



Standard Test Method for Determining Energy Consumption of Vacuum Cleaners¹

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1. Scope

1.1 This test method covers only a laboratory test for determining the energy usage-of household and commercial upright, canister, stick, and wet/dry vacuum cleaners operating on carpet when tested under specified conditions.

1.1.1 This procedure may be used in conjunction with other performance criteria, such as cleaning effectiveness.

1.1.2 Vacuum cleaners, other than upright vacuum cleaners, that provide a carpet-cleaning function are tested in accordance with the carpet-cleaning instructions provided in the manufacturer's instruction manual. If the manufacturer's instruction manual does not contain instructions for a carpet-cleaning function, the vacuum cleaner is not within the scope of this procedure.

1.2 This test method is applicable to household and commercial types of vacuum cleaners.

1.3 The values stated in SI units are to be regarded as standard. The inch-pound units given in parentheses are mathematical conversions that are provided for information only and are not considered standard.

1.4 *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:²

F655 Specification for Test Carpets and Pads for Vacuum Cleaner Testing

¹ This test method is under the jurisdiction of ASTM Committee F11 on Vacuum Cleaners and is the direct responsibility of Subcommittee F11.20 on Performance (Test Methods).

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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.

2.2 Other Standards:

IEC 60312 Vacuum cleaners for household use - Methods of measuring the performance, Fourth Edition³

UL 1017 Vacuum Cleaners, Blower Cleaners, and Household Floor Finishing Machines⁴

3. Terminology

3.1 Definitions:

3.1.1 *energy usage, n*—amount of electrical energy consumed by a vacuum cleaner during cleaning, measured in Joules (Watt-seconds). There are 3600 watt-seconds in one watt-hour.

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

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

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

3.1.5 *repeatability standard deviation, Sr, n*—standard deviation of test results obtained under repeatability conditions.

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

3.1.7 *reproducibility standard deviation, SR, n*—standard deviation of test results obtained under reproducibility conditions.

3.1.8 *sample, n*—group of vacuum cleaners taken from a large collection of vacuum cleaners of one particular model which serves to provide information that may be used as a basis for making a decision concerning the larger collection.

3.1.9 *strip, n*—width covered during one stroke, defined by the extreme outside geometric width of the power head or nozzle.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁴ Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, <http://www.ul.com>.

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

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

3.1.12 *watt-hour meter, n*—meter that measures and registers the integral, with respect to time, of the active power of the circuit in which it is connected; the unit of measurement is usually the kilowatt-hour.

4. Significance and Use

4.1 This test method provides an indication of the amount of energy usage of the vacuum cleaner while operating over a specified cleaning area at a specified stroke speed and total number of cleaning strokes.

4.1.1 The test area is divided into a number of strips, the strip being defined as the width of the power head or nozzle. For the purpose of this procedure, the cleaning area is specified as 10 m² (15 500 in.²), the stroke speed is defined as 0.5 ± 0.03 m/s (1.7 ± 0.1 ft/s), with a total of 10 strokes per strip.

4.2 In order to provide a uniform basis for measuring the performance described in 1.1, standardized test carpets are employed in this procedure.

5. Apparatus

5.1 *Stopwatch*, with a second hand or other type of equipment capable of establishing the specified rate of movement and total cycle time.

5.2 *Voltmeter*, to measure input volts to the vacuum cleaner, to provide measurements accurate to within ±1 %.

5.3 *Wattmeter*, to measure input watts to the vacuum cleaner, to provide measurements accurate to within ±1 %.

5.4 *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 ±1 % and rated frequency having a wave form that is essentially sinusoidal with 3 % maximum harmonic distortion for the duration of the test.

5.5 *Data-Acquisition System*, controlled in such a way that, depending on the movement of the agitator nozzle, at least 10 power measurements are recorded during each stroke.

5.6 *Temperature and Humidity Indicators*, to provide temperature measurements accurate to within ±½ °C (±1 °F) and humidity measurements accurate to within 3 % relative humidity.

5.7 *Supporting Surface*—A flat surface consisting of a piece of 19-mm (¾-in.) thick exterior grade plywood with the “A” surface upward to support the test carpet and pad. If necessary, the four corners (only) of the test carpet and pad may be fastened to the supporting surface by any acceptable means.

6. Materials

6.1 Standard level loop or Wilton carpet conforming to Specification F655.

6.2 Standard carpet padding conforming to Specification F655.

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.

7.1.1 To determine the best estimate of energy usage associated with the population of the vacuum cleaner model being tested, the arithmetic mean of the energy consumed by the sample from the population shall be established by testing it to a 90 % confidence level within ±5 % of the mean value of the energy usage rating.

8. Conditioning

8.1 *Test Room*—Maintain the test room in which all conditioning and vacuum cleaner testing is performed at 21 ± 3°C (70 ± 5°F) and 45 to 55 % relative humidity.

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

9. Procedure

9.1 Test Procedure:

9.1.1 The energy consumed by the sample vacuum cleaner shall be established as follows:

9.1.1.1 New test carpets and padding shall be level loop or Wilton conforming to Specification F655.

9.1.1.2 Supporting surface conforming to 5.7.

9.1.1.3 Replace the carpet and padding when it has holes, tears, or other signs of wear.

9.1.1.4 Speed shall be 0.5 ± 0.03 m/s (1.7 ± 0.1 ft/s).

9.1.1.5 Use of automated methods are optional.

9.1.2 *Preparation of Test Vacuum Cleaners:*

9.1.2.1 *New Test Vacuum Cleaners:*

(1) Change brush drive belt on vacuum cleaners or agitator nozzles using manufacturer's instructions, if equipped.

(2) Run the vacuum cleaner in at rated voltage ±1 % and rated frequency with filters in place.

(3) In a stationary position, operate the vacuum cleaner for 1 h with the agitator bristles not engaged on any surface.

9.1.2.2 *Used Test Vacuum Cleaners*—Recondition a used test vacuum cleaner, prior to each test run, as follows:

(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, all filters and inside hose and wands.

(2) For vacuum cleaners using disposable filters as the primary filters, use a new disposable primary filter from the manufacturer for each test. Weigh the filter to the nearest 0.10 g (0.0035 oz) and install it as recommended by the vacuum cleaner manufacturer.

(3) For vacuum cleaners using non-disposable dirt receptacles, empty in accordance with the manufacturer's instructions after each test run and clean the receptacle until its weight is within 2 g (0.07 oz) of its original weight. Weigh the receptacle to the nearest 0.10 g (0.0035 oz) and install it as recommended by the vacuum cleaner manufacturer.

NOTE 1—While this procedure may be used by itself, there is a strong

likelihood that it will be used as a precursor for other performance testing. Therefore, it is considered reasonable to measure and record the initial bag or dirt cup weights prior to testing. If no additional testing is to be conducted, this step could be skipped.

9.1.3 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 the test carpet being used. Contact the manufacturer if no instructions are given, or if the instructions are unclear or inadequate.

9.1.4 If the vacuum cleaner has not been energized for more than 60 min prior to testing energize the cleaner for 5 min at nameplate rated voltage ($\pm 1\%$) and frequency (± 1 Hz) immediately preceding the test. For vacuum cleaners with dual nameplate voltage ratings, conduct testing at the highest voltage.

9.1.4.1 Place the vacuum cleaner agitator or nozzle agitator, if equipped, such that the bristles clear the supporting surface and no loose dirt is picked up.

9.1.5 Immediately following the 5-min “run-in” of **9.1.4**, de-energize the vacuum cleaner and place the vacuum cleaner nozzle on the test surface so that the front edge of the vacuum cleaner coincides with the line defining the beginning of the test area.

NOTE 2—In the case of canister or wet/dry vacuum cleaners, the nozzle is attached at the end of a hose and wand. It will be the nozzle intended for use on carpet. For combination tools, it will be set for carpet cleaning.

9.1.5.1 If an automated method is not used, reasonable efforts shall be made to maintain the handle height at 800 mm (31.5 in.) during each test run for vacuum cleaners with a pivoting handle.

9.1.6 Measure the power consumed while vacuuming carpet with either of the methods defined in IEC 60312, clause 4.14 or UL 1017, clause 5.2, as modified below.

9.1.6.1 Operate the vacuum cleaner or nozzle (with or without agitator) for a period of 2 min back and forth on the test carpet.

9.1.6.2 Take power measurements during the last minute, with a minimum of five measurements in each stroke direction averaging the readings to determine the mean power, P_{AVG} , consumed.

NOTE 3—The IEC 60312 test method includes the transition areas at the end of each stroke. There is no evidence indicating that including or excluding the transition areas has any significant effect on the results.

9.1.7 Using the same test vacuum cleaner, repeat **9.1.3 – 9.1.6** two additional times for a total of three test runs.

9.1.8 The average energy used for each individual test vacuum cleaner from the population sample for a given carpet is the average of three test runs meeting the repeatability statement in Section **11**.

9.1.9 The energy, Joules (W-s), consumed by the sample vacuum cleaner cleaning a 10 m^2 area with ten total cleaning strokes per strip is calculated with the following equation:

$$E = P_{AVG} \times N \times A / (b \times 10^{-3} v) \text{ Joules (W - s)} \quad (1)$$

where:

P_{AVG} = average power as determined by **9.1.6.2**

N = total number of cleaning strokes per strip

A = area to be cleaned (10 m^2)

b = power head or nozzle width (in millimetres)

v = stroke speed (0.5 m/s)

With a cleaning area of 10 m^2 , stroke speed of 0.5 m/s and ten cleaning strokes per strip, the result is:

$$\begin{aligned} E &= P_{AVG} \times 8 \times 10 / (b \times 10^{-3} \times 0.5) \\ &= P_{AVG} \times 16 \times 10^4 / b \\ &= 16 \times 10^4 \times P_{AVG} / b \end{aligned} \quad (2)$$

NOTE 4—A complete derivation of the equation may be found in IEC 60312.

9.1.10 A minimum of two additional test sample units of the same model shall be selected in accordance with the sampling statement of Section **7**. Repeat **9.1.1 – 9.1.9** for each new test sample unit selected.

10. Report

10.1 For each vacuum cleaner sample from the population being tested, report the following information:

10.1.1 Manufacturer’s name, product name, product model, and serial number.

10.1.2 Type of cleaner.

10.1.3 Nozzle height settings.

10.1.4 Cleaning head test width used for energy-use calculations.

10.1.5 The average energy used.

10.2 The overall average(s), standard deviations), and 90 % confidence results for all of the population sample tested shall also be reported.

11. Precision and Bias

11.1 Precision—No interlaboratory tests have been performed; therefore, no precision statements regarding the repeatability and reproducibility of this test method are available at this time.

11.2 Bias—No justifiable statement can be made on the bias of the method to evaluate energy of household/commercial vacuum cleaners since the true value of the property cannot be established by an acceptable referee method.

12. Keywords

12.1 energy usage; energy use; vacuum cleaners

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