Designation: F2366 – 12

Standard Practice for Determining the Relative Lightfastness of Ink Jet Prints Exposed to Window Filtered Daylight Using a Xenon Arc Light Apparatus[1]

This standard is issued under the fixed designation F2366; 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 specific procedures and test conditions that are applicable for xenon-arc exposure of ink jet media prints conducted in accordance with Practices G151 and G155. The laboratory accelerated procedure is intended to determine the relative lightfastness of ink jet prints in office environments where window filtered daylight is used for illumination.

1.2 The two criteria used to determine relative lightfastness are instrumental color change and change in optical density.

1.3 This practice is useful in determining the relative lightfastness of a series of prints or the relation of the lightfastness of the print of interest to the performance of controls with known lightfastness exposed simultaneously.

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.* Specific precautionary statements are given in section 8.

1.5 There is no equivalent ISO standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials

D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D3424 Practice for Evaluating the Relative Lightfastness and Weatherability of Printed Matter

E1347 Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry

E1348 Test Method for Transmittance and Color by Spectrophotometry Using Hemispherical Geometry

E1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry

G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

2.2 *ANSI Standard:*

ANSI/NAPM IT9.9-1990 Stability of Color Photographic Images-Methods for Measuring

IT2.17–1995 ANNEX A1 Density Measurements–Part 4: Geometric Conditions for Reflection Density, Backing Material

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions given in G113 are applicable to this Practice.

3.1.2 Ink jet media substrates used by ink jet printers to receive inks. The substrate may be paper, plastic, canvas, fabric, or other ink receptive material. The substrate may, or may not be, coated with one or more ink receptive layers.

4. Summary of Practice

4.1 Printed ink jet media are exposed to radiant energy from a xenon arc light source equipped with a Window-Glass Filter.

4.2 The duration of the exposure may vary widely depending on the lightfastness of the ink/media.

4.3 During the course of the exposure, changes in color and optical density in the printed samples are periodically evaluated. Color changes are determined either visually by comparison with the unexposed file specimens or instrumentally by comparison with the color of the same specimen prior to

[1] This practice is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.07 on Ink Jet Imaging Products.

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[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.

exposure and reported as color difference, ΔE. The color changes of a series of prints are compared with each other or with those of a control exposed at the same time for which performance under use conditions are known. The change in optical density is determined instrumentally and reported as percent retained optical density.

4.4 The exposure may be continued for a specific duration of time, or until a predetermined color change and change in optical density has been achieved.

5. Significance and Use

5.1 Lightfastness of printed ink jet media for specified periods of time is pertinent to the end use of these materials. Since the ability of ink jet prints to withstand color changes is a function of the spectral power distribution of the light source to which it is exposed, it is important that lightfastness be assessed under the conditions appropriate to the end use application. While ink jet prints may be handled and displayed under a variety of conditions, this practice is intended to produce the color changes that may occur in ink jet prints upon exposure to irradiation from daylight filtered through window glass by simulating these conditions.

5.2 The accelerated procedure covered in this practice is intended to provide a means for the rapid evaluation of relative lightfastness under laboratory test conditions. The Practice does not provide a rating of the lightfastness of the prints, but determines the lightfastness ranking of a series of prints or the performance compared to controls with known lightfastness. Test results are useful for specification acceptance between producer and user, for quality control, and for research and product development.

5.3 Color changes may not be a linear function of duration of exposure. The preferred method of determining effect of the light is to expose the prints for a number of intervals and to assess the exposure time required to obtain a specific color change or change in optical density.

6. Interferences

6.1 It is recognized that the rate of photo degradation of ink jet prints will vary significantly due to factors such as initial color density, the area printed (solid versus half-tone), the substrate, the ink type (dye versus pigment inks), and the coating type and thickness. Consequently, test results must be determined individually for each printed substrate.

6.2 Variations in exposure time, temperature and humidity may also affect results.

7. Apparatus

7.1 Use xenon-arc apparatus with a Window Glass Filter that conform to the requirements defined in Practices G151 and G155.

7.2 Use an uninsulated black panel thermometer as described in ASTM G151.

7.3 Unless otherwise specified, the spectral power distribution (SPD) of the xenon arc shall conform to the requirements of Table 2 in Practice G155 for a xenon arc with a Window Glass Filter. Also refer to Fig. X1.1 of Appendix X1 for a representative spectral power distribution graph of a xenon arc with a Window Glass Filter.

7.4 Use an appropriate spectrophotometer, spectrocolorimeter or colorimeter for measuring color changes and a densitometer for measuring changes in optical density. Alternatively, a spectrodensitometer can be used for both color and optical density measurements.

8. Test Specimen

8.1 The substrate, method of printing, ink lay-down, and handling of printed specimens shall be consistent with the anticipated end use of the specimens.

8.2 The test image may be generated with personal computer word processing, drawing/graphics or page layout software, saved as a print file for each printer/method of printing (contributing its unique ink and ink/receiver interactions that may impact in the image light stability), trial-printed, and evaluated for appropriate ink lay-down (purity and amount) and ease of printing and testing. Each print file should have its filename, type, and version identified in the image area and a place for experimental notes (for example, time, printer, environmental conditions, operator). The printer settings and a trial print of each print file version should be archived.

8.3 The recommended test image shall consist of a standardized arrangement of color patches printed using print files containing the appropriate printer setup specific for each application. This test image shall contain color patches at maximum print density (100 % fill) for each of the primary colors (cyan, magenta, yellow, and black), secondary colors (red, green, blue), and composite black (cyan plus magenta yellow). In addition, since lightfastness may vary as a function of print density, low optical density patches are recommended to test the lightfastness of binary images of discrete ink spots. A step wedge containing patches with a range of optical densities (for example 25 %, 50 %, 75 %, and 100 % fill) may be useful for this test.

8.4 For visual examination, the specimen size as indicated in practice D1729 is a minimum of 3-½ by 6-½ in. (90 by 165 mm). For instrumental evaluation, the specimen must be large enough to cover the specimen port; a minimum size of 1.25 in. × 1.25 in. (35 mm × 35 mm) is satisfactory for many instruments.

8.4.1 Unless otherwise specified, expose at least three replicate specimens of each test material and of the control material, if used.

8.5 The unexposed file specimens are prepared for visual evaluations or measured for instrumental evaluations as described in 8.5.1 and 8.5.2, respectively.

8.5.1 For visually evaluated tests, set aside a replicate print or cut off a segment of suitable size; store in a dark, dry place.

8.5.2 For instrumentally evaluated tests, make color measurements in the relevant specimen area(s) prior to exposure.

NOTE 1—The unexposed file specimen control should not be a masked specimen. Even though shielded from radiation, some materials may undergo color changes, due to the heat or moisture present during the test.

8.6 Test prints on opaque substrates do not require backing material and shall be tested in accordance with their intended use. Transparencies shall be backed with a white backing material. Translucent substrates shall be backed with a diffuse black backing material with an image density of 1.5 ± 0.2 as described in ANSI IT2.7–1995 Annex A1.

9. Conditioning

9.1 It is recommended that samples be conditioned at 25°C and 45 % RH for at least 24 h prior to testing. Specimens shall be visually inspected for color uniformity and surface irregularities, which could adversely affect color measurement.

10. Exposure Procedure

10.1 Practice G155 lists several exposure cycles that are used for xenon-arc exposures of nonmetallic materials. Unless otherwise specified, use a xenon-arc apparatus with a Window Glass Filter and operate in accordance with Practice G155. Use the following exposure cycle:

Set the machine to maintain an irradiance level of 0.35 $W/(m^2 \cdot nm)$at 340 nm. The settings at other wavelengths or spectral regions that provide equivalent irradiance at 340 nm are: 0.90 $W/(m^2 \cdot nm)$ at 420 nm; 42.3 W/m^2 at 300 to 400 nm; and 490 W/m^2 at 300 to 800 nm. Expose specimens to 100 % light. The uninsulated Black Panel Temperature shall be 63°C. In devices that provide for humidity control, set the relative humidity at 55 %. In devices that provide for chamber air temperature control, set the chamber air temperature for 48°C.

NOTE 2—Information developed by Committee G03 on allowed operational fluctuations of the set points and guidance for measuring uniformity conditions in the test chamber is published in the Annexes of Practice G151.

10.2 Specimens should be confined to an exposure area in which the irradiance is at least 90 % of the irradiance at the center of the exposure area. Unless it is known that irradiance uniformity meets this requirement, use one of the procedures described in Practice G151, section 5.1.4 to ensure equal radiant exposure on all specimens or to compensate for irradiance differences within the exposure chamber. If the specimens do not completely fill the racks, fill the empty spaces with blank metal panels to maintain the test conditions within the chamber. The apparatus shall be operated continuously. However, if the test needs to be interrupted to perform routine maintenance or inspection, it should be during a dry period.

11. Evaluation Procedure

11.1 Immediately before exposure, measure all test specimens on a spectrophotometer or spectrocolorimeter (see Test Method E1348 or E1349) or colorimeter (see Test Method E1347) using CIE 1964 (10°) Supplementary Standard Observer and Standard Illuminant D65. Exclude specular reflection from the measurements.

11.2 Evaluate the exposed specimens for changes in color either visually or instrumentally in accordance with Test Methods D1729 and D3424, Section 11, respectively. For instrumental evaluations, using the CIE 1976 L* a* b* equation described in Test Method D2244, calculate ΔL^*, Δa^*, Δb^*, and ΔE^*_{ab} between each exposed specimen and its unexposed counterpart.

11.3 Evaluate the exposed specimens for changes in optical density measured per ANSI/NAPM IT9.9-1996, paragraphs 3.3 - 3.6. Percent retained density shall be calculated as follows:

$$\%\ Retained\ Optical\ Density = \frac{Optical\ Density\ After\ Exposure}{Optical\ Density\ Before\ Exposure} \times 100 \quad (1)$$

NOTE 3—If instrumental color measurements are used, the type of equipment, the method and the color-difference equation used must be stated.

12. Report

12.1 The report shall include the following:

12.1.1 Identification of test specimens and control specimen(s), including the method of printing, print area (% fill), and substrate.

12.1.2 Type and model of exposure device.

12.1.3 Type of light source.

12.1.4 Type and age of filters at the beginning of the exposure, and whether there were any filter changes during the period of exposure.

12.1.5 Elapsed exposure time, h.

12.1.6 If required, procedure to ensure equal radiant exposure on all specimens or to compensate for differences in the test chamber.

12.1.7 Results from the visual examination or instrumental evaluation of color change per Practice D1729 or Test Method D2244.

12.1.8 Percent retained optical density.

APPENDIX

(Nonmandatory Information)

X1.

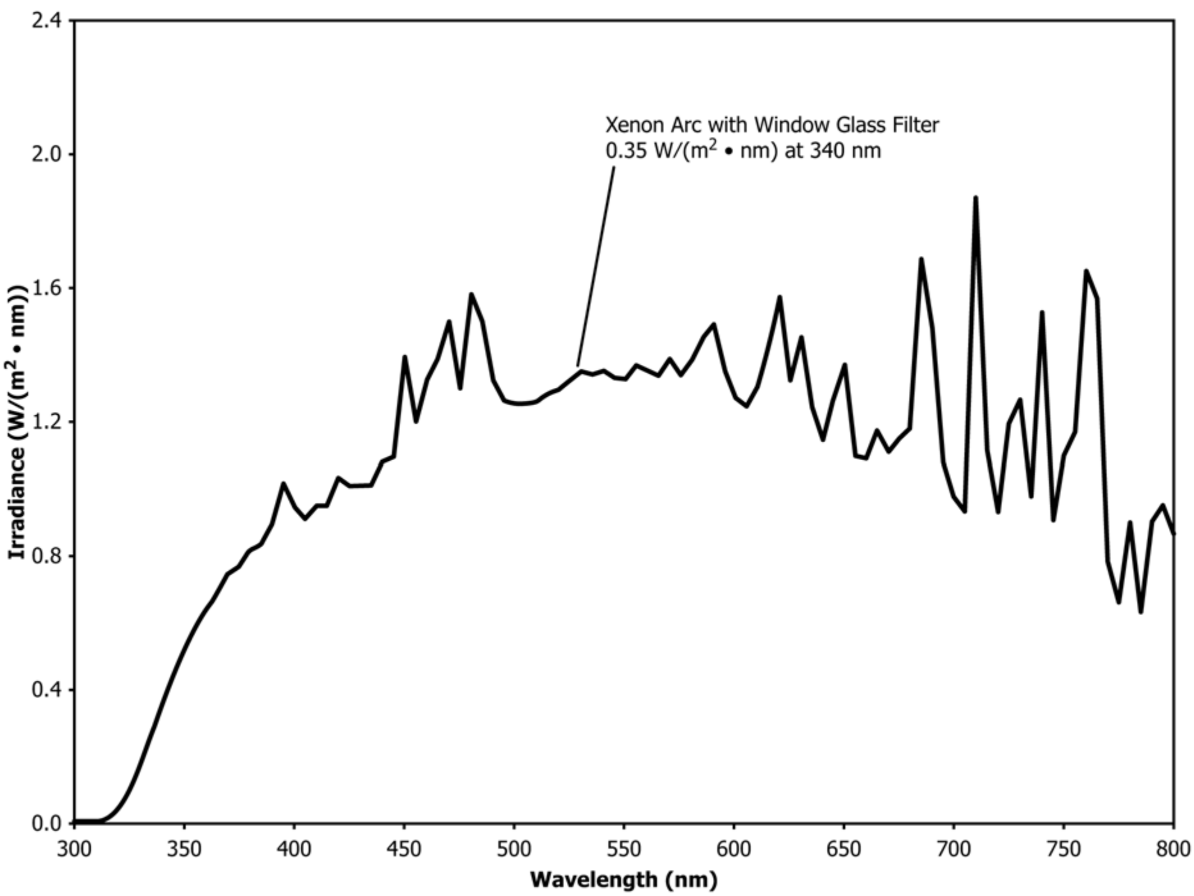

FIG. X1.1 Spectral Power Distribution of Xenon Arc With Window Glass Filter Controlled at 0.35 W/(m^2 · nm) at 340 nm