Designation: F 1320 – 01

Standard Test Method for Evaluating Thermal Paper Employing a Facsimile Thermal Printer as a Test Instrument[1]

This standard is issued under the fixed designation F 1320; 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 a standardized procedure utilizing the facsimile thermal printer as an imaging device for measuring the performance properties of direct thermal paper.

1.2 This test method may also be used to evaluate some imaging properties of facsimile printers.

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.* For a specific warning statement, see 9.1.

2. Referenced Documents

2.1 *ASTM Standards:*

F 335 Terminology Relating to Electrostatic Copying[2]

F 360 Practice for Image Evaluation of Electrostatic Business Copies[2]

F 556 Test Method for Curl of Carbonless Copy Papers[2]

F 909 Terminology Relating to Printers[2]

2.2 *ANSI Standards:*

PH2.17 Density Measurements—Geometric Conditions for Reflection Density[3]

PH2.18 Density Measurements—Spectral Conditions[3]

2.3 *IEEE Standard:*

167 A Facsimile Test Chart[4]

3. Terminology

3.1 *Definitions:*

3.2 *thermal facsimile printer*—a type of non-impact printer that uses special paper coated with materials which react to heat applied by electrical resistance elements; the heat causes the materials in the coating to form a visible image; the unit is used to transmit and receive information in hard copy form over telephone lines.

3.2.1 For definitions of other terms used in this test method, see Terminology F 335 and F 909.

4. Summary of Test Method

4.1 This test method consists of using a facsimile printer in copy mode under specified conditions to produce images for the evaluation of direct thermal paper on a comparative basis. The method is not intended for manufacturing control testing. The method also examines curl, feeding characteristics, coating residue, and possible operational problems which may be associated with thermal papers from different manufacturers.

5. Significance and Use

5.1 This test method will permit the user to make comparisons of image quality and machine performance for thermal paper. This test method is not intended for manufacturing control testing.

5.2 This test method is designed to test only thermal papers designed for use with facsimile machines. The test method is not appropriate for the evaluation of thermal papers designed for use with calculators, chart recorders, and other thermal printers.

6. Interferences

6.1 Some facsimile printers in different modes may operate at various speeds. The quality of the imaging and performance of the thermal paper can differ depending on the speed and mode of operation.

6.2 Facsimile printers default setting is recommended to eliminate variations in quality of output due to electrical and telephone line interference.

6.3 Densitometry readings can also be affected by voltage fluctuations requiring similar precautions to be taken as described in 6.2.

6.4 When making density readings with some densitometers, care must be taken that the unit does not damage the sample during the time required to make the measurement. Some units will cause the sample to darken (image).

6.5 Machine damage results may occur if the grade of thermal paper to be tested is not matched to the requirements of the facsimile unit given by the facsimile printer manufacturer.

6.6 When evaluating the curl characteristics of the thermal paper, differences in the diameter of the core and the amount of

[1] This test method is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.06 on Carbonless and Thermal Imaging Products.

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[2] *Annual Book of ASTM Standards*, Vol 15.09.

[3] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[4] Available from IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

paper on the roll should be considered. Some machines feature rollers that attempt to reverse the amount of curl in the paper. This should also be taken into consideration during the evaluation.

6.7 Imaging can vary as a function of the sequence position of a given copy in a series of copies. For example, the image of the third copy of a run of 20 copies on a given machine may be different from that of the fifteenth copy of that same run.

6.8 Most machines make only one copy unless they have memory. Consequently, the mechanical condition of the original deteriorates proportionately to the number of copies created. Multiple originals may be required to test a full roll. The variation between originals, if any, must be considered in the evaluation. Any variation in density can be examined using reflection spectrometry.

6.9 The age of the paper should be considered in the evaluation. Older rolls of paper, especially if stored unwrapped in high heat or humidity conditions, may result in poorer imaging and subsequently incorrect results. Older rolls may also experience transport problems due to changes in moisture content or curl if stored unwrapped. There can be other causes for curl which relate to the coating operation and storage.

6.10 Variation in print density can occur due to resistance variation in the print elements across the print head. Density measurements should be made in the same relative positions on sets of test samples.

6.11 Different brands of thermal paper may require varying lengths of time until the final density is reached.

7. Apparatus

7.1 *Facsimile Printer*, used to prepare images. The unit in copy mode shall be employed for the application. Adjust the unit to the manufacturer's specifications.

7.2 *Reflection Densitometer*, with proper calibration. The aperture diameter of the instrument should not be larger than the imaged areas to be measured.

7.3 *Magnifying Lens*, 5 or 10×.

8. Materials

8.1 *Thermal Paper*, of the grade recommended by the thermal paper producer or by the facsimile printer manufacturer.

8.2 *Test Target*:

8.2.1 Various test targets are available for evaluation of thermal paper depending on the specific objectives of the study. Test targets can be prepared which range from normal printing to ones which include resolution targets, large printed areas or figures and pictures with half tones. Refer to Practice F 360 regarding development of test targets.

8.2.2 Standardized test targets have been developed by Comite Consultatif International Telegraphique et Telephonique (CCITT)[5] and Institute of Electrical and Electronic Engineers (IEEE). The CCITT test targets include information on the interpretation of results. Both test targets are designed to assess the transmission performance of facsimile units but are suitable for testing the performance of thermal paper.

8.2.3 The user may consider employing a series of secondary test targets to reduce the "wear and tear" to the main test target.

8.2.4 The user may choose to intersperse examples of documents normally processed at the user's location with the test target. The frequency with which the test target is repeated should be established by the experimental design. If this option is chosen, the same test set should be used with each roll of thermal paper being tested.

9. Preparation of Apparatus

9.1 Before starting the test, the facsimile printer should be examined. Clean the print head and feed rollers following the manufacturer's recommended procedure. Some models of facsimile printers may not allow access to the print head for inspection, cleaning, or adjustments.

NOTE 1—The print head may be hot.

9.2 Where possible, set speed, contrast, resolution, and grayscale as desired and record. Standard settings are recommended. Use the same settings throughout the test.

10. Procedure for Preparing the Image

10.1 Insert the roll of thermal paper in the facsimile machine and check for proper operation.

10.1.1 In some facsimile units, the copy mode may operate at a different speed compared to standard transmission mode operation which can affect thermal paper performance. If possible, adjust the copy mode speed to be equivalent to the speed at standard transmission mode. In some units, the operating speed may slow down to protect the thermal head from overheating.

10.1.2 To reduce the possibility of electrical interference, an isolation transformer or other voltage stabilization device can be used. To eliminate the influence of telephone line interference on the results the facsimile printer shall be operated in the copy mode using default settings.

10.2 Load the test target(s) in the document feeder.

10.3 Operate the unit in the copy mode.

10.4 Continue to operate the unit using the same test targets until the roll of thermal paper is exhausted. Record the number of images produced, any feeding problems, paper jams, noncut pages, abnormal images, or other unusual behavior or noises which occur during operation. Record any interruptions in the test and the reason on a log sheet.

10.5 Inspect the print head and feed rollers for presence of any residue and record. Rate the amount of residue on a three point scale, where 0 is no residue and 3 is significant residue. If a residue is noticed, clean the machine as described in Section 9.

10.6 Evaluate the curl characteristics of the imaged sample at ambient conditions employing the curl classifications described in Test Method F 556.

10.7 Repeat 10.1 to 10.7 for other rolls of thermal paper. Allow the machine printhead to cool for 30 min before starting the next test.

10.8 Allow at least 30 min for the image to develop before making any visual or density measurements.

10.9 If a printhead burns out or is damaged during the test, the test must be repeated.

[5] Available from the Omnicon Institute, 115 Park St., SE, Vienna, VA 22180-4607.

11. Procedure for Evaluation of Image Quality

11.1 *Visual Means*:

11.1.1 Visually compare the facsimile images to the original test document(s) for the following properties (5 or 10× magnification may aid in the evaluation):

11.1.1.1 Intensity of image,

11.1.1.2 Sharpness and resolution,

11.1.1.3 Voids or streaks, and

11.1.1.4 *Length*—Shorter or longer than original.

11.1.2 Compare the quality of the images throughout the run.

11.2 *Reflectance Density*:

11.2.1 Calibrate and operate the densitometer in accordance with the instructions supplied by the manufacturer, including line voltage, warm up time, and adjustment of the scale.

11.2.2 Establish a plan for the selection of the samples for measurement. A minimum of thirty samples should be employed to provide statistical results according to the Central Limit Theorem. To determine the interval between samples selected for measurement, *n*, utilize the total number of images produced and divide by the number of samples desired. Select the first sheet and every *n*th sheet thereafter.

11.2.3 For measurements, choose areas on the imaged samples that are larger than the aperture of the densitometer. Select at least five areas for measurement on each sample in separate imaged areas of the specimen. Place an imaged specimen under the viewing head of the reflection densitometer and read the density obtained. Average the readings taken. Additional readings may be taken to improve statistical significance.

11.2.4 Repeat with additional samples until a set of data representative of the thermal paper's characteristics has been established. Make measurements in the exact same locations as made in 11.2.3 to minimize any variation due to the print head (refer to 6.10).

11.2.5 Check to make sure the unit is not darkening the sample by placing a sample of the thermal paper under the reading head for several minutes. If the density reading slowly drifts, then readings will need to be taken rapidly. If the drift is relatively rapid, another instrument must be chosen. The sample can also be checked visually.

11.3 Establish a ranking order for the characteristics evaluated by comparing paired samples on the basis of equal to, above, or below.

12. Report

12.1 Report the following information:

12.1.1 The relative value and ranking order of the images as compared to the target for each roll of thermal paper tested. Note any trends in the data. The results should include:

12.1.1.1 *Reflection Density or Visual Intensity*—Average, standard deviation, minimum and maximum values.

12.1.1.2 Sharpness and resolution.

12.1.1.3 Voids or streaks indicative of possible wear, residue build-up, or damage to the print head.

12.1.1.4 Variation in length.

12.2 The presence of any residue on either the feed rollers or the print head.

12.3 The average and maximum curl measured for each roll.

12.4 The equipment configuration, operating parameters including speed, test conditions, temperature, relative humidity, feeding problems, and any unusual behavior (for example, a "popping" noise indicative of a sticking problem) encountered during the test.

13. Precision and Bias

13.1 *Precision*—An interlaboratory study of this test method was conducted in 1990 by operators in four laboratories involving four thermal paper samples on five facsimile units with meduim printhead energy classifications. A ranking order was repeatable between the laboratories. One sample had a significantly lower average density than the other three samples. The data demonstrates an inverse relationship between average density values and all precision parameters. For samples with average density values ranging from 1.0 to 1.3, the within-laboratory standard deviation varied between 0.036 and 0.007 (or 3.6 and 0.6 %); the between-laboratories standard deviation varied between 0.087 and 0.017 (or 8.7 and 1.3 %), respectively. The design of the experiment and summary of the analysis of the data employing Practice E 691 are given in the research report.[6] Based on statistical analysis of the results, the following criteria should be used for judging the acceptability of results at the 95 % confidence level:

13.1.1 *Repeatability*—Two average density results, each the average of ten measurements consisting of five individual values obtained by the same operator, should be considered suspect if they differ by more than 0.1 density unit or 10 % relative. If the density measurement is between 1.25 and 1.30, two average density results should be considered suspect if they differ by more than 0.035 density units or 3.0 % relative.

13.1.2 *Reproducibility*—Two average density results, each the average of ten measurements consisting of five individual readings obtained by operators in different laboratories, should be considered suspect if they differ by more than 0.24 density units or 25 % relative. If the density measurements are between 1.25 and 1.30, two average density results should be considered suspect if they differ by more than 0.086 density units or 6.10 % relative.

13.2 *Bias*—Bias cannot be determined as there are no standard materials.

14. Keywords

14.1 copy products; facsimile printer; image quality; thermal paper

[6] Supporting data are available from ASTM Headquarters. Request RR:1004.