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Standard Test Method for Evaluation of Larger Area Density and Background on Electrophotographic Printers[1]

This standard is issued under the fixed designation F2036; 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 describes the procedure for measuring the monochrome diffuse reflection print density and background for large areas on printed pages from electrophotographic printers. It describes the test target and calculations for evaluating the print density and background.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1856 Practice for Determining Toner Usage for Printer Cartridges

2.2 *ANSI Standards:*

IT2.17–1995 (ISO 5-4) Density Measurements—Part 4: Geometric Conditions for Reflection Density[3]

IT2.17–1995 ANNEX A1 Density Measurements—Part 4: Geometric Conditions for Reflection Density, Backing Material[3]

3. Summary of Test Method

3.1 A standard test target is printed under specified conditions. Black areas and background areas of the print are measured using a diffuse reflection densitometer. The values are recorded and the results interpreted.

3.2 The diffuse reflection density is the logarithm of the inverse of the ratio of the reflected light to the incident light.

4. Significance and Use

4.1 This test method can be used for the evaluation of the electrophotographic printer output image quality, aesthetic appearance, visual impression of blackness and the ability to distinguish information from the background.

4.2 This test method can be used for the evaluation of new and remanufactured toner cartridges and their respective components used in an electrophotographic printing process.

4.3 This test method can be used to evaluate printer output image density and background under specified environmental conditions.

4.4 This test method is suitable for research and development and quality acceptance evaluations.

5. Interferences

5.1 Relative humidity can impact test results. The tests should be performed at a controlled temperature and humidity within the operating humidity range of the printer. This usually is between 20 and 80 % RH. All equipment and materials should be conditioned in the same temperature and relative humidity for at least 24 h prior to testing.

5.2 Printer related items such as the power supply, density control settings, resolution enhancements, toner saver settings, economy mode settings, and laser optics may impact image quality, print density and background.

5.3 The printer should be in good mechanical and electrical condition. Preferably, printers with a continuous history of preventative maintenance should be used.

5.4 Component wear can cause the print density and background to change during the life of the cartridge. Repeated tests may be required to evaluate the average print quality.

5.5 The printer variations and cartridge wear can cause variations in the print density on a single page.

6. Apparatus

6.1 *Electrophotographic Test Printer,* suitable for testing purposes.

6.2 *Printer Data System,* capable of generating the test target for density and background. A sample is shown in Fig. 1.

[1] This test method is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.04 on Electrostatic 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] Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

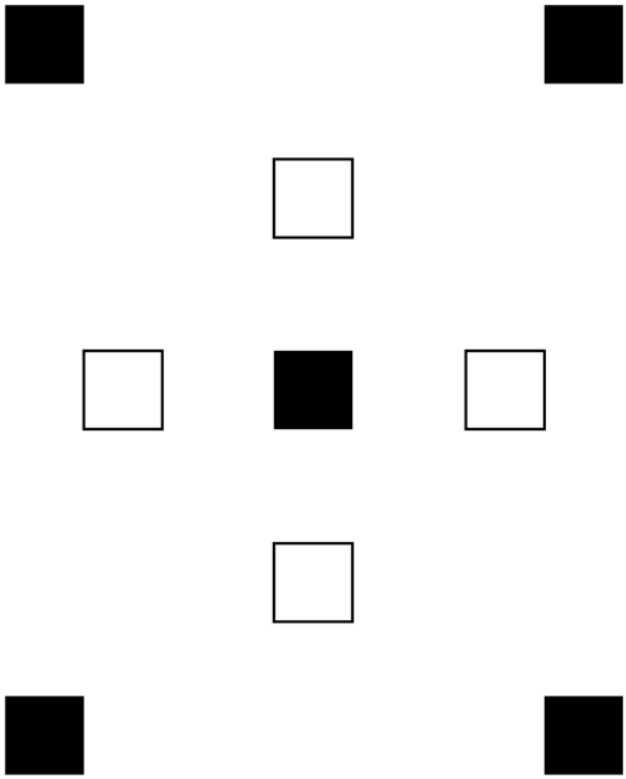

FIG. 1 Sample Density and Background Test Target

6.2.1 The target will have five solid black squares, approximately 25 mm square (1 in. square), located in each corner and center of the printable area.

6.2.2 The target will have four outlined nonimaged (blank) squares, approximately 25 mm square (1 in. square):

6.2.2.1 Two are centered on the left and right sides equidistant between the printable area edge and center of the target, and

6.2.2.2 Two are centered at the top and bottom sides equidistant between the printable area edge and center of the target.

6.2.3 The printable area is 8 in. × 10 in. (0.203 m × 0.254 m) making it usable for both U.S. standard letter and A4 paper sizes.

6.3 *Test Cartridge,* designed for use in the test printer.

6.4 *Conditioned Paper,* that meets the requirements of the printer. This same paper type and manufacturer should be used for all comparative tests.

6.5 *Densitometer,* meeting the requirements of ANSI IT2.17–1995 (ISO 5-4). The densitometer reads the diffuse reflection density, which is the logarithm of the inverse of the ratio of the reflected light to the incident light.

6.6 Black backing meeting the requirements of ANSI IT2.17–1995, Annex A1.

7. Test Procedure

7.1 Using conditioned paper print ten pages of a full page text target with approximately 5 % coverage. If available, use the test target in Practice F1856.

7.2 Immediately following 7.1 using conditioned paper print one page of the density and background target as described in 6.2.

7.3 Calibrate the densitometer according to the manufacturer's instructions.

7.4 Measure the reflection density of a conditioned sheet of paper before printing using a densitometer as specified in 6.5. Measure the reflection density at four different locations, at approximately the same locations as the four "blank" squares on the density and background test target. Use the correct black backing as described in ANSI 2.17–1995, Annex A1.

7.5 Measure the reflection density of the five solid black squares using a densitometer as described in 6.5. Use the black backing as described in ANSI 2.17–1995, Annex A1. Take one measurement per square in the center of the square.

7.6 Measure the reflection density of the four outlined nonimaged (blank) squares using a densitometer as described in 6.5. Use the black backing as described in ANSI 2.17–1995, Annex A1. Take one measurement per square in the center of the square.

7.7 Record values measured in 7.4 – 7.6.

8. Calculation

8.1 Calculate the average solid area density from the five values obtained in 7.5. Because the densitometer reads the logarithm of the inverse of the ratio of the reflected light to the incident light, the values must be converted from the logarithmic form before averaging and then converted back to the logarithmic form after averaging. This can be done by taking the inverse logarithm (base 10) of the density reading (see Table X1.1 in Appendix X1). This is equal to $1/10^{(\text{density reading})}$, where the density reading is the exponent of 10. The values in the form of percent reflection can then be averaged. The average value can be returned to the logarithmic (density) format by calculating the logarithm (see Appendix X1.2),

$$\text{Density} = \log_{10}\left[1/(\text{percent reflection})\right] \quad (1)$$

8.2 Determine the highest and lowest density of the five solid area density values in 7.5.

8.3 Calculate the average nonimaged (blank) density from the four values obtained in 7.6. Because the densitometer reads the logarithm of the inverse of the ratio of the reflected light to the incident light, the values must be converted from the logarithm to percent reflectance before averaging. A conversion table is shown in the Appendix as Table X1.3.

8.4 Calculate the average reflection density of a conditioned sheet of paper before printing from the four values obtained in 7.4. Because the densitometer reads the logarithm of the inverse of the ratio of the reflected light to the incident light, the values must be converted from the logarithm to percent reflectance before averaging. A conversion table is shown in the Appendix as Table X1.3.

8.5 Determine the average background by calculating the difference in the percent reflectance values obtained in 8.3 and 8.4. Subtract the percent reflectance value calculated in 8.3 from the percent reflectance value calculated in 8.4.

9. Report

9.1 The report shall include the following information:

9.1.1 Test conditions (temperature and humidity), cartridge identification, printer setup conditions, printer identification, test target data.

9.1.2 The average reflection density as determined in 8.1.

9.1.3 The print density range or variation as determined in 8.2.

9.1.4 The average background as determined in 8.5.

10. Precision and Bias

10.1 *Repeatability*— Tests will be performed using the same laboratory, equipment, and operator.

10.2 *Reproducibility*— Tests will be performed using the same print samples in different laboratories and different operators.

10.3 *Bias*—There is no reference material suitable for determining bias.

11. Keywords

11.1 background; cartridge; electrophotographic; laser printer; nonimpact printer; reflection density

APPENDIX

(Nonmandatory Information)

X1. TABLES FOR CONVERTING REFLECTION DENSITY TO OR FROM PERCENT REFLECTION

TABLE X1.1 Converting Reflection Density to Percent Reflection

Reflection Density	Percent Reflected	Reflection Density	Percent Reflected
1.00	10.00 %	1.31	4.90 %
1.01	9.77 %	1.32	4.79 %
1.02	9.55 %	1.33	4.68 %
1.03	9.33 %	1.34	4.57 %
1.04	9.12 %	1.35	4.47 %
1.05	8.91 %	1.36	4.37 %
1.06	8.71 %	1.37	4.27 %
1.07	8.51 %	1.38	4.17 %
1.08	8.32 %	1.39	4.07 %
1.09	8.13 %	1.40	3.98 %
1.10	7.94 %	1.41	3.89 %
1.11	7.76 %	1.42	3.80 %
1.12	7.59 %	1.43	3.72 %
1.13	7.41 %	1.44	3.63 %
1.14	7.24 %	1.45	3.55 %
1.15	7.08 %	1.46	3.47 %
1.16	6.92 %	1.47	3.39 %
1.17	6.76 %	1.48	3.31 %
1.18	6.61 %	1.49	3.24 %
1.19	6.46 %	1.50	3.16 %
1.20	6.31 %	1.51	3.09 %
1.21	6.17 %	1.52	3.02 %
1.22	6.03 %	1.53	2.95 %
1.23	5.89 %	1.54	2.88 %
1.24	5.75 %	1.55	2.82 %
1.25	5.62 %	1.56	2.75 %
1.26	5.50 %	1.57	2.69 %
1.27	5.37 %	1.58	2.63 %
1.28	5.25 %	1.59	2.57 %
1.29	5.13 %	1.60	2.51 %
1.30	5.01 %	1.61	2.45 %

TABLE X1.2 Converting Percent Reflection to Reflection Density

Percent Reflected	Reflection Density	Percent Reflected	Reflection Density
10.00 %	1.00	6.10 %	1.21
9.90 %	1.00	6.00 %	1.22
9.80 %	1.01	5.90 %	1.23
9.70 %	1.01	5.80 %	1.24
9.60 %	1.02	5.70 %	1.24
9.50 %	1.02	5.60 %	1.25
9.40 %	1.03	5.50 %	1.26
9.30 %	1.03	5.40 %	1.27
9.20 %	1.04	5.30 %	1.28
9.10 %	1.04	5.20 %	1.28
9.00 %	1.05	5.10 %	1.29
8.90 %	1.05	5.00 %	1.30
8.80 %	1.06	4.90 %	1.31
8.70 %	1.06	4.80 %	1.32
8.60 %	1.07	4.70 %	1.33
8.50 %	1.07	4.60 %	1.34
8.40 %	1.08	4.50 %	1.35
8.30 %	1.08	4.40 %	1.36
8.20 %	1.09	4.30 %	1.37
8.10 %	1.09	4.20 %	1.38
8.00 %	1.10	4.10 %	1.39
7.90 %	1.10	4.00 %	1.40
7.80 %	1.11	3.90 %	1.41
7.70 %	1.11	3.80 %	1.42
7.60 %	1.12	3.70 %	1.43
7.50 %	1.12	3.60 %	1.44
7.40 %	1.13	3.50 %	1.46
7.30 %	1.14	3.40 %	1.47
7.20 %	1.14	3.30 %	1.48
7.10 %	1.15	3.20 %	1.49
7.00 %	1.15	3.10 %	1.51
6.90 %	1.16	3.00 %	1.52
6.80 %	1.17	2.90 %	1.54
6.70 %	1.17	2.80 %	1.55
6.60 %	1.18	2.70 %	1.57
6.50 %	1.19	2.60 %	1.59
6.40 %	1.19	2.50 %	1.60
6.30 %	1.20	2.40 %	1.62
6.20 %	1.21	2.30 %	1.64

TABLE X1.3 Converting Reflection Density to Percent Reflection for Blank Paper and Non-Imaged Areas

Reflection Density	Percent Reflection	Reflection Density	Percent Reflection	Reflection Density	Percent Reflection
0.080	83.2%	0.120	75.9%	0.160	69.2%
0.081	83.0%	0.121	75.7%	0.161	69.0%
0.082	82.8%	0.122	75.5%	0.162	68.9%
0.083	82.6%	0.123	75.3%	0.163	68.7%
0.084	82.4%	0.124	75.2%	0.164	68.5%
0.085	82.2%	0.125	75.0%	0.165	68.4%
0.086	82.0%	0.126	74.8%	0.166	68.2%
0.087	81.8%	0.127	74.6%	0.167	68.1%
0.088	81.7%	0.128	74.5%	0.168	67.9%
0.089	81.5%	0.129	74.3%	0.169	67.8%
0.090	81.3%	0.130	74.1%	0.170	67.6%
0.091	81.1%	0.131	74.0%	0.171	67.5%
0.092	80.9%	0.132	73.8%	0.172	67.3%
0.093	80.7%	0.133	73.6%	0.173	67.1%
0.094	80.5%	0.134	73.5%	0.174	67.0%
0.095	80.4%	0.135	73.3%	0.175	66.8%
0.096	80.2%	0.136	73.1%	0.176	66.7%
0.097	80.0%	0.137	72.9%	0.177	66.5%
0.098	79.8%	0.138	72.8%	0.178	66.4%
0.099	79.6%	0.139	72.6%	0.179	66.2%
0.100	79.4%	0.140	72.4%	0.180	66.1%
0.101	79.3%	0.141	72.3%	0.181	65.9%
0.102	79.1%	0.142	72.1%	0.182	65.8%
0.103	78.9%	0.143	71.9%	0.183	65.6%
0.104	78.7%	0.144	71.8%	0.184	65.5%
0.105	78.5%	0.145	71.6%	0.185	65.3%
0.106	78.3%	0.146	71.4%	0.186	65.2%
0.107	78.2%	0.147	71.3%	0.187	65.0%
0.108	78.0%	0.148	71.1%	0.188	64.9%
0.109	77.8%	0.149	71.0%	0.189	64.7%
0.110	77.6%	0.150	70.8%	0.190	64.6%
0.111	77.4%	0.151	70.6%	0.191	64.4%
0.112	77.3%	0.152	70.5%	0.192	64.3%
0.113	77.1%	0.153	70.3%	0.193	64.1%
0.114	76.9%	0.154	70.1%	0.194	64.0%
0.115	76.7%	0.155	70.0%	0.195	63.8%
0.116	76.6%	0.156	69.8%	0.196	63.7%
0.117	76.4%	0.157	69.7%	0.197	63.5%
0.118	76.2%	0.158	69.5%	0.198	63.4%
0.119	76.0%	0.159	69.3%	0.199	63.2%