Designation: B 915 – 01

Standard Test Method for Measuring the Static Heat Resistance of a Self-Cleaning Oven Coating[1]

This standard is issued under the fixed designation B 915; 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 test method covers the procedure for the qualitative and quantitative evaluation of static heat effects on porcelain enamel coatings.

1.2 This test method is adaptable to various temperatures and times, since the requirements in the porcelain enameling industry differ between manufacturers.

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:*

D 523 Test Method for Specular Gloss[2]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *blistering*, *n*—a defect caused by gas evolution consisting of a bubble that protrudes on the surface of the glass.

3.1.2 *color and gloss change*, *n*—this is determined by the color and gloss delta values calculated between each heat test cycle.

3.1.3 *copper heads/stickers*, *n*—protrusions of iron oxide crystals permeated from the steel substrate or conglomerated metal components in the enamel.

3.1.4 *crazing*, *n*—a defect appearing as one or more fine cracks in the porcelain enamel from thermal contraction and expansion in the glass.

3.1.5 *edge burn off*, *n*—this may occur in the first 24 to 72 h and appears as a thin dull discolored gray line around the entire edge of the test plate.

3.1.6 *enamel breakdown*, *n*—the point at which the glass composite has disintegrated. Microscopic examination will show loss of enamel bubble structure and devitrification of the enamel. This stage reveals metallic type elements derived from the glass composition and the iron oxide from the steel substrate that has completely permeated the glass.

3.1.7 *hazy appearance/scumming*, *adj*—the glass will develop an opaque film that exhibits low gloss on the surface of the porcelain enamel.

3.1.8 *metalizing*, *n*—enamel on test plates will have a reflective copper color from condensed metals in the enamel that may increase with the deterioration of the glass during the heat test cycle.

4. Significance and Use

4.1 This test method is intended for testing the porcelain enamel finish on oven parts of self-cleaning ranges.

4.2 The numerical values and visual evaluation derived by this test method are used to measure differences in heat resistant characteristics between enamel formulas intended to meet oven manufacturer specifications.

5. Apparatus

5.1 *Furnace*, capable of holding a constant temperature of 920°F (493°C) minimum.

5.2 *Standing Bracket*, approximately 10 by 10 by 6 in. (25.4 by 25.4 by 15.24 cm). Dimensions may vary according to test plate size.

5.3 *Two Heavy-Gauge Steel Rods*, approximately 12 in. (30.48 cm) long and ⅛ in. (0.32 cm) in diameter.

5.4 *Standard Size ⅜-16 or ⅜-24 (0.96-cm) Nuts*, used for spacers between heat test plates.

5.5 *Spectrocolorimeter*, capable of reading color by reflection of enameled plates on reflectance 45°/0° and L*, a*, b* color space.[3] Equipment available for making color readings is

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[2] *Annual Book of ASTM Standards*, Vol 06.01.

[3] L*, a*, b* color space: "A uniform-color space using an Adams-Nicherson cube root formula, suggested in 1974 for adaptation by the CIE (International Commission on Illumination) in 1976 for use in the measurement of small color differences."

an instrument that reads Spectrocolorimeter L, a, b scale[4] such as Macbeth Color Eye or a Hunter Lab ColorQUEST.[5]

5.6 *Gloss Meter*, capable of reading 60° ASTM gloss measurements (see Test Method D 523).[6]

6. Procedure

6.1 Punched holes are located ¼ in. (0.63 cm) down from the top and ½ in. (1.2 cm) from the right and left sides on a 5⅜- by 5⅜-in. (13.65- by 13.65-cm) uncoated metal plate.

6.2 The metal plate is processed in the enamel formula that is to be subjected to static heat testing.

6.3 Before placing the test plate on heat test, initial color (L, a, b) and gloss (60°) readings are recorded, dated, and established as 0 h.

6.4 The enameled plate should be clean and free of any fingerprints or smudges. To clean a soiled plate, a lint-free paper towel dampened with alcohol is rubbed back and forth on the surface until plate is clean. To prevent further smudging, handle test plates on the edges.

6.5 A steel rod is passed through each hole of the test plate. The test plates are suspended across the top of the standing bracket by the steel rods.

6.6 If more than one test plate is required, a spacer is placed on the rods between each test plate. This allows a ¼-in. (0.63-cm) space between each test plate. Approximately 26 heat test plates can be suspended from the two steel rods.

6.7 A cover plate is placed on both ends of each row. The cover plate should be an enameled plate the same size as the heat test plates (previous heat test plates no longer needed for testing may be used). Place cover plates on the two rods with enamel side towards test plates. The cover plates protect the end heat test plates from being subjected to direct oven wall heat.

6.8 The standing bracket containing the heat test plates is placed in a constant oven temperature of 920°F (493°C) for 360 h.[7]

6.9 The test plates are removed from the oven after every 24 h, stand at room temperature and evaluated for the amount of change in color, gloss, and physical appearance.

6.10 The color and gloss readings of test plates are dated and recorded after every 24 h of exposure to heat. Deltas are calculated by measuring the gloss and color change from 0 to 24 h as shown in example 1. With the final change from 0 to 360 h or at failure, whichever occurs first.

Example 1:

0 h 9-1-95	Gloss	L	a	b
Plate No. 1	90.4	+19.86	–.23	–2.65
24 h 9-2-95	Gloss	L	a	b
Plate No. 1	89.3	+18.48	–.10	–1.50
Delta at 24 h:	D Gloss	DL	Da	Db
	–1.1	–1.38	+.13	+1.15

6.10.1 The (+) and (–) values indicate the direction of change, that is, a (+a) change in value would indicate an increase in redness, while a (–a) change in value would indicate an increase in green. Similarly, a (+b) change in value would indicate an increase in yellowness, while a (–b) change in value would indicate an increase of blueness in the color values of the test plate.

6.11 The plates are checked visually for enamel breakdown, such as, metalizing, crazing, blistering, copperheading, hazy appearance, and edge burnoff, color, and gloss change.

6.12 Heat test plates that do not display any extreme physical breakdown are returned to the 920°F (493°C) oven to continue the heat test cycle.

6.13 Test plates are removed every 24 h from the oven, set to room temperature, and visually examined. Color and gloss readings are recorded, dated, and the total number of hours of exposure is recorded.

6.14 Test plates that fail because of excessive color and gloss change or show extreme enamel breakdown as described in 6.11 are removed from the test and recorded as to what time failure has occurred.

6.15 Test plates that complete the 360 h are examined visually. Deltas of color and gloss readings from 0 to 360 h are recorded.

7. Rating Test Specimens

7.1 A full heat test life cycle begins when the enameled plate(s) is placed in the preheated furnace and ends after the 360-h time frame.

7.2 The plate(s) shall be rated for the number of cycles it has passed without failure. For example, enamel that failed at 168 h would be unfavorable compared to enamel that did not fail until 336 h. Heat test plates are rated by the number of hours accumulated in the furnace before failure occurs.

7.3 For comparison purposes, sample plates processed in standard enamel would have to be heat tested at the same time to complete the rating of the test enamel from 0 to 360 h.

7.4 Visual examination of an enameled test plate after a 360-h heat cycle would be rated according to the calculation of total color change. (DE)[8], when its value is equal to or less than the (DE) calculated for a standard enamel, which might be a current production enamel, over the full 360-h heat cycle.

7.5 Change in gloss over full heat cycle must be comparable to the standard enamel.

8. Report

8.1 The following is a list of data to be recorded:

8.1.1 Amount of hours test plate has accumulated in the furnace.

[4] Hunter L, a, b scales: "A uniform color scale devised by Hunter in 1958 for use in a color difference meter, based on Herings opponent-colors theory of color vision."

[5] Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22092–5280. Macbeth, Little Britain Road, P.O. Box 230, Newburgh, NY 12550.

[6] 60° ASTM gloss measurements: "The 60° optical head reads the angles of incidence (i) and view (v) are 60° as measured from perpendicular to the specimen."

[7] The heat test cycle of 920°F (493°C) for 360 h was established to represent the average home use of running 12 cleaning cycles per year on a 10-year basis = 120 cycles, assuming the oven cleaning cycle runs 3 h at peak temperature (approximately). Heat test oven temperature and time may be adjusted in accordance to user specifications.

[8] By definition, DE = Ö $(DL)^2 + (Da)^2 + (Db)^2$, where DL, Da, and Db are the total color element changes from 0 to 360 h. See *ASTM Color Appearance Measurements*, 3rd Ed., available from ASTM Headquarters.