Designation: F 1946 – 04

Standard Practice for Accelerated Testing of the Lightfastness of Ink Jet Prints Exposed to Indoor Fluorescent Lighting and Window–Filtered Daylight[1]

This standard is issued under the fixed designation F 1946; 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 an accelerated procedure intended to screen ink jet prints for lightfastness in office environments where overhead fluorescent light and window-filtered daylight is used for illumination.

1.2 *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.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 1729 Practice for Visual Appraisal of Color and Color Differences of Diffusely Illuminated Opaque Materials

D 2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

D 3424 Test Methods for Evaluating the Relative Lightfastness and Weatherability of Printed Matter

D 4674 Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments

G 113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

2.2 *ANSI Standard:*

ANSI/NAPM IT9.9-1996 Stability of Color Photographic Images—Methods of Measuring[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *ink jet media*—recording elements 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.

3.2 The definitions given in Terminology G 113 are applicable to this practice.

4. Summary of Practice

4.1 Printed ink jet media are exposed to radiant energy from an array of 11 very high output (VHO) cool, white fluorescent lamps and, simultaneously, to intermittent energy from two soda-lime glass-filtered fluorescent UV lamps. The extent of UV radiant exposure (nominal UV actinic exposure or UVAE) from both sources is determined separately as the product of UV irradiance at the start of the test and exposure time, in Watt-hours/m^2(W-h/m^2).

NOTE 1—The relative spectral power distribution for cool white fluorescent lamps may be found in ANSI/NAPM IT9.9-1996, Table 5.

4.1.1 The contribution of the sunlamp actinic exposure to the total UV actinic exposure is maintained constant by adjusting the on/off cycle time of the sun lamps.

4.1.2 The average nominal sunlamp UV actinic exposure is set at 12 % of the value of for the VHO lamps.

NOTE 2—Most UV exposure results from fluorescent lighting, although some is due to sunlight. The 12 % is an estimate of a representative office environment.

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, the color changes in the printed samples are periodically evaluated either visually or instrumentally. Results are compared to an exposed control, an unexposed file specimen, or the same specimen prior to exposure. The color change shall be measured as percent retained density and color difference, ΔE^*.

[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.

[3] American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

4.4 The exposure may be continued for a specific duration of time, or until a predetermined color change 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 an ink jet print 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 the effect of accelerated testing 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 office lighting where overhead fluorescent light and window-filtered daylight is used for illumination by simulating these conditions.

5.2 The accelerated procedure covered in this practice is intended to provide a means for the rapid evaluation of the effect of light under laboratory conditions. 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 the effect of light is to expose the prints for a number of intervals and to assess the exposure time required to obtain a specific color change.

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 recording element.

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

7. Apparatus

7.1 The apparatus shall conform to the device described in Practice D 4674, Annex A1.

8. Safety Precautions

8.1 Follow the safety instructions described in Practice D 4674, Section 7.

9. Test Specimen

9.1 The substrate, method of printing, ink, ink laydown, and handling of printed specimens shall be consistent with the anticipated end use of the specimens.

9.2 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 on the image light stability), trial-printed, and evaluated for appropriate ink laydown (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.

9.3 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 plus 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.

9.4 For visual examination, the specimen size as indicated in Practice D 1729 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.

9.5 For comparison of the exposed specimens with unexposed file specimens, prepare or measure the latter in the following manner:

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

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

NOTE 3—The unexposed sample 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.

9.6 Test prints on opaque substrates shall be backed with a non-reactive and non-yellowing white material, for example, 100 % cotton cellulose mount board or ceramic-coated steel plate. Transparencies shall be backed with a black tinted polyester backing, for example. Test samples on translucent substrates shall be tested in accordance with their intended use. Dummy specimens identical to the test samples should occupy vacant test positions in the light stability apparatus. Potential variables such as temperature, relative humidity, and the amount of reflected light must be monitored and controlled to guard against sample induced changes.

10. Preparation of Apparatus

10.1 The apparatus shall be prepared in accordance with Practice D 4674, Section 9.2 for Method I.

11. Conditioning

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

11.2 Pre-age the lamps by leaving them on for a minimum of 48 h prior to initial test. Replace the cool white lamps if UV_{OFF} is greater than or equal to one, as specified in Practice D 4674, Section 9.2.6.1.

12. Procedure

12.1 The test shall be performed in accordance with Practice D 4674, Sections 9.2, 10 and 11.

13. Evaluation

13.1 Evaluate the exposed specimens for changes in color either visually or instrumentally in accordance with Practice D 1729 and Test Methods D 3424, Section 11, respectively. For instrumental evaluations, using the CIE 1976 L*a*b* equation described in Practice D 2244, calculate ΔL*, Δa*, Δb*, and ΔE^*_{ab} between each exposed specimen and its unexposed counterpart.

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

$$\%\ \textit{Retained Optical Density} = \frac{\textit{Optical Density After Exposure}}{\textit{Optical Density Before Exposure}} \times 100$$

14. Report

14.1 The report shall include the following:

14.1.1 Specimen identification, including the method of printing, print area (% fill), and substrate.

14.1.2 Exposure apparatus type, temperature, and RH.

14.1.3 Initial and final CW UV irradiance, W/m^2.

14.1.4 Initial and final FS UV irradiance, W/m^2.

14.1.5 Total exposure time, h.

14.1.6 Total FS on time, h

14.1.7 FS off-time interval.

14.1.8 Procedure for evaluating color changes (either visual or instrumental) and the test results.

14.1.8.1 Results from the visual examination of color change per Practice D 1729.

14.1.8.2 Percent retained optical density.

NOTE 4—If instrumental color measurements are used, the type of equipment, the method, and the color-difference equation used must be stated.