



Designation: D6486 – 01 (Reapproved 2017)

Standard Practice for Short Term Vehicle Service Exposure of Automotive Coatings¹

This standard is issued under the fixed designation D6486; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the protocol for vehicle service exposure testing of automotive coatings. Such exposure testing is valuable for the verification of the performance of automotive coatings and correlation with laboratory test data. Vehicle service exposure is intended to provide short term (2 to 20 weeks) exposure to the stress factors associated with vehicle operation. Factors included are scratch, mar, impact, stone chipping, insect impact, bird dropping, tree sap and staining, environmental fallout, etc.

NOTE 1—Vehicle service exposure is not intended to provide the conditions that are needed for characterizing the long term effects of weathering or corrosion exposure.

1.2 The exposure conditions are produced by the placement of multiple test panels of automotive finishes on automotive test fleets that traverse a defined road course. Exposure to the operating environment can be 20 h/day, 7 days/week allowing for accumulation of over 100 000 miles in 10 weeks of exposure.

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

1.4 *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.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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 D01.55 on Factory Applied Coatings on Preformed Products.

Current edition approved June 1, 2017. Published June 2017. Originally approved in 1999. Last previous edition approved in 2011 as D6486 – 01 (2011). DOI: 10.1520/D6486-01R17.

2. Referenced Documents

2.1 ASTM Standards:²

- D523 Test Method for Specular Gloss
- D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products
- D714 Test Method for Evaluating Degree of Blistering of Paints
- D823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels
- D1005 Test Method for Measurement of Dry-Film Thickness of Organic Coatings Using Micrometers
- D1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (Withdrawn 2006)³
- D1400 Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base (Withdrawn 2006)³
- D3170 Test Method for Chipping Resistance of Coatings
- D3359 Test Methods for Rating Adhesion by Tape Test
- D5767 Test Methods for Instrumental Measurement of Distinctness-of-Image Gloss of Coating Surfaces

2.2 U.S. Federal Standard:

- DOT NHTSA Reg. #49 CFR Part 575⁴

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *blistering, n*—formation in the film of dome-shaped, liquid- or gas-filled projections resulting from local loss of adhesion and lifting of the film from the previously applied coating or the substrate.

3.1.2 *chipping, n*—removal of a coating, usually in small pieces, resulting from impact by hard objects or from wear during service.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.

3.1.3 *cracking, n*—formation of breaks in a film that extend through to the underlying surface.

3.1.4 *distinctness-of-image-gloss, n*—aspect of gloss characterized by the sharpness of images of objects produced by reflection at a surface.

3.1.5 *gloss, n*—angular selectivity of reflectance, involving surface-reflected light, responsible for the degree to which reflected highlights or images of objects may be seen as superimposed on a surface.

3.1.6 *staining, n*—discoloration, arising from foreign materials, that penetrates into the coating.

4. Significance and Use

4.1 Since the exposure of automotive coatings to the various mechanical and chemical stresses encountered in actual operations, is very opportunistic, obtaining statistically significant data from which valid conclusions can be drawn, requires rigorous attention to the experimental designs and conditions of exposure.

5. Limitations

5.1 Vehicle service exposure is not intended to provide the conditions that are needed for characterizing the long term effects of weathering or corrosion exposure.

5.2 Vehicle service exposure is not intended to provide absolute values. The performance of the test coatings is relative to that of a control coating.

6. Vehicle Test Fleets

6.1 Various commercial organizations operate multi-vehicle fleets that can conform to the required test conditions. Among other objectives, they are operated to comply with federal tire wear rating requirements. The U. S. Federal requirements are published in DOT NHTSA Reg. #49 CFR Part 575, and specifies specific route and operating conditions. The addition of properly designed specimen racks to these vehicles can be accommodated.

7. General Requirements

7.1 Test panels are mounted on the major surfaces (front, sides, and roof) of the vehicle. Since the exposure of automotive coatings to the various mechanical and chemical stresses encountered in actual operation is very opportunistic, obtaining statistically significant data from which valid conclusions can be drawn requires rigorous attention to the experimental design and conditions of the exposure.

7.1.1 Control and test coatings must be exposed simultaneously.

7.1.2 All coatings must be exposed on the major (front, sides and roof) vehicle surfaces.

7.1.3 Exposure specimen positions in the specimen mounting racks must be randomized.

7.1.4 All coatings must be exposed to the maximum probability of stresses in the shortest possible time. The selection of the specific road course to be traversed controls this requirement.

7.1.5 A sufficient number of vehicles, operating under identical controlled conditions must be available, to allow for maximum exposure and minimum vehicle operational problems.

7.1.6 The selection of the operational environment must be chosen to ensure the highest probability of exposure to the stress of interest.

7.2 The fleet operating environment should be defined to optimize the stress factors of interest. Examples are; gravel/unpaved road segments to evaluate stone chipping, mechanical car washing after dust road travel to evaluate mar resistance, operation during insect season to evaluate insect impact, etc.

8. Procedure

8.1 Prepare a minimum of two test panels per specimen rack, in accordance with the coatings manufacturers specifications, for the coatings to be evaluated. Prepare the test panels as described in Practices [D609](#) or [D823](#). The coating film thickness should be controlled in accordance with the manufacturers specifications and measured in accordance with Test Methods [D1186](#), [D1005](#) or [D1400](#).

NOTE 2—Control and test coating specimens (panels) must have a large enough surface area to be able to accumulate sufficient occasions of stress, and thus be statistically meaningful. Specimen size of 203 by 305 mm (8 by 12 in.) has been found to be adequate.

8.2 Measure the gloss and distinctness of image (DOI) of the test and control coating panels in accordance with Test Methods [D523](#) and [D5767](#).

8.3 Place the test and control coating panels on the specimen racks.

8.4 Mount the specimen racks on the carrier vehicles.

NOTE 3—Specimen racks are to be mounted on the center front bumper (front), right and left front doors (side) and roof of the vehicle.

NOTE 4—A minimum of three test vehicles, operating in convoy, so that by rotating position periodically, all test specimens acquire the stresses that are specific to their convoy position.

8.5 Begin the operation of the test run.

NOTE 5—It is highly desirable that the vehicles providing the test platform operate 24 h/day over a broad range of road surfaces, for example, dirt, gravel, concrete, etc. The vehicles should operate at specific speeds over a prescribed route. Such accumulations allow for the accumulation of 10 000 miles/week and therefore a high increase of stress with minimal weathering exposure.

NOTE 6—From a cost consideration the test should be conducted by piggybacking on vehicle fleets operating for other test purposes.

NOTE 7—Periodic exposure to mechanical car washing should be integrated into the test schedule. This will provide exposure to mar and scratching.

NOTE 8—Periodic parking under trees should be integrated into the test schedule. This will provide exposure to tree sap and bird droppings.

8.6 At the completion of the test run remove the specimen racks from the test vehicles.

8.7 Remove the control and test panels from the specimen racks.

8.8 Examine the control and test panels for the following;

8.8.1 Gloss in accordance with Test Method [D523](#).

8.8.2 DOI in accordance with Test Methods [D5767](#).

8.8.3 Scratch.

- 8.8.4 Mar.
- 8.8.5 Staining.
- 8.8.6 Etching.
- 8.8.7 Chipping in accordance with Test Method **D3170**.
- 8.8.8 Cracking.
- 8.8.9 Adhesion loss in accordance with Test Method **D3359**.
- 8.8.10 Blistering in accordance with Test Method **D714**.

NOTE 9—There are no ASTM methods for quantitatively measuring scratch, mar, staining, chipping or cracking of an automotive coating. Therefore, these observations are subjective and should be made versus the control coating.

9. Report

- 9.1 Report the following information:
 - 9.1.1 Type of coating tested.
 - 9.1.2 Identification of coating tested (control or test coating).
 - 9.1.3 Initial coating film properties to serve as base point (gloss, DOI).
 - 9.1.4 Test specimen locations.
 - 9.1.5 Test specimen rotation sequence.
 - 9.1.6 Any special stress conditions.
 - 9.1.7 Name of fleet operator and location.
 - 9.1.8 Time frame of exposure test.
 - 9.1.9 Number of vehicles involved in exposure test.

- 9.1.10 Convoy organization.
- 9.1.11 Road course description.
- 9.1.12 Distance traveled for duration of exposure test.
- 9.1.13 Stress conditions encountered, for example, bugs, stone chips, etc.
- 9.1.14 Weather conditions during exposure test.
- 9.1.15 Final coating film properties (gloss, DOI, scratch, mar, stain, etch), and
- 9.1.16 Final coating film integrity (chips, cracks, adhesion loss, blistering).

10. Precision and Bias

10.1 *Precision*—It is not practical to specify precision because the values obtained by this practice have no absolute value and should only be used to derive relative performance rankings for test panels. Because of this, no statements on *Repeatability* and *Reproducibility* are being made.

10.2 *Bias*—Since there is no accepted reference procedure suitable for determining the bias for this practice, no statement on bias is being made.

11. Keywords

11.1 coatings; coatings performance; road hazards; short term exposure

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