Standard Test Method for
Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance[1]

1. Scope

1.1 This test method covers the visual evaluation of gloss differences of coating surfaces, using special types of lamps for illumination. It identifies six aspects or types of gloss that one may look for when using the lamp to assess gloss differences between surfaces. It describes the conditions for using the lamps to best identify small differences in each of the six types of gloss. Four levels of visual gloss differences are distinguished.

1.2 While this technique is useful for both weathered and unweathered specimens, it has not been applied to metallics.

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 all of the safety concerns, if any, associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
D3964 Practice for Selection of Coating Specimens for Appearance Measurements
E284 Terminology of Appearance

3. Terminology

3.1 *Definitions*—For definitions of terms used in this method, see Terminology E284.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *directionality of surface, n*—perceived change of glossy appearance of a surface with rotation of the surface in its own plane (see Fig. 1).

3.2.2 *gloss, distinctness-of-image, n*—perceived sharpness of images reflected by an object surface (see Fig. 2).

3.2.3 *gloss, of a surface, n*—perceived directionally selective reflecting properties responsible for the degree to which reflected highlights or images of objects may be seen as superimposed on the surface.

3.2.4 *reflection haze, n*—cloudy or milky appearance of a surface adjacent to directions of specular reflection (see Fig. 3).

3.2.5 *sheen, n*—perceived shininess at a near-grazing angle of incidence for an otherwise matte specimen (difficult to photograph).

3.2.6 *specular gloss, n*—the relative luminous reflectance factor of a specimen in the specular direction. The luminous reflectance factor is the ratio of the luminous flux reflected from, to that incident on, a specimen for specified solid angles (see Fig. 4).

3.2.7 *texture, n*—perceived structure, pattern, or topography or combination thereof, of a surface (see Fig. 5).

4. Summary of Test Method

4.1 Test specimens are illuminated by special light sources that provide reflected images suitable for rating the gloss of coating surfaces. Two types of lamps may be used to produce reflected images. Lamp A consists of a modified fluorescent desk lamp covered with screen mesh. Lamp B consists of an incandescent bare filament bulb installed in an adjustable angle fixture.

4.2 Light from the selected lamp illuminates the test specimens. The reflected images reveal specular gloss reflection; the sharpness of the images of the screen or lamp filament reveals the detail and quality of the surface reflection (distinctness of image); and spreading of the reflected light into dark areas, such as the space between fluorescent tubes or near the filament image, reveals the presence of near-specular haze.
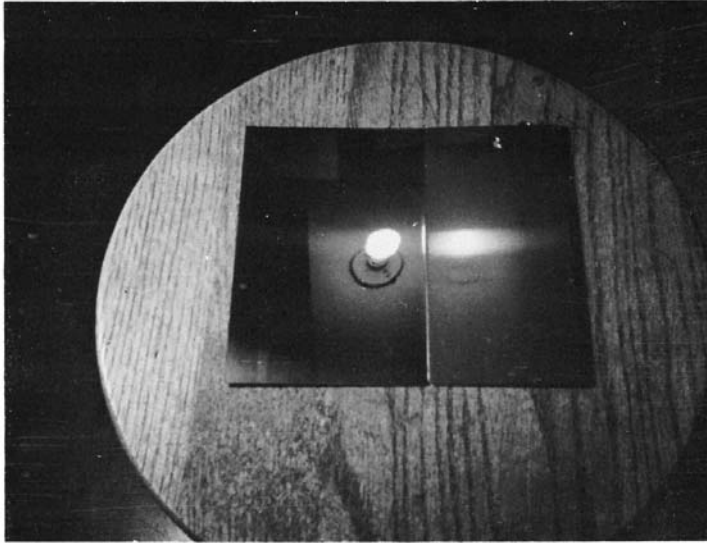
Note 1—The left panel is free of directionality. The right panel is highly directional because of buffing marks.
FIG. 1 Reflection of Bright Incandescent Lamp in Two Panels
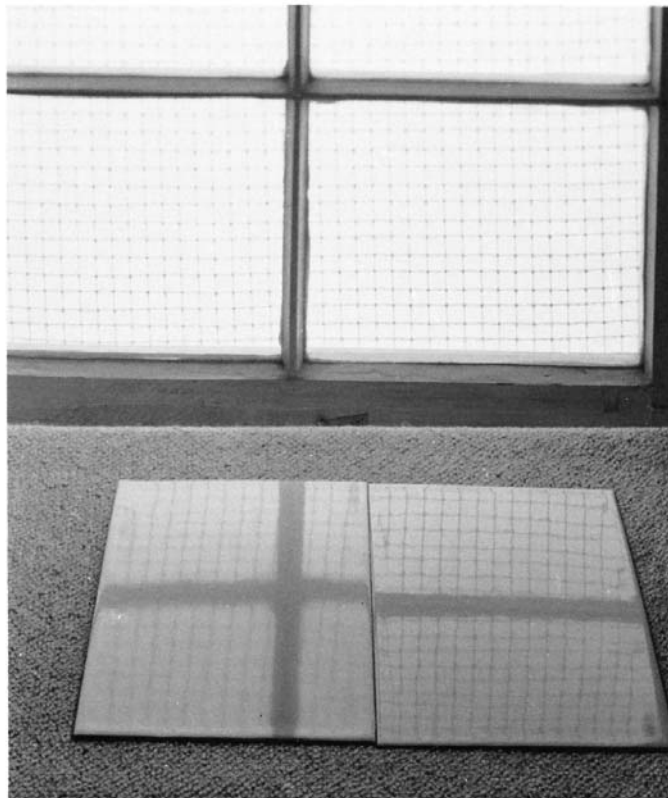
Note 1—The panels exhibit a difference in distinctness-of-reflected image.
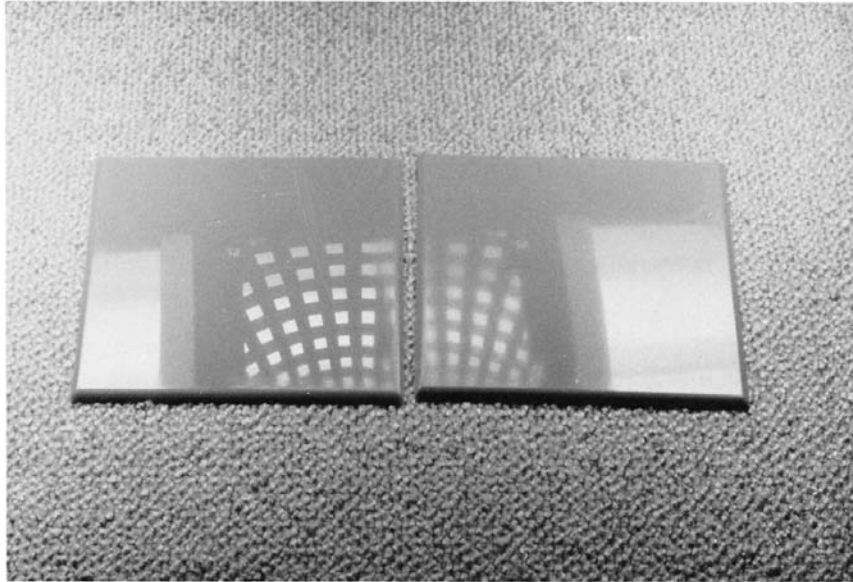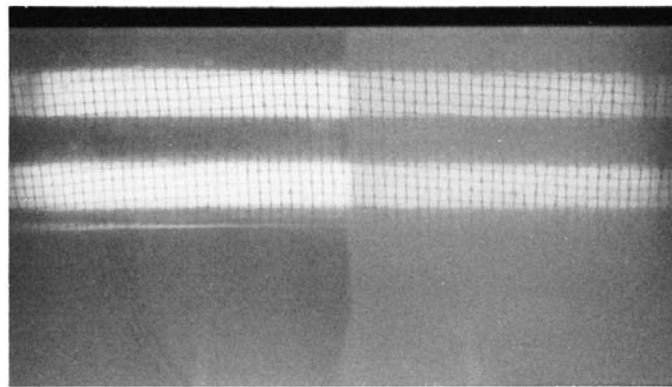**FIG. 2 Two White Porcelain Enamel Panels**

FIG. 3 Two Blue Plastic Wall Tiles Exhibiting a Difference in Reflection Haze

NOTE 1—The panel is polished on left end to produce higher specular gloss than the right end.

FIG. 4 Panel Coated with an Automobile Finish

5. Significance and Use

5.1 Gloss[3] is associated with the capacity of a surface to reflect more light in some directions than in others. The directions associated with mirror (or specular) reflection normally have the highest reflectances. Gloss is best seen and analyzed when the surfaces studied are illuminated by a light source that provides strong contrasting patterns of light and dark. Such a light source is described in this test method.

5.2 The simplest concept of gloss is that it corresponds to the mirror-like reflectances of surfaces. However, the distributions and intensities of this surface-reflected light are (for real materials) highly variable and affected by a variety of factors: surface smoothness and contour, refractive index, absorptance, angle of incidence, and (to a generally small extent) wavelength. From the great variety of surface-reflection patterns met in materials of commerce, it has been possible to identify seven surface-reflection criteria or "types of gloss" regularly used by skilled technologists for intercomparing and rating their products for gloss. Six of the seven criteria, or "types of gloss," are identified in the section on definitions. The seventh, luster or contrast gloss, is seldom of concern to the coatings industry.

6. Apparatus

6.1 *Lamp A*—The recommended apparatus is constructed by modifying a conventional fluorescent desk lamp that has two 15-W, 18-in. (450-mm) tubes. Fig. 6 is a photograph; Fig. 7 is a drawing of this lamp. The conventional lamp is modified by painting matte black the normally white reflector behind the

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[3] For a more detailed account of gloss, its measurement, and relationship to appearance generally, see R. S. Hunter and R. W. Harold, *The Measurement of Appearance, 2nd Edition*, John Wiley and Sons, New York, NY, 1986.
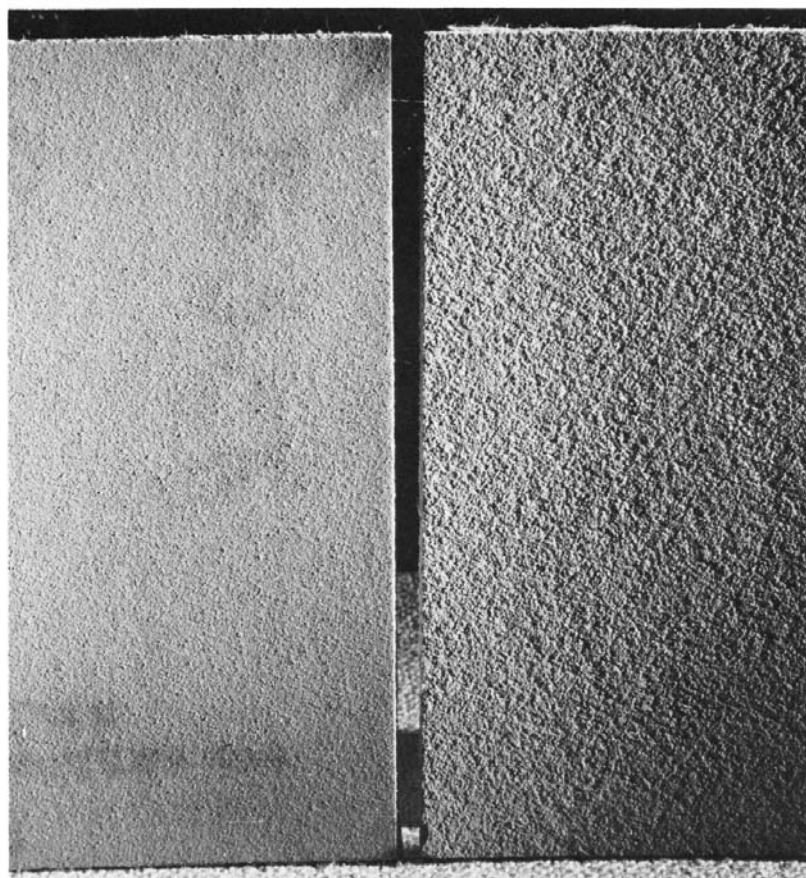
FIG. 5 Two Painted Panels Differing in Texture

lamp tubes. Then, after replacing the tubes, a piece of ¼-in. (6.3-mm) mesh hardware cloth is fastened to the front of the reflector.

6.2 *Lamp B*—The recommended apparatus is an incandescent bare filament bulb mounted on an adjustable angle fixture.[4]

7. Preparation of Specimens

7.1 Since gloss is ascribable largely to the top layer of the surface of any given object, dirt and other surface contamination significantly affect gloss. Therefore, the conditions and care of the surface, while preparing and examining it for gloss, are critically important.

7.2 Methods for preparing paint surfaces for examination are described in Practice D3964.

7.3 *Specimen Sizes*—Preferred sizes of specimens for the indicated use are from 2¾ to 12 in. (70 to 300 mm) wide and 5½ to 16 in. (140 to 400 mm) long.

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[4] Suitable bare filament bulbs and mounting fixtures such as a night light bulb mounted in a" goose-necked" desk lamp equipped with a screw-in receptacle or mounted in a hanging lamp socket equipped with screw-in receptacle, or an auto bulb, installed in an adjustable microscope lamp fixture, or a 120V 25-W tubular bulb, installed in a "goose-necked" desk lamp or installed in a hanging lamp socket have been found suitable for this purpose.

8. Procedure

8.1 *Placement of Lamp and Specimens for Study*—From Fig. 8, select the relative positions of lamp, specimen surfaces, and observer appropriate to the gloss differences in the specimens under study. Level of ambient illumination *must* be such that a photometer, placed in the specimen plane, decreases in reading with the gloss lamp turned off to less than 1/10 the value with the gloss lamp on.

8.2 *Visual Examination of Gloss of Surfaces*—Place the specimen surfaces side by side. Examine the light from the gloss lamp reflected to the observer by looking for the appropriate gloss attributes described in 3.2.

8.3 Interchange positions of surfaces being compared a number of times to ensure that comparisons are free of bias as the result of specific position relationships. Record:

8.3.1 Each attribute or type of gloss for which judgment is made.

8.3.2 Nature and magnitude to the nearest whole number of gloss difference (see 9.1.3). Add specimen identification to the record before proceeding to the next intercomparison. Record the mean of two readings.
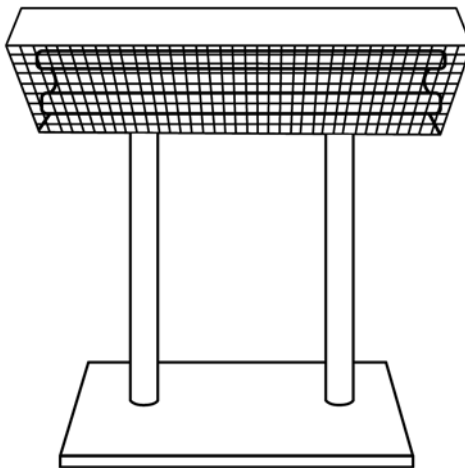
9. Report

9.1 Report the following information:

NOTE 1—The lamp is used to demonstrate gloss or geometric differences in the appearances of surfaces.
FIG. 6 Desk Lamp

NOTE 1—The lamp is modified by the addition of a black reflecting surface behind tubes and a wire screen in front.
FIG. 7 Modified Desk Lamp

9.1.1 Specimens and their method of preparation, including any pretreatment of test surfaces by cleaning, polishing, wetting, drying, or other action.

9.1.2 Lamp-specimen relationship used from those shown in Fig. 8.

9.1.3 Type and magnitude of gloss differences observed. Identify differences between each pair of surfaces compared as either:

None (or indistinguishable)	= 0
Very slight (barely distinguishable)	= 1
Moderate (easily seen)	= 2
Considerable	= 3

9.1.4 Which of the pair appears glossier (except in first case).

10. Precision and Bias

10.1 The precision of this test method is based on an interlaboratory study of ASTM D4449, Standard Test Method for Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance, conducted in 2013. Observers from 16 laboratories participated in this study. Each of the observers was asked to report the gloss difference rating of 16 samples (representing eight pairs of blind duplicates). Every "test

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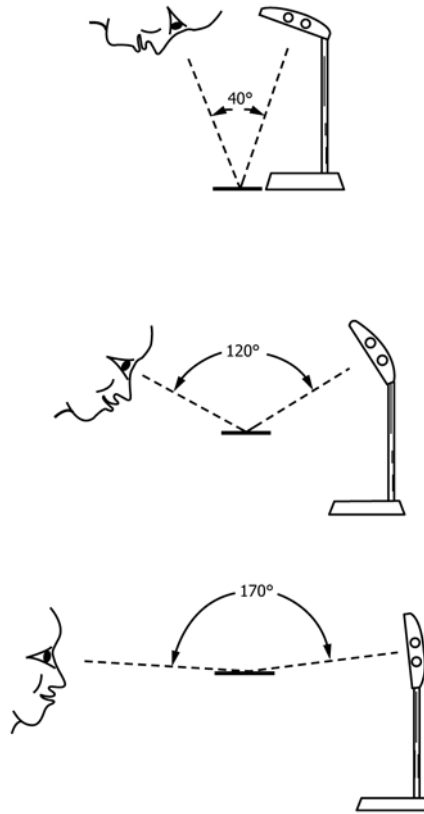
(a) For high specular gloss, distinctness-of-image gloss, and reflection haze
(b) For intermediate and low specular gloss and directionality of plane surfaces
(c) For sheen

FIG. 8 Recommended Positions of Gloss Inspection Lamp, Observer, and Surfaces of Different Levels of Gloss Being Intercompared
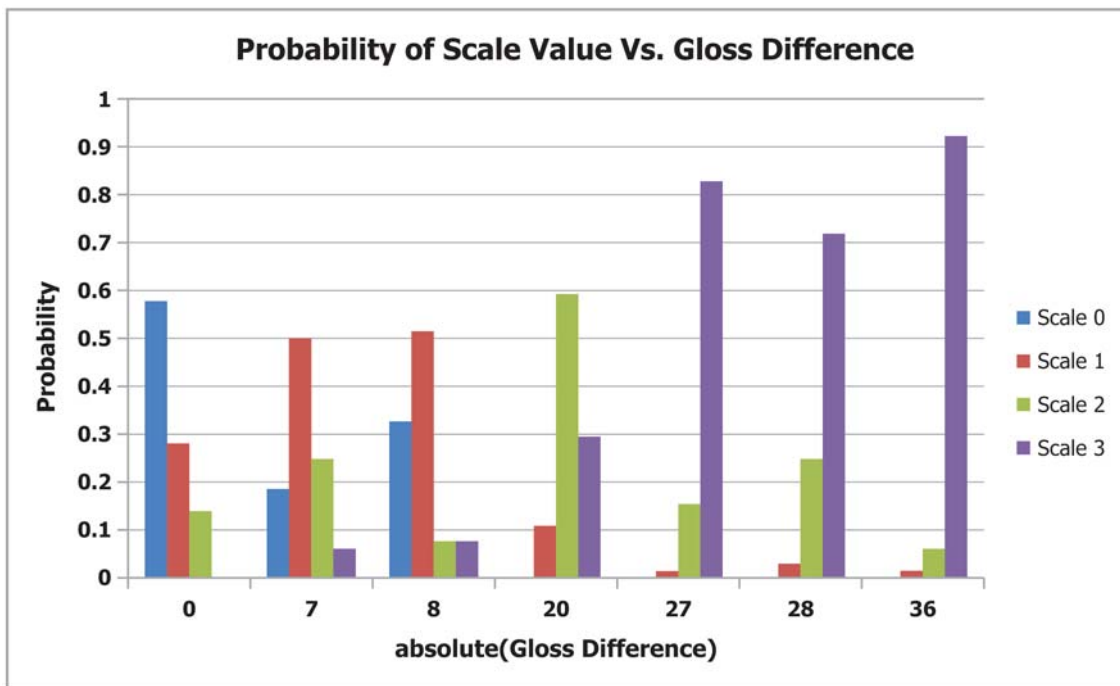

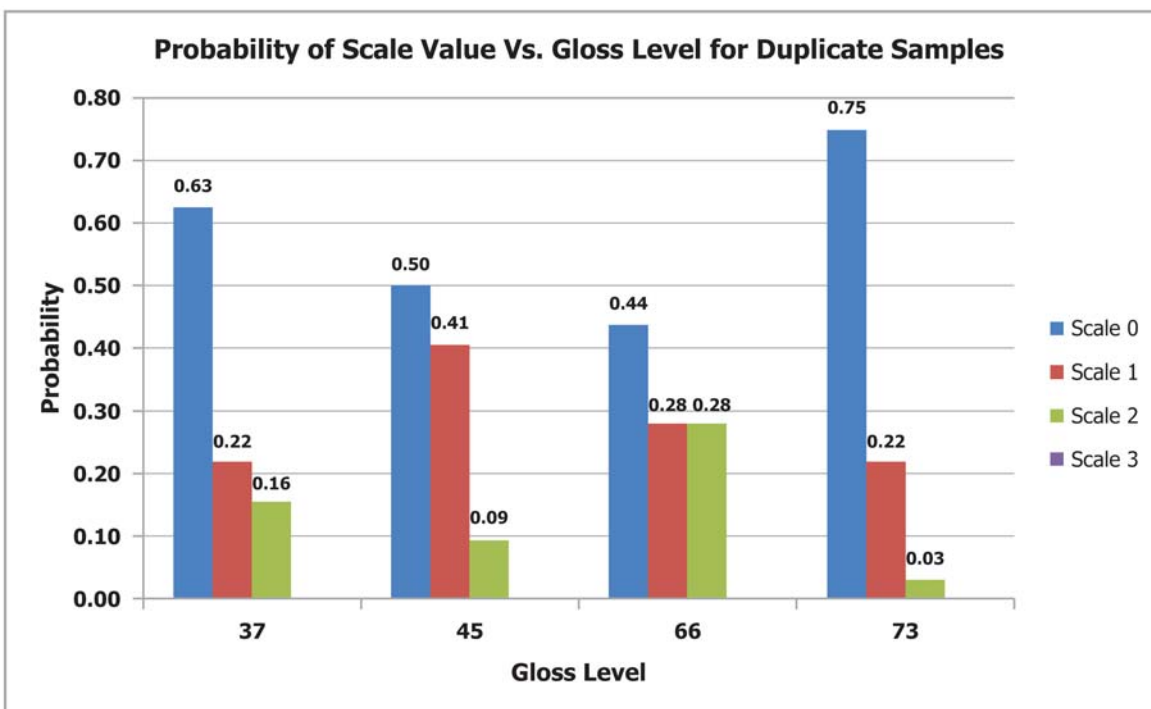**FIG. 9 Probability of Scale Value versus Gloss Difference**

FIG. 10 Probability of Scale Value versus Gloss Level for Duplicate Samples

result" reported represents an individual gloss difference determination. The data was analyzed to determine the probability of an observer reporting a given rating based upon calculated absolute gloss differences for each duplicate sample pair;[5] the details are given in ASTM Research Report No. RR:E12-1008.[6]

10.2 *Probability of Scale Value versus Gloss Difference* (Fig. 9):

10.2.1 Calculated absolute gloss difference=|gloss1-gloss2| for example: |45-37|=8.

10.2.2 Calculated probability of scale value based on observer's responses at each gloss difference levels.

10.2.2.1 Probability of scale 3 at gloss difference 27 and above is more than 0.7.

10.2.2.2 Probability of scale 0 at gloss difference 20 and above is zero.

10.2.2.3 Probability of scale 2 at gloss difference 20 is about 0.6.

(1) There is an uncertainty in scale 2 and 3 at gloss difference 20.

10.2.2.4 Probability of scale 3 at gloss difference 8 and below is less than 0.1.

(1) There is uncertainty in scale 0 and 1 at gloss difference 7 to 8.

NOTE 1—The term scale is used as an alternative term for magnitude.

10.3 *Sensitivity of Visual Scaling Based on Duplicate Samples* (Fig. 10):

10.3.1 Calculated probability of scale value based on observer's responses at each gloss level for duplicate samples.

10.3.1.1 Probability of scale 3 is zero for duplicate samples at all gloss levels.

10.3.1.2 Probability of scale 0 is more than 0.6 at gloss levels 37 and 73.

(1) There is uncertainty in scale 0 and 1 at gloss level 45 and 66.

10.4 The precision statement was determined through statistical examination of 256 results, from 16 observers on 8 pairs of samples (described in the following table).

No.	Sample	60 Gloss	Duplicates	Pairs
1	A	46.0	F-A	P-I
2	B	73.1	E-B	O-K
3	C	65.8	H-C	M-J
4	D	37.4	G-D	N-L
5	E	72.8		
6	F	46.5		
7	G	37.7		
8	H	65.9		
9	I	44.4		
10	J	65.4		
11	K	73.1		
12	L	36.6		
13	M	65.1		
14	N	36.9		
15	O	72.5		
16	P	45.0		

10.5 There are several factors causing variation in observer's responses including, but not limited to:

10.5.1 Nature of visual experiment as a subjective experiment.

10.5.2 Inconsistencies in illumination/viewing geometry within laboratories.

10.5.3 Observers at different levels of experience.

[5] Data analysis completed by Mahnaz Mohammadi, *Axalta Coating Systems*, on February 13, 2014.

[6] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:E12-1008. Contact ASTM Customer Service at service@astm.org.

10.5.4 Ordinal-based experiment instead of scaling.

11. Keywords

11.1 distinctness of image; gloss; haze; visual gloss