Designation: D2794 – 93 (Reapproved 2010)

Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)[1]

This standard is issued under the fixed designation D2794; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers a procedure for rapidly deforming by impact a coating film and its substrate and for evaluating the effect of such deformation.

1.2 This test method should be restricted to testing in only one laboratory when numerical values are used because of the poor reproducibility of the method. Interlaboratory agreement is improved when ranking is used in place of numerical values.

1.3 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.

1.4 *This standard does not purport to address 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]

D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products

D823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels

D1186 Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base (Withdrawn 2006)[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *impact resistance, of a coating, n*—the number of inch-pounds (kilogram-metres) required to produce cracking in the deformed coating.

4. Summary of Test Method

4.1 The organic coatings under test are applied to suitable thin metal panels. After the coatings have cured, a standard weight is dropped a distance so as to strike an indenter that deforms the coating and the substrate. The indentation can be either an intrusion or an extrusion. By gradually increasing the distance the weight drops, the point at which failure usually occurs can be determined. Films generally fail by cracking, which is made more visible by the use of a magnifier, by the application of a copper sulfate ($CuSO_4$) solution on steel, or by the use of a pin hole detector.

5. Significance and Use

5.1 Coatings attached to substrates are subjected to damaging impacts during the manufacture of articles and their use in service. In its use over many years, this test method for impact resistance has been found to be useful in predicting the performance of organic coatings for their ability to resist cracking caused by impacts.

6. Apparatus

6.1 *Tester,* consisting of a vertical tube to guide a cylindrical weight that is dropped on a punch resting on the test panel.

6.1.1 *Guide Tube,* 24 to 48 in. (0.6 to 1.2 m) long mounted vertically in a base plate. A slot is cut lengthwise on one side of the tube to act as a guide for a cylindrical weight that fits inside the tube. Graduations are marked in inch-pounds along the slot. The base is constructed so that a thin flat panel can be inserted at 2 in. (50 mm) below the tube.

6.1.2 *Weight,* metal cylinder, made to fit inside the guide tube. A pin is fitted into one side of the weight to act as a guide by riding in the slot of the tube and to serve as a handle by which the weight can be raised and released and serve as the indicator of inch-pounds (kilogram-metres).

---

[1] 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 D01.23 on Physical Properties of Applied Paint Films.

Current edition approved Dec. 1, 2010. Published December 2010. Originally approved in 1969. Last previous edition approved in 2004 as D2794 – 93 (2004). DOI: 10.1520/D2794-93R10.

[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.

6.2 *Indenter*—A steel punch with a hemispherical head having a diameter of either 0.500 in. (12.7 mm) or 0.625 in. (15.9 mm). The head rests on the test panel and the punch is held vertically by a guide ring.

6.3 *Panel Support*—A steel fixture with a 0.64-in. (16.3-mm) diameter cylindrical hole centered under the indenter for supporting the test panel.

6.4 *Magnifier.*

6.5 *Pin Hole Detector.*

7. Reagents

7.1 An acidified copper sulfate ($CuSO_4$) solution prepared by dissolving 10 g of $CuSO_4 \cdot 5H_2O$ in 90 g of 1.0 *N* hydrochloric acid (HCl).

8. Test Specimens

8.1 Apply uniform coatings of the material to be tested to 24-gage (0.025 in. or 0.63 mm) steel panels treated with a conversion coating in accordance with Procedure A of Practice D609, unless otherwise specified. Prepare a minimum of four coated panels for the material.

NOTE 1—The coatings should be applied in accordance with Practices D823, or as agreed upon between the producer and the user. Other gage steel panels may be used if agreed upon between the producer and the user.

8.2 Cure the coated panels under conditions of humidity and temperature agreed upon between the producer and the user.

NOTE 2—The thickness of the dry coatings should be measured in accordance with Test Methods D1186.

9. Conditioning

9.1 Unless otherwise agreed upon between the producer and the user, condition the coated test panels for at least 24 h at 73.5 ± 3.5°F (23 ± 2°C) and 50 ± 5 % relative humidity. Conduct the test in the same environment or immediately on removal therefrom.

10. Procedure

10.1 Install the punch having the head diameter specified or agreed upon. Place the test panel in the apparatus with the coated side either up or down as specified or agreed upon. Be sure the panel is flat against the base support and that the indenter is in contact with the top surface of the panel. Lightly place the weight on the indenter and adjust the guide tube so that the lifting pin is at the zero mark. Raise the weight up the tube to a height where it is expected that no failure will occur. Release the weight so that it drops on the indenter.

10.2 Remove the test panel from the apparatus and observe the impact area for cracks in the coating. If no cracks are evident, repeat the procedure at a greater height, increasing 1 in. (25 mm) at a time. Once visible cracks are observed, repeat the test five times at each of three heights; slightly above, slightly below, and at that determined in the first trial. Test in a random fashion so that all impacts from one height are not made in succession or on one panel.

10.3 Examine the impacted areas for cracking by one of the following methods:

10.3.1 Use a magnifier to examine the area for cracks.

10.3.2 Hold a white flannel-type cloth saturated with the acidified copper sulfate ($CuSO_4$) solution (7.1) over the impacted areas for at least 15 min. Remove the cloth and examine both the test areas and cloth for evidence of copper deposition or iron-rust staining respectively.

NOTE 3—The copper sulfate solution will not perform properly on zinc-phosphate-treated metal unless the conversion coating cracks.

10.3.3 To detect breaks in the film with a pin hole detector, first connect the ground lead from the instrument to the bare substrate and connect the instrument to an electrical power source. Moisten the probe sponge with tap water and slowly draw the probe over the impact area. The presence of cracks will be indicated by an audible alarm.

10.4 For each inch-pound (kilogram-metre) level, tabulate the number of times the coating passed or failed. The value where the results change from mainly passing to mainly failing is the impact failure end point.

11. Report

11.1 Report the following for each coating tested:

11.1.1 The inch-pounds (kilogram-metres) at the impact failure end point,

11.1.2 Whether intrusion or extrusion was used,

11.1.3 Diameter of the punch used,

11.1.4 Thickness of coating,

11.1.5 Substrate thickness and type of metal,

11.1.6 Method of panel preparation, and

11.1.7 Atmospheric conditions under which the coated panels were conditioned and tested.

NOTE 4—Because of the poor reproducibility of this method, the reporting of inch-pounds (kilogram-metres) in comparing coatings for impact resistance should be restricted to one laboratory. For interlaboratory comparisons, rankings of coatings for impact resistance should be reported.

12. Precision and Bias

12.1 On the basis of an interlaboratory test in which operators in six laboratories tested three paints having a broad range of impact resistance on two metal substrates, the between-laboratories coefficients of variation were found to be as follows:

	Coefficient of Variation	
	Intrusion, %	Extrusion, %
Brittle coating (less than 6 in.-lb)	25	100
Average coating (between 6 and 140 in.-lb)	80	100
Flexible coating (more than 140 in.-lb) (0.625 in.-diameter punch)	10	25

12.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedure in this test method, bias cannot be determined.

13. Keywords

13.1 cracking failure; extrusion indentation; intrusion indentation; impact failure