

Department of Forensic Science

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**IMPRESSIONS -
FOOTWEAR AND TIRE TREAD
PROCEDURES MANUAL**

VIRGINIA
DEPARTMENT
OF
FORENSIC SCIENCE

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1 INTRODUCTION

1.1 Evidence Examination

- 1.1.1 Any time two objects come into contact, there is the potential for impression evidence. These procedures apply to the preservation, recovery and examination of footwear and tire tread impressions on a variety of surfaces.
- 1.1.2 Three-dimensional and two-dimensional impressions are customarily submitted for examination/comparison. Preservation of the impression will differ depending upon the type of impression, the substrate and the receiving surface.
- 1.1.3 Two-dimensional impressions can occur when there is transfer of materials (trace or residue) between the footwear or tire and the surface. The resulting impression has a visible length and width, but not significant depth.
- 1.1.3.1 A negative impression results from the removal of a substance from a substrate by a footwear outsole or tire tread.
- 1.1.3.2 A positive impression or transfer impression is made on a two-dimensional surface as a result of a footwear outsole or tire tread coming in contact with and acquiring a substance that the outsole or tire tread subsequently deposits or transfers to a substrate in the form of an impression.
- 1.1.3.3 A wet origin impression is formed under wet conditions including impressions consisting of residues of blood, grease, mud and other wet substances.
- 1.1.3.4 A dry origin impression is formed when the substrate, matrix, and object are dry (e.g. footwear impressions in dust).
- 1.1.4 Three-dimensional impressions occur when a footwear or tire comes in contact with a soft receiving surface. The impression is then impressed into the substrate (dirt, mud, etc.). The resulting impression has a visible length, width and depth.
- 1.1.5 Short term storage is used when evidence is in the process of examination. The length of time evidence may remain in short term storage is thirty (30) days. After this time period, evidence must be placed into long term storage according to the Quality Manual.
- 1.1.6 The Department's laboratory facilities provide sufficient environmental conditions to conduct all tests listed in the Procedures Manual with no further consideration required.

1.2 Examination Documentation

Examination documentation shall include each examination activity conducted, the sequence of those activities, and the result of each. Activities can include the development techniques, quality control checks, the preservation technique (lifting and/or digitally capturing), database searches conducted to include the result, source of known test impressions (if applicable), comparisons conducted, and the conclusions reached. Documentation shall be sufficient such that in the absence of the examiner, another competent examiner could evaluate what was completed and interpret the data.

1.3 Cross Comparison / Inter-Related Cases

- 1.3.1 It is acceptable for comparison documentation to be retained in one case file and include information in other case files indicating which case file contains the complete comparison documentation. It is not required to duplicate the comparison documentation. This approach is only acceptable for cases which were submitted in the same calendar year.

- 1.3.2 Comparison documentation shall reside in the case file associated with the questioned impression(s). If comparing a questioned impression to a questioned impression the comparison documentation shall be retained in one casefile, not both.
- 1.3.3 The examination documentation associated with the items, questioned impression or knowns, shall reside in the case file under which they were submitted. For Example: The documentation associated with known footwear, tire or known standard shall reside in the case file associated with that submission.
- 1.3.4 The CoA shall contain details related to where the supporting examination documentation is retained.

1.4 Terminology

- 1.4.1 ACE-V
 - 1.4.1.1 Methodology used in impression examination
 - 1.4.1.2 Acronym for Analysis - Comparison - Evaluation - Verification
- 1.4.2 Analysis
 - 1.4.2.1 Interpretation of observed data in an impression in order to categorize its suitability for comparison
- 1.4.3 Class Characteristics
 - 1.4.3.1 A feature shared by two or more items of footwear or tires. The footwear outsole or tire tread design and the physical size features of a footwear outsole or tire tread are two common manufactured class characteristics. General wear of the outsole or tire tread is also a class characteristic.
- 1.4.4 Comparison
 - 1.4.4.1 Search for and detection of similarities and differences in the observed data between two potentially corresponding impressions.
- 1.4.5 Evaluation
 - 1.4.5.1 Weighting of aggregate strength of the observed similarities and differences between the observed data in the two impressions in order to formulate a source conclusion
- 1.4.6 Exclusion
 - 1.4.6.1 Conclusion reached when an examiner determines that there is sufficient observed data in disagreement to conclude that the impression did not originate from the same source
- 1.4.7 Identification
 - 1.4.7.1 Conclusion reached when an examiner determines there is sufficient observed data in agreement to conclude that the impressions originated from the same source
 - 1.4.7.2 Reached when the impressions have corresponding detail and the examiner would not expect to see the same arrangement of details repeated in an impressions that came from a different source
- 1.4.8 Impression
 - 1.4.8.1 Unintentional recording of an impression from an unknown source

- 1.4.8.2 Used generally to refer to any questioned impression or impression of unknown source
- 1.4.9 Inconclusive
- 1.4.9.1 Conclusion reached when an examiner is unable to identify or exclude the source of an impression because the corresponding areas detail are absent or unreliable
- 1.4.9.2 Reached when the observations do not provide a sufficient degree of support for exclusion or identification
- 1.4.10 Individual Characteristic
- 1.4.10.1 A measurable feature that differentiates a single member of a set from every other member of that set. Individual characteristics are exceptional characteristics that may establish uniqueness of an object. These unique markings are accidental, or unintentional, characteristics resulting from wear and random markings on the item during manufacturing and subsequent use.
- 1.4.11 Known Standard
- 1.4.11.1 Intentional recording of an outsole of tire tread from a known source
- 1.4.12 Lift
- 1.4.12.1 Used generally to refer to any method of impression recovery utilizing tape or adhesive material
- 1.4.13 Observed data
- 1.4.13.1 Any demonstrable information observed within an impression that an examiner relies upon to reach a decision, conclusion or opinion
- 1.4.14 Randomly Acquired Characteristics (RACs)
- 1.4.14.1 A feature on a footwear outsole or tire tread resulting from random events including, but not limited to: cuts, scratches, tears, holes, stone holds, abrasions and the acquisition of debris. The position, orientation, size and shape of these characteristics contribute to the uniqueness of a footwear outsole or tire tread. Randomly acquired characteristics are essential for an identification of a particular item of footwear or tire as the source of an impression.
- 1.4.15 Schallamach
- 1.4.15.1 Microscopic patterns that develop as ridges on rubber material as a result of repeated abrasive forces. These patterns are very similar in their size and appearance to skin friction ridges and are highly individual. They continue to change rapidly as affected by continued abrasion. Schallamach patterns are randomly acquired characteristics. The term gets its name from a researcher of the same name.
- 1.4.16 Suitability
- 1.4.16.1 Usefulness of an impression for a further step in the examination process; used as “suitable for capture”, “suitable for comparison”, “of value for comparison” and “suitable for database searches”
- 1.4.17 Verification
- 1.4.17.1 Confirmation, through re-examination by another examiner, that a conclusion or opinion conforms and is reproducible

1.4.17.2 Independent application of ACE by a second qualified examiner

1.4.18 Wear

1.4.18.1 The extent to which a footwear outsole or tire tread has been eroded.

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2 INVENTORY AND CASE APPROACH

2.1 Introduction

Every case is unique and must be evaluated by the individual examiner. It is the examiner's responsibility to choose the best analytical approach for each case, particularly for evidence not routinely encountered or for large evidence submissions. It is expected that Supervisors or the Physical Evidence Program Manager (PM) will be consulted for deviations from existing procedures in accordance with the Department's QM.

2.2 Order and Scope of Examinations

2.2.1 Evaluation of the unknown impression is conducted prior to examining known or known standard.

2.2.1.1 The unknown impression could be a footwear, tire or pattern impression, but is only compared to a footwear outsole or tire tread.

2.2.2 In general, forensic biology examinations should be completed before impression examinations.

2.2.3 In general, the most appropriate sequence of examinations for trace evidence and digital media will be determined via consultation.

2.2.4 If any questions arise as to the proper sequence of examinations between disciplines, consult with a representative from the appropriate section(s).

2.2.5 General procedures for evidence examination are usually divided into two categories, those for porous and those for non-porous surfaces. Each category contains an enormous variety of materials with individual properties that may enhance or diminish the effectiveness of a particular technique.

2.2.6 It is acceptable to discontinue processing once an identification is effected and verified if agreed to by the submitting agency. If this approach is taken, the extent of processing and possibilities for future examination shall be clearly communicated in the Certificate of Analysis (CoA).

2.2.7 It is acceptable to discontinue comparisons once an identification is effected. If this approach is taken, it shall be clearly communicated in the CoA that comparisons were discontinued due to the identification and that additional comparisons can be performed if needed.

2.3 Inventory

2.3.1 Upon opening the case, an inventory is performed in order to document the item(s) of evidence received and develop the processing plan for item(s).

2.3.2 Non-manufactured writing or markings on documents shall be recorded via photocopying, digitally scanning or digitally photographing prior to the application of any chemicals. The CoA shall inform the customer that the writing or markings were preserved as part of the examination documentation.

2.3.2.1 Due to the destructive nature of the chemicals, some inks may be damaged. The writings are captured to preserve them in case of possible damage.

2.3.3 If the condition of the item(s) is such that it necessitates a change to the usual processing sequence for the item(s), it shall be discussed with the Section Supervisor prior to processing, be documented on the CoA and within the examination documentation.

2.4 Case Approach

2.4.1 The evidence submitted will dictate the exam sequence. Evidence commonly seen in the section includes: submitted digital media containing images, casts, lifts, knowns for comparison and items to be processed.

- 2.4.2 Development techniques will be chosen based on the appropriate sequential processing for that item and its properties.

2.4.2.1 Approved development techniques and the associated item(s) properties:

Porous: DFO, NIN, PD, ORO	Non-Porous: CA, Dye Stains, Powder, SPR	Adhesive: GV, SSP, TapeGlo™, WetWop™	Blood: Amido Black, Coomassie Blue, LCV, NIN
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- 2.4.3 The following processing sequences are recommended for the items below:

2.4.3.1 Digitally photograph all items prior to the application of any processing techniques

2.4.3.2 Lifts: Visual

2.4.3.3 Known for comparison: Visual

2.4.3.4 Porous items: Visual, NIN

2.4.3.5 Porous items (thermal): Visual, NIN (thermal)

2.4.3.6 Porous items (wet or previously wet): Visual, ORO and/or PD

2.4.3.7 Non-porous item: Visual, CA, dye stain

2.4.3.8 Non-porous items (wet or previously wet): Visual, SPR

2.4.3.8.1 CA may occur as part of this sequence

2.4.3.9 Adhesive items:

2.4.3.9.1 Non-adhesive side processing shall occur before adhesive side processing. The adhesive side should be as protected as possible throughout.

2.4.3.9.2 The non-adhesive side processing should follow a processing sequence suitable for the properties of the non-adhesive side.

2.4.3.9.3 Adhesive side: Visual, Adhesive processing

2.4.3.10 Blood-stained items:

2.4.3.10.1 Blood-stained, porous items: Visual, DFO, NIN

2.4.3.10.2 Amido Black, Coomassie Blue and LCV may occur as part of this sequence

2.4.3.10.3 Blood-stained, non-porous items: Visual, LCV and/or Amido Black

2.4.3.10.3.1 CA may occur as a part of this sequence

2.4.3.11 Combination items:

2.4.3.11.1 Items that exhibit combinations of different properties should be processed in a manner that allows for the most complete development of impressions.

2.4.3.12 Unique surfaces:

2.4.3.12.1 Bloody Carpet/Fabric: Visual, LCV, Amido Black

2.4.3.12.2 Dust on Fabric: Visual, Lift

2.4.3.12.3 Skin: Visual

2.4.3.12.4 Rubber/nitrile gloves: Visual, CA, dye stain

2.4.3.12.5 Glossy paper/cardboard (semi-porous): Visual, CA, IND, NIN, dye stain

2.4.3.13 Powder may be used in addition to, or in lieu of, and prior to dye stain as appropriate.

2.4.3.14 Wet or blood-stained items shall be dried before proceeding with processing.

2.4.3.15 Alternate processing sequences shall be discussed with the Section Supervisor prior to use in casework and documented.

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3 CHEMICAL PROCESSING METHODS

3.1 Use of Chemical Processing Methods

- 3.1.1 Any of the listed preparations or commercially purchased reagents may be used at the examiner's discretion.
- 3.1.2 A performance check of methods used shall be completed for each case.
- 3.1.2.1 The result of the check and the batch number will be included in the examination documentation.
- 3.1.2.2 The procedure for creating test strips is outlined in the QA section of this manual.
- 3.1.3 When mixing a stock solution into a working solution, the use of a magnetic stirrer is not recommended. Magnetic stirrers could cause the reagent to fall out of solution in the working solution.

3.2 Amido Black

Amido Black is used to enhance impressions that have been deposited in blood or other protein-based substances on either porous or non-porous items. Caution must be used when applying the methanol-based formula to painted surfaces. The formula may destroy the impressions as well as the surface beneath.

3.2.1 Preparation:

3.2.1.1 Amido Black Methanol Working Solution

Chemicals Required

- 2 g Amido Black
- 100 mL Glacial Acetic Acid
- 900 mL Methanol

Directions

1. Combine the ingredients and stir using a magnetic stirrer for approximately thirty minutes or until Amido Black is dissolved.

3.2.1.2 Amido Black Methanol Rinse Solution

Chemicals Required

- 100 mL Glacial Acetic Acid
- 900 mL Methanol

Directions

1. Combine the ingredients.

3.2.1.3 Amido Black Aqueous Working Solution

Chemicals Required

- 500 mL Reverse Osmosis (R/O) or Deionized (DI) water
- 20 g 5-Sulfosalicylic Acid
- g Amido Black
- g Sodium Carbonate

- 50 mL Formic Acid
- 50 mL Glacial Acetic Acid
- 12.5 mL Surfactant
- R/O or DI water

Directions

1. Combine the ingredients in the order listed using a magnetic stirrer to mix well.
2. Dilute the solution to 1 L using R/O or DI water.

3.2.2 Instrumentation:

3.2.2.1 None noted.

3.2.3 Minimum Standards and Controls:

3.2.3.1 Amido Black and rinse have an indefinite shelf life.

3.2.3.2 Deposit an impression with a small amount of animal or synthetic blood on a surface similar to the item(s) to be processed. Follow the procedure listed below to process the test impression once the blood is dry. If the test impression turns blue-black, the working solution can be used to process evidence.

3.2.4 Procedure or Analysis:

3.2.4.1 Ensure the blood is dry before proceeding with application.

3.2.4.2 Amido Black Methanol application:

3.2.4.2.1 Apply the solution to the item(s) by immersion, spraying or squirting.

3.2.4.2.2 Allow the solution between 30 seconds and one minute to set.

3.2.4.2.3 Apply the rinse solution.

3.2.4.2.4 These steps can be repeated to improve contrast.

3.2.4.2.5 Rinse the item(s) with R/O or DI water.

3.2.5 Amido Black Aqueous application:

3.2.5.1.1 Apply the solution to the item(s) by dipping or squirting.

3.2.5.1.2 Allow the solution three to five minutes to set.

3.2.5.1.3 Rinse the item(s) with R/O or DI water.

3.2.5.1.4 These steps can be repeated to improve contrast.

3.2.6 Review the item(s) for any developed impressions.

3.2.7 Capture impressions for analysis and further examination.

3.3 Ardrox

Ardrox is a dye stain that can be used undiluted or as part of a solution that enhances impressions previously developed with cyanoacrylate ester. Ardrox is applied to the object and visually examined utilizing an alternate light source (ALS).

3.3.1 Preparation:

3.3.1.1 Ardrox Working Solution

Chemicals Required

- 2 mL Ardrox
- 10 mL Acetone
- 25 mL Methanol
- 10 mL Isopropyl Alcohol
- 8 mL Acetonitrile
- 945 mL Petroleum Ether

Directions

1. Combine the ingredients in the order listed.

3.3.2 Instrumentation:

3.3.2.1 An ALS is required for visualization of developed impressions.

3.3.3 Minimum Standards and Controls:

3.3.3.1 Ardrox working solution shall not exceed six months.

3.3.3.2 Follow the procedure listed below to process a test impression previously deposited and developed with cyanoacrylate ester. If the test impression fluoresces, the working solution can be used to process evidence.

3.3.4 Procedure or Analysis:

3.3.4.1 Undiluted Ardrox application

3.3.4.1.1 Completely cover the item(s) by immersion or squirt bottle.

3.3.4.1.2 Allow the liquid to remain on the item(s) for about ten minutes.

3.3.4.1.3 Rinse the item(s) under R/O or DI water until no yellow color remains.

3.3.4.2 Ardrox Working Solution application.

3.3.4.2.1 Apply the solution to the item(s) by immersion or squirt bottle.

3.3.4.2.2 Allow the solution to remain on the item(s) for several minutes.

3.3.4.3 Review the item(s) using an ALS with appropriate goggles without rinsing to evaluate if/how much background staining may have occurred.

3.3.4.4 If no background staining is noted, proceed to the next step.

- 3.3.4.5 If background staining is observed and prevents visualization, subject the item(s) to a light R/O or DI water rinse.
- 3.3.4.6 Allow the item(s) to dry completely.
- 3.3.4.7 Review the item(s) for any developed impressions using an ALS with appropriate goggles.
- 3.3.4.8 Ardrox fluoresces best with blue-green light and can be viewed using yellow barrier filters.
- 3.3.4.9 Capture impressions for analysis and further examination.

3.4 Basic Yellow 40 (BY40)

BY40 is a dye stain that enhances impressions previously developed with cyanoacrylate ester. BY40 is applied to the object and visually examined utilizing an ALS.

3.4.1 Preparation:

3.4.1.1 BY40 Working Solution

Chemicals Required

- 3 g Basic Yellow powder concentrate
- 1 L Methanol

Directions

1. Combine the ingredients and stir the solution until all of the powder is dissolved.

3.4.2 Instrumentation:

- 3.4.2.1 An ALS is required for visualization of developed impressions.

3.4.3 Minimum Standards and Controls:

- 3.4.3.1 BY40 working solution shall not exceed six months.
- 3.4.3.2 Follow the procedure listed below to process a test impression previously deposited and developed with cyanoacrylate ester. If the test impression fluoresces, the working solution can be used to process evidence.

3.4.4 Procedure or Analysis:

- 3.4.4.1 Apply the solution to the item(s) by immersion, brush, spray canister or squirt bottle.
- 3.4.4.2 Allow the solution at least one minute to set.
- 3.4.4.3 Rinse the item(s) thoroughly under running R/O or DI water. It is acceptable to rinse the item(s) with a solution of 200 parts R/O or DI water to one part Surfactant.
- 3.4.4.4 Allow the item(s) to dry completely.
- 3.4.4.5 Review the item(s) for any developed impressions using an ALS with appropriate goggles.
- 3.4.4.6 BY40 fluoresces best with blue light and can be viewed using yellow barrier filters.
- 3.4.4.7 Capture impressions for analysis and further examination.

3.5 Coomassie Brilliant Blue R250

Coomassie Brilliant Blue R250 is used to enhance impressions that have been deposited in blood on either porous or non-porous items.

3.5.1 Preparation:

3.5.1.1 Coomassie Working Solution

Chemicals Required

- 0.96 g Coomassie Brilliant Blue R250
- 84 mL Glacial Acetic Acid
- 410 mL Methanol
- 410 mL R/O or DI water

Directions

1. Dissolve Coomassie Brilliant Blue R250 in Methanol.
2. Add R/O or DI water and Glacial Acetic Acid to the Methanol solution and stir.

3.5.1.2 Coomassie Destaining Solution

Chemicals Required

- 200 mL Methanol
- 200 mL R/O or DI water
- 40 mL Glacial Acetic Acid

Directions

1. Add Methanol to R/O or DI water and stir.
2. Add Glacial Acetic Acid to the Methanol solution and stir.

3.5.2 Instrumentation:

3.5.2.1 None noted.

3.5.3 Minimum Standards and Controls:

3.5.3.1 Coomassie Brilliant Blue R250 and rinse have an indefinite shelf life.

3.5.3.2 Deposit a test impression with a small amount of animal or synthetic blood on a surface similar to the item(s) to be processed. Follow the procedure listed below to process the test impression once the blood is dry. If the test impression turns blue-black, the working solution can be used to process evidence.

3.5.4 Procedure or Analysis:

3.5.4.1 Ensure the blood is dry before proceeding with application.

3.5.4.2 Agitate the working solution before application to the item(s).

3.5.4.2.1 Immersion application:

- 3.5.4.2.1.1 Immerse the item(s) in the working solution and agitate for two minutes
- 3.5.4.2.1.2 Immerse the item(s) in the destaining solution for one minute.
- 3.5.4.2.1.3 Agitate the solution until background discoloration fades.
- 3.5.4.2.1.4 Staining and destaining may be repeated until optimal contrast is achieved.

3.5.4.2.2 Squirt Bottle application:

- 3.5.4.2.2.1 Apply to large surfaces by squirt bottle or pouring for about five minutes or until maximum contrast is achieved.
- 3.5.4.2.2.2 Apply the destaining solution by squirt bottle or pouring.

3.5.4.3 Review the item(s) for any developed impressions.

3.5.4.4 Capture impressions for analysis and further examination.

3.6 Cyanoacrylate Ester Fuming (CA)

Cyanoacrylate esters are the active ingredients in super bond adhesives and, in an atmosphere of relatively high humidity, the molecules are attracted to residue and polymerize upon the deposit.

3.6.1 Preparations:

- 3.6.1.1 No specific preparations are needed as the cyanoacrylate materials being used are commercially prepared.

3.6.2 Instrumentation:

- 3.6.2.1 A CA fuming chamber, either atmospheric or vacuum, is required.

3.6.3 Minimum Standards and Controls:

- 3.6.3.1 Cyanoacrylate ester has an indeterminable shelf life and may be used as long as it remains in a semi-liquid state and has a positive reaction with the test impression.
- 3.6.3.2 Apply a test impression to a non-evidentiary item. Follow the procedure listed below to process the test impression along with the item(s). Terminate the processing once the test impression has reached optimal development.

3.6.4 Procedure or Analysis:

- 3.6.4.1 Follow the instrument manufacturer's instructions for optimal processing conditions.
- 3.6.4.2 Terminate the processing once the test impression has reached optimal development.
- 3.6.4.3 Review the item(s) for any developed impressions.
- 3.6.4.4 Capture impressions for analysis and further examination.

3.7 1,8-Diazafluoren-9-One (DFO)

DFO reacts with amino acids in perspiration, and once the reaction is completed, the developed impressions will fluoresce using an ALS.

3.7.1 Preparations:

3.7.1.1 DFO Stock Solution

Chemicals Required

- 1 g DFO
- 200 mL Methanol
- 200 mL Ethyl acetate
- 40 mL Glacial acetic acid

Directions

1. Combine the ingredients and stir for approximately 20 minutes or until the DFO is dissolved.

3.7.1.2 DFO Working Solution

Chemicals Required

- 1560 mL Petroleum Ether

Directions

1. Dilute the stock solution to 2L with Petroleum Ether.

3.7.2 Instrumentation:

- 3.7.2.1 A laboratory oven, dry iron, photographic heat press, or hair dryer is recommended. An ALS is required for visualization of developed impressions.

3.7.3 Minimum Standards and Controls:

- 3.7.3.1 DFO stock and working solution shall be stored in a dark bottle and have a shelf life not exceeding six months.
- 3.7.3.2 Apply a test impression to a porous item similar to the evidence being processed or use a test strip. Follow the procedure listed below to process the test impression/strip. If the impression /strip fluoresces, the working solution can be used to process evidence.

3.7.4 Procedure or Analysis:

- 3.7.4.1 Item(s) may be dipped or sprayed.
- 3.7.4.2 Once processed with DFO, the item(s) must be dried in an oven at approximately 100 degrees C for 20 minutes.
- 3.7.4.3 If an oven is not available, a dry iron may be used.
- 3.7.4.4 Review the item(s) for any developed impressions using an ALS with appropriate goggles.
- 3.7.4.5 DFO fluoresces best with blue-green light and can be viewed using orange barrier filters.
- 3.7.4.6 Capture impressions for analysis and further examination.

3.8 Gentian Violet (GV)

GV is a solution that results in a color change when in contact with skin cells or other residues left in the adhesive material.

3.8.1 Preparation:

3.8.1.1 GV Working Solution

Chemicals Required

- 1 g GV
- 1 L R/O or DI water

Directions

1. Combine the ingredients.

3.8.2 Instrumentation:

3.8.2.1 None noted.

3.8.3 Minimum Standards and Controls:

3.8.3.1 GV working solution has an indefinite shelf life.

3.8.3.2 Apply a test impression on a surface similar to the evidence being processed. Follow the procedure listed below to process the test impression. If the test impression turns purple, the working solution can be used to process evidence.

3.8.4 Procedure or Analysis:

3.8.4.1 Immerse the item(s) in the solution for approximately 30 seconds while agitating.

3.8.4.2 Rinse the item(s) with a gentle flow of cold R/O or DI water.

3.8.4.3 These steps can be repeated to improve contrast.

3.8.4.4 Review the item(s) for any developed impressions.

3.8.4.5 Capture impressions for analysis and further examination.

3.9 Leucocrystal Violet (LCV)

LCV is used to enhance impressions that have been deposited in blood or other protein-based substances on either porous or non-porous items.

3.9.1 Preparation:

3.9.1.1 LCV Solution #1: Stock Solution A

Chemicals Required

- 10 g 5-Sulfosalicylic Acid
- 100 mL R/O or DI water

Directions

1. Dissolve 5-Sulfosalicylic acid in R/O or DI water.

3.9.1.2 LCV Solution #1: Stock Solution B

Chemicals Required

- Stock Solution A
- 400 mL 3% Hydrogen Peroxide

Directions

1. Add Stock Solution A to Hydrogen Peroxide.

3.9.1.3 LCV Solution #1: Working Solution

Chemicals Required

- 0.75 g LCV
- Stock Solution B

Directions

1. Add LCV to Stock Solution B and stir the solution vigorously.

3.9.1.4 LCV Solution #2

Chemicals Required

- 10 g 5-Sulfosalicylic Acid
- 500 mL 3% Hydrogen Peroxide
- 3.7 g Sodium Acetate
- 1 g LCV

Directions

1. Dissolve 5-Sulfosalicylic acid in 3% Hydrogen Peroxide.
2. Dissolve Sodium Acetate and LCV in 3% Hydrogen Peroxide solution.
3. Stir the solution vigorously.

3.9.2 Instrumentation:

- 3.9.2.1 None noted.

3.9.3 Minimum Standards and Controls:

- 3.9.3.1 LCV stock solutions shall not exceed one year.

- 3.9.3.2 LCV working solution shall not exceed thirty days.

- 3.9.3.3 Deposit a test impression with a small amount of animal or synthetic blood on a surface similar to the item(s) to be processed. Follow the procedure listed below to process the test impression once the blood is dry. If the test impression turns violet, the working solution can be used to process evidence.

3.9.4 Procedure or Analysis:

- 3.9.4.1 Ensure the blood is dry before proceeding with application.
- 3.9.4.2 Apply the solution to the item(s) by spraying, immersion or washing the solution over the item(s).
- 3.9.4.3 Review the item(s) for any developed impressions.
- 3.9.4.4 Capture impressions for analysis and further examination.

3.10 7-(P-Methoxybenzylamino-4-Nitrobenz-2-Oxa-1,3-Diazole) (MBD)

MBD is a dye stain that enhances impressions previously developed with CA. MBD is applied to the object and visually examined utilizing an ALS.

3.10.1 Preparation:

3.10.1.1 MBD Solution #1

Chemicals Required

- 0.12 g MBD
- 1 L Methanol

Directions

1. Combine the ingredients and continue to stir the solution until all powder is dissolved.

3.10.1.2 MBD Solution #2: Stock Solution

Chemicals Required

- 1 g MBD
- 1 L Acetone

Directions

1. Combine the ingredients and continue to stir the solution until all powder is dissolved.

3.10.1.3 MBD Solution #2: Working Solution

Chemicals Required

- 10 mL MBD Stock Solution
- 30 mL Methanol
- 10 mL Isopropanol
- 950 mL Petroleum Ether

Directions

1. Combine the ingredients in the order listed. Do not place on a magnetic stirrer.

3.10.2 Instrumentation:

3.10.2.1 An ALS is required for visualization of developed impressions.

3.10.3 Minimum Standards and Controls:

3.10.3.1 MBD stock solution has an indefinite shelf life.

3.10.3.2 MBD working solution shall not exceed six months.

3.10.3.3 Follow the procedure listed below to process a test impression previously deposited and developed with cyanoacrylate ester. If the test impression fluoresces, the working solution can be used to process evidence.

3.10.4 Procedure or Analysis:

3.10.4.1 Apply the solution to the item(s) by immersion, spray canister or squirt bottle.

3.10.4.2 Allow the item(s) to dry completely.

3.10.4.3 Review the item(s) for any developed impressions using an ALS with appropriate goggles.

3.10.4.4 MBD fluoresces best with blue to green light and can be viewed using orange or red barrier filters.

3.10.4.5 Capture impressions for analysis and further examination.

3.11 MRM 10

MRM 10 is a combination dye stain that enhances impressions previously developed with CA. MRM 10 is applied to the object and visually examined utilizing an ALS at various wavelengths.

3.11.1 Preparation:

3.11.1.1 R6G Stock Solution

Chemicals Required

- 1 g R6G
- 1 L Methanol

Directions

1. Combine the ingredients.

3.11.1.2 BY40 Stock Solution

Chemicals Required

- 2 g BY40
- 1 L Methanol

Directions

1. Combine the ingredients.

3.11.1.3 MBD Stock Solution

Chemicals Required

- 1 g MBD
- 1 L Acetone

Directions

1. Combine the ingredients.

3.11.2 MRM 10 Working Solution

Chemicals Required

- mL R6G Stock Solution
- 3 mL BY40 Stock Solution
- 7 mL MBD Stock Solution
- 20 mL Methanol
- 10 mL Isopropanol
- 8 mL Acetonitrile
- 950 mL Petroleum Ether

Directions

1. Combine the ingredients in the order listed.

3.11.3 Instrumentation:

- 3.11.3.1 An ALS is required for visualization of developed impressions.

3.11.4 Minimum Standards and Controls:

- 3.11.4.1 The stock solutions have indefinite shelf lives.
- 3.11.4.2 MRM 10 working solution shall not exceed six months.
- 3.11.4.3 Follow the procedure listed below to process a test impression previously deposited and developed with cyanoacrylate ester. If the test impression fluoresces, the working solution can be used to process evidence.

3.11.5 Procedure or Analysis:

- 3.11.5.1 Apply the solution to the item(s) by immersion, spray canister or squirt bottle.
- 3.11.5.2 Allow the item(s) to dry completely.
- 3.11.5.3 Review the item(s) for any developed impressions using an ALS with appropriate goggles.
- 3.11.5.4 MRM 10 fluoresces within the same range as its component dye stains and can be viewed using the appropriate barrier filters.
- 3.11.5.5 Capture impressions for analysis and further examination.

3.12 Ninhydrin (NIN)

NIN or triketo-hydrindene hydrate, is an extremely sensitive indicator of alpha-amino acids, proteins, peptides and polypeptides. The reaction produces a violet to blue-violet coloring of these substances and is effective even with older deposits and/or minute amounts of amino acids. NIN processing is normally confined to porous items which

are not water-soaked and do not contain inherent animal proteins. NIN coloration is not permanent, and while some impressions have remained visible for years, others have faded in a matter of days.

3.12.1 Recommended Preparations (0.5% concentration):

3.12.1.1 Petroleum Ether Solution

Chemicals Required

- 10 g NIN
- 60 mL Methanol
- 80 mL 2-Propanol (Isopropyl Alcohol)
- 1860 mL Petroleum Ether

Directions

1. Dissolve NIN crystals in Methanol.
2. Add 2-Propanol to NIN/Methanol solution and stir.
3. Add NIN/ Methanol/2-Propanol solution to Petroleum Ether and stir.

3.12.1.2 Acetone Solution

Chemicals Required

- 25 g NIN
- 1 L of Acetone

Directions

1. Dissolve NIN crystals in Acetone.

3.12.1.3 Heptane Solution

Chemicals Required

- 33 g NIN
- 220 mL Ethyl Alcohol (use Absolute Ethanol, DO NOT use Denatured Ethanol)
- 1 L Heptane

Directions

1. Dissolve NIN in Ethyl alcohol.
2. Remove 220 mL of Heptane from bottle.
3. Add NIN/Ethyl Alcohol solution to Heptane and stir.

3.12.2 Commercially prepared NIN, including those formulations containing HFE, may be used; no specific preparation is needed.

3.12.3 Instrumentation:

3.12.3.1 A humidity chamber or a steam iron may be used to control the heat and relative humidity to accelerate the development of impressions after processing.

3.12.3.2 If using a humidity chamber, the chamber should be set at no greater than 80 degrees Celsius/176 degrees Fahrenheit and between 60% and 80% relative humidity.

3.12.4 Minimum Standards and Controls:

- 3.12.4.1 NIN shall be stored in a dark bottle and have a shelf life not exceeding one year.
- 3.12.4.2 Apply a test impression to a porous item similar to the evidence being processed or use a test strip. Follow the procedure listed below to process the test impression/strip. If the test impression/strip turns purple, the working solution can be used to process evidence.

3.12.5 Procedure or Analysis:

- 3.12.5.1 Item(s) may be dipped, sprayed or washed.
- 3.12.5.2 Allow the item(s) to dry for a minimum of 1 hour prior to the application of heat or steam.
- 3.12.5.3 Place the item(s) in the heat/humidity chamber or the item may be steam ironed.
- 3.12.5.4 Check the item(s) periodically to monitor the impression development and to avoid saturating the item with water vapor.
- 3.12.5.5 After a minimum of 12 hours, review the item(s) and document any additional impressions that developed.
- 3.12.5.6 If using a heat/humidity chamber to achieve optimal development, it is not necessary to wait 12 hours.
- 3.12.5.7 Capture impressions for analysis and further examination.

3.13 Oil Red O (ORO)

ORO is a fat-soluble dye that is sensitive to the lipid component of residue. Staining with ORO will produce a dark red to brown coloring of lipids and fats on porous surfaces. ORO is insoluble in water, as are the lipids it stains, enabling it to be used on porous items that have been wet.

3.13.1 Preparation:

3.13.1.1 ORO Working Solution

Chemicals Required

- 1.54 g ORO powder
- 770 mL Methanol
- 9.2 g Sodium Hydroxide
- 230 mL R/O or DI water

Directions:

1. Dissolve ORO powder in Methanol and stir.
2. Dissolve Sodium Hydroxide in water and stir.
3. Add Sodium Hydroxide solution to ORO solution and stir.
4. Filter combined solution.

3.13.2 Instrumentation:

- 3.13.2.1 A shaker table is recommended during staining to ensure the entire item remains immersed.

3.13.3 Minimum Standards and Controls:

- 3.13.3.1 ORO shall be stored in a dark bottle and have a shelf life not exceeding one year.
- 3.13.3.2 Apply a test impression using natural sebaceous residue to a porous item similar to the evidence being processed. Follow the procedure listed below to process the test impression. If the test impression turns red to brown in color, the working solution can be used to process evidence.
- 3.13.4 Procedure or Analysis:
- 3.13.4.1 Immerse each item(s) to be processed in the ORO staining solution. Impressions generally develop between five and ninety minutes, depending on the lipid content.
- 3.13.4.2 Place the tray with the staining solution and item(s) on a shaker table to ensure immersion.
- 3.13.4.3 Remove the item(s) from the ORO staining solution and drain.
- 3.13.4.4 Immerse the item(s) in a tray of continuously running DI water to neutralize the pH of the porous substrate.
- 3.13.4.5 Remove the item(s) from the water and dry completely.
- 3.13.4.6 Review the item(s) for any developed impressions.
- 3.13.4.7 Capture impressions for analysis and further examination.

3.14 Physical Developer (PD)

PD is reactive with the lipid content of the residue and is specifically for the examination of wet or water soaked porous items. Impressions appear as dark gray images which increase in contrast. This technique utilizes sensitive reactions that precipitate silver to the non-sebaceous material present in the residue.

3.14.1 Preparations:

3.14.1.1 Maleic Acid Pre-wash Solution

Chemicals Required:

- 1 L R/O or DI water
- 25 g Maleic Acid

Directions

1. Add Maleic Acid to R/O or DI water.
2. Stir until dissolved with a magnetic stir bar previously rinsed with R/O or DI water.

3.14.1.2 Detergent Stock Solution

Chemicals Required

- 1 L R/O or DI water
- g n-Dodecylamine Acetate
- mL Surfactant

Directions

1. Add n-Dodecylamine Acetate to R/O or DI water and stir with a magnetic stir bar previously rinsed with R/O or DI water. If some of the n-Dodecylamine Acetate sticks to the weigh boat, the weigh boat can be immersed in the solution.
2. Add 3 mL Surfactant to the n-Dodecylamine Acetate solution. Place the weigh boat in the solution as the surfactant will adhere to the weigh boat.
3. Stir for thirty minutes.
4. Remove the weigh boat(s).
5. This solution must not be used for at least 24 hours. If solids are present after 24 hours, discard and remix.

3.14.1.3 Buffered Ferrous/Ferric Redox Solution

Chemicals Required

- 1000 mL R/O or DI water
- 30 g Ferric Nitrate
- 80 g Ferrous Ammonium Sulfate
- 20 g Citric Acid

Directions

1. Pour 900 mL of R/O or DI water into a beaker and stir with a magnetic stir bar previously rinsed with R/O or DI water.
2. Add Ferric Nitrate to R/O or DI water and stir until dissolved.
3. When Ferric Nitrate has fully dissolved, add Ferrous Ammonium Sulfate and stir until dissolved.
4. When Ferrous Ammonium Sulfate has fully dissolved, add Citric Acid and stir until dissolved.
5. Stir until the Citric Acid is fully dissolved, and then stir for an additional five minutes.

3.14.1.4 Silver Nitrate Solution

Chemicals Required

- 50 mL R/O or DI water
- 10 g Silver Nitrate

Directions

1. Add Silver Nitrate to R/O or DI water and stir until dissolved.

3.14.1.5 Physical Developer Combined Working Solution

Chemicals Required

- 40 mL Stock Detergent Solution
- Buffered Ferrous/Ferric Redox Solution
- Silver Nitrate Solution

Directions

1. Add Stock Detergent Solution to Redox Solution and stir.
2. Examine Silver Nitrate solution to ensure all solid material has dissolved. Stir as needed.
3. Add Silver Nitrate solution to Redox/Stock Detergent solution and stir for two minutes.

3.14.1.6 Photofix Rinse Solutions

3.14.1.6.1 Rinse 1

Chemicals Required

- Four or five drops Polymax Fixer per L of R/O or DI water
- R/O or DI water

Directions

1. Add Polymax Fixer to R/O or DI water in a glass or plastic tray.

3.14.1.6.2 Rinse 2

Chemicals Required

- One part Photographic Fixer
- Nine parts R/O or DI water

Directions

1. Add Photographic Fixer to R/O or DI water in a glass or plastic tray.

3.14.1.7 Bleach Solution

Chemicals Required

- One part Bleach
- One part R/O or DI water

Directions

1. Combine bleach and R/O or DI water.

3.14.2 Instrumentation:

3.14.2.1 All glassware and utensils must be dedicated to the technique to avoid reagent contamination.

3.14.2.2 Certain rubber products and glove types may cause contamination and should not be used and/or come in contact with the item(s) of evidence after the pre-wash.

3.14.2.3 Plastic rinse trays may be used but must be clean.

3.14.2.4 Plastic or bamboo tongs without serrated edges are recommended for item handling.

3.14.3 Minimum Standards and Controls:

3.14.3.1 The stock solutions have a one year shelf life.

3.14.3.2 The PD combined working solution is unstable and shall be discarded after use.

3.14.3.3 Apply a test impression to a porous item similar to the evidence being processed. Follow the procedure listed below to process the test impression. If the test impression turns dark gray, the working solution can be used to process evidence.

3.14.4 Procedure or Analysis:

- 3.14.4.1 Immerse item(s) in Maleic Acid pre-wash solution in a glass tray for five to ten minutes or until bubbles are no longer given off.
- 3.14.4.2 Pre-wash is necessary to avoid reagent contamination.
- 3.14.4.3 Immerse item(s) in the PD working solution and gently rock the tray.
- 3.14.4.4 Impression development time will vary and can be as little as one minute or up to twenty minutes.
- 3.14.4.5 Keep the item(s) separated and be careful not to crease or extensively handle the item(s). Monitor development closely to avoid over processing.
- 3.14.4.6 Remove the item(s) when optimum contrast is observed.
- 3.14.4.7 Rinse the item(s) of evidence using either the water rinse or two-step Photofix rinse.
- 3.14.4.8 Water rinse
- 3.14.4.8.1 Immerse item(s) of evidence in a tray with continuous gentle running R/O or DI water.
- 3.14.4.9 Photofix rinse
- 3.14.4.9.1 Immerse item(s) of evidence in the Photofix Rinse 1 solution for 30 seconds.
- 3.14.4.9.2 Transfer the item(s) of evidence into Photofix Rinse 2 solution for three minutes.
- 3.14.4.9.3 Wash the item(s) in running water for three to five minutes.
- 3.14.4.10 Allow the item(s) of evidence to dry while lying flat.
- 3.14.4.11 The item(s) can be blotted carefully with blotter paper to speed the drying process if the item(s) are not fragile.
- 3.14.4.12 If needed, a bleach rinse may be used to improve the contrast of the impression.
- 3.14.4.13 All impressions should be photographed before proceeding with this step.
- 3.14.4.14 Immerse item(s) of evidence in the bleach solution for two to three minutes.
- 3.14.4.15 Rinse item(s) of evidence in running R/O or DI water for two to three minutes.
- 3.14.4.16 Review the item(s) for any developed impressions.
- 3.14.4.17 Capture impressions for analysis and further examination.

3.15 Rhodamine 6G-Ardrox-MBD (RAM)

RAM is a combination dye stain that enhances impressions previously developed with CA. RAM is applied to the object and visually examined utilizing an ALS at various wavelengths.

3.15.1 Preparation:

3.15.1.1 R6G Stock Solution

Chemicals Required

- 1 g R6G
- 1 L Methanol

Directions

1. Combine the ingredients in the order listed.

3.15.1.2 MBD Stock Solution

Chemicals Required

- 1 g MBD
- 1 L Acetone

Directions

1. Combine the ingredients in the order listed.

3.15.1.3 RAM Working Solution

Chemicals Required

- 3mL R6G Stock Solution
- 2 mL Ardrex
- 7 mL MBD Stock Solution
- 20 mL Methanol
- 10 mL Isopropanol
- 8 mL Acetonitrile
- 950 mL Petroleum Ether

Directions

1. Combine the ingredients in the order listed.

3.15.2 Instrumentation:

- 3.15.2.1 An ALS is required for visualization of developed impressions.

3.15.3 Minimum Standards and Controls:

- 3.15.3.1 RAM working solution shall not exceed six months. RAM working solution may separate after 30 days; if after stirring or shaking the solution it still separates, discard the solution.
- 3.15.3.2 Follow the procedure listed below to process a test impression previously deposited and developed with cyanoacrylate ester. If the test impression fluoresces, the working solution can be used to process evidence.

3.15.4 Procedure or Analysis:

- 3.15.4.1 Apply the solution to the item(s) by immersion, spray canister or squirt bottle.

- 3.15.4.2 Allow the item(s) to dry completely.
- 3.15.4.3 Review the item(s) for any developed impressions using an ALS with appropriate goggles.
- 3.15.4.4 RAM fluoresces within the same range as its component dye stains and viewed using the appropriate barrier filters.
- 3.15.4.5 Capture impressions for analysis and further examination.

3.16 Rhodamine 6G (R6G)

R6G is a dye stain that enhances impressions previously developed with CA. R6G is applied to the object and visually examined utilizing an ALS.

3.16.1 Preparation:

3.16.1.1 R6G Methanol Solution #1

Chemicals Required

- 0.0048 g R6G
- 1 L Methanol

Directions

1. Combine the ingredients and stir the solution until all of the powder is dissolved.

3.16.1.2 R6G Methanol Solution #2: Stock Solution

Chemicals Required

- 0.48 g R6G
- 1 L Methanol

Directions

1. Combine the ingredients and stir the solution until all of the powder is dissolved.

3.16.1.3 R6G Methanol Solution #2: Working Solution

Chemicals Required

- 10 mL R6G Stock Solution
- 1 L Methanol

Directions

1. Combine the ingredients.

3.16.1.4 R6G Aqueous Solution #1

Chemicals Required

- 0.0048 g R6G
- 1 L R/O or DI water

- 3 - 6 drops Surfactant

Directions

1. Combine the ingredients and continue to stir the solution until all powder is dissolved.

3.16.1.5 R6G Aqueous Solution #2: Stock Solution

Chemicals Required

- 0.48 g R6G
- 1 L R/O or DI water

Directions

1. Combine the ingredients and continue to stir the solution until all powder is dissolved.

3.16.1.6 R6G Aqueous Solution #2: Working Solution

Chemicals Required

- 10 mL R6G Aqueous Stock Solution
- 1 L R/O or DI water
- 3 - 6 drops Surfactant

Directions

1. Combine the ingredients.

3.16.2 Instrumentation:

- 3.16.2.1 An ALS is required for visualization of developed impressions.

3.16.3 Minimum Standards and Controls:

- 3.16.3.1 R6G solutions have a six-month shelf life.

- 3.16.3.2 Follow the procedure listed below to process an impression previously deposited and developed with cyanoacrylate ester. If the test impression fluoresces, the working solution can be used to process evidence.

3.16.4 Procedure or Analysis:

- 3.16.4.1 Apply the solution to the item(s) by immersion, spray canister or squirt bottle.
- 3.16.4.2 Allow the item(s) to dry completely.
- 3.16.4.3 Review the item(s) for any developed impressions using an ALS with appropriate goggles.
- 3.16.4.4 R6G fluoresces best with blue-green to green light and can be viewed using orange or red barrier filters.
- 3.16.4.5 Capture impressions for analysis and further examination.

3.17 TapeGlo™

TapeGlo™ is a fluorescent dye stain that develops impressions on the adhesive side of tape.

3.17.1 Preparation:

3.17.1.1 Follow manufacturer's recommendations for any preparation.

3.17.2 Instrumentation:

3.17.2.1 A soft-bristle brush may be used for application.

3.17.3 Minimum Standards and Controls:

3.17.3.1 The manufacturer's shelf-life recommendations shall be followed.

3.17.4 Procedure or Analysis:

3.17.4.1 Immerse, spray or brush the item(s) with the solution to completely cover the surface.

3.17.4.2 Allow the suspension to remain on the item(s) for 10 to 15 seconds.

3.17.4.3 Gently rinse with R/O or DI water

3.17.4.4 Review the item(s) for any developed impressions using an ALS with appropriate goggles.

3.17.4.5 TapeGlo™ fluoresces best with blue light and can be viewed using orange barrier filters.

3.17.4.6 Capture impressions for analysis and further examination.

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4 PHYSICAL PROCESSING METHODS

4.1 Use of Physical Processing Methods

4.1.1 Any of the listed preparations may be used at the examiner's discretion.

4.2 Powder, Fluorescent

4.2.1 Powdering is the application of applying finely ground, colored powder to an item to make impressions visible. The powder binds to moisture, oil, and other residues. Fluorescent powders were developed specifically to be luminescent, excited by light sources emitting blue-green light.

4.2.1.1 Preparations:

4.2.1.1.1 No specific preparations are needed as the powders are commercially prepared.

4.2.1.2 Instrumentation:

4.2.1.2.1 Brushes are required for application of the powder.

4.2.1.2.2 An ALS is required for visualization of developed impressions.

4.2.1.3 Minimum Standards and Controls:

4.2.1.3.1 Fluorescent powder has an indeterminable shelf life; however, if clumping of the powder is observed, it shall be discarded.

4.2.1.3.2 Fluorescent powder should not be exposed to high humidity or moisture as this may cause clumping of the powder. Store fluorescent powder in a manner that minimizes this exposure.

4.2.1.4 Procedure or Analysis:

4.2.1.4.1 Coat the ends of the brush bristles with powder and gently tap several times to remove excess powder.

4.2.1.4.2 With the brush handle in a nearly perpendicular position to the surface, lightly and delicately move the bristle ends over the surface. Impressions will develop in contrast with each light pass until no further development can be observed.

4.2.1.4.3 Excessive powder will cause a fill between the details. This fill can be removed with continued brush strokes until the impression is as free of extraneous powder as possible.

4.2.1.4.4 Extraneous residue on the surface may cause a general painting effect, which can obscure impression detail. A lift of the area can sometimes remove the extraneous residue and permit a second, higher quality application of powder that may offer better contrast between the impression and the background.

4.2.1.4.5 Review the item(s) for any developed impressions using an ALS with appropriate goggles.

4.2.1.4.6 Capture impressions for analysis and further examination.

4.2.1.4.7 If lifting is required, process with standard powder prior to lifting.

4.3 Powder, Magnetic

Powdering is the application of finely ground, colored powder to an item to make impressions visible. The powder binds to moisture, oil, and other residues. Magnetic powders are powder-coated, fine iron filings subject to magnetic attraction.

4.3.1 Preparations:

4.3.1.1 No specific preparations are needed as the powders are commercially prepared.

4.3.2 Instrumentation:

4.3.2.1 Magnetic applicators are required for application of the powder.

4.3.3 Minimum Standards and Controls:

4.3.3.1 Magnetic powder has an indeterminable shelf life; however, if clumping of the powder is observed, it shall be discarded.

4.3.3.2 Magnetic powder should not be exposed to high humidity or moisture as this may cause clumping of the powder. Store magnetic powder in a manner that minimizes this exposure.

4.3.4 Procedure or Analysis:

4.3.4.1 Pick up the magnetic powder with the end of the magnetic applicator.

4.3.4.2 Without touching the surface with the applicator, lightly and delicately move the powder over the surface. Impressions will develop in contrast with each light pass until no further development can be observed.

4.3.4.3 Excessive powder can sometimes be removed by passing the magnetic applicator, without powder, near the surface to pick up the extra powder.

4.3.4.4 Review the item(s) for any developed impressions.

4.3.4.5 Capture impressions for analysis and further examination.

4.4 Powder, Standard

Powdering is the application of finely ground, colored powder to an item to make impressions visible. The powder binds to moisture, oil, and other residues.

4.4.1 Preparations:

4.4.1.1 No specific preparations are needed as the powders are commercially prepared.

4.4.2 Instrumentation:

4.4.2.1 Brushes are required for application of the powder.

4.4.3 Minimum Standards and Controls:

4.4.3.1 Standard powder has an indeterminable shelf life; however, if clumping of the powder is observed, it shall be discarded.

4.4.3.2 Standard powder should not be exposed to high humidity or moisture as this may cause clumping of the powder. Store standard powder in a manner that minimizes this exposure.

4.4.4 Procedure or Analysis:

4.4.4.1 Coat the ends of the brush bristles with powder and gently tap several times to remove excess powder.

4.4.4.2 With the brush handle in a nearly perpendicular position to the surface, lightly and delicately move the bristle ends over the surface. Impressions will develop in contrast with each light pass until no further development can be observed.

4.4.4.3 Excessive powder will cause a fill between the ridges. This fill can be removed with continued brush strokes until the impression is as free of extraneous powder as possible.

4.4.4.4 Extraneous residue on the surface may cause a general painting effect, which can obscure impression detail. A lift of the area can sometimes remove the extraneous residue and permit a second, higher quality application of powder that may offer better contrast between the impression and the background.

4.4.4.5 Review the item(s) for any developed impressions.

4.4.4.6 Capture impressions for analysis and further examination.

4.5 Small Particle Reagent (SPR)

SPR contains molybdenum disulfide, which is sensitive to lipids that may be present in residue. Processing with SPR is effective on non-porous items that were previously wet and as a secondary treatment of cyanoacrylate ester processed items.

4.5.1 Preparations:

4.5.1.1 Follow the manufacturer's instructions for pre-mixed solutions.

4.5.1.2 Surfactant Stock Solution

Chemicals Required

- 8 mL Surfactant such as Photo-Flo or an equivalent
- 500 mL R/O or DI water

Directions

1. Dissolve Surfactant into R/O or DI water

4.5.1.3 SPR Suspension Working Solution

Chemicals Required

- 10 g Molybdenum Disulfide
- 50 mL Surfactant Stock Solution
- 900 mL R/O or DI water

Directions

1. Add Molybdenum Disulfide to Surfactant Stock Solution slowly and stir continuously. A mixture that is creamy and free of dry powder is ideal.

2. While stirring continuously, add the Disulfide mixture to R/O or DI water.

4.5.2 Instrumentation:

- 4.5.2.1 None noted.

4.5.3 Minimum Standards and Controls:

- 4.5.3.1 SPR Suspension working solution shall have a shelf life not exceeding one year or, for commercially available products, the manufacturer's shelf life recommendations.
- 4.5.3.2 Apply a test impression to a non-porous item similar to the evidence being processed. Follow the procedure listed below to process the test impression. If the test impression develops, the working solution can be used to process evidence.

4.5.4 Procedure or Analysis:

4.5.4.1 Immersion Application

- 4.5.4.1.1 Shake the working solution well and place it in a shallow tray that will allow for the item(s) to be completely submerged in the solution.
- 4.5.4.1.2 Stir the solution again before each item(s) is placed into the solution.
- 4.5.4.1.3 Place the item(s) in the solution as flat as possible in the tray.
- 4.5.4.1.4 Allow the item(s) to remain in the suspension for approximately 30 seconds. The molybdenum particles will settle on the item(s).
- 4.5.4.1.5 Turn the item(s) over and allow it to remain in the suspension for approximately 30 seconds.
- 4.5.4.1.6 Repeat procedure until all item(s) surfaces have been exposed to the solution.
- 4.5.4.1.7 Place the item(s) in a tray of water and rock the tray or flow water through the tray to remove excess SPR.

4.5.4.2 Wash Bottle Application

- 4.5.4.2.1 Spray a flow of SPR over the surface of the item(s).
- 4.5.4.2.2 Wash the surface of the item(s) with a light to moderate flow of water.
- 4.5.4.2.3 Allow the item(s) to dry.
- 4.5.4.2.4 Review the item(s) for any developed impressions.
- 4.5.4.2.5 Faint impressions may benefit from re-processing.
- 4.5.4.2.6 Capture impressions for analysis and further examination.
- 4.5.4.2.7 SPR lifts easily from dried, processed, non-porous surfaces.

4.6 Sticky Side Powder (SSP)

SSP consists of powder in suspension that binds to moisture, oil, and other residues. The suspension provides an effective delivery system for the powder.

4.6.1 Preparation:

4.6.1.1 SSP Working Solution

Chemicals Required

- Photo-Flo 200 or Surfactant
- R/O or DI water
- Sticky Side or other similar powder

Directions

1. Combine the Surfactant and R/O or DI water at a ratio of 1:1.
2. Add Sticky Side or other powder to the solution and stir until the mixture is a consistency of thin paint.

4.6.2 Instrumentation:

4.6.2.1 A soft-bristle brush could be used for application.

4.6.3 Minimum Standards and Controls:

4.6.3.1 SSP should be prepared as needed.

4.6.3.2 Apply a test impression on a surface similar to the evidence being processed. Follow the procedure listed below to process the test impression. If the test impression develops, the working solution can be used to process evidence.

4.6.4 Procedure or Analysis:

4.6.4.1 Immerse the item(s) in the suspension or paint the suspension on the sticky side of the tape using a soft bristled brush.

4.6.4.2 Allow the suspension to remain on the item(s) for approximately 10 seconds.

4.6.4.3 Remove the item(s) from the suspension and rinse excess suspension from the item(s) with a gentle flow of cold R/O or DI water.

4.6.4.4 These steps can be repeated to improve contrast.

4.6.4.5 Review the item(s) for any developed impressions.

4.6.4.6 Capture impressions for analysis and further examination.

4.7 Wetwop™/ Wet Powder Solution

WetWop™ consists of powder in suspension that binds to moisture, oil, and other residues. The suspension provides an effective delivery system for the powder.

4.7.1 Preparation:

4.7.1.1 Follow manufacturer's recommendations for any preparation.

4.7.1.2 Instrumentation:

4.7.1.2.1 A soft-bristle brush may be used for application.

4.7.2 Minimum Standards and Controls:

4.7.2.1 The manufacturer's shelf-life recommendations shall be followed.

4.7.3 Procedure or Analysis:

4.7.3.1 Immerse the item(s) in the suspension or paint the suspension on the sticky side of the tape using a soft bristled brush.

4.7.3.2 Allow the suspension to remain on the item(s) for approximately 10 seconds.

4.7.3.3 Remove the item(s) from the suspension and rinse excess suspension from the item(s) with a gentle flow of cold R/O or DI water.

4.7.3.4 These steps can be repeated to improve contrast.

4.7.3.5 Review the item(s) for any developed impressions.

4.7.3.6 Capture impressions for analysis and further examination.

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5 PRESERVATION TECHNIQUES

5.1 Introduction

- 5.1.1 All lifts, photographs, digital media, images and negatives received from an outside agency shall be treated as evidence and returned to the submitting agency.
- 5.1.2 All lifts and images made of impressions, developed by the Laboratory on items of evidence shall be treated as evidence and returned to the submitting agency.
- 5.1.2.1 Digital media (CD or DVD) containing original impressions shall be designated DM1, DM2, etc.
- 5.1.2.2 For instances where impressions were developed on more than one item, the digital media shall be returned with the first item on which the impressions were developed.
- 5.1.2.3 The examiner shall verify and document that the appropriate images are on the media.
- 5.1.2.4 The packaging for the digital media shall be sealed and labeled with the FS lab number, examiner's initials and items numbers associated with the impressions.
- 5.1.3 Lifts shall be sub-itemed according to the evidence from which the impression was removed. These sub-items shall be added to the RFLE and created in LIMS.
- 5.1.4 Photographs or digital images which serve as examination documentation shall be retained. Original and clarified images shall be retained on a CD/DVD with the case file in order to preserve the history log of clarification steps.
- 5.1.5 Digitally capture all impressions prior to lifting.

5.2 Digital Imaging

5.2.1 Introduction

Footwear and tire impression evidence may have inherent limitations due to substrate features, quality of the original impression, and method of collection, that affect the quality of the digital capture obtainable.

5.2.2 Minimum Standards and Controls

- 5.2.2.1 A rigid L-shaped or 90° scale shall be placed along the length of the impression on the same plane as the bottom of the impression. For long tire impressions, in addition to a rigid scale, a long tape measure may be placed along the full length of the impression being captured.
- 5.2.2.2 All images shall include the following, either in the image or electronically associated with the file.
- Scale
 - FS Lab #
 - Examiner and photographer initials
 - Item / sub-item designation

5.2.3 Procedure

5.2.3.1 Capture

- 5.2.3.1.1 It is not necessary to capture footwear and tire impressions at 1000ppi. It is acceptable to capture small areas at 1000 ppi if necessary due to the quality of the impression.
- 5.2.3.1.2 For digital camera capture utilize the TIFF Large setting.
- 5.2.3.1.3 For scanning utilize 24 bit color or 8 bit gray scale settings.
- 5.2.3.1.4 If the entire lift, cast or object is captured it is not necessary to mark the area of interest on the evidence. If sections of the lift, cast or object are captured, either through photography or scanner, then the area of interest shall be indicated by marking the item of evidence with a bracket or outline and the impression designation. The impression designation is the number followed by the letters FW, TT or PI and the impression #.

5.2.3.2 Clarification

- 5.2.3.2.1 The original and the final version of the image shall be retained with the examination documentation. The images shall be saved to a CD/DVD to allow for the retention of the history log file of the clarification techniques used.
- 5.2.3.2.2 If utilizing Adobe Photoshop to clarify an image, the below log options shall be set as follows:
 - Choose Edit>Preferences>General
 - Check the “History Log” option (a checkmark must appear in the check box to enable the History Log)
 - Select “Both” for “Save Log Items To” option
 - Select “Detailed” option for the “Edit Log Items”
 - Click OK to save settings

5.2.4 Interpretation of Results

Compare captured image to original impression to ensure necessary detail is present.

5.3 Electrostatic Dust Lifter

5.3.1 Introduction

Electrostatic dust lifters allow for impressions to be lifted from various surfaces and preserved for examination. The electrostatic dust lifter can be used at the crime scene as well as in the laboratory. It is used primarily to lift dry origin impressions.

5.3.2 Preparation

The unit must be adequately charged before each use or contain a battery, and a good supply of unused lifting film should be stocked.

5.3.3 Instrumentation

There are several versions of electrostatic dust lifters manufactured by different companies. Some of the units are equipped with a convenient carrying case, capable of storing an adequate supply of lifting film, a roller, flashlight and a measuring device, for your convenience. Some units are smaller hand-held units and are just as effective.

5.3.4 Minimum Standards and Controls

If required, the electrostatic units must be sufficiently charged prior to use. Observation of the mylar being compressed during use will serve as a positive indication. The lifting film must be free of dust and other contaminants prior to use.

5.3.5 Procedure

5.3.5.1 Locate the impression to be lifted.

5.3.5.2 Cut a piece of lifting film that is larger than the impression.

5.3.5.3 Place the lifting film over the impression, black side down against the impression and the metalized side will face up.

5.3.5.4 Ensure the unit is properly grounded per the instructions of the particular unit.

5.3.5.5 Place the probe on the lifting film to charge the lifting film. Use a roller to smooth the lifting film allowing it to come in contact with the impression.

5.3.5.6 Turn off the unit and wait several seconds for the film to discharge. Remove the film from the evidence by lifting one end and rising to the other end. Do not slide the film across the evidence.

5.3.5.7 Photograph the impressions that are present on the lifting film to preserve the impression. Caution must be exercised when handling and packaging the lifting film to avoid destroying the dust impression.

5.3.6 Interpretation of Results

If the impressions are faint, photography can enhance and preserve the impression using various photographic techniques.

5.4 Lifts/Casts

5.4.1 Introduction

Adhesive coated materials or tapes can be used to lift impressions from surfaces. Lifts can be made of dust or residue impressions, wet origin impressions, and impressions developed with fingerprint powder.

Casting materials can be used to recover two-dimensional impressions and three-dimensional impressions. Casts can be made of impressions developed with fingerprint powder on two-dimensional surfaces and impressions made in pliable substrates.

5.4.2 Preparation

The substrate, components of the impression, and environmental conditions should be considered prior to selecting a lifting method.

5.4.3 Equipment

- Gelatin lifters
- Static lifts
- Adhesive lifters
- Fingerprint lifting tape
- Dental stone or other casting material
- Silicone (such as Mikrosil™)

5.4.4 Minimum Standards and Controls

5.4.4.1 Ensure the lifting material is free from foreign material prior to applying to the impression.

5.4.4.2 Label the lifts and casts with the case number, item number, date and initials.

5.4.4.3 All lifts and casts shall be digitally captured and compared to the original to ensure all detail was captured adequately.

5.4.4.4 All lifts and casts shall be treated as evidence and handled according to the Quality Manual.

5.4.5 Procedure - Gelatin Lifters

5.4.5.1 Select the appropriate color of lifting material.

5.4.5.1.1 White gel lifters provide greater contrast with impressions enhanced with dark colored powders or residue impressions.

5.4.5.1.2 Black gel lifters provide greater contrast with light colored powders or residue impressions.

5.4.5.1.3 Clear gel lifters normally do not provide good contrast.

5.4.5.1.4 Lift the impression and adhere the appropriate backing or protective material.

5.4.5.1.5 Digitally capture without the acetate cover, whenever possible.

5.4.6 Procedure – Adhesive Lifters

5.4.6.1 Adhesive lifters are an option for lifting impressions developed with dark colored powder, however they are not recommended for lifting dust or residue impressions.

5.4.6.1.1 White backgrounds are recommended for clear adhesive lifters.

5.4.6.1.2 Clear adhesive on a clear background is not recommended.

5.4.6.2 Cut the lifting material to a size that will adequately cover the area of interest. It is preferable to lift the entire impression with one piece of lifting material.

5.4.6.3 Lift the impression and adhere the appropriate backing or protective material.

5.4.6.4 Digitally capture without the acetate cover, whenever possible.

5.4.7 Procedure – Static Lifts

5.4.7.1 Recommended for lifting dust impressions.

5.4.7.1.1 Peel off white backing to activate the charge.

5.4.7.1.2 Lay lift over impression, holding or taping one end down.

5.4.7.1.3 Apply pressure evenly using a roller or hand.

5.4.7.1.4 Lift and store in a manila folder or tape inside a cardboard box.

5.4.8 Procedure – Rigid Casting

5.4.8.1 Dental stone or other similar material can be used to lift impressions such as mud and tire residues from surfaces such as concrete and tile.

5.4.8.1.1 Mix according to instructions or recommended ratio for the product.

5.4.8.1.2 Place a cardboard frame around the impression.

5.4.8.1.3 Pour a thick layer of dental stone over the impressions area and lift when dry.

5.4.8.1.4 Do not clean cast of a 2-dimensionl residue impression.

5.4.9 Procedure – Flexible Casting

5.4.9.1 Silicone such as Mikrosil™ can be used to lift impressions enhanced with powder from any surface, particularly textured surfaces.

5.4.9.1.1 Mix according to instructions and apply an even coating of the material over the impressions and lift when material has cured. Consult the manufacturer's recommendation for curing times.

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6 KNOWN STANDARDS

6.1 Introduction

Various techniques are non-destructive and not sequence dependent; it is at the examiner's discretion to choose the appropriate technique, and continue to apply additional techniques as necessary to maximize results. The recording of known standards for footwear and tire tread design can be accomplished using these procedures. Known standards provide a recording of the characteristics already present on the outsole of a footwear or tire. The quality of the comparison directly relates to the quality of the known. It is not required to create known standards if the images of the outsole or tire tread are sufficient for comparison.

6.2 Preparation

Prior to making known standards, preserve trace evidence and digitally capture the original condition of the outsole or tire.

6.2.1 Dental Stone

6.2.1.1 Mix according to instructions or recommended ratio for the product

6.2.2 No specific preparations are needed for commercially prepared products.

6.3 Procedure

6.3.1 A minimum of two known standards shall be created using two different methods. (e.g., dynamic vs. static, gel lifter vs. adhesive lifter).

6.3.1.1 Compare the known standards to each other and document if the characteristics are reproducing.

6.3.1.2 Verification is not required for standard to standard comparison.

6.3.2 Footwear Known Standards

6.3.2.1 Footwear known standards should record fine detail with good contrast and be suitable for use in the comparison process.

6.3.2.2 Document the footwear brand, model, size and tag information, if available, in the examination documentation.

6.3.2.3 Initial known standards should be made of the entire footwear.

6.3.2.4 Excess dirt should be removed from the footwear with care so as not to damage the outsole.

6.3.2.5 Document which of the below techniques were used to create the standard.

6.3.2.5.1 Gel Lifter

6.3.2.5.2 Adhesive film and fingerprint powder

6.3.2.5.3 Identicator® or other inkless technique

6.3.2.5.4 Silicone spray, wipes or other suitable substance and magnetic fingerprint powder

6.3.2.5.5 BIO-FOAM® and dental stone

6.3.3 Tire Known Standards

- 6.3.3.1 Known standards should record the full rotation of the tire. Documentation for not recording the full rotation shall be included in the notes.
- 6.3.3.2 Excess dirt should be removed from the tire with care so as to not damage the tread.
- 6.3.3.3 Methods for making tire impressions should record fine detail with good contrast and be suitable for use in the comparison process.
- 6.3.3.4 Document tire brand, make, size, DOT number, and other relevant information in the examination documentation.
- 6.3.3.5 Petroleum jelly or silicone wipes on chart board with magnetic fingerprint powder
- Prepare two pieces of chart board, each of sufficient length to record a full rotation of the tire.
 - Apply a light coat of chosen substance on the tire surface.
 - Roll the tire over chart board.
 - Label the chart board with relevant information regarding tire, position and direction of travel.
 - Develop the impression with magnetic fingerprint powder.
- 6.3.4 Known standards for elimination can include any of the methods listed above, or any other method suitable for recording design detail. Photography is suitable to record the design detail for some elimination conclusions.
- 6.3.4.1 Proposed significant deviations from methods of recording known standards in this manual must be presented to the TRT for evaluation and Program Manager for approval.

6.4 Interpretation of Results

Compare known standard to actual item to ensure adequate detail was captured for comparison purposes.

7 IMPRESSION EXAMINATION

7.1 Introduction

- 7.1.1 Impressions shall be digitally captured and images retained as examination documentation.
- 7.1.2 Impression examinations are conducted using the analysis, comparison, evaluation and verification methodology, utilizing both qualitative and quantitative analysis.
- 7.1.3 The right and left footwear shall be treated as separate objects and the results shall be recorded for each analysis, comparison and evaluation separately, as applicable.
- 7.1.4 If it is not possible to examine the original evidence, then examinations may be performed with the examination documentation images existing in the case file after a protocol deviation is approved as outlined in the Quality Manual.
- 7.1.5 Impressions captured for analysis shall be designated by a number. When possible, multiple and overlapping impressions shall be designated by a separate impression number for each impression.
- 7.1.6 For submitted digital media, create and retain a contact sheet with each file name and its associated sub-item designation, as applicable.

7.2 Procedure

- 7.2.1 Lifts
 - 7.2.1.1 Photograph using appropriate lighting, which may include, but is not limited to, oblique lighting, alternate light sources, or ambient light.
- 7.2.2 Submitted Digital Media
 - 7.2.2.1 Document the number and type of files on the media. Create a contact sheet of all images on the media, Document the file name and designate the sub-item number of the images that will be examined. Images not examined do not require a sub-item number.
- 7.2.3 Dental Stone Casts
 - 7.2.3.1 Clean with a soft brush and water to remove extraneous material, taking care not to damage the cast impression. If other techniques are utilized it shall be documented. Casts shall be photographed.

7.3 Analysis

Examine the questioned footwear or tire impressions prior to the knowns to determine if there are sufficient gross design features and clarity to conduct a comparison.

- 7.3.1 Document the following:
 - 7.3.1.1 Full or Partial impression.
 - 7.3.1.1.1 Full footwear impression; toe to heel with the medial and lateral sides visible.
 - 7.3.1.1.2 Full tire impression; shoulder to shoulder visible. Record the number of Ribs and Grooves.
 - 7.3.1.1.3 Partial footwear impression; Toe, Forefoot Arch area, Heel or Unknown.

7.3.1.1.4 Partial tire impression; number of Ribs and Grooves.

7.3.1.2 Design elements.

7.3.1.3 Quality of the impression.

7.3.1.3.1 Excellent - little to no distortion, characteristics are clearly defined, high clarity

- Footwear - able to determine right footwear or left footwear and the area of outsole
- Tire - discernable characteristics, discernable noise treatment, shoulder to shoulder, sipes present

7.3.1.3.2 Moderate – slightly distorted, characteristics discernable

- Footwear – able to determine area of outsole
- Tire – partial noise treatment, discernable elements in the ribs and visible groves

7.3.1.3.3 Limited – heavily distorted, characteristics are difficult to determine, improper recovery technique

- Footwear – unable to determine area of outsole
- Tire – elements are not clearly defined, able to determine distinct ribs and groves

7.3.1.3.4 Poor – lacks quantity and quality of class characteristics

7.3.2 Possible analysis conclusion

7.3.2.1 Value for Comparison –Sufficient characteristics to allow for a full range of conclusions.

7.3.2.2 Not of Value for Comparison – Lacks reliable characteristics needed to draw a comparison conclusion.

7.3.2.3 Limited Specificity for Comparison - Lacks specificity of characteristics present in the impression for comparison conclusions other than limited association based on design or exclusion.

7.4 Comparison

7.4.1 Visually compare questioned impressions with known item.

7.4.2 Visual comparison of design

7.4.2.1 If design is different, document, discontinue these procedures, and report accordingly.

7.4.2.2 If design is similar, prepare a known standard and continue with these procedures.

7.4.3 Comparisons of the questioned impressions are done with the known item, an image of the known item, known standard(s) and/or overlays of the known standard.

7.4.3.1 The image(s) of the known item shall accurately depict all characteristics that support the conclusion.

7.4.4 Compare the physical size of the impression and the physical size and shape of the design elements.

7.4.4.1 Annotate the size and shape of design features present.

7.4.4.2 If specific design and/or physical size and shape of design, to include noise treatment (pitch sequence) of tires, are different, document, discontinue these procedures, and report accordingly.

7.4.4.2.1 If physical size is different, consider scaling, perspective and other issues.

7.4.5 Compare the wear marks

7.4.5.1 Document the degree of wear, general wear, holes, position and orientation of wear, specific location of wear, and tears, if present.

7.4.5.2 If the position and degree of wear are different, document and evaluate possible wear changes between date of crime and date footwear or tires were recovered.

7.4.5.3 If the position and degree of general wear corresponds, continue with procedure.

7.4.6 Compare the randomly acquired characteristics

7.4.6.1 Document randomly acquired characteristic such as; cuts, scratches, tears, holes, stone holds, abrasions and the acquisition of debris from random events, if present.

7.4.6.1.1 Documentation shall include the position, orientation, size and shape of the randomly acquired characteristics that contribute to the conclusion.

7.4.6.1.2 Due to varying circumstances, not all randomly acquired characteristic will reproduce in every impression. Therefore, the absence of a randomly acquired characteristic is not a basis for elimination and does not preclude identification.

7.5 Evaluation - Conclusions

The following conclusion opinions are reached in impression examinations.

7.5.1 Elimination (definite exclusion)

Sufficient differences were noted between characteristics. Known footwear or tire was not the source and did not make the questioned impression.

7.5.2 Indications of non-association

The questioned impression contains dissimilarities when compared to the footwear or tire, however, certain details or features were not sufficiently clear to permit elimination.

7.5.3 Limited association of class characteristics

Some similar class characteristics are present; however, there are significant limiting factors in the questioned impression that do not permit a stronger association between the impression and a known. Factors may include, but are not limited to, insufficient detail, lack of scale, improper position of scale, improper photographic techniques, distortion or significant lengths of time between the date the incident occurred and when the footwear or tires were recovered that could account for a different degree of general wear. Some association is observed, however details available for comparison preclude a more discriminating conclusion. No confirmable differences were observed that could eliminate the footwear/tire.

7.5.4 Association of class characteristics

The class characteristics of design, physical size and shape correspond between the questioned impression and the known footwear/tire. Correspondence of general wear may be present. The known

footwear/tire is a possible source of the questioned impression; however, other footwear/tires with the same class characteristics are included as possible sources.

7.5.5 High degree of association

Observable correspondence of class characteristics with the existence of 1) wear that by virtue of its specific location, degree and orientation, make it unusual and/or 2) one or more randomly acquired characteristics. The characteristics observed exhibit strong associations indicating the known footwear/tire is the source of the impression but are insufficient for identification. Other footwear/tires with the same characteristics could be included as the possible source only if they also display the same wear and/or randomly acquired characteristics observed in the questioned impression.

7.5.6 Identification

The questioned impression and the known footwear/tire share sufficient agreement of observable class and randomly acquired characteristics to conclude the known footwear/tire was the source of the questioned impression.

7.5.7 Inconclusive

Insufficient detail is present in the questioned impression and/or known standard to reach a conclusion of identification, exclusion or association.

7.6 Documentation Requirements

7.6.1 Uniquely label each area of interest that was analyzed. See below for examples.

1FW1 would be used for Item 1 Footwear Impression 1
 2TT2 would be used for Item 2 Tire Track Impression 2
 3PI3 would be used for Item 3 Pattern Impression 3

7.6.2 Document characteristics observed during the examination process that support conclusions.

7.6.3 The examiner shall label the images used to perform the comparison with the conclusion, date the examination was complete and their initials.

7.6.4 The following are suggested formats for annotations:

- a circle is drawn around a specific feature with a written explanation of the feature
 - the written explanation should include the description of the class characteristics such as design, size or wear
- draw an outline around or brackets on each side of each impression to indicate the area that was analyzed and examined to render the reported conclusion

7.6.5 If known footwear/tires are excluded as a source of the questioned specimen, an examination quality recorded copy of the outsole design or tread pattern must be maintained in the case documentation.

7.6.6 Examination documentation must acknowledge impressions which were not analyzed, compared or evaluated.

7.7 Verification

Verification is the independent analysis, comparison and evaluation of a questioned impression with the known item, an image of the known item, the known standard and/or known overlays. The primary examiner shall provide unmarked examination quality images.

- 7.7.1 All comparison conclusions shall be verified by another examiner.
 - 7.7.1.1 Verifications shall be documented on the applicable Impression Verification form(s).
 - 7.7.1.2 The verifying examiner shall mark the characteristics used to render the conclusion on the images of the known and questioned impressions.
 - 7.7.1.3 The verifying examiner shall label the images used to perform the comparison with the conclusion, date the examination was complete and their initials.
- 7.7.2 Verifications must be completed prior to communicating the information to the submitting agency, either verbally or in writing.

7.8 Review of “No Value” and “Limited Specificity” Impressions

- 7.8.1 A qualified examiner shall review all impressions that the examiner deemed No Value or Limited Specificity for Comparison. The review shall be documented in the examination documentation to include agreement/disagreement, date of review, and reviewer's initials.

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8 FOOTWEAR AND TIRE TREAD REFERENCE MATERIAL

8.1 Introduction

- 8.1.1 Footwear and tire tread reference material can be used to determine the manufacturer's name and model associated with an unknown impression.
- 8.1.2 The examination documentation shall include the specific reference material used to reach the reported conclusion.
- 8.1.3 The results of the all searches shall be included on the CoA and the information retained as examination documentation. If the search results in a possible manufacturer, a printout shall be included with the examination documentation and provided with the CoA.
- 8.1.4 It is not required to search an impression that contains a common class characteristic that would yield results that lack specificity to determine a manufacturer.

8.2 Procedures

8.2.1 Tread Design Guide

- 8.2.1.1 The information is categorized alphabetically by manufacturer and is divided into tire types (i.e., passenger tires, small highway and light truck tires, medium and large highway truck tires, off-the-road, agricultural, ATV, motorcycle and truck retread designs).

8.2.2 SoleMate®

- 8.2.2.1 The selection of the shape coding in the SoleMate ® software can affect the result of the search. If a potential match is not located, additional searches shall be performed.

8.2.2.1.1 A minimum of three searches shall be performed when a potential match is not found.

- 8.2.2.2 A printout depicting the search parameters and potential matches for each search shall be retained in the casefile.

- 8.2.2.3 If a potential match is not located in the SoleMate ® database, another qualified examiner shall perform at least one search.

8.2.2.3.1 In an instance where the second examiner locates a potential match, the first examiner will review the search results and report the appropriate conclusion.

8.2.2.3.2 Documentation associated with the second examiner's search shall be retained in the casefile.

8.2.3 Retail re-sellers

- 8.2.3.1 On-line or physical stores are acceptable resources to locate a manufacturer of an unknown footwear outsole and tire tread patterns.

- 8.2.3.2 Websites searched/physical stores visited and the results shall be included in the examination documentation.

9 REPORT WORDING

9.1 Introduction

Utilize the following report formats to the extent possible when reporting results to ensure consistency within the section. Specific report language cannot be provided to address all situations; the following examples should be used when appropriate. When drafting report wording for evidence types not listed or when specific examples do not appear for a particular type of evidence, look first to existing wording that may be applied to the current situation. If a situation is so unusual that appropriate report wording is not available in the manual, it is expected that the Section Supervisor / Examiner shall consult with other Section Supervisors / Examiners for wording that may have been previously applied to the situation, with the Physical Evidence Program Manager and/or the Director of Technical Services.

The Certificate of Analysis (CoA) shall include in the report statement the types of examinations that were conducted to reach the stated conclusions.

9.2 Guidelines

- 9.2.1 CASE INFORMATION:** Agency name, name of investigating officer, laboratory case number, agency case number, victim(s), suspect(s), and additional information found on the Request for Laboratory Examination form.
- 9.2.2 EVIDENCE SUBMITTED:** A listing and description of items as received from an agency.
- 9.2.3 RESULTS:** A summary of the pertinent information relating to the examination, analysis and conclusions of Items listed. The **COMPARISON RESULTS** section of the CoA shall be sub-sectioned into the following three parts, as applicable:
- If no impressions were recovered, it is not required to include the **ANALYSIS** and **COMPARISON RESULTS** section.
 - If after analysis there are no impressions of value for comparison, it is not required to include the **COMPARISON RESULTS** section.
- 9.2.3.1 PROCESSING AND EXAMINATION:** This section details the processing examinations (e.g., visual, chemical and/or physical) and results for each item. The results shall include the number of impressions recovered or designated from each item.
- 9.2.3.2 ANALYSIS:** This section provides details related to the analysis conducted on each impression.
- The designated number is the Item number followed by the letters “FW”, “TT” or “PI” and a number which is sequential for the series of impressions captured on the item.
- Examples:
- Three footwear impressions are preserved on Item 3-5; the impressions would be designated 3-5 FW1, 3-5 FW2, and 3-5 FW3
 - Four tire track impressions are preserved on Item 5383; the impressions would be designated 5383 TT1, 5383 TT2, 5383 TT3, and 5383 TT4
- 9.2.3.3 COMPARISON RESULTS:** This section details the comparisons and evaluations of the impressions designated as of value for comparison in the Analysis section.

9.3 Wording Examples

The italicized portions in the proposed statements are examples.

There is no need to further describe the item beyond the number as that information is available in the evidence lists. It is acceptable to include the description again in the processing section if deemed necessary for clarification.

9.3.1 **PROCESSING AND EXAMINATION:** Statement of the processing and examinations performed on the Item(s)

9.3.1.1 The below can be used for an item that was visually examined with no processing techniques applied.

No patterned impressions were visible on *Item 1*.

No impressions of value for comparison are visible on *Item 2*, therefore no comparisons were made with *Item 3*.

Item 4 was visually examined, no impressions were located and no further processing was done due to the surface not being suitable.

9.3.1.2 The below can be used for an item that was physically and/or chemically processed with the intent to develop or clarify an impression.

Item 1 was visually examined and chemically processed. The *footwear* impression developed on *Item 1* may be of value for comparison. Known *footwear* or known standards should be submitted for comparison.

Item 1 was visually examined, chemically processed, viewed with an alternate light source and then physically processed. No impressions were observed or developed on *Item 1*.

9.3.1.3 The below can be used for submitted knowns.

Item 1 (known footwear/tire) was visually examined, digitally captured, utilized to create known standards (*sub item #s*) and used for comparison.

9.3.1.4 The below can be used when impression detail is visible but is of no value for comparison:

No impressions of value for comparison were observed and/or developed.

9.3.1.5 The below can be used when no impression detail is visible:

No impressions were observed and/or developed.

9.3.1.6 The below can be used when impressions are captured. The number of impressions captured shall be documented for each item processed:

One tire impression was lifted.

Two footwear impressions were digitally captured.

Five tire impressions were lifted and/or digitally captured.

9.3.1.7 The below can be used when impressions were captured or submitted, but were not analyzed.

The remaining impressions were not analyzed.

9.3.1.8 The below can be used for images on submitted digital media.

9.3.1.8.1 *Item 1*, disc, contained images designated *1A thru 1E*. The images were visually examined and not used for comparison.

9.3.1.8.2 *Item 1*, disc, contained images *1A thru 1E*. The images were visually examined and three contain impressions which were designated *1FW1, 1FW2 and 1FW3* for analysis. The remaining images did not contain impressions or were not suitable for analysis due to lack of visible detail.

9.3.2 **ANALYSIS:** Result statement for the analysis performed on each impression preserved and documented in the **PROCESSING AND EXAMINATION** section.

9.3.2.1 The below can be used when an impression is determined to be of value for comparison:

Item 1 – Three impressions of value for comparison have been designated *1 FW1, 1 FW3 and 1 FW5*.

9.3.2.2 The below can be used when preserved impressions were determined to be of no value for comparison:

Item 2 – the impressions captured were analyzed and determined to be of no value for comparison.

Item 2 – the impressions submitted were analyzed and lack sufficient detail for comparison.

9.3.3 **COMPARISON RESULTS:** Statements related to the comparison results of the impressions designated to be of value for comparison. This section shall be organized by impression number.

9.3.3.1 Identification

The *1FW1* impression was made by the *Item 2 right shoe* based on sufficient agreement of observable class and randomly acquired characteristics.

9.3.3.2 Elimination

Sufficient differences were noted between the characteristics present in the *footwear* impression on *Item 2* and those present on *Item 5* to conclude that the impression was not made by *Item 5*.

Sufficient differences were noted between the characteristics present in the *tire* impression on *Item 3* and the *tire* producing the *Item 6* known standard to conclude that the impression was not made by *Item 6*.

9.3.3.3 Inconclusive

The comparison of *Item 5 footwear* impression to the *Item 6 left footwear* is inconclusive; the impression could not be associated with or excluded from the submitted footwear due to insufficient detail present in the impression.

9.3.3.4 Indications of non-associations

The impression in *Item 3* exhibits dissimilarities when compared to the *Item 6 left footwear*, however, certain details or features are not sufficiently clear to permit an elimination.

9.3.3.5 Limited association of class characteristics

The class characteristics present in the *tire* impression on *Item 5* are similar to those present in the *Item 6 tire*, however, due to *distortion* present in the known standard of *Item 6* a more discriminating examination cannot be performed. There are no confirmable differences that would exclude the *Item 6 tire* from being the source of the *Item 5* impression. Other *tires* with the same characteristics could be the source of the impression if they also display the same wear and randomly acquired characteristics observed in the impression.

9.3.3.6 Association of class characteristics

The general wear and class characteristics present in *Item 6 left footwear* correspond with design and physical size of the characteristics present in the *Item 8* impression, therefore *Item 6* is a possible source of the *Item 8* impression. Other footwear with the same class characteristics could have been the source of the *Item 8* impression.

9.3.3.7 High degree of association

The specific location, degree and orientation of the wear present in the *Item 9 tire* corresponds with the wear present in the *Item 10* impression. In addition to the wear correspondence there exist randomly acquired characteristics in both the *Item 9* tire and the *Item 10* impression that indicate a strong association that the *Item 9 tire* is the source of the *Item 10* impression but the characteristics are insufficient for an identification. Other *tires* with the same characteristics could be the source of the impression if they also display the same wear and randomly acquired characteristics observed in the impression.

9.3.4 Multiple Case Associations/ Cross-Comparisons

9.3.4.1 As requested, *Item 1* was compared to *Item 2* submitted under *FS Lab # C12-xxxx (Richmond PD Case# 12-yyyy)*.

- The comparison results, as outlined in the previous section, should be inserted here.

9.3.4.2 The three impressions submitted as *Item 1, 3 and 4* under *FS Lab #C12-xxxx* were previously reported as, (*insert comparison result*). The below listed items were examined, compared to *Item 1* and (*insert comparison result*).

The *Item 6* impression lift submitted by your agency case # *2012aaaa*, *FLS Lab # C12-xxxx*.
The *Item 54* impression lift submitted by *Hampton PD* case # *2012bbbb*, *FLS Lab # C12-yyyy*.

9.3.5 **TERMINUS STATEMENTS:** All reports shall conclude with an applicable statement listed in each of the below sections.

9.3.5.1 The following statement shall be included on all reports:

Date(s) of Testing: mm/dd/yyyy – mm/dd/yyyy

Supporting examination documentation is maintained in the case file. The above listed methods are those approved for use at the time of analysis. Current methods can be found in the Impressions – Footwear and Tire Tread Procedure Manual, which can be found at www.dfs.virginia.gov/documentation-publications/manuals/.

9.3.5.2 Request for known samples

The known *footwear* should be submitted for a conclusive comparison of the *Item 1* impression.

9.3.5.3 Brand/Manufacturer search

The questioned *tire* impression was determined to be a *Firestone* or any other brand of *tire* with a similar *tread* design. An image of the *tire tread* design is enclosed.

The manufacturer of the questioned *footwear* impression could not be determined.

I FWI was not suitable for manufacturer searching due to lack of specificity of characteristics present in the impression.

9.3.5.4 Photographs / digital images / known standards

The returned digital media, *Item DMI*, contains images of impressions captured from *Item 1, 3 and 6*. This item of evidence is being returned in *container 2* and should be retained. Should further comparisons be required, *DMI* must be resubmitted.

9.3.5.5 Disposition of evidence

Document the disposition in the CoA according to the Quality Manual.

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10 QUALITY ASSURANCE

10.1 Introduction

The purpose of this section is to provide a uniform Quality Assurance Program for the Impression Section of the Virginia Department of Forensic Science. It is to establish a baseline or reference point of reliability and system performance.

10.2 Reagents

- 10.2.1 Chemicals and solvents used in reagents should be of at least Certified Analytical Reagent ACS grade. Water used in reagent preparation should be reverse osmosis (RO) or deionized (DI), unless otherwise noted.
- 10.2.2 Commercially purchased reagents are an approved alternative to laboratory prepared reagents. However, they still must meet the minimum QA/QC requirements for that particular reagent.
- 10.2.3 Stock solutions shall be labeled according to the Quality Manual and documented in the Reagent Preparation Log.
- 10.2.4 A performance check, ensuring the reagent is working as intended, shall be performed and appropriately documented in the examination documentation prior to use on evidence.
- 10.2.4.1 The result of the check shall be recorded.
- 10.2.4.1.1 “Positive” or “+” indicating the reagent is working as intended.
- 10.2.4.1.2 “Negative” or “-“ indicating the reagent is not working as intended.

10.3 Test Strip Preparation

- 10.3.1 Dissolve 1 gram of Noreleucine in 100 mL of warm water. Saturate blotter paper with solution. Allow paper to air dry and then cut into strips. The test strips shall be stored in a bottle and have a shelf life not exceeding two years.

10.4 Powders

- 10.4.1 Powders should be of a homogenous mixture, free of clumps and foreign debris. Contaminated powders shall not be returned to stock containers.
- 10.4.2 Individual hair (or fiber) brushes should be used for different colors or types of powders.

10.5 Evidence Handling

Evidence packaging and evidence shall be documented and marked as outlined in the Quality Manual.

10.6 Equipment

- 10.6.1 Balances
- 10.6.1.1 Balances shall be calibrated by an outside vendor annually that is accredited to ISO/IEC 17025 and whose scope of accreditation covers the calibration performed. New balances shall be calibrated prior to being placed into service. Calibration certificates shall be evaluated by the Section Supervisor, Group Supervisor, or designee prior to placing the balance into service.
- 10.6.1.2 All balances shall be performance checked quarterly (every three months) for accuracy using ASTM Class 1 weights.

10.6.1.2.1 Weights used to check balance accuracy shall be re-certified every three years by an ISO/IEC17025 accredited vendor whose scope of accreditation covers the certification performed.

10.6.1.3 Record the weight displayed on the balance using the Latent Print Balance Log form 241-F104.

10.6.1.4 If the accuracy of a weight is outside the acceptable range listed in the table below, ensure the balance is level and clean prior to rechecking. If, after these actions, the weight check is still outside the acceptable range it shall be taken out of service and labeled as such until maintenance and/or calibration is performed by a qualified vendor.

BALANCE TYPE	BALANCE EXAMPLES	CHECK WEIGHTS
Toploading (± 0.01) gram	Mettler PE 1600 Mettler PB302 Ohaus Scout Pro SP202 Sartorius BP21005	1.00 (± 0.02) gram, 10.00 (± 0.05) grams, 100.00 (± 0.05) grams
Toploading (± 0.001) gram	Ohaus Explorer Mettler PB303	0.100 (± 0.002) gram 1.000 (± 0.002) gram 100.000 (± 0.05) grams

10.6.1.5 Records of calibration and performance check shall be maintained in the equipment maintenance log.

10.6.2 Environmental Chambers

10.6.2.1 The certified hygro-thermometer used to monitor the chamber shall be calibrated annually.

10.6.2.2 Maintenance of the environmental chamber should be in conjunction with the manufacturer's specifications.

10.6.3 Alternate Light Source (ALS)

Maintenance of the light source should be in conjunction with the manufacturer's specifications.

11 ABBREVIATIONS

The following is a list of abbreviations and acronyms commonly used by examiners in the Impression Section of the Latent Print Section. This list has been generated to assist in the interpretation of case file notes and is not a standardized list of required abbreviations. The abbreviations are appropriate written in either lower or upper case and they are appropriate with or without punctuation such as periods. Common chemical formulas, chemical, mathematical and shorthand abbreviations are equally acceptable and will not be listed here.

Agency Case Number	ACN
Alternate Light Source	ALS
Amido Black	AB
Aqueous Leuco Crystal Violet	LCV
Association of Class Characteristics	ACC
Bearing the Name	BTN
Black Powder	BP, blk. pdr.
Blind Verification	BV
Brown	Brn, BN
Central Laboratory	C or CL
Compared	Comp.
Comparison(s)	Comp(s)
Container	Cont./C
Crimescope	CS
Cyanoacrylate Ester	CA
1,8-Diazafluoren-9-one	DFO
Designated	Desig.
Developed	Dev.
Digital	Dig.
Digital Media	DM
Disposition	Dispo.
Elimination	Elim.
Envelope	Env.
Eastern Laboratory	T, EL
Evidence Receiving	ER
Excluded	Exc.
Facsimile	Fax
Fingerprint(s)	Fp(s), Fgpt.
Firearms Section	FX
Footwear	FW
Forensic Advantage, Case and Evidence	FACE
Forensic Biology Section	SX
Forensic Photographer	FP
Gentian Violet	GV
Environmental Chamber/Cabinet	HC
High Degree of Association	HDA
Identification	Ø, ID.
Impression(s)	Imp(s)

Inconclusive	Inc.
Indications of Non-association	INA
Latent Print Section	LX
Left	L
Leucocrystal Violet	LCV
Limited Association of Class Characteristics	LACC
Luma-Lite	LL
Magnetic	Mag.
Manila	Man.
Negative(s)	Neg(s)
Ninhydrin	Nin, NIN
No Value	NV
Northern Laboratory	N, NOVA
Of Value	OV
Oil Red O	ORO
Pattern Impression	PI
Physical Developer	PD
Pick-up	PU
Possible	Poss.
Present	Pres.
Previous	Prev.
Print(s)	Prt(s).
Processed	Proc.
Randomly Acquired Characteristics	RACs
Received	Rec.
Registered	Reg.
Remaining	Rem.
Reported	Rept'd.
Retained	Retn'd.
Returned	Ret'd.
Reverse	Rev.
Reverse position	Rev. pos.
Reverse color	Rev. col.
Right	R
Schallamach	SM
Sealed Brown Box	SBB
Sealed Envelope	SE
Sealed Manila Envelope	SME
Sealed paper bag	SPB
Sealed brown paper bag	SBPB
Sealed plastic bag	SPLB
Sealed White Box	SWBX
Sealed yellow envelope	SYE
See Other Photo	SOP
Separate	Sep

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Silver Nitrate	SN
Sticky Side Powder	SSP
Submitted	Sub.
Small Particle Reagent	SPR
Superglue	SG, Cyano
Suspect	S or Susp.
Tire Impression	TI
Tire Track	TT
Trace	TE
Victim	V or Vic.
Visible	Vis.
Wear	W
Western Laboratory	W

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