

Standard Laboratory Practice For Quantifying Respirable Particulate Emissions Generated by Residential/Commercial Vacuums and Central Vacuum Systems

1. Scope

- 1.1 This test method provides a laboratory test for measuring respirable particulate generated from the use of specific residential and/or commercial upright, canister, central, and combination vacuum systems.
- 1.2 This test practice applies to removal of a specific test dust from floor coverings, not the removal of surface litter and debris.
- 1.3 This test practice may involve hazardous materials, operations, and equipment. This test practice does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this test practice to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Reference Documents

- 2.1 ASTM F2608 Test Method for Determining the Change in Room Air Particulate Counts as a Result of the Vacuum Cleaning Process.

3. Precision & Bias

- 3.1 No precision and bias has been established.

4. Significance & Use

- 4.1 The test method will be used to generate data that can quantify the carpet vacuum performance of various vacuum cleaning equipment.

- 4.2 This test practice will determine the amount of respirable particulate from a specific floor covering during the operation of a specific vacuum following vacuum manufacturer recommendations. The amount of respirable dust generated in the laboratory practice will differ from that in residential or commercial installations due to variations in floor covering styles, soil and other solid particulate compositions, the vacuuming process employed by individual operators, the air exchange rate of HVAC systems and other factors.
- 4.3 In order to provide a uniform basis for measuring the performance in section 1.1, a standardized test chamber, equipment, floor covering material and dust particulate are employed in this practice.
- 4.4 There is no established correlation between field and laboratory results. However, the relative differences between equipment tested under this specific test method provide a means for performance comparisons.

5. Apparatus

- 5.1 Environmentally Controlled Test Chamber (See Annex A.5.1)
- 5.2 Relative Humidity Control Unit (See Annex A.5.2)
- 5.3 Room Air Purifier (See Annex A.5.3)
- 5.4 Electronic Air Cleaner (See Annex A.5.4)
- 5.5 Real-Time Aerosol Monitor (See Annex A.5.5)
- 5.6 Weight Scales (See Annex A.5.6)
- 5.7 Jar Mill and Ball Jar (See Annex A.5.7)
- 5.8 Solid Particulate Dispenser (See Annex A.5.8)
- 5.9 Cylindrical Ceramic Mill Stones (See Annex A.5.9)
- 5.10 Reciprocating Conveyor (or equivalent) (See Annex A.5.10)
- 5.11 Tachometer scaled in feet/second. (See Annex A.5.11)
- 5.12 Control Vacuum Cleaner (See Annex A.5.12)
- 5.13 Carpet Sample Rack. (See Annex A.5.13)

6. Reagents and Materials

6.1 Test Carpet (See Annex A.6.1)

Test Material	
Construction	Tufted Cut Pile
Weight	25 Oz/Sq Yd
Pile Height	.56 Inch
Gauge	3/16
Yarn	100% BCF Nylon 6
Treatment	None

6.2 Test Carpet Template (See Annex A.6.2)

6.3 ISO 12103-A2 Arizona Fine Test Dust (See Annex A.6.3)

7. Conditioning

7.1 Test room temperature and humidity are maintained in standard laboratory conditions, 70° F ± 5° F and 50% ± 5% relative humidity in which all conditioning and sample preparation is performed.

7.2 Test chamber temperature and humidity are maintained in standard laboratory conditions, 70° F ± 2° F and 50% ± 2% relative humidity. (See Annex A.5.1)

7.3 All components involved in the test shall remain and be exposed in the controlled laboratory conditions for at least 16 hours prior to the start of the test.

7.4 The test carpets may be prepared and stored in the test room up to 72 hours in advance of testing.

8. Sampling, Test Specimens, and Test Units

8.1 Only one test vacuum unit is required for this test method.

8.2 New test carpet material and template carpet material shall conform to 6.1 and 6.2.

8.3 Cut three samples of the cut pile test carpet (see 6.1) to a size of 263 mm X 1003 (10 ³/₈" X 39 ¹/₂"). (See Annex A.8.3)

- 8.4 Mark the test samples with test identification numbers to clearly identify each.
- 8.5 Prepare test materials for conditioning by vacuuming edges to remove loose fibers and latex with a rotating agitator equipped CRI Green Label approved vacuum.
- 8.6 Continuously condition prepared samples a minimum of 16 hours in the standard laboratory conditions prior to testing in a horizontal, non-ventilated sample rack. (See Annex A.5.13)

9. Vacuum Cleaner Conditioning

- 9.1 Preconditioning a new test vacuum cleaner by energizing the vacuum cleaner in a stationary position at the rated voltage $\pm 1\%$ and rated frequency with filters in place for one (1) hour.
- 9.2 Preconditioning New Rotating Agitator Type Test Vacuum Cleaner in a stationary position by energizing the vacuum cleaner for one (1) hour with the agitator bristles not engaged on any surface.
- 9.3 Preconditioning a New Straight-Air Canister Test Vacuum Cleaner by energizing the vacuum cleaner in a stationary position for one (1) hour with a wide-open air inlet with hose attached.

10. Test Carpet Preparation

- 10.1 Prepare three (3) test carpet samples in accordance with section 8.
- 10.2 Place prepared-conditioned sample in ball jar along with solid particulate dispenser (see Annex A.5.8) containing 5 grams of ISO Test Dust (see Annex A.6.3) and a quantity of 160 count of 0.5" diameter (12.7 mm) plus a quantity of 35 count of 0.813" diameter (20.65 mm) ceramic mill stones. (See Annex A.5.7 and A.5.9)
- 10.3 Run ball jar five (5) minutes ± 10 seconds at 40 RPMs.
- 10.4 Remove solid particulate dispenser and carpet test sample from ball jar to prevent dislodging ISO Fine Test Dust. Soiled samples may be stored in a horizontal, non-ventilated sample rack until transferred to the environmental chamber. Do not stack samples against each other.

11. Environmental Chamber Test Procedure

- 11.1 Place sample with particulate dust in a clean carpet template (see Annex A.6.2). Position on the reciprocating conveyor's top plate in the test chamber with pile lay, if present, towards the vacuum start position.
- 11.2 Enter the test chamber and install test vacuum (with new bag) on conveyor as specified in Annex A.5.10. Position vacuum on the carpet template 4-6 inches in front of the carpet test specimen on the carpet template.
- 11.3 If settings are provided, set the motor speed, suction regulator, nozzle height, or combination thereof using the manufacturer's specifications provided in the vacuum cleaner instruction manual. Contact the manufacturer if no instructions are given, or if the instructions are unclear or inadequate. Ensure that each direction change is made with the vacuum head on the template and not on the test specimen.
- 11.4 Exit the test chamber and initiate the particulate monitoring devices (see Annex A.5.5) which are programmed to take continuous readings throughout the duration of the test.
- 11.5 Energize the chamber purge/room air purifier (see Annex A.5.3 and A.5.4) until the established base line of 0.0 to 1.0 $\mu\text{g}/\text{m}^3$ particulate level has reached equilibrium as determined by the particulate monitors.
- 11.6 De-energize both the chamber purge/room air purifier and room conditioning equipment (see Annex A.5.2). Test is to be conducted in a static environment.
- 11.7 Immediately energize vacuum and monitor emissions for ten (10) minutes \pm 5 seconds. (Conveyor and carpet sample are not moving for this step. Vacuum remains in start position on template.)
- 11.8 Set reciprocating conveyor to achieve 10 minutes \pm 5 seconds of back and forth vacuuming of carpet sample at 1.8 ft/sec, then, with vacuum still energized in its starting position, energize the conveyor.
- 11.9 At the conclusion of 10 minutes \pm 5 seconds of reciprocating vacuuming passes that remove test dust from the sample carpet, de-energize the conveyor with the vacuum in its original position, then de-energize the vacuum.

- 11.10 Continue to monitor respirable particulate emissions an additional four (4) minutes \pm 5 seconds after de-energizing the vacuum.
- 11.11 Prior to entering the test chamber, energize the chamber purge/room air purifier, then proceed into the test chamber. Remove test specimen then clean chamber surfaces with a CRI SOA approved HEPA filter-equipped control vacuum and microfiber cloth. Place samples in a horizontal, non-ventilated sample rack. Do not stack samples against each other.
- 11.12 Install a new prepared test sample in a prepared carpet template, then repeat 11.1 through 11.11 until the three (3) required samples have been tested.

12. Evaluation

- 12.1 Review the continuous particulate monitoring results from clauses 11.4 -11.8 and record the peak value.

13. Report

- 13.1 Product test number, chain of custody number (CRI number), test date, test method conducted, vacuum name, model number, manufacturer, serial number, bag type, and filter types.
- 13.2 Complete carpet test material description, including carpet style and other specifications. (See 6.1)
- 13.3 Solid particulate type and amount.
- 13.4 Speed of travel of vacuum cleaner expressed in feet/second.
- 13.5 The time the vacuum cleaner ran over the test carpet.
- 13.6 Type and model of particulate monitors.
- 13.7 Averaged peak concentration of respirable particulate expressed in $\mu\text{g}/\text{m}^3$.

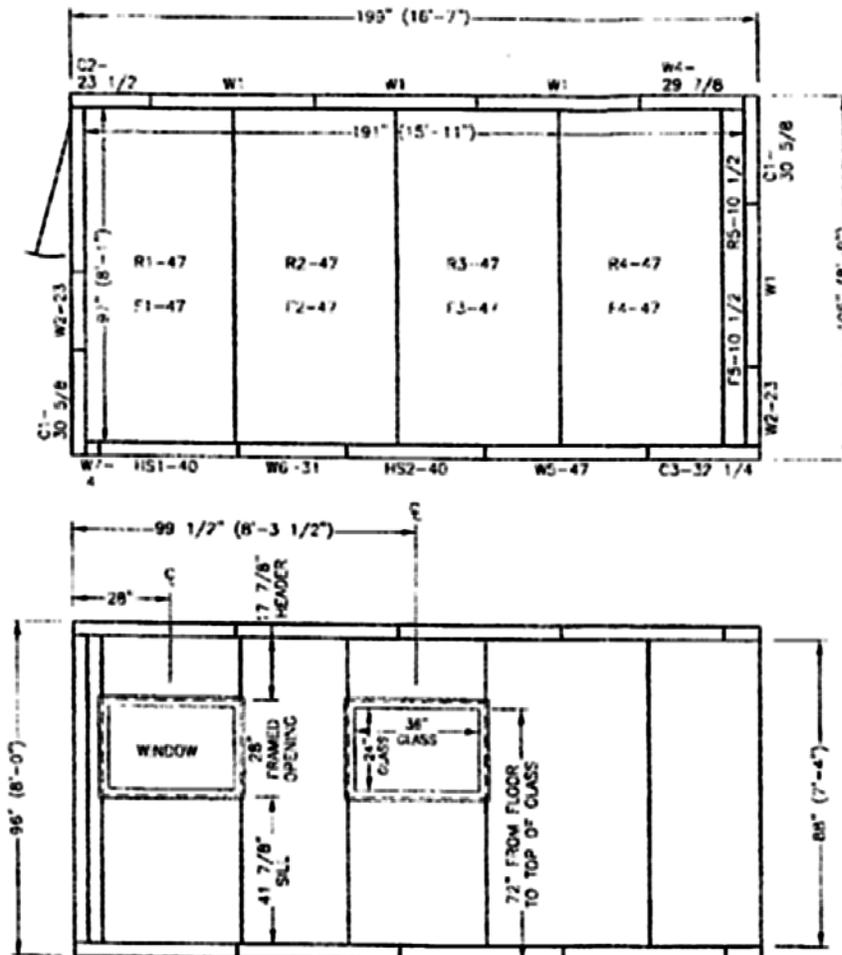
**ANNEX A
(Mandatory Information)**

A.5.0 Apparatus Details

A.5.1 **Environmentally Controlled Test Chamber** 16' x 8' x 8' nominal dimensions with stainless steel interior, two observation windows on one side and door, externally sealable ports, internal electrical outlet and fluorescent lighting, conditioned and maintained at 70° F ± 5° F and 50% ± 5% relative humidity per diagram below

Custom Manufactured Environmental Enclosure

Professional Testing Laboratory
706-226-3283



- A.5.2 **850 CFM Fan/Coil and Chilled Water Module** set to maintain 70° F ± 5°F and 50% ± 5% relative humidity environmental conditions or other similar equipment capable of maintaining specified conditions in test chamber 5.1.

Datamate 850 CFM Fan/Coil and Chilled Water Module
Liebert Manufacturing
Joe Paul & Associates Distributors
800-543-2778

(installed in Environmentally Controlled Test Chamber A.5.1)

- A.5.3 **2000 CFM Room Air Purifier** containing a Type A HEPA filter with minimum filter efficiency of 99.97% on 0.3 µg particulate.

Purafil 2000 CFM Room Air Purifier
Atmos Tech Industries
732-493-8400

- A.5.4 **Electronic Air Cleaner** designed to remove airborne particles down to 0.01 microns. This air cleaner is positioned in the chamber purge system to back up the HEPA filter in 5.3.

Carrier Electronic Air Cleaner
Model: AIRAAXCCC020 2000 CFM
800-227-7437

- A.5.5 **Real Time Aerosol Monitor** capable of measuring airborne particulate concentrations from 0.1 ug/m³ to 40 mg/m³ with resolution to 0.1 ug /m³. Data logging averaging periods are 10 sec with report generating maximum, minimum and average particulate emissions concentrations over the duration.

Mass Concentration Monitor
Thermo Electron Corp.
508-533-6949

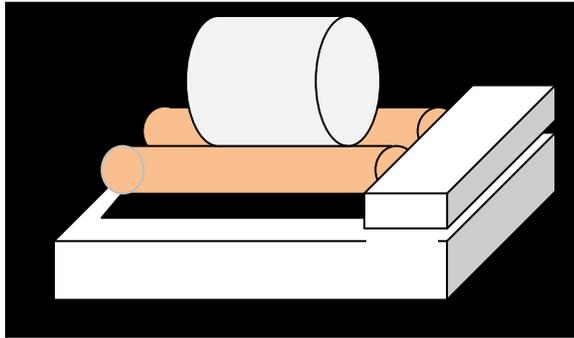
- A.5.6 **Weight Scales – 1)** a scale having a capability of weighing specimens up to 100 grams with an accuracy of 0.01 grams, and 2) a scale having a minimum 2000 gram capacity and an accuracy of 0.1 grams.

Precision Balance
Mettler Toledo
770-476-8500

A.5.7 **Jar Mill and Bell Jar** capable of containing a 263 mm X 1003 mm (10 $\frac{3}{8}$ $\frac{3}{8}$ " X 39 $\frac{1}{2}$ ") carpet test specimen.

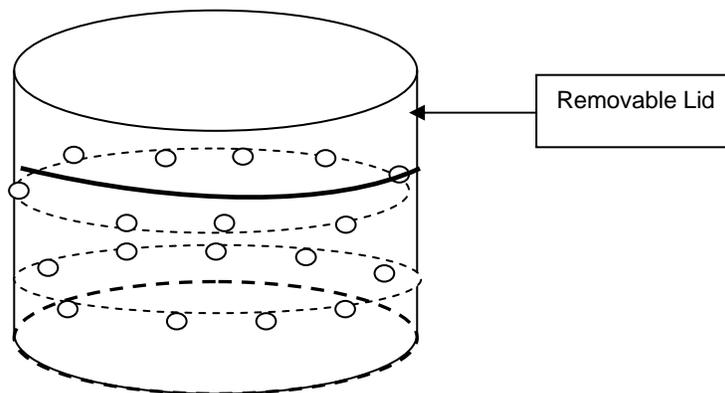
Jar Mill
U.S. Stoneware
800 East Clarke St.
East Palestine, OH 44413
Fax: (330)426-1859

Bell Jar (1 gallon glass)
Fisher Scientific
800-766-7000



A.5.8 **Solid Particulate Dispenser.** A cylindrical device 1.5" x 1.5" with 18 count 1/32" diameter holes evenly spaced in two rows (of 9 holes each) centered around the circumference per diagram below.

Dalton Metal Fabricators
706-226-7194



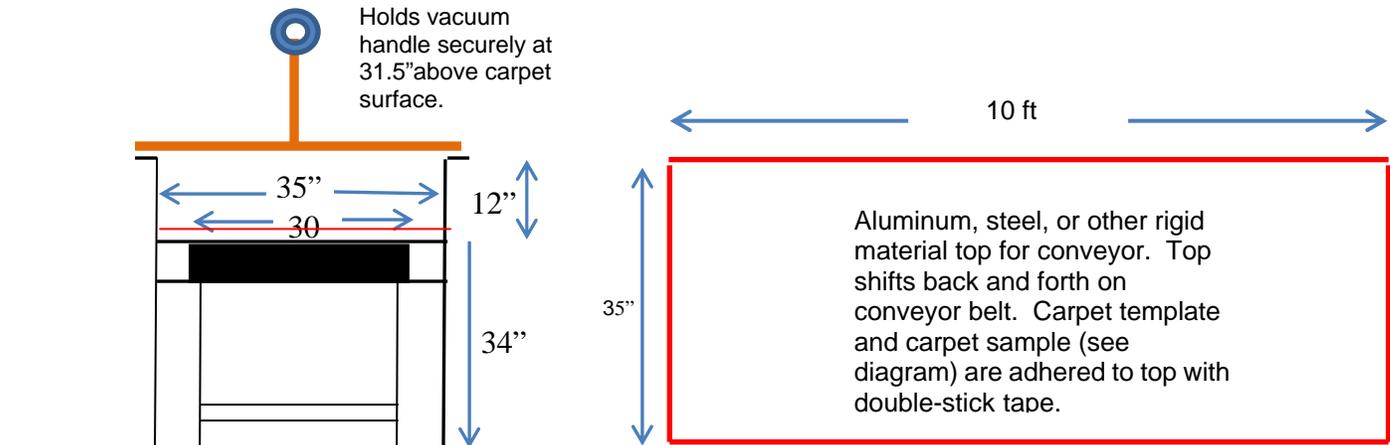
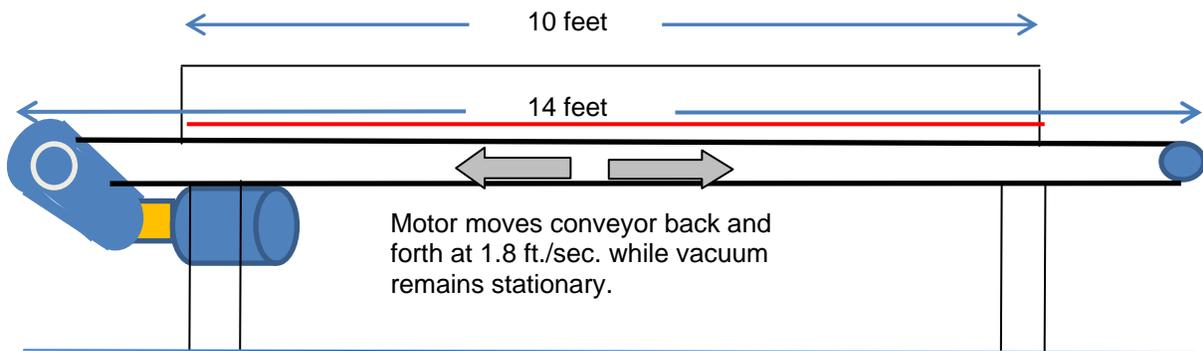
A.5.9 **Cylindrical Ceramic Mill Stones** quantity 160 count of 0.5" diameter and quantity 35 count of .813" diameter.

Part# BRUN050 90% Burundum Grinding Media $\frac{1}{2}$ " X $\frac{1}{2}$ "
Part# BRUN081 90% Burundum Grinding Media $\frac{13}{16}$ " X $\frac{13}{16}$ "
U.S. Stoneware
800 East Clarke St.
East Palestine, OH 44413
Fax: (330)426-1859

A.5.10 Reciprocating Conveyor (or equivalent) with minimum bed length of 4.3 m (14 ft) and width of 0.9 m (3 ft) equipped with a 1/8" X 35" X 10 foot rigid plate loosely affixed to the conveyor to which a carpet template and carpet test specimen may be attached (see 6.6 and 6.2). The conveyor must be capable of maintaining specified test speeds between 1 meter (3.3 ft.) per second and 0.55 meters (1.8 ft.) per second in a reciprocating cycle of forward and reverse directions. Conveyor bed must be equipped with brackets to hold the test vacuum in a stationary inclined operating position during testing with the vacuum handle at 888 mm (31 1/2") vertical height above the test material.

Perpetual Machines
706-226-1883

Reciprocating Carpet Conveyor



A.5.11 **Tachometer** used to calibrate conveyor speed in feet/second.

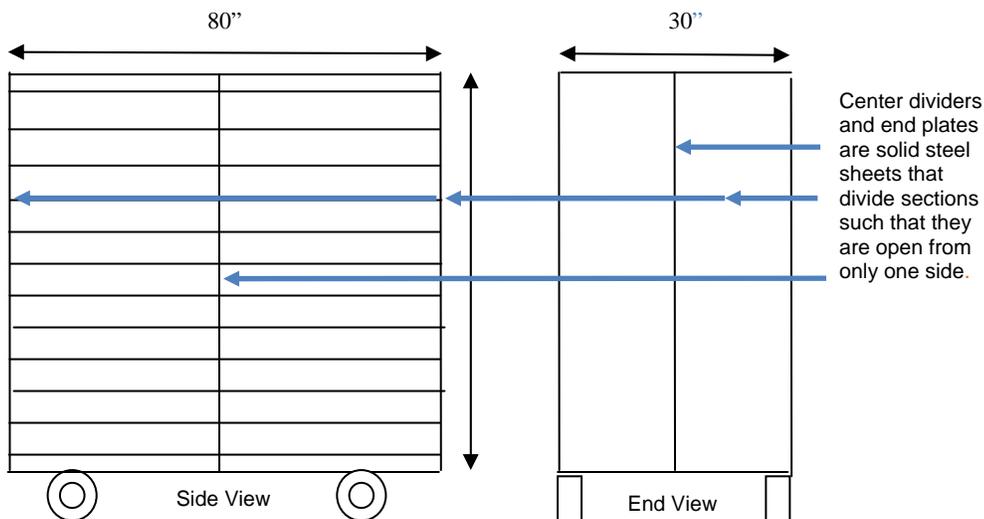
Grainger Industries
888-361-8649

A.5.12 **Control Vacuum Cleaner** – Agitator equipped upright vacuum with a minimum SOA/GL Bronze level certification.

CRI SOA/GL Approved Vacuum Cleaner
See CRI website: [http://: www.carpet-rug.org](http://www.carpet-rug.org)

A.5.13 **Sample Rack** – horizontal, non-ventilated sample storage rack per diagram below.

Professional Testing Laboratory
706-226-3283



A.6.0 Reagents and Materials

A.6.1 Test Carpet

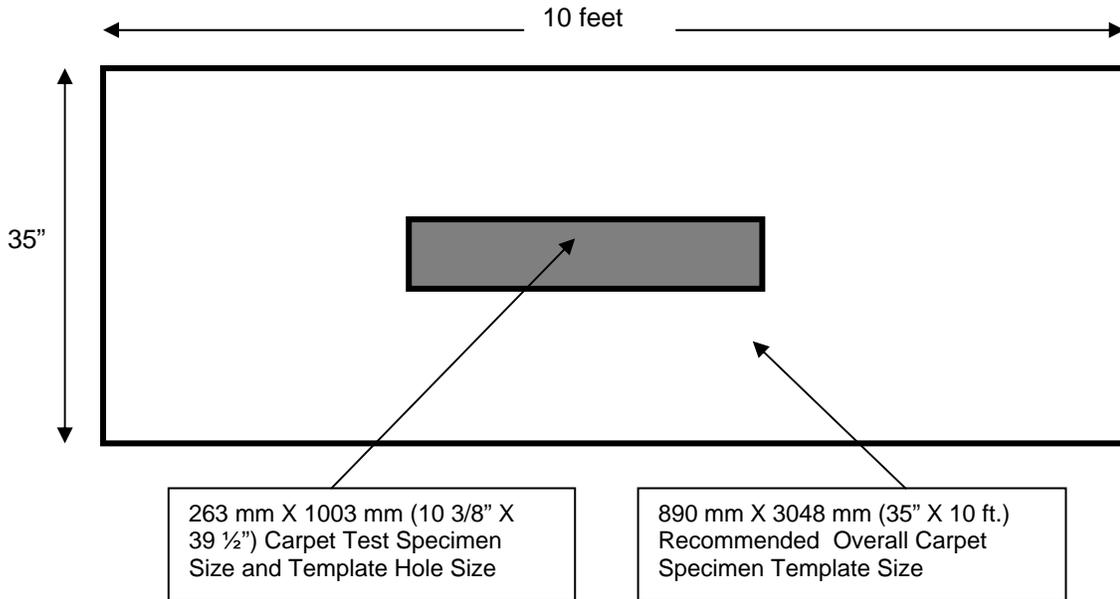
Test Material	
Construction	Tufted Cut Pile
Weight	25 Oz/Sq Yd
Pile Height	.56 Inch
Gauge	3/16
Yarn	100% BCF Nylon 6
Treatment	None

Residential Cut Pile Carpet **Style #: 42B61**

Note: All carpets for this test method are custom orders.

Shaw Industries, Inc.
800-521-7429

A.6.2 Test Carpet Template is comprised of the same material as test material, and is a minimum of 10 cm (4 inch) wider on all four sides than the head of the test vacuum. The featured template is mounted to a 35" X 10 ft. rigid 1/8" plate positioned on top of the conveyor using double sided tape. The carpet template must have a 263 mm X 1003 mm (10 3/8" X 39 1/2") hole centered and/or aligned with the head of the test vacuum for the soil removal phase per diagram below.



See Test Carpet A.6.1

A.6.3 ISO 12103 1, A2 (Arizona) Fine Test Dust Particle Distribution

Cumulative Volume Numeric Data	
Micron Size	% 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

