



Designation: E2389 – 05

# Standard Guide for Examination of Documents Produced with Liquid Ink Jet Technology<sup>1</sup>

This standard is issued under the fixed designation E2389; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This guide provides procedures that should be used by forensic document examiners (Guide E444) for examinations of documents produced with liquid inkjet technology and related procedures.

1.2 These procedures are applicable whether the examination is of a questioned and known item(s) or of exclusively questioned item(s).

1.3 These procedures include evaluation of the sufficiency of the material available for examination.

1.4 The particular methods employed in a given case will depend upon the nature and sufficiency of the material available for examination.

1.5 This guide may not cover all aspects of unusual or uncommon examinations.

1.6 These methods are applicable to examinations involving copiers, printers, facsimile devices, and multifunction devices using ink jet technology.

1.7 *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:*<sup>2</sup>

D1968 Terminology Relating to Paper and Paper Products (Withdrawn 2010)<sup>3</sup>

E444 Guide for Scope of Work of Forensic Document Examiners

E1732 Terminology Relating to Forensic Science

E2195 Terminology Relating to the Examination of Questioned Documents

E2331 Guide for Examination of Altered Documents

F221 Terminology Relating to Carbon Paper and Inked Ribbon Products and Images Made Therefrom

F909 Terminology Relating to Printers

F1156 Terminology Relating to Product Counterfeit Protection Systems (Withdrawn 2001)<sup>3</sup>

F1457 Terminology Relating to Laser Printers

F1857 Terminology Relating to Ink Jet Printers and Images Made Therefrom

## 3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms in this guide, refer to Terminologies E1732 and E2195.

3.1.2 *coalescence, n*—puddling or pooling of adjacent ink drops on the substrate before they can be dried or absorbed resulting in nonuniformity of color density. **F1857**

3.1.3 *cockle, n—of paper*, a defective, puckered condition of a paper sheet as a result of non-uniform hygro-expansion which can be related to any non-uniformity in the sheet, including mass distribution and drying stresses. **D1968**

3.1.4 *continuous spray, n*—ink jet technology where drops are generated at a regular unbroken rate. Images are then generated by deflections of the ink droplets after they are charged so they are either intercepted by a catcher and not permitted to impact the substrate or deflected to intercept the substrate at specific locations.

3.1.5 *cracking, n*—condition in which ink that has been absorbed into a substrate causes the coating to shrink to a state much smaller than the original coating dimension causing fractures in the image area. **F1857**

3.1.6 *crystallization, n*—condition in which ink evaporates and forms crystals. **F1857**

3.1.7 *drop on demand (DOD), n*—ink jet technology where drops are generated as needed to create an image.

3.1.8 *full-color copiers, n—of ink jet technology*, copiers that can reproduce color originals containing gradations of color. They have a minimum of three colored inks (cyan, magenta and yellow).

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee E30 on Forensic Sciences and is the direct responsibility of Subcommittee E30.90 on Executive.

Current edition approved Dec. 1, 2005. Published January 2006. DOI: 10.1520/E2389-05.

<sup>2</sup> 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.

<sup>3</sup> The last approved version of this historical standard is referenced on www.astm.org.

3.1.9 *image area*, *n*—area on a page occupied by all the printed information. **F1457**

3.1.10 *image density*, *n*—contrast between image and background as measured by densitometer. **F221**

3.1.11 *image*, *n*—optical counterpart of an object produced by means of an image producing device. **F221**

3.1.12 *ink jet printer*, *n*—nonimpact printer in which the characters are formed by projecting droplets of ink onto a substrate. **F909**

3.1.13 *landscape mode*, *adj*—printer output orientation in which printed lines run parallel to the direction of movement of the paper. **F1457**

3.1.14 *maximum print position*, *n*—rightmost point at which the printer can mark the paper. **F1457**

3.1.15 *nonimpact printer*, *n*—printer in which image formation is not the result of mechanical impacts. Examples are thermal printers, electrostatic printers, electrophotographic printers, and inkjet printers. **F909**

3.1.16 *offset*, *n*—unintentional transfer of ink (as from a freshly printed substrate). **F1857**

3.1.17 *piezoelectric*, *n*—ink jet technology where the electrically stimulated deformation of a crystal causes the expulsion of the droplets from the ink chamber.

3.1.18 *pixelation*, *n*—stairstepped or jagged effect resulting from analog to digital conversion.

3.1.19 *platen*, *n*—flat plate or roller used as a support for printing or copying a document. **F1156**

3.1.20 *portrait mode*, *adj*—printer output orientation in which print lines run perpendicular to the direction of movement of the paper. **F1457**

3.1.21 *printhead*, *n*—printing device of an ink jet printing system.

3.1.22 *printer output area*, *n*—maximum area on the page to which the printer will print. **F1457**

3.1.23 *raster output scanner*, *n*—output peripheral, either stand alone or within a printer, that converts computer data into a bit mapped image, which is sent to the host for storage or a printer for output. **F1457**

3.1.24 *slit glass*, *n*—alternate scanning surface found in some digital photocopiers used in conjunction with an automatic document feeder.

3.1.25 *smudge*, *n*—tendency of an image to smear or streak onto an adjacent area when rubbed; involves the redeposition of abraded material. **F221**

3.1.26 *thermal impulse*, *n*—ink jet technology where the rapid expansion of a bubble in the ink created by localized electrical heating expels the droplets from the ink chamber.

## 3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *banding*, *n*—uniform density variations or voids in a given color which appear in the direction that the printhead travels. **F1857**

3.2.2 *bleed*, *n*—ink feathering of one color into an adjacent color over time. **F1857**

3.2.3 *circularity*, *n*—ratio of a single ink dot height divided by its width with 1.0 being a perfect circle. **F1857**

3.2.4 *feathering*, *n*—ink spread over substrate causing fuzzy edges, spidery lines and poor print quality. **F1857**

3.2.5 *liquid ink jet device*, *n*—device in which the ink supply is in fluid (for example, solvent or aqueous) form.

3.2.6 *mottling*, *n*—nonuniformity of image density which follows patterns in the substrate or by non-uniform ink-substrate interaction. **F1857**

3.2.7 *satellite*, *n*—extraneous or undesirable ink droplets. (See also *spatter*, *spray*) **F1857**

3.2.8 *spatter*, *n*—type of extraneous or undesirable ink droplet originating when a portion of an ink droplet strikes the intended area and is deflected to an unintended area. **F1857**

3.2.9 *spray*, *n*—type of extraneous or undesirable ink dot near the printed zones which originate from the printhead. **F1857**

## 4. Significance and Use

4.1 The procedures outlined here are grounded in the generally accepted body of knowledge and experience in the field of forensic document examination. By following these procedures, a forensic document examiner can reliably reach an opinion concerning whether two or more documents produced with ink jet technology are from the same device, whether a particular device created the document, or the determination of the make or model of a device.

## 5. Interferences

5.1 Items submitted for examination may have inherent limitations that can interfere with the procedures in this guide. Limitations should be noted and recorded.

5.2 Limitations can be due to the generation of the document(s), limited quantity or comparability, or condition of the items submitted for examination. Such features are taken into account in this guide.

5.3 The results of prior storage, handling, testing, or chemical processing (for example, for latent prints) may interfere with the ability of the examiner to see certain characteristics. The effects can include, but are not limited to, partial destruction of the substrate, stains, and deterioration of the ink. Whenever possible, document examinations should be conducted prior to any chemical processing. Items should be handled appropriately to avoid compromising subsequent examinations.

5.4 Consideration should be given to the possibility that various forms of manipulation and duplication of ink jet-produced items can be generated by computer, scanner, digital camera, graphic pad or other means.

5.5 Some ink supply units are interchangeable between different brands or models of machines. Some ink units are refillable and ink from suppliers other than the original manufacturer may be used.

5.6 Some multi-function devices utilizing toner technology can operate in either printing or copying mode, at different

resolutions and can produce both multi-color (for example, CMYK) black or monochrome (for example, one color black). These various outputs from one machine have many significant differences among them.

## 6. Equipment and Requirements

6.1 Appropriate light source(s) of sufficient intensity to allow fine detail to be distinguished.

NOTE 1—Natural light, incandescent or fluorescent sources, or fiber optic lighting systems are generally used. Transmitted illumination, side lighting, and vertical incident lighting may be useful in a variety of situations.

6.2 Magnification sufficient to allow fine detail to be distinguished.

6.3 Rulers in metric, U.S. customary units, printers' measure, and desktop publishing units.

6.4 Other apparatus as appropriate (for example, measuring grids and magnetic detectors).

6.5 Imaging or other equipment for recording observations as required.

6.6 Reference materials can aid in the determination of a manufacturer.

6.7 Sufficient time and facilities to complete all applicable procedures.

## 7. Procedures

7.1 All procedures shall be performed (consistent with Toner Guide) and noted when appropriate. These procedures need not be performed in the order given.

7.2 Examinations performed, relevant observations, and results shall be documented.

7.3 At various points in these procedures, a determination that a particular feature is not present or that an item is lacking in quality or comparability may indicate that the examiner should discontinue or limit the procedure(s). It is at the discretion of the examiner to discontinue the procedure at that point and report accordingly or to continue with the applicable procedures to the extent possible. The reasons for such a decision shall be documented.

7.4 Determine whether the submitted questioned document(s) was produced with liquid ink jet technology. If not, discontinue examination and report accordingly.

7.5 Determine whether the examination is comparison of a questioned document(s) to a known document(s), a comparison of exclusively questioned documents, or is another type of examination of a questioned item(s) (e.g., to determine date limitations or class of machine).

7.6 Determine whether the questioned document(s) is suitable for examination, or comparison, or both. If it is not suitable, discontinue the procedure and report accordingly. Factors that affect the suitability include clarity, detail, or condition of the document.

7.7 If no known document(s) or device(s) was submitted, go to 7.9.

7.8 If a known document(s) is submitted, determine whether the known document(s) is suitable for examination, or comparison, or both. If it is not suitable, discontinue the procedure and report accordingly. Factors that affect the suitability include clarity, detail, or condition of the document.

7.9 If the original is not submitted, evaluate the quality of the best available reproduction to determine whether significant details have been reproduced with sufficient clarity for comparison purposes and proceed to the extent possible. If the reproduction is not of sufficient clarity for comparison purposes, discontinue these procedures and report accordingly.

7.10 If a device is examined, its condition should be noted. Service records should be requested and pertinent information noted and recorded.

7.10.1 *Discussion*—Consultation with a qualified technician may be advantageous or necessary.

7.11 Note the capabilities, features, and settings of any variable features on each device examined. If the device has internal memory, retain or recover any stored information.

7.12 Note visible external components of the device such as the platen, slit glass, collators, and cover/automatic document feeder that may contain physical evidence, obstructions, debris, correction fluid, marks, or scratches.

NOTE 2—Before taking exemplars, consideration must be given to the possible destruction or loss of physical evidence within the device (for example, fragments torn from the questioned document).

7.13 Prepare appropriate exemplars, taking into consideration the features of the device and possible chemical ink examinations.

7.14 Note damage to easily accessible internal components of the device such as the print head or paper transport mechanism.

7.15 If applicable, take additional exemplars.

7.16 If none of the exemplars are suitable for comparison and no others are obtained, discontinue these procedures and report accordingly.

7.17 Examine the questioned item(s), or the questioned and known items.

7.17.1 *Discussion*—The type of substrate used in an ink jet printer may affect the appearance of the ink such as banding, circularity, feathering, bleed, mottling, offset, spatter or satellite droplets.

7.18 Examination(s) for indentations (Guide E2291) may be performed for the purpose of visualizing indented writing or physical characteristics such as marks from the paper transport mechanism.

7.19 Various illumination techniques (color filtering, infrared, or ultraviolet) may be used to provide additional information such as security features or stains.

7.20 Examination(s) for alterations (Guide E2331) may be performed.

7.21 Identification of the typestyle(s) may provide useful information (for example, dating information).

7.22 Compare class characteristics (for example, paper supply system, ink type, marks caused by mechanics, color capability). If significant unexplainable differences exist, discontinue and report accordingly.

NOTE 3—Some ink supply units are interchangeable among different brands or models of machines and most units are refillable.

7.23 If possible, classify the device used to produce a questioned document(s). When identifying a manufacturer of a questioned item(s), refer to laboratory and published industry resources. If necessary, contact the device manufacturer or distributor for further information.

7.24 Compare individualizing characteristics such as wear and damage defects, misalignments, reproducible marks, banding, voids, and improper or extraneous ink transfer. Perform and note critical measurements, where needed.

NOTE 4—Successive copying on the same machine will make marks slightly out of register. Doubling or tripling of a pattern of dots or marks indicates, respectively, two or three generations of copies on the same machine. Copying on more than one device may bear the distinctive marks of all machines.

7.25 Evaluate similarities, differences, and limitations. Determine their significance individually and in combination.

NOTE 5—Care must be taken in the evaluation of characteristics as some may be caused by factors external to the print device (for example, artifacts from or manipulation of the source computer file) or characteristics common to a particular model of machine.

7.26 Reach a conclusion according to the criteria set forth in Section 8.

## 8. Report

8.1 Conclusion(s), opinion(s), or findings resulting from the procedures in this guide may be reached once sufficient

examinations have been conducted. The number and nature of the necessary examinations is dependent on the question at hand.

8.2 The bases and reasons for the conclusion(s), opinion(s), or findings should be included in the examiner's documentation and may also be included in the report.

8.3 *Identification*—When the examination reveals no significant differences between two or more items and there is agreement in significant individualizing characteristics, an identification is appropriate. There may be limitations.

8.4 *Elimination*—If significant differences between two or more items are found at any level of the analyses, an elimination may be appropriate. There may be limitations. There may be similarities.

8.5 *Qualified Opinions*—When there are limiting factors and the examination reveals similarities or differences of limited significance between two or more items, the use of qualified opinions can be appropriate. This opinion requires explanation of the limiting factors.

8.6 *No Conclusion*—When there are significant limiting factors, a report that no conclusion can be reached is appropriate. This opinion requires explanation of the limiting factors.

## 9. Keywords

9.1 facsimile devices; forensic sciences; ink jet; photocopiers; questioned documents

## BIBLIOGRAPHY

- (1) Doherty, P., "Classification of Ink Jet Printers and Inks," *Journal of the American Society of Questioned Document Examiners*, Vol 1, No. 2, December 1998, pp. 88–106.

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