 g of test dust in a room meeting the requirements of 5.1. See Table 1 for a description of the dust.

TABLE 1 ISO 12103-1, A2 Fine Test Dust Particle Distribution

Cumulative Volume Numeric Data	
Size, $\mu\text{m}$	Less Than, %
1	2.6
2	11.3
3	20.4
4	28.9
5	35.8
7	44.6
10	52.9
20	70.7
40	88.2
80	99.8

NOTE 1—Relative humidity can have a significant effect upon the weight and amount of test dust.

## 7. Sampling

7.1 A minimum of three units of the same model vacuum cleaner selected at random, in accordance with good statistical practice, shall constitute the population sample.

7.2 To determine the best estimate of the total particulate counts during the activity of cleaning for the population of the vacuum cleaner model being tested, the arithmetic mean of the particulate level in the air rating of the samples from the population shall be established by testing to a 90 % confidence level within  $\pm 5\%$  of the mean value.

7.3 Annex A1 provides a procedural example for determining the 90 % confidence level and when the sample size shall be increased.

## 8. Standard Test Carpet Preparation

8.1 Cut panels as needed of the test carpet, specified in 6.1, to a size of 68.6 cm (27 in.) warp by 182.9 cm (72 in.) fill.

8.2 Mark the carpet panel(s) with test identification numbers for later reference.

### 8.3 Preconditioning New Test Carpet Panels:

8.3.1 Vacuum new test carpet panels using a rotating agitator-equipped vacuum cleaner to remove any loose materials before soiling and testing.

8.3.2 Vacuum the carpet with the first stroke in the direction of the pile lay and continue vacuuming the entire area of the carpet until less than 2 g of carpet fiber or soil is picked up after 5 min of cleaning.

### 8.4 Reconditioning Used Carpet Panels:

8.4.1 Using the vacuum cleaner or a central vacuum cleaning system listed in 5.14, clean then entire carpet area for 5 min using a stroke rate of 0.55 m/s (1.8 ft/s) in the direction of the

pile lay to ensure removal of all residual dust embedded in the carpet. Clean the test chamber in accordance with 9.2.

**8.5 Clean Carpet Particle Background Counts**—Perform the following test to establish a baseline for clean carpet particle counts for use in referencing and calibration checks. This test is to be performed when carpet is new and after every 20 test runs.

8.5.1 Position the test carpet on the supporting surface.

8.5.2 Mark a baseline test area 40 by 102 cm (16 by 40 in.). This area is based upon a standard nozzle width of 25 cm (10 in.), plus an additional 7.6 cm (3 in.) per side. Nozzle width is measured at the extreme outside dimension of the nozzle. For nozzle widths exceeding 25 cm (10 in.), the test area width shall be increased accordingly.

8.5.3 Place the control vacuum cleaner with new bag and filters on the test carpet 10 to 15 cm (4 to 6 in.) in front of the test area. Set the drive run to include carpet an additional 10 to 15 cm (4 to 6 in.) after the test area as well.

8.5.4 Exit the test chamber and initiate the particulate counter or photometer or both. Set the instrument(s) to take continuous readings throughout the duration of the test. The particle counter range sizes are 0.3, 0.5, and 1.0  $\mu\text{m}$  (other particle size ranges are optional).

8.5.5 Energize the chamber purge/room air purifier until the baseline particulate level is under 1000 particles/ $\text{ft}^3$  at 0.3  $\mu\text{m}$  and count variation is under 10 % for 5 min at the 0.3- $\mu\text{m}$  range. For the photometer, the  $\mu\text{g}/\text{m}^3$  baseline should be less than 1  $\mu\text{g}/\text{m}^3$ , with a variation of less than 10 % from the mean.

8.5.6 De-energize both the chamber purge/room air purifier and room-conditioning equipment.

NOTE 2—Testing is to be conducted in a static environment.

8.5.7 Immediately energize vacuum and monitor particle counts (and concentration if using photometer) for 10 min. A hard surface or a method for raising the agitator off of the carpet should be employed to protect the carpet during this portion of the test. If a hard surface is employed it shall not be included in the test strokes.

8.5.8 Set conveyor or vacuum stroke counter at the proper number of strokes to accomplish 10 min  $\pm$  5 s of back and forth vacuuming at 55 cm/s (1.8 ft/s), then energize conveyor and continue to monitor particle counts (and concentration if using photometer).

8.5.9 At the conclusion of 10 min of vacuuming, de-energize the conveyor with the vacuum in its original position, then de-energize the vacuum.

NOTE 3—For products employing a soft dust bag, emissions generated due to bag collapse (“blow-back”) when powering down will be monitored and captured during the settling period of this test.

8.5.10 Record the photometer readings (if used) and particle counts from step 8.5.7 for the 0.3, 0.5, and 1.0  $\mu\text{m}$  particle size ranges. This information will act as a baseline for reference and calibration checks after every 20 test runs performed on the test carpet. Replace carpeting or evaluate potential problems with test system whenever the particle counts from reference and calibration checks of test carpet vary from the baseline level by  $\pm$ 20 %.

## 9. Test Chamber Setup and Conditioning

9.1 All components involved in the test shall remain and be exposed in the controlled environment for at least 16 h before the start of the test.

9.2 *Test Chamber Cleaning Procedure*—To be performed as needed:

9.2.1 Using the vacuum cleaner or a central vacuum cleaning system listed in 5.14, clean all surfaces of the test chamber and equipment to remove all residual dust.

9.2.2 Wipe down all surfaces of the test equipment with a tack cloth or damp rag to remove any dust not removed by the vacuum cleaner.

## 10. Vacuum Cleaners

10.1 *New Test Vacuum Cleaners:*

10.1.1 *Preconditioning a New Test Vacuum Cleaner*—Run the vacuum cleaner in at rated voltage ( $\pm$ 1 %) and frequency ( $\pm$ 1 Hz) with filters in place for 1 h.

10.1.1.1 *Preconditioning Rotating Agitator-Type Vacuum Cleaner*—In a stationary position, operate the vacuum cleaner for 1 h with the agitator bristles not engaged on any surface.

10.1.1.2 *Preconditioning a Straight Air Canister Vacuum Cleaner*—Operate the vacuum cleaner for 1 h with a wide-open inlet (without hose).

10.2 *Used Test Vacuum Cleaners:*

10.2.1 *Recondition a Used Vacuum Cleaner*—Before each test run:

10.2.1.1 Thoroughly remove excess dirt from the vacuum cleaner. Without using tools for disassembly, clean the entire outer surface, brushes, nozzle chamber, ductwork, inside of the chamber surrounding the primary filter, and inside hose and wands.

10.2.1.2 For vacuum cleaners using disposable filters as the primary filters, use a new disposable primary filter from the manufacturer for each test.

10.2.1.3 For vacuum cleaners using non-disposable dirt receptacles, empty in accordance with the manufacturer’s instructions after each test run, clean the receptacle, and then install it as recommended by the vacuum cleaner manufacturer.

NOTE 4—Effectiveness of this cleaning can be seen in the uniformity of the successive runs.

10.3 *Test Vacuum Cleaner Settings*—If various settings are provided, set the motor speed setting, suction regulator, nozzle height, or combination thereof using the manufacturer’s specifications as provided in the instruction manual for this type of carpet. Contact the manufacturer if no instructions are given or if the instructions are unclear or inadequate.

10.4 The settings to be used for this test method (nozzle, motor speed, suction regulator, and so forth.) shall be the same settings that are used in conducting straight line movement (Test Method F1409), sound power (Test Method F1334), embedded dirt cleaning effectiveness (Test Method F608), and motor life evaluation (Test Methods F555, F884, F922, and F1038) for the specified carpet employed in this standard (level loop per Specification F655).