John P. Nielson,[1] *C.L.P.E. and Allan I. Katz,*[1] *M.S.*

A Processing Protocol for Drug Residue and Latent Print Evidence

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ABSTRACT: Thirty percent cocaine : inositol residues and latent fingerprints were deposited on a wide variety of porous and nonporous substrates typical of the types of materials encountered in casework. Protocols were investigated which would optimize the probability of recovery of both drug residues and latent prints. Different protocols are required for porous and nonporous surfaces.

KEYWORDS: forensic science, protocols, cocaine, drug residues, fingerprints, mass spectrometry, latent prints

As awareness of the breadth of drug abuse grows, forensic science laboratories are being called upon to provide a greater number of analyses in the furtherance of investigations or prosecutions. The authors' laboratory has recorded an increasing number of submissions wherein the object of examination is believed to have contained controlled substances or is believed to have been in close proximity to controlled substances. Particularly in cases in which requests are made to document the presence of trace amounts of drugs as well as possession by a particular person (through latent print examination), some question has arisen as to the potential for one type of examination to interfere with the other.

No published protocols for the recovery of both drug residues and latent prints could be found. As a result, a study was constructed to determine the optimum protocol when requests for both types of examination were received. The following questions were investigated in this study:

1. Do reagents commonly employed in the detection of latent prints interfere with efforts to recover drug residues?
2. Can items which have been previously analyzed in an effort to recover drug residues still yield latent prints?
3. What is the optimum work flow for drug residue/latent print combination cases?

The conclusions upon which this protocol is based are the result of over 100 experiments using porous and nonporous substrates with a variety of concentrations of cocaine residue. The model drug residue most often used was a 30% cocaine : inositol mixture. All confirmatory drug testing was conducted using gas chromatography/mass spectrometry (GC/MS).

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[1]Crime laboratory analysts III, Wisconsin State Crime Lab—Milwaukee, Milwaukee, WI.

Materials

Fingerprints and small quantities of a cocaine mixture were deposited on a variety of substrates. These were designed to simulate surfaces routinely encountered when requests for drug residue determination and latent print examination are made. The tests were made up by one author and passed to the second author for "blind" testing. Drug-free "blanks" were included among the tests.

Nonporous substrates included glass (5.1- by 7.1-cm microscope slides), Plexiglas® acrylic, plastic (polypropylene) bags (4 mil), glassine paper, two types of highly calendered or coated papers, and filled polypropylene "snuff seals" (sold under proprietary names such as Pyramid™, Gem Pacs™, and Seals™).

Porous substrates included newsprint, photocopier paper, mimeograph paper, coated paper from a magazine, and glassine. The coated paper and glassine were tested as both porous and nonporous substrates because their surfaces cause them to exhibit properties similar to each type if latent print examinations are conducted within a relatively short time after print deposition.

Drug Analysis

Materials—Cocaine:hydrochloride (HCl) was obtained from Merck Pharmaceutical Corp. Inositol was Natural Sales, purchased from General Nutrition Corp. The methanol (glass distilled OMNI-SOLV) was obtained from EM Industries. A 0.5-nm Davison molecular sieve was obtained from Fisher Scientific.

Apparatus—Indicative testing, when performed, was conducted on a Perkin Elmer, Sigma 3B gas chromatograph, with a 6-ft (2-m) column packed with 3% OV-101 as the liquid phase on Gas Chrom-Q as the solid support. Nitrogen was used as the carrier with a flow rate of 30 mL/min. A flame ionization detector (FID) was used.

Identification of the residues was by gas chromatograph/mass spectrometer, using a Hitatchi 663-30 gas chromatograph interfaced to an ELQ 400-1 mass spectrometer. The column used in the gas chromatograph was a J&W Scientific 15-m fused silica capillary column, bonded with a 25-μm film of DB-1 (cross-linked methyl silicone). Helium was used as the carrier with a flow rate of 1.5 mL/min. The split ratio was 1:10.

Latent Print Examination

Materials—Ninhydrin (triketohydrindene hydrate) (No. T-349) and ethyl acetate (No. E195) were obtained from Fisher Scientific. Methanol (OMNI-SOLV, No. 0488) was obtained from EM Industries. *1,1,2*-trichloro-trifluoroethane (No. TX1167) was obtained from MCB. Methyl-cyanoacrylate ("Hot Stuff") was obtained from Satellite City, Inc., Simi, CA.

Apparatus—Cyanoacrylate development was accomplished in a 75.7-L (20-gal) closed tank, using a heat source to vaporize the cyanoacrylate material.

A temperature/humidity chamber was used to maintain a constant 30°C, 80% relative humidity environment during ninhydrin development.

Methods

Several fundamental hypotheses were advanced concerning latent print examination.

First, that cyanoacrylate development is the initial method of choice for nonporous materials. When objects are subjected to an atmosphere of cyanoacrylate vapors, the ester will often polymerize around latent print deposits, (usually) leaving a permanent, durable, white colored deposit. The deposit can be later subjected to various physical and chemical tests to enhance contrast with the background.

It was further assumed that prints must be fixed by cyanoacrylate development before attempts at drug recovery. This assumption was based on the fact that the methanol (or any solvent), regardless of the method of application, would remove all or part of the constituents of the latent print deposit and therefore hinder subsequent development.

On the basis of past observation that the cyanoacrylate deposit appears permeable, it was further postulated that if a deposit polymerized around drug residues, the deposit would not preclude recovery of the residues.

The majority of methods used to increase contrast between the cyanoacrylate deposit and substrate use solvents which would dissolve the drug residue or contain compounds which could interfere with instrumental analysis. Simply "fixing" latent prints with cyanoacrylate development would preserve any latent prints present for later visualization, while allowing intervening recovery of drug residues.

Second, it was assumed that ninhydrin development was the method of choice for porous surfaces. Ninhydrin has been widely used for over 30 years for the detection of latent prints on porous surfaces. Ninhydrin reacts with amino acids in the latent print deposit, forming a blue to purple color complex. Amino acids have proved to be one of the most stable constituents of latent print deposits over time.

Ninhydrin, which is usually mixed in a 1/2 to 2% solution, can be dissolved in a number of organic solvents. Since drugs are also soluble in a number of these solvents, a carrier was selected which would minimize the danger of washing away any drug residues. A 1/2% ninhydrin:freon 113 (MeOH:AcOEt) formulation [*1*] was selected because it contained a minimum amount of methanol (the only organic solvent in the formulation which would dissolve drug deposits).

Because the ninhydrin formulations invariably contain some solvent in which the drug residue is soluble, a portion of the drug deposit could be removed if the substrate were treated with the ninhydrin:MeOH solution first. It was therefore believed that the optimal protocol would allow drug collection attempts to precede latent print examination if such previous (drug) examination would not obscure latent prints.

The preceding hypotheses were tested in the following manner:

1. Experiments were conducted to determine whether cyanoacrylate development on nonporous surfaces would significantly interfere with subsequent recovery of the drug residues. The cyanoacrylate deposit polymerizes around active sites and this "encapsulation" could potentially interfere with drug recovery. A hypothesis of noninterference was tested empirically.
2. In the case of porous surfaces, it was hypothesized that the solvents used in drug collection would not degrade the latent print, since the same solvents can be used as carriers for ninhydrin. This hypothesis was tested through empirical observation.

A third question investigated dealt with whether prior treatment of porous surfaces with ninhydrin:freon 113 (MeOH:AcOEt) would preclude subsequent recovery of drug residues.

Nonporous Materials

To investigate the hypothesis that cyanoacrylate development would not significantly interfere with drug recovery on nonporous surfaces, latent fingerprints were deposited on a series of glass slides. Subsequent to latent print deposit, the slides were weighed. A small amount of 30% cocaine/inositol mixture was sprinkled over the latent print, the slide was tapped on edge to remove the excess cocaine/inositol, and the slides were reweighed. The average deposit was 1.2 mg of 30% cocaine.

The slides were exposed to an atmosphere of cyanoacrylate vapors for 1 h using approximately ten times the normal amount of cyanoacrylate to overexpose the slides intentionally in an effort to exacerbate any interaction between cocaine and the cyanoacrylate.

The slides were swabbed using a cotton-tipped swab in approximately 1 mL of MeOH. Each slide was individually swabbed using a clean swab and a fresh volume of methanol. The methanol was then reduced to 0.1-mL volume. Care was taken to prevent cross and accidental contamination of the specimens. The specimens were analyzed on a gas chromatograph/mass spectrometer, and MeOH blanks were run between specimens to ensure no carryover (Fig. 1). For all specimens, the intensity of the spectra generated were of sufficient quality to confirm the presence of cocaine [*2*] (see Fig. 2). The gas chromatograph/mass spectrometer was run isothermally at 240°C for the confirmation of cocaine.

Several temperature programmed runs were also made in an attempt to detect any degradation of the cocaine by the cyanoacrylate, or of the cyanoacrylate itself. No unexpected degradation products for cocaine or for cyanoacrylate were found (Fig. 3).

The concentrations of drug residue recovered were sufficient to not only confirm cocaine but to allow for reanalysis.

Subsequent retesting was performed to determine a threshold for detection of cocaine residues recovered by this method (that is, cyanoacrylate followed by MeOH swabbing). Residues that contained 300-μg cocaine:HCl proved sufficient for confirmatory analysis.

Other nonporous test surfaces (Plexiglas, highly calendered and coated paper, plastic bags, "snuff seals," and glassine) were prepared in the manner outlined above and exposed to normal levels of cyanoacrylate for 15 min. Drug collection was performed after cyanoacrylate exposure. Results consistently confirmed the presence of cocaine and analysis was performed in a straightforward manner.

Porous Materials

In an effort to determine if swabbing (scrubbing) the surface of the paper would degrade the quality of latent print deposits, we deposited latent fingerprints on white mimeograph paper. The prints were cut in half, and one half of the paper was swabbed in an deliberately abrasive manner while the other half was untouched, being used as a control. Prints were

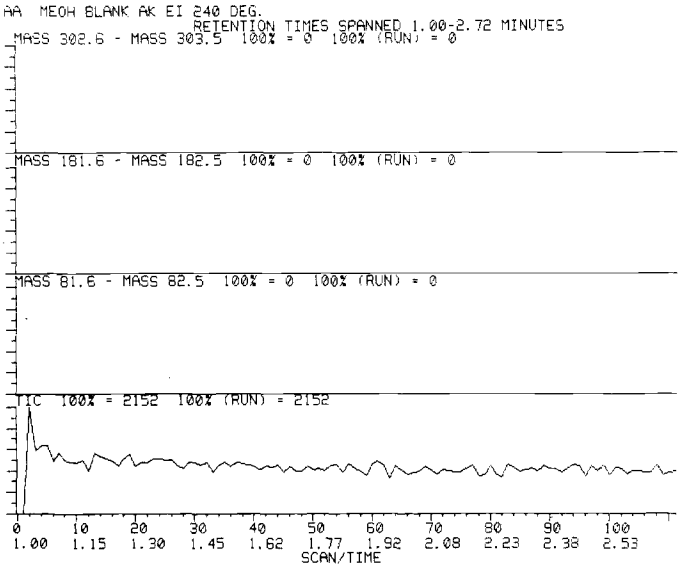

FIG. 1—*Typical result of MeOH runs. Blanks were run between each sample.*

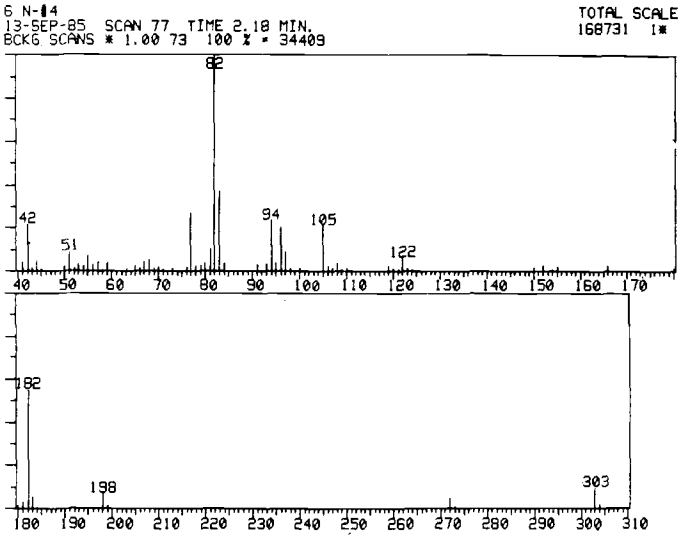

FIG. 2—*Illustrative spectra from "residue" amounts of cocaine typically recovered in these experiments.*

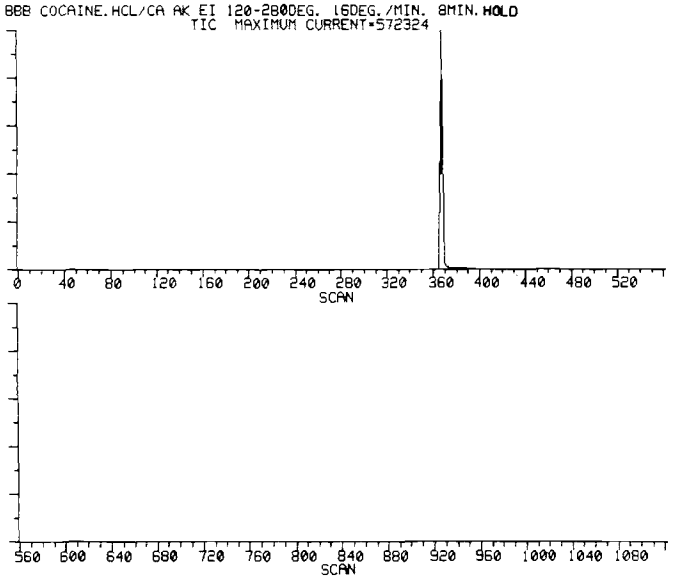

FIG. 3—*A programmed GC/MS run—cocaine exposed to a cyanoacrylate atmosphere. Only a cocaine peak is seen.*

visualized using a 1/2% ninhydrin : freon 113 (MeOH : AcOEt) solution. No detectable degradation of the latent prints were observed (Fig. 4).

We then tried to determine if there were any observable differences when using methanol dried over molecular sieve versus methanol exposed to ambient humidity. Latent prints were deposited on a variety of papers which were cut into three sections: one section was swabbed

FIG. 4—*Right half of each print "scrubbed" vigorously with an MeOH-saturated swab after prints deposited. Left half is the control. Ninhydrin development followed swabbing.*

with "dry" methanol, one section was swabbed with "wet" methanol, and the remaining section was left unswabbed, acting as control. No discernible difference was observed.

Drug collection from the papers was straightforward. Approximately 40 different experiments were conducted using a variety of substrates. A 30% cocaine:inositol mixture was typically used. A quantity of the powder mixture was placed on the substrate, which was then folded into a "bindle" (pharmaceutical fold) and then reopened and the powder emptied; or the cocaine mixture was placed on the substrate and pressed onto the surface using a micro spatula. In either case, the papers were tapped or scraped to remove obvious "specks" of residue. In some cases, latent prints were deliberately deposited on the surface of the substrate; in other cases normal handling was presumed to have allowed for deposit.

Drug residues were collected by swabbing with a MeOH saturated cotton-tipped swab, using 1 mL of MeOH which was reduced to 0.1 mL. Gas chromatography/mass spectrometry was conducted at 240°C, isothermal. On average, enough residue was present to produce a confirmatory spectra.

The final hypothesis to be examined concerned the possibility of recovering drug residues after latent print examination on porous surfaces had occurred. To investigate whether prior ninhydrin processing would hinder collection of drug samples, approximately 35 specimens of the various porous substrates were prepared in the manner outlined above.

Each of the specimens was treated with the 1/2% ninhydrin solution. A variety of methods was used to apply the ninhydrin for testing purposes. (In casework, the only acceptable method which ensures that no cross-contamination occurs is by applying the ninhydrin by using a pipette or by pouring, saturating the surface, and disposing of any excess which runs off the surface.)

After the specimens were incubated for 24 h in a temperature and humidity controlled environment, we attempted to recover drug residues. Specimens were obtained and reduced as outlined above. Subsequent gas chromatography/mass spectrometry revealed intensities which averaged less than one half of those for untreated papers, and in some cases gave negative results; confirmatory spectra were still obtained in some cases, however. Several types of papers, notably newsprint and one type of white memo pad paper, gave consistently poor results when processed in this sequence.

When porous surfaces are processed in the presence of cocaine residues, a medium blue development of the ninhydrin is sometimes noted in areas where cocaine is apparently present. This reaction is undoubtedly due to the fact that cocaine contains a tertiary amine, which provides a receptor site for a cocaine:ninhydrin reaction.

To determine if the color reaction observed affected spectra for cocaine, we placed approximately 5 mg of 100% cocaine in four 5-dram vials. To two vials, approximately 10 mL of the standard 1/2% ninhydrin solution was added. To the other two vials, the 1/2% ninhydrin solution was added as well as approximately 5 mL of MeOH to aid in dissolving the cocaine. The vials were allowed to sit for approximately two weeks. Specimens were injected without purification. Temperature programmed gas chromatograph/mass spectrometry revealed no unexpected degradation products (Figs. 5 and 6).

Results and Discussion

If more than one section of a laboratory becomes involved in the analysis of submitted materials when a request for latent print and drug residue collection is received, close cooperation between the sections will be necessary.

Any examination for drug residues should begin with a physical examination to determine if visible amounts of residue can be seen adhering to the surface. If visible residue is present, the obvious protocol in such a case is to physically "pick off" or scrape off the residue, obviating the need for further drug examination. If no physically retrievable residues are present, consultation should establish if the substrate is porous or nonporous and to determine the optimum work flow.

Nonporous Surfaces

On the basis of the protocol investigated above, initial exposure of the substrate to an atmosphere of cyanoacrylate vapors, followed by recovery of drug residues, followed by visu-

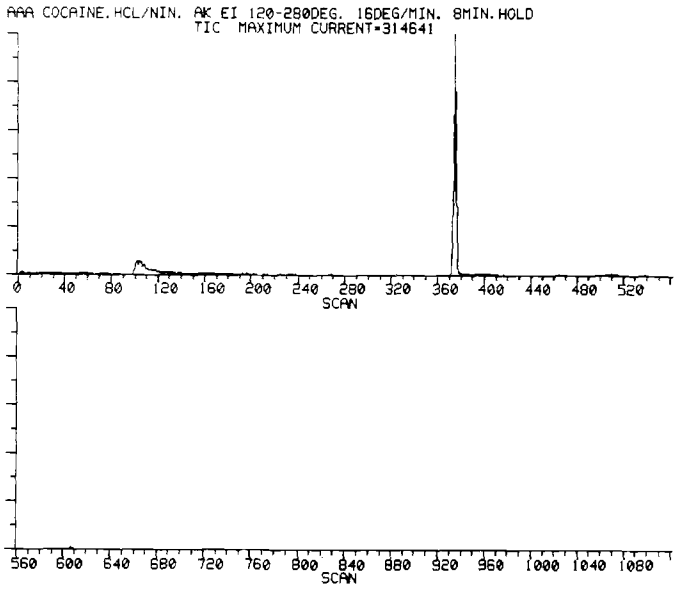

FIG. 5—*A programmed GC/MS run—cocaine in a 1/2% ninhydrin solution (5% MeOH). Two peaks are observed: minor peak is ninhydrin; major peak is cocaine.*

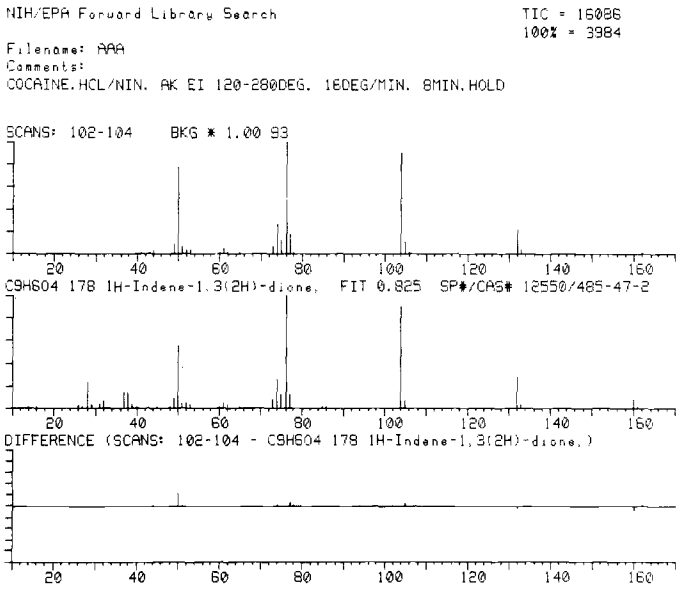

FIG. 6—*Comparison of minor peak from Fig. 5 versus computer generated spectra of ninhydrin.*

alization of the latent prints, allows for the optimum changes of recovery of both types of evidence. Exposure to cyanoacrylate vapors does not appear to trap the drug residue in the cyanoacrylate matrix. In the majority of cases, the polymerized cyanoacrylate deposit is sufficiently durable to allow for gentle swabbing to recover drug residues and still allow subsequent visualization of the latent prints. Because cocaine: HCl is highly soluble in MeOH and water (the two most common carriers for laser dyes) and most powders and dyes would interfere with instrumental analysis, drug recovery *must* occur before attempts at latent print visualization.

Porous Surfaces

As seen from empirical observation, the optimum protocol for porous surfaces begins with collection of the drug residue by gentle MeOH swabbing. Prints deposited on shiny papers appeared to exhibit occasional blurring, therefore a minimum amount of abrasion when swabbing is advised. After drug residue collection has been attempted, the substrate can be processed using ninhydrin.

In a situation where a request for latent print examination is made without (prior) request for drug examination and the surface has already been processed with ninhydrin, attempts at drug residue collection should not automatically be considered futile. While probability of recovery of residue is lessened, confirmatory spectra could still be obtained in some cases. This processing sequence is less than optimum, however.

Subsequent case work revealed that at least one type of (porous) paper apparently traps the drug residues in its matrix. In this case, the protocol described in this paper was used and failed to reveal the presence of drug residues. An additional protocol was developed which is described in a separate paper [*3*], and this additional protocol revealed confirmatory levels of drug residue.

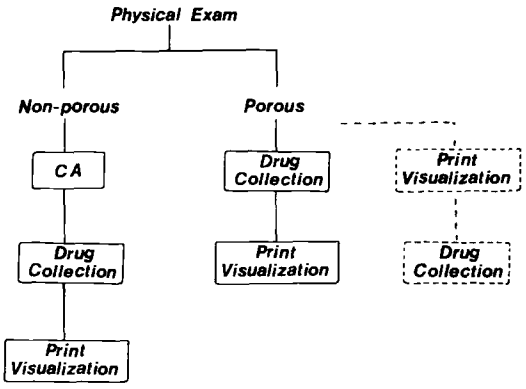

FIG. 7—*Recommended processing protocol based on the results of this paper. (Dotted lines represent the nonpreferred route.)*

Empirically, we have found that the procedure outlined in this paper is universally effective for *nonporous* substrates, and is effective in the majority of cases when porous substrates were encountered. Because the protocol outlined here is straightforward, time- and cost-effective, uses a minimum of additional equipment, and is effective in the vast majority of cases, it is the initial protocol of choice. If negative results are obtained when examining porous surfaces for drug residues, the additional protocol then can be followed. It is recommended that the additional protocol be used only as a last resort, and not as a routine procedure.

Although cocaine was used as our model drug residue, this protocol is applicable to most drug residues. Indeed, after exposure to cyanoacrylate vapors, sufficient amounts of phencyclidine (PCP), pentazocine, and heroin residues have been recovered from nonporous surfaces to yield confirmatory levels of those substances.

In the case of porous surfaces, the protocol suggests recovery of the drug residues before latent print examination. Since recovery of drug residues by MeOH swabbing is a long-standing method of collection for a variety of drugs, the protocol does not interfere with existing procedures. As long as MeOH is the solvent of choice, drug recovery should not interfere with subsequent latent print examination.

Summary

This study determined that, when applied in the proper sequence, reagents used in the collection of drug samples would not interfere with subsequent attempts to visualize latent prints; neither, in the proper sequence, would fixation of latent prints (on nonporous substrates) interfere with subsequent drug recovery.

While certainly less than optimum, prior processing with an organic solvent based ninhydrin solution does not automatically exclude the possibility of confirmatory levels of drug residues being detected. Probability of detection is reduced, however, and when requested in advance, recovery of drug samples should precede latent print examination.

For drug residue/latent print examinations, the protocol represented in Fig. 7 is recommended.

References

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Address requests for reprints or additional information to
John P. Nielson, C.L.P.E.
Wisconsin Department of Justice
State Crime Lab—Milwaukee
1578 S. 11th St.
Milwaukee, WI 53204