Designation: F1977 – 22

Standard Test Method for Determining Initial, Fractional, Filtration Efficiency of a Vacuum Cleaner System[1]

This standard is issued under the fixed designation F1977; 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 may be used to determine the initial, fractional, filtration efficiency of household and commercial canister (tank-type), stick, hand-held, upright, and utility vacuum cleaner systems.

1.1.1 Water-filtration vacuum cleaners which do not utilize a replaceable dry media filter located between the water-based filter and cleaning air exhaust are not included in this test method. It has been determined that the exhaust of these vacuum cleaners is not compatible with the specified discrete particle counter (DPC) procedure.

1.2 The initial, fractional, filtration efficiencies of the entire vacuum cleaner system, at six discrete particle sizes (0.3, 0.5, 0.7, 1.0, 2.0, and >3 μm), is derived by counting upstream challenge particles and the constituent of downstream particles while the vacuum cleaner system is being operated in a stationary test condition.

1.3 The vacuum cleaner system is tested either at the floor nozzle, the end of the hose (handle), or at the vacuum cleaner inlet (for handheld products) at the normal airflow rate.

1.4 The vacuum cleaner system is tested with a new filter(s) installed, and with no preliminary dust loading. The fractional efficiencies determined by this test method shall be considered initial system filtration efficiencies.

1.5 Neutralized potassium chloride (KCl) is used as the challenge media in this test method.

1.6 One or two particle counters may be used to satisfy the requirements of this test method. If using one counter, flow control is required to switch between sampling the upstream and downstream air sampling probes.

1.7 To efficiently utilize this test method, automated test equipment and computer data acquisition is recommended.

1.8 Different sampling parameters, flow rates, and so forth, for the specific applications of the equipment and test procedure may provide equivalent results. It is beyond the scope of this test method to define those various possibilities.

1.9 This test method is limited to the test apparatus, or its equivalent, as described in this document.

1.10 This test method is not intended or designed to provide any measure of the health effects or medical aspects of vacuum cleaning.

1.11 This test method is not intended or designed to determine the integrity of HEPA filtration assemblies used in vacuum cleaner systems employed in nuclear and defense facilities.

1.12 The inch-pound system of units is used in this test method, except for the common usage of the micrometer, μm, for the description of particle size which is a SI unit.

1.13 *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.*

1.14 *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]

D1193 Specification for Reagent Water

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D3154 Test Method for Average Velocity in a Duct (Pitot Tube Method)

F50 Practice for Continuous Sizing and Counting of Airborne Particles in Dust-Controlled Areas and Clean Rooms Using Instruments Capable of Detecting Single

[1] This test method is under the jurisdiction of ASTM Committee F11 on Vacuum Cleaners and is the direct responsibility of Subcommittee F11.23 on Filtration.

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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.

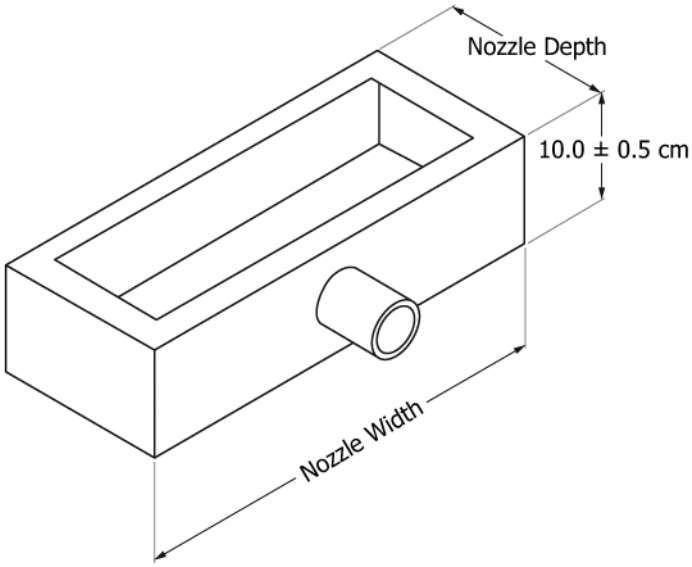

FIG. 1 Nozzle Adapter

Sub-Micrometre and Larger Particles
F395 Terminology Relating to Vacuum Cleaners
2.2 *Other Documents:*
IEST-RP-CC001 Recommended Practice for HEPA and ULPA Filters[3]
ISO Guide 25 General Requirements for the Competence of Calibration and Testing Laboratories[4]
ISO 5801:2017 Fans – Performance testing using standardized airways[4]
ISO 29463-1 High-efficiency filters and filter media for removing particles in air – Part 1: Classification, performance testing and marking[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *challenge, n*—aerosolized media introduced upstream of the test unit and used to determine the filtration characteristics of the test unit.

3.1.1.1 *Discussion*—Also known as test aerosol. The term "contaminant" shall not be used to describe the media or aerosol used to challenge the filtration system in this test method. The term "contaminant" is defined in Terminology D1356 and does not meet the needs of this test method.

3.1.2 *chamber airflow, n*—the sum of all airflows measured at a point near the downstream probe.

3.1.3 *filter, n*—the entity consisting of the converted filter media and other items required to be employed in a vacuum cleaner for the purpose of arresting and collecting particulate matter from the dirt-laden air stream; sometimes referred to as a filter element, filter assembly, cartridge, or bag.

3.1.4 *normal airflow, n*—that airflow produced by the vacuum cleaner when operating at maximum normal use settings.

3.1.5 *nozzle adaptor, n*—a small plenum chamber, fabricated to mount to the inlet nozzle of the test unit in a sealable manner and shown in Fig. 1, to be used for vacuum cleaners without above the floor cleaning capabilities.

3.1.5.1 *Discussion*—Construction specifications are discussed in the Apparatus section.

3.1.6 *particle count, n*—the numeric sum of particles per cubic foot over the specified sample time.

3.1.6.1 *Discussion*—Throughout this test method, the units of measure for this term, generally, do not accompany the term "particle count" and are assumed to be understood by the reader.

3.1.7 *primary motor(s), n*—the motor(s) which drive(s) the fan(s), producing airflow through the vacuum cleaner.

3.1.8 *secondary motor(s), n*—the motor(s) in the vacuum cleaner system not employed for the generation of airflow.

3.1.9 *sheath air, n*—the air flowing over and around the test unit that is mounted in the test chamber.

3.1.10 *stabilization, n*—those conditions of operation which produce results having a total variation of less than 3 % and at least 1000 total count in all size ranges for challenge, and equal to or less than 15 counts per cubic foot in the 0.3-µm channel for the background count.

3.1.10.1 *Discussion*—Total variation is calculated as the difference between the maximum particle count and the minimum particle count divided by the maximum particle count in percentage. The difference is determined within the same period of the test.

3.1.10.2 *Discussion*—The assurance of statistical control is not a simple matter and needs to be addressed. A process is in a state of statistical control if the variations between the observed test results vary in a predictable manner and show no unassignable trends, cyclical characteristics, abrupt changes, excess scatter, or other unpredictable variations.

3.1.11 *system filtration efficiency, n*—a numerical value based on the ratio of a discrete size, particle count emerging from the vacuum cleaner, relative to the upstream challenge, particle count of the same size.

3.1.12 *test chamber, n*—the enclosed space surrounding the vacuum cleaner being tested, used to maintain the controlled environmental conditions required during the test procedure.

3.1.13 *trial, n*—the definitive procedure that produces a singular measured result.

3.1.13.1 *Discussion*—A trial is the period of time during which one complete set of upstream or downstream air sample data, or both, is acquired.

3.2 *Definitions:*

3.2.1 *aerosol, n*—a suspension of solid or liquid particles in a gas.

3.2.2 *background particles, n*—extraneous particles in the air stream prior to the start of the test.

3.2.2.1 *Discussion*—Under conditions required of this test

[3] Available from Institute of Environmental Sciences and Technology (IEST), Arlington Place One, 2340 S. Arlington Heights Rd., Suite 100, Arlington Heights, IL 60005-4516, http://www.iest.org.

[4] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.