Designation: F1944 – 98 (Reapproved 2008)

Standard Practice for Determining the Quality of the Text, Line- and Solid-Fill Output Produced by Ink Jet Printers[1]

This standard is issued under the fixed designation F1944; 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 describes a procedure that can be used to determine the image quality of text, line- and solid-fill images produced by ink jet printers.

1.2 This practice can be used to evaluate black, process-black and primary ink, single-color images produced by ink jet printers.

1.3 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.

1.4 *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 limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F909 Terminology Relating to Printers

F1125 Terminology of Image Quality in Impact Printing Systems

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

F1623 Terminology Relating to Thermal Imaging Products

F1942 Practice for Creating Test Targets for Determining the Ink Yield of the Imaging Supplies Used in Ink Jet Printers

F1857 Terminology Relating to Ink Jet Printers and Images Made Therefrom

3. Terminology

3.1 *Definitions:*

3.1.1 See Terminology F1125 for terms of image quality in impact printing systems.

3.1.2 See Terminology F909 for terms relating to printers.

3.1.3 See Terminology F1623 for terms relating to thermal imaging products.

3.1.4 See Terminology F1857 for terms relating to ink jet printers and images made therefrom.

4. Significance and Use

4.1 This practice may be used to determine the image quality of text, line- and solid-fill images produced by ink jet printers.

4.2 This practice may be used to evaluate the image quality of black, process-black and primary ink, single-color images produced by ink jet printers.

4.3 This practice may be used to evaluate the interaction between ink(s) and various substrate types as it relates to image quality.

4.4 This procedure may be used for substrate (for example, paper, paperboard, film, labels, fabric, envelopes), printer and ink specifications-acceptance, research and product development.

4.5 Although this practice is suitable for the evaluation of all printer, ink and substrate combinations, it is not intended for use in the evaluation of color fidelity or continuous-tones.

5. Interferences

5.1 Ink jet substrates may be purchased from a variety of sources and may affect the image quality produced by a given system. The user should only use the grade and weight of substrates recommended by the printer manufacturer when evaluating printer image quality. When there is a difference in the performance between the two sides of the substrate, it is up to the manufacturer of the substrate to specify the print side.

5.2 All substrates should be from the same source and production lot. Some inherent variability may affect image-quality evaluations, as will certain unintentional defects. Some variability may be encountered from one ream of substrate to the next, or sometimes encountered within a ream. Both sides of evaluation substrates should be evaluated if a print side is not specified by the manufacturer of the substrate.

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[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.

Current edition approved July 1, 2008. Published July 2008. Originally approved in 1998. Last previous edition approved in 2003 as F1944 – 98 (2003). DOI: 10.1520/F1944-98R08.

[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.

5.3 Many printers are subject to imaging-system variations due to fluctuation of line voltage. Voltage stabilizing devices may be used. If a stabilizing device is not used, sample prints should be produced when the line load is low or stabilized.

5.4 Fluctuations in temperature and humidity may affect the substrate used for image reception. Samples printed on different days could show variation in results. All print samples should be dated with temperature and relative humidity recorded.

5.5 The following evaluations of image-quality attributes are performed visually. All comparative evaluations should be performed under the same viewing conditions.

5.6 The following evaluations utilize digital test originals that are created using software. Always use the same originals when comparing printers, supplies and substrates.

5.7 Note that some print defects may be the result of clogged or malfunctioning ink jet nozzles. Solid fill print samples should be periodically examined for alternating high and low density horizontal bands. If this defect is noted, it is likely that a nozzle is clogged or has malfunctioned. In this case, the evaluation should be stopped, the nozzles cleaned or replaced and the evaluation restarted from the beginning.

6. Apparatus

6.1 *Ink jet printer.*

6.2 *Word processing or page layout (desktop publishing) software,* which allows the user to create, copy and place graphic elements on a page, as well as specify the size of these graphic elements.

6.3 *5X Magnifier or optical comparator* .

6.4 *Metric ruler,* graduated to 1 mm.

7. Calibration

7.1 Adjust the printer used to conduct the evaluation per the manufacturer's instructions or in accordance with Practice F1174.

7.2 Skew and nozzle misalignment may be an irreparable aspect of a particular printer. It is recommended that if these weaknesses are predisposed, that it should be determined before the evaluation commences (refer to Sections 12 and 14).

8. Conditioning

8.1 Condition the printer, supplies and substrates to be evaluated for 24 h in the same atmospheric conditions as those present where the evaluation is to be conducted.

8.2 All comparison evaluations should be run under the same conditions of temperature and humidity.

9. Text-Quality Evaluation

9.1 *Feathering*—Feathering is a common characteristic of ink jet imaging and causes poor text quality. Feathering occurs when ink flows along substrate fibers causing protrusions from the image. The length of the feather, as well as their frequency and optical density, have an effect on the print quality. A severe form of feathering is called "wicking" and occurs when the feather is long enough to form a bridge to adjacent images. Feathering should not be confused with spray (14.1).

9.1.1 *Feathering Evaluation:*

9.1.1.1 Using a word processor or text editor, create several lines of text.

9.1.1.2 Print the text using the conditioned printer, imaging supplies and substrate.

9.1.1.3 Using the magnifier or optical comparator, examine all of the text in the printed sample. Compare to the following references and report the results.

(1) No feathering observed.

(2) Some feathering is observed.

(3) Frequent feathering distorts the outline of text image.

(4) Wicking is observed.

10. Solid-Fill Evaluation

10.1 *Mottling and Coalescence*—Mottling is an image-quality defect that results in non-uniformity of the image density of a "solid fill" area (for example, thick lines, letters or blocks). Mottling defects follow patterns in the substrate or are caused by the interaction between ink and substrate. Coalescence defects are caused by pooling of the ink before it has time to dry or be absorbed into the substrate.

10.1.1 *Mottling Evaluation:*

10.1.1.1 Using Practice F1942, create a document consisting of solid-fill areas sufficiently large enough to visually evaluate. Several 1 in. square (25.4 mm) solid fill elements located around the page should suffice.

10.1.1.2 Print the document using the conditioned printer, imaging supplies and substrate.

10.1.1.3 Use a magnifier or optical comparator and examine all of the solid-fill areas in the printed sample for non-uniform density. Compare to the following references and report the results.

10.1.1.4 If apparent density defects follow patterns in the substrate, they are mottling defects. If apparent density defects are caused by pooling of the ink on the surface of the substrate, it is a coalescence defect.

(1) No mottling or coalescing observed.

(2) Some mottling or coalescing is observed.

(3) Severe mottling or coalescing is visible to the naked eye.

10.2 *Banding*—Banding is a image-quality defect that results in alternating high and low density bands across solid-fill areas. Note that this defect may occur even though the quality of the text is acceptable and may be caused by clogged or malfunctioning nozzles.

10.2.1 *Banding Evaluation:*

10.2.1.1 Using Practice F1942, create a document consisting of solid-fill areas sufficiently large enough to visually evaluate. Several 1 in. square (25.4 mm) solid fill elements and several lines of text located around the page should suffice.

10.2.1.2 Print the document using the conditioned printer, imaging supplies and substrate.

10.2.1.3 Using the magnifier or optical comparator, examine all of the solid-fill areas in the printed sample. Compare to the following references and report the results.

(1) No banding observed.

(2) Some banding is observed but is not apparent in text.

(3) Severe banding is observed and is apparent in both solid fill areas and text.

10.3 *Bronzing*—Bronzing is an image-quality defect that may sometimes be observed in solid-fill areas where the black ink reacts with the substrate, so that the image displays a bronze sheen.

10.3.1 *Bronzing Evaluation:*

10.3.1.1 Using Practice F1942, create a document consisting of black solid fill areas sufficiently large enough to visually evaluate. Several 1 in. square (25.4 mm) solid fill elements located around the page should suffice.

10.3.1.2 Print the document using the conditioned printer, imaging supplies and substrate.

10.3.1.3 Using the magnifier or optical comparator, examine all of the solid-fill areas in the printed sample. Compare to the following references and report the results.

(1) No bronzing is observed.

(2) Some bronzing is observed within some elements around the page.

(3) Some bronzing is observed in all elements around the page

(4) Consistent bronzing is apparent in all elements on the page.

10.4 *Wet cockle*—Wet cockle is an image quality defect that results in non-uniform image density of a solid fill area. As solid-fill areas are printed on substrate, ink causes fibers in the substrate to swell. This produces a wave pattern on the substrate and is observed during the printing process prior to ink drying. Sometimes the substrate swells enough to cause the ink jet nozzles to come in contact with the substrate and smear the image.

10.5 *Dry cockle*—Dry cockle is an image-quality defect that results in non-uniform image quality of a solid fill area. As the ink dries, the wet-cockle wave pattern usually diminishes and is then referenced to as dry cockle.

10.5.1 *Wet/Dry Cockle Evaluation:*

10.5.1.1 Using Practice F1942, create a document consisting of solid-fill areas sufficiently large enough to visually evaluate.

10.5.1.2 Print the document using the conditioned printer, imaging supplies and substrate.

10.5.1.3 Using the magnifier or optical comparator, examine all of the solid-fill areas in the printed sample. Compare to the following references and report the results.

(1) No wet or dry cockle observed.

(2) Some wet cockle is observed.

(3) Some dry cockle is observed.

(4) Print head comes in contact with substrate and smears image.

11. Bleed Evaluation

11.1 *Image bleed*— Image bleed is the bleeding of one color of ink into an adjacent color and is a common result of the interaction between the ink and substrate. The evaluation of bleed is similar to that for evaluating feathering, and depends on the amount and frequency of the line-width expansion.

11.1.1 *Image-Bleed Evaluation:*

11.1.1.1 Using a word processor or page layout program, create black text inside of a yellow box and yellow text inside of a composite black box. Other combinations of primary ink color may be used for bleed evaluation.

11.1.1.2 Print the document using the conditioned printer, imaging supplies and substrate.

11.1.1.3 Using the magnifier or optical comparator, examine the printed sample. Compare to the following references and report the results.

(1) No increase in image width is observed.

(2) Some increase in image width is observed

(3) Protrusion defects distort image width.

(4) Protrusions into adjacent background color are observed.

12. Skew Evaluation

12.1 *Skew*—Skew is relationship of the imaged area to one or more edges of the substrate. Nearly all images (especially text) should be imaged square on the page. An image that is not produced squarely on the page is "skewed." Skew is measured as deviation between the side of the image and the edge of the substrate (see Fig. 1).

12.1.1 *Skew Evaluation:*

12.1.1.1 Using a word processor or page layout program, create and place a 25 cm line or rectangular object along the long edge of the page.

12.1.1.2 Print the document using the conditioned printer, imaging supplies and substrate.

12.1.1.3 Using a ruler, measure the distance from the outer edges ("A" and "B") of the elements to the edge of the sheet.

12.1.1.4 Calculate (*A*-*B*)/25. Report the results.

(1) No skew is measured.

(2) Skew measure is less than 0.06 mm/cm.

(3) Skew measure is greater than 0.06 mm/cm.

13. Background Evaluation

13.1 *Artifacts*—Artifacts are extraneous spray or droplets that may be visually detected in the background or non-imaged area of a printed page. Artifacts can be caused by a substrate that has an extremely rough surface or protruding fibers that come in contact with the ink nozzle. Artifacts can also be caused by faulty nozzles (refer to 14.1 and 14.2) and may not be related to the substrate.

13.1.1 *Artifact Evaluation:*

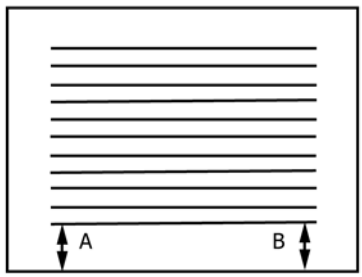

FIG. 1 Skew

13.1.1.1 Using the magnifier or optical comparator, examine the various images created during the evaluation. Compare to the following references and report the results.

(1) No artifacts are observed.

(2) Some artifacts are observed.

(3) Numerous artifacts affect text, solid fill or background-area uniformity.

14. Differentiating Nozzle Characteristics from Substrate Influences

14.1 *Spray*—Spray is extraneous droplets of ink around the outside of the image area. When a nozzle ejects droplets of ink, a certain amount of spray is normally ejected. With printers equipped with a moving print head, spray predominately appears along the trailing edge of the image. An image with a significant amount of spray can result in a halo effect around the image.

14.1.1 *Spray Evaluation:*

14.1.1.1 Since most printers print bidirectionally, examine the edge definition of both leading and trailing edges of previously produced images with the magnifier or optical comparator to determine whether poor image quality is a substrate (feathering) or a nozzle problem.

(1) No spray is observed.

(2) Some spray is observed.

(3) Spray gives images a hazy appearance.

14.2 *Stray droplets*— Stray droplets are ink droplets that land on the substrate away from the image area. This is a nozzle problem and not related to the substrate.

14.2.1 *Stray Droplet Evaluation:*

14.2.1.1 Using the magnifier or optical comparator, examine the non-imaged area of the previously produced images for evidence of any stray droplets.

(1) No stray droplets are observed.

(2) Some stray droplets are observed.

(3) Stray droplets are visible to naked eye.

14.3 *Inconsistent drop volume*—Inconsistent drop volume is varying droplet volumes between nozzles or within a nozzle. Low drop volumes can lead to low optical density and loss of image uniformity while high drop volumes can result in feathering and image distortion.

14.3.1 *Drop Volume Evaluation:*

14.3.1.1 Using a word processor or page layout program, create 1 in. long vertical lines of the thinnest allowable width and place them around the page.

14.3.1.2 Print the document using the conditioned printer, imaging supplies and substrate.

14.3.1.3 Using the magnifier or optical comparator, examine the dot produced from each nozzle to form each vertical line and compare the size and shape of each dot.

(1) Dot sizes are consistent within a line and from line-to-line.

(2) Some dot-size inconsistency is observed from line-to-line.

(3) Dot-size inconsistency is observed within several lines.

15. Differentiating Printer Characteristics from Substrate Influences

15.1 *Nozzle/Platen Alignment*—When the distance between nozzle and substrate varies or is too great, minor image-quality errors are magnified. A properly adjusted printer is required in order to produce straight horizontal and vertical lines.

15.1.1 *Alignment Evaluation:*

15.1.1.1 Using the magnifier or optical comparator, examine the edge definition of previously produced images to determine whether poor image quality is a substrate (feathering) or an alignment problem.

(1) Edge definition is good—all four edges of an image are crisp and free of stairstepping, depressions or protrusions.

(2) Edge definition is fair—some stairstepping or depressions and protrusions are noted.

(3) Edge definition is poor—stairstepping or depressions and protrusions are visible to the naked eye.

16. Report

16.1 Interpretation of the results should be made by one evaluator.

16.2 Enter report data into the sample data worksheet (see Fig. 2).

16.3 Report the make, model and serial number of the printer used for the evaluation.

16.4 Report the brand and lot of supplies and substrates used for the evaluation.

16.5 Report the atmospheric conditions at the time of image production.

16.6 Enter the numeric reference describing the results of each evaluation.

16.6.1 Report the degree of feathering observed (9.1.1.3).

16.6.2 Report the degree of mottling or coalescence observed (10.1.1.3).

16.6.3 Report the degree of banding observed (10.2.1.3).

16.6.4 Report the degree of bronzing observed (10.3.1.3).

16.6.5 Report the degree of wet and dry cockle observed (10.5.1.3).

16.6.6 Report the degree of bleed observed (11.1.1.3).

16.6.7 Report the amount of skew observed (12.1.1.3).

16.6.8 Report the degree of background artifacts observed (13.1.1.3).

16.6.9 Report the degree of spray observed (14.1.1.3).

16.6.10 Report the degree of stray ink droplets observed (14.1.2.1).

16.6.11 Report the degree of inconsistent drop volume observed (14.1.3.1).

16.6.12 Report the degree of misalignment observed (15.1.1.1).

16.7 Add the reference numbers and enter in the score section for each column.

16.8 When comparing the performance of printers, supplies or substrates, compare the aggregate scores from Fig. 2.

17. Keywords

17.1 image quality; ink jet; ink jet printer

Worksheet for Determining the Image-Quality Attributes of Ink Jet Printers, Supplies and Substrates

Printer Make _____ Model _____ Serial # _____

Date _____ Time _____ Temp _____ R.H._____

Supplies Evaluated _____

Description _____ Lot # _____

Description _____ Lot # _____

Description _____ Lot # _____

Description _____ Lot # _____

Substrate Evaluated _____

Description _____ Lot # _____

Tally Sheet
Image-Quality Attributes

Ink/Substrate Attributes	Ref. #	Printer/Substrate Attributes	Ref. #	Printer/Nozzle Attributes	Ref. #
Feathering (9.1.1.3)		Wet Cockle (10.5.1.3)		Spray (14.1.1.1)	
Mottlingor Coalescence (10.1.1.3)		Skew (12.1.1.3)		Stray Droplets (14.2.1.1)	
Banding (10.2.1.3)		Artifacts (13.1.1.1)		Drop Volume (14.3.1.1)	
Bronzing (10.3.1.3)				Alignment (15.1.1.1)	
Wet/Dry Cockle (10.5.1.3)					
Bleed (11.1.1.3)					
Score (lowest is best)					

FIG. 2 Sample Data Worksheet