



# Standard Practice for Determination of Graffiti Resistance<sup>1</sup>

This standard is issued under the fixed designation D 6578; 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 practice covers a basic method for evaluating graffiti resistance of coatings, and use of this practice to evaluate graffiti resistance of coatings after outdoor or laboratory accelerated exposure. Graffiti resistance is based on how a defined set of markings is removed by a defined set of cleaning agents.

1.2 A procedure for evaluating graffiti removal by alternate cleaning agents is included in a mandatory annex.

1.3 This practice also defines procedures to evaluate graffiti removal after remarking with subsequent re-cleaning. It does not address recoatability after a coating is no longer graffiti resistant.

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

1.5 *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:

D 523 Test Method for Specular Gloss<sup>2</sup>

D 740 Specification for Methyl Ethyl Ketone<sup>3</sup>

D 5402 Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs<sup>4</sup>

E 1347 Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry<sup>2</sup>

E 1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional Geometry<sup>2</sup>

G 7 Practice for Atmospheric Environmental Exposure of Nonmetallic Materials<sup>5</sup>

G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials<sup>5</sup>

G 147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests<sup>5</sup>

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications, and is the direct responsibility of Subcommittee D01.46 on Industrial Protective Coatings.

Current edition approved July 10, 2000. Published September 2000.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 06.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 06.04.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 06.02.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 14.04.

G 154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials<sup>5</sup>

## 3. Terminology

3.1 The definitions given in Terminology G 113 are applicable to this practice.

### 3.2 Definitions of Terms Specific to This Practice:

3.2.1 *graffiti resistance*—The property of coatings to be resistant to the application of graffiti or exhibiting easy removal of graffiti without surface damage.

3.2.2 *repellent*—The property of coatings that prevents materials commonly used as graffiti markings, from forming a continuous film upon application.

## 4. Summary of Practice

4.1 A series of materials typically used as graffiti markings is applied to test panels of the surface being evaluated. The graffiti markings are removed using a series of procedures that begin with wiping with a dry cloth and end with cleaning the surface with an aggressive cleaner. The graffiti resistance is reported as a cleanability level based on the first method, which completely removes the graffiti marking.

## 5. Significance and Use

5.1 Graffiti on building and structures is an ongoing and increasing problem. A number of coatings have been produced that are intended to be resistant to the application of a graffiti marking, or to provide a surface from which such markings can be easily removed. The procedures described in this practice provide a standard set of conditions that can be used to evaluate the graffiti resistance of a surface.

5.2 Graffiti resistance determined according to this practice is applicable to smooth surfaces. Graffiti resistance of the same coatings applied to a rough or textured surface may be lower.

5.3 Graffiti resistance of materials determined after natural or laboratory accelerated weathering conducted according to this practice, is considered as having more weight than graffiti resistance of the same material determined using freshly applied graffiti on surfaces, that have not been weathered. Graffiti resistance of materials determined after natural weathering should be considered as having more weight than graffiti resistance determined after laboratory accelerated weathering.

## 6. Apparatus

6.1 *Aluminum Panels*, sized to fit the washability apparatus used unless otherwise specified. A minimum of 15 panels will

be needed for each surface being tested for graffiti resistance.

6.2 *Straight-line Washability Apparatus*, capable of a moving a sponge/holder assembly over the marked area of a test panel at a speed of  $37 \pm 1$  cycles per min. The travel of the sponge/holder assembly shall be at least 203 mm (8 in.) in each direction.

6.2.1 *Cellulose Sponge*, coarse pore grade meeting Federal Specification L-S-626, Type II. The thickness of the sponge shall be such that when compressed between the holder and test panel, there is at least 3 mm ( $\frac{1}{8}$  in.) between the test panel surface and the bottom of the sponge holder.

6.2.2 *Sponge Holder and Weights*. The total dry weight of the holder plus weights shall be  $1500 \pm 10$  g.

6.2.3 *Stainless Steel Pan*.

6.2.4 *“C” Clamps*.

6.2.5 *Lint-free Cloth or Paper Towels*, for cleaning apparatus.

6.3 *Graffiti Marking Material*:

6.3.1 *Solvent-Based Ink Marker*, blue,<sup>6</sup>

6.3.2 *Solvent-Based Spray Paint*, red,<sup>6</sup>

6.3.3 *Wax Crayon*, blue or black.

6.3.4 *Water-based Ink Marker*, black,<sup>6</sup>

6.3.5 Other marking materials based on mutual agreement between all interested parties.

6.4 *Template*, with 51-mm (2-in.) diameter hole used to define area where graffiti marking material will be applied.

6.5 *Cleaning Material*:

6.5.1 *Dry, Lint-Free Cotton Cloth*.

6.5.2 *Mild Detergent*, 1 % aqueous solution.

6.5.3 *Citrus-Based Cleaner*, meeting the following basic composition: 40 to 90 % D-limonene, up to 50 % glycol ether, up to 13 % non-ionic surfactant.

6.5.4 *Isopropyl Alcohol*.

6.5.5 *Methyl Ethyl Ketone (MEK)*, conforming to Specification D 740.

6.6 *Pipet or Syringe*, capable of depositing  $10 \pm 1$  mL of cleaning liquid on the test panel.

6.7 *For Outdoor Exposures—Outdoor Exposure Rack*, meeting the requirements of Practice G 7 for open backed exposures.

6.8 *For Laboratory Accelerated Exposures—Fluorescent UV Exposure Device*, equipped with fluorescent UVA lamps with peak emission at 343 nm, and operated in accordance with Practice G 154.

6.9 *Proper Safety Equipment*, as determined from the solvent Material Safety Data sheets (MSDS), for example, solvent resistant gloves, and respirator.

## 7. Test Specimen

7.1 Apply the material to be evaluated for graffiti resistance to the aluminum test panels according to the manufacturer's instructions, following any relevant procedures for surface preparation prior to application.

7.2 Unless otherwise specified, prepare at least three specimens of each material being evaluated for each phase of the

procedure described in this practice.

NOTE 1—For the four markings and five cleaning agents specified in this practice, a total of 60 panels would provide three replicates for each marking/cleaner combination.

7.2.1 Prepare also at least one file specimen that can be used for comparison to the unmarked or unexposed materials, or both.

7.3 Unless otherwise specified, allow the coated test specimens to cure for at least 24 h at room temperature before continuing the test.

NOTE 2—Some anti-graffiti coatings may require more than 24 h to achieve optimum graffiti resistance. In such cases, follow the manufacturer's recommendations for curing.

7.4 Measure and record initial 60° gloss on coated test specimen.

7.5 After measuring gloss, place the template over the center of the prepared test panel and apply the following graffiti marking materials uniformly within the outlined area. Do not apply more than one marking material to any test panel. Store the marked panels at room temperature for at least 24 h before beginning to evaluate for removal.

7.5.1 Solvent based ink marker: blue permanent marker<sup>6</sup>,

7.5.2 Solvent based spray paint: red<sup>6</sup>,

7.5.3 Wax crayon: blue or black,

7.5.4 Water Based ink marker: Black<sup>6</sup>, and

7.5.5 Other making materials based on mutual agreement between all interested parties.

7.5.6 If the graffiti marking material does not uniformly wet out the test panel, the test surface is considered “repellent”. Cover as much of the surface as possible. In this case, the appearance of the dried marking may be very irregular.

## 8. Graffiti Removal Procedure Using Washability Tester

8.1 Level the washability apparatus and set it to operate at a speed of  $37 \pm 1$  cycles/min (cpm); each cycle consisting of a complete forward and reverse stroke.

8.2 Center the stainless steel tray and test panel below the path traveled by the sponge/holder and use “C” clamps to securely clamp them in place.

8.3 Wrap a dry, lint-free cotton cloth around the sponge so that there are at least two layers covering the top and bottom surfaces.

8.4 Place the cotton-wrapped sponge in the sponge holder and position on the traveling arm of the washability apparatus.

8.5 Operate the washability apparatus until the wrapped sponge moves across the marked area 50 times (25 complete cycles).

8.5.1 After the panel has been washed for 25 complete cycles, gently wipe it with no more than three complete cycles using a clean, lint-free cotton cloth to remove the last remains of any material.

8.6 Evaluate the test specimen for removal of graffiti.

8.6.1 Proceed to the next most aggressive cleaner, (see 6.5), if visual inspection shows that it is obvious that the marking has not been removed (8.8).

8.6.2 A marking is considered as completely removed if there is no visual evidence of residual material or “shadow” and the following two criteria are met:

<sup>6</sup> Solvent-based permanent ink marker, Blue Sharpie<sup>®</sup>, water-based ink marker, Eberhard Faber Black, and solvent-based spray paint, Krylon<sup>®</sup> Red have been found to be suitable marking agents.

8.6.2.1 *Retention of 60° Gloss*—After the graffiti marking has been removed, measure the 60° gloss according to Test Method D 523 on each specimen. Determine the ratio of the average gloss measured after the marking has been removed, to the average gloss measured on the panels prior to marking. The ratio shall be at least 0.80.

8.6.2.2 *Color Shift*—For each replicate specimen, measure color in accordance with Test Methods E 1347 or E 1349 in the area where the graffiti was removed, and in an area where no graffiti was applied. Calculate Delta *E* CIE LAB based on comparison of the average color coordinates for the cleaned surface, and the average color coordinates for the surface prior to marking, or for an unmarked area of the same specimen. For a graffiti marking to be considered as completely removed, the Delta *E* shall be less than 1.

8.6.2.3 Evaluate and report any other damage that may have occurred during the graffiti removal (for example, blistering, softening, loss of adhesion, etc.) according to relevant standards.

8.7 If the marking is completely removed from all replicate panels after cleaning with the dry cotton cloth according to 8.2-8.6, the test is complete, and the surface can be rated as “Cleanability Level 1”.

8.8 If cleaning with the cotton cloth wrapped sponge does not completely remove the marking, mount a fresh test panel with the graffiti marking in the tray of the washability apparatus according to 8.2. Saturate a clean sponge with a 1 % aqueous solution of mild detergent and place it in the sponge holder assembly. Place 10 mL of the aqueous detergent solution on either side of the marked area and operate the washability apparatus according to 8.5, until the sponge moves across the marked area 50 times (25 complete cycles). Repeat for each replicate panel with the marking being evaluated, and evaluate for graffiti removal according to 8.6. If the marking is completely removed from all replicate panels, the test is complete and the surface can be rated as “Cleanability Level 2”.

8.9 If cleaning with the 1 % aqueous solution of mild detergent does not completely remove the marking, repeat the steps described in 8.8 using the citrus cleaner. If the marking is completely removed from all replicate panels, the test is complete, and the surface can be rated as “Cleanability Level 3”.

8.10 If cleaning with the citrus cleaner according to 8.9 does not completely remove the marking, repeat the steps described in 8.8, using isopropanol. If the marking is completely removed from all replicate panels, the test is complete and the surface can be rated as “Cleanability Level 4”.

8.11 If cleaning with the isopropanol according to 8.10 does not completely remove the marking, repeat the steps described in 8.8 using MEK. If the marking is completely removed from all replicate panels, the test is complete and the surface can be rated as “Cleanability Level 5”. If the graffiti marking is not completely removed from any of the replicate panels, the test is complete and the surface is rated as “Not Cleanable”.

8.12 If the washability tester does not comply with applicable safety requirements for use of solvents near electrical equipment, evaluate cleanability with isopropanol, MEK, and

any other solvents using the manual method described in Section 9.

NOTE 3—Evaluation of other cleaning agents is described in Annex A1 of this practice.

## 9. Graffiti Removal Procedure Using Manual Solvent Rubs

9.1 In some cases, it may not be possible to evaluate graffiti resistance using a washability tester. In these cases, the following manual cleaning procedure may be used if agreed upon between all interested parties.

9.2 Wrap a clean sponge with at least two layers of dry, lint-free cotton cloth and rub across the marked area of a set of marked specimens for 25 complete back and forth cycles, in accordance with Practice D 5402. If it is obvious that the marking has been removed, the rubbing can be stopped before 25 complete cycles.

9.2.1 After the panel has been cleaned for 25 complete cycles, gently wipe it with no more than three complete cycles using a fresh clean, lint-free cotton cloth to remove the last remains of any material, then evaluate for graffiti removal in accordance with 8.6.

9.3 If cleaning with the cotton cloth wrapped sponge does not completely remove the marking, saturate a clean sponge with a 1 % aqueous solution of mild detergent, and rub across the marked area of a set of marked specimens for 25 complete back and forth cycles in accordance with Practice D 5402. If it is obvious that the marking has been removed, the rubbing can be stopped before 25 complete cycles. Repeat for each replicate panel with the marking being evaluated and evaluate for graffiti removal according to 8.6. If the marking is completely removed from all replicate panels, the test is complete, and the surface can be rated as “Cleanability Level 2”.

9.4 If cleaning with the 1 % aqueous solution of mild detergent does not completely remove the marking, repeat the steps described in 9.3 using the citrus cleaner. If the marking is completely removed from all replicate panels, the test is complete, and the surface can be rated as “Cleanability Level 3”.

9.5 If cleaning with the citrus cleaner according to 8.9 does not completely remove the marking, repeat the steps described in 9.3 using isopropanol. If the marking is completely removed from all replicate panels, the test is complete, and the surface can be rated as “Cleanability Level 4”.

9.6 If cleaning with the isopropanol according to 8.10 does not completely remove the marking, repeat the steps described in 9.3 using MEK. If the marking is completely removed from all replicate panels, the test is complete and the surface can be rated as “Cleanability Level 5”. If the graffiti marking is not completely removed from any of the replicate panels, the test is complete, and the surface is rated as “Not Cleanable”.

## 10. Recleanability Procedure

10.1 In many cases, it is necessary to evaluate whether a graffiti resistant material will show the same level of cleanability after it has been cleaned and remarked with graffiti. To evaluate recleanability use the following procedure.

10.2 After a graffiti marking is completely removed, re-apply the marking to each replicate panel in accordance with 7.4.

10.3 Use the cleaning agent that completely removed the marking and follow the appropriate cleaning procedure from Section 8 or Section 9 to remove the marking, and evaluate for removability in accordance with 8.6.

10.4 If the graffiti marking is not completely removed, repeat 10.2 and 10.3 with the next most aggressive cleaning agents (see 6.5). If none of these cleaning agents results in complete removal of the marking, the surface is classified as “Not Recleanable”.

10.5 If the graffiti marking is completely removed, repeat 10.2 and 10.4 until the marking cannot be completely removed. The recleanability is classified as the number of cycles needed before the marking cannot be removed.

**NOTE 4**—If a surface could be effectively cleaned with citrus cleaner for three successive marking applications, its recleanability rating would be as follows: “3 Cycles, Cleanability Level 3”. If a surface could be effectively cleaned with citrus cleaner, but after remarking, it took MEK to completely remove the marking, its recleanability rating would be “1 Cycle, Cleanability Level 5”.

## **11. Graffiti Removal From Panels That Have Been Subjected To Outdoor Exposure**

11.1 *Method A*—Removal of freshly applied graffiti markings from coatings that have been subjected to outdoor exposure:

11.1.1 Prepare a set of specimens to be evaluated in accordance with Section 7.

11.1.2 Engrave or indent each of the panels in accordance with Practice G 147 so that they can be identified upon return from exposure.

11.1.3 Unless otherwise specified, expose this set of panels in accordance with Practice G 7 on an open backed rack that faces the Equator and oriented at an angle of 45° to the horizontal for 24 months in a hot, desert climate. For the exposure site, the mean monthly temperature during the coldest month of the year shall be at least 10 °C, and the mean monthly temperature during the warmest month of the year shall be at least 28 °C.

11.1.3.1 If other exposure locations and times are used, the location and dates of exposure shall be included in the report.

11.1.4 After the panels have been returned from exposure, apply graffiti markings in accordance with 7.4.

11.1.5 Evaluate cleanability of marked panels in accordance with Sections 8 or 9.

11.1.6 Evaluate recleanability in accordance with Section 10.

11.2 *Method B*—Removal of graffiti markings after the marked panel has been subjected to outdoor exposure:

11.2.1 Apply the graffiti resistant material in accordance with 7.1-7.3 and mark them in accordance with 7.4.

11.2.2 Unless otherwise specified, expose this set of panels in accordance with Practice G 7 on an open backed rack that faces the Equator and oriented at an angle of 45° to the horizontal for 12 months in a hot, desert climate. For the exposure site, the mean monthly temperature during the coldest month of the year shall be at least 10 °C, and the mean monthly

temperature during the warmest month of the year shall be at least 28 °C.

11.2.3 Evaluate cleanability of the marked, exposed panels in accordance with Sections 8 or 9.

11.2.4 Evaluate recleanability in accordance with Section 10.

## **12. Graffiti Removal From Panels That Have Been Subjected To Laboratory-Accelerated Weathering Exposure**

12.1 *Method A*—Removal of freshly applied graffiti markings from coatings that have been subjected to laboratory-accelerated weathering:

12.1.1 Prepare a set of specimens to be evaluated in accordance with Section 7.

12.1.2 Engrave or indent each of the panels in accordance with Practice G 147 so that they can be identified after completion of the exposure.

12.1.3 Unless otherwise specified, expose this set of panels in accordance with Practice G 154 for at least 2000 h using the following cycle:

(a) Eight h UV at a black panel temperature of 60 °C,

(b) Four h dark with condensation at a black panel temperature of 50 °C.

12.1.3.1 If other exposure conditions or times are used, provide a complete description of the exposure conditions and times in accordance with Practice G 154 and include it with the report.

12.1.4 After the panels have complete laboratory accelerated weathering, apply graffiti markings in accordance with 7.4.

12.1.5 Evaluate cleanability of marked panels in accordance with Sections 8 or 9.

12.1.6 Evaluate recleanability in accordance with Section 10.

12.2 *Method B*—Removal of graffiti markings after the marked panel has been subjected to laboratory accelerated weathering:

12.2.1 Apply the graffiti resistant material in accordance with 7.1-7.3 and mark them in accordance with 7.4.

12.2.2 Engrave or indent each of the panels in accordance with Practice G 147 so that they can be identified after completion of the exposure.

12.2.3 Expose this set of panels for 1000 h in accordance with 12.1.3.

12.2.4 Evaluate cleanability of marked panels in accordance with Sections 8 or 9.

12.2.5 Evaluate recleanability in accordance with Section 10.

## **13. Report**

13.1 Report the following information for each material being evaluated:

13.1.1 Identification of coating or material being tested,

13.1.2 Procedure for preparation of the coating or material being tested including cure time and temperature,

13.1.3 Type of substrate, (if coating is applied to a material that has been applied to the test panels),

13.1.4 Dry film thickness of surface being tested,

- 13.1.5 Exposure method used,
- 13.1.6 Removal method used (washability tester or manual rubs), and
- 13.1.7 Repellency, cleanability, Delta E, gloss ratio, and any other damage observed in accordance with Table 1.

**14. Precision and Bias**

14.1 *Precision*—There is not yet enough data to prepare a

precision statement for this practice. Subcommittee D1.46 is working on a round-robin to generate data for an appropriate precision statement.

14.2 *Bias*—The concept of bias is not applicable to this practice.

**15. Keywords**

15.1 anti-graffiti; cleanability; graffiti; removal

**TABLE 1 Report Form for Repellency, Cleanability, and Re-cleanability of Graffiti Resistant Materials**

Identification of surface being tested:			
Exposure Method (if used) (circle one)	<i>Outdoor exposure—Method A</i> (exposure of panels prior to marking and cleaning). Provide complete description of exposure conditions if different from those described in 11.1.3. <i>Outdoor exposure—Method B</i> (exposure of panels marked with graffiti before exposure) Provide complete description of exposure conditions if different from those described in 11.2.2. <i>Laboratory Accelerated Weathering—Method A</i> (exposure of panels prior to marking and cleaning). Provide complete description of exposure conditions if different from those described in 12.1.2. <i>Laboratory Accelerated Weathering—Method B</i> (exposure of panels marked with graffiti before exposure). Provide complete description of exposure conditions if different from those described in 12.2.3)		
Marking Material	Repellent (yes or no)	Cleanability level (1 - 5, or not cleanable <sup>4</sup> )	Re-Cleanability Level (number of remarkings with complete removal and the cleanability level for last cycle where graffiti completely removed)
Blue Permanent Marker <sup>6</sup>			
Red spray paint <sup>6</sup>			
Blue or black wax crayon			
Black water based ink marker <sup>6</sup>			
Other marking material agreed upon by all interested parties			

<sup>4</sup>Cleanability Levels 1-5 are defined as:

- Level 1 Graffiti completely removed with dry cotton cloth.
- Level 2 Graffiti completely removed with 1 % aqueous detergent solution.
- Level 3 Graffiti completely removed with citrus cleaner (see 6.5.3).
- Level 4 Graffiti completely removed with isopropanol.
- Level 5 Graffiti completely removed with MEK.
- Not cleanable Graffiti still remains, or gloss ratio is less than 0.8, or Delta E of cleaned surface, compared to an unmarked area is greater than 1.0.

**ANNEX**

**(Mandatory Information)**

**A1. PROCEDURE FOR EVALUATION OF ALTERNATE GRAFFITI CLEANING AGENTS**

**A1.1 Scope**

A1.1.1 This annex describes a procedure for the evaluation of a graffiti cleaning agent by comparing how it removes a defined set of markings from a surface with how a defined set of cleaning agents removes the same markings from the same surface.

**A1.2 Panel Preparation**

A1.2.1 Prepare a set of panels according to Section 7 of this practice.

**A1.3 Evaluation of Graffiti Removal With Cleaner**

A1.3.1 Evaluate graffiti removal with the five defined agents according to Section 8 or Section 9 of this practice.

A1.3.2 Follow the basic procedures described in either 8.8-8.11 or 9.4-9.6 of this practice and attempt to remove each

of the graffiti markings described in 7.4.

A1.3.3 Evaluate for graffiti removal in accordance with 8.6 of this practice.

A1.3.4 If graffiti is completely removed, rate the graffiti removal for the cleaner according to the following scale:

- Graffiti removal rating = 1 Graffiti is completely removed by both a dry cotton cloth, and the cleaning agent being evaluated.
- Graffiti removal rating = 2 Graffiti is completely removed by both the 1 % aqueous detergent solution, and the cleaning agent being evaluated.
- Graffiti removal rating = 3 Graffiti is completely removed by both the citrus cleaner, and the cleaning agent being evaluated.
- Graffiti removal rating = 4 Graffiti is completely removed by both IPA, and the cleaning agent being evaluated.
- Graffiti removal rating = 5 Graffiti is completely removed by both MEK, and the cleaning agent being evaluated.

A1.3.5 Report graffiti removal rating for alternate cleaner using Table A1.1.

**TABLE A1.1 Form for Reporting Graffiti Removal Rating of Cleaning Agents**

---

Complete description of cleaning agent being evaluated:

Complete description of surface from which markings were removed:

Graffiti marking material	Graffiti removal rating (1-5)
Blue Permanent marker <sup>6</sup>	
Red spray paint <sup>6</sup>	
Blue or black wax crayon	
Black water based ink marker <sup>6</sup>	
Other marking material agreed upon by all interested parties	

---

*The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).*