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Standard Practice for Determination of Graffiti Resistance¹

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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 (either prior to or after graffiti is applied). Graffiti resistance is based on how a defined set of markings is removed by a defined set of cleaning agents.

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

~~1.3~~ 1.2 This practice also defines procedures (optional) to evaluate graffiti removal after re-marking with subsequent re-cleaning. It does not address recoatability after a coating is no longer graffiti resistant.

~~1.4~~ 1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

~~1.5~~ 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

D 523 Test Method for Specular Gloss

~~D740~~ Specification for Methyl Ethyl Ketone 4587 Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings

~~D5402~~ Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs

E 1347 Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry

E 1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional Geometry²

Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45:0 or 0:45) Geometry

G 7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials

G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials⁵

G147 Practice for Conditioning and Handling of Nonmetallic Materials for Natural and Artificial Weathering Tests⁵

G154 Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials⁵ Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

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. cleaning agent, n—a material used to remove a marking material from the coating surface.

3.2.2 repellent—The property of coatings that prevents materials commonly used as graffiti markings, from forming a continuous film upon application. graffiti resistance, n—the property of coatings to be resistant to the application of graffiti or exhibiting removal of graffiti without surface damage.

3.2.3 marking material, n—a material that can be used to produce graffiti.

3.2.4 re-cleanability, n—the ability of a coating to withstand multiple cycles of marking with subsequent cleaning while maintaining its original characteristics.

¹ This practice 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.

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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* Vol 06.01, volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.5 repellent, n—the property of coatings that prevents materials commonly used as graffiti markings, from forming a continuous film upon application.

4. Summary of Practice

4.1A 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.

4.1 A series of materials typically used as graffiti markings is applied to test panels of the surface being evaluated. Test specimens may be exposed to outdoor or accelerated exposures (either before or after markings have been applied). 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. After the best attempt has been made to remove markings, specimens are evaluated visually, or alternatively, by gloss and color change measurements to determine cleanliness. The graffiti resistance is reported as a cleanability level based on the mildest cleaning agent that completely removes the graffiti marking without damaging the coating.

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 materialscoatings determined after natural or laboratory accelerated weathering, either before or after marking, conducted according to this practice, is considered as having more weight than graffiti resistance of the same materialcoating determined using freshly applied graffiti on surfaces, that have not been weathered without weathering. Graffiti resistance of materialscoatings 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. 15 by 30 cm (6 by 12 in.) panels representing the intended substrate.

6.2 Straight-line Washability Apparatus, capable of moving a sponge/holder assembly over the marked area of a test panel at a speed of 37 ± 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-5-626, 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 ± 10 g.

6.2.3 Stainless Steel Pan Lint-Free Cotton Cloth.

6.2.4 "C" Clamps.

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

6.3

6.3 Graffiti Marking Material:

6.3.1 Solvent-Based Permanent Ink Marker, blue,

6.3.2 Solvent-Based Acrylic Spray Paint, red,

6.3.3 Wax Crayon, blue or black. Solvent-Based Alkyd Spray Paint, red,

6.3.4 Wax Crayon, blue or black,

6.3.5 Ballpoint Ink,

6.3.6 Water-based Ink Marker, black,⁶

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, black,

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

6.4 15 by 30 cm (6 by 12 in.) Template, with 25 by 25 mm (1 by 1 in.) square holes used to define area where graffiti marking material will be applied. The number of holes should be equal to the number of marking materials, should be spread apart from each other as much as possible, and should have a 13 mm (0.5 in.) margin along the perimeter.

6.5 Cleaning Agents:

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, as agreed upon between purchaser and seller (a solution of 5 % sodium phosphate is recommended),

6.5.3 Isopropyl Alcohol,

6.5.4 Mineral Spirits,

6.5.5 Xylene,

6.5.6 Methyl Ethyl Ketone (MEK), conforming to Specification D740.

6.6 Pipet or Syringe, capable of depositing 10 ± 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.

6.8.7 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 G154D 4587.

6.9

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

6.9 Glossmeter, 60°, (for Evaluation Method B only).

6.10 Colormeter, capable of D65, CIE LAB measurements meeting Test Method E 1347 or Test Method E 1349 (for Evaluation Method B only).

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. Test Specimen

7.1 Apply the coating to be evaluated for graffiti resistance to the 15 by 30 cm (6 by 12 in.) test panels according to the manufacturer's instructions, following any relevant procedures for surface preparation prior to application.

7.2 Prepare at least three specimens of each coating being evaluated.

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

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

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. 1—It may be useful to prepare several sets of panels for each coating and allow the different sets to cure for different periods. The purpose would be to determine the point at which optimum graffiti resistance occurs.

7.5 Measure and record initial 60° gloss in accordance with Test Method D 523 and color in accordance with Test Method E 1347 or Test Method E 1349 (using a D65 illuminant, CIE LAB calculations) on coated test specimens (for Evaluation Method B only).

7.6 Place the template described in 6.4 over the prepared test panel and apply the entire complement of marking materials prescribed in 6.3 so that each panel is marked with a 25 by 25 mm (1 by 1 in.) square of all graffiti materials (one marking material for each space in the template).

7.6.1 Be careful not to cross-contaminate one marking material with another. Remove template. Store the marked panels at room temperature for at least 24 h before beginning to evaluate for removal.

7.7 If the graffiti marking material does not uniformly cover the test area of the panel, or resists adhering to it, the test surface is considered "repellent." In this case, beading of the marking material might occur. In this case, the appearance of the dried marking may be very irregular.

8. Graffiti Removal Procedure

8.1 Attempt to remove each marking material from the panel with a cotton cloth alone, then by using a cotton cloth that has been wetted with the following cleaning agents, working through them in the order listed (increasing strength).

(a) mild detergent

(b) isopropyl alcohol (IPA)

(c) mineral spirits

(d) xylene

(e) methyl ethyl ketone (MEK)

The area of the cotton cloth that is wetted should be well saturated, but not dripping.

8.2 Rub each marking vigorously until it is completely cleaned off, or until it is visually evident that no more of the mark can be removed.

8.3 Reposition and re-wet the cotton cloth between markings as necessary, working through the entire panel with one cleaning agent at a time.

8.4 Use a different cotton cloth with each cleaning agent.

NOTE2—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 marker⁶;

7.5.2 Solvent-based spray paint: red⁶;

7.5.3 Wax crayon: blue or black;

7.5.4 Water-Based ink marker: Black⁶, and

7.5.5 Other marking 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 ± 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:

8.6.2.1 *2—As cleaning agents of increasing strength are used, some of the markings will probably be cleanable, whereas others will not. Exercise care so that areas that have been cleaned are not contaminated with stronger agents that are being used to clean other marks.*

9. Evaluation of Cleanability

9.1 *Method A, Visual:*

9.1.1 After the best attempt has been made to clean a mark, visually examine it and note any trace of the mark, that is, a color change (shadow) or a loss of gloss.

9.1.2 If the spot has returned to its original condition before marking, note which cleaning agent was used to remove the mark. The mark will be considered to be cleanable with this agent.

9.2 *Method B, Instrumentally:*

9.2.1 *Retention of 60° Gloss*—After the graffiti marking has been removed, measure the 60° gloss according to Test Method D523 on each specimen. Determine the ratio of the average gloss measured after the marking has been removed, removed to the average gloss measured on the panels prior to marking. The ratio shall be at least 0.80-0.90.

8.6.2.2.2 *Color Shift*—For each replicate specimen, measure color in accordance with Test Methods E1347 or E1349 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 —After the graffiti marking has been removed, measure color in the area where the graffiti was removed. 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 2.

9.2.3 Note the cleaning agent. The mark will be considered to be cleanable with this agent if the criteria in 9.2.1 and 9.2.2 are met.

10. Confirmation of Cleanability

10.1 Repeat procedures in Sections 8 and 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 D5402. 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 D5402. 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 (using either Method A or B for Section 9) on the other two replicates, only begin with the next weakest cleaning agent that removed each mark from the first replicate of each system rather than beginning all removal attempts with a dry cotton cloth. If it does not remove the mark move to the next strongest agent (the one that removed the mark the previous time). Although unlikely,

it may be that this does not remove the mark. If this occurs, work up through the cleaning agents in order of strength. If a particular mark was not removed from the first replicate with MEK, begin with xylene on subsequent replicates.

10.2 If it is not possible to completely remove the spot without adversely affecting the film, it is considered to be not cleanable.

10.3 Based upon the average of the results of the 3 replicate trials, use the following rating scale for cleanability for each coating.

Cleanable with a dry rag = 10
 Cleanable with detergent = 9
 Cleanable with IPA = 8
 Cleanable with mineral spirits = 7
 Cleanable with xylene = 6
 Cleanable with MEK = 5
 Not cleanable, gloss loss = 4
 Not cleanable, slight shadow = 3
 Not cleanable, heavy shadow = 2
 Not cleanable, shadow and gloss loss = 1

11. Recleanability Procedure (Optional)

11.1 In some 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.

11.2 Re-mark the areas on the panels in the same locations that they were marked prior to cleaning with the same marking materials and allow the markings to cure for at least 24 hours.

11.3 Attempt to remove the mark using procedures in Sections 8 or Section and 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."

11.1 Graffiti Removal From Panels That Have Been Subjected To Outdoor Exposure

11.1

11.4 If the marking is completely removed, repeat steps 11.2 and 11.3 until the marking cannot be completely removed without damaging the coating. The recleanability is classified as the number of cycles performed until the marking is no longer cleanable.

12. Graffiti Removal From Panels That Have Been Subjected To Outdoor Exposure

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

12.1.1 Prepare a set of specimens to be evaluated in accordance with Section 7.1-7.4.

11.1.2 Engrave or indent each of the panels in accordance with Practice G147 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 G7 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

12.1.2 Engrave or indent each of the panels so that they can be identified upon return from exposure.

12.1.3 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. Note general atmospheric conditions, geographical location, and dates of exposure.

NOTE 3—Conditions will vary among geographic locations, which could produce different results. South Florida and Arizona desert are commonly used locations.

12.1.4 Remove from exposure and apply graffiti markings in accordance with 7.5-7.7.

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

NOTE 4—The purchaser and seller shall agree upon whether or not the panels should be washed (or to what extent the panels should be washed) before marking.

12.1.5 Determine cleanability of marked panels in accordance with Sections 8-10.

11.1.6 Evaluate recleanability in accordance with Section 10.

11.2