David S. Moore,[1] *B.S., M.Ed.*

The Electrostatic Detection Apparatus (ESDA) and Its Effects on Latent Prints on Paper

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ABSTRACT: For almost a decade, document examiners have used the electrostatic detection apparatus (ESDA) to detect and visualize indentations on paper. Many of the same papers that undergo the ESDA process, however, may also be capable of yielding latent print evidence of vital importance to the successful prosecution of a case. Both the questioned document examiner and the latent print analyst, therefore, have a valid interest in the protection of paper evidence. It is common knowledge that treating a paper document with ninhydrin for latent prints can effectively destroy any indentations. This study was initiated to determine whether the ESDA process resulted in any corresponding detrimental effects to latent prints on paper documents. Four different variables were manipulated and evaluated during the testing process. The results, which seem to contradict earlier published data, are discussed as well as what steps may be necessary to best protect both latent print and indentation evidence.

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

Undoubtedly, the electrostatic detection apparatus (ESDA) has been one of the most important recent scientific advancements in the field of forensic questioned document examination. No previous technique has been so successful as the ESDA in the detection and decipherment of indented writing on documents. First commercially produced by the firm of Foster and Freeman[2] in the latter 1970s [*1,2*], the ESDA, which uses an electrostatic imaging procedure to visualize the indentations, has become an object of necessity within document laboratories associated with criminal investigative organizations, as well as within many of those laboratories involved strictly in civil matters.

The extreme sensitivity of the ESDA in detecting indented impressions on paper has been chronicled in a number of well-written, informative papers [*1-4*]. There are several factors, however, that can adversely affect the ESDA results. Among these are dryness of the paper and the treatment of paper with ninhydrin to detect latent prints or treatment with a solvent [*2,3*].

Initial results of this study were presented at the 1986 Meeting of the California State Division of the International Association for Identification, Tahoe City, CA, 21 May 1986. Also presented at the 39th Annual Meeting of the American Academy of Forensic Sciences, San Diego, CA, 16-21 Feb. 1987. Received for publication 18 Feb. 1987; accepted for publication 9 June 1987.

[1]Examiner of questioned documents, Department of Justice, Bureau of Forensic Services, Questioned Document Section, Sacramento, CA.

[2]Present address: Foster & Freeman Ltd., 25 Swan Lane, Evesham, Worchestershire, WR11 4PE, England.

Many crime laboratories employ the services of both questioned document examiners and latent print examiners. Frequently, documents are submitted to these laboratories by agencies that desire examinations of their evidence by both of these forensic science disciplines.

It is common practice in many crime laboratories to have paper evidence cases initially evaluated by the document section and subsequently by the latent section. As mentioned previously, one of the reasons the document section conducts their examination first is that paper evidence treated with ninhydrin does not yield satisfactory results on the ESDA. The ninhydrin treatment effectively destroys most indentation evidence. This research project was initiated to determine whether any corresponding detrimental effects might be done to latent prints on paper by the ESDA process.

Review of the Literature

A review of the available literature disclosed that several articles mentioned that paper evidence should initially be processed on the ESDA by the document examiner *before* being processed with ninhydrin by the latent print examiner [*2,3*]. However, only one article was located that specifically addressed the issue of whether the ESDA process had any adverse effects on latent prints.

This paper [*5*], written by Noblett and James, concluded in part on p. 712 that, "This limited study indicated that examination by ESDA had no effect on subsequent development of latent fingerprints." The authors acknowledged on p. 699 that, in their research, "No consideration was given to the quality or quantity of the developed latent fingerprints." By contrast, this study was designed to evaluate specifically the quality of latent prints on paper that had undergone the ESDA process before the ninhydrin treatment.

Experimental Procedure

This project was structured to conform, as close as possible, to the actual procedures that are followed at the author's current place of employment within the Bureau of Forensic Services, California Department of Justice. As it occurs in many other laboratory settings throughout the United States, cases that involve both questioned documents and latent prints within our laboratory begin their evaluation in the Questioned Documents Section. If the case so dictates, it will be processed on the ESDA by a document examiner and later released to a latent print analyst for chemical treatment with ninhydrin.

The testing procedure was conducted in two separate phases. The first phase consisted of a total of 576 separate tests. The second stage was initiated as a result of the initial test results and it consisted of only 16 separate tests.

Four different variables were manipulated and evaluated during the testing process in an attempt to determine their relative impact, if any, on the quality of latent prints on paper. These variables were:

(1) paper type,
(2) time between when the latent print was placed on the paper and the beginning of the ESDA process,
(3) time within the ESDA humidity cabinet, and
(4) time between completion of the ESDA process and treating the document with ninhydrin.

Paper Type

Table 1 lists the various papers tested. Each paper was selected so as to fairly represent the variety of papers encountered by both forensic science disciplines within this laboratory. For

TABLE 1—*Paper tested in study.*[a]

Paper No.	Description
1	Index card, DG Grade-110 lb., unlined, white, manufactured by Globe-Weis; purchased under CA Dept. of General Services Stock No. 7530 244 7456 4 size: 3 by 5 by 0.0095 in.
2	"Racerase" bond typewriter paper, white, 25% cotton, manufactured by Southworth Company, West Springfield, MA 01089 size: 8 1/2 by 11 by 0.0035 in.
3	Baronet Xerographic bond paper, white with writing finish, 20 lb., purchased under CA Dept. of General Services Stock No. 7530 290 0631 5 size: 8 1/2 by 11 by 0.0045 in.
4	Writing tablet, white with blue lines, manufactured by Paperulers, Inc., purchased under CA Dept. of General Services Stock No. 7530 286 6173 5 size: 8 1/2 by 11 by 0.0035 in.
5	Bond paper, white, 25% cotton, white cockle finish, 20 lb., manufactured by Gilbert Paper Company, purchased under CA Dept. of General Services Stock No. 7530 290 0509 8 size: 8 1/2 by 11 by 0.0035 in.
6	Check stock, gray, furnished by Sacramento Valley Bank, Sacramento, CA 95825 size: 2 3/4 by 6 by 0.004 in.
7	Donor sheet of Redi-Note 4S462 NCR (No Carbon Required) paper, white with blue lines, manufactured by Rediform, Los Angeles, CA 90051 size: 7 1/2 by 4 1/4 by 0.003 in.
8	Receptor sheet of Redi-Note 4S462 NCR (No Carbon Required) paper, yellow with blue lines, manufactured by Rediform, Los Angeles, CA 90051 size: 7 1/2 by 4 1/4 by 0.002 75 in.
9	Newspaper stock, off-white with black print size: 27 by 22 1/2 by 0.0035 in.

[a]1 in. = 25.4 mm.

the testing process, each piece of paper was initially cut to the approximate size of 3 by 5 in. (7.6 by 12.7 cm).

Time Between Print and Humidity Cabinet

A total of six different time frames were selected to evaluate whether any detrimental effects to the latent prints might be caused by a delay between when the print was placed onto the paper and when it began the ESDA process in the humidity cabinet. The following time frames were established for the first phase of this study for the periods of time between when the print was affixed to the paper and when it was placed into the humidifier: immediately, 10 min, 30 min, 60 min, one day, and five days.

Even though most latent prints on documents submitted to this laboratory are older than the five-day maximum time frame established for this study, it was surmised that this uppermost limit was sufficient to adequately evaluate the passage of time.

Time in ESDA Humidifier

Routinely, documents in this laboratory are placed into the ESDA's humidity cabinet for periods of from 5 to 15 min, depending on the type of paper and the personal preferences of the individual examiners. The initial phase of this study selected four separate time frames: 5, 10, 30, and 60 min.

Time Between ESDA and Ninhydrin

Because of the practical problems of case backlog, often days or weeks pass before documents are ultimately treated with ninhydrin after undergoing the ESDA process. It was believed, however, that no appreciable differences would result in the quality of the prints beyond the upper limit of one day selected for this variable. Three different time frames were established for this aspect of the initial phase of this study: 5 min, 1 h, and one day.

Phase 1

An alphanumeric code was established to identify each particular variation within the different categories. This code was recorded in pencil in the upper left and right corners of each cut piece of 3- by 5-in. (7.6- by 12.7-cm) paper (Fig. 1) (for example, the two codes for the piece of Type 1 paper that would be immediately placed into the humidity cabinet for a 5-min period after the latent print was affixed and would then undergo treatment with ninhydrin 5 min after completing the ESDA process were A-1-A-5-A-5 and B-1-A-5-A-5, where the "A" and "B" prefixes designate the left and right sides of the paper, respectively). Since the pieces of paper would themselves be cut in half during the testing procedure, the placement of the code on each half of the paper insured that these halves could be later joined and evaluated together.

After recording the codes, a single latent print was affixed to each piece of paper. One set of each of the nine paper types was prepared at the same time. The prints were made by "rolling" a finger or thumb from nail to nail.

The area covered by the print was immediately outlined in pencil as the print was placed onto the paper (Fig. 2). Cotton gloves were worn during handling of the test and control papers to insure that no extraneous latent prints encroached into the outlined areas. Several "volunteers" were selected from among the laboratory staff and they were pressed into service to make the multitude of latent prints required for completion of this study. Particular attention was given to help insure that acceptable prints would be taken from these assistants.

The paper with the newly affixed print was then cut in two vertically so that one half of the print would be on each piece of the paper (Fig. 3). In this manner, two groups of documents were created out of each set of the different paper types. The left half of each set was selected to go through the ESDA process. The right side became the "control" side and it was not processed on the ESDA. The right side pieces of paper were placed in sets so that their half-

FIG. 1—*Coding on left and right halves to insure proper association of test results.*

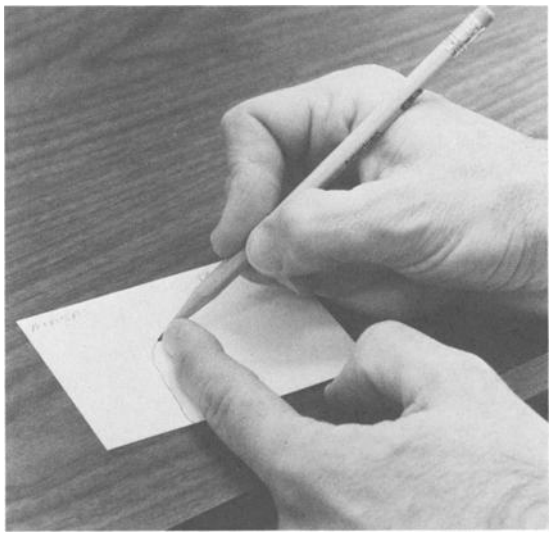


FIG. 2—*Latent print placed onto test paper and outlined in pencil.*

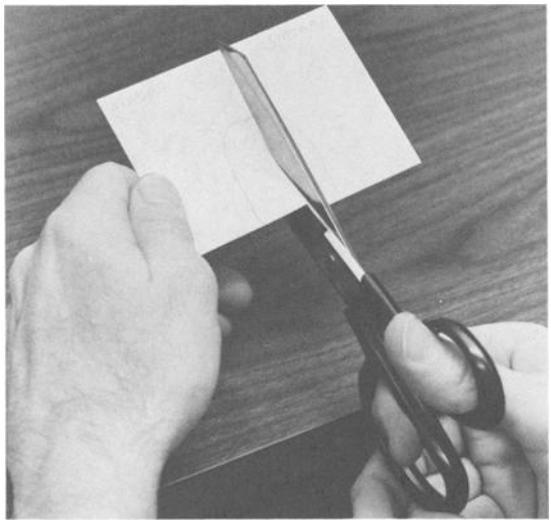


FIG. 3—*Latent print divided to create the test and control halves.*

print areas were not touching one another (Fig. 4). None of the papers were exposed to direct sunlight and they were stored on open desks in an office environment.

After the print was affixed and the appropriate length of time had passed, the left side sets were placed into the ESDA's humidity cabinet for the designated time period. The raised platform within the humidity cabinet (Fig. 5), which measures approximately 14 1/2 by 10 1/2 in. (37 by 27 cm), would accommodate two sets of papers at the same time. As each set completed its stay within the cabinet, it was removed and the ESDA process was completed;

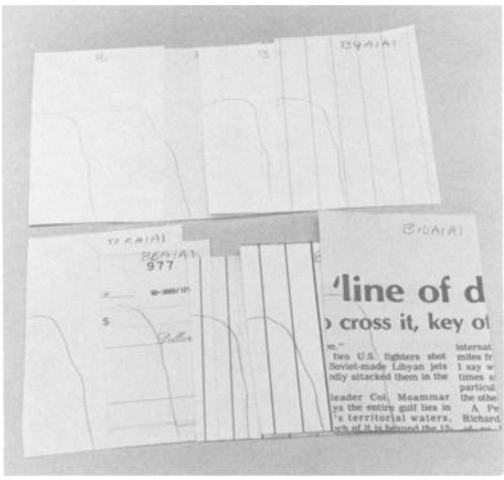


FIG. 4—*One set of control halves arranged so that latent prints did not overlap.*

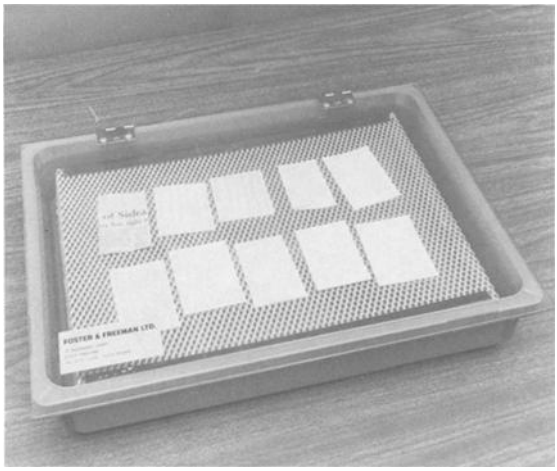


FIG. 5—*One set of test halves inside ESDA's humidity cabinet.*

the individual sheets were placed onto the vacuum bed, covered with imaging film, electrostatically charged, and exposed to the toner by using the cascade method. A resultant "lift" from one of the sets is shown in Fig. 6. Upon completion of the ESDA process, both the left and right sides of the papers in each set were taken to the Latent Print Section where, after the designated waiting period was completed, they were treated with ninhydrin.

Two different methods of ninhydrin treatment were used during the testing process. The first method, which was chosen because it is the preferred method of choice within this laboratory in those cases that involve relatively small numbers of exhibits, was to treat the papers with ninhydrin spray.[3] The two halves of each paper type within the set being tested were

[3]Ninhydrin spray, 16-oz. container size, catalog No. 201C, Sirchie Fingerprint Laboratories, Raleigh, NC 27612.

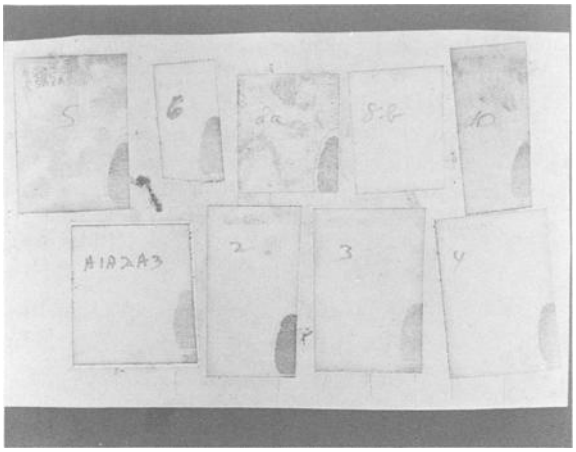


FIG. 6—*"Lift" from one set of test halves after completion of the ESDA process.*

then held side by side and sprayed with ninhydrin until the papers were completely saturated (Fig. 7).

The second method of treatment, used after the ninhydrin spray stock was depleted, was a liquid mixture of acetone and ninhydrin crystal[4] in a 1000-mL:5-g ratio. In this method, the matching paper halves were immersed together in the liquid mixture. Neither method of ninhydrin treatment appeared to be superior in developing the latent prints.

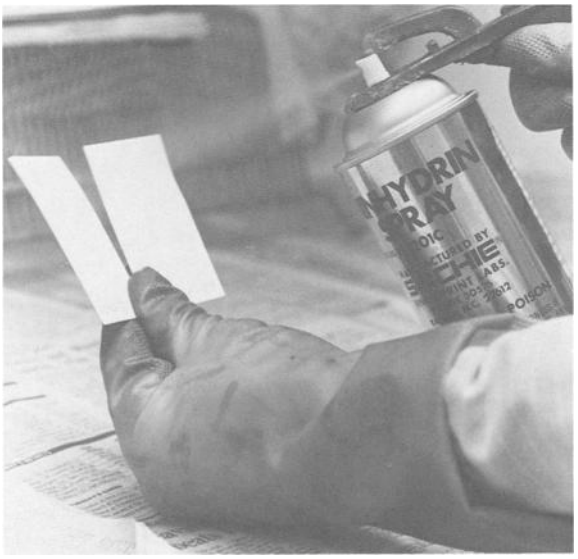


FIG. 7—*Test and control halves were saturated with ninhydrin spray.*

[4]Acetone, (CH3)2CO, Catalog No. C4300, American Scientific Products, McGaw Park, IL 60085. Monohydrate ninhydrin (1,2,3-indantrione, C9H403 · H2O), Baker Analyzed Reagent, J. T. Baker Chemicals, Phillipsburg, NJ 08865.

Following saturation, both halves of each paper within their respective set were allowed to dry completely. The ninhydrin development process was assisted by an electric steam iron held several inches above the paper surfaces (Fig. 8).

The dried halves were then mounted side by side on 5- by 8-in. (12.7- by 20-cm) stock with clear cellophane tape affixed to the top of each half. The matching print halves were then independently evaluated by 2 examiners who, together, possessed in excess of 58 years of experience in the identification of latent prints.

Phase 2

The necessity for a second phase was realized as the results of the first phase were compiled. Phase 2 consisted of evaluating two separate sets of the nine different paper types. Both left half sets were placed into the humidity cabinet only 5 min after the prints were affixed to the papers. One of these sets remained in the cabinet for 2 h; the second set for a total of 4 h. All papers were treated with ninhydrin immediately after the left side completed the entire ESDA process. After being mounted to the 5- by 8-in. (12.7- by 20-cm) card stock, the Phase 2 prints were evaluated in the same manner as were the prints of Phase 1.

Results and Discussion—Phases 1 and 2

The initial evaluations divided the dried prints into two groupings:

(1) those prints with no discernible change between the left and right sides and
(2) those prints in which some changes was evident.

The group that showed some change was then further divided into four subgroupings, primarily dependent on the degree of alteration to the ESDA processed print in relation to its control. These subgroups included:

(1) ESDA side better;
(2) ESDA side exhibited good ridge detail, but poor contrast;

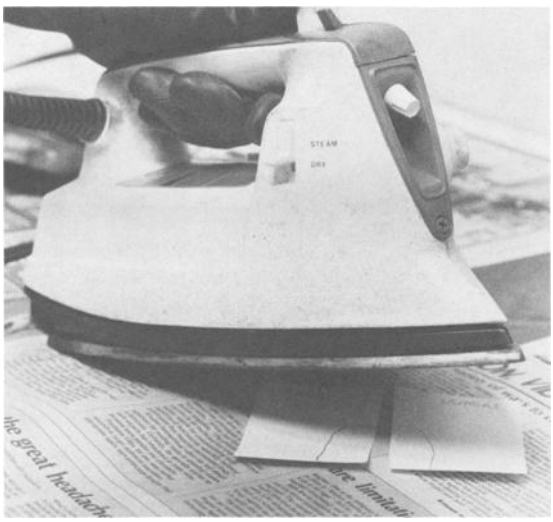


FIG. 8—*An electric steam iron was used to hasten development of ninhydrin treated latent prints.*

(3) ESDA side worse; and
(4) ESDA side illegible.

A diagram of the tests conducted during Phase 1 and their results is shown in Fig. 9. From the total of 576 prints evaluated, 554 showed no appreciable change to the portion of the print that underwent the ESDA process. Some change, however, was observed in 22 of the ESDA processed prints.

In only 1 of these 22, was the ESDA processed side of the print better. Since this was the only print that appeared to have been enhanced by the ESDA process, it was opined that some external factor may have interceded to cause this result (for example, it was possible that during the ninhydrin treatment, the control side might not have been completely saturated, thereby resulting in less development to that side of the print in relation to the ESDA processed half). The existence of the sole print in this category was not deemed significant.

A total of 5 of the 22 ESDA processed prints were evaluated as having good ridge detail but poor contrast, while the control side prints were characterized as having poor ridge detail but good contrast. Both evaluators agreed that this phenomenon, an example of which is shown in Fig. 10, did not inhibit the print's identifiability. Rather, it appeared that the ridge details of the ESDA processed portion of the print were enhanced while the overall print contrast declined, with sort of a counterbalancing effect. Both the ESDA processed and control sides of these prints were equally identifiable.

A total of six of the ESDA processed prints that had been effected were categorized as "worse." While none of these prints was completely destroyed, their identifiability was certainly threatened. An example of one of the prints in this category is shown in Fig. 11.

The remaining 10 prints of the 22 that had been effected by the ESDA process were determined to be illegible. These prints were degraded to such an extent that no identification could be made, while their control sides that had not undergone the ESDA process were both legible and identifiable. An example of an illegible print and its control half is shown in Fig. 12.

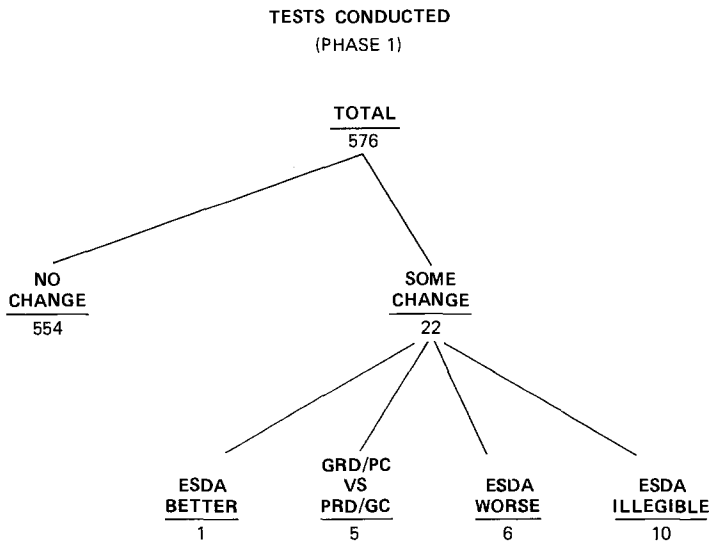


FIG. 9—*Categories and totals of tests in Phase 1.*

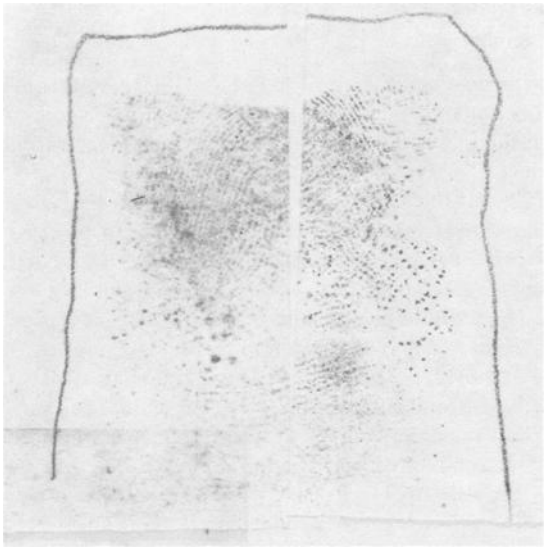


FIG. 10—*Good ridge detail with poor contrast (GRD/PC) on left, ESDA processed side; poor ridge detail with good contrast (PRD/PC) on right, control side.*

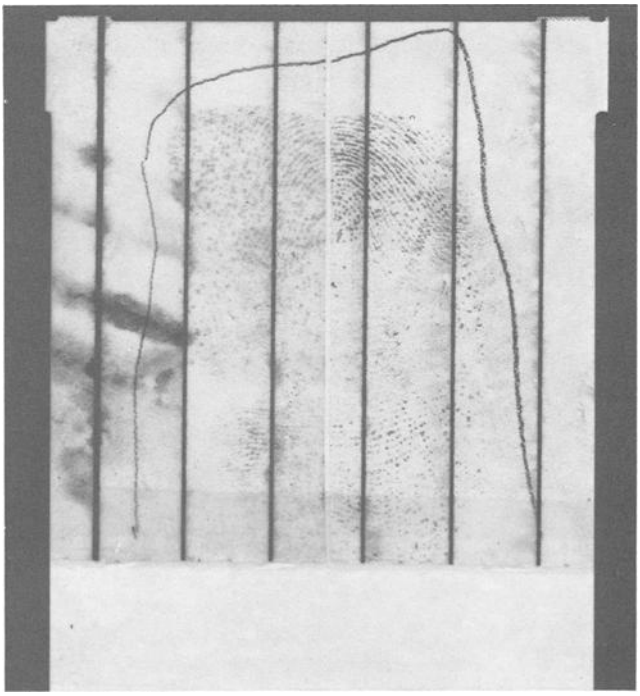


FIG. 11—*Left, ESDA processed side of print has been degraded and categorized as "worse," in comparison to the right, control side.*

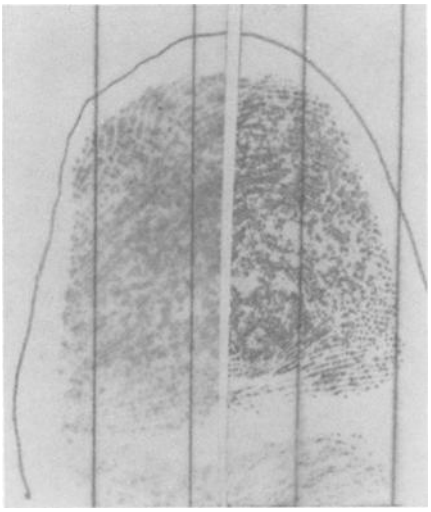


FIG. 12—*Left, ESDA processed side of print, categorized as "illegible," is no longer identifiable. Right half of print is control side.*

Paper Type

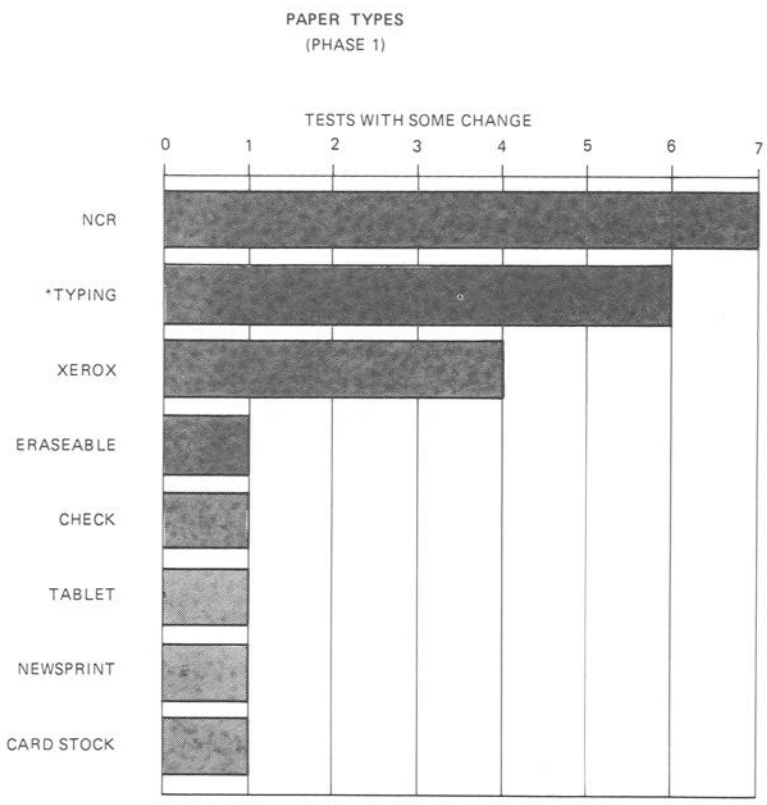
Table 2 depicts, by paper type, the 22 total prints of Phase 1 that were determined to have been effected to some degree by the ESDA process. Three types of paper were more susceptible than the others to the process: NCR paper (Type 8), typing paper (Type 2), and Xerox paper (Type 3). A complete listing of the degrees to which each paper type was effected is shown in the diagram in Table 3.

Note that a full evaluation could not be conducted on paper Type 7, the donor sheet of the NCR paper. The latent prints on this type of paper, when treated with ninhydrin, were completely destroyed. The encapsulated blue dye on the paper surface was released during the ninhydrin treatment, thereby obliterating the print. Figure 13 shows one of the donor sheets of NCR paper treated with ninhydrin. The existence of this condition was discovered after the initial three test sets, and therefore, this paper type was removed from further testing. The totals expressed in this project do not reflect any of the donor sheets of NCR paper (Type 7).

Time Between Print and Humidity Cabinet

Table 4 depicts the 22 total prints that were effected in relation to the 6 time periods between when the print was affixed to the paper and when it was placed into the ESDA's humidity cabinet. The 30-min time period clearly altered more prints than the other time frames. It was not determined why this particular time period was most detrimental. It was also noted that, assuming the 1 print in the category of "ESDA side better" could be excluded as a result of the interaction of external factors, the 5-day time frame would have the least effect on prints. Since many of the prints on documents treated by latent print examiners are in excess of 5 days old, this would appear to be a favorable result. Table 5 depicts the degree to which the different paper types were effected by this category.

TABLE 2—*Phase 1 results, by paper type, of prints showing some change.*



Time in ESDA Humidifier

Table 6 reflects that both the 30- and 60-min periods within the humidity cabinet effected the most prints. The degree to which each different time period was instrumental in affecting the quality of these prints is shown in Table 7. These Phase 1 results implied that the longer the document stayed within the ESDA's humidity cabinet, the more the print was adversely affected. Phase 2 of this study was initiated primarily because of the results in this category of variables.

Time Between ESDA and Ninhydrin

The results of this final category, which are shown in Table 8, disclosed that while all three time periods were represented, the 5-min and the one-day periods had the most impact on the prints that were affected. It would appear that 1 h would be the optimum length of time for the least detrimental effects. This might suggest that, in rush cases, documents processed on the ESDA should be allowed at least this length of time before treatment with ninhydrin. Table 9 depicts the degree to which these different time periods effected the prints.

TABLE 3—*Complete listing of Phase 1 results by degree of change and paper type.*

		PAPER TYPES (PHASE 1)
GRD/PC VS PRD/GC	5	2 Typing 2 Xerox 1 Check
ESDA SIDE WORSE	6	4 NCR 1 Typing 1 Eraseable
ESDA SIDE ILLEGIBLE	10	3 NCR 2 Typing 2 Xerox 1 Tablet 1 Card Stock 1 Newsprint
ESDA SIDE BETTER	1	1 Typing
		22 of 576 tests

Phase 2 was begun upon completion of the 576 tests from the first phase. The initial phase results suggested a significant pattern of deterioration was developing the longer the paper remained in the ESDA's humidity cabinet. To determine whether this trend would continue, Phase 2 was initiated. Figure 14 depicts the results of this second phase which consisted of a total of 16 tests: 2 sets of the 8 different paper types. Each set was placed into the humidity cabinet 24 h after the prints were affixed to the papers. The first set was kept inside the humidity cabinet for a period of 2 h, the second set for a total of 4 h. All papers were treated with ninhydrin 5 min after the ESDA process was completed.

Table 10 shows the results, by paper type, of the effects to prints subjected to both time periods within the humidity cabinet. The prints on paper Type 1 (3- by 5-in. index cards) in both sets of tests in Phase 2 were the only prints that did not suffer appreciable change. It was observed that paper Type 1 was the heaviest, thickest paper tested. The construction of this paper may impede the deterioration process. It was felt, however, that some change might logically occur to prints on this paper type if the time within the humidity cabinet were lengthened beyond the 4-h limit.

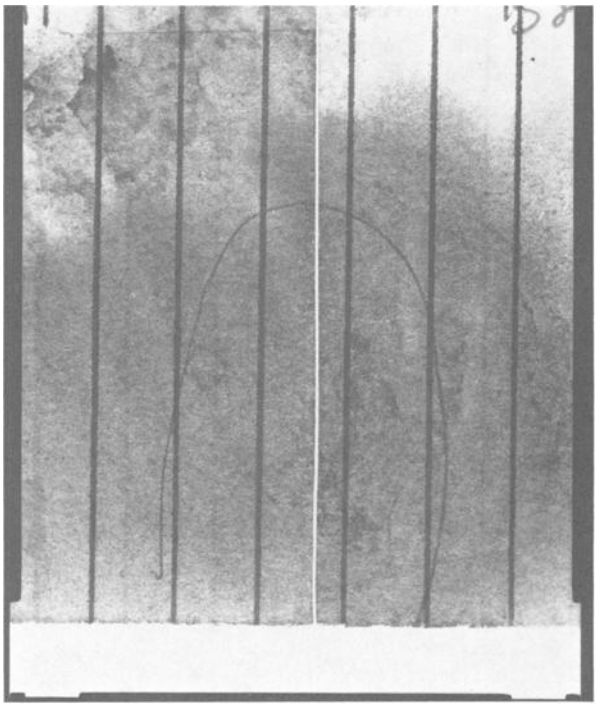


FIG. 13—*Ninhydrin treatment destroyed both halves of prints by releasing the encapsulated dye on the donor sheet of NCR paper (Type 7).*

The results of the 2- and 4-h periods in the humidity cabinet that were tested in Phase 2 are depicted in Table 11. The prints categorized as "worse" in this table were in the first set of the Phase 2 tests and they were kept within the humidity cabinet for the 2-h period. The remaining prints in the first set, as well as all prints in the second set, were categorized as "illegible" (excluding the prints on the Type 1 papers).

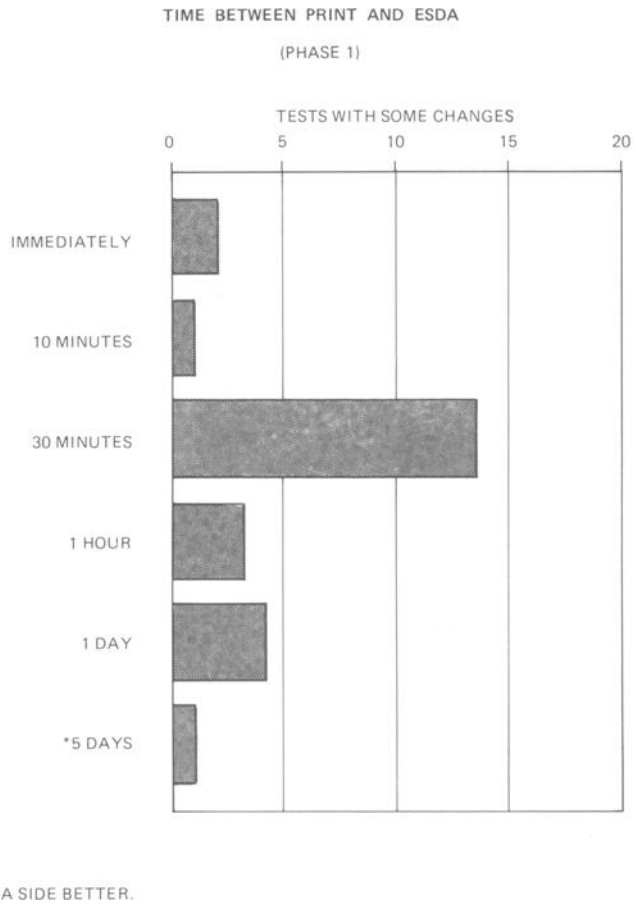
The Phase 2 results confirmed that the longer papers remained in the humidity cabinet, the more detrimental the effects to the latent prints. In effect, these prints were being slowly immersed in water and latent print examiners have long ago recognized the devastating effects of water to latent prints on paper.

Conclusions and Recommendations

The research results disclosed that under normal operations the ESDA process did not cause appreciable harm to latent prints on paper. Of the 576 tests conducted in Phase 1, only 22 prints showed some change, and in less than half of this small group was the deterioration sufficient to cause an acceptable print to become unidentifiable.

These results also revealed, however, that in those instances where the documents were left within the humidity cabinet for an extended period of time—occasionally as short as 30 min—change occurred to some prints on some types of paper. This fact should alert the document examiner to the hazards of keeping the paper within the humidity cabinet for much longer than the optimum 5 to 15 min.

TABLE 4—*Phase 1 results of prints showing some change, by time periods, between making the print and beginning the ESDA process.*



*1 ESDA SIDE BETTER.

It must be admitted that there have been rare instances in the past when documents have been placed in the humidity cabinet and inadvertly left for extended periods of time. The reasons for these occurrences have been varied: phone interruptions, visitors, lunch breaks, and mental lapses. One of the practical outcomes of this study has been the purchase of a timer with a loud bell which is now located beside the ESDA. This timer is activated for the desired length of time by the examiner when the document is first placed into the humidity cabinet.

Although it was not specifically tested for during this project, the reinsertion of paper into the humidity cabinet for multiple examinations for indentations may have an accumulative effect to prints on these documents. George Lewis, in his exhaustive paper [*3*] on the subject of the ESDA's use, stated that "Occasionally, fifteen or more lifts are made of a single document." Reinsertion into the humidity cabinet for an extended number of 10-min periods could very well have detrimental effects to any latent prints that were present.

Latent print examiners have long acknowledged that the quality of prints developed on paper varies. Some of these prints are on the borderline of identifiability. It is therefore

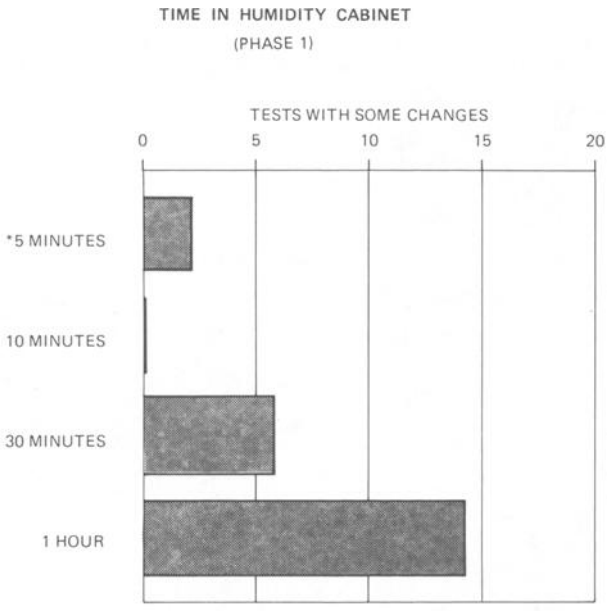
TABLE 5—*Complete listing of Phase 1 results, by degree of change and time periods, between making the print and beginning the ESDA process.*

	TIME BETWEEN PRINT AND ESDA (PHASE 1)	
GRD/PC VS PRD/GC	5	All @ 30 minutes
ESDA SIDE WORSE	6	1 @ Immediately 1 @ 10 minutes 3 @ 30 minutes 1 @ 1 day 6
ESDA SIDE ILLEGIBLE	10	1 @ Immediately 5 @ 30 minutes 2 @ 1 hour 3 @ 1 day 10
ESDA SIDE BETTER	1	1 @ 5 days
		22 of 576 tests

logical to assume that, given the results of this study, the ESDA process and, in particular, the humidity cabinet portion of this process may have an adverse effect on some of these borderline prints. In some instances, the direct actions of the document examiner may cause a particular print to become unidentifiable.

Realization that specific actions by the document examiner may drastically impact on the potential latent print evidence should not be taken lightly. Several ethical questions arise from this condition. Should the document examiner be content with only one or two ESDA lifts, when again returning the paper to the humidity cabinet may cause harm to latent prints? Should this decision be properly left to the individual document examiner? His/her supervisor? The case submitter? The prosecuting or defending attorney? Should written procedures be established for multiple ESDA examinations on the same document? These are just a few some of the ethical considerations that arise from the results of this research project.

TABLE 6—*Phase 1 results of prints showing some change, by time periods, within the humidity cabinet.*



*1 ESDA SIDE BETTER.

There were two variables that could have been evaluated during this project but were not:

(1) as mentioned above, whether multiple insertions of paper into the humidity cabinet results in a cumulative detrimental effect on latent prints and

(2) whether other methods of latent print detection (for example, "Physical Developer") may be effective in "salvaging" latent prints damaged by extended periods within the ESDA's humidity cabinet.

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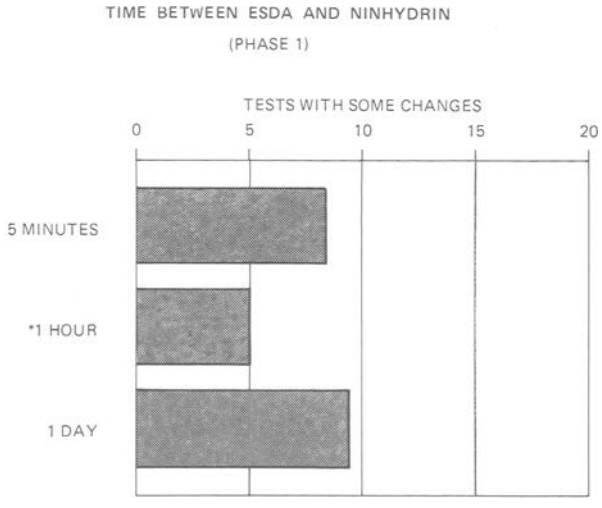
TABLE 7—*Complete listing of Phase 1 results, by degree of change and time periods, within the humidity cabinet.*

	TIME IN HUMIDITY CABINET (PHASE 1)	
GRD/PC VS PRD/GC	5	2 @ 30 minutes 3 @ 1 hour
ESDA SIDE WORSE	6	1 @ 5 minutes 5 @ 1 hour
ESDA SIDE ILLEGIBLE	10	4 @ 30 minutes 6 @ 1 hour
ESDA SIDE BETTER	1	1 @ 5 minutes
	22 of 576 tests	

TABLE 8—*Phase 1 results of prints showing some change, by time periods, between completing the ESDA process and treatment with ninhydrin.*



*1 ESDA SIDE BETTER.

TABLE 9—*Complete listing of Phase 1 results, by degree of change and time periods, between completing the ESDA process and treatment with ninhydrin.*

	TIME BETWEEN ESDA AND NINHYDRIN (PHASE 1)	
GRD/PC VS PRD/GC	5	2 @ 1 hour 3 @ 1 day
ESDA SIDE WORSE	6	3 @ 5 minutes 1 @ 1 hour 2 @ 1 day
ESDA SIDE ILLEGIBLE	10	5 @ 5 minutes 1 @ 1 hour 4 @ 1 day
ESDA SIDE BETTER	1	1 @ 1 hour
	22 of 576 tests	

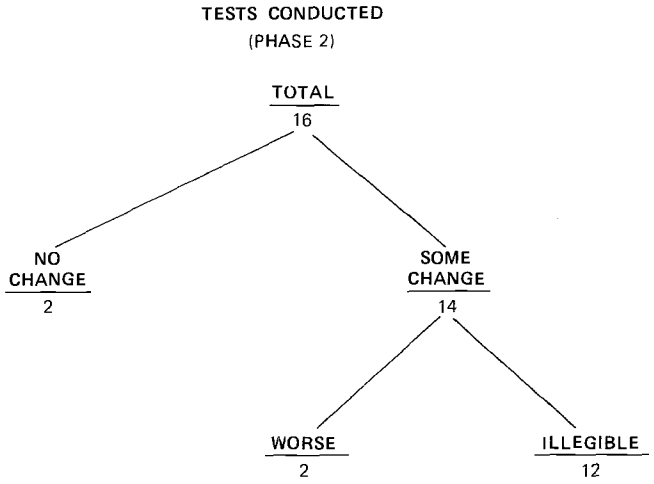


FIG. 14—*Categories and totals of test in Phase 2.*

TABLE 10—*Complete listing of Phase 2 results by degree of change and paper type.*

	PAPER TYPES (PHASE 2)	
GRD/PC VS PRD/GC	0	
ESDA SIDE WORSE	2	1 Tablet 1 Newsprint
ESDA SIDE ILLEGIBLE	12	All Types (except Card Stock)
ESDA SIDE BETTER	0	
	14 of 16 tests	

TABLE 11—*Complete listing of Phase 2 results, by degree of change and time periods, within the humidity cabinet.*

	TIME IN HUMIDITY CABINET (PHASE 2)	
GRD/PC VS PRD/GC	0	
ESDA SIDE WORSE	2	Both @ 2 hours
ESDA SIDE ILLEGIBLE	12	5 @ 2 hours 7 @ 4 hours
ESDA SIDE BETTER	0	
	14 of 16 tests	

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Address requests for reprints or additional information to
David S. Moore
Department of Justice
Bureau of Forensic Services
Questioned Document Section
P.O. Box 903337
Sacramento, CA 94203-3370