

## Standard Test Method for the Evaluation of Texture Appearance Retention of Carpets for Minimum Carpet Standards Program

### 1. Scope

- 1.1 This practice describes the equipment and operation of the hexapod tumble drum tester for testing carpets to produce changes in texture appearance due to changes in surface structure by mechanical action tester.
- 1.2 This practice is applicable for use in testing unused carpets of all types. It is not applicable for use in testing used pile yarn floorings.
- 1.3 This practice may be used by mutual agreement between the purchaser and supplier to set purchasing specifications.
- 1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.
- 1.5 *This practice 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 practice 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>
  - D123 Terminology Relating to Textiles
  - D1776 Practice for Conditioning and Testing Textiles
  - D5684 Standard Terminology Relating to Pile Floor Coverings

### 3. Terminology

- 3.1 For all terminology related to Pile Floor Coverings, see Terminology D5684
  - 3.1.1 The following terms are relevant to this standard: carpet, finished, finished pile yarn floor covering, floor covering, lengthwise direction, pile, pile lay, pile yarn floor covering, pitch, practice, primary backing, secondary backing, textile, tufted fabric.

3.2 For all other terminology related to textiles see Terminology D123.

3.3 Definitions:

- 3.3.1 change in surface appearance, *n* – for pile yarn floor coverings, the cumulative change in surface appearance between unexposed and exposed specimens due to crushing, loss of tuft definition, and matting.
- 3.3.2 crushing, *n* – in pile yarn floor covering, restorable or non- restorable loss of pile thickness due to traffic.  
Discussion – Crushing due to static load is excluded from this definition.
- 3.3.3 matting, *n* – for pile yarn floor coverings, loss of pile definition of a textile floor covering due to entanglement and compression of pile fibers.
- 3.3.4 loss of tuft definition, *n* – the bursting, opening, and untwisting of the pile yarn and/or decrimping of the fibers in the surface pile of a pile yarn floor covering.

#### 4. Summary of Practices

- 4.1 The specimen is secured to a backing sheet that is mounted inside the rotatable drum with the pile surface exposed. A metal hexapod, with six polyurethane studs, rolls randomly on the pile surface inside the rotating drum for a specified number of revolutions.

#### 5. Significance and Use

- 5.1 This equipment may be used to bring about the changes in appearance and texture on the surface of pile floor covering caused by mechanical action.
- 5.2 This practice does not simulate surface appearance changes due to soiling, pivoting, or rolling traffic, or traffic on stairs.

#### 6. Apparatus, Materials, and Reagent

- 6.1 *Hexapod Tumble Tester*  
6.1.1 *Drum* – constructed of Nylon or other like material and capped by a lid that is secured by a latching device. The drum and lid have a locating groove to hold the specimen backing sheet flat to the inner wall of the drum. A photograph of a typical drum is show in Photograph 1. The drum dimensions are:

Internal Diameter	12 ± 0.18 in.	(302 ± 5mm)
Wall Thickness	0.3 in. approx	(8 mm approx)
Internal Depth	8.2 ± 0.2 in.	(207 ± 5 mm)



Photograph 1a: Typical front view of drum cover

Photograph 1b: Typical inside of drum without cover.

6.1.2 *Driving System* - cradles the drum on rollers and keeps the axis of the drum level, and rotates the drum at  $35 \pm 2$  rpm ( $3.6 \pm 0.2$  rad/s). The driving direction reverses after approximately 500 revolutions. After the 500 rotations the unit will stop and stand stationary for approximately 5 to 15 seconds, then begin rotating in the opposite direction. After 2000 rotations the unit will stop and wait for the operator to restart the unit.

6.1.3 *Hexapod Tumbler* – there are two types of Hexapod Tumblers: the 2.8 lb (1270 g) or the 8.4 lb (3810 g), as specified below. The selection of which depends on the end use of the pile floor covering.<sup>1</sup>

Note 1: The 2.8 lb Residential Hexapod Tumbler is recommended for residential pile floor covering test applications and the 8.4 lb. Commercial Hexapod Tumbler is recommended for commercial pile floor covering test applications.

6.1.3.1 8.4 lb Commercial Hexapod Tumbler – Comprised of a steel (or other suitable material)  $2.0 \pm 0.04$  in ( $.50 \pm 1$  mm) cube with 1 inch (25 mm) thick plates welded to each side. The outside corners are welded such that when the studs are fitted and the hexapod placed on a flat surface, no metal touches the flat surface. The total length of any axis, not including hexapod feet, should be  $3.8$  in  $\pm 0.08$  in ( $96 \pm 2$  mm). Replaceable tumbler feet (see 6.1.3.3) are screwed centrally into each face. The specified total mass of Commercial Hexapod Tumbler

with six feet installed is  $8.4 \pm 0.2$  lb ( $3810 \pm 90$  g). A photograph of a typical 8.4 lb Commercial Hexapod Tumbler is shown in Photograph 2a.

- 6.1.3.2 2.8 lb Residential Hexapod Tumbler – Comprised of Aluminum (or other suitable material)  $2.00 \pm 0.04$  inch ( $50 \pm 1$  mm) cube with 25 mm (1 inch) thick plates welded to each side. The outside corners are welded such that when the studs are fitted and the hexapod placed on a flat surface, no metal touches the flat surface. Alternatively, the ball may be milled from a solid block if the construction meets the specifications. The total length of any axis, not including hexapod studs, should be  $3.8$  inch  $\pm 0.08$  inch ( $96 \pm 2$  mm). Replaceable tumbler feet are screwed centrally in each face. The specified total mass of the Residential Hexapod Tumbler with six feet installed is  $2.8 \pm 0.13$  lb ( $1270 \pm 60$ g). A photograph of a typical 2.8 lb Residential Hexapod Tumbler is shown in Photograph 2b.



Photograph 2a – 8.4 lb  
Commercial Hexapod Tumbler



Photograph 2b – 2.8 lb  
Residential Hexapod Tumbler

### 6.1.3.3 Hexapod Tumbler Feet Specifications

Tumbler Feet parameters are:

Diameter of Foot	1.60 ± 0.04 inch	(40 ± 1mm)
Height of Foot	0.60 ± 0.04 inch	(15 ± 1mm)
Edge of Radius Stud	0.60 ± 0.04 inch	(15 ± 1mm)
Steel Backing for Polyurethane		
Foot Hardness	83 ± 6 Type A Durometer	(3.00 ± 0.25 mm)
Foot Thickness	0.12 ± 0.01 inch	
Threading for 0.75 inch Bolt to attach Foot to Tumbler	Metric M8 – 1.25 (typical)	



Photograph 3 – Typical Hexapod Tumbler Foot

6.2 *Specimen Backing Sheet* – polyethylene approx 375 x 8.5 x 0.08 inch (approx 950 x 215 x 2 mm)

6.3 *Tape* – double-sided adhesive, approximately 2.0 in (50 mm) width.

6.4 *Vacuum Cleaner* – each specimen shall be vacuumed and pile erected with hand held vacuum that meets the following general specifications: powered rotating brush, bagless design, HEPA filtration, 7 amps motor, nozzle width 6.5 ± 0.3 inches (165 ± 7 mm), and overall weight 6.5 ± 0.5 pounds (3.0 kg ± 0.2 kg). Replace the rotating brush when the bristlelength changes more than 15% of the original length.

6.5 *Cleaning Frame (optional)* – a rectangular frame approx. 40 x 12 inches (1000 x 300 mm) with a central rectangular aperture approx 37 x 8 inches (940 x 200 mm) to receive the test specimen, of material

similar construction to the test specimen and mounted on a rigid backing sheet.

6.6 *Solvent* – use only ethyl alcohol, or isopropyl alcohol, technical grade.

6.7 CRI Reference Scales<sup>1</sup> - A series of imaged standards ranging from 5 (no change) to 1 (severe change) showing degrees of change in surface appearance is available for the following carpet constructions:

<u>Scale</u>	<u>Description</u>
CRI - 1	Saxony Cut-Pile
CRI - 2	Berber, Loop
CRI - 3	Commercial Loop, Low Profile
CRI - 4	Cut Pile Commercial Plush
CRI - 5	Cut Pile Frieze
CRI - 6	Tip Sheared with pattern
CRI - 7	Loop Pile Pattern

NOTE: This third series of scales is supplied color images with intermediate half-steps.

6.8 Option grading masks - made from cardboard or other suitable material used in viewing the unexposed and exposed specimens. These masks shall be non-reflective dark gray color with an aperture of 300 mm x 200 mm (12 in. x 8 in.) for use in grading laboratory drum tested samples and 350mm x 350 mm (14 in. x 14 in.) for floor traffic samples.

6.9 Illumination system for assessment - either portable or fixed lighting may be used which provides for 1500 lux ± 100 lux (~150 lumens per square foot) at the surface illumination with predominance of the light from directly above. Either North Sky light or Cool White fluorescent is satisfactory.

## **7. Preparation of Specimen**

7.1 *Marking Specimen* – before cutting out the test specimen, mark on the backing the direction of manufacturer with the head of the arrow pointing in the same direction as the lay of the pile.

7.2 *Size of Specimen* – cut the specimen approximately 37 x 8 inches (940 x 200 mm) with the long dimension parallel to the lengthwise direction of the pile yarn floor covering. Take no specimen within 4.0 inch (100 mm) of the trimmed selvedge. Alternatively, up to four

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<sup>1</sup> Available from Carpet and Rug Institute, P. O. Box 2048, Dalton, GA 30722

smaller specimens of similar thickness may be tested together, although if this is done, cut the specimen to allow for a 0.2 inch (5 mm) gap between each specimen, and insure that the pile lay is in the same direction.<sup>1</sup>

Note 2: Texture change results can be noticeably different when testing a specimen in the machine direction<sup>2</sup> versus across the machine direction.

**7.3 *Cleaning of Specimen*** – prior to testing, vacuum the specimen to remove any loose tufts or fibers.

**7.4 *Specimen Attachment*** – attach the double-sided adhesive tape along each side and across the end of the specimen backing sheet leaving approximately -0.2 inch (5 mm) clear at each edge, pressing down firmly to insure adhesion. If testing multiple specimens, attach an additional strip tape at each cross junction. Mount the specimen pile surface uppermost, allowing a 0.2 inch (5mm) gap at the end and between 0.2 to 0.4 inches (5 to 10 mm) between specimens to allow space for the pile when the backing sheet is curved to fit the drum.

## **8. Conditioning**

8.1 Bring the specimen to moisture equilibrium for testing in the standard atmosphere approaching equilibrium from the dry side without the use of heat. Determine that moisture equilibrium for testing has been attained as directed in Practice D1776.

## **9. Procedure**

- 9.1 Perform this practice on a specimen prepared as described in Section 8, maintaining the Hexapod Tumble Drum Tester in a temperature controlled atmosphere of  $70 \pm 5F$  ( $21 \pm 3C$ ).
- 9.2 Wipe the hexapod tumbler and the inside of the drum with a clean lint free tissue or cloth and one of the recommended solvents (See 6.6)
- 9.3 Insure that a Hexapod Tumble Drum Testing Unit has been maintained to the recommended checks found in ANNEX A.
- 9.4 Insure that the specimen lie smoothly around the internal circumference when the backing sheet is curved to fit the drum and that it is firmly held in place by the locating grooves. If necessary, adjust the specimen length.

- 9.5 Place the selected hexapod tumbler in the drum on the specimen surface.
  - 9.6 Secure the lid to the drum and position the drum on the rollers of the drive mechanism. Insure that the drum is level.
  - 9.7 Set the revolution counter for 2,000 revolutions. When the machine stops, remove the mounted specimen and prepare to vacuum the specimen. An optional central aperture of the cleaning frame can be used to hold the specimen
  - 9.8 The entire specimen must be vacuumed using the vacuum cleaner, make four passes (1 pass = 1 forward and back motion) along the length of the mounted specimen. The final pass must be in the lay of the pile.
  - 9.9 Return the mounted specimen to the drum and repeat 9.4 – 9.8 until 12,000 rotations has been completed.
  - 9.10 Do not let the tumbler lay on the specimen without movement for more than 2 hours.
  - 9.11 All specimens should be vacuumed and allowed to recover at normal room conditions, undisturbed, for a minimum of 16 hours prior to grading
- NOTE - Do not stack carpet specimens. Care should be exercised to prevent contact with the pile surface.
- 9.12 Place unexposed and exposed specimens under and perpendicular to the specified lighting such that the unexposed specimen is adjacent to the trafficked portion of the exposed specimen. Make sure both specimens are oriented the same with regard to pile direction.
  - 9.13 Place the appropriate mask, if used, over the specimens located in such a way that one-half of the aperture of the mask reveals the unexposed specimen and the other half reveals the maximum wear area of the exposed specimen.
  - 9.14 Select the appropriate reference scale series which most nearly resembles the construction of the pile yarn floor covering being assessed.
  - 9.15 Observing such features as crushing, loss of tuft definition, and matting, choose the reference scale grade which most nearly



resembles the degree of surface appearance change of the exposed specimen.

NOTE: Some specimens may display noticeable variation in appearance change within same trafficked area. If these exist, and are considered as a rating variable, note in the report the type of variation, e.g., pile reversal, small spot distortion, color change, fuzzing, or other.

9.16 At least three graders shall grade the specimens. The graders shall each observe the specimens from a distance of 0.5-1.0 m (approximately 1.5 ft. - 3 ft) at a 45°-90° angle from the specimen. Graders should observe specimens from various directions and rate the highest degree of surface change.

9.17 Each grader shall grade each specimen independently of the other graders.

9.18 Record the individual ratings for each specimen to the nearest 0.5 grading scale unit.

## **10. Report**

10.1 Report the following information:

10.1.1 Average rating of all graders for specimens trafficked to the nearest 0.5 number value.

10.2 State that the tester was operated as directed in CRI TM 103

10.3 Report the following information:

10.2.1 The number of drum rotations.

10.2.2 The type of vacuum cleaner used.

10.2.3 Detail any deviations from this practice.

10.2.4 The type of Tumbler Used (8.4 lb Commercial Hexapod Tumbler or 2.8 lb Residential Hexapod Tumbler).

## **11. Keywords**

11.1 appearance; carpet; floor covering; hexapod; pile yarn



## ANNEX A1

### Hexapod Pod Unit, Quality Control and Repeatability Process (Mandatory Practices)

- A1.1 To insure unit to unit reproducibility, it is important for every unit and tumbler combination be evaluated for conformance to the specifications listed in this ANNEX. The operators of this equipment must understand and consistently observe the running of the equipment and report any discrepancies for repair.
- A2.1 Verify the rpm of each machine is  $35 \pm 2$  rpm at least weekly. If the rpm is not within specification then take the unit out of service, and check the following.
- Drive belt worn or out of tension.
  - Evaluate counting system for improper set up or function. If using a reflectance system, replace tape / **clean eyes**. If using a metal proximity system evaluate the distance between sensors.
  - If rpm is not within specification, make an adjustment to the speed to obtain the proper rpm.
  - If the unit is gear driven, consider changing drive pulley size or converting unit to variable drive system.
- A2.2 Evaluate operational control of the hexapod unit at least once every 6 months. If the unit fails any of the verifications remove the unit from service until repaired.
- Check each unit's programmed rotation cycle. The unit must rotate in one direction for approximately 500 rotations (or 14.5 minutes); stop, wait approximately 60 seconds, and then rotate in the opposite direction for another 500 rotations (or 14.5 minutes). The unit's control system should **produce a** cycle of 2,000 rotations, stop and wait for the operator to remove the specimen for vacuuming.
  - Insure that the unit stops when the desired number of rotations has been obtained.
- A2.3 Hexapod Tumblers should be weighed with new hexapod feet installed. If weight is out of specification, make necessary changes to insure tumbler is in specification.
- Weight for 8.4 lb Commercial Hexapod Tumbler,  $8.40 \pm 0.20$  lbs. ( $3810 \pm 90$  grams)
  - Weight for 2.8 lb Residential Hexapod Tumbler,  $2.80 \pm 0.13$  lbs. ( $1270 \pm 60$  grams)

- A2.4 Hexapod Tumbler Feet should meet all specifications for manufacturer, and should be evaluated for the following attributes before being put into service, and during the normal course of it usefulness. Check each foot for cuts, tears, abrasions, and any other damage or imperfections that might cause additional texture change to the test carpet specimen. If found, discard the foot and replace with a new foot.
- a. Shape must meet the specifications found in section 6.1.3.3. Shape will change over time, visually check specimen versus a control Tumbler Foot, and determine if the shape is changing. If the shape becomes visually different, discard all studs and replace with new.
  - b. Check hardness of stud versus section 6.1.3.3. Typically, the hardness will change with usage. If the hardness exceeds the tolerance, remove from use.
- A2.5 Break In Period for New Hexapod Feet
- a. When installing a complete set of new hexapod feet, run the ball with new feet for 24 hours on a trial carpet specimen (no vacuuming required). This break-in period is necessary to insure accurate results for the life of the stud.
  - b. If the unit has been in constant use, it is recommended that the feet of a hexapod unit be replaced every 6 months or 1 million cycles. Constant use equals >20 hours / week for 26 weeks.
- A3.1 Hexapod Unit to Unit Texture Change Evaluation - If multiple hexapod units are used within a facility, an evaluation of the texture change produced should be conducted twice per year. Specimens for this evaluation should be obtained from the same carpet sample. The results are evaluated to insure each unit will produce similar texture change results.