Michael G. Noblett,[1] *B.S. and Elizabeth L. James,*[1] *B.A.*

Optimum Conditions for Examination of Documents Using an Electrostatic Detection Apparatus (ESDA) Device to Visualize Indented Writings

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ABSTRACT: This study indicated that preconditioning a document in a humidity chamber maintained at 40 to 60% provided the most information from indented writings. It further indicated that aerosol application of the toner provided more information than cascade application. This study also indicated that electrostatic detection apparatus (ESDA) examination for indented writing has no deleterious effect on subsequent latent fingerprint development.

KEYWORDS: questioned documents, electrostatic detection apparatus (ESDA), fingerprints, indented writing

Background

The use of the electrostatic detection apparatus (ESDA) device to visualize indented writings has been commonplace for several years. While the exact mechanism of this visualization process is not clearly understood, the results are dramatic and allow the questioned document examiner to provide information that was previously unobtainable.

While ESDA is an effective tool for the examiner of questioned documents, some question has arisen in the recent past as to whether or not ESDA or some preconditioning requirement such as exposure of the document to humidified air may have a negative effect in latent fingerprint development.

It is not the intent of this paper to postulate a mechanism for this visualization nor to suggest a mechanism for the effect of relative humidity (RH). This paper presents the results of an empirical study involving two methods of toner application, distance of the corona discharge wand from the questioned document, the effect of relative humidity, and the effect of ESDA on subsequent latent fingerprint development.

Equipment

The work was done using the following:

(1) electrostatic detection apparatus (ESDA) device manufactured by Foster and Freeman Ltd, 36 Broadway, Grays, Essex, RM 17 6 E W, England and

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[1]Special agent and document analyst, respectively, Federal Bureau of Investigation, Washington, DC.

(2) Model TH JR Constant Humidity and Temperature Test Chamber manufactured by Tenny Engineering Inc., 1090 Springfield Road, Union, NJ 07083.

Procedure

Papers from the sources listed in Table 1 were tested.

Each of these ten types of paper were identified and then written on such that each test piece bore four levels of indented writing. All test pieces were handled with no protection so that fingerprints could logically be expected.

Three test pieces from each of the ten types of paper were placed in the chamber of the Tenny model TH JR for approximately 15 min at a controlled humidity. The humidities used for this study were 90, 75, 60, 40, and 0%, all at approximately 20°C. (0% was approximated by storing the test specimens in a vacum desiccator for 24 h). Following this humidity conditioning the three test pieces were examined on ESDA.

One of the three test pieces conditioned at a specific humidity was examined by aerosol application of toner. The corona discharge wand was kept at a constant 38 mm (1½ in.) from the paper surface and the corona discharge wand passed over the test piece seven times (approximately 15 s). The aerosol trigger was pressed for short periods of time (approximately 1 s) and the indented writings allowed to develop normally.

One of the three test pieces conditioned at the same humidity was examined using cascade application of the toner. Again, the corona discharge wand was kept at a constant 38 mm (1½ in.) from the paper surface for seven passes (approximately 15 s).

TABLE 1—*Paper tested in study.*[a]

Paper No.	Description
1	U.S. Government Bond, watermarked, manufactured by Howard Paper Mills Inc., Dayton, OH 25% cotton fiber size: 8½ by 11 by 0.004 in.
2	4024 dual purpose "xerox paper" size 8½ by 11 by 0.0035 in.
3	GSA stock No. 7530-00-239-8479 white unruled scratch pad size 5 by 8 by 0.003 in.
4	GSA issued "steno pad" white, lined size 6 by 9 by 0.003 in.
5	Eagle-A erasable white bond, manufactured by Fox River Paper Co., Appleton, WI 54913 size 8½ by 11 by 0.0035 in.
6	Eagle-A white bond, manufactured by Fox River Paper Co., Appleton, WI 54913 100% cotton fiber size 8½ by 11 by 0.005 in.
7	GSA stock No. 7530-00-286-6173 yellow legal pad size 8 by 12½ by 0.003 in.
8	GSA stock No. 7530-00-285-3083 white lined writing tablet size 8 by 10 by 0.004 in.
9	GSA issued three-hole white lined notebook filler with rounded corners size 8½ by 11 by 0.003 in.
10	Continuous feed computer printer paper supplied by Elgin Business Forms Inc., Elgin, IL 60123 size 15 by 11 by 0.0035 in.

[a]1 in. = 25.4 mm.

One of the three test pieces conditioned at the same humidity was examined using cascade application of the toner with the corona discharge wand kept a constant 76 mm (3 in.) from the paper surface for seven passes (approximately 15 s).

To test the reproducibility of the observations, the test was repeated 45 days after the initial test using additional three test specimens each from the same original ten types of paper.

Table 2 summarizes the test procedure for the specimens tested.

In addition to the specimens taken for ESDA examination, an additional specimen was used as a control for latent fingerprint development.

Data regarding the visualization of the four levels of indented writing on each specimen were recorded. In order to evaluate the conditions tested, the legibility of the visualized indented writings at each of the four levels were assigned point values. If the indented writing was rendered legible it was scored as two points. If some writing was rendered visible but not legible, it was scored as one point. If no writing was observed it was scored as zero points.

For instance, a technique that visualized legible writing on all four levels was scored as eight. A technique that visualized some writing on one level that was not legible and no visualization of the other three was scored as one.

The raw data for the two test series (a total of 300 specimens) are shown in Table 3 and summarized in Table 4.

Figure 1 is a graph of the data in Table 4 that represents the average for all ten paper types tested comparing aerosol application of toner versus cascade application of toner.

Figures 2 through 11 are graphs of the data for the individual ten paper types.

After all ESDA testing was complete, the 300 test specimens and the control specimens were treated for latent fingerprint development. The development technique was standard ninhydrin treatment. The effect of ESDA examination was determined by comparing the ability to develop latent fingerprints on the test specimens with that same ability on the control specimens that had not been examined on ESDA. No consideration was given to the quality or quantity of the developed latent fingerprints.

Comments

Note that the results given reflect the average for all ten papers tested. The reader should refer to the data and graphs of the individual paper types for a more precise comment on the effects of humidity and toner application.

TABLE 2—*Test procedure.*[a]

Sample Population Of Each Paper Type	Relative Humidity, %	Toner Application		
			Cascade	
		Aerosol	1½ in.	3 in.
3	0	1	1	1
3	40	1	1	1
3	60	1	1	1
3	75	1	1	1
3	90	1	1	1
Total 15[b]	...	...	...	...

[a] 1 in. = 25.4 mm.

[b] A total of 150 specimens were tested (15 specimens from 10 paper types) during the initial test phase then repeated using an additional 150 specimens for a total population of 300 specimens.

TABLE 3—*Raw data (a score of 2 is legible, 1 is illegible, and 0 is nothing seen).*[a]

Relative Humidity, %	Toner Application			Test 1 Score Indented Writing Level					Test 2 Score Indented Writing Level					Average of Both Totals
	Aerosol	Cascade 1½ in.	Cascade 3 in.	1	2	3	4	Total	1	2	3	4	Total	
						PAPER TYPE 1								
0	x	...	...	0	0	0	0	0	0	0	0	0	0	0
40	x	...	...	0	0	0	0	0	2	1	0	0	3	1.5
60	x	...	...	2	2	0	0	4	1	2	1	1	5	4.5
75	x	...	...	0	0	0	0	0	2	2	0	0	4	2
90	x	...	...	2	1	0	0	3	2	2	0	0	4	3.5
0	...	x	...	0	0	0	0	0	0	0	0	0	0	0
40	...	x	...	1	1	0	0	2	0	0	0	0	0	1
60	...	x	...	1	0	0	0	1	1	1	0	0	2	1.5
75	...	x	...	0	0	0	0	0	2	2	0	0	4	2
90	...	x	...	2	1	0	0	3	2	1	0	0	3	3
0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	1	0	0	0	1	0	0	0	0	0	0.5
60	...	...	x	0	0	0	0	0	0	0	0	0	0	0
75	...	...	x	0	0	0	0	0	0	0	0	0	0	0
90	...	...	x	0	0	0	0	0	0	0	0	0	0	0
						PAPER TYPE 2								
0	x	...	...	0	1	0	1	2	2	2	1	1	6	4
40	x	...	...	2	2	2	1	7	2	2	1	0	5	6
60	x	...	...	2	2	2	2	8	2	2	2	1	7	7.5
75	x	...	...	2	1	2	1	6	2	2	1	0	5	5.5
90	x	...	...	2	2	0	0	4	2	2	1	1	6	5
0	...	x	...	2	2	0	0	4	2	2	0	0	4	4
40	...	x	...	2	2	2	2	8	2	2	0	0	4	6
60	...	x	...	2	2	1	1	6	2	2	1	1	6	6
75	...	x	...	2	1	0	0	3	1	2	0	0	3	3
90	...	x	...	2	2	1	0	5	2	1	0	0	3	4

0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	0	0	0	0	0	0	0	0	0	0	0
60	...	...	x	1	0	0	0	1	1	1	0	0	2	1.5
75	...	...	x	0	0	0	0	0	0	0	0	0	0	0
90	...	...	x	0	0	0	0	0	0	0	0	0	0	0
							PAPER TYPE 3							
0	x	...	...	1	1	2	2	6	1	2	1	1	5	5.5
40	x	...	...	0	0	1	1	2	1	2	1	1	5	3.5
60	x	...	...	2	2	2	2	8	2	2	2	2	8	8
75	x	...	...	2	2	2	1	7	2	2	1	0	5	6
90	x	...	...	1	0	0	0	1	2	2	1	0	5	3
0	...	x	...	0	0	0	0	0	1	1	1	0	3	1.5
40	...	x	...	2	2	1	0	5	2	1	1	0	4	4.5
60	...	x	...	2	1	0	0	3	1	0	0	0	1	2
75	...	x	...	1	1	0	0	2	2	2	0	0	4	3
90	...	x	...	1	0	0	0	1	0	0	0	0	0	5
0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	0	0	0	0	0	0	0	0	0	0	0
60	...	...	x	2	0	0	0	2	0	0	0	0	0	1
75	...	...	x	0	0	0	0	0	0	0	0	0	0	0
90	...	...	x	0	0	0	0	0	0	0	0	0	0	0
							PAPER TYPE 4							
0	x	...	...	1	1	2	1	5	2	2	2	0	6	5.5
40	x	...	...	2	2	1	1	6	2	2	2	1	7	6.5
60	x	...	...	2	2	2	1	7	2	2	2	2	8	7.5
75	x	...	...	1	1	1	0	3	2	2	2	1	7	5
90	x	...	...	2	2	1	0	5	2	2	2	2	8	6.5
0	...	x	...	2	2	0	0	4	0	0	1	0	1	2.5
40	...	x	...	2	2	2	2	8	2	2	2	0	6	7
60	...	x	...	2	1	1	1	5	2	2	2	0	6	5.5
75	...	x	...	2	2	1	0	5	2	2	1	1	6	5.5
90	...	x	...	2	2	1	0	5	2	2	1	0	5	5
0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	0	0	0	0	0	0	0	0	0	0	0

TABLE 3—*Continued*.

Relative Humidity, %	Toner Application			Test 1 Score Indented Writing Level					Test 2 Score Indented Writing Level					Average of Both Totals
		Cascade												
	Aerosol	1½ in.	3 in.	1	2	3	4	Total	1	2	3	4	Total	
60	...	...	x	0	0	0	0	0	0	0	0	0	0	0
75	...	...	x	0	0	0	0	0	2	2	1	0	5	2.5
90	...	...	x	0	0	0	0	0	0	0	0	0	0	0
				PAPER TYPE 5										
0	x	...	...	0	0	0	0	0	1	1	0	0	2	1
40	x	...	...	0	0	0	0	0	0	0	0	0	0	0
60	x	...	...	2	2	1	0	5	0	0	0	0	0	2.5
75	x	...	...	0	0	0	0	0	0	0	0	0	0	0
90	x	...	...	0	0	0	0	0	0	0	0	0	0	0
0	...	x	...	0	0	0	0	0	0	0	0	0	0	0
40	...	x	...	0	0	0	0	0	0	0	0	0	0	0
60	...	x	...	0	0	0	0	0	1	1	1	0	3	1.5
75	...	x	...	0	0	0	0	0	0	0	0	0	0	0
90	...	x	...	0	0	0	0	0	0	0	0	0	0	0
0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	0	0	0	0	0	0	0	0	0	0	0
60	...	...	x	0	0	0	0	0	0	0	0	0	0	0
75	...	...	x	0	0	0	0	0	0	0	0	0	0	0
90	...	...	x	0	0	0	0	0	0	0	0	0	0	0
				PAPER TYPE 6										
0	x	...	...	1	1	0	0	2	1	1	0	0	2	2
40	x	...	...	2	2	1	0	5	2	1	0	0	3	4
60	x	...	...	1	1	0	0	2	2	1	0	0	3	2.5
75	x	...	...	2	1	0	0	3	2	2	0	0	4	3.5
90	x	...	...	2	2	0	0	4	2	2	0	0	4	4

0	...	x	...	1	0	0	0	1	2	1	0	0	3	2
40	...	x	...	0	0	0	0	0	0	0	0	0	0	0
60	...	x	...	2	1	0	0	3	1	1	0	0	2	2.5
75	...	x	...	2	1	0	0	3	2	2	0	0	4	3.5
90	...	x	...	2	2	1	0	5	2	2	1	0	5	5
0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	0	0	0	0	0	0	0	0	0	0	0
60	...	...	x	0	0	0	0	0	1	2	1	0	4	2
75	...	...	x	0	0	0	0	0	2	1	0	0	3	1.5
90	...	...	x	0	0	0	0	0	0	0	0	0	0	0

PAPER TYPE 7

0	x	...	...	0	0	0	0	0	0	0	0	0	0	0
40	x	...	...	2	2	2	2	8	0	0	0	0	0	4
60	x	...	...	1	1	0	0	2	0	1	1	0	2	2
75	x	...	...	0	0	0	0	0	2	1	1	0	4	2
90	x	...	...	2	2	1	0	5	2	1	0	0	3	4
0	...	x	...	0	0	0	0	0	0	0	0	0	0	0
40	...	x	...	2	2	1	0	5	0	0	0	0	0	2.5
60	...	x	...	0	0	0	0	0	0	0	0	0	0	0
75	...	x	...	0	0	0	0	0	2	1	0	0	3	1.5
90	...	x	...	1	0	0	0	1	1	0	0	0	1	1
0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	0	0	0	0	0	0	0	0	0	0	0
60	...	...	x	2	0	0	0	2	0	0	0	0	0	1
75	...	...	x	0	0	0	0	0	0	0	0	0	0	0
90	...	...	x	0	0	0	0	0	0	0	0	0	0	0

PAPER TYPE 8

0	x	...	...	0	0	0	0	0	0	0	0	0	0	0
40	x	...	...	0	0	0	0	0	0	0	0	0	0	0
60	x	...	...	1	0	0	0	1	0	0	0	0	0	0.5
75	x	...	...	0	0	0	0	0	1	0	0	0	1	0.5
90	x	...	...	0	0	0	0	0	0	0	0	0	0	0
0	...	x	...	0	0	0	0	0	0	0	0	0	0	0
40	...	x	...	0	0	0	0	0	0	0	0	0	0	0

TABLE 3—*Continued*.

Relative Humidity, %	Toner Application: Aerosol	Toner Application: Cascade 1½ in.	Toner Application: Cascade 3 in.	Test 1 Score Indented Writing Level: 1	2	3	4	Total	Test 2 Score Indented Writing Level: 1	2	3	4	Total	Average of Both Totals
60	...	x	...	1	0	0	0	1	0	0	0	0	0	0.5
75	...	x	...	0	0	0	0	0	0	0	0	0	0	0
90	...	x	...	0	0	0	0	0	0	0	0	0	0	0
0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	0	0	0	0	0	0	0	0	0	0	0
60	...	...	x	1	0	0	0	1	0	0	0	0	0	0.5
75	...	...	x	0	0	0	0	0	0	0	0	0	0	0
90	...	...	x	0	0	0	0	0	0	0	0	0	0	0
				PAPER TYPE 9										
0	x	...	...	1	2	1	0	4	1	1	1	1	4	4
40	x	...	...	2	2	1	1	6	0	0	0	0	0	3
60	x	...	...	2	2	2	1	7	2	2	2	1	7	7
75	x	...	...	2	1	2	1	6	2	1	1	0	4	5
90	x	...	...	2	2	1	2	7	2	1	2	1	6	6.5
0	...	x	...	0	0	0	0	0	1	1	0	0	2	1
40	...	x	...	2	1	2	1	6	1	2	0	0	3	4.5
60	...	x	...	2	2	1	0	5	2	1	1	0	4	4.5
75	...	x	...	2	2	2	1	7	2	1	1	0	4	5.5
90	...	x	...	2	2	1	0	5	2	2	2	0	6	5.5
0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	0	0	0	0	0	0	0	0	0	0	0
60	...	...	x	2	2	1	0	5	0	0	0	0	0	2.5
75	...	...	x	0	0	0	0	0	0	0	0	0	0	0
90	...	...	x	1	1	0	0	2	0	0	0	0	0	1

PAPER TYPE 10

0	x	...	...	2	2	0	0	4	2	1	0	0	3	3.5
40	x	...	...	2	2	1	0	5	2	1	0	0	3	4
60	x	...	...	2	1	1	0	4	2	1	0	0	3	3.5
75	x	...	...	2	2	1	0	5	2	2	1	1	6	5.5
90	x	...	...	2	2	1	0	5	2	2	1	0	5	5
0	...	x	...	0	0	0	0	0	2	1	1	0	4	2
40	...	x	...	2	1	0	0	3	2	2	1	0	5	4
60	...	x	...	2	1	0	0	3	2	2	1	0	5	4
75	...	x	...	2	2	1	0	5	2	2	1	0	5	5
90	...	x	...	0	0	0	0	0	2	1	0	0	3	1.5
0	...	...	x	0	0	0	0	0	0	0	0	0	0	0
40	...	...	x	0	0	0	0	0	0	0	0	0	0	0
60	...	...	x	1	0	0	0	1	0	0	0	0	0	0.5
75	...	...	x	0	0	0	0	0	1	0	0	0	1	0.5
90	...	...	x	0	0	0	0	0	0	0	0	0	0	0

[a] 1 in. = 25.4 mm.

TABLE 4—*Summary of scores.*[a]

Paper Type	0% RH			40% RH			60% RH			75% RH			90% RH		
		Cascade			Cascade			Cascade			Cascade			Cascade	
	Aerosol	1½ in.	3 in.	Aerosol	1½ in.	3 in.	Aerosol	1½ in.	3 in.	Aerosol	1½ in.	3 in.	Aerosol	1½ in.	3 in.
1	0	0	0	1.5	1	0.5	4.5	1.5	0	2	2	0	3.5	3	0
2	4	4	0	6	6	0	7.5	6	1.5	5.5	3	0	5	4	0
3	5.5	1.5	0	3.5	4.5	0	8	2	1	6	3	0	3	0.5	0
4	5.5	2.5	0	6.5	7	0	7.5	5.5	0	5	5.5	2.5	6.5	5	0
5	1	0	0	0	0	0	2.5	1.5	0	0	0	0	0	0	0
6	2	2	0	4	0	0	2.5	2.5	2	3.5	3.5	2	4	5	0
7	0	0	0	4	2.5	0	2	0	1	2	1.5	0	4	1	0
8	0	0	0	0	0	0	0.5	0.5	0.5	0.5	0	0	0	0	0
9	4	1	0	3	4.5	0	7	4.5	2.5	5	5.5	0	6.5	5.5	1
10	3.5	2	0	4	4	0	3.5	4	0.5	5.5	5	0.5	5	1.5	0
Average	2.55	1.3	0	3.25	2.95	0.05	4.55	2.8	0.8	3.5	2.85	0.5	3.75	2.55	0.1

[a]1 in. = 25.4 mm.

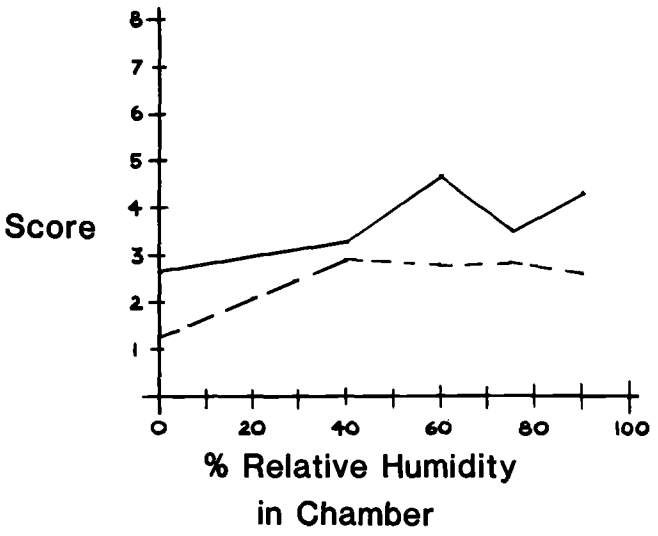

FIG. 1—*Average of all ten papers where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

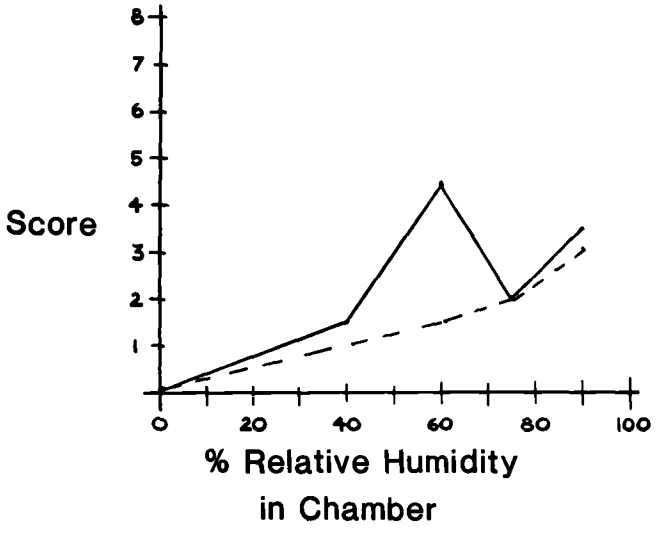

FIG. 2—*Paper Type 1 where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

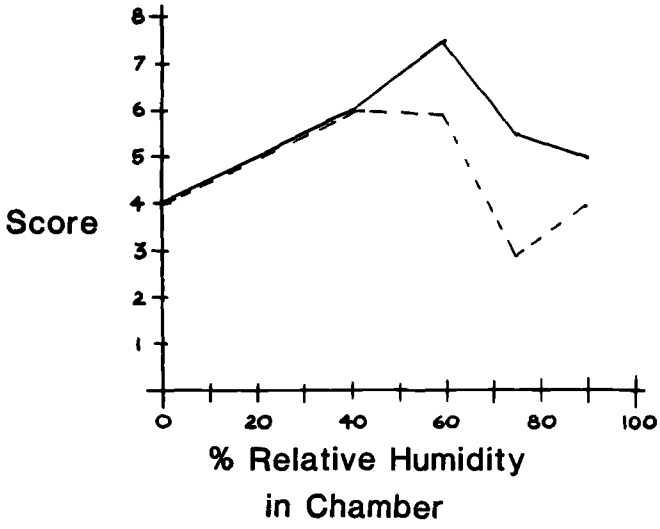

FIG. 3—*Paper Type 2 where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

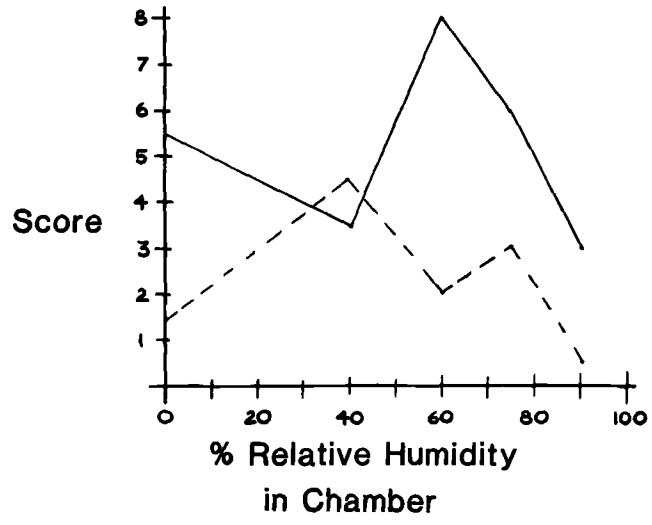

FIG. 4—*Paper Type 3 where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

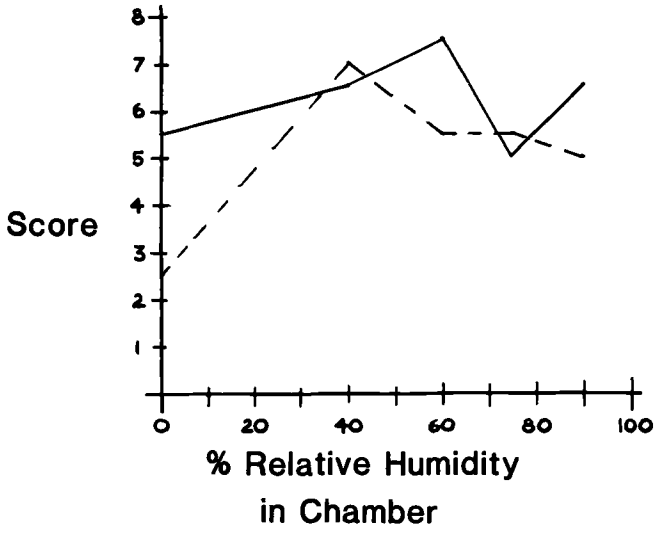

FIG. 5—*Paper Type 4 where aerosol is solid line and cascade (38 mm [1.5 mm]) is dashed line.*

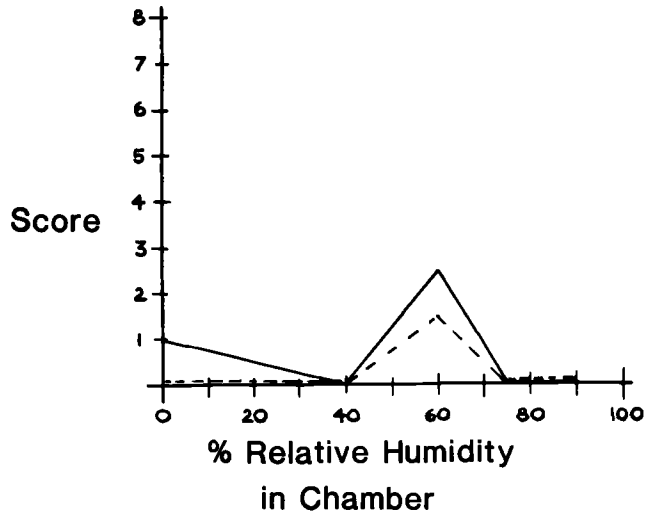

FIG. 6—*Paper Type 5 where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

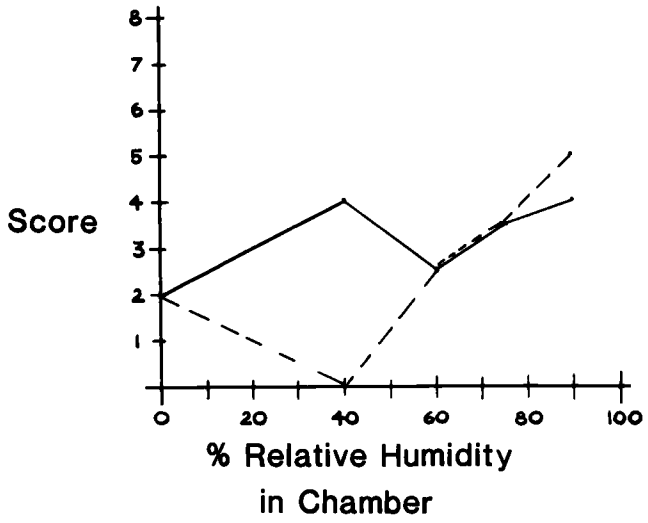

FIG. 7—*Paper Type 6 where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

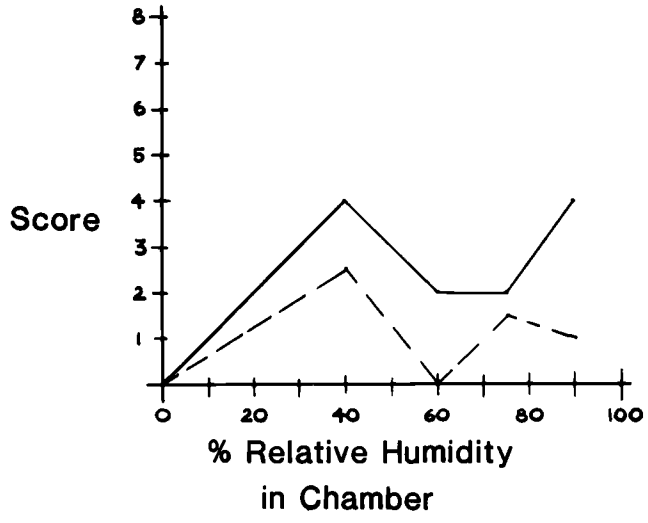

FIG. 8—*Paper Type 7 where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

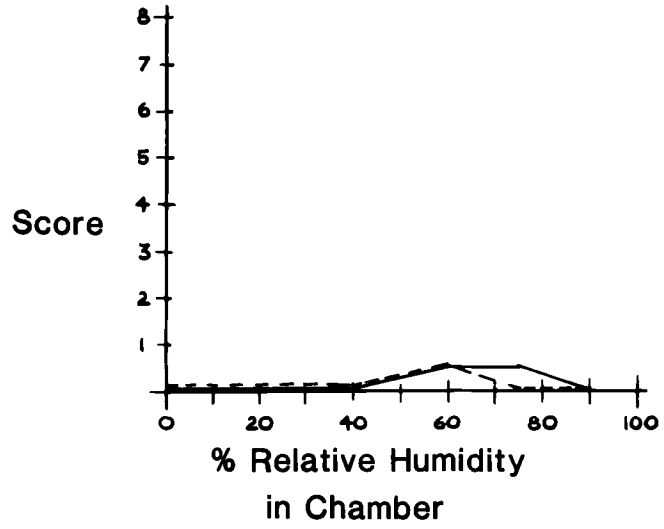

FIG. 9—*Paper Type 8 where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

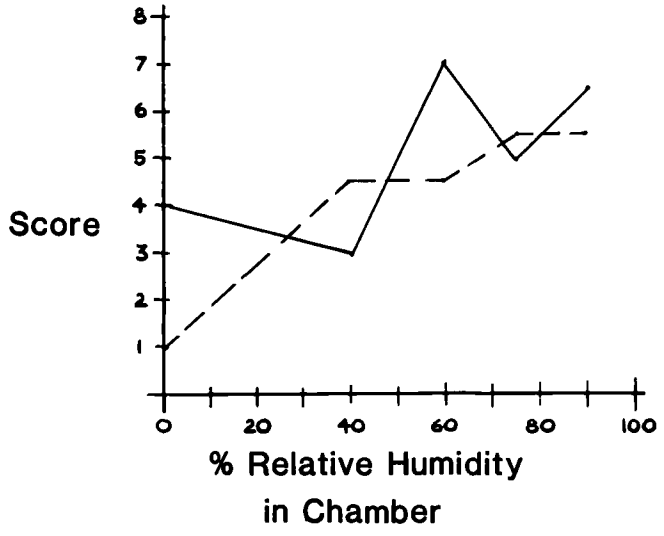

FIG. 10—*Paper Type 9 where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

The subject of length of time in the humidity chamber for optimum results will be addressed in another study.

Results

1. The ability of ESDA to visualize indented writings varies greatly from one paper type to another.
2. The aerosol method of toner application produced the most usable information from the indented writings.
3. When the cascade method of toner application was used, the corona discharge wand

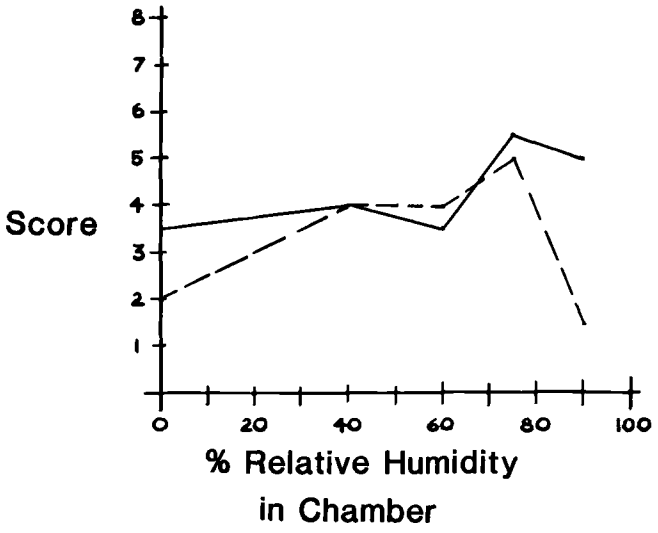

FIG. 11—*Paper Type 10 where aerosol is solid line and cascade (38 mm [1.5 in.]) is dashed line.*

kept at a constant distance of 38 mm (1½ in.) from the paper surface produced more information than the wand kept 76 mm (3 in.) from the surface.

4. The study indicated that the most useful information was gained from documents that were conditioned in a humidity chamber for 15 min at 40 to 60% RH.

5. This limited study indicated that examination by ESDA had no effect on subsequent development of latent fingerprints.

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Address requests for reprints or additional information to
Michael G. Noblett
FBI Laboratory
Washington, DC 20535