Designation: F1443 – 93 (Reapproved 2009)

Standard Practice for Using 0.008-in. (0.203-mm) Aperture Reflectometers as Test Instruments for Measuring Visual Image Quality of Business Copy Images[1]

This standard is issued under the fixed designation F1443; 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 the use of the reflectance-type optical character testers with a 0.008-in. (0.203-mm) aperture as test instruments for measuring image quality.

1.2 Although other systems may be available, this practice covers two of the most commonly used instruments; the Clearwave 082 Optical Character Tester[2] and the Macbeth Print Contrast Meter.[3]

1.3 These instruments also have the capability of predicting machine readability of documents. This practice does not address this capability.

1.4 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.

1.5 *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:*[4]

F497 Practice for Use of the Electric and Electronic Typewriter as a Test Instrument

F597 Practice for Evaluation of One-Time Carbon Paper in Carbon-Interleaved Business Forms by Use of an Electric Typewriter

F686 Practice for Evaluation of Image Quality Produced by Carbonless Copy Paper with an Electric or Electronic Typewriter

F1033 Test Method for Comparing Lift-Off Correction Media

F1125 Terminology of Image Quality in Impact Printing Systems

F1174 Practice for Using a Personal Computer Printer as a Test Instrument

F1175 Practice for Using the Computer Impact Print-Out Unit as a Test Instrument for Manifold Comparison

3. Terminology

3.1 *Definitions*—Refer to Terminology F1125 for definitions of terms applicable to this practice.

4. Summary Of Practice

4.1 This practice describes the use of small-aperture (0.008-in.) (0.203-mm) reflectance meters in evaluating business copy images from any source including but not limited to copiers, printers, typewriters, and facsimile machines. Image quality characteristics common to all systems include reflectance, sharpness, cleanliness, and character width. Other characteristics may be evaluated depending on the imaging method.

4.2 The 0.008-in. (0.203-mm) optical character testers equipped with a one-to-one lens option have the ability to

[1] This practice is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.03 on Research.

Current edition approved Oct. 1, 2009. Published October 2009. Originally approved in 1992. Last previous edition approved in 2003 as F1443 – 93(2003). DOI: 10.1520/F1443-93R09.

[2] The sole source of supply of the apparatus known to the committee at this time is Clearwave Inc., 8701 Buffalo Ave., Niagara Falls, NY 14304 (formerly manufactured by Moore). If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[3] The sole source of supply of the apparatus known to the committee at this time is Macbeth, Division of Kollmorgen Instruments Corp., 405 Little Britain Rd., New Windsor, NY 12553-6148. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[4] 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.

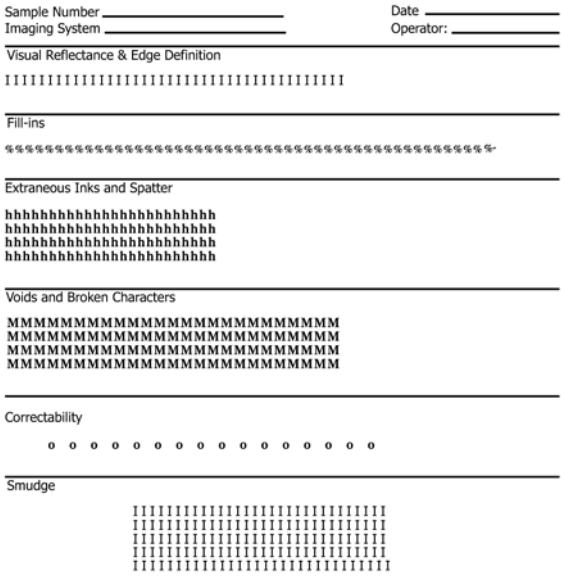

FIG. 1 Test Pattern for Image Quality Evaluation

examine large areas for average reflectance in the 1× mode and make measurements of small localized spots within these areas in the 20× mode. The graduated projection viewing screen allows accurate measurements of objects within the viewing area in the 5× or 20× mode.

4.3 Place the sample so that the image to be measured is over the 0.008-in. (0.203-mm) target area as observed on the viewing screen or in the viewing port. Reflectance values can be read out directly on the digital meter. This capability may be used to measure reflectance of printed characters, base paper, or areas in which characters have been corrected, or combination thereof.

4.4 Images for evaluation are produced by various systems using ASTM standards where available. When standards are not available, knowledge of the imaging system and its characteristics should be applied. Although the test pattern used will depend on the ASTM standard being used, a typical pattern is shown in Fig. 1.

5. Significance and Use

5.1 This practice enables image quality evaluation on samples generated by various imaging systems. It can be used to conduct investigations, including image reflectance, sharpness, voids, character width, and degradation of materials. The test instruments can be used for research and development projects as well as for manufacturing control.

6. Interferences

6.1 Variations in paper surfaces and thickness will affect some print quality parameters. If sheeted paper is used, the user should be aware that sheet to sheet smoothness and brightness variations within a ream may have a significant effect, particularly on reflectance readings. Most papers contain a felt and a wire side that have different surface smoothness levels and this in turn can also affect test results.

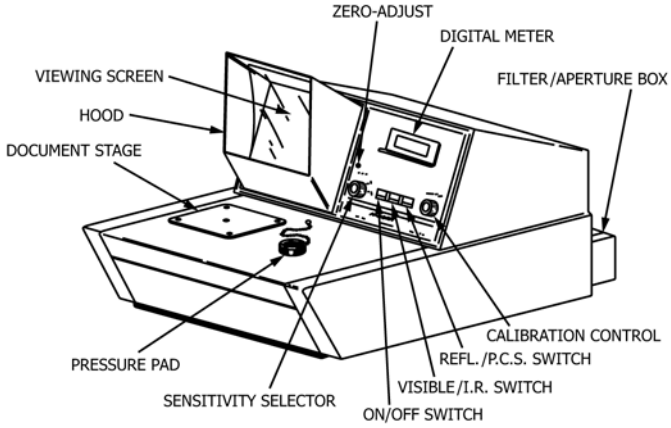

FIG. 2 Clearwave Optical Character Tester (082)[2]

6.2 The frequency between calibration may affect reflectance readings. The use of a voltage regulator for those not having one built in will minimize drift and eliminate variations in line voltage which could affect reflectance measurements.

6.3 Evaluation equipment cleanliness is important for accurate readings. Users should follow manufacturer's recommended cleaning procedures.

6.4 Imaging system used, and the various settings on it can affect the results.

6.5 Differences in the skill level of the tester and differences between instruments may affect the measurements.

6.6 Some reflectance type optical character testers contain optical filters. The spectral response of filters can change with time. Although the calibration procedure guarantees calibration when reading black/white images, it does not on colored images.

6.7 Heat generated by the lamps of both the 082A[2] and PCM II[3] can damage samples that contain thermally sensitive materials such as direct thermal paper and samples employing toners for the image. Reflectance readings can be taken but care must be employed to prevent damage or alteration to the samples during the measurement.

6.8 Care must be maintained when moving the imaged specimen on the instrument, so as not to mar the image.

7. Apparatus and Materials

7.1 *Clearwave Optical Character Tester:*

7.1.1 *Clearwave 082A,* [5] with the 20× magnification and one-to-one lens options (see Fig. 2),

7.1.2 *Voltage Regulator* (115 or 230 V), for the available line voltage (optional), and

7.1.3 *Barium Sulfate Calibration Standard and White Ceramic Tile.*

7.2 *Macbeth Print Contrast Meter:*

7.2.1 *Macbeth PCM II* [6] (see Fig. 3), and

7.2.2 *Barium Sulfate Calibration Standard.*

[5] "Clearwave Model 082A Optical Tester Instruction Manual," available from Clearwave Inc., 8701 Buffalo Ave., Niagara Falls, NY 14304.

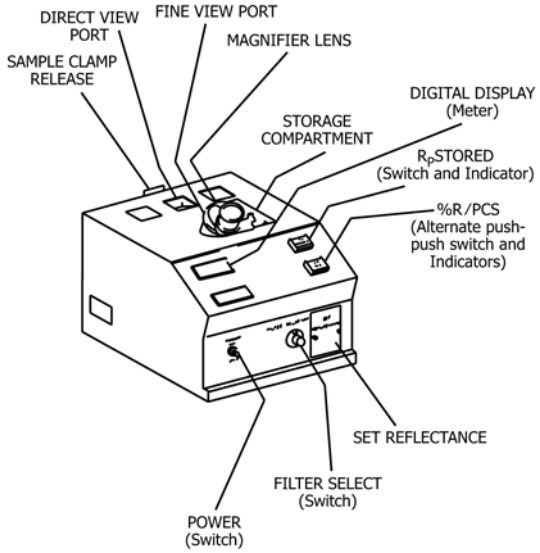

FIG. 3 Macbeth Print Contrast Meter (PCM II)[3]

8. Test Specimens

8.1 Prepare the test specimens using the procedure outlined in 10.2 for the imaging system. A type font should be selected so the 0.008-in. (0.203-mm) aperture area will fit within the printed character boundaries.

8.2 Generate the test specimen in accordance with the instructions given in the test procedure chosen for the printing system concerned. A printing systems self test pattern may be used or a standard test pattern as shown in Fig. 1.

9. Calibration

9.1 *Clearwave 082:*

9.1.1 The "visual neutral" filter and "0.008-in. (0.203-mm) aperture" should be in the appropriate holders in the filter/aperture box, located at the rear of the instrument. In instruments containing the optional filter wheel, the "visual neutral" filter may be selected by rotating the wheel to the appropriate position. Refer to the instrument's operator's manual for further information on the operation of the unit.[5,6]

9.1.2 Be sure filters are in place, as prolonged use without filters can damage the photomultiplier. Depress the main power switch ON. Allow 30 min warm-up time. Refer to the instrument's operator's manual for further information on the operation of the unit.

9.1.3 Depress the VISIBLE/IR switch to VISIBLE.

9.1.4 Depress REFL/PCS switch to REFL.

9.1.5 Set sensitivity selector at Position 1.

9.1.6 Set 1:1 lens system to 20× magnification and be sure it is positively seated (on testers equipped with 1:1 lens option).

9.1.7 Clear the document stage viewing port of any obstructions. Zero the instrument with a screwdriver by rotating the zero adjust control for a zero reading on the display meter while nothing is over aperture.

9.1.8 Be sure the barium sulfate calibration tablet is clean and free of scratches.

9.1.9 Place the barium sulfate calibration tablet over the viewing port and adjust with the calibration control to read 1.00. (Do not use the zero adjust control.)

9.1.10 The inability to adjust either the calibration reflection or zero potentiometer usually indicates the 50-W lamp should be replaced.

9.2 *Macbeth PCM II:*

9.2.1 Set the filter select switch to the visible filter position (Standard Response A).

9.2.2 Depress the main power switch ON. Allow at least 5 min warm-up time.

9.2.3 Operate %R/PCS button so that the %R light is on.

9.2.4 The PCM II[3] has no operator adjustment for the zero calibration check. Calibrate the instrument by placing a freshly pressed or commercially available $BaSO_4$ (barium sulfate) tablet in the measuring port and adjusting the instrument to read 100 % with the SET REFLECTANCE potentiometer if necessary. If the barium sulfate calibration tablet is used, be sure it is clean and free of scratches.

9.3 *Image Generation*—Generate the image following the procedure described in the appropriate ASTM standard.

9.3.1 Use Practice F497 for images from an electric typewriter.

9.3.2 Use Practice F597 for images from one time carbon paper.

9.3.3 Use Practice F686 for images from carbonless copy paper.

9.3.4 Use Practice F1174 for images from a personal computer.

9.3.5 Use Practice F1175 for images from a computer impact printer.

9.3.6 Use Test Method F1033 for evaluation of effectiveness of image correction systems.

9.3.7 For preparation of images from other imaging systems, knowledge of the imaging system and its characteristics should be applied.

10. Conditioning

10.1 Condition all test samples in accordance with the directions given in the test method being used.

11. Procedure

11.1 *Visual Reflectance Measurement*—To measure the image visual reflectance, place the image to be measured on the document stage so the circle in the center of the viewing screen is on the center of the image. This circle encompasses a 0.008-in. (0.203-mm) diameter on the document. The document to be measured should always be backed with the black pressure pad when using the 082 or black spring-loaded sample holder when using the PCM.[3]

11.1.1 The reflectance measurement is the amount of perceptible light reflected from the sample within the 5.03 by 10^{-5}-in.^{2} area at the center of the screen as compared to a known value. This known value is the barium sulfate standard.

11.1.2 Move the sample print until the 0.008-in. (0.203-mm) circle is centered on the area being measured. Record the

[6] "Macbeth Print Contrast Meter, PCM 11 Operations Manual," available from Macbeth, 405 Little Britain Rd., New Windsor, NY 12553-6148.

reflectance reading. A minimum of ten readings must be taken in order to obtain meaningful results. With the capital "I" test pattern, the preferred test method is to make five equally spaced readings each on five different I's and average the twenty-five readings. Include the highest value, lowest value, and standard deviation of the twenty-five readings.

11.1.2.1 Some instruments like the PCM II[3] and 082A[2] allow for automatic calculation of the print contrast signal (subtract the percent reflectance of imprint from the percent reflectance of background, then divide this difference by the percent reflectance of background). See the individual instrument operations manual for the correct procedure of automatic calculation.

11.2 *Image Evaluation*—Establish ranking order or compare with the control or known system using the following subjective criteria.

11.2.1 Additional comparisons should be made based on standards for individual imaging systems.

11.2.2 Terminology F1125 may be used as a guide for defining image defects.

12. Identification

12.1 For the identification of printed images, the following is suggested:

12.1.1 Image system identification,

12.1.2 Image supplies identification, if applicable,

12.1.3 Paper type, lot number, basis weight, grade, and which side was printed (wire or felt),

12.1.4 Date/time,

12.1.5 Operator identification, and

12.1.6 Reflectometer description, including serial numbers, settings, and filter used.

13. Report

13.1 Include image measurements made under magnification and background. These will include the average, highest value, lowest value, and standard deviation.

14. Keywords

14.1 Clearwave 082A densitometer; image quality; Macbeth PCM II; reflection