Designation: D4400 – 99 (Reapproved 2012)ε1

Standard Test Method for Sag Resistance of Paints Using a Multinotch Applicator[1]

This standard is issued under the fixed designation D4400; 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 U.S. Department of Defense.

ε[1] NOTE—Sole source of supply footnote was removed editorially and new footnote placed in Precision section in November 2012.

INTRODUCTION

The multinotch applicator used in this test method is a drawdown blade with a series of notches of successively higher clearance, referred to as the Anti-Sag Meter. See Fig. 1 and Fig. 2 for a representative diagram and photograph. The numerical value for sag resistance obtained with this instrument is referred to as the Anti-Sag Index.

Anti-Sag Meters are made with several clearance ranges for different types of coatings (see 5.1 and Table 1). In developing this standard the task group used an instrument with a range from 4 to 24 mils, but the method is applicable to any clearance range, and results using instruments with overlapping ranges correlate and have equal validity.

The basic method was developed in 1962[2] and is referenced in U.S. Federal specifications TT-E-508, TT-E-506, and TT-P-1511.

A preshear program is essential for a drawdown sag test to duplicate the breakdown in structure that occurs when thixotropic paints are applied by brushout or other practical application methods. The procedures therefore include the preshearing of paints just prior to making test applications.

1. Scope

1.1 This test method covers the laboratory determination of the sag resistance of aqueous and nonaqueous liquid coatings at any level of sag resistance.

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

1.3 *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:*[3]

D2196 Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer

2.2 *U.S. Federal Specifications:*[4]

Fed. Spec. TT-E-508 Alkyd semi-gloss enamel

Fed. Spec. TT-E-506 Alkyd gloss enamel

Fed. Spec. TT-P-1511 Interior latex gloss and semi-gloss finishes

3. Summary of Test Method

3.1 After preshearing, the coating is applied to a test chart with a multinotch applicator. The charts are immediately hung vertically with the drawdown stripes horizontal, similar to rungs of a ladder, with the thinnest stripe at the top. After

[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 D01.42 on Architectural Coatings.

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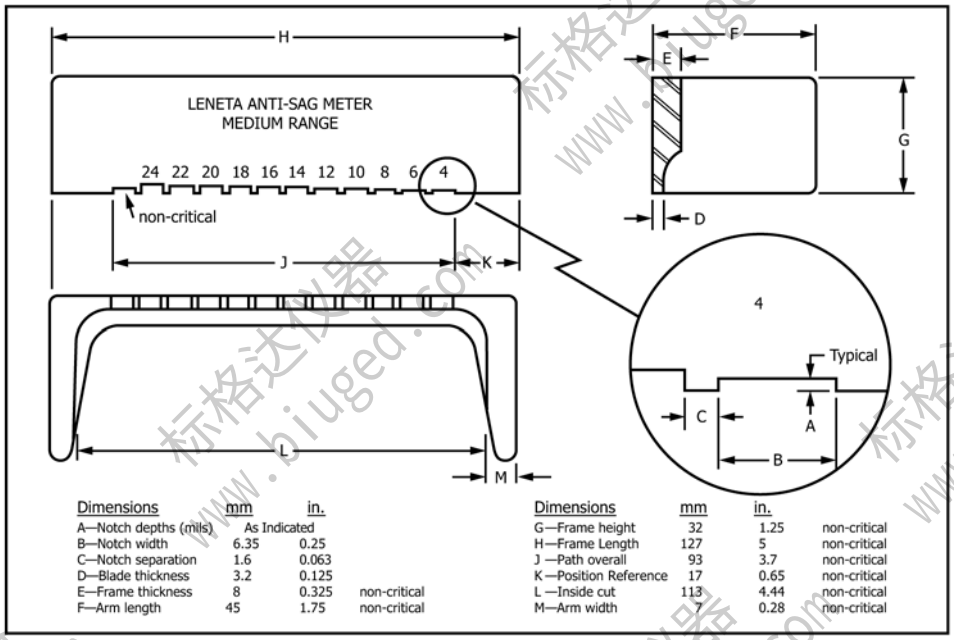
[2] "Design of an Improved Sag Tester," *Official Digest*, Vol 34, No. 453, October 1962.

[3] 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.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.



Dimensions	mm	in.	
A—Notch depths (mils)	As Indicated		
B—Notch width	6.35	0.25	
C—Notch separation	1.6	0.063	
D—Blade thickness	3.2	0.125	
E—Frame thickness	8	0.325	non-critical
F—Arm length	45	1.75	non-critical

Dimensions	mm	in.	
G—Frame height	32	1.25	non-critical
H—Frame Length	127	5	non-critical
J —Path overall	93	3.7	non-critical
K—Position Reference	17	0.65	non-critical
L —Inside cut	113	4.44	non-critical
M—Arm width	7	0.28	non-critical

FIG. 1 Diagram of the Medium Range Anti-Sag Meter

FIG. 2 Medium Range Anti-Sag Meter

drying in this position, the drawdown is examined and rated for sagging. A typical sag pattern obtained by this procedure is shown in Fig. 3.

4. Significance and Use

4.1 Evaluation of sag resistance is essential in quality control for both producers and purchasers of coatings. Practical application tests are poor in reproducibility, while viscometric methods, for example Test Methods D2196, are time-consuming and lack the convincing aspect of actual sagging. This method provides simple and rapid tests, whereby sag resistance is demonstrated by a visible sag pattern, and is rated objectively in terms of numerical values that correlate with brushout test observations.

5. Apparatus

5.1 *Multinotch Applicator,* Anti-Sag Meter, a drawdown blade with a series of notches of successively higher clearance. Select a clearance range suitable for the type of coating under test in accordance with Table 1.

5.2 *Test Surfaces,* sealed, smooth-surfaced paper test charts, with sizes and designs as follows:

5.2.1 *Black and White Charts,* about 193 by 288 mm (7⅝ by 11⅜ in.), the black area comprising about 140 mm (5½ in.) centered on the drawdown path. A chart of this design is shown in Figs. 3 and 4.

5.2.2 *Plain White Charts,* about 193 by 285 mm (7⅝ by 11¼ in.).

5.3 *Glass Drawdown Plate,* plus straightedge guide for attachment thereto.

5.4 *Catch-papers,* thin sheets of sealed paper, for catching surplus paint at the completion of a drawdown.

5.5 *Equipment for the Preshearing of Aqueous Coatings:*

5.5.1 *Syringe,* 10-mL, disposable plastic type.

5.5.2 *Syringe Needle,* 15 g by 40 mm (1½ in.) to fit syringe.

5.5.3 *Syringe Extension Tubing,* clear vinyl, inside diameter 3.2 mm (⅛ in.), outside diameter 5 mm (⅜ in.).

5.6 *Equipment for the Preshearing of Nonaqueous Coatings:*

5.6.1 *Rotary Mechanical Stirrer,* variable speed.

5.6.2 *Circular Mixing Paddle,* diameter approximately 48 mm (1⅞ in.).

5.6.3 *Mixing Container,* cylindrical jar or can with capacity of up to 500 mL (1 pt).

6. Procedure

6.1 *Preparation of Sample:*

6.1.1 Stir thoroughly with a spatula in the original container.

6.1.2 Strain if necessary to remove large particles or skins.

6.1.3 Adjust the temperature of the coating to 23 ± 2°C (73.5 ± 3.5°F).

6.2 *Preshearing with Syringe and Needle (Aqueous Coatings):*

6.2.1 Prepare the paint as described in 6.1.

6.2.2 Cut a 60-mm (2½-in.) length of syringe extension tubing and attach it to the syringe.

6.2.3 Press the syringe barrel firmly to expel air, dip the end of the syringe into the coating, pump slightly to expel remaining air, then withdraw 8 mL of coating.

TABLE 1 Anti-Sag Meters—Available Ranges

	Range	For Coating Type:		Notch Clearances[A]										
ASM-1	Standard	Solvent-borne architectural	Mils	3	4	5	6	7	8	9	10	11	12	
			µm	75	100	125	150	175	200	225	250	275	300	
ASM-2	Low	Industrial O.E.M. coatings	Mils	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
			µm	25	38	50	63	75	88	100	113	125	138	150
ASM-3	High	High build coatings	Mils	14	16	18	20	25	30	35	40	45	50	60
			µm	350	400	450	500	625	750	875	1000	1125	1250	1500
ASM-4	Medium	Water borne architectural	Mils	4	6	8	10	12	14	16	18	20	22	24
			µm	100	150	200	250	300	350	400	450	500	550	600

[A] Mils are exact. Wet film thickness is about half of clearance.

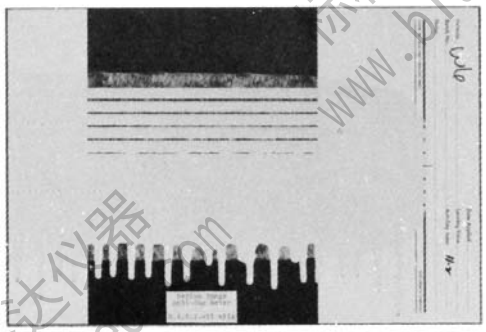


FIG. 3 Typical Sag Pattern

NOTE 1—Note use of straightedge guide.

FIG. 4 Drawing Down with the Anti-Sag Meter

6.2.4 Remove and discard the extension tubing and then attach a syringe needle.

6.2.5 Eject the contents of the syringe in front of the applicator as rapidly as possible, with firm, steady pressure.

6.3 *Preshearing with a Rotary Mechanical Mixer (Non-aqueous Coatings):*

6.3.1 Prepare the paint as described in 6.1 and fill the mixing container slightly more than half. Set the container under the stirrer so that the paddle is about 5 mm (¼ in.) from the bottom.

6.3.2 Mix vigorously for 1 min at a speed sufficient to form a moderate vortex, with the entire contents of the can in rapid circular motion. Rotor speeds of 1300 to 3600 r/min have been found satisfactory, the optimum speed depending on the relative diameters of the mixing paddle and container. For referee tests the operators should agree upon the specific container, paddle, and mixing speed.

6.3.3 Immediately after mixing place about 8 mL of paint in front of the applicator and draw down in accordance with 6.4.

6.4 *Application of the Test Coating:*

6.4.1 Affix a suitable test chart onto the drawdown plate. Use black and white charts in accordance with 5.2.1 for light or moderately dark colored coatings and white charts in accordance with 5.2.2 for very dark coatings.

6.4.2 Fasten the straightedge onto the drawdown plate in a suitable position.

6.4.3 Place the Anti-Sag Meter at the far end of the chart, the open side toward the operator and shoulder against the straightedge guide.

6.4.4 If desired, position a catch-paper just underneath the lower edge of the chart.

6.4.5 Preshear in accordance with 6.2 or 6.3 and immediately draw down the coating at a uniform speed of about 150 mm (6 in.)/s, with the applicator pressed against the straightedge to maintain a straight path. See Fig. 4 for illustration of this step.

6.4.6 Immediately hang the chart with the drawdown stripes in a horizontal position like rungs in a standing ladder, the thinnest stripe at the top, and allow to dry in that position. A typical test pattern derived using this procedure is shown in Fig. 3.

6.5 *Rating the Drawdown:*

6.5.1 When the film is dry, note the notch numbers marked on the Anti-Sag Meter and identify the corresponding stripes accordingly.

6.5.2 Observe the sag pattern, ignoring the bottom stripe, which serves only as a position reference for the stripe above it, and the leading and trailing edges of the drawdown, considering only the central 140 mm (5½ in.) of the blade path. This corresponds to the black area of the black and white chart described in 5.2.1. (See Fig. 3 for a typical sag pattern of this type.)

6.5.3 Select the lowest (thickest) stripe that has resisted crossing the gap to touch the next lower stripe. This is referred to as the index stripe.

6.5.4 Estimate the degree to which the next lower stripe (the post-index stripe) has merged with the one below it, and determine the corresponding addendum fraction, as specified in Table 2.

TABLE 2 Intermediate Ratings

Degree of Merger of Post-Index Stripe	Addendum Fraction
Complete	0.0
Almost complete	0.2
Somewhat more than half	0.4
Half	0.5
Somewhat less than half	0.6
Slight (just touching)	0.8

6.5.5 Multiply the fraction from 6.5.4 by the difference between the index and post-index stripe number to obtain the index addendum.

6.5.6 Add the index addendum to the index stripe number to obtain the Anti-Sag Index and record same.

7. Report

7.1 Report the Anti-Sag Index of the coating as recorded in 6.5.6.

8. Precision [5,6]

8.1 *Correlation*—In an interlaboratory study in which operators in seven laboratories tested six water-reducible paints covering a wide range of sag resistance and in five laboratories tested four solvent-reducible paints covering a wide range of sag resistance, the Spearman Rank Correlation Coefficient was 0.92 versus brushouts (a coefficient of 1.0 indicates perfect agreement in ranking).

8.2 *Sensitivity*—In the interlaboratory study described in 8.1, the sensitivity criterion values have been computed to be 4 for brushouts versus 11 for this procedure. The latter is thus approximately three times more sensitive to differences in sag resistance than brushouts.

8.3 *Precision:*

8.3.1 Two interlaboratory tests were conducted to establish the precision of this test method. The first test was that described in 8.1. The second test consisted of operators in five laboratories performing three tests on each of three paints. On the basis of the second interlaboratory test, the within-laboratory pooled coefficients of variations for both water- and solvent-reducible paints were 4.4 %. On the basis of the first interlaboratory test, the between-laboratory pooled coefficient of variation was found to be 12.4 % for water-reducible paints and 8.8 % for solvent-reducible paints. Based on these coefficients of variation, the following criteria should be used for judging the acceptability of results at the 95 % confidence level:

8.3.1.1 *Repeatability*—Two results obtained by the same operator for either water-reducible or solvent-reducible paints should be considered suspect if they differ by more than 10.7 %.

8.3.1.2 *Reproducibility*—Two results obtained by operators in different laboratories should be suspect if they differ by more than 34.4 % for water-reducible paints and 23.4 % for solvent-reducible paints.

9. Keywords

9.1 Anti-Sag Index; rheological properties; sag-resistance

[5] The Leneta Anit-Sag Meter was used in the interlaboratory study.

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D01-1040. Contact ASTM Customer Service at service@astm.org.